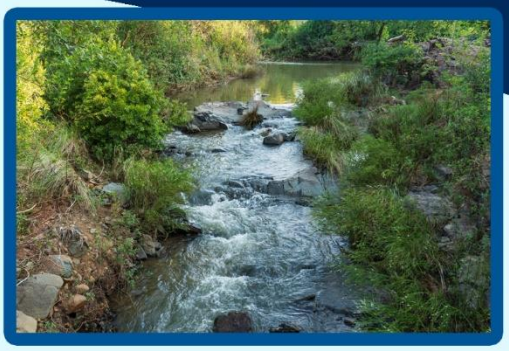
REHABILITATION MANAGEMENT GUIDELINES FOR WATER RESOURCES

GUIDELINES IN PRACTICE



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LIST OF ACRONYMS

AIS	Alien and Invasive Species
AIP	Alien and Invasive Plants
AMD	Acid Mine Drainage
AR	Artificial Recharge
ARC	Agricultural Research Council
C.A.P.E	Cape Action Plan for the Environment Estuaries
CARA	Conservation of Agricultural Resources Act 43 of 1983
CBD	Convention on Biodiversity
CFR	Cape Floristic Region
CMAs	Catchment Management Agencies
CMFs	Catchment Management Forums
CMS	Catchment Management Strategy
CPLUS	Climate Positive Use Strategy
CSA	Conservation South Africa
CSIR	Council for Scientific and Industrial Research
DALRRD	Department of Agriculture, Land Reform and Rural Development
DEA	Department of Environmental Affairs
DEA&DP	Department of Environmental Affairs and Development Planning
DEDEAT	Department of Economic Development, Environmental Affairs and Tourism
DFFE	Department of Forestry, Fisheries and Environment
DMRE	Department of Mineral Resources and Energy
DWS	Department of Water and Sanitation
ECF	eThekwini Conservancies Forum
ECPTA	Eastern Cape Parks and Tourism Agency
EFZ	Estuarine Functional Zone
EI	Ecological infrastructure
EIA	Environmental Impact Assessment
EIP	Environmental Implementation Plan
EMP	Environmental Management Plan
EMPr	Environmental Management Programme
EPWP	Expanded Public Works Programme
ERS	Environmental and Rural Solutions
EWR	Ecological Water Requirements
EWRP	eMalahleni Water Reclamation Plant
EWT	Endangered Wildlife Trust
FEN	Freshwater Ecosystem Network
FEPAs	Freshwater Ecosystem Priority Areas
FHI	Freshwater Health Index
GBF	Global Biodiversity Framework
GEF	Global Environmental Facility
GWW	Global Wetland Watch
HDRP	Hartbeespoort Dam Integrated Biological Remediation Programme
HGM	Hydrogeomorphic classification system
HiPRO	High Recovery Precipitating Reverse Osmosis
IAPs	Invasive Alien Plants
IWQMS	Integrated Water Quality Management
IWRM	Integrated Water Resource Management
KNP	Kruger National Park
MAR	Managed Aquifer Recharge
MDTP	Maloti Drakensberg Transfrontier Project
M & E	Monitoring and Evaluation
MMP	Maintenance Management Plan

MPA	Marine Protected Area
MPRDA	Mineral and Petroleum Resources Development Act 28 of 2002
MSA	Municipal Systems Act 32 of 2000
NBA	National Biodiversity Assessment
NBF	National Biodiversity Framework
NBSAP	National Biodiversity Strategy and Action Plan
NCS	Natural Climate Solutions
n.d.	Not dated
NDP	National Development Plan
NECSA	Nuclear Energy Corporation of South Africa
NEPAD	New Partnership for Africa's Development
NFEPAs	National Freshwater Ecosystem Priority Areas
NGOs	Non-Governmental Organisations
NPAES	National Protected Areas Expansion Strategy
NEMA	National Environmental Management Act 107 of 1998
NEM: BA	National Environmental Management: Biodiversity Act 10 of 2004
NEM: PAA	National Environmental Management: Protected Areas Act 57 of 2003
NEM: WA	National Environmental Management: Waste Act 59 of 2008
NRM	Natural Resource Management
NWA	National Water Act 36 of 1998
NWMF	National Wetland Management Framework
NWP	National Wetland Policy
NWMS	National Waste Management Strategy
NWRS	National Water Resource Strategy
NW&SMP	National Water and Sanitation Master Plan
PNE	Protected Natural Environment
RMGs	Rehabilitation Management Guidelines
SADC	Southern African Development Community
SAIAB	South African Institute of Aquatic Biodiversity
SAHRA	South African Heritage Resources Agency
SANBI	South African National Biodiversity Institute
SANCO	South African National Civic Organisation
SANParks	South African National Parks
SAWS	South African Wetland Society
SER	Society of Ecological Restoration
SWC	Sustaining the Wild Coast
SWSAs	Strategic Water Sources Areas
SDGs	Sustainable Development Goals
SDS	Sources Directed Studies
SPLUMA	Spatial Planning and Land Use Management Act 16 of 2013
TNC	The Nature Conservancy
VRESAP	Vaal River Eastern Sub-system Augmentation Project
UCP	Umzimvubu Catchment Partnership
UEIP	uMngeni Ecological Infrastructure Partnership
UN	United Nation
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
UWC	University of Western Cape
WCETT	Western Cape Estuaries Task Team
WCT	Wildlands Conservation Trust
WDCS	Waste Discharge Charge System
WESSA	Wildlife and Environment Society of South Africa
WfW	Working for Water
WfWet	Working for Wetlands

WRC	Water Research Commission
WSA	Water Services Act 108 of 1997
WTG	Wetland Task Group
WULs	Water Use Licences
WWF	Worldwide Fund for Nature
WWTWs	Wastewater Treatment Works

GLOSSARY OF TERMS

An **aquifer** is a geological formation which has structures or textures that hold water or permit appreciable water movement through them.

Aquifer state means a state in whose territory any part of a transboundary aquifer or aquifer system is situated.

Artificial wetlands also known as **constructed wetlands** are engineered systems designed to utilise natural processes involving wetland vegetation, soils, and their associated microbial assemblages to treat contaminated water or to enhance ecology, ecological class, aesthetics, recreation, land use, land value or landscape design. These are tailored to meet specific regulatory and site-specific requirements and can be designed in several configurations depending on the treatment or other goals.

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.

Catchment Management Agencies (CMAs) are institutions to which the Minister acting through the Department of Water and Sanitation delegates water resource management to the regional or catchment level. The CMAs have governing boards, which are appointed by the Minister. These boards represent all stakeholders (including current and potential user groups) and their interests in the Water Management Areas (WMAs) (also refer to the definition of WMAs).

Catchment Management Area is an area established as a management unit in the National Water Resource Strategy within which a catchment management agency will conduct the Protection, Use, Development, Conservation, Management and Control of water resources.

The **Catchment Management Strategy** sets principles for allocating water to existing and new water users. It provides the framework for managing water resources within the water management area to ensure that water resources in the water management area are protected, used, developed, conserved, managed and controlled.

Freshwater ecosystems refer to all inland water bodies, whether fresh or saline, including rivers, lakes, wetlands, sub-surface waters and estuaries.

The **Estuary Functional Zone (EFZ)** is an area that not only covers the estuary water body but also areas that support physical and biological processes and habitats necessary for estuarine function and condition. The latter includes areas influenced by long-term estuarine sedimentary processes (*i.e.,* sediment stored or eroded during floods), changes in channel configuration, aeolian transport processes, and changes due to coastal storms. The EFZ also encompasses floodplain ecotones and estuarine vegetation (salt marshes, mangroves etc.) that contribute detritus to the base of the estuarine food chain and provides refuge to estuarine biota during high flow events from strong currents.

Groundwater is water found in the subsurface in the saturated zone below the water table or contained in an aquifer (also refer to the definition of an aquifer).

Ecological Infrastructure (EI) refers to naturally functioning ecosystems that generate or deliver valuable services to people and the economy. It complements built or hard infrastructure and is just as important for providing services and underpinning development, and provides services such as fresh water, climate regulation, soil formation and disaster risk reduction

Ecological Water Requirements (EWRs) are 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 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 considers 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.

Artificial Recharge or Managed Aquifer Recharge 'artificial' does not capture the process of humans enhancing natural recharge in a systematic manner. These deficiencies in the term "Artificial Recharge" have been overcome by the now generally accepted term "Managed Aquifer Recharge**"** which is a practice of increasing the amount of water that enters an aquifer through human-controlled means.

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

Monitoring refers to 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.

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.

Rehabilitation is the process of improvement or restoring impacted areas or resources to resemble the closest achievable approximation of its pre-impact state.

Resources Directed Measures (RDM) are a set of guidelines for water resources (it focuses on quantity and quality) 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, 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 (RWQOs) are the water quality component of the Resource Quality Objective. These 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.

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.

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 refers to 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.

Water Management Areas (WMAs) are areas established as management units in the national water resource strategy within which a catchment management agency will conduct the protection, use, development, conservation, management and control of water resources.

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EXECUTIVE SUMMARY

Healthy freshwater ecosystems provide humans with critical ecosystem services and bolster resilience against the impacts of climate change. However, when these ecosystems are degraded, biodiversity is reduced, ecological functions are impaired, and critical ecosystem services are compromised, increasing vulnerability to climate change. In South Africa, freshwater ecosystem degradation is prevalent due to declining water quality caused by rising pollution from various industries, including inadequate sewage treatment. The ever-increasing population, industrialisation, urbanisation, over-utilisation of natural resources, land degradation and climate change are amongst other impacts associated with the deterioration of freshwater ecosystems.

In response to the degradation of freshwater ecosystems caused by, amongst others, altered flows, alien and invasive plants (AIP) and animal species, wetland draining and pollution leading to degraded freshwater rivers, riparian and wetland ecosystems, the Rehabilitation[1] Management Guidelines (RMGs) for Water Resources were developed to address the impacts associated with water resource quality degradation to ensure the maintenance of healthy water ecosystems. The RMGs for water resources were developed based on their interactions with characteristics of watercourses, namely, hydrology (surface flow and interflow), geomorphology, water quality, habitat, biota, and groundwater flow. These guidelines followed a phased approach encompassing diagnostic, planning and assessment, rehabilitation objective setting, execution, monitoring, evaluation and reporting. The RMGs were also aimed at integrating, aligning, and harmonising rehabilitation work across various disciplines and institutions.

Thus, the current RMGs in Practice Report is underpinned by the RMGs developed for water resources (*i.e.,* rivers, wetlands, estuaries, lakes and dams as well as groundwater). This report aims to demonstrate the practical application of RMGs by showcasing rehabilitation initiatives , ongoing or completed at the catchment level. It highlights efforts by various authorities and organisations and assesses their real -world effectiveness.

[1] ***Rehabilitation*** *is the process of improvement or restoring impacted areas or resources to resemble the closest achievable approximation to natural conditions.*

1. INTRODUCTION

1.1 BACKGROUND

The freshwater ecosystems of South Africa are remarkably diverse, encompassing all inland water bodies, fresh or saline. This includes rivers, wetlands, estuaries, lakes, dams, and groundwater. Healthy rivers, wetlands, and groundwater systems maintain water supply and buffer the effects of storm events, reducing the loss of life and damage to property due to floods. Riverbanks with natural vegetation trap sediments, stabilise riverbanks and break down pollutants draining from the surrounding land (WRC, 2011). On the other hand, estuaries provide nursery areas for marine and estuarine animals, and supply fresh water and nutrients to the sea, which drive marine food webs and maintain important fisheries (Lamberth *et al.,* 2009). Concerningly, global trends indicate high levels of threat to freshwater ecosystems. The National Biodiversity Assessment (NBA) revealed that more than half of South African rivers, wetlands and estuary ecosystem types are threatened (SANBI, 2019). These threats arise from water demand that outstrips supply, and declining water quality due to increased pollution from industries, urban expansion, mining, power generation, agriculture, forestry, and inadequate sewage treatment.

The Department of Water and Sanitation (DWS), the custodian of water resources in South Africa is mandated in terms of Chapter 3 of the National Water Act (NWA) (Act 36 of 1998) to ensure the protection, use, conservation, and management of water resources in an efficient, sustainable, and equitable manner. The development and use of water resources (and ecosystems within them) must not exceed the threshold beyond which their integrity is jeopardised. The sensitive and vulnerable water resources require specific attention in management and planning procedures, especially when subjected to significant human use and development pressures.

To realise and achieve the above-mentioned goals of the NWA, the Rehabilitation Management Guidelines (RMGs) were developed to give effect to broader DWS strategic objectives and actions contained in the National Water and Sanitation Master Plan (NW&SMP) that requires protection and maintenance of existing freshwater ecosystem priority areas to ensure that they are in good functional condition by managing riparian zones, wetland buffers, critical groundwater recharge areas and carrying out rehabilitation of strategic water ecosystems such as rivers, wetlands, estuaries, lakes, dams, and groundwater resources.

The RMGs for water resources are an in-house project initiated by the DWS in 2020 to address the impacts associated with water resource quality degradation to ensure the maintenance of healthy water ecosystems. The project drew from existing rehabilitation work completed to date in South Africa. The major focus of the developed RMGs was to integrate, align, and harmonise efforts across different projects, programmes, and initiatives given the separate mandates and various institutions responsible for rehabilitation work. The RMGs for water resources were developed in terms of their interactions with characteristics of watercourses, namely, hydrology (surface flow and interflow), geomorphology, water quality, habitat, biota, and groundwater flows. This was achieved through a phased approach including, diagnostic, planning and assessment, setting of the rehabilitation objectives, execution, monitoring, evaluation and reporting phases. In addition, the following aspects were covered under each characteristic of the watercourse:

- Description of the specific characteristics of watercourses;

- Types of impacts for each characteristic of the watercourse – a brief overview and description of the impacts that give 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.

1.2 PURPOSE OF REHABILITATION MANAGEMENT GUIDELINES IN PRACTICE

The current RMGs in Practice report is the culmination of the developed RMGs for water resources, which include, Rivers (Volume 1), Wetlands (Volume 2), Estuaries (Volume 3), Lakes and Dams (Volume 4) and Groundwater (Volume 5) and is aimed at serving as a valuable tool to demonstrate to intended users how the guidelines can be applied in real-world situations. Thus, the RMGs in Practice report serves as a guide by presenting a comprehensive account of rehabilitation initiatives, either ongoing or completed undertaken by various authorities, organisations, institutions and demonstrating their applicability in real-world situations.

1.3 INTENDED USERS OF THE REPORT

The RMGs in Practice Report, underpinned by the developed RMGs for water resources, serves as a valuable guide for various stakeholders involved in water resource management, including Government Departments (National, Provincial, and Local), Catchment Management Agencies (CMAs), sectoral institutions such as higher education institutions, civil society members, non-governmental organisations, private sector entities (including agriculture, industries, and mining) and all other interested and affected parties involved in the water sector. This report aims to clarify how the RMGs can be effectively applied ensuring that all stakeholders have the necessary information to implement these guidelines in real-world situations.

1.4 STRUCTURE OF THE REPORT

The report is divided into five 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 on the development of RMGs for water resources, the purpose of developing the RMGs in Practice report, the intended users of the report and the structure of the report.
- **Section 2** provides the linkages between the RMGs in Practice and broader objectives.
- **Section 3** provides a comprehensive account of rehabilitation objectives undertaken by various authorities, organisations, institutions and subsequent application in real-world situations.
- **Sections 4** and **5** provide a conclusion and a way forward.

2. ALIGNMENT WITH BROADER OBJECTIVES

2.1 INTERNATIONAL OBLIGATIONS

2.1.1 Sustainable Development Goals

South Africa is a signatory to various international environmental agreements between member states in a bid to ensure sustainable environmental management. The Sustainable Development Goals (SDGs) represent a global partnership and a call to action that is aimed at eradicating poverty, improving health and education, reducing inequality, stimulating economic growth, and tackling climate change challenges. The SDGs were presented for the first time by the United Nations in 2015 and comprise 17 Global Goals aimed to improve the world we live in by 2030. **Goals 6** and **15** are particularly pertinent, as they are directly linked to water resource protection and management as follows (Stats SA, 2023; DWS, 2023b):

- **Goal 6** - ensure the availability and sustainable management of water and sanitation for all. **Target 6.6** explicitly highlights the protection and rehabilitation of water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, estuaries and lakes. This target acknowledges that conserving pristine wetland ecosystems and rehabilitating degraded wetlands would safeguard current water resources and further enhance the quality and quantity of water available for all if achieved. The target indicators for SDG Target 6.6 are as follows:
  - Indicator 6.6.1D(1): change in the spatial extent of water-related ecosystems over time, including wetlands, reservoirs, lakes, and estuaries as a percentage of total land area;
  - Indicator 6.6.1D(2): number of systems affected by high trophic and turbidity states;
  - Indicator 6.6.1D(3): change in the national discharge of rivers and estuaries over time; and
  - Indicator 6.6.1A(1): change in the ecological condition of rivers, estuaries, lakes, and wetlands.
- **Goal 15** - protect, rehabilitate and promote the sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and biodiversity loss.

The SDGs in general also recognise the need for rehabilitation and management of water-related ecosystems (including wetlands) as a basis for addressing water scarcity and risks, as well as addressing several key challenges related to food security and climate change.

2.1.2 Global Biodiversity Framework

Biodiversity is of importance to human well-being, a healthy planet, and economic prosperity for all people, including a balance and harmony with Mother Nature. Humans depend on biodiversity for food, medicine, energy, clean air and water, security from natural disasters, recreation, and cultural inspiration. The Kunming-Montreal Global Biodiversity Framework (GBF) seeks to respond to the Global Assessment Report of Biodiversity and Ecosystem Services issued by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. The GBF has 23 action-oriented global targets for urgent action over the decade to 2030, and the most pertinent targets linked directly to water resource protection and management include **Targets 2, 6, 8,** and **11** as follows (GBF, 2022):

- **Target 2** - ensure that by 2030, at least 30 per cent of areas of degraded terrestrial, inland water and marine and coastal ecosystems are under effective rehabilitation to enhance biodiversity and ecosystem functions and services, ecological integrity, and connectivity.

- **Targets 6** - eliminate, minimise, reduce, and/or mitigate the impacts of alien and invasive species (AIS) on biodiversity and ecosystem services by identifying and managing:
  - pathways of the introduction of alien species;
  - preventing the introduction and establishment of priority AIS
  - reducing the rates of introduction and establishment of other known or potential AIS by at least 50 per cent by 2030; and
  - eradicating or controlling AIS, especially in priority sites, such as islands.
- **Target 8** - minimise the impact of climate change and ocean acidification on biodiversity and increase its resilience through mitigation, adaptation, and disaster risk reduction actions, including through nature-based solutions and/or ecosystem-based approaches, while minimising negative and fostering positive impacts of climate action on biodiversity; and
- **Target 11** - restore, maintain and enhance nature's contributions to people, including ecosystem functions and services, such as the regulation of air, water and climate, soil health, pollination and reduction of disease risk, as well as protection from natural hazards and disasters, through nature-based solutions and/or ecosystem-based approaches for the benefit of all people and nature.

2.1.3 Convention on Biological Biodiversity

The Convention on Biological Biodiversity (CBD) was first adopted at the 1992 Earth Summit in Rio de Janeiro and encouraged co-operation between governmental authorities and the private sector in developing methods for sustainable uses of biological resources. The imperatives of the convention can be realised through measures aimed at the conservation and effective management of ecosystems. The three main objectives of the CBD are to conserve biological diversity, to ensure sustainable use of the components of biological diversity and the fair and to ensure equitable sharing of the benefits arising out of the utilisation of genetic resources. The CBD (1992) call on contracting Parties, of which South Africa became a member in 1996, to do the following:

- Rehabilitate and restore degraded ecosystems and promote the recovery of threatened species through the development and implementation of plans or other management strategies;
- Prevent the introduction of alien species, including the control or eradication of alien species that threaten ecosystems and habitats; and
- Adopt measures for the recovery and rehabilitation of threatened species for their re-introduction into their natural habitats under appropriate conditions.

2.1.4 United Nations Framework Convention on Climate Change

The objective of the United Nations Framework Convention on Climate Change (UNFCCC) is to stabilise greenhouse gas concentrations at a level that would prevent hazardous anthropogenic interference with the climate system. The UNFCCC moderates Reducing Emissions from Deforestation and Forest Degradation (REDD+)[2], which is a process that supports countries' efforts to reduce emissions from deforestation and forest degradation, foster conservation, sustain the management of forests, and enhance forest carbon stocks. Thus, the Convention of Climate Change (1992) calls on all parties,

[2] ***REDD+*** *is framework developed under the United Nations Framework Convention on Climate Change (UNFCCC) that aims to reduce climate change by protecting forests, promoting conservation, sustainable forest management, and enhancing forest carbon stocks.*

considering their common but differentiated responsibilities and their specific national and regional development priorities, objectives, and circumstances, to:

- Promote sustainable management, cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gases not controlled by the Montreal Protocol, including biomass, forests, and oceans, as well as other terrestrial, coastal, and marine ecosystems;
- Cooperate in preparing for adaptation to the impacts of climate change; and
- Develop and elaborate appropriate and integrated plans for coastal zone management, water resources and agriculture, as well as the protection and rehabilitation of areas, particularly in Africa, affected by drought and desertification, as well as floods.

2.1.5 United Nations Convention to Combat Desertification

The objective of the United Nations Convention to Combat Desertification (UNCCD), adopted in Paris in 1994 and came into effect in 1996, is to combat desertification and mitigate the effects of drought in countries experiencing severe drought and/or desertification, particularly in Africa. This can be achieved through implementing effective action at all levels, supported by international cooperation and partnership arrangements, in the framework of an integrated approach which is consistent with Agenda 21, contributing to the achievement of sustainable development in affected areas. The UNCCD [not dated (n.d.)] calls on all parties to:

- Establish strategies and priorities, within the framework of sustainable development plans and/or policies, to combat desertification and mitigate the effects of drought;
- Involve long-term integrated strategies that focus on improved productivity of land and the rehabilitation, conservation and sustainable management of land and water resources, leading to improved living conditions at the community level; and
- Develop, in a spirit of partnership, co-operation among all levels of government, communities, non-governmental organisations and landholders to establish a better understanding of the nature and value of land, as well as scarce water resources.

2.1.6 Ramsar Convention

The Ramsar Convention on Wetlands is an intergovernmental treaty whose mission is the conservation and wise use of all wetlands through local, regional, and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world. This convention was developed to call international attention to the rate at which wetland habitats were disappearing, in part due to a lack of understanding of their crucial functions, values, goods and services.

The commitments of parties joining the Ramsar Convention (Ramsar Convention on Wetlands, 2016) include the following:

- **List sites** - designate at least one wetland at the time for inclusion in the list of wetlands of international importance (*i.e.,* the Ramsar List) and to promote their conservation;
- **Wise use** - formulate and implement the planning of important wetlands to promote as far as possible their wise use;
- **Reserve and training** - establish nature reserves in wetlands that are internationally important and included in the Ramsar List. This also includes the promotion of training in the fields of wetland research and wetland management;

- **International cooperation** - consult with other contracting parties on the implementation of the convention, especially regarding transboundary wetlands, shared water systems, and shared species, including the establishment of wetland rehabilitation projects; and
- **Compliance with the commitments** - the Ramsar Convention is not a regulatory regime and has no punitive sanctions for violations of defaulting upon treaty commitments - its terms do, however, constitute a solemn treaty and are binding in international law in that sense.

2.1.7 United Nations Educational, Scientific and Cultural Organisation

In October 2022, the United Nations Educational, Scientific and Cultural Organisation (UNESCO) identified several key resolutions, including the adoption of a resolution on groundwater by South Africa. South Africa, through its Permanent Delegation to UNESCO and the DWS, led the drafting of a resolution on groundwater, which was tabled at the 215th Session of the Executive Board. The resolution aimed to raise the international profile of groundwater and its importance, particularly in the context of climate change mitigation strategies. Groundwater resolutions **12(a)** and **12(e)** are pertinent to groundwater resource protection and management and call upon Member States, international organisations, academic institutions, the donor community, professional organisations and other relevant stakeholders, to (UNESCO, 2022):

- Contribute to the development and adoption of measures and initiatives for groundwater studies, aquifer assessment, monitoring and research, data collection and the dissemination of available information at the local, regional and global level, as appropriate; and
- Work towards the establishment of improved integrated and sustainable management and governance of local and transboundary groundwater resources, where applicable, to preserve natural resources and achieve the SDGs.

Articles **6** and **12** of the Law on Transboundary Aquifers listed in **Table 1** below, submitted to the General Assembly as a part of the Commission's report, promote co-governance mechanisms between countries in the effort to prevent, reduce and control pollution of aquifers.

Table 1: Articles 6 and 12 of the Law on Transboundary Aquifers
Source: United Nations, 2008

Article	Description
Article 6: Obligation not to cause significant harm	• Aquifer states shall, in utilising transboundary aquifers or aquifer systems in their territories, take all appropriate measures to prevent the causing of significant harm to other aquifer states or other states in whose territory a discharge zone is located. • Aquifer states shall, in undertaking activities other than utilisation of a transboundary aquifer or aquifer system that have, or are likely to have, an impact upon that transboundary aquifer or aquifer system, take all appropriate measures to prevent the causing of significant harm through that aquifer or aquifer system to other aquifer states or other states in whose territory a discharge zone is located. • Where significant harm nevertheless is caused to another aquifer state or a state in whose territory a discharge zone is located, the aquifer state whose activities cause such harm shall take, in consultation with the affected state, all appropriate response measures to eliminate or mitigate such harm, having due regard for the provisions of draft article 4 related to equitable and reasonable utilisation and article 5, which details the factors relevant to equitable and reasonable utilisation.

Article	Description
Article 12: Prevention, reduction and control of pollution	• Aquifer states shall, individually and, where appropriate, jointly, prevent, reduce and control pollution of their transboundary aquifers or aquifer systems, including through the recharge process, that may cause significant harm to other aquifer states. Aquifer states shall take a precautionary approach in view of uncertainty about the nature and extent of a transboundary aquifer or aquifer system and of its vulnerability to pollution.

2.2 EXECUTIVE PLANS AND FRAMEWORKS

Various policies, strategies and guidelines that inform the rehabilitation management of water resources in South Africa are detailed in this section.

2.2.1 National Development Plan

The National Development Plan (NDP) is a plan for the country to eliminate poverty and reduce inequality by 2030 through uniting South Africans, unleashing the energies of its citizens, growing an inclusive economy, building capabilities, enhancing the capability of the state and leaders working together to solve complex problems. This plan envisions a South Africa where everyone feels free yet bounded to others; where everyone embraces their full potential, and a country where opportunity is determined not by birth, but by ability, education, and hard work.

Realising such a society would require a transformation of the economy and focused efforts to build the country's capabilities. To eliminate poverty and reduce inequality, the economy must grow faster and in ways that benefit all South Africans. **Chapter 5** of the NDP promotes environmental sustainability and resilience, with **Objective 2** prioritising to put in place a regulatory framework for land use, to ensure the conservation and rehabilitation of protected areas (NPC, 2012).

2.2.2 National Water Resource Strategy (Edition 3)

The National Water Management Strategy (NWRS) is a statutory strategy, required in terms of the NWA 36 of 1998 and binding on all authorities and institutions implementing the act (DWS, 2023a). The NWRS sets out a strategic direction for water resources management in South Africa with a particular focus on priorities and objectives for the period of 2023 – 2030. It provides the framework to ensure that water resources at a regional or catchment level and within defined water management areas are protected, used, developed, conserved, managed, and controlled sustainably and equitably. It further calls for the development of government policies and strategies for proactive measures to mitigate water resource quality degradation and address legacy deterioration while maintaining healthy water ecosystems (*i.e.,* rivers, wetlands, estuaries, lakes, dams, and groundwater) to ensure their continued provision of ecosystem services.

The NWRS (DWS, 2023a) highlights strategic actions that directly address rivers, wetlands, estuaries, and groundwater management and includes the following:

- The DWS and CMAs should work with the national and provincial departments of agriculture to ensure the implementation of the Conservation of Agricultural Resources Act (CARA) (43 of 1983) to protect riparian and wetland buffer zones, critical groundwater recharge areas, and estuaries;
- Prioritisation of pollution prevention, treatment, and rehabilitation of polluted water bodies;
- Proactive management and rehabilitation of water resources such as mountain catchments, rivers, wetlands, aquifers, and estuaries;

- Incorporate Freshwater Ecosystem Priority Areas (FEPAs) into planning and decision-making processes that impact aquatic ecosystems;
- Strengthening collaboration around managing and conserving water ecosystems between key government departments; and
- Support the sustainable use of aquatic ecosystems for sustainable livelihoods in poor rural communities.

2.2.3 National Water and Sanitation Master Plan

The National Water and Sanitation Master Plan (NW&SMP) (DWS, 2018a,b) constitutes the roll-out mechanism for the NWRS implementation and specifies, *inter alia*, priority budget items, scheduled up to 2030 and beyond, for the entire water sector. The NW&SMP prioritises the protection and rehabilitation of ecological infrastructure to maintain water ecosystems. **Strategic Objective 5.3** of the NW&SMP requires the protection and maintenance of existing freshwater ecosystem priority areas in good functional condition by managing riparian zones, wetland buffers, and critical groundwater recharge areas and conducting rehabilitation of strategic water ecosystems. The NW&SMP also focuses on maintaining and improving water quality through the implementation of the Waste Discharge Charge System, which is critical to increasing the funding available for the management and rehabilitation of polluted catchments, including the incentivisation for the reduction of pollution. In addition, the NW&SMP priorities for the future implementation of the polluter-pays principle and rehabilitation of water quality impacts, including the acid mine drainage for long-term actions and the need to develop rehabilitation systems.

2.2.4 Integrated Water Quality Management Policy and Strategy

The Integrated Water Quality Management (IWQM) Policies and Strategies (DWS, 2016a; 2017; 2023c) were developed to establish the status quo for water quality, its management practices and instruments, the challenges in South Africa and the institutional arrangements. A review of existing policies, strategies, and other relevant documents, both locally and internationally was used to: **i)** analyse the root cause of the water quality issues; **ii)** determine the gaps in the IWQM approaches that have been used; **iii)** understand impacts that emerging trends may have on water quality (*e.g.*, climate change, unconventional gas exploration, amongst others); and iv) look for innovative practices for IWQM. **Principle 10** of the IWQM promotes green/ecological infrastructure restoration, including rehabilitation and restoration of degraded catchments. However, the IWQM also note that the costs associated with rehabilitation of degraded water resources, or of emergency responses to pollution incidents can be extremely high.

2.2.5 Draft National Wetland Policy

The adoption and implementation of national wetland policies by contracting parties has emerged as a high priority for Ramsar, and much effort has been invested by the Convention to encourage the establishment of such policy frameworks at national and subnational levels. South Africa opted not to develop a stand-alone wetland policy, but to incorporate objectives relating to wetland conservation and wise use into relevant sectoral policies, including those covering the environment, agriculture, biodiversity, and water (Dini and Everard, 2016). The development of the National Wetland Policy (NWP) would entail using the information gathered and priorities identified in the National Wetland Management Framework (NWMF) as a basis for developing clear policy principles that would serve to further guide wetland management actions in South Africa (DFFE, 2021d). During this phase of the development of the NWP, it would be important to further clarify the roles and responsibilities of supporting institutions (DWS, 2021d).

The NWP aims to jointly coordinate the fragmented mandates and approaches for the effective implementation of wetland protection, management, and conservation by three key national government departments, namely the Department of Forestry, Fisheries and the Environment (DFFE), DWS and the Department of Agriculture, Land Reform and Rural Development (DALRRD) (DFFE, 2021d). **Figure 1** illustrates **Phase 2** of the NWP in which a draft policy and implementation plan were developed. **Phase 2A** involved the review of selected international literature to benchmark and learn from experiences (*i.e.,* to better understand wetland impacts and management challenges to inform policy direction) that provide a sound basis against which to pursue further wetland policy development. At the time the NWMF (2021d) was published, it was reported that the NWP would be gazetted by the year 2023.

The NWMF serves as a step towards the development of a joint NWP for South Africa (DFFE, 2021d).

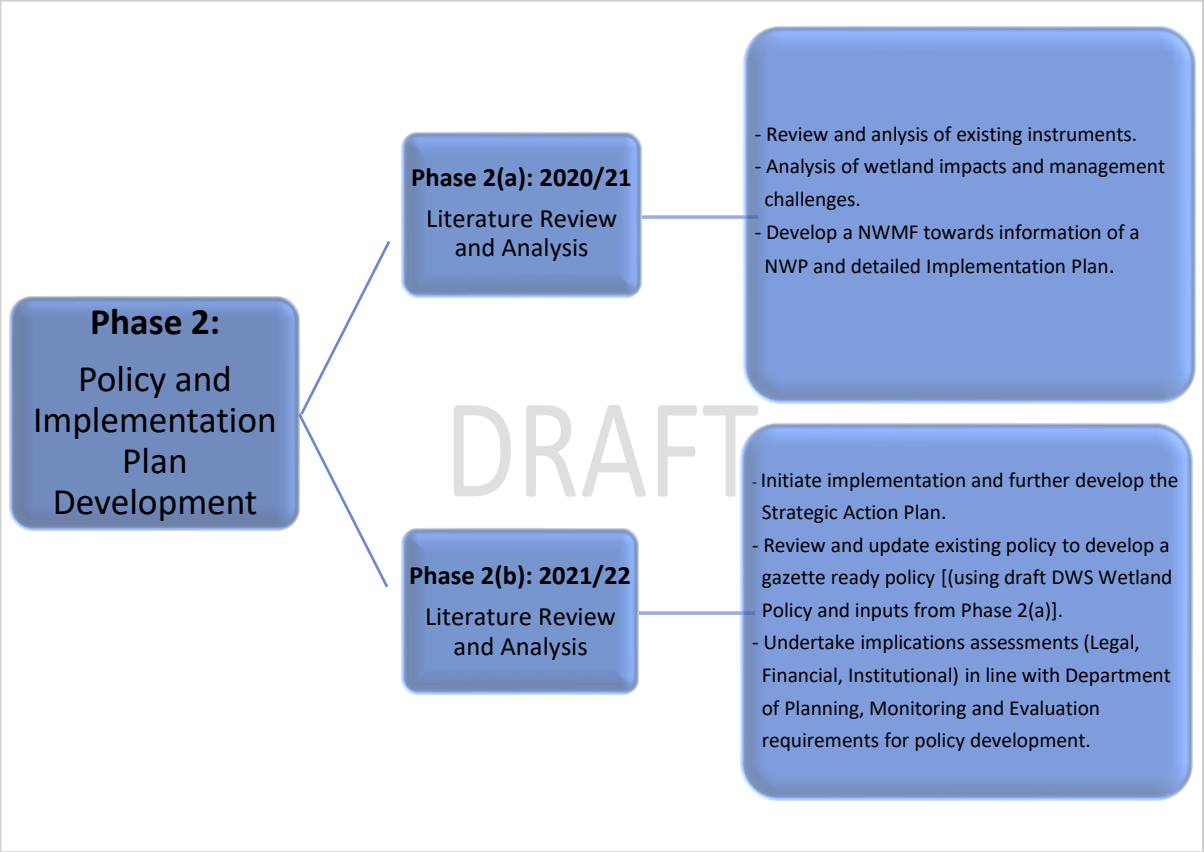

Figure 1: Overview of the different phases involved in the project development of the NWP
Source: modified after DFFE, 2021c

2.2.6 National Wetland Management Framework

The project to develop the NWMF was initiated in September 2020 with the appointment of Eco-Pulse Environmental Consulting Services in partnership with the DWS, DFFE and DALRRD. The development of the NWMF followed a step-by-step approach including a series of national stakeholder consultations for clarification of the scope and purpose of the project (DFFE, 2021c; DFFE, 2021d). The NWMF was developed principally to strengthen alignment and coordination at a national level as a basis for stimulating and guiding wetland management actions (DFFE, 2021d). The purpose of the NWMF is to provide guidance and assistance with the conservation, preservation, and management of wetlands at a national level for implementation at provincial and local levels (DFFE, 2021d). The vision and mission of the NWMF is to ensure that wetlands in South Africa are recognised, prioritised,

adaptively managed, protected, sustainably used, and restored through collaborative efforts between and/or amongst relevant and responsible authorities, organisations, or institutions (DFFE, 2021d).

It is foreseen that the progress in implementing the NWMF will be monitored and evaluated annually. The NWMF will further be reviewed every three years to reflect on the progress made and lessons learnt and to identify new and emerging issues that need to be addressed (DFFE, 2021d). It is recommended that a National Wetland Committee be established to ensure and monitor the implementation and review of the NWMF (DFFE, 2021d).

The following recommendations are made to achieve the aspirations outlined in the NWMF (DFFE, 2021d):

- Appropriate capacity and financial commitments to implement key actions identified;
- A review of financial requirements should be undertaken by key departments *(i.e.,* DFFE, DWS and DALRRD), and resources should be targeted to support effective implementation;
- Designation of wetland champions in each department and the establishment of a National Wetland Management Committee to oversee the implementation of the NWMF. This could be achieved through the reconstitution of the existing Wetland Task Team. Once established, it is suggested that task teams or working groups be established to lead, refine and report back on various priority activities;
- The implementation of the NWMF should be championed at a national level, with the intention for lower levels of government to actively support its implementation of the NWMF. For this to be realised, it is anticipated that the national departments would facilitate a process to integrate the strategic framework into plans at regional and local levels; and
- Advocacy and outreach activities are necessary to promote the uptake of the NWMF by a broader stakeholder group, which, amongst others, includes Provincial Conservation Agencies, Municipalities, Non-Governmental Organisations (NGOs), Business Sectors, Learning and Academic Institutions and Civil Society.

2.2.7 National Biodiversity Strategy and Action Plan

The National Biodiversity Strategy and Action Plan (NBSAP) was developed for the DFFE and funded by the United Nations Development Programme (UNDP). The NBSAP is a requirement of contracting parties to the CBD. It sets out a strategy and plan for contracting parties to fulfil the objectives of the Convention. It identifies the priorities for biodiversity management in South Africa, aligning these with the priorities and targets in the global agenda, and national development imperatives. **Strategic Objective 2.1** of the NBSAP requires the mapping and prioritisation of ecological infrastructure and such prioritisation should guide the planning of investments in ecological infrastructure, such as through the Natural Resource Management (NRM) programmes, and efforts to scale up rehabilitation and maintenance of ecological infrastructure (DEA, 2015). It should also guide efforts to secure ecological infrastructure, such as Strategic Water Source Areas (SWSAs) or important marine ecological infrastructure that are best managed under appropriate legal protection.

2.2.8 National Freshwater Ecosystem Priority Areas

South Africa's freshwater ecosystems are diverse and refer to all inland water bodies, whether fresh or saline, including rivers, lakes, wetlands, sub-surface waters and estuaries. The National Freshwater Ecosystem Priority Areas (NFEPAs) project was a three-year partnership project between the South African National Biodiversity Institute (SANBI), Council for Scientific and Industrial Research (CSIR), Water Research Commission (WRC), DFFE, DWS, Worldwide Fund for Nature (WWF), South African

Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). The project responded to the urgent need to ensure the conservation of some natural examples of the different ecosystems that make up the natural heritage of this country for current and future generations. The project also provided strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting the sustainable use of water resources.

The NFEPA products, such as maps and supporting information, form part of a comprehensive approach to the sustainable and equitable development of South Africa's scarce water resources. For integrated water resources planning, the NFEPA guides 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 NWA (Act 36 of 1998) and for biodiversity resilience and persistence (WRC, 2011).

2.2.9 National Biodiversity Assessment

The National Biodiversity Assessment (NBA) is the main tool used to monitor and report on the current condition of biodiversity in South Africa and thus, forms the empirical evidence upon which existing policies and strategic objectives are based and informs current and future activities aimed at improving the management and conservation of biological resources (SANBI, 2019). The results of the NBA feed into the NBSAP, the National Biodiversity Framework (NBF) and the National Protected Areas Expansion Strategy (NPAES), among others, which include the National Spatial Development Framework, the NW&SMP and the National Biodiversity Economy Strategy. The NBA acknowledges the following (SANBI, 2019):

- The ecological infrastructure of rivers, inland wetlands and their catchment areas complements built infrastructure (such as dams) for the sustainable delivery of water to people. Catchment-level water resource planning and management are crucial to ensure that the diversity, functionality, and connectivity of ecological infrastructure are managed and maintained;
- The SWSAs are areas in the landscape that supply a disproportionate quantity of water to their size and/or have high groundwater recharge. These nationally critical areas provide freshwater for downstream urban areas. Protection and rehabilitation, particularly the management of invasive plants, should be prioritised in the SWSAs; and
- The protection and rehabilitation of estuaries through the implementation of Ecological Water Requirements (EWR) and protecting the Estuarine Functional Zone (EFZ) and its structural habitat from poorly planned coastal development is critical for maintaining resilience and enhancing future estuary benefits.

2.2.10 National Groundwater Strategy

The National Groundwater Strategy (NGS) of 2016 is a detailed review of the strategy of 2010 subdivided into chapters with each consisting of current groundwater challenges and recommended actions. The NGS aims to improve the recognition of the strategic value, use and protection of groundwater as provided for by the NWA (Act 36 of 1998). The following strategic actions from Theme 9 on Groundwater Resource Planning and Development of the NGS are pertinent to the current project (DWS, 2016):

- The development of regional and sub-regional information on areas expected to be most affected by drought, with plans for monitoring and targeting drought-proofing measures

during and ahead of droughts (e.g. rehabilitation of groundwater supply infrastructure and well deepening); and

- Conduct groundwater resource assessment and development programmes (including the rehabilitation of existing water supply boreholes) for towns threatened by surface water shortages as water needs increase.

3. REHABILITATION MANAGEMENT GUIDELINES IN PRACTICE

3.1 OVERVIEW

Policy implementation has been a great challenge for governments across all public sectors since 1994 (von Holdt, 2010). Three processes are reported to be the contributing factors, namely, political transition, state transformation and administrative restructuring linked to new mandates, missions, and policies under the new dispensation (Bourblanc, 2017). The combination of these factors results in massive disorganisation within public administrations (Bourblanc, 2017). There is, and would continue to be, a notable change in the institutional arrangements, water governance and organisational responsibilities within the South African water sector. Clarity in areas around defined roles and responsibilities is critical for effective management and decision-making concerning water resources and their quality. This section of the report, therefore, focuses on roles and responsibilities as well as initiatives in the rehabilitation and management of water resources.

3.2 RELEVANT AUTHORITIES AND THEIR ROLES AND RESPONSIBILITIES IN REHABILITATION MANAGEMENT OF WATER RESOURCES

Cooperative governance is a prerequisite for the successful conservation and management of the country's scarce water resources (DFFE, 2021b). The environmental governance of rehabilitation of water resources is hampered by the fragmentation of efforts across different projects, programmes, and initiatives due to separate mandates and various institutions responsible for this work. For example, the three national Departments that are responsible for regulating wetland management include the DWS, DFFE and DALRRD. Whilst significant progress has been made in developing an enabling legislative environment for water resource management and protection in terms of the National Environmental Management Act (NEMA) (Act 108 of 1998), the NWA, and the CARA, legislation deals with water resources in a fragmented manner, hampering effective implementation whilst effective mechanisms to coordinate cross-departmental actions are not well established (DFFE, 2021c).

In response to the challenges discussed above, **Table 2** presents the summarised roles and responsibilities of several regulating authorities with a mandate for rivers, wetlands, estuaries, lakes and dams as well as groundwater management in South Africa to ensure a coordinated approach for the effective protection, management, and conservation of water resources (DFFE 2021a; 2021b; ICLEI - Local Governments for Sustainability[3], 2018).

[3] ***ICLEI - Local Governments for Sustainability*** *is an international non-governmental organisation that promotes sustainable development. ICLEI provides technical consulting to local governments to identify and meet sustainability objectives.*

Table 2: Roles and responsibilities of regulating authorities in rehabilitation management of water resources

Sources: DFFE, 2021a; 2021b; ICLEI - Local Governments for Sustainability, 2018

Relevant Authority	Role in Rehabilitation Management of Water Resources
DWS	The DWS is mandated in terms of the NWA 36 of 1998 to manage, protect, control, and conserve water resources as well as to regulate activities that affect water resources. The DWS is also responsible for the implementation of the related NWRS which places considerable demand on water management and calls for research support. For example, the primary focus for the management of wetlands is principally ensuring the sustainable management of the factors that drive wetland formation and functioning, which includes their flow, geomorphology, and water quality to ensure that the desired response in terms of the habitat and biota and thus ecosystem services is maintained. The NWA provides for the establishment of Water Management Areas (WMAs) and Catchment Management Agencies (CMAs) to manage the water resources in each WMA. The establishment of CMAs is targeted for the purpose of delegating water resource management to the regional or catchment level and involving local communities. It is envisaged that the water resources within every WMA will be managed by its own CMA, which would have its own board. The CMAs are responsible for the protection of water resources and for developing a Catchment Management Strategy (CMS) for their WMAs. At the time of writing of this report, the Inkomati Usuthu CMA and the Breede-Olifants CMA are the only CMAs that are fully operational, although others are in the process of being fully established.
DFFE	The DFFE is mandated with environmental management and regulation of activities that affect the environment and ecosystems, including wetland ecosystems, within the framework of sustainable development, in terms of NEMA (Act 108 of 1998). The key policy documents related to the achievement of this mandate is the provincial Environmental Implementation Plan (EIP) and the Environmental Management Plan (EMP). The DFFE ensures the appropriate protection of wetland ecosystems through their protection and management. Below are the legal mandates given to the DFFE in relation to the rehabilitation of water resources: • 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 sustainably manage such areas, in terms of the National Environmental Management: Protected Areas Act 57 of 2003 (NEM:PAA); • To provide for the management, conservation, and sustainable utilisation of biodiversity, including wetlands and wetland-dependent species, in terms of the National Environmental Management: Biodiversity Act 57 of 2003 (NEM:BA). The key policy document related to the achievement of this mandate is the National Biodiversity Framework; • To protect health, well-being and the environment, including wetland ecosystems, by providing reasonable measures for avoiding and minimise the generation of waste, treating and safely disposing of waste, preventing pollution and ecological degradation and remediating contamination and significant health and pollution risks, in terms of the National Environmental Management: Waste Act 59 of 2008 (NEM: WA). The key policy document related to the achievement of this mandate is the National Waste Management Strategy (NWMS); and • To determine the coastal zone, provide for integrated and cross-sectoral coastal zone management, and the regulation of activities that affect the coastal zone, including estuaries and wetland ecosystems, within the framework of sustainable development, in terms of the National Environmental Management: Integrated Coastal Management Act 24 of 2008 (ICMA).

Relevant Authority	Role in Rehabilitation Management of Water Resources
	In addition to the above, the Working for Wetlands (WfWets) Environmental Management Programme (EMPr) was gazetted in 2020 by the Minister. The EMPr has been adopted to allow for the exclusion of all activities triggered by the WfWets projects as identified in the Environmental Impact Assessment Regulations Listing Notice 1, 2 and 3 of 2014, as amended, from the requirement to obtain environmental authorisation from the competent authority as contemplated in section 24(2)(e) of the Act.
DALRRD	The DALRRD is mandated to develop agricultural value chains, provide agricultural inputs, and monitor production and consumption in the agriculture sector, as well as facilitate comprehensive rural development. Chapter 6 of the NDP envisions an integrated and inclusive economy that involves the expansion of agricultural activity, the need for effective land reform and the promotion of sustainable rural development. The following are the roles and responsibilities of DALRRD to the rehabilitation of water resources: • **National LandCare Programme -** This is a government-supported community-based initiative which is active throughout the country. It is driven by both the public and private sectors through partnerships and cooperation. It seeks to achieve the following: o Conserve natural resources and sustainably use them; o Create a conservation ethic through education awareness; and o Create jobs through initiatives such as the Expanded Public Works Programme – (EPWP) and address poverty by launching various natural resource rehabilitation, improvement, and conservation projects. This initiative identifies serious concerns about land and water degradation in each province, and specific projects address these issues. The EPWP projects have been implemented in all nine provinces through the LandCare Conditional Grant, whereby ring-fenced funding is transferred to provinces. The assessment and reporting on the projects are required, and the provincial departments use the reporting tools provided by the EPWP to report on the number of jobs created. The provincial departments forward additional quarterly and annual reports to the DALRRD to monitor performance and the impact of the programme on the state of the natural agricultural resources. • **Wetlands -** the DALRRD engages in wetland protection and management. This is from a perspective of ensuring that the impacts on wetlands on agricultural land are managed such that it allows for the continued provision of services by those wetlands and thereby limits land degradation and ensures sustainable agricultural development. In addition to the above, the EMPr for LandCare projects was published under Government Notice 276 in Government Gazette 44341 on March 29, 2021. It allows for the exclusion of specific LandCare projects from requiring individual environmental authorisations, provided they adhere to the conditions outlined in the generic EMPr. This implies that LandCare projects can proceed without separate environmental authorisations if they comply with the generic EMPr's guidelines for managing and mitigating environmental impacts.
SANBI	The SANBI, a regulatory body, plays a leading role in South Africa's national commitment to biodiversity management and mainstreaming biodiversity considerations into other government sectors or industries. It is mandated in terms of the NEM:BA 10 of 2004 to account for the conservation of South Africa's biological resources and includes several measures that serve to protect our biodiversity, which includes the regulation of activities affecting threatened or protected species and ecosystems and activities involving AIS. The

Relevant Authority	Role in Rehabilitation Management of Water Resources
	core activities of SANBI involve research, conservation, sustainable use, biodiversity information systems, education, garden development, horticulture, ecosystems rehabilitation and bioregional planning programmes and policies. The SANBI coined the term 'Ecological Infrastructure (EI)'[4] because rivers, wetlands and their catchment areas are crucial EI for water security, often complementing built infrastructure, but the benefits of these ecosystems are currently compromised by their poor ecological condition. Ecological Infrastructure has received attention and initiated further innovative biodiversity mainstreaming work at the interface between the biodiversity and water sectors, which includes a strong emphasis on wetland management. The Freshwater programme is a SANBI initiative which recognises the value and threatened status of South Africa's freshwater biodiversity, and the need to build competence and leadership in this area. Initiatives falling within the Freshwater Programme to date include: • The WfWet, which focuses on the rehabilitation, protection, and sustainable use of wetlands; • National Wetland Inventory, which entails mapping the extent, distribution, and diversity of freshwater ecosystems; and • The NFEPA project, which aims to identify a national network of freshwater conservation areas and to explore institutional mechanisms for their implementation.
WRC	The WRC was established in terms of the Water Research Act 34 of 1971 with the function to: • Promote coordination, cooperation and communication in water research; • Establish water research needs and priorities; • Stimulate and fund water research according to priority, promote the effective transfer of information and technology; • Enhance knowledge and capacity building within the water sector. The WRC also has a research support function for the DWS in terms of the following: • Addressing issues such as water for all, quality of life, and a sustainable environment which are essential parts of the country's national priorities and require considerable attention; • Implementation of the NWA 36 of 1998 and the related NWRS, which places considerable demand on water management and calls for research support; and • The role of South Africa in the Southern African Development Community (SADC) and the New Partnership for Africa's Development (NEPAD), especially regarding water resources and water supply and sanitation issues, poses new challenges and requires new initiatives, which are within the mandate of the WRC. The primary source of funding for wetland-related research in South Africa has, to date, been directed through the WRC. This institution has remained responsive to the needs of the sector, which has resulted in the emphasis on research shifting regularly. For example, in recognition of the complexity of wetland management on the ground, and to facilitate alignment with the United Nations (UN) SDGs, the WRC now encourages multi-disciplinary and multi-sectoral wetland-related research that integrates socio-economic aspects.
Department of Mineral Resources and Energy (DMRE)	The DMRE is mandated by the Mineral Petroleum and Resources Development Act of 2002 (MPRDA), which serves to regulate mining activities that are considered a threat to ecosystems. Chapter 4, Mineral and Environmental Regulation 37(1) considers the

[4] ***Ecological Infrastructure (EI)*** *refers to naturally functioning ecosystems that generate or deliver valuable services to people and the economy. It complements built or hard infrastructure and is just as important for providing services and underpinning development, and provides services such as fresh water, climate regulation, soil formation and disaster risk reduction (SANBI, 2024).*

Relevant Authority	Role in Rehabilitation Management of Water Resources
	principles set out in section 2 of NEMA. The principles of NEMA shall: (a) *apply to all prospecting and mining operations and any matter relating to such operations; and (b) serve as guidelines for the interpretation, administration and implementation of the environmental requirements of the act*. According to the MPRDA, the holder of a mining right or permit is held liable for any environmental damage and pollution that takes place during their mining operations and must provide sufficient financial provisions for the rehabilitation of the natural environment adversely impacted by the associated pollution and damage incurred. These Acts resulted in the "One Environmental Management System" on the 8th of December 2014, which essentially represents an inter-departmental agreement between DMRE, DFFE and DWS. The agreement states that DMRE is considered the Competent Authority for the Environmental Authorisation of mining-related activities; however, appeals with regards to Environmental Authorisation would still be dealt with by the DFFE Minister. The DWS remains the Competent Authority for the review, approval and issuing of Water Use Licences (WULs) and according to the agreement set out through these amendment acts would aim to align and integrate the WUL process and timeframes with the processes and timeframes associated with applications for mining rights under the MPRDA and environmental authorisation under NEMA.
Local Government *i.e.,* Municipalities	Local governments are mandated with water management as part of their wider mandates for environmental management and sustainable development. This mandate is broad and not clearly set out in legislation and policy. Whilst there is no explicit mandate for local municipalities to manage, conserve and regulate the activities that affect water resources including wetlands in their jurisdiction, the points mentioned below are a broad but clear mandate for local governments to ensure that their by-laws, plans, strategies, frameworks, programmes and day-to-day operations and provision of services adhere and give effect to the following principles and objectives: • Promote and ensure a safe and healthy environment that is not harmful to human health and well-being in terms of the Constitution of the Republic of South Africa, 1996, and Municipal Systems Act 32 of 2000 (MSA); • Promote and ensure environmental sustainability through ensuring ecologically sustainable development, natural resource use, land use and service provision in terms of the Constitution, Municipal Systems Act, Spatial Planning and Land-Use Management Act 16 of 2013 (SPLUMA), NEMA and NWA; • Minimise negative environmental and natural resource impacts in terms of SPLUMA, NEMA, and NWA; • Promote and ensure the conservation and protection of the environment for the benefit of present and future generations in terms of the Constitution, NEM:PAA, NEM:BA); and • Prevent and/or mitigate the occurrence or re-occurrence of disasters in terms of the Disaster Management Act 52 of 2002. ***Note:*** *South Africa is a signatory to several international agreements relating to biodiversity and wetlands, such as the United Nations Convention on the CBD and the RAMSAR Convention. International agreements such as these provide a framework and commitment for national action and international co-operation, which municipalities are obliged to adhere to.*

In addition to the regulating authorities and their associated responsibilities discussed in **Table 2**, the following are some of the existing coordinating bodies that also ensure the protection, management, and conservation of water resources consultative process**:**

- The **Wetland Task Group (WTG)** coordinated by the DWS, was formed in 2005. It was originally formed to promote integrated and co-operative management of wetland resources with the DWS and ensure coordinated efforts between the DWS national office directorates and its provincial offices and institutions. In 2016, it was agreed that partner departments should form part of the WTG, and the task group would be the Inter-departmental WTG. Currently, the WTG is attended by representatives from the DWS (both National and Provincial Offices, including CMAs), DFFE, DFFE WfWet, DALRRD, Agricultural Research Council (ARC), and the WRC. This group also serves as a platform for members of the South African Wetland Society (SAWS), NGOs and other external specialists to discuss wetland-related matters, concerns and ideas with government departments, as and when required;
- The **Freshwater Ecosystem Network (FEN)** is an initiative focused on the management of freshwater ecosystems coordinated by the SANBI. The purpose of the initiative is to obtain feedback and discuss freshwater ecosystems-related research, challenges, solutions, experiences, and ideas to ensure alignment on work done by various stakeholders such as government, civil society, and academia, through a consultation process;
- The **South African Wetland Society (SAWS)** is a forum through which the professional field of practice of wetland science is developed. Their vision is to *build and promote excellence, professionalism and ethics in the Wetland Community of Practice of South Africa.* The mission is to *develop and maintain professional standards and best management practices of subscribed wetland practitioners in South Africa to promote wetland sciences, conservation and management through accreditation, collaboration and self-regulation of all society members*;
- **Society of Ecological Restoration (SER)** is a global network of members, both individuals and organisations, who are engaged in the management of ecologically sensitive ecosystems. The mission of SER is to promote ecological restorations as a means of sustaining the diversity of life on Earth and re-establishing an ecologically healthy relationship between nature and culture;
- **National Ramsar** or **Wetland Committees** provide a mechanism to promote the objectives of the Convention beyond the individuals and branches of government that are officially charged with its implementation. National Committees include government agencies and other stakeholders as well as National Focal Points from the other multilateral environmental agreements;
- The **Western Cape Estuaries Task Team (WCETT)** is a forum for the various stakeholders to coordinate and jointly plan management strategies for estuaries. This assists the provinces in preventing mutually incompatible activities and promoting sustainable development of the coast for the benefit of its citizens. The WCETT discusses development proposals that could impact the ecological functioning of estuaries and advises the authorities of any possible impact. The WCETT fosters formal linkages between the local, district and provincial spheres of government regarding the management of estuaries. This results in improved dialogue on the various activities that affect the coastal management of estuaries. The forum also allows stakeholders in the provinces to play a role in decision-making regarding the selection and implementation of funded estuary research and management projects;
- The **National Water Quality Management Forum** is a platform with the purpose of discussing issues regarding water quality in the country and formulating solutions to address those challenges. The forum also provides regular progress reports and feedback on the Anti-Pollution Task Team and National Water Quality Steering Committee actions. The Directorate of Water Resources Regulations within the DWS is responsible for coordinating this forum.

- The **National Water Monitoring Committee** is a platform where strategic documents such as the National Water Monitoring Plan and National State of Water Report are developed to provide guidelines towards the maintenance and enhancement of National Monitoring Systems and National Information Systems as stipulated in Chapter 14 of NWA 36 of 1998, Chapter 10 of Water Services Act (WSA) 108 of 1997 and Chapter 14 of NWRS Edition 3; and
- **Catchment Management Forums (CMFs)**[5] are platforms where co-operative and consultative water resource management takes place. The platforms allow water users within various catchments to provide and share information relating to their respective water related issues (e.g., water quality, poor infrastructure, illegal abstractions, etc). This is achieved through various regional collaborations aimed at continuously improving relationships amongst adjacent landowners and water users to ensure a sustainable and climate change-resilient environment.

3.3 INITIATIVES

This section of the report provides an account of the various water resources rehabilitation-related projects, programmes and initiatives that are either ongoing or completed at a catchment level, with specific reference to rivers, wetlands, lakes, dams, estuaries, and groundwater resources in South Africa. The aim of this section is to detail and demonstrate on the ground rehabilitation activities where the RMGs can be applied in real-world situations. It is worth noting that this section provides examples of rehabilitation projects for water resources, and the list is not intended to be comprehensive.

3.3.1 Rivers

River ecosystems are increasingly threatened and adversely affected by alterations in flow and physico-chemical properties driven by activities such as unlawful damming, irrigation, excessive water abstractions and poor catchment management (SANBI, 2014). In addition, continuous and excessive amounts of pollutants from domestic (formal and informal settlements), agricultural, mining and industrial sources upstream, solid waste along with infestation and encroachment of AIP and AIS, exacerbate these impacts.

A great deal of research and concerted efforts were undertaken by various institutions to identify the impacts and implement a wide range of rehabilitation interventions. An example of an initiative that was completed and yielded positive results is that of the Kuils River, located in the Western Cape. The river was adversely affected by channelisation and rehabilitation interventions, primarily aimed at flood control, were initiated in 2000 and completed in 2002 (WRC, 2003). Similarly, the Palmiet River, located in the Kwazulu-Natal, was highly compromised due to the impacts of waste materials emanating from massive informal settlements and discharging into the water resource (eThekwini Municipality, n.d). To address this challenge and to rehabilitate the watershed services along the river, artificial wetlands[6] were constructed to emulate the features of natural wetlands and act as bio-filters to remove/trap sediments, and pollutants, before entering the river system (eThekwini Municipality,

[5] *CMFs are not mandated by any legislation but are responsible for forming partnerships with government departments and private institutions to improve catchment conditions.*

[6] ***Artificial wetlands,*** *also known as* ***constructed wetlands,*** *are engineered systems designed to utilise natural processes involving wetland vegetation, soils, and their associated microbial assemblages to treat contaminated water or to enhance ecology, ecological class, aesthetics, recreation, land use, land value or landscape design. They are tailored to meet specific regulatory and site-specific requirements and can be designed in several configurations depending on the treatment or other goals (DWS, 2025).*

Note: *see summarised* ***examples,*** *extracted from DWS (2025), of various types of* ***constructed wetlands*** *and/or* ***artificial wetlands*** *and their applicability in South Africa on* ***Annexure A.***

n.d). The said rehabilitation intervention has been active since 2014. **Table 3** provides an overview of river rehabilitation initiatives implemented on the systems listed below and their respective outcomes:

1. Tsitsa (Eastern Cape) and Tolwane River (Gauteng) System: 2024 – ongoing;
2. Cape Peninsula rivers, Western Cape: 2024 – ongoing;
3. Six Water Management Areas (*i.e.,* Breede-Gouritz, Limpopo): 2021 – ongoing;
4. Aller River, Kwazulu-Natal: 2017 – ongoing;
5. Palmiet River, Kwazulu-Natal, 2014 – ongoing;
6. Rondegat River, Western Cape: 2013 – 2013;
7. The river system of the uMzimbuvu Catchment, Eastern Cape: 2013 – ongoing;
8. Lakenvlei, Upper Wilge: 2011 – ongoing;
9. Westlake River, Western Cape: 2004 – ongoing;
10. Selected Rivers of the Zandvlei Catchment, Western Cape: 2003 – ongoing;
11. Silvermine River, Western Cape: 2000 – 2002;
12. Kuils River, Kwazulu-Natal, 2000 – 2002;
13. Lourens River, Western Cape: 2000 – 2002;
14. Kruger National Park (KNP) Rivers, Limpopo: 1999 – 2002.
15. Vaal, Orange, Tugela basins: 1970 – ongoing; and
16. Critical catchments (*i.e.,* Steenkamps Berg, uMngeni Vlei: X – X.

Table 3: River rehabilitation initiatives implemented in South Africa.

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
1.	• Table Mountain Aquifer Partnership	• Groundwater recharge via managed river abstraction; and • Contamination monitoring	Cape Peninsula rivers (*i.e.,* Liesbeek, Salt.	Augment urban water supply; reduce sediment pollution.	Pilot phase (2024–2026); supplies 10% of Cape Town's water .	• Aquifers mitigate climate-induced flow variability. • Urban runoff requires advanced filtration.
2.	• DWS Adopt-a-River, in collaboration with DFFE, SANBI, ARC, UNEP and Global Environmental Facility (GEF).	The initiative aims to directly mitigate the negative impacts of AIS on South Africa's biodiversity assets and indirectly contribute to the improvement of rural food security and livelihoods. This will be achieved through ~~a~~ clearing of the AIS using a combination of physical and biological control methods as per the WRC Comprehensive Manual for River Rehabilitation (WRC Project KSA2: K5/2270) and the DWS RMGs of Water Resources with specific reference to Volume 1: Rivers.	Eastern Cape (Tsitsa River System) and Gauteng (Tolwane River System).	Clearing of AIS to enhance sustainable biodiversity conservation and livelihood improvement.	The planning activities commenced in 2024, and the initiative is ongoing. It is envisaged that the initiative would be carried out over three years. The initiative entails the following planned activities: • Stakeholder engagement; • Surveillance and documentation of livelihoods; • Development of the Management Action Plan for control of AIS at each site; • Identification and recruitment of community participants; • Identification of sensitive Indigenous vegetation for protection;	The initiative is still new and ongoing.

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
					• Prioritise AIS plants for control; • Categorisation of prioritised AIS for removal based on habitat type and impact on local ecology; • Identify clearing methods; • Disposal of cleared material/biomass; • Rehabilitation of sites (optional, especially in the Tsitsa Catchment); • Monitoring and Evaluation.	
3.	• CMAs.	• Decentralized water allocation; and • Community engagement in river health monitoring.	Six Water Management Areas *(i.e.,* Breede-Gouritz, Limpopo).	Implement the National Water Act; balance agricultural/urban demand with ecological flows.	Established in 2021, operational in six provinces.	• Engaging local stakeholders decreases conflict. • Data-sharing gaps hinder enforcement.
4.	• Kloof Conservancy[7] • eThekwini Conservancies Forum (ECF)[8]	The rehabilitation activity entails the rehabilitation of the ecological condition of selected rivers within the eThekwini Municipal Area. The rivers are under stress from the growth of AIP waste pollution spills. These are regarded as threats to	eThekwini Municipality, KwaZulu-Natal, South Africa.	Rehabilitation of a 5.8km stretch of the Aller River.	The rehabilitation activities commenced in July 2017 and are ongoing with the status below: • Significant progress was made in the clearing of AIP and waste;	• Importance of natural environment in providing the foundation for human well-being, development and resilience; • Issues of biodiversity, water and climate change

[7] ***Kloof Conservancy*** *seeks to restore the health of selected rivers across the municipal area by means of river assessments, rehabilitation activities, restoration strategies and the mobilisation of resources for implementation.*

[8] *The* ***ECF*** *is part of the regional node of conservancies, 'Conservation KZN' and represents all conservancies in the eThekwini Municipal Area.*

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
	Sectors and stakeholders.[9]	human health and the environment. A pilot approach was followed for a 5.8km stretch of the Aller River, which passes through New Germany and Clermont.			• Steady flow of status quo updates and incident reports on sewage spills to inform stakeholders, project managers and relevant municipal departments; • Sewerage manholes were fixed timeously and improved water quality.	were assimilated, as was the need to address these as part of Durban's overall resilience strategy; • Importance of active and engaged citizens in contributing towards resilience strategy; and • Capacity building played a key role in creating awareness, building knowledge and equipping citizens with the skills for employment and contributing to a resilient society and economy.
5.	• eThekwini Municipality; • SANBI; • uMngeni Ecological Infrastructure Partnership (UEIP); and • NGO - Amanzi Ethu Nobuntu.	Palmiet River was highly compromised due to impacts from massive informal settlements built in wetland areas and along the riverbanks. Critical wetlands and riparian zones were severely modified. Increased surface run-off from informal settlements and flushing of various waste materials directly discharged into water resources and deteriorated water quality.	Palmiet River[KZN] is a tributary that flows into the uMngeni River located in KwaZulu-Natal. It originates from the Kloof escarpment and drains into the larger uMngeni River system.	Rehabilitation of the impacted reaches along the river.	The rehabilitation activities have been active since 2014.	• The initiative is ongoing.

[9] ***Key sectors*** *and* ***stakeholders*** *involved include the Environmental Planning and Climate Protection Department, the Municipal Department, the Municipal Department of Water and Sanitation, District Health Services (Provincial Department of Health and the Local Government authority), and local schools, communities, and local NGOs.*

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		The eThekwini Municipality identified strategic positions along the river reach to be rehabilitated by constructing artificial wetlands. The artificial wetlands emulated the features of natural wetlands and acted as bio-filters, by removing and/or trapping sediments and pollutants before entering the uMngeni river system. The other plans included the removal of Invasive Alien Plants (IAPs) and re-vegetating the banks with indigenous plants to stabilise the riparian zones. This rehabilitation intervention was aimed to reduce the sediment loads and pollutants in the river channel thereby helping to improve and maintain water quality. The filtering of pollutants would further decrease the build-up of water hyacinth that has resulted in poor water quality in the uMngeni river channel. The municipality recognised that a wide-scale initiative in the greater uMngeni catchment was necessary to pursue investments in the rehabilitation and sustainable management of ecological infrastructure as an effective additional strategy				

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		towards reconciling supply and demand in this system.				
6.	• DFFE Working for Water (WfW); • Cape Nature; • WRC; and • Sectors and stakeholders.[10]	The presence of AIS in the Cape Floristic Region (CFR) has negative consequences on the rich biodiversity and endemism of the region. To control this problem, a national-scale programme was launched, namely the Rondegat River Rehabilitation Programme. The river is regarded as nationally important, and to address its impacts, dense infestations of the invasive Australian *Acacia* and *Eucalyptus* species were cleared from the riparian zone. The clearing took place in the lower reaches of the river and was followed by the eradication of the smallmouth bass (*Micropterus dolomieu*), using piscicide rotenone[11], a commonly used pesticide to eradicate fish populations. This method was used to ensure that the native fish, which had become a threatened species due to the presence of the smallmouth bass, could recolonise from the upper reaches of the river.	Rondegat River, Cederberg Wilderness Area, Western Cape, South Africa.	Rehabilitation of the native biodiversity of the river through eradication of alien trees and predatory alien fish along the riparian zone of the lower reaches of the river - eradication was important for native threatened fish species re-colonisation from the upper reaches of the river.	The rehabilitation activities commenced in 2013 and were completed the same year. The early results suggested that the native riparian vegetation and fish are recovering well post-rehabilitation.	Valuable lessons were learned, and the project illustrated the success of various aspects of good practice. These include, amongst others: • Careful planning, close and enthusiastic collaboration between the affected catchment and private landowners; • Public participation to address concerns; • Simultaneous and coordinated application of mechanical, chemical and biological control of alien plants and chemical control of alien fish; and • Advice and direction were provided by qualified ecologists. ***Note:*** • *Literature indicates that it is not yet possible to assess the longer-term success of the project. The lessons learned should be*

[10] ***Key sectors*** *and* ***stakeholders*** *involved included Cape Nature, WfW, University of Stellenbosch, Rhodes University, the Centre for Invasion Biology, SAIAB and National Research Foundation.*

[11] ***Rotenone*** *is only possible under very specific conditions as it wipes out all fish at the dosing site and downstream.*

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
						considered for similar projects in other locations. • *It is also important to note that the use of ~~using~~ piscicide rotenone is only applicable under very specific conditions and should not be advocated as a general solution*.
7.	• Conservation South Africa (CSA), in partnership with Environmental and Rural Solutions (ERS), as well as sectors and stakeholders[12]. • Conservation International's Freshwater Science Program and CSA, with funding from the Pisces Foundation, and in collaboration with	The river system extends over 200km from its source, which is in the Maloti Drakensberg watershed and extends to its estuary at Port St Johns, where it drains into the Indian Ocean. The river system is, however, classified as being vulnerable due to inappropriate land uses and alien plant infestation (mainly *Acacia mearnsii* and *Acacia dealbata*), uncontrolled burning that has led to degrading effects on the sustainability of the upper catchment area. The most prominent types of degradation that are observable include soil	The river system lies along the northern boundary of the Eastern Cape in the uMzimvubu Catchment.	• Rehabilitation and protecting catchment integrity and stability; • Improving livelihoods and the resilience of ecosystems and economies, through sound	• The rehabilitation activities commenced in 2013 and are envisaged to be completed in 2032. The rehabilitation activities are ongoing with the following planned project phases: ○ **Phase 1:** 2013 – 2017 ○ **Phase 2:** 2018 – 2022 ○ **Phase 3:** 2023 – 2027	• Literature indicates that the project was still in **Phase 1** of its implementation when it was published; and • The results of the FHI assessment (**Annexure B**) demonstrated that the ecosystem service delivery is under stress, mainly due to poor water supply reliability and cultural service delivery. These results call for the need to enhance the supply of benefits that

[12] ***Key sectors*** *and* ***stakeholders*** *involved include, Alfred Nzo District Municipality, Alfred Nzo Development Agency, Amazawa Agricultural Co-op, Bakoena Traditional Council, The Cedarville Conservancy, DFFE and DALRRD (Eastern Cape), Department of Economic Development, Environmental Affairs and Tourism (DEDEAT) (Eastern Cape Provincial Operations), DWS (Eastern Cape region), Eastern Cape Parks and Tourism Agency (ECPTA), Eastern Cape NGO Coalition, Endangered Wildlife Trust (EWT), LIMA Rural Development Foundation, Maloti Drakensberg Transfrontier Project (MDTP), Matatiele Local Municipality, Mehloding Trust, Moshesh Traditional Council, Mount Currie Community Development Organisation, SANBI, Save Act, Sikhululiwe Bawo Women's Co-operative, Sustaining the Wild Coast (SWC), WESSA, Wildlands Conservation Trust (WCT).*

Authority/ Organisation/Institution	Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
various institutional partners, including the Umzimvubu Catchment Partnership (UCP)[13].	erosion, damage to infrastructure, water supply shortages and loss of grazing land.		institutional cooperation.	○ **Phase 4:** 2028 – 2032 • During 2022, Conservation International's Freshwater Science Program and CSA including other partners, developed and applied the Freshwater Health Index (FHI) tool[14] to evaluate its overall health in three components namely Ecosystem Vitality, Ecosystem Services and Governance and Stakeholders. Importantly, the assessment process included stakeholder meetings to obtain some of the data necessary for the FHI calculations and to validate results.	people in the catchment need and strengthening the institutional decision-making for water resources management.

*[13] The **UCP** is a platform where various stakeholders have committed to foster collective action to implement a catchment management strategy and restoration plan for the benefit of people and nature (Conservation International, 2022).*

*[14] The **FHI** is a **tool** used monitor and measure the achievement of collaborative efforts adopted within the Umzimvubu Catchment, through the UCP. It provides a "State of the Catchment" report that can be used to inform the initiatives and approaches of stakeholders working in this landscape (Conservation International, 2022).*

	Authority/ Organisation/Institution	Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
8.	• BirdLife South Africa.	• Protection of river-dependent birds; and • Advocacy for environmental water allocations.	Key bird areas (e.g., Lakenvlei, Upper Wilge).	• Safeguard habitats for endemics like White-winged Flufftail and Grey Crowned Crane.	Active since 2011; 12 priority catchments identified.	• Flagship species (*i.e.,* Orange-breasted Waxbill) raise public awareness. • Mining/agriculture requires stricter buffer zones.
9.	• City of Cape Town.	Westlake River rehabilitation initiative - the river rises along the slopes and flows South of the Westlake golf course and Pollsmoor prison. Near Pollsmoor, the river was dammed before flowing under the Simon van der Stel freeway and into the Suburb of Kirstenhof. The City of Cape Town undertook rehabilitation of the river to improve its ecological health by addressing impacts of water quality, invasive plant removal, erosion control, and improving the river's functionality as a natural asset for the surrounding community.	Westlake River rises along the slopes of the Steenberg koppie about 3km to the west of Kirstenhof, Western Cape.	Improvement of the river's ecological condition and functionality as a natural asset for the surrounding community.	The rehabilitation activities commenced in 2004 and are ongoing.	• The rehabilitation had a positive impact on the suburb's entire property market. This was due to the aesthetic and recreational opportunities it afforded to all whose homes were within easy walking distance of the river. • The main potential benefit of the initiative for the biodiversity of the area was the clearing of alien species, mainly *typha* reeds. These reeds tend to choke systems, making it difficult for other species to grow. The ongoing maintenance of the river and wetlands undoubtedly enhanced the ability to attenuate floods. The removal of silt

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
						and clearing of vegetation enhanced this ability. The landscaping of the area was improved, paths were laid, bridges and benches installed as well as a play park for children.
10.	• Source to Sea[15] in partnership with the City of Cape Town, South African National Parks (SANParks), civil society, as well as sectors and stakeholders[16].	To develop a cohesive management strategy to rehabilitate and maintain the Zandvlei Catchment to restore healthy ecosystems, create jobs, build climate resilience and offer increased recreational and mobility benefits. The catchment is critical because close to Table Mountain National Park which contains critical fynbos vegetation that is critically endangered in sections of the broader municipal area.	Zandvlei Catchment, Cape Town, South Africa.	• Maximise urban natural recreational space, restore degraded natural and open space corridors for biodiversity conservation; • Improve water quality, link river corridors and	The rehabilitation activities commenced in 2003 and are ongoing as this is a long-term project.	• An **Integrated approach** promotes coherence within government and non-government collaborations. It builds bridges between communities and stakeholders and creates physical linkages between nodes along the rivers. It also requires coordination to ensure collaboration, coherence partnership building. • The **network** optimises job creation cost-efficiency. It provides the basis to promote the city and stimulate the local

[15] ***Source to Sea*** *is a network of businesses, communities and stakeholders that collectively seek to manage water quality and quantity to support the Cape Town region's abundant biodiversity.*

[16] ***Key sectors*** *and* ***stakeholders*** *involved include SANParks, City of Cape Town, ICLEI Local Governments for Sustainability, Wildlife and Environment Society of South Africa (WESSA), World Wildlife Foundation (WWF), Table Mountain Fund, Cape Action for People and the Environment, Cape town Tourism, Aurecon, SANBI, the Watershed Project, NGOs, private organisations and landowners and volunteers.*

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
				catchments via recreational multi-use trails and enhance eco-heritage.		economy. Investing in natural assets leverages high economic values through tourism, and recreation, builds resilience to climate change and reduces vulnerability.
11.	• WRC initiative in collaboration with: ○ Freshwater Research Unit, University of Cape Town; ○ National Parks; ○ City of Cape Town; and • DFFE WfW.	Silvermine River rehabilitation initiative - the river is about 12km long, rises on Table Mountain and drains into False Bay. At the time the initiative was undertaken, all the river's catchment was occupied by South African National Parks except for the last 1-2km that flows through a golf course located in a municipal land, which includes an estuary. Much of the upper catchment burnt in the January 2000 fires and the remaining alien vegetation was hand-cleared. The initiative focussed on the responses of the river to clearance activities at different points along the river length.	Silvermine River rises at an altitude of 640m in the Steenberg Mountains, 10km South of Cape Town.	Monitor and record any changes to the river and its associated habitats as recovery took place after the fires in January 2000 and as the remaining alien vegetation was cleared.	The rehabilitation activities commenced in January 2000 and were completed in 2002.	The different sections of the catchment responded in different ways to the fires and clearing methods. The recovery of indigenous vegetation was more successful in old pine areas than in those that supported *Acacia*. The riparian and in-stream plant communities responded more rapidly than those of the hillslopes. Near vertical sandy banks collapsed into the river with every flood, affecting all downstream reaches. More investigation of this deposit, including consideration of possible active removal, was recommended.
12.	• WRC in collaboration with: ○ Department of Earth Science, University of	Kuils River rehabilitation initiative - the river rises on the Cape Flats. Land-use changes, especially urbanisation and wastewater inputs, changed the flow of the river to perennial. Increased	The Kuils River rises at a low altitude in the eastern foothills of the Tygerberg Hills	Upgrade the river channel to reduce flood risk and to record in detail the	The rehabilitation activities commenced in January 2000 and were completed in 2002. • Data collection started early in the 2000/2001	No reference is made to lessons learned in literature other than extensive learning of new biomonitoring techniques in the 2000/2001 data collection period, which

	Authority/ Organisation/Institution	Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
	Western Cape (UWC) as part of the MSc thesis[17]; ○ National Parks; ○ City of Cape Town; and • DFFE WfW.	stormwater run-off heightened the risk of flooding in the lower parts of the river. Channelisation impacted the geomorphological and ecological nature of the river. Alien species were also a concern in the lower reaches. The initiative focused on flood control and engineering works on the middle reaches of the river.	in the Durbanville area.	geomorphological and ecological characteristics of the river in an area of channelisation; and to track changes over one year of engineering activities and winter floods.	summer and was completed before the autumn rains started. The full sampling programme was repeated in the second summer (2001/2002), to assess short-term change.	guided the second summer of data collection. The sites were observed during the winter floods of 2001, and channel geometry was re-measured when changes occurred.
13.	• WRC in collaboration with: ○ Department of Earth Science, UWC as part of the MSc thesis[18]; ○ National Parks; ○ City of Cape Town; and • DFFE WfW.	Lourens River Rehabilitation initiative - the upper catchment is dominated by pine plantations, orchards, prestigious wineries and a piggery along its middle reaches, and an urban area on its lower reaches. These activities led to the invasion of alien plants along riverbanks, poor water quality, reduced aquatic and riparian biodiversity and stream bank erosion. This resulted in observed channel changes or adjustments in the river, such as bank scouring and undercutting, channel erosion and channel migration, as well as the formation of bars and islands.	The Lourens River rises at an altitude of 1080m in the Hottentots Holland Nature Reserve, Western Cape.	Investigate the relationship between channel discharge, hydraulic biotopes and channel morphology.	The rehabilitation activities commenced in January 2000 and were completed in 2002. • The original plan of the initiative was to record the river's response to the clearance of alien vegetation, but this was cancelled. Similarly, the plan to record the river's response to flood control measures in the urban area was also cancelled because of changes in plans by other organisations.	• Channel morphology was largely determined by high flows; • Hydraulic biotopes changed as discharge changed; • Aquatic invertebrate assemblages indicated the river ecosystem was in a fair to good condition; • Floods enhanced the diversity of riparian and aquatic plants; and • Channel processes such as degradation and aggradation, and the

[17] *M.Sc. thesis of Ruth-Mary Fisher titled: The impacts of channelisation on the geomorphology and ecology of the Kuils River.*

[18] *M.Sc. thesis of Lindie Smith titled: The relationship between channel discharge, hydraulic biotopes and channel morphology in the Lourens River.*

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
					• Finally, in the 2nd year of the project, this initiative was centred on the geomorphological investigation of two similar reaches of the river, their hydraulic characteristics and their responses to floods.	occurrence of aquatic organisms could be correlated with the distribution of different-sized sediments.
14.	• KNP Rivers Research Programme; and • DFFE WfW as well as sectors and stakeholders.[19]	Coordinate and/or develop a protocol, tools[20], and approaches for upstream and downstream activities relating to river and catchment management that were negatively affected by global climate change, population growth and distribution, over-utilisation, and changes in land use along the rivers. The main activities that imposed pressure (*i.e.,* water scarcity, land degradation and siltation of canals) on the rivers included forestry, agriculture, tourism, municipal activity, and industrialisation. The alien plants	Sabie-Sand Catchment, Limpopo.	Develop a protocol to support the catchment stakeholders in their development of strategies to promote cooperative river management.	The rehabilitation activities commenced in 1999 and were completed in 2002.	• The use of all, as opposed to select knowledge sources, stimulated a conducive environment for discussion; • Dialogue and shared understanding are essential for effective co-operative governance; • Defining the most efficient and effective levels at which government and society engagement can enhance governance;

*[19] **Key sectors** and **stakeholders** involved included the environmental, forestry, economic, agriculture, tourism, irrigation, and industrial sectors. Other stakeholders included were the DWS, farmers and traditional leaders, Council for Development and Cooperation, Kgarudi Tribal Authority, South African National Civic Organisation (SANCO), Bushbuckridge Water Board, Sappi, KNP Conservation Section, Local Government and Sabie River Working Group.*

*[20] **Climate Positive Use Strategy (CPLUS)** tool is a spatial decision support tool developed and designed by the Conservation International, CSA, and partners. It is used to prioritise land-use planning for climate mitigation strategies at a jurisdictional level. The first project for CPLUS was piloted in Kruger to Canyons Biosphere, South Africa, and leveraged on the co-design principles, local high-resolution spatial data and stakeholder engagement (Conservation International, n.d).*

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		had negatively affected water use and riparian zone health.				• The river management process offered opportunities for forging quality relationships; and • The application of scientific information is necessary and helps to develop an understanding that informs people's behaviour, directing it towards the sustainable use of the resource.
15.	• Department of Water and Sanitation (DWS)	National Water Resource Infrastructure management; Dam safety and catchment protection	Vaal, Orange, Tugela basins.	Ensure water security through integrated river basin management; mitigate drought impacts.	Ongoing; Orange River Project operational since the 1970s	• Centralized management improves drought resilience. • Requires coordination with local municipalities.
16.	• Working for Wetlands (SANBI/DFFE)	Riverbank stabilization, erosion control, and invasive species removal.	Critical catchments (*i.e.,* Steenkamps Berg, uMngeni Vlei).	Restore natural flow regimes; protect wetland-river linkages.	200+ projects since 2004; 75% reduction in erosion hotspots.	• Combining engineering and biodiversity restoration yields long-term benefits. • Community "River Ranger" programs enhance sustainability.

3.3.2 Wetlands

The most notable impacts on wetland ecosystems are afforestation, mining, surface and groundwater abstraction, agriculture, siltation/sedimentation of banks, sewage discharge, AIS, urbanisation and infrastructure development and Industrial Development Zones (IDZs). Afforestation alters the characteristics of the wetlands and the water supply that sustains them. Conversely, wetlands located near farming areas are impacted by fertilisers and pesticides, leading to nutrient enrichment of water and, ultimately, eutrophication. In addition, conversions of land for agricultural use cause wetland drainage, which results in wetlands that are less effective at regulating stream flow and purifying water, because the drainage channels speed up the movement of water through the wetland and exacerbate erosion by concentrating water flow (Collins, 2005). The main threats to the depression wetlands include industrial developments, recreational demands, and pollution from agricultural herbicides and pesticides (DEA, 2019a-f).

A great deal of research and concerted efforts have been undertaken by various institutions to identify the impacts and implement a wide range of rehabilitation interventions. An example of an initiative that was completed and yielded positive results is that of the Zaalklapspruit wetland system in Mpumalanga. A series of unchannelled and channelled valley bottom wetlands were affected by agricultural and mining activities. To address these impacts, one of the rehabilitation interventions implemented in 2016 involved the diversion of water out of the main channel and spreading it across the width of the valley bottom while deactivating all agricultural drains. Monitoring conducted by the CSIR within the first year following rehabilitation revealed remarkable positive results. The Zaalklapspruit seep wetland was affected by erosion gullies that drained the water feeding the wetland. The proposed interventions included stabilisation of the gullies with gabions, a series of sediment fences and the use of rock packing. The planning phase for these interventions commenced in 2018, and the initiative is ongoing, with the next step being the implementation of the compiled rehabilitation plan. **Table 4** provides an overview of wetland rehabilitation initiatives implemented on the systems listed below and their respective outcomes:

1. Zuurvlak wetland, Western Cape: 2018 – ongoing;
2. Du Toits River wetland, Western Cape: 2018 – ongoing;
3. Riviersonderend wetland system, Western Cape: 2018 – ongoing;
4. Sekhukhune 1 and 2 wetlands, Limpopo: 2017 – ongoing;
5. Maluti-A-Phofung (Ararat 2) wetland, Free State: 2017 – ongoing;
6. Zaalklapspruit wetland, Mpumalanga: 2016 - 2016;
7. Leliefontein wetland, Northern Cape: 2010 – 2010;
8. Manalana wetland system, Mpumalanga: 2006 - 2007;
9. Palmiet fens, Highveld peatlands, and Eastern Cape swamp forests: 2004 – 2013;
10. Agulhas Plain: 2000 – ongoing;
11. Krom River wetlands, Eastern Cape: 2000 – ongoing;
12. Rietvlei wetland system, Gauteng: 2000 – ongoing; and
13. Magaliesberg foothills (Ramsar Site): X – X.

Table 4: Wetland rehabilitation initiatives implemented in South Africa.

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
1.	• Freshwater Research Centre, in collaboration with The Nature Conservancy (TNC) and Anchor Environmental Consultants; • DFFE WfWet; and • Cape Nature.	Zuurvlak wetland is classified as a seep, but there are areas of valley-bottom wetland associated with the stream channel. The wetland was assessed and erosion around plantation roads, exacerbated by afforestation with pines and their subsequent removal, was a major concern. Erosion gullies led to the draining of seeps feeding into the main wetland. The proposed interventions were to replace the road crossing with a drift and stabilise with gabions, a series of sediment fences and rock packing where the gully was shallower and narrower.	Zuurvlak wetland is located on the Waterval River, a tributary of the Klein Berg River, which supplies water to Voëlvlei Dam, Western Cape .	Investigation, assessment and prioritisation of affected wetlands for planned rehabilitation.	The Planning Phase started in 2018, and the initiative is ongoing. • The wetland condition was assessed, and a rehabilitation plan and associated costs were compiled. The next step was to implement the rehabilitation plan.	The initiative is ongoing. The completed rehabilitation plan is yet to be implemented.
2.	• Freshwater Research Centre, in collaboration with TNC and Anchor Environmental Consultants. • DFFE WfWet: and • Cape Nature.	Du Toits River wetland rehabilitation initiative - the wetland is a channelled valley-bottom, dominated by plant communities. The wetland was assessed, and there were no major impacts that were considered threatening to the wetland's ecosystem services. During the early 2000s, there was an erosion event in the catchment that led to the deposition of considerable sediment in the wetland. The wetland has largely recovered from this event, with a mixed plant community growing quite rapidly over the deposited sediment. There has been extensive AIS removal over the past	The wetland is located on the north-western margin of the Theewaterskloof Dam, Western Cape.	Investigation, assessment and prioritisation of affected wetlands for planned rehabilitation. The prioritisation aimed to rank the wetlands in order of their perceived importance for the supply	The Planning Phase started in 2018, and the initiative is still ongoing. • The wetland condition was assessed, and a total area of approximately 82ha required clearing of AIS. The next step was to implement further clearing of the alien species.	The initiative is ongoing. The completed rehabilitation plan is yet to be implemented.

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		few years, and the vegetation now appears to be in good condition. The proposed intervention for the wetland is further clearing of alien species.		of ecosystem services relating to water security.		
3.	• Freshwater Research Centre, in collaboration with TNC and Anchor Environmental Consultants; • WfWet; and • Cape Nature.	Riviersonderend wetland system rehabilitation initiative - the wetland system is a channelled valley-bottom that flows into the Theewaterskloof Dam near the agricultural settlement of Vyeboom. The wetland was assessed as being largely modified, returning an overall D Category using the WET-Health assessment. Erosion and loss of vegetation were of major concern, which led to channelisation of flows in erosion gullies. This further led to the draining and desiccation of wetland areas. Rapid changes in water level around the margins of a dam triggered head-cut erosion into the wetlands feeding the dam. The following interventions were proposed for the impacts identified: Geo-cell concrete chute, extension of an existing earthen berm, sloping of the right bank and active revegetation along banks.	The wetland is in quaternary catchment H60B, Western Cape.	Investigation, assessment and prioritisation of affected wetlands for planned rehabilitation for water security in Cape Town.	The planning Phase started in 2018, and the initiative is ongoing. • The wetland condition was assessed, and the rehabilitation plan and the associated costs were compiled. The next step was to implement the rehabilitation plan.	The initiative is ongoing. The completed rehabilitation plan is yet to be implemented.
4.	• DFFE WfWet.	Sekhukhune wetland rehabilitation initiative - the wetlands (Sekhukhune 1 and 2) have been subjected to various impacts associated with the modification of the system's hydrology. Extensive grazing and	The Sekhukhune 1 and 2 wetlands are in Quaternary Catchment	Re-instate a more natural water distribution and retention pattern to	The Planning Phase started in 2017, and the project is ongoing. • The wetland condition was assessed, and the rehabilitation plan and	The initiative is ongoing. The completed rehabilitation plan is yet to be implemented.

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		trampling within the wetlands occur, impacting the preferential flows and the vegetation's roughness coefficient. The poor management of roads, fires, incision of the channel in places, sediment plumes and the diversion of water have resulted in further impacts on the system's hydrology, such as the desiccation of the adjacent wetland habitat and the encroachment of terrestrial species. A variety of interventions, including stone masonry weirs, and chutes with gabion structures were selected to deal with the high energy levels experienced. Soft interventions were selected to prevent erosion and trap sediment in lower flow energy sections. These include earthworks for sloping and infilling rock and soil blankets to stabilise surfaces and promote further stabilisation with re-vegetation.	B51C in the Sekhukhune District Municipality, Limpopo Province.	improve the overall functioning of the wetlands and associated habitat for important biota; and deactivate and stabilise head-cut erosion in drainage channels.	associated costs were compiled. The next step is to implement the rehabilitation plan, which will be advertised for a tender in the 2025/26 financial year for implementation in 2026.	
5.	• DFFE WfWet.	Maluti-A-Phofung wetland rehabilitation initiative - the wetland (Ararat 2) can be accessed from the Qwantani Road. It is dominated by temporarily to seasonally saturated soils. The eroded state of the hillslope seepage wetland caused a flow of sediment-laden water into the Sterkfontein Dam. The wetland has been extensively eroded, and the road acts as a sediment source during	The Ararat 2 wetland is in Quaternary Catchment C81D, Free State.	To halt sediment loss due to the eroded state of the wetland.	The Planning Phase started in 2017, and the initiative is ongoing. • The wetland condition was assessed, and the rehabilitation plan and associated costs were compiled. The next step is to implement the rehabilitation plan, which will be advertised	The initiative is ongoing. The completed rehabilitation plan is yet to be implemented.

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		rainfall events. The proposed interventions for the wetland are sediment fences to trap sediments generated from the catchment and the road. Secondly, an appropriate revegetation plan was recommended for implementation within the gully behind the sediment fences to promote vegetation growth within the trapped sediments.			for a tender in the 2025/26 financial year for implementation in 2026.	
6.	• WRC, SANBI, DFFE, CSIR and DFFE WfWet.	The Zaalklapspruit wetland system comprises a series of unchannelled and channelled valley bottom wetlands that have been impacted by agricultural and mining activities. Rehabilitation interventions were then designed to divert water out of the main channel and spread it across the width of the valley bottom and deactivate all agricultural drains. This entailed the construction of a series of concrete weirs down the central channel and the construction of supplementary concrete walls, earthen berms, and earthworks in the broader wetland system.	The wetland is situated in the B20G Quaternary Catchment within the Olifants WMA, approximately 15km east of Emalahleni in the Mpumalanga Province.	Improvement of water quality impacted by agricultural and mining activities.	The rehabilitation activities were conducted in the year 2016.	Monitoring undertaken by the CSIR within the first-year post rehabilitation showed remarkably positive outcomes: • The pH and alkalinity were increased (acidity reduced) to levels in the natural freshwater range, where the metals became insoluble and precipitated out of the water column. • Decreased metal concentrations in the surface water; and reduced sulphate and TDS concentrations.
7.	• Agricultural Research Council (ARC) Animal Production Institute based at the University of	Leliefontein wetland rehabilitation initiative - the wetland was degraded under the threats posed by grazing, plant harvesting and the alien invasive poplar trees (*Populus sp*.) that were planted by the missionaries to provide additional sources of firewood to the community. The alien	The Leliefontein Wetland is in the Kamiesberg Local Municipality, Northern Cape.	Rehabilitate the natural spring and its surrounding wetland and protect this wetland from	The rehabilitation activities commenced in 2010 and were completed the same year. • The ARC continually provided technical advice and support on the initiative's progress.	• The greatest ecological and biodiversity benefit of this initiative was the clearing of alien species. The *Populus* trees were cut down because they consumed water, using up to 150 litres of water, per tree per day. Clearing of these invasive

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
	the Western Cape (UWC); • Leliefontein Methodist Church; and • Agri-Kameelkrans Farmers Union.	trees reduced the biodiversity as they out-competed indigenous wetland vegetation for sunlight and space, reduced water supply for communal use, and damaged infrastructure such as fencing and water channels. As a result, nine indigenous wetland plant species, including the arum lilies, became locally extinct. The wetland lost its ability to provide valuable ecosystem services to the community. *Populus* trees were selectively cut down mainly to prevent infrastructure damage and soil erosion. A weir with an outlet leading to the wetland was built to create a pool of fresh water. The top section of the historic boreholes was rehabilitated with sandstone and was waterproofed to prevent leaking.		further land use impacts.	Removing the alien *Populus* trees was no easy task and follow-ups were necessary to ensure they did not re-grow.	trees released more water for use by wetland plants and animal species, as well as the community. Locals also witnessed an increase in invertebrate and bird species after the wetland had been rehabilitated; and • The greatest lesson from the initiative is that the success rate of community initiatives is largely determined by how well the people involved work together. The removal of the alien *Populus* trees and rehabilitating the wetland resulted in education, awareness raising, plant propagation and enhancing recreational activities. These interventions contributed to improved ecosystem services that strengthened resilience to climate change.
8.	• DFFE WfWet.	The Manalana wetland system consists of a small unchannelled valley bottom wetland unit at the head of the system and a long and narrow channelled valley bottom wetland unit of varying width and varying channel dimensions. The wetland system has been affected by gully erosion and headcut migration, with both Hydrogeomorphic	The wetland is located within the village of Craigieburn in the Bushbuckridge Local Municipality, Mpumalanga Province.	Deactivation of headcut and gully erosion.	The rehabilitation activities started in 2006 and were completed in 2007.	The provisioning services that were examined upstream of the structures included crop production, reeds for harvesting, grazing for cattle, water for livestock and water for domestic purposes. The benefits upstream of the structures were found to be substantial, while the benefits

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		classification system (HGM) units being affected by gully erosion at their downstream end. Considering the importance of the wetland system to local livelihoods, and the fact that the wetland and its provisioning goods and services were under considerable threat from headcut advancement or migration, and gully erosion, two erosion control structures were established to deactivate the active headcuts.				downstream were smaller by comparison.
9.	• Working for Wetlands (WfWet), SANBI & DFFE	Combines engineering solutions (e.g., erosion control, rewetting) with community training and awareness programs.	Palmiet fens, Highveld peatlands, and Eastern Cape swamp forests.	Rehabilitate 50% degraded wetlands; create jobs; integrate poverty alleviation with conservation	Active since 2004; 15,000+ jobs created (2004-2013); 40% of projects target peatlands (ongoing)	• Proactive measures prevent degradation more cost-effectively than remedial fixes. • Training locals as custodians ensures sustainability.
10.	• Nuwejaars Wetlands SMA (25 landowners & communities	Invasive alien species removal, ecological corridors, sustainable farming, wildlife reintroduction.	Agulhas Plain, Overberg (460 km²).	Balance biodiversity conservation with agriculture; restore extinct species habitats.	Active since 2002; 230+ bird species recorded; buffalo/hippo reintroduced.	• Community landownership drives long-term commitment . • Economic incentives (e.g., ecotourism) aid conservation funding.
11.	• DFFE WfW and WfWet.	Krom River wetlands rehabilitation initiative - it was estimated that half of the wetlands were lost because of infestation by alien vegetation and destructive human activities such as	The Krom River wetlands are located in the eastern part of the Langkloof of	To rehabilitate wetlands and eradicate AIPs.	The rehabilitation activities commenced in 2000, and the initiative is still ongoing.	The initiative is ongoing.

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		large-scale cultivation on floodplains. The focus of the initiative was to rehabilitate wetlands and eradicate AIPs. Since 2001, 10 large structures have been built to combat erosion that threatened the remaining large, intact wetlands.	the Eastern Cape.		• In 2006, the Krom River experienced its most severe floods since measurements began in 1938, resulting in heavy loss of life and property. The remaining wetlands played a key role in managing the floods, slowing the velocity and destructive potential of the floodwaters, and trapping sediment. The structures that were put in place accomplished their purpose, and the two main wetland basins emerged from the floods largely unscathed.	
12.	• DFFE WfWet, in partnership with the City of Tshwane municipality; and • Global Wetland Watch (GWW) with the South African Government.	Rietvlei wetland system rehabilitation initiative - the wetlands were heavily eroded and desiccated, having been drained for cultivation and peat mining before the area was proclaimed a nature reserve. In recent years, the Rietvlei Dam became severely overloaded with nutrients and other pollutants due to the highly urbanised catchment receiving increased volumes of treated domestic sewage and industrial effluent. In 2000, the wetlands upstream of the dam were	The wetland system is situated immediately upstream of the Rietvlei Dam within the Rietvlei Nature Reserve just outside the capital city of Pretoria, Gauteng.	• Rehabilitate wetlands upstream of the dam to improve their ability to purify the water flowing into the	• The rehabilitation activities started in 2000, and the initiative is still ongoing; and • Pilot phase (2025) Global portal launch in 2026.	• Lessons extracted from the monitoring results is that the rehabilitated wetlands are improving the quality of water flowing into the dam with ammonia, nitrates, fluoride and sulphate levels down compared to the section upstream of the wetlands. This reduction in pollutants entering the dam is contributing to reduced algal growth, thereby reducing the

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		rehabilitated to improve their ability to purify the water flowing into the dam. Interventions included gabions, concrete and earthen structures to control erosion, rewetting the organic soils to increase the retention time of water; and ensure even distribution of flow across the wetlands. Satellite mapping of wetland health, workshops for data integration, and field trials of restoration techniques.		• Rietvlei Dam; and • Develop high-resolution wetland inventory; prioritize rehabilitation sites; improve water quality in urban-adjacent wetlands.		costs of treating the water for human consumption. • 10m-resolution annual data meets national needs. • Urbanization and invasive species require satellite-based monitoring.
14	• Kgaswane Nature Reserve Management.	Protection of groundwater-dependent peatlands; crack-and-seep hydrological system conservation.	Magaliesberg foothills (Ramsar Site).	Safeguard freshwater for communities; mitigate mining impacts; promote responsible mineral extraction.	Ongoing; mining pressures observed.	• Mining regulations must enforce post-operation restoration. • Geological features dictate wetland resilience.

3.3.3 Estuaries

Anthropogenic (human-induced) activities are the main causes of estuarine impacts. These activities, whether **direct** or **indirect**, are increasingly impacting estuaries and their ability to sustain productivity and associated essential ecosystem services. **Direct** anthropogenic pressures can be grouped broadly into five major categories that have been identified as follows:

- **Water resource use,** *i.e.,* hydrological alterations - flow modification patterns due to weirs, dams, and excessive water abstractions not only from surface resources but also from groundwater*;*
- **Land-use,** *i.e.,* anthropogenic alterations such as canalisation, riparian infrastructure development, and land infilling;
- **Exploitation of living resources,** *i.e.,* Over-exploitation of fish and invertebrates;
- **Pollution,** *i.e.,* point [*e.g.,* Wastewater Treatment Works (WWTWs)] and diffuse sources (*e.g.,* runoff);
- **Artificial breaching,** *i.e.,* manipulation of estuary mouths; and
- **Alien vegetation,** *i.e.,* both terrestrial species in the riparian zone, as well as aquatic aliens.

Indirect pressures largely relate to biological invasions by plants and animals, such as AIS, which poses a significant threat. The increasing trend of aquatic alien vegetation in many estuaries is closely linked to water quality and catchment problems. Early detection is important as shown in the successful removal of the highly invasive cord grass *Spartina alterniflora* in the Groot/Great Brak Estuary. Additionally, climate change is another impact that causes significant changes in the ecosystem structure and function and results in the loss of biodiversity. In the Verlorenvlei Estuary a reduction in open water through a combination of drought and over abstraction of groundwater resulted in the first ever record of acid soils, which in turn lead to a loss of ecosystem health.

Extensive research was undertaken by the iSimangaliso Wetland Park Authority with the support of the Global Environment Facility (GEF) to find a long-term solution to rejoin the St Lucia system that was artificially separated from the uMfolozi River. As part of the rehabilitation interventions to address the hydrological and ecological issues, the uMfolozi River was rejoined to Lake St Lucia in July 2012. The natural processes of the system were reinstated, and the system allowed the opening and closing of the estuary to the sea naturally. Major progress has been achieved in restoring the health of St Lucia, South Africa's flagship estuary and one of the most important nurseries for marine fish, based on a new management approach informed by science. (the initiative is still ongoing). **Table 5** provides an overview of the initiatives implemented on the systems listed below and their respective outcomes:

1. Rietvlei Estuary, Gauteng; 2025 – ongoing;
2. Orus Estuary, Western Cape: 2024 – ongoing;
3. uThukela, Berg: 2020 – ongoing;
4. Hartenbos Estuary, Western Cape: 2016 – ongoing;
5. St Lucia system, Kwazulu-Natal: 2012 – ongoing;
6. Eerste River Estuary, Western Cape: 2011 – ongoing;
7. Hout Bay River Estuary, Western Cape: 2011 – ongoing;
8. Lourens River Estuary, Western Cape: 2011 – ongoing;
9. Silvermine River Estuary, Western Cape: 2011 – ongoing;
10. Sir Lowry's Pass River Estuary, Western Cape: 2011 – ongoing;
11. Zeekoevlei River Estuary, Western Cape: 2011 – ongoing;
12. Diep River Estuary mouth, Western Cape: 2011 – ongoing;

13. Zandvlei Estuary mouth, Western Cape: 2011– ongoing;
14. Swart Estuary, Eastern Cape: 2009 – ongoing;
15. Berg Estuary, Western Cape: 2010 – ongoing;
16. Agulhas Plain (Overberg): 2002 – ongoing; and
17. Great/Groot River Estuary, Western Cape: 1990 – ongoing;

Table 5: Estuaries rehabilitation initiatives implemented in South Africa.

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
1.	• GWW	Satellite mapping of estuary health: Change detection	Rietvlei (Pretoria); **Breede Estuary.**	• Develop national estuary inventory; track urbanization impacts.	Pilot launched in 2025; full implementation by 2026.	• 10m resolution data detects pollution plumes. • Predicts erosion hotspots.
2.	• Overstrand Local Municipality; • Anchor Environmental Consultants (Pty) Ltd; • Western Cape DEA&DP; • CapeNature; • The Breede-Olifants Catchment Management Agency; and • The Western Cape Department of Agriculture.	The Onrus River and Estuary are prone to flooding. The flood event of September 2023 resulted in destructive erosion of an upstream peat wetland. This flooding led to the deposition of sediment in the lower river and estuary, with the estuarine bed level being raised by over three meters in places. In its current state, the estuary has no flood attenuation potential, and any subsequent flood/ heavy rainfall events are likely to put the lives of the residents of the nearby villages, as well as their properties, at risk. The surrounding terrestrial environment to the river and estuary is also heavily impacted by alien invasive plants. Recent satellite imagery suggests that the estuarine functional zone is almost completely covered with alien invasive plants, mostly tree, with these species	The estuary located within the Onrus River catchment (G40H), Cape Town, Western Cape.	• To address the identified impacts, with the primary strategies being to conduct bulk dredging (sediment removal) to clear the estuary of the accumulated material.	To address the identified impacts, the following plans were developed: • Maintenance Management Plan (MMP) to facilitate the management of sedimentation accumulation in the lower reaches of the river and estuary. • Comprehensive dredging, dewatering, and sediment reuse plan to enable sediment to be strategically removed from the estuary in a manner which maximises ecological and anthropogenic benefits, whilst minimising unnecessary environmental impacts.	The initiative is ongoing. The MMP including the dredging, dewatering, and sediment reuse plan are yet to be implemented by Overstrand Local Municipality.

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		outcompeting indigenous vegetation, and increasing rates of soil erosion.				
3.	• SANBI Working for Estuaries.	Mangrove restoration, sediment control, and fish habitat rehabilitation.	Eight Priority estuaries (e.g., uThukela, Berg).	• Rebuild nursery habitats for fish; sequester blue carbon.	• 15 sites restored (2020–2025); and • 120 ha of mangroves replanted.	• Community-led patrols reduce illegal gill-netting. • Sand mining increases erosion by 300%.
4.	• Mossel Bay Municipality; • Anchor Environmental Consultants (Pty) Ltd; • Cape Nature; • Western Cape Department of Environmental Affairs and Development Planning (DEA&DP); and • DWS.	The Hartenbos Estuary is classified as a temporarily open/closed estuary. It is a small estuary with a relatively large floodplain and covers in total approximately 268ha. The estuary ranks 74th of all South African estuaries in terms of its overall conservation importance and can be considered as moderately important for estuarine biodiversity on a national scale. It is an important recreational area along the Cape south coast, and the small resident population of Hartenbos is bolstered considerably during holiday periods. However, the estuary faces pressures from reduced freshwater inflow due to the upstream Hartebeeskuil Dam, increasing coastal development and tourism activities and deteriorating water quality. The channel and mouth dynamics of the estuary have been strongly	The estuary located within the Breede-Gouritz Catchment Management Area, Cape Town, Western Cape.	• To manage the estuary such that water quality is improved to supports a healthy and functioning ecosystem, which contributes towards economic growth and facilitates improved	• To address the identified impacts, the Estuary Management Plan was developed for a period of 2016 to 2021. This plan has since lapsed, and Mossel Bay Municipality has filed a request for the extension of the plan. • Hartenbos wetlands project - construction of floating wetlands is still in the planning process.	The initiative is ongoing. Mossel Bay Municipality has filed a request for the extension of the Estuary Management Plan.

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		influenced by anthropogenic developments in the catchment. Currently, artificial breaching of the estuary mouth by the Mossel Bay Municipality occurs most frequently in response to severe water quality deterioration in summer and associated excessive algae growth when the water becomes stagnant during closed mouth conditions. Reportedly, concerned residents and holiday makers also occasionally open the estuary illegally for the same reason. The estuary is also dug open illegally by bait harvesters to reduce water levels and allow easy access to the burrowing sand prawns.		recreation al use.		
5.	• iSimangaliso Wetland Park Authority, with the support of the GEF.	Rehabilitation of Lake St Lucia - the estuary is a dominant feature of the World Heritage Site, iSimangaliso Wetland Park, and is one of the country's most significant estuaries from a biodiversity point of view. For about six decades, the uMfolozi River, which is the largest river catchment feeding Lake St Lucia, was separated from it and this resulted in the loss of fresh water. The system also lost an important driving force that interacted with the sea to open and close the mouth and remove sediments. Coupled with this human interference, a drought resulted in the estuary mouth remaining closed	Lake St Lucia, the largest estuary in the country, is located in the southern region of iSimangaliso Wetland Park, North coast of KwaZulu-Natal.	Rehabilitation of the natural ecological processes of the estuarine system by relinking the river and estuary.	The rehabilitation activities commenced in 2012, and the initiative is ongoing with extensive research and long-term solutions. • An Invasive Species and Control Plan (2017-2021) was implemented focusing on priority areas. • Fish and certain plants continue to be harvested. Monitoring of these activities is in place.	• Following the rejoining of uMfolozi River with Lake St Lucia in July 2012, the natural processes were reinstated, and the system was allowed to open and close to the sea naturally. The mouth opening allowed for the migration of fish and prawn species using the Lake system as a nursery. • Significant achievements have been made to date with regards to the participation of local communities in decision-making and the implementation of programmes that deliver

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		to the sea for 10 years, ending with September 2012. Direct abstraction from tributary rivers and indirect abstraction of the groundwater prevented the freshwater volumes from reaching the estuary. Water quality in tributary rivers and several alien plant species around the system were a concern. As part of the rehabilitation interventions to address the hydrological and ecological issues, the uMfolozi River was rejoined to Lake St Lucia in July 2012, leading to an open mouth for the Lake St Lucia system. In addition, an alien species control plan was implemented.			• Monitoring of biotic and abiotic components is ongoing. Monitoring of physical and chemical parameters has improved with the implementation of an automatic electronic data gathering and storage application. This has allowed the Management Authority to assess the impact of the rehabilitation initiative. Monitoring in the marine environment includes line fish, surf-zone fish, turtles, Coelacanth, whale shark and bull shark populations. • Phase 3 (2023–2027); 70% salinity stability achieved.	tangible benefits to local communities. • The national and provincial conservation and environmental laws and regulations are enforced by staff of the Management Authority stationed at strategic locations within the World Heritage site. • Budget provision is made annually to the iSimangaliso Wetland Authority from the National and Provincial Governments. The Management Authority continues to obtain funding for rehabilitation, restoration and re-development, including the implementation of substantial local economic development programmes. • In-house training of staff is ongoing, and programmes are in place for staff to advance in their skills and/or qualifications. • Over 5200 learners visit the Park annually as part of the environmental education programme, while 112 academic achievers have been supported thus far in tertiary education as they study in fields relevant to the Park's management.

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
						• Currently, 130 research projects are being undertaken by researchers and postgraduate students from both South Africa and other countries. Research is approved based on its contribution to the management of the site, and to science in general. Research findings are fed into management decisions. The iSimangaliso Authority also commissions research required to assist with the management of the site. • River reconnection revives prawn/fish stocks.
6.	• City of Cape Town; • Cape Nature; • The Coastal and Environmental Consulting; and • C.A.P.E Programme.	The Eerste River Estuary mouth forms at the western boundary of the Helderberg Marine Protected Area (MPA). It comprises a ponding area with a highly mobile estuary mouth. The mouth is not canalised or fixed and is highly influenced by the prevailing coastal dynamics of a wind-driven sand system, as well as altered flow due to urban and farming impacts on the greater catchment area. Although there are no residential properties located near the estuary, the Macassar WWTW is located adjacent to the back ponding area and discharges its final treated effluent directly into the estuary.	The estuary meets the ocean at Macassar Beach on the False Bay coastline, Western Cape. (**Annexure C**)	Manage the estuary and catchment to reduce and minimise urban pollutants; and where possible allow free and natural movement of the estuary mouth; manage alien invasive species; and continuously	A management plan has not yet been developed; however, management objectives were developed with each objective having a specific operational protocol.	• The initiative is ongoing. The management plan is yet to be implemented by the City of Cape Town. • The City of Cape Town does monitor the estuary on a monthly basis.

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		The Eerste River is joined by the Kuils River approximately 4km upstream of the estuary and receives treated effluent from a number of WWTWs located in the Kuils River catchment area. The flow of the river at the mouth is persistent, as a net seawards flow. This is partly due to the wastewater discharge contribution, which has the effect of keeping the mouth generally open. Since this system has a significant component of treated sewage effluent, the natural estuarine characteristics have been permanently altered.		work towards achieving high standards of water quality and habitat.		
7.	• City of Cape Town; • Cape Nature; • The Coastal and Environmental Consulting; and • C.A.P.E Programme.	The Hout Bay River Estuary is an intermittently open system that opens when the Hout Bay River suddenly floods but generally closes during summer months. The reduction in natural flows is due to retention of water in upper catchment dams, increase in urban stormwater flows, urban development, bank stabilisation failures and flood levees, sedimentation, litter from informal settlements, and stormwater discharges all impact the estuary and its contributing river. This has led to alterations in the estuary's condition, water quality and depth.	The estuary connects with the ocean at Hout Bay Beach, Western Cape. **(Annexure D)**	Manage the estuary and catchment to reduce and minimise urban pollutants; and where possible allow free and natural movement of the estuary mouth; manage AIS; and continuously work towards	A management plan has not yet been developed; however, management objectives were developed with each objective having a specific operational protocol.	• The initiative is ongoing. • A management and rehabilitation plan for the Hout Bay Dunes were compiled, which point to sand accumulation on Hout Bay Beach contributing to the unpredictable meandering of the river mouth. However, the management plan including the rehabilitation plan for the dunes are yet to be implemented by the City of Cape Town.

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		The estuary is no longer in its natural state and tends to meander, effectively compromising efforts for dune rehabilitation. There are several developments below the 1:50 flood line of the Hout Bay River exposed to the effects of coastal dynamics, especially erosion.		achieving high standards of water quality and habitat.		
8.	• City of Cape Town; • Cape Nature; • The Coastal and Environmental Consulting; and • C.A.P.E Programme.	The Lourens River was declared a Protected Natural Environment (PNE) in 1997 and is the only river in South Africa that is a declared PNE. The river originates in the Hottentots Holland Mountains, flows through Somerset West and discharges to the sea at the Strand Beach. The Estuary of the Lourens River also defines the Helderberg MPA eastern boundary and as such, must be considered a core component to the marine conservation objectives of the MPA. The estuary is connected to the sea by means of a small western overflow channel. The estuary naturally tends to be saline during summer and becomes less saline during periods of high rainfall. The estuary has been	The estuary connects with the ocean at Strand Beach[21], Western Cape. **(Annexure E)**	Manage the estuary and catchment to reduce and minimise urban pollutants; and where possible allow free and natural movement of the estuary mouth; manage alien invasive species; and continuously work towards achieving high	A management plan was developed for the estuary in 2011 (for a period of 2011 to 2015), however, the project is ongoing.	The initiative is ongoing. The management plan is yet to be implemented by the City of Cape Town.

[21] *The **Strand Beach** Road crosses the estuary approximately 100m from the high-water mark of the sea, on the south of Beach Road. The estuary is abutted by the Lourens River Pump Station to the west and a recreational area to the east. North of Beach Road the estuary is abutted by the Strand Golf Course to the West and the residential properties to the east.*

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		impacted by the following urban impacts: • Agricultural and stormwater runoff; • Bank stabilisation failures; • Sewage pump station failures; • Alien fish; and • Changes in runoff due to urbanisation and surface hardening. Consequently, the above impacts led to the decrease in the estuary's water quality. The overall condition of the river was generally regarded as fair.		standards of water quality and habitat.		
9.	• City of Cape Town; • Cape Nature; • The Coastal and Environmental Consulting; and • C.A.P.E Programme.	The Silvermine River Estuary is a small, confined estuary that extends across a road and rail bridges. It provides vital connectivity between the river and the coastline. The mouth of the estuary is generally closed during the dry season[22] and occasionally open during winter months. The estuary's ability to effectively function as an ecological corridor has been threatened by rubble within the river channel and beneath the bridges, informal dwelling under the bridge, stormwater drainage, and overflows	The estuary is located at the north-eastern corner of Fish Hoek Bay's, Western Cape. **(Annexure F)**	Manage the estuary and catchment to reduce and minimise urban pollutants; and where possible allow free and natural movement of the estuary mouth; manage alien	A management plan was developed for the estuary in 2011 (for period of 2011 to 2015), however, the project is ongoing.	The initiative is ongoing. The management plan is yet to be implemented by the City of Cape Town.

[22] *The Western Cape (coastal area as opposed to inland areas) of South Africa experiences a Mediterranean climate, with a distinct dry summer and a wet winter. Most of the region's rainfall occurs from June to September, driven by stormy cold fronts from the Atlantic. Conversely, December through March is a very dry period.*

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		from the sewage pump station. The estuary is a focal point on the beach for recreational activities, however human beings encountering the estuary's water expose themselves to possible health risks as the water quality of the estuary is poor due to stagnation of the water.		invasive species; and continuously work towards achieving high standards of water quality and habitat.		
10.	• City of Cape Town; • Cape Nature; • The Coastal and Environmental Consulting; and • C.A.P.E Programme.	Sir Lowry's Pass River originates on the slopes of the Hottentots Holland mountains. Most of the lower part of the river is contained between earth banks stabilised by vegetation and partially canalised in places. The flow in the lower channel is sporadic consisting almost entirely of runoff from the local residential area. An artificial diversion channel splits the river at Gordon's Bay WWTW and delivers the bulk of the river flows and treated effluent from the WWTW to the sea at a location west of Harbour Island. Due to this significant change in the hydrology of the original river, few of the original estuarine characteristics remain. The river mouth thus opens only periodically depending on the season. The portion of the river flowing in the historic channel is fair from a water quality	The estuary[23] is located on the western side Gordon's Bay, Western Cape. **(Annexure G)**	Manage the estuary and catchment to reduce and minimise urban pollutants; and where possible allow free and natural movement of the estuary mouth; manage alien invasive species; and continuously work towards achieving high standards of water quality and habitat.	A management plan was developed for the estuary in 2011 (for period 2011 to 2015), however, the project is ongoing.	The initiative is ongoing. The management plan is yet to be implemented by the City of Cape Town.

[23] *The estuary is confined by Hendon Park Resort to the west, Beach Road Bridge to the north, and Hendon Park recreational braai area to the east.*

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		perspective, but moderately to highly impacted in terms of ecological functioning. Water quality in the artificial diversion canal is impacted by the discharge of final effluent from the WWTW.				
11.	• City of Cape Town; • Cape Nature; • The Coastal and Environmental Consulting; and • C.A.P.E Programme.	The Zeekoevlei River Estuary is an outlet of the Zeekoevlei Catchment drainage area. The outlet channel extends from the Zeekoevlei weir to the sea for approximately 3km. The channel receives final sewage effluent from the Cape Flats WWTW and, as such, it forms an important component of the City's urban drainage system. The outlet channel is surrounded by City infrastructure - the Coastal Park landfill site to the north and the Cape Flats WWTW to the east. In addition, Baden Powell – a major east-west transport artery - crosses the Zeekoevlei outlet channel a short distance upstream of its entry point to the sea. The Zeekoevlei Catchment and its associated aquatic ecosystems have over many decades become significantly impacted and nutrient enriched and unfortunately do not support any endemic or threatened species. The Zeekoevlei River mouth is subject to considerable movement. While interventions were implemented in	The estuary is located at the outlet of the Zeekoevlei Catchment drainage area which encompasses the Big and Little Lotus Rivers and Zeekoevlei in the Western Cape. **(Annexure H)**	Manage the estuary and catchment to reduce and minimise urban pollutants; and where possible allow free and natural movement of the estuary mouth; manage alien invasive species; and continuously work towards achieving high standards of water quality and habitat.	A management plan was developed for the estuary in 2011 (for period 2011 to 2015), however, the project is ongoing.	The initiative is ongoing. The management plan is yet to be implemented by the City of Cape Town.

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		the past to prevent the eastward migration of the river mouth, the river is still subject to significant westward migration. This migration is not limited to the east-west plain but may also move in a northerly direction due to erosion.				
12.	• City of Cape Town; • Cape Nature; • The Coastal & Environmental Consulting; and • C.A.P.E Programme.	The Diep River Estuary is considered the most important area for waterbirds in the region and is recognised as an Important Bird Area by Birdlife International. It is also an important recreational site and supports some bait collecting activities. The system comprises of the Rietvlei wetland and the Milnerton lagoon. The developments near the estuary continued to encroach on the margins of the estuary, the hydrodynamics of the system were altered, water quality was seriously deteriorated, and most of the area was invaded by several alien and indigenous species.	The estuary is located about 65km south-west towards Cape Town, Western Cape. **(Annexure I)**	To manage the estuary, Rietvlei wetland, the Milnerton Lagoon, and their environment in a manner that is sustainable, and compatible with the conservation of an ecosystem of international significance for biological diversity.	The Estuarine Management Plan has been approved for implementation in the Western Cape. It outlines the broad management actions, which will improve/sustain the health of the estuary in the long-term.	The initiative is ongoing. The management plan is yet to be implemented by the City of Cape Town.
13.	• City of Cape Town; • Cape Nature; • The Coastal and	The Zandvlei catchment is relatively small and comprises several rivers and streams (*i.e.,* Little Princess Vlei stream, Westlake stream, Keyser River, Langvlei canal and Sand River canal). The rivers converge on the	The estuary is located on the boundaries of the City of Cape Town and is bordered by	Manage the estuary and environment, including the catchment in a balanced	The Estuarine Management Plan has been approved for implementation in the Western Cape. It outlines the broad management actions, which will improve/sustain	The initiative is ongoing. The management plan is yet to be implemented by the City of Cape Town.

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
	Environmental Consulting; and • C.A.P.E Programme.	Zandvlei Estuary with the Keyser River and Westlake stream entering the estuary through an extensive reed bed on the north-western margin. The estuary system also includes a wetland area that covers 60ha, the main body of a vlei of about 56ha and a 31ha marina along the eastern margin. Over the years, there have been numerous changes to the physical structure of the estuary and the influent rivers. These have led to changes in the volumes and quality of water and associated sediments flowing into the estuary (both from the rivers and sea) as well as the biological communities. Given the extent of the development in the catchment and immediate surroundings to the estuary, including physical presence of the marina, roads, railway bridge, the system will never function as a complete natural system again.	Muizenberg Mountain, Silvermine Plateau, Constantiaberg Cecilia Ridge, Wynberg Hill and a watershed along the eastern boundary, Western Cape. **(Annexure J)**	manner that promotes the rehabilitation and conservation of its biodiversity values; mitigate flooding of adjacent properties; and maintain the estuary for its suitability for recreation and education.	the health of the estuary in the long-term.	
14.	• Cape Action Plan for the Environment Estuaries (C.A.P.E) Programme; and • Enviro-Fish Africa (Pty) Ltd	The Swartkops Estuary is a medium-large, permanently open estuary which is fed by two major river systems, namely the Swartkops River and its largest tributary, the Elands River. Two tributaries of the Elands River are impounded, and the Groendal Dam is located on the Swartkops River approximately 35 km from the estuary. These obstructions	The estuary is located north of Port Elizabeth, Eastern Cape.	To investigate the historical and current situation both on the estuary to inform the development of the Estuarine	A situation assessment study was undertaken in 2009 to form the basis of the Estuarine Management Plan.	The initiative is ongoing.

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		are thought to hold back in the region of 16% of the mean annual rainfall but reduce freshwater inflow by approximately five percent. The townships of Kwazakele and Motherwell are located further from the estuary but have an indirect effect on the system through pollution. Industrial activities are a major land-use within the immediate estuarine area and include saltpans, sewage works, sand/clay mining, brickworks, a power station, motor industry and wool industry, tanneries, extractive/beneficiation processes, aquaculture and railway yards and depots, with only limited agriculture taking place.		Management Plan.		
15.	• C.A.P.E Programme.; • Cape Nature; • Anchor Environmental Consultants (Pty) Ltd; • DFFE; and • SANBI.	The Berg Estuary is one of the largest permanently open estuaries in the west coast, with a total area of 61km^2. It currently receives some 65% of the natural mean annual runoff. While this does not affect mouth condition, since the mouth of the estuary has been stabilised, reduction in flow has had a considerable impact on water quality, both due to reduced ability to dilute pollution and due to the increase in polluted return flows because of use of the water in irrigation. The reduced flows have probably also altered the physical	The estuary is located in the Overstrand Municipality, Western Cape.	• Improvement of water quality; • Improvement of the quantity of freshwater inflows; • Removal of significant obstructio	• The Estuarine Management Plan was developed in 2010 with the four focal areas outline in the column for objectives. • Designated 28th Ramsar Site (2022). • 60% reduction in sewage inflows.	• The initiative is ongoing. • Saltmarsh recovery is critical for migratory birds - 250+ bird species. • Industrial effluent requires real-time sensors. • Estuaries require integrated land-sea governance.

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		habitat of the estuary in that the depth and profile may have changed and have affected the extent of flooding on the floodplain areas surrounding the estuary. The reduction in flows have resulted in considerable changes to the biota. Pollution control, Ramsar-compliant management, and bird monitoring.		• ns to flow; and • Elimination of illegal fishing activity (gill netting). • Protect 127 waterbird species; maintain estuarine functions (worth R4.2bn/yea) • Maintain estuarine functions.		
16.	• Nuwejaars Wetlands SMA	Sustainable farming, hippo/buffalo reintroduction, erosion barriers.	Agulhas Plain (Overberg).	• Balance agriculture with biodiversity; rebuild coastal lake systems.	• Active since 2002; 25 landowners engaged.	• Livestock exclusion zones improve water clarity. • Wildlife corridors reduce human-wildlife conflict.
17.	• DWS	The Groot/Great Brak Estuary lies about midway between the towns of George and Mossel Bay. When the Wolwedans Dam was built upstream	The estuary is located George and Mossel Bay	• Maintain the ecosystem as closely	• The DWS developed a water release or Estuarine Management Plan (date not disclosed)	The initiative is ongoing. There are times when elevated water levels pose a flood risk when there's rainfall in the catchment and the dam is

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		in the Great Brak River, the estuary of was affected as follows: • The natural freshwater flow to the estuary was reduced, which changed the way in which the estuary functions naturally; • The ecological environment of the estuary changed; • The quality of the water in the estuary changed; and • The socio-economic character of the estuary and its surroundings are changed. The artificial breaching of the estuary commenced in the 19th century to control floods and high estuary water levels.	in Cape Town, Western Cape.	as possible to the current state. • Maintain the recreational value and potential of the estuary, especially during peak visitor periods.	that would set out the best way in which the water reserved in the dam every year for the estuary should be used so that there would be as little change as possible to the estuarine environment. • The estuary is artificially breached for ecological reasons between September to November every year.	spilling. This scenario would necessitate an emergency breach.

3.3.4 Lakes and Dams

The South African dams and water reservoirs are impacted by sedimentation, mineralisation/salinisation, nutrient enrichment (at an excessive rate leads to eutrophication) and acid mine drainage (AMD). These impacts are either related to natural processes or anthropogenic activities. In addition, the key pressures on freshwater lakes are caused by alterations to the hydrological regime, water pollution, habitat modification, invasive species, and climate change.

A great deal of research and concerted efforts were undertaken by various institutions to identify the impacts and implement a wide range of rehabilitation interventions. The Hartbeespoort Dam Integrated Biological Remediation Programme (HDRP) is an example of an intervention that was implemented from 2006 to 2013 to explore a wide variety of short-term and long-term methods, as well as techniques to control the level of eutrophication in the dam. The following interventions have been implemented to date (DWAF, 2007):

- **Control and remove algae - floating booms**[24] (see **Annexure K** for images) were used to assist with the surface movement concentration and physical removal (pumping out) of algae from the water to be composted. Four to five positions for boom placement have been identified, one of which has already been placed successfully at the dam wall as a prototype. **Compost**[25] is produced from the harvested algae and hyacinth.
- **Control and remove water hyacinths -** similarly to algae, water hyacinths are removed from the water by concentrating the movement of water plants on the dam. Hyacinths may possibly be used as plant material in the floating wetlands (mesocosms) which are harvested on a regular basis.
- **Shoreline vegetation** - is important to improve the biodiversity of the dam. It contributes to the control of water pollution, prevents benthic erosion, serves as a spawning substrate for fish and creates micro habitats for fish and invertebrates.
- **Floating wetlands -** floating islands of preferably indigenous water plants are considered an important extension of shoreline vegetation as they provide the capacity for nutrient removal from surface water. They also serve as a habitat for aquatic organisms and for fish to survive and grow. This artificial safe habitat for zooplankton contributes to increasing the size and diversity of its population since it feeds on algae. The floating wetlands can therefore form an important part of the food-web structure.
- **Sediment removal** - significant volumes of nutrients are captured in the organic and inorganic layers of incoming **sediment**[26] in the dam basin. The treatment of water flowing into the dam hardly changes the appearance of the water unless sediment can be cleared of its high nutrient levels.
- **Fisheries management and monitoring** - management, coordination and monitoring of the commercial fisheries[27] in the dam, including the monitoring of the impact the fisheries have on the fish community. The undesirable fish species are removed by netting to achieve the

[24] ***Floating booms**, (although similar to LG Sonic, MPC-Buo technology in shape & structure), is an aquatic technology used to concentrate cyanobacteria so it can be pumped out and composted. On the other hand, a LG Sonic, MPC-Buoy is an aquatic technology that uses ultrasound waves to control algae (see **Annexure K** for images).*

[25] ***Compost**, a high source of protein for fish and chicken is used for breeding of earthworms. The composting combined with the removed sediment will produce a high-quality soil conditioner.*

[26] ***Sediments** removed combined with compost are re-used economically and in an environmentally safe manner for rehabilitation of depleted soil including for other household, agriculture or mining purposes.*

[27] ***Commercial fisheries** involve catching fish and other seafood for profit.*

desired trophic structure, and a commercial fishery was developed by harvesting the dam on a sustainable basis for the community to benefit from this additional protein source.

Phase 1 of the HDRP achieved many successes which include the large-scale removal of hyacinth and other alien plants. **Phase 2** of the HDRP is planned for the near future and will be implemented with all lessons learned from **Phase 1** .

Table 6 provides overview of other lakes and dams rehabilitation interventions implemented on the systems listed below and their respective outcomes:

1. Rehabilitation of the Vlakfontein Canal, Mpumalanga: 2024 – ongoing;
2. Zeekoevlei Lake, Western Cape: 2024 – ongoing;
3. National Siltation Management Strategy for Dams in South Africa (NatSilt): 2021 – ongoing;
4. Solar-Powered Reservoir Circulator / Solar Bees, Gauteng, Rietvlei, Pretoria: 2018 – ongoing no completion date as this was a pilot study; and
5. Hartbeespoort Dam Integrated Biological Remediation Programme (HDRP), North-West: **Phase 1** started in 2006 – 2013. **Phase 2** is planned for the near future.

Table 6: Lakes and Dams rehabilitation initiatives implemented in South Africa.

	Authority/ Organisation/Institution	Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
1.	• City of Cape Town.	The Zeekoevlei Lake is a designated Ramsar site – one of the highest levels of conservation that can be accorded internationally to wetlands. It is also part of an Important Bird and Biodiversity Area. This 250ha coastal lake is affected by a high level of organic pollutants, largely resulting from urban impacts such as sewage and agricultural runoff and upstream pollution from the Big and Little Lotus Rivers. It has a long history of human impact over the past century, and large volumes of organic sediments have accumulated in the lake over several decades, resulting in frequent algal blooms, periodic fish kill events, and unpleasant odours. The City of Cape Town intends to dredge the Zeekoevlei, removing up to 750 000 m^3 of the accumulated organic	The lake is located in the False Bay Nature Reserve, Cape Town.	• Reduce algal blooms; • Reduce the frequency of lake closures for existing recreational uses; • Improve aquatic ecosystem conditions and habitat complexity, especially on the lakebed; • Reduce the foul odour of the lake; • Improve the lake's aesthetics; • Removal pollutants	• The City of Cape Town was granted environmental authorisation by the Department of Forestry, Fisheries and the Environment in April 2024, based on an environmental impact assessment process. • The City also received water use authorisation from the Department of Water and Sanitation in 2023. • The initiative is estimated to take 20 months, with a start date to be determined based on logistical aspects.	The initiative is ongoing, and the dredging activities are yet to be implemented by the Citty.

	Authority/ Organisation/Institution	Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		matter. The material targeted for dredging is concentrated in two areas of the lake: Home Bay (in the west, north of the Peninsula) and Stormy Bay (in the south).		and organic sediment accumulation; and • Reduce the rate of reedbed expansion.		
2.	• DWS.	Rehabilitation of the Vlakfontein Canal – the canal has outlived its design life of 25 years and needed major rehabilitation throughout its whole length of 37.1km. The purpose of the canal is to transport raw water pumped from the Grootdraai Dam at Standerton, Mpumalanga over 37.1km to the Grootfontein Pump Station, where water is discharged into the canal just north of Standerton. The pumped water is piped to the Knoppiesfontein Diversion Tank where it splits. The two pipelines then supply Bossiespruit Dam for private energy and chemical company Sasol, and Trichardsfontein Dam for state electricity company Eskom. The rehabilitation process was	Grootdraai Dam at Standerton, Mpumalanga.	To rehabilitate sections of the canal in a prioritised way to mitigate the risk of failure. Potential failure of the canal could result in substantial financial losses for strategic stakeholders.	The initiative commenced in October 2010 and is ongoing. It should be noted that there will be continuous operation and maintenance of the canal. • To date, the following rehabilitation activities have been undertaken on the canal: o All the fill sections have been re-lined; o Canal lining (raising of walls), which is ongoing; and o Formwork and Steel.	• The initiative is ongoing with planned continuous operation and maintenance of the canal. • Rehabilitation of the canal is dependent on Vaal River Eastern Sub-system Augmentation Project (VRESAP) being operational and reliable to supply Sasol and Eskom with raw water for periods (6 weeks at a time) while a section of the canal is rehabilitated. This has been problematic to date.

	Authority/ Organisation/Institution	Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		divided into two Phases: **Phase 1 (Fill Sections) and Phase 2 (Cut Sections).** The high priority of construction was given to the fill sections, as it was identified as a high-risk area which is more prone to canal failure. The fill section adds up to 8.1km of the canal's full length of 37.1km, while the remaining sections of the canal would be rehabilitated in order of the priority assigned to them.				
3.	• WRC in collaboration with the DWS and Zutari (Pty) Ltd – Consultants.	National Siltation Management Strategy for Dams in South Africa (NatSilt) WRC - this programme aims to produce tools and know-how to arrest the situation and mitigate against future increases in siltation through the deployment of social, economic, technological, engineering and management tools and systems; and to control the impact of sedimentation. The programme also aims to expand the footprint of a dam to include all upstream activities, to improve the understanding of the current	South Africa.	Develop a strategy for the control and management of dam siltation in South Africa.	The initiative commenced in 2021 and is ongoing. • To date, the following deliverables have been completed: ○ **Task 1:** Project inception; ○ **Task 2:** Literature review; ○ **Task 3:** Dam storage classification); ○ **Task 4:** Dam operations model): and ○ **Task 5:** Institutional and finance guidelines.	The initiative is ongoing.

	Authority/ Organisation/Institution	Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		status quo of dam sedimentation in the country and to develop support tools for the cross-departmental co-ordination of activities to combat dam sedimentation.			• The next step of the initiative is to pilot-test the efficacy and veracity of the developed models and tools. o The Vortex Settling Basin (VSB) Technology Demonstration Handover Event is planned for 12 June 2025. The demonstration of the VSB technology will take place at the Thukela River abstraction works in Middledrift, Madungela[28] , KwaZulu-Natal **(Annexure L)**. The event will celebrate the culmination of the research and development phase of the VSB prototype, developed as part of the NatSilt	

[28] ***Madungela*** *is the preferred site for demonstration due to the following:* ***(i)*** *the Large contributing catchment downstream of existing Spioenkop Dam, this high sediment concentrations. Great for robust demonstration and analysis;* ***(ii)*** *the pump station abstracts raw water directly from the Thukela River and has no gravel trap, thus VSB supply will be at the hydro-cyclones with a tap-off from the raw water rising main from the river;* ***(iii)*** *the current sediment extrusion is by hydro-cyclones, therefore a good comparison with VSB performance will be possible;* ***(iv)*** *located in a secure location, with an available platform to place the VSB; and* ***(v)*** *proximity to Durban airport and good access road.*

	Authority/ Organisation/Institution	Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
					Programme. The demonstration will showcase the innovative, low-cost solution for mitigating the effects of river siltation, specifically for the removal of fine non-cohesive sediment at small river abstraction works. The handover will involve a formal presentation, a guided tour of the site, and the operational commencement of the VSB plant.	
4.	• Tshwane Metropolitan Council.	Rietvlei Dam was constructed between 1932 and 1934. It has been an important source of drinking water for the City of Tshwane. Unfortunately, the location of Rietvlei Dam's catchment, which extends as far as OR Tambo International Airport and the resultant urban, industrial and agricultural pollution, has caused the dam to become hypertrophic. In 2008, the	Rietvlei Dam, Tshwane Metropolitan Municipality, Pretoria.	Improvement of in-lake eutrophication using Solar-Powered Reservoir Circulator / Solar Bees at the Rietvlei Dam.	The rehabilitation initiative started in 2008 and is ongoing. • The technology has been proven to improve water quality (increase oxygen levels throughout the dam) and reduced algal toxins (high phosphorus reduction) in the water. • Cyanobacterial growth has decreased allowing the ecosystem to return to a more natural state by	The initiative is ongoing. The key lessons learned to date are as follows: • The SolarBee units are a true 'green' technology. • The SolarBee units tend to move out of position during periods of high rainfall or wind. However, they are easily towed back into position, and the city is now looking into using a different anchoring mechanism

	Authority/ Organisation/Institution	Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
		Solar-Powered Reservoir Circulator / SolarBees for cyanobacterial (blue-green algae) control was introduced. The floating solar-powered reservoir long-distance circulation pump system was used to mix water columns and accelerate the biological and solar processes that clean up water. Both horizontal and vertical circulation patterns were created for improved distribution of oxygen, enhanced water clarity, elimination of cyanobacterial (blue-green algae) blooms and reduced nuisance aquatic weed growth.			enabling the growth of green algae. These green algae are consumed, allowing for the improvement of the entire food chain. • The system is very economical, requires minimum maintenance, and can operate day and night using only solar energy.	to improve their spatial stability. • The units have proved a significant attraction to the local water bird population. Fortunately, the SolarBees have been equipped with bird-repellent kits to prevent the birds from using the machines as nesting perches. • Yachters and canoeists have also expressed their satisfaction with improved conditions at the dam. ***Note:*** • *WfWet did much to restore the wetland in the Rietvlei Nature Reserve, which aids in cleaning the incoming water to the dam.* • *The WRC in partnership with North-West University launched a project from 2008 to 2015 to unlock some of the scientific reasons behind the improvement of the dam's water quality. The present ecological data was compared with historical data to determine the ecological status of the dam and the influence of the SolarBees.*

	Authority/ Organisation/Institution	Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
5.	• DWS - Project Lead) • Rand Water (Implementing Agent) - the main Regional Water Services Provider in the catchment of the Hartbeespoort Dam working together with a core group of service providers and specialists.	**The HDRP also known as Harties Metsi-a-Me Programme** – the HRDP is a complex system that, in practice, integrates the activities in the catchment upstream. These activities include urbanisation, industrial, mining developments, agriculture and recreation. These activities have been increasing over the 90-year life of the dam. The dam is also the centre of a hub of economic activity both centred on the dam and water users downstream. The severe algal growth (hypertrophic state) in the dam has detrimental implications for both humans and the broader environmental health.	Hartbeespoort Dam, North-West Province.	Investigating the short-term and long-term methods and techniques to control the status of eutrophicatio n in the Hartbeespoort Dam.	**Phase 1** of HDRP started in 2006 and the period of the review ended in 2013 which is a short period in the life of the dam. **Phase 2** of HDRP is planned for the near future. • **Phase 1** achieved many successes which include the large-scale hyacinth and other alien plant removal with the beneficiation of this biomass, the testing of floating reed bed systems which increase the biodiversity and biomass of the open water, a fisheries programme and the clearing of debris from the system.	**Phase 1** of HDRP paved the way for the planned **Phase 2**. **Phase 1** experienced some challenges, namely, a lack of phosphate management and weakness in technical and financial governance. As a result, key lessons learned for implementation of the next **Phase 2** are as follows: • There should be a focus on the catchment upstream of the dam, specifically on improving the quality of the water flowing into the dam. The waste discharge charge system has been piloted in this catchment, and this provides the opportunity to implement the system. • Certain of the in-lake activities started in **Phase 1** should be continued. However, the programme should be broadened to effectively address the quality of the inflowing water to reduce the loading of plant nutrients. • The 1 mg/ℓ Phosphate standard for effluents discharged into designated sensitive catchments by wastewater treatment works be reviewed in the light of the

	Authority/ Organisation/Institution	Description of the Activity	Location	Objective	Timeline and Status	Lessons Learned
						capabilities of modern technology. • A stakeholder forum should be established.

3.3.5 Groundwater

The over-abstraction of groundwater resources is a major concern, leading not only to aquifer depletion and water quality degradation but also negative effects on the ecological integrity of streams and wetlands. This in turn, results in significant habitat and biodiversity losses. Biological contaminants in groundwater resources include algae and microbial organisms, such as bacteria, viruses, and protozoa. Drinking water contaminated by microbial contaminants can result in public health risks, potentially leading to serious waterborne diseases such as typhoid, diarrhea and cholera. Groundwater is vulnerable to pollution from feedlots or cattle kraals, stock watering points, septic tanks, pit latrines, landfill sites and cemeteries, especially in areas with high rainfall and shallow water tables. Groundwater vulnerability is potentially significant in environments with high permeability, such as sandy and gravelly soils, or where fractured bedrock lies close to the ground surface.

A great deal of research and concerted efforts were undertaken by various institutions (*i.e.,* WRC, Council for Geoscience, higher education institutions and private consultants) to clearly identify the impacts and implement a wide range of rehabilitation interventions. Artificial Recharge[29] (AR) or Managed Aquifer Recharge (MAR)[30] is an example of an intervention that was implemented in Atlantis, Cape Town, whereby stormwater from the residential area is directed to the MAR basins and undergoes softening and chlorination before it is distributed to the town for water supply. This MAR scheme was initiated in 1979, and it is still in operation to date. This initiative has alleviated some of the pressure on the surface water resources in the region, especially with the impacts of climate change and further population and economic growth. It is worth noting that groundwater contributes to baseflow in rivers, wetlands and lakes and is critical in sustaining ecosystems during dry periods. **Table 7** provides a summary of key groundwater rehabilitation initiatives implemented across South Africa, highlighting the diversity of approaches, implementation statuses, and lessons learned. These initiatives span from MAR, in-situ treatment methods, and ecological rehabilitation efforts:

1. In-situ iron removal treatment technique in preventing clogging of production boreholes, South Africa: 2014 - It is not documented whether the initiative is still in progress, or it was completed;
2. Rehabilitation of the veld and hydrogeology in the Nama Karoo, Western Cape: 2010 – It is not documented whether the initiative is still in progress, or it was completed;
3. eMalahleni Water Reclamation Plant, Mpumalanga: 2007 – ongoing;
4. Rehabilitation of the Arbor Colliery, Mpumalanga: 2005 - It is not documented whether the initiative is still in progress, or it was completed;
5. Karkams MAR Scheme, Northern Cape: 1995 – ongoing; and
6. Langebaan MAR Scheme, Western Cape: not yet in operation;
7. Plettenberg Bay MAR Scheme, Cape Town: not yet in operation; and
8. Atlantis MAR Scheme, Western Cape: 1979 – ongoing.

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*[29] The term **'Artificial'** does not capture the process of humans enhancing natural recharge in a systematic manner. These deficiencies in the term "Artificial Recharge" have been overcome by the now generally accepted term "**Managed Aquifer Recharge**" (MAR).*

*[30] **MAR** is the practice of increasing the amount of water that enters an aquifer through human-controlled means. For example, groundwater can be artificially recharged by redirecting water across the land surface through canals, infiltration basins, or ponds from which water seeps into the subsurface; creating irrigation furrows to allow infiltration of excess irrigation water; using sprinkler systems to irrigate with surface water, some of which infiltrates beyond plant roots; or injecting water directly into the subsurface through boreholes.*

Table 7: Groundwater rehabilitation initiatives implemented in South Africa.

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline Status	Lessons Learned
1.	• WRC; • Council for Geoscience; and • Private Consultant.	Preventing production borehole clogging by in-situ iron removal in aquifer systems – the initiative entailed the investigation and feasibility of the in-situ iron removal treatment technique in preventing clogging of production boreholes in a South African context by removing Iron (Fe^{2+}) and Manganese (Mn^{2+}) from the groundwater. Although existence of iron and manganese in water generally do not cause health complications, problems are associated with water colouring and taste, clothes staining, and encouragement of bacterial growth in water distribution networks which affect a pipe's transfer efficiency. The investigation found that iron removal by the in-situ iron removal method is feasible, even at small-scale application. The investigation also found that the in-situ iron removal treatment using ozone[31] has the potential to increase the removal efficiency of iron and manganese in groundwater, particularly in areas with high organic carbon and/or	Western Cape, South Africa.	To investigate the feasibility of the in-situ treatment technique in preventing clogging of production boreholes in a South African context by removing Fe^{2+} and Mn^{2+} from groundwater.	The rehabilitation initiative started in 2014. It is not documented whether the initiative is ongoing or when it was completed. • The initiative found that iron removal by the in-situ removal method is feasible, even at small-scale application; and • Results of the investigation showed that iron and manganese concentrations in the dissolved phase were reduced considerably.	• The lesson learned from the initiative is that the in-situ iron removal treatment using ozone has the potential to increase the removal efficiency of Fe and Mn in groundwater, particularly in areas with high organic carbon and/or silica concentrations, which complexes with Fe and Mn. The findings of the initiative are critical for groundwater rehabilitation, especially in areas experiencing excessive concentrations of Fe and Mn; and • The use of ozone was found to be very effective in generating the desired high DO concentrations in the subsurface.

[31] ***Ozone*** *is well-known and widely applied for disinfection and oxidation purposes in the treatment of drinking water. In this case, ozone is used an oxidant for in-situ treatment and removal for Fe and Mn through its injection into the aquifer. The use of ozone allows for the injection to be either as a gas (in-situ ozone sparging) or as a liquid (in-situ ozonated water).*

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline Status	Lessons Learned
		silica concentrations. In addition, ozone was applied on-site and injected back into the aquifer by means of well points at the Atlantis wellfields and this yielded positive results.				
2.	• WRC; • Department of Conservation Ecology and Entomology and School of Public Management and Planning, Stellenbosch University; and • CSIR.	Restoration of the veld and hydrogeology in the Nama Karoo – the site is in the heavily grazed and degraded area. Invasion by alien plants (*Prosopis* species) was a major environmental and economic problem in the area. The concentration of species around water points, combined with their deep root system, was thought to have reduced the availability of groundwater through both the interception of water in the upper soil levels as well as the deep roots tapping into the groundwater. This groundwater contributes to the water supply for the Karoo town of Beaufort West, and it was important to protect this resource. The sustainability of the meat and wool-based small-stock industry of the area relies entirely on natural pasture and this industry is threatened by the erosion of natural capital base by infestations of the species.	Nama Karoo, Beaufort West in the Western Cape.	Clearing of the *Prosopis* species to raise the level of groundwater and regeneration of natural rangeland vegetation cover and grazing capacity.	The rehabilitation activities commenced in 2010, and literature does not reveal the completion date. Clearing of *Prosopis* species has not yet shown positive benefits. Although the vegetation has changed following clearing to resemble un-invaded vegetation, its grazing value has not improved significantly as plant species have not yet recolonised the cleared areas. It was recommended that, following the clearing, the area be re-seeded with plants and livestock and game be excluded from the treated site for a period to allow the plants to establish. The effect of *Prosopis* removal on the water table is being investigated.	It is not documented whether the initiative is in progress, or it was completed.
3.	• BHP Billiton; and	eMalahleni Water Reclamation Plant (EWRP) – the catchment is water-	The Reclamation Plant is located in	To manage safety and	The initiative was established in 2007, and it is still in	The plant currently purifies 30 m^3/day to potable quality. Out of this, 16

Authority/ Organisation/Institution	Description of the Activity	Location	Objective	Timeline Status	Lessons Learned
• Anglo American	stressed due to a growing population and climate change induced reductions in annual rainfall, which has increased pressure on the drinking water supply for the city. The city is already struggling to meet the water demand by extracting 120m^3/day from the local Witbank Dam, exceeding the licensed withdrawal volume of 75 m^3/day. The EWRP system was set up to pump excess mine water from the Kleinkopje Colliery, Landau Colliery, the Greenside Colliery and the South Witbank Colliery to EWRP, where it is treated to potable water standards and provided to the local municipality. The plant uses a High Recovery Precipitating Reverse Osmosis (HiPRO) process, from which low salinity product water is generated by a membrane process. To maintain the proper level of water quality, the plant is fitted with online instrumentation for constant monitoring. The produced water is also stored batch-wise in reservoirs and quality tested again before it is pumped to the municipal reservoirs. Any water not complying with SANS241 is not added to the municipal water supply and is	the Nkangala District Municipality of Mpumalanga.	environmental problems caused by rising underground mine water.	operation. According to the current prognosis, the current volume of 30 m^3/day of purified water is going to increase to 180 m^3/day by 2030.	m^3/day of is chlorinated and provided to the local municipality, providing 20% of the total potable demand.

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline Status	Lessons Learned
		instead returned to the WRP for re-processing				
4.	• DWS.	The DWS commissioned a study to determine the total number of abandoned and defunct coal mines within the upper Olifants River catchment. Arbor Colliery was identified as one of the 27 mines with a high priority, based on the potential impact on water quality and safety issues. A major factor in this assessment was the presence of a large informal community living near the mined-out area. The mine comprises a series of opencast pits, as well as poorly defined underground workings. The water within the opencast pits showed high levels of acidity, elevated sulfate levels and elevated metals (*i.e.,* Al, Fe and Mn). From the investigations, it was concluded that there was an urgent need for this mine to be rehabilitated, given the risk to the community. The proposed rehabilitation intervention was the backfilling of the open cast operations. Initial water would be cascaded from one pit to the next to avoid spilling as backfilling progresses.	The mine is located in the upper Olifants River catchment, Mpumalanga.	Rehabilitation of the mine to improve water quality as well as safety issues.	Rehabilitation of the mine was scheduled to commence in October 2005 and there is no indication whether the proposed interventions were implemented.	It is not documented whether the initiative i still in progress, or it was completed.

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline Status	Lessons Learned
		The long-term options for water management were as follows: • Discharge of water to the catchment after treatment to remove sulphates, probably using biological treatment systems. Operation of these treatment systems would offer some employment opportunities to the community. • Pump excess water to a nearby underground mine, from where an operational mine would abstract the water for use in their coal washing plant.				
5.	• Kamiesberg Local Municipality; • DWS; and • WRC.	Kharkams MAR Scheme **(Annexure M)** – with no perennial rivers in the area and a mean annual rainfall of 250mm, the village depends solely on groundwater pumped from the municipality's three abstraction boreholes. Natural groundwater recharge is very low, and because of continuous abstraction since the mid-1990s, groundwater levels had dropped 10m and the water quality (salinity) had deteriorated significantly. The scheme includes a sand filter that is built in the bed of the ephemeral river**.** Most of the water, when available, flows over and past the filter, but some infiltrates the sand filter and flows to the injection boreholes.	Kharkams is a small village in Namaqualand region, Northern Cape.	Replenishing the aquifer when river runoff is available, during periods of irregular flooding	The MAR scheme commenced in 1995, and it is ongoing. • Three controlled injection runs from 1999 to 2001 had the effect of reversing the declining water level trend. • The water quality improved significantly after injecting the clear filtered river water.	The initiative demonstrates the value of opportunistic MAR (simple and cost-effective method), with no pumping and maintenance costs. The only maintenance required during operation is weekly removal of the fine sediment that settles on the filter since it slows down infiltration. An additional benefit of introducing fresh water to the aquifer is that it significantly lowers the salinity of the groundwater.

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline Status	Lessons Learned
6.	• DWS; • WRC and • Saldanha Bay Municipality and West Coast District Municipality.	Langebaan MAR Scheme - the town has struggled with water shortages due to extreme drought weather conditions since 2014. The possible water sources for the scheme are excess volumes from the Berg River during the winter season and secondary treated wastewater. The 2008/2009 investigation by the CSIR proposed the scheme at Langebaan Road as part of a suite of suitable and appropriate water supply augmentation schemes. The scheme contains two wellfields, Langebaan Road and Elandsfontein already connected to the municipal water supply pipeline. The borehole injection method **(Annexure N**) had already been pilot-tested for this aquifer and infiltration tests would be required, as infiltration may be better suited for this area.	Langebaan town is located approximately 100km north of Cape Town, along the west coast.	Recharging the Langebaan aquifer with treated wastewater for the town's industrial and domestic use	The MAR scheme is not yet in operation. • The Langebaan Road wellfield with four production boreholes authorised to abstract was initiated for Saldanha Bay Municipality during the early 1990s. • Test phase commenced during 2008/2009 to determine the feasibility of the scheme.	No reference is made to lessons learned as the scheme has not commenced and is still in testing phase. Local and district municipalities together with consultants are working together to explore and study the groundwater system, to better understand it and successfully implement sustainable water supply schemes.
7.	• Bitou Local Municipality and Eden District Municipality.	Plettenberg Bay MAR Scheme – the area has both a high demand for water in the summer and a surplus of water in the winter, making it potentially a good candidate for MAR. At present (see existing water supply components on **Annexure O**), the town depends on surface water from the Keurbooms River for most of its domestic water supply needs. Water quality in the Keurbooms is generally very good. During periods of low	Plettenberg Bay, Southern Cape.	Recharging the aquifer with surplus of water in the winter period to allow the aquifer to deliver more water during high peak summer.	The MAR scheme is not yet in operation. • A MAR pre-feasibility study and assessment was conducted in 2007, and the results were favourable indicating that the aquifer is highly permeable with high storage capacity and can easily accept injection water.	The results of the assessments indicated how peak demand could be met through incorporation of the scheme into the Plettenberg Bay supply system. Injection of the water would take place in July to September and abstraction in November to March, with rest periods in between.

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline Status	Lessons Learned
		demand, raw water bypasses the treatment plant and is piped to the Roodefontein Dam, where it can be retrieved when necessary. In addition to the surface water resources, there is groundwater source in the Kwanokuthula township area used solely in the township. The combined average yield of the Kwanokuthula boreholes is not sufficient to meet the total demand of township, and the balance is drawn from the Keurbooms River via the water treatment works. The proposed scheme contains an injection borehole that would triple the volumes of groundwater in the aquifer. The aquifer would need to hold the recharged water from winter when it is recharged until summer when the water is abstracted again during the peak season.				
8.	• City of Cape Town; • DWS; and • WRC.	Atlantis MAR Scheme **(Annexure P**) – the initial groundwater supply planned for Atlantis was insufficient to support the population and growing industry within the area. The closest alternative water source was the Berg River, which is 70km away and piping water would be too costly. Thus, groundwater resources were further explored and the Witzand and Silwerstroom wellfields were developed. Stormwater detention basins were constructed and much of	Atlantis town is approximately 50km north of the City of Cape Town.	Recharging the Atlantis aquifer with treated wastewater for the town's industrial and domestic use.	The MAR scheme was initiated in 1979, and it is still in operation. • Water quality is measured intensively, both in the aquifer and in the urban water management system. The aquifer water quality is assessed by sampling boreholes within the developed wellfields as well as monitoring points	The scheme is an excellent example of wise and efficient water use, including water recycling for potable services. It has also alleviated some of the pressure on the surface water resources in the region, especially with impacts of climate change and further population/economic growth. The scheme ensured the sustainability of the Atlantis water supply for over four decades and continues to play a key role. A major component of the

Authority/ Organisation/Institution		Description of the Activity	Location	Objective	Timeline Status	Lessons Learned
		the water infiltrated into the sandy soils, inadvertently recharging the groundwater. A total of 12 stormwater retention and detention basins capture stormwater from the residential areas. The combined stormwater from the residential area is directed to the MAR basins and undergoes softening and chlorination before it is distributed to town for water supply.			spread throughout the Atlantis water management area on a five-week cycle. Most of the water quality parameters fall within the drinking water standards.	scheme has been the separation of the source water into different fractions, as this has allowed recharge of the highest quality water in the areas of greatest importance. The scheme provides a cost-effective water supply option when coupled with careful management of the water sources and the aquifer as opposed to transporting surface water 70km from the Berg River.

4. CONCLUSION

Several rehabilitation initiatives have been undertaken across institutions in the South African water sector for rivers, wetlands, estuaries, lakes and dams as well as groundwater. **Tables 3** to **7** provided succinct summaries of these initiatives, highlighting their role in enhancing the ecosystem' functioning. The benefits derived from these efforts include improved water quality, biodiversity, flood prevention, waste decomposition, and soil generation to better aesthetic and recreational spaces for the surrounding communities. To this end, it is apparent that the rehabilitation of water resources requires institutional collaboration and cooperative governance given the large number of organisations, institutions and government departments that play a role in the rehabilitation.

For instance, the rehabilitation of urban rivers that are of importance to supporting the natural processes in the Zandvlei Catchment was achieved through an integrated approach to promote coherence within government and between government as well as non-government collaborations. Similarly, the rehabilitation of rivers in the Sabie-Sand Catchment promoted collaborative research, diverse knowledge sources and partnership between the KNP Rivers Research Programme and communities as well as staff from the DFFE WfW programme to jointly coordinate upstream and downstream activities relating to river and catchment management.

The assessment undertaken by the DFFE WfWet Programme on wetlands was aimed to identify priority catchments and associated wetlands within which rehabilitation work needed to be completed. As part of the intervention, a review was conducted to determine local knowledge and identify existing studies in the quaternary catchments of each province. The decisions on the selection of priority wetlands to be rehabilitated, namely Sekhukhune 1 and 2 and Maluti-A-Phofung (Ararat) wetlands, were informed by input from wetland fora, existing biodiversity and/or conservation plans, municipalities, state departments and various other stakeholders.

The harvesting of reeds and sedges is of cultural and commercial importance to local communities surrounding Lake St Lucia. The separation of Lake St Lucia from the uMfolozi River had dire implications for human welfare, especially local communities. The iSimangaliso Wetland Park Authority prioritised the rehabilitation of St Lucia in 2012, with assistance from the GEF, including investing in extensive research to find long-term solutions to the hydrological and ecological issues. Major progress has been achieved to date, which includes, amongst others, the reinstating of the natural processes of the system (*i.e.,* the natural opening and closing of the estuary mouth to the sea) which allowed for the migration of fish and prawn species. It is also reported that fish and other plants continue to be harvested for beneficial use. These milestones were made possible by the participation of local communities in decision-making and the implementation of various programmes that delivered tangible benefits to local communities.

Phase 1 of the HDRP is another example of an intervention that was implemented from 2006 to 2013 to explore a wide variety of short-term and long-term methods and techniques to control the status of eutrophication in the dam. One of the lessons learned during **Phase 1** of the HDRP was the challenge of practical implementation of cooperative governance. One of the recommendations from planned **Phase 1** of HDRP was the establishment of an effective stakeholder forum to assist with the harmonisation of all other related activities in the area to ensure optimal economic growth and sustainability. Stakeholder involvement would create awareness of the successes and challenges of the programme and the opportunities for involvement. Extensive awareness activities would target the public, local authorities, industry, mining, agriculture and international interests. In addition, education and advocacy are also critical to facilitate behaviour change with regards to the way people and institutions manage their water and deal with their waste.

The Kharkams and Atlantis MAR Schemes have been operational for over 30 and 40 years respectively, providing the most cost-effective sources of new safe water supply for towns and small communities. Both schemes have been found to have a wide range of benefits such as the alleviation of the pressure and reliance on the scarce surface water resources, as well as water quality improvement (*i.e.,* lowering the salinity of the groundwater) when fresh water is injected into the aquifer. Despite the successful pre-feasibility assessments conducted for both the Langebaan and Plettenberg Bay MAR schemes, the slow progress in the roll-out is attributed to a lack of appropriate governance and institutional development for the sustainable utilisation and management of groundwater resources. Therefore, it is for this reason that challenges and opportunities that exist in cooperative governance and partnerships must be investigated. The knowledge generated from such investigations should be used in guiding how the concept of cooperative governance and partnerships could be applied in future groundwater resource rehabilitation initiatives.

The current RMGs in Practice report was the culmination of the developed RMGs for water resources including, Rivers (Volume 1), Wetlands (Volume 2), Estuaries (Volume 3), Lakes and Dams (Volume 4) and Groundwater (Volume 5) that served as a valuable tool to demonstrate to intended users how the guidelines can be applied in real-world situations (*i.e.,* initiatives contained in **Tables 3** to **7**. The RMGs in Practice report fulfilled its purpose of providing a succinct account of rehabilitation initiatives, either ongoing or completed at a catchment level, by various authorities/organisations/institutions and a demonstration of their applicability in real-world situations.

5. WAY FORWARD

The next step of the RMG project is to conduct the Monitoring and Evaluation (M & E) inclusive of the reporting on the components of the ongoing rehabilitation interventions that were implemented as presented in **Tables 3** to **7**. Monitoring and Evaluation will also encompass some of the new and relevant rehabilitation projects that are not covered in this report. This task will be achieved through consultation and requests for information on the progress made to date from the relevant authorities, organisations, and/or institutions involved in the initiatives. The monitoring systems/mechanisms should be put in place by the responsible authorities to support the continuous evaluation of the interventions to assist project/WMA/CMA managers and the RMG champions to assess whether the interventions are progressing on schedule and are proceeding as planned. Furthermore, the evaluation process will also assist managers in determining whether the set rehabilitation objectives of the interventions are achieved in terms of environmental and social aspects. In essence, these systems/mechanisms monitor both environmental and social interventions. This monitoring would ensure that the interventions are within range as per the initial rehabilitation objectives that were set. In terms of instances whereby there are rehabilitation structures damaged (*i.e.,* structures that were damaged and/or failing and thus requires maintenance) due to vandalism as an example, community interventions such as promotion of awareness and education on water resource management would be applicable.

Reporting is an integral part of M & E and should duly be executed in a systematic and timely manner to provide information on the progress of interventions at periodic intervals. Monitoring, Evaluation, and Reporting are important components of rehabilitation projects that need to be conducted before, during and after interventions to demonstrate the aspects that ought to be reported upon. Monitoring, Evaluation, and Reporting should therefore be applied to assess amongst others, the quality of interventions implemented and ensure the rectification of any problems, and provision of feedback by the relevant authorities, organisations, and/or institutions regarding lessons learnt. The following are some of the key indicators to assess the overall performance of the interventions.

- Monitor the results of the techniques and methods employed for rehabilitation;
- Determine whether the rehabilitation objectives were achieved and whether there are any additional interventions required;
- Evaluate the effectiveness of interventions against the achievement of rehabilitation objectives and outcomes; and
- Determine maintenance objectives.

As part of the reporting process, a framework should be designed to capture the data as per the M & E activity for reporting purposes. An example of a data-gathering template is provided in **Annexure Q.**

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ANNEXURES

ANNEXURE A: EXAMPLES OF VARIOUS TYPES OF CONSTRUCTED WETLANDS AND/OR ARTIFICIAL WETLANDS AND THEIR APPLICABILITY IN SOUTH AFRICA (DWS, 2025).

A.1 Types of Artificial and/or Constructed Wetlands

There are several types of constructed wetlands, each suited to different water treatment needs:

- **Surface Flow Wetlands:** water flows horizontally over a bed of vegetation, allowing for exposure to the atmosphere, sunlight, and plants, which helps to break down contaminants. Mimic natural wetlands where water flows over the vegetation and soil surface. Ideal for treating municipal wastewater, urban runoff and Acid Mine Drainage (AMD). Also used extensively in ecological planning, landscape design and recreational features. Can be combined with sub- surface flow wetlands.

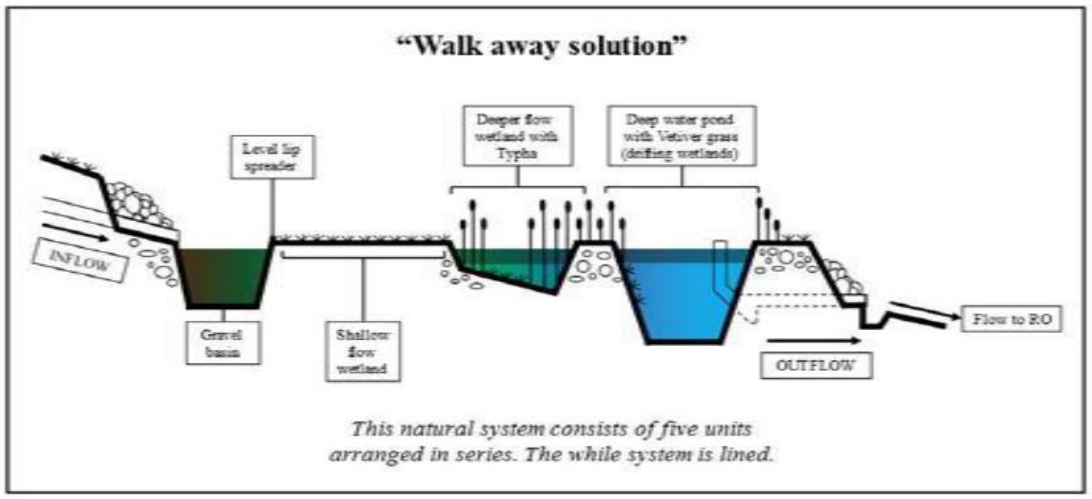


Figure 2: Examples of Mooiplaats Campus constructed wetlands

Source: DWS, 2025

- **Subsurface Flow Wetlands:** water flows through a porous substrate (usually gravel or sand) below the surface, which prevents exposure to air and enhances microbial activity for water purification. Treat water by allowing it to flow horizontally or vertically through a permeable medium planted with wetland vegetation. Used for more controlled treatment processes where contact with humans and animals is minimised. The latest WWTW constructed wetlands mostly make use of vertical flow, like at Midstream Estate and Mooiplaats student campus.
- **Hybrid Systems:** these systems combine elements of surface flow and subsurface flow wetlands to maximise treatment efficiency, particularly in complex scenarios where multiple types of pollutants need to be addressed. Combine multiple wetland types to maximise treatment efficiency and address complex or variable waste streams.
- **Instream versus off- stream:** constructed wetlands can be designed in- stream or off- stream and should be considered in the planning and alternatives phase to cause minimum impacts to natural systems.

A.2. Applications of Artificial and/or Constructed Wetlands

Constructed wetlands are specifically engineered to perform functions that natural wetlands would otherwise provide. They are typically used in settings where natural wetlands are unavailable, insufficient, or require additional assistance to manage water-related challenges. Some unique applications of constructed wetlands include:

- **AMD Rehabilitation:** using constructed wetlands to treat the acidic, metal-laden water resulting from mining activities, these systems neutralise acidity and remove heavy metals.
- **Sewage and Industrial Effluent Treatment:** constructed wetlands can purify wastewater from municipal and industrial treatment facilities, providing an efficient, cost-effective solution for improving water quality before discharge or reuse.
- **Stormwater Management:** in both urban and rural areas, constructed wetlands help manage stormwater runoff, reduce flood risks, and improve the quality of water entering rivers and lakes.
- **Agricultural Runoff Treatment:** by filtering nutrients, pesticides, and other pollutants from agricultural runoff, constructed wetlands prevent downstream water contamination and support sustainable agricultural practices.
- **Urban Greening and Cooling:** in urban environments, constructed wetlands are integrated into green infrastructure projects, helping to mitigate the urban heat island effect and providing green spaces that enhance biodiversity and human well-being.
- **Industrial Water Management:** wetlands treat water used in industrial processes, reducing pollution and enabling water reuse, thereby promoting sustainable industrial practices.
- **Landscape Architecture:** in most landscape architecture projects, constructed wetlands play a role to enhance the ecological category of watercourses, recreation, sense of place, open space experience.

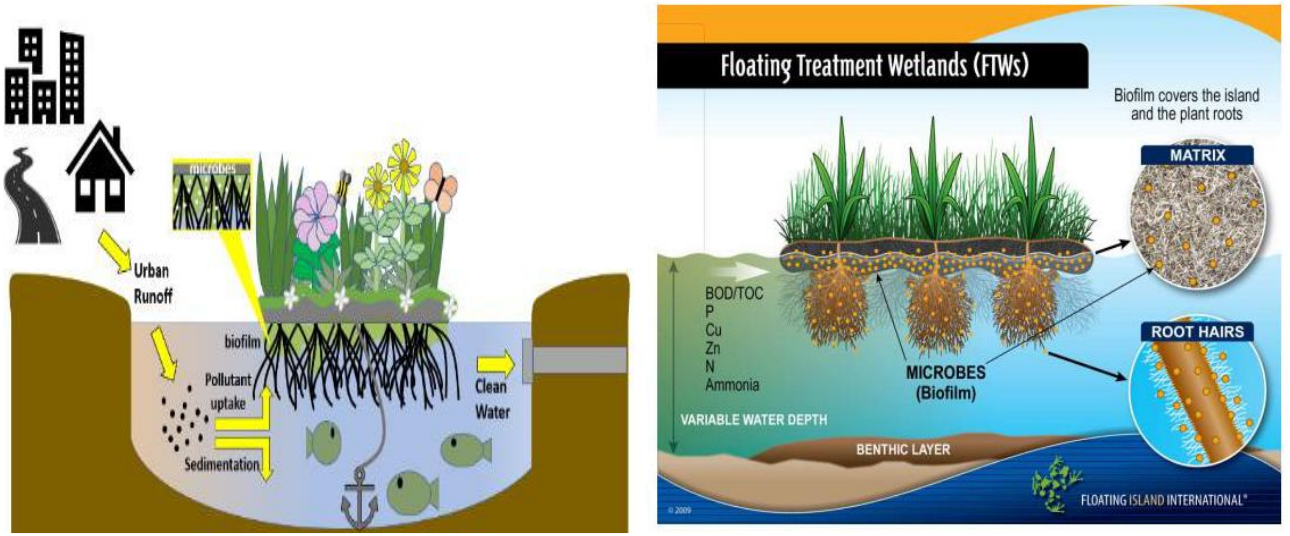
A.4. Examples and Applications of Artificial and/or Constructed Wetlands

Table 8: Examples and Applications of Artificial and/or Constructed Wetlands
Source: DWS, 2025

EXAMPLES	DESCRIPTION AND APPLICATION
Example 1: Klein Kariba	Example of constructed wetland weirs, stream canalisation and stream rehabilitation in a stream at Klein Kariba as part of landscape architecture (landscape planning, landscape design, landscape rehabilitation, flood protection, stream rehabilitation). Important is to add natural veld scientific buffers for ecological connectivity, riparian habitat and to add topsoil and vegetation on the side slopes of constructed streams to enhance the ecological category.  **Figure 3: Constructed wetland weirs, stream canalisation and stream rehabilitation in a stream** Source: DWS, 2025
Example 2.	In the Western Cape, a constructed wetland was developed adjacent to a winery to treat effluent. The site was selected based on proximity to the pollution source, suitable clay soils, and existing infrastructure access, ensuring efficient treatment and minimal environmental impact.
Example 3.	In Mpumalanga, an ecologically engineered wetland was established on a degraded agricultural site. The project aimed to restore natural hydrology, enhance biodiversity, and reconnect fragmented habitats. Site selection focused on areas with high restoration potential and opportunities to create ecological corridors.
Example 4.	A municipal wastewater treatment plant in Limpopo conducted a feasibility study for a constructed wetland to reduce operational costs and improve effluent quality. Economic analysis showed significant savings over time, and community engagement addressed

EXAMPLES	DESCRIPTION AND APPLICATION
	concerns about potential odours. Environmental assessments ensured compliance with regulations, and adaptive management plans were established
Example 5.	In the Northern Cape, a feasibility assessment for restoring a degraded wetland focused on enhancing water security for local communities. Stakeholder engagement included farmers and indigenous groups. Economic valuation of ecosystem services demonstrated long-term benefits outweighing initial costs. Environmental assessments highlighted the potential for significant biodiversity gains.
Example 6: Lakenvlei wetland.	A regenerative wetland rehabilitation project in a rural catchment area uses a combination of surface and subsurface flow areas to treat agricultural runoff while enhancing the local biodiversity. The design includes zones for different plant species that provide habitats for various wildlife species, improving ecological connectivity in the region. Another example might include removing agriculture out of wetlands by implementing scientific buffers and re- vegetation with wetland species. The rehabilitation of Lakenvlei wetland can also be seen as an example where the focus is on wetland rehabilitation as part of Glencore Mining Company efforts to comply with a Water Use License condition to implement wetland offsetting for wetlands authorised by the Department of Water and Sanitation to be destructed.  **Figure 4: Lakenvlei wetland rehabilitation via ecologically engineered methods like rock weirs and dongalocks courtesy of Birdlife Africa** Source: DWS, 2025

EXAMPLES	DESCRIPTION AND APPLICATION
Example 7: Zaalklapspruit wetland.	The Zaalklapspruit wetland plays a significant role in improving the AMD ending up in the Wilge River in the upper Olifants River catchment. Average Sulphate concentrations were reduced by 70%, while Al, Fe, and Mn levels were reduced by 98%, 80%, and 83%, from the inflow to the outflow sites of the wetland over a period of ~~5~~ five years of monitoring. Groundwater and surface water interaction is crucial to determine if an ecologically engineered wetland can retain its passive treatment capacity during drought conditions. From the study, it was evident that groundwater did not play a role in the passive treatment of the wetland during the dry and wet seasons. Valuable Lessons learned from the Zaalklapspruit wetland that can be used for the development of constructed surface wetlands.  **Figure 5: Zaalklapspruit ecological engineered wetland implemented by the University of the Free State (UFS) to treat AMD** Source: DWS, 2025
Example 8.	A constructed wetland treating industrial effluents incorporates a multi-stage treatment process with separate zones for sedimentation, nutrient removal, and final polishing. The hydraulic design includes adjustable weirs to control water depth and flow speed, optimizing treatment efficiency across various operating conditions.

EXAMPLES	DESCRIPTION AND APPLICATION
Example 9.	In a community park, a constructed wetland is designed with a variety of flowering wetland plants that treat urban runoff while providing a beautiful focus point, sense of place and educational landscape for visitors. The plant selection includes species with different sizes, forms, colours, textures, shapes and blooming periods to ensure year-round visual interest and ecological function.
Example 10: Floating wetlands.	• **Dams:** Enhance biodiversity on dams, farmlands and watercourses through constructed wetlands. Best practice materials selection is required**.** • **Water quality:** Enhance water quality through a range of design options.  **Figure 6: Floating wetlands concepts and materials** Source: DWS, 2025
Example 11.	A farm incorporates a small, constructed wetland to treat and recycle livestock wastewater or housing conservancy tank sewage water. The wetland is strategically placed to intercept runoff from barnyards and feedlots, reducing nutrient loads into local waterways and providing irrigation for pastures.
Example 12.	A city park includes a constructed wetland that manages stormwater while providing a scenic setting for visitors. The wetland features a combination of water-loving trees, perennial flowers, and grasses, with paths and benches that invite public interaction and enjoyment.

EXAMPLES	DESCRIPTION AND APPLICATION
Example 13.	A rural community develops a wetland to treat agricultural runoff, which also serves as a community gathering space. The project includes a partnership with local schools to provide educational programs and is funded by grants aimed at improving rural water quality and community health.
Example 14: Molopo Eye peat wetland.	Wetlands play a crucial role in carbon sequestration and biodiversity conservation, making them valuable tools for ecological restoration and climate change mitigation. Peat Formation: Some wetlands, particularly peatlands, are highly effective at storing carbon in their soil and vegetation. Molopo Eye peat wetland that is mismanaged by over abstraction which leads to the peat burning and wetland destruction. The Molopo Eye wetland is in urgent need of rehabilitation because of over abstraction. Long-Term Sequestration: Design wetlands to maximize carbon capture and storage, considering factors such as plant species selection and water management.
Example 15.	A national wildlife refuge includes a series of ecologically engineered wetlands designed to restore indigenous fish populations and support migratory bird species. The wetlands are part of a larger effort to restore a riverine ecosystem, providing critical habitats and connecting existing protected areas. Examples include Chrissiesmeer and Wilderness wetlands. All these wetlands are interconnected
Example 16.	An urban wetland park uses solar-powered sensors to continuously monitor water quality and control gates that adjust water levels. The park features an education centre with interactive exhibits that teach visitors about the functions of wetlands and the importance of water conservation. The centre also hosts workshops for local schools and community groups, promoting environmental education and stewardship.

ANNEXURE B: RESULTS FOR FRESHWATER HEALTH INDEX INDICATORS

Table 9: Results for Freshwater Health Index Indicators
Source: Conservation International, 2022

Indicators	Score	SUBINDICATORS	Score
ECOSYSTEM VITALITY	47		
Water Quantity	30	Deviation of Natural Flow	14
		Groundwater Storage Depletion	65
Water Quality	69	Water Quality Index	69
Catchment Condition	67	Bank Modification	88
		Flow Connectivity	44
		Land Cover Naturalness	77
Biodiversity	36	Species of Concern	48
		Invasive Species	27
ECOSYSTEM SERVICES	32		
Provisioning	33	Water Supply Reliability	29
		Biomass for Consumption	76
Regulation and Support	47	Sediment Regulation	18
		Water Quality Regulation	70
		Regulation of Diseases	67
		Flood Regulation	43
Cultural	14	Conservation and Cultural Heritage	11
		Recreation	61
GOVERNANCE & STAKEHOLDERS	51		
Enabling Environment	44	Water Resource Management	46
		Rights to Resource Use	51
		Incentives and Regulations	49
		Technical Capacity	38
		Financial Capacity	30
Stakeholder Engagement	57	Information Access	54
		Engagement in Decision-Making Processes	60
Effectiveness	49	Enforcement and Compliance	42
		Distribution of Benefits from Ecosystem Services	55
		Water-Related Conflict	53
Vision and Adaptive Governance	58	Monitoring Mechanisms	61
		Comprehensive Planning and Adaptive Management	56

ANNEXURE C: LOCALITY MAP OF THE EERSTE RIVER ESTUARY

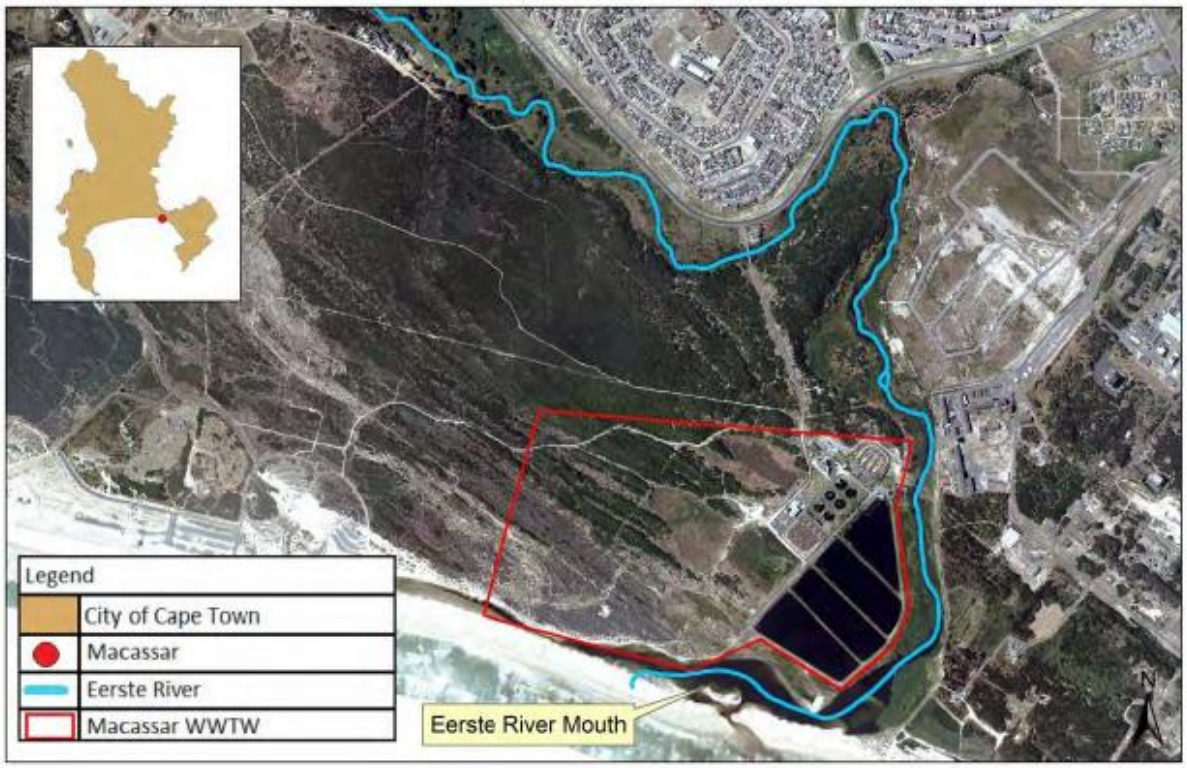


Figure 7: Locality map of the Eerste River Estuary
Source: Cape Action Plan for the Environment Estuaries (C.A.P.E) Programme, 2011

ANNEXURE D: LOCALITY MAP OF THE HOUT BAY RIVER ESTUARY

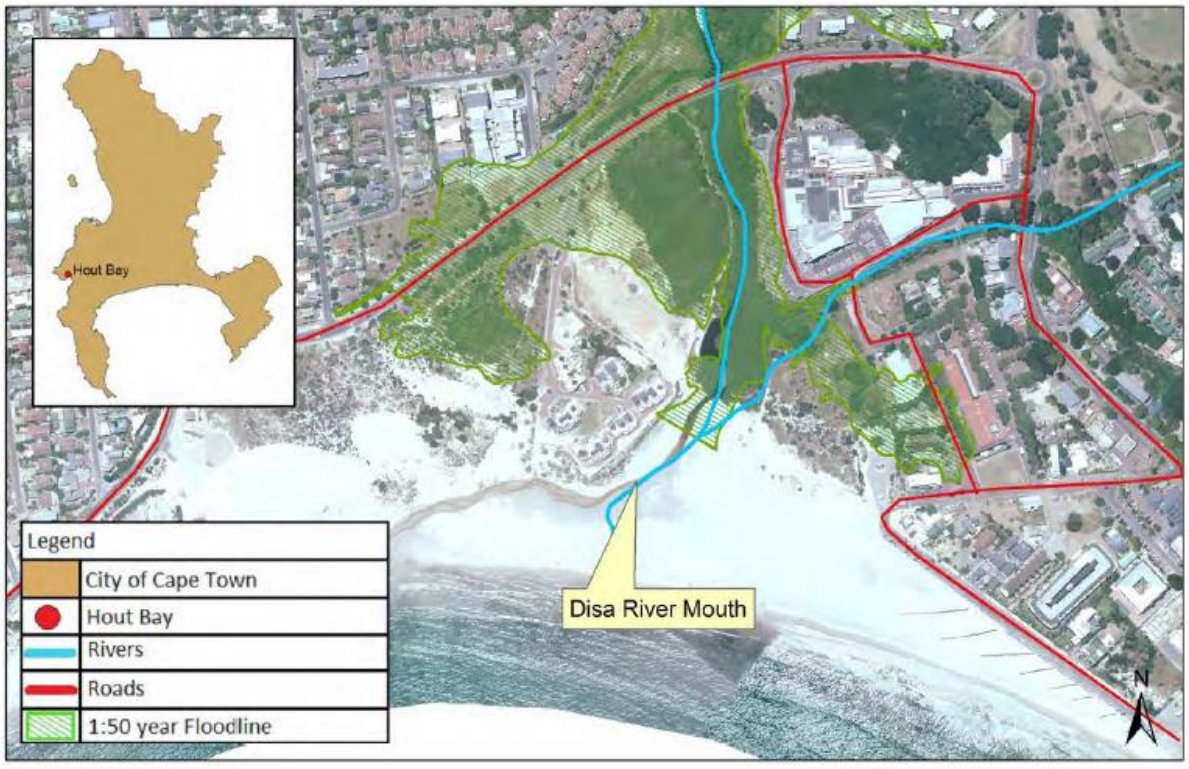


Figure 8: Locality map of the Hout Bay River Estuary
Source: Cape Action Plan for the Environment Estuaries (C.A.P.E) Programme, 2011

ANNEXURE E: LOCALITY MAP OF THE LOURENS RIVER ESTUARY

Figure 9: Locality map of the Lourens River Estuary
Source: Cape Action Plan for the Environment Estuaries (C.A.P.E) Programme, 2011

ANNEXURE F: LOCALITY MAP OF THE SILVERMINE RIVER ESTUARY

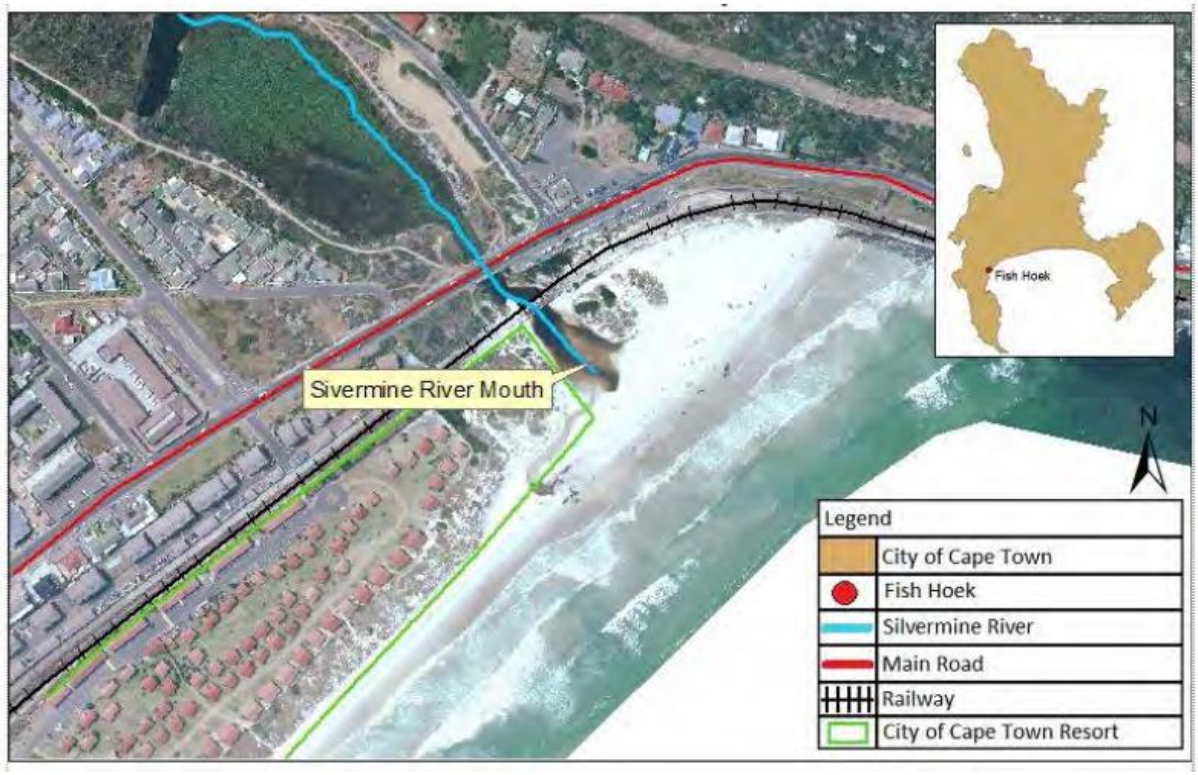


Figure 10: Locality map of the Silvermine River Estuary
Source: Cape Action Plan for the Environment Estuaries (C.A.P.E) Programme, 2011

ANNEXURE G: LOCALITY MAP OF THE SIR LOWRY'S PASS RIVER ESTUARY

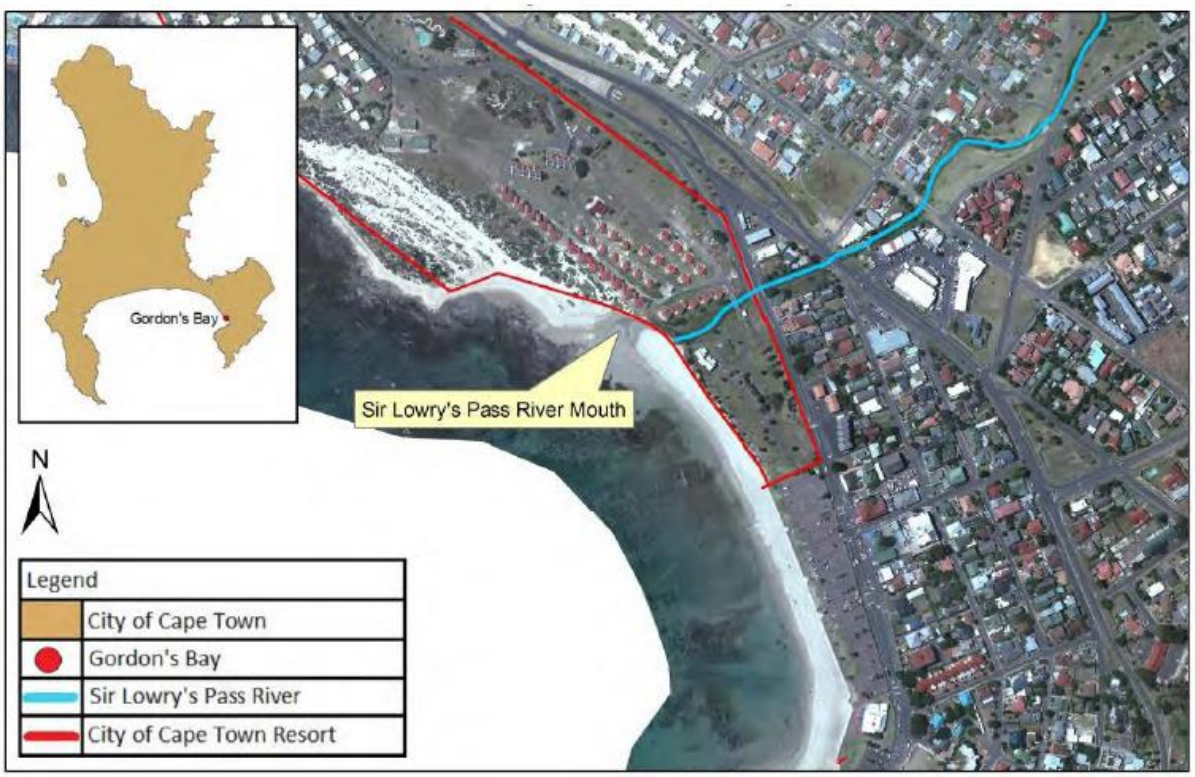


Figure 11: Locality map of the Sir Lowry's River Estuary
Source: Cape Action Plan for the Environment Estuaries (C.A.P.E) Programme, 2011

ANNEXURE H: LOCALITY MAP OF THE ZEEKOEVLEI RIVER ESTUARY

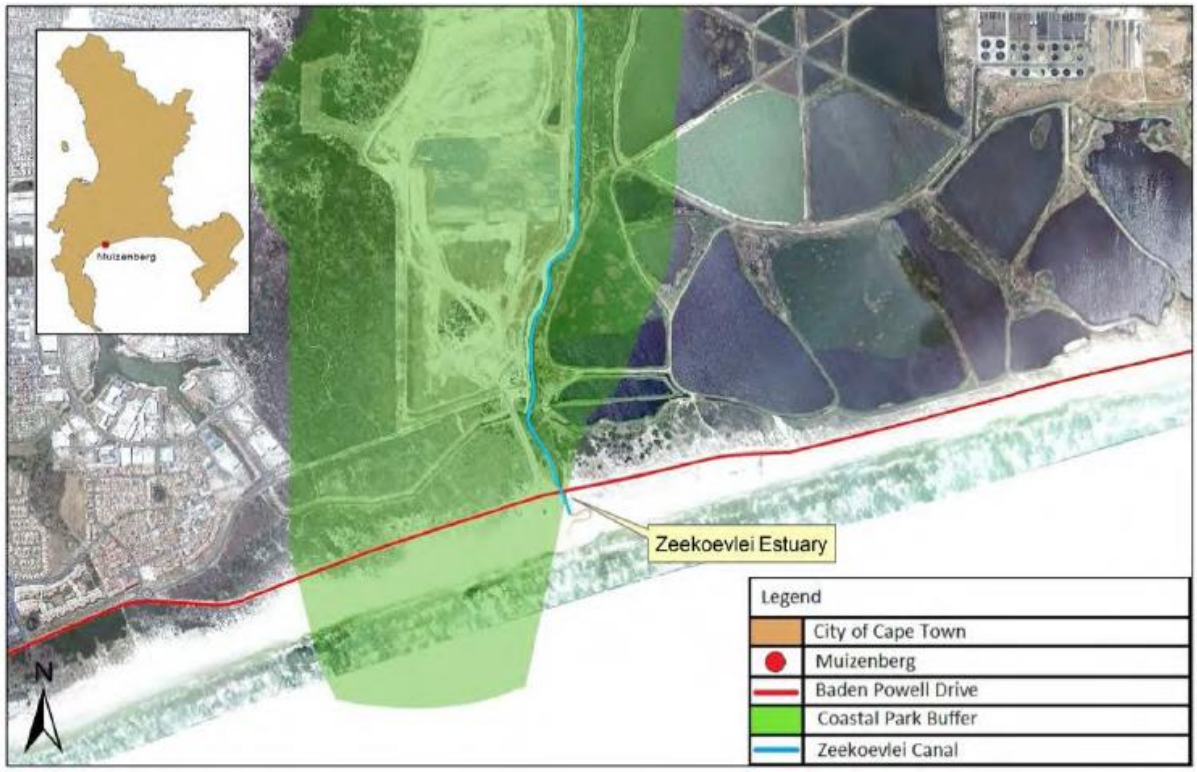


Figure 12: Locality map of the Zeekoevlei River Estuary
Source: Cape Action Plan for the Environment Estuaries (C.A.P.E) Programme, 2011

ANNEXURE I: LOCALITY MAP OF THE DIEP RIVER ESTUARY

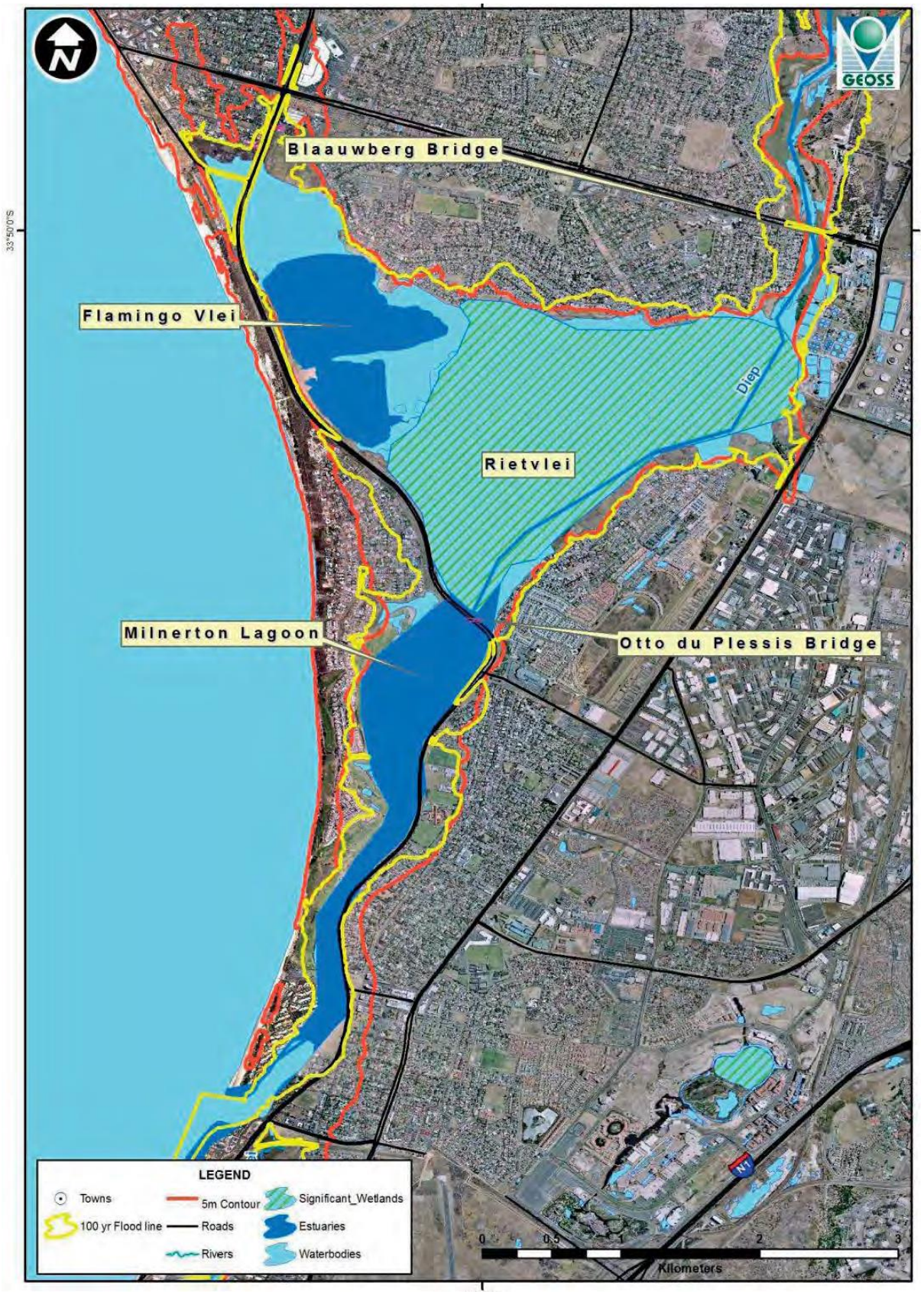


Figure 13: Locality map of the Diep River Estuary comprising of Rietvlei and the Milnerton Lagoon
Source: Cape Action Plan for the Environment Estuaries (C.A.P.E) Programme, 2011

ANNEXURE J: LOCALITY MAP OF THE ZANDVLEI ESTUARY

Figure 14 Locality map of the Diep Zandvlei Estuary compromising the channel, vlei, marina and wetland

Source: Cape Action Plan for the Environment Estuaries (C.A.P.E) Programme, 2011

ANNEXURE K: FLOATING BOOMS AT HARTBEESPOORT DAM, LOCATED IN THE NORTH-WEST PROVINCE OF SOUTH AFRICA

Figure 15: Floating booms [(Clockwise, from top left (1 to 6) implemented at Hartbeespoort Dam, including other technologies used for rehabilitation of eutrophication]

Sources: Hans et al., 2015

(Clockwise from top left)

1. **Floating booms** at Hartbeespoort Dam used to concentrate cyanobacteria, pumped out and composted.
2. A **constructed wetland** at Open Grounds Farm, near Beaufort, Northern Cape, designed to reduce the amount of nutrients and sediments entering the headwaters of the South River, a tributary of the Neuse River.
3. A **pumping barge** is used to remove harmful cyanobacteria from Dianchi Lake, China.
4. **Aluminium sulfate** and **sodium aluminate** are pumped to combat phosphorus loading and harmful cyanobacterial blooms.
5. A **dredging operation** in Lake Roaming Rock, Ohio, to remove nutrient-rich sediments.
6. A **riparian buffer** along Bear Creek in Story County, Iowa, designed to filter runoff of nutrients and sediments from adjacent farmland.
7. **LG Sonic**, MPC-Buoy using ultrasound waves to control algae.
8. **SolarBee solar** water circulator, used to reduce surface algae blooms in Santuit Pond in Mashpee, Massachusetts.
9. **Phoslock** is applied to Laguna Niguel Lake, to bind and remove phosphorus from the water column.

ANNEXURE L: THUKELA RIVER ABSTRACTION WORKS IN MIDDLEDRIFT, MADUNGELA WHERE VORTEX SETTLING BASIN (VSB) DEMONSTRATION IS APPLIED

Figure 16: Thukela River abstraction works in Middledrift, Madungela where Vortex Settling Basin (VSB) demonstration is applied
Source: WRC, 2025

ANNEXURE M: KHARKAMS RECHARGE SCHEME LAYOUT WITH SAND FILTER – RIVER SAND IS SIEVED FOR THE FILTER.

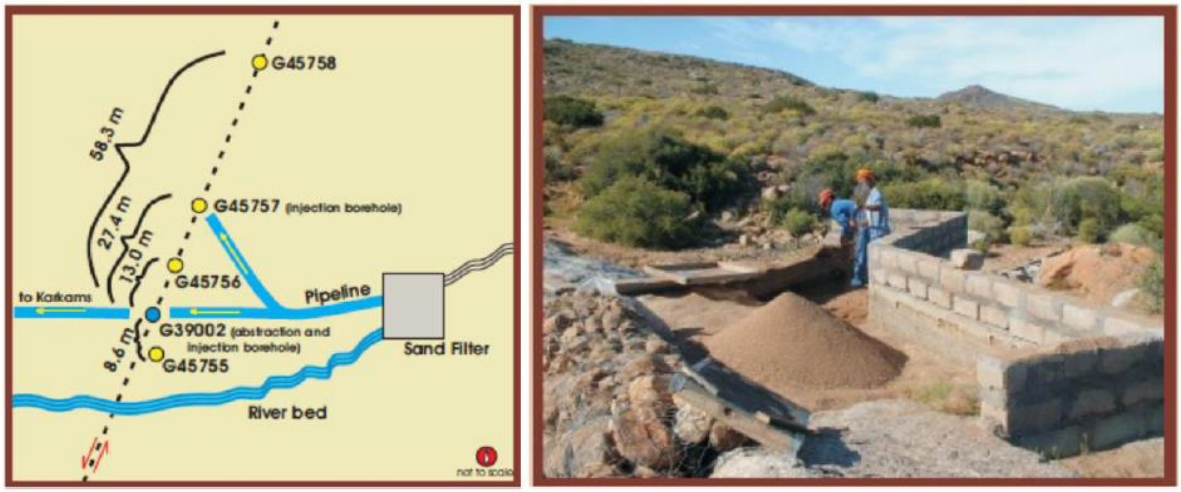


Figure 17: Kharkams Recharge Scheme layout with sand filter – river sand is sieved for the filter
Source: Braune and Sumaya, 2021

ANNEXURE N: BOREHOLE INJECTION TESTING AT LANGEBAAN ROAD AQUIFER.

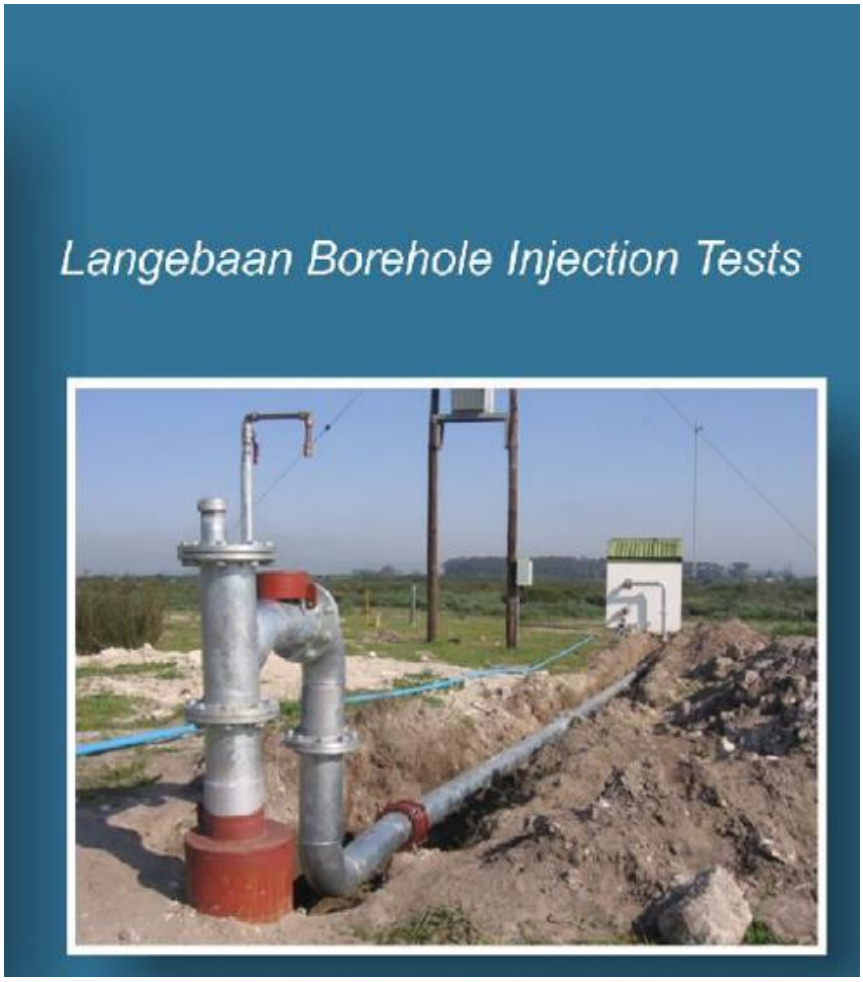


Figure 18: Borehole injection testing at Langebaan Road Aquifer
Source: Braune and Sumaya, 2021

ANNEXURE O: SCHEMATIC DIAGRAM OF THE EXISTING WATER SUPPLY ARRANGEMENTS FOR GREATER PLETTENBERG BAY.

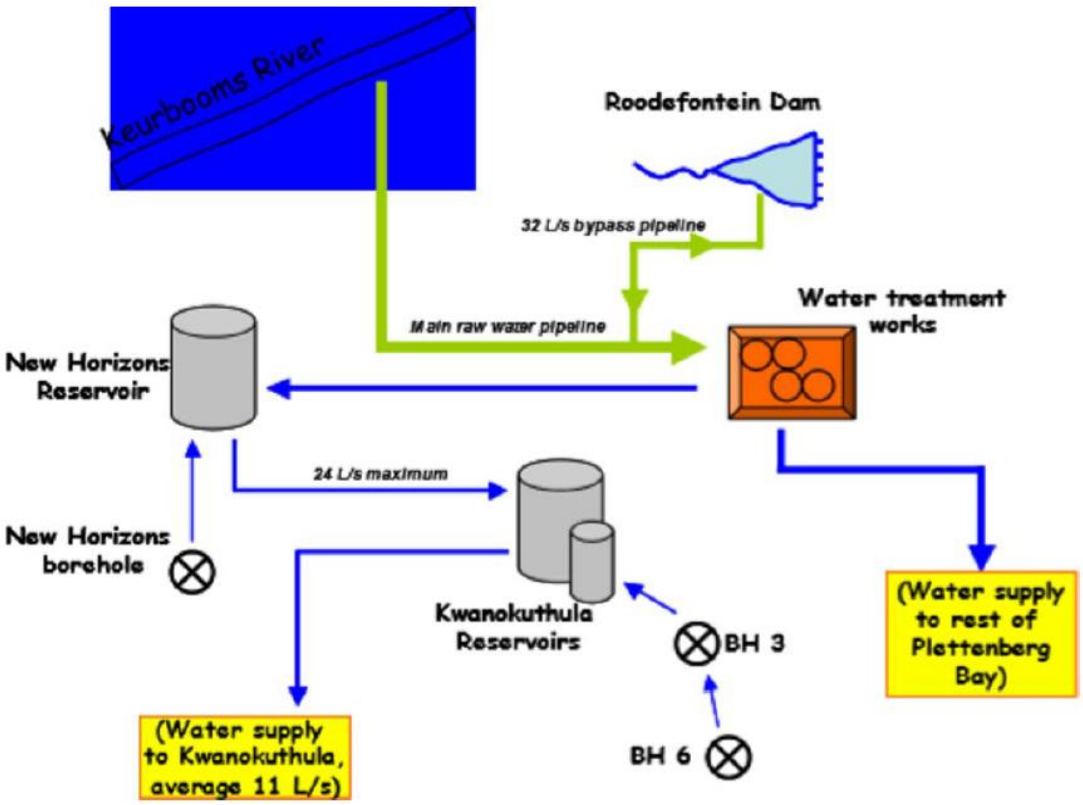


Figure 19: Schematic diagram of the existing water supply arrangements for greater Plettenberg Bay

Source: Braune and Sumaya, 2021

ANNEXURE P: ATLANTIS MANAGED AQUIFER RECHARGE SCHEME.

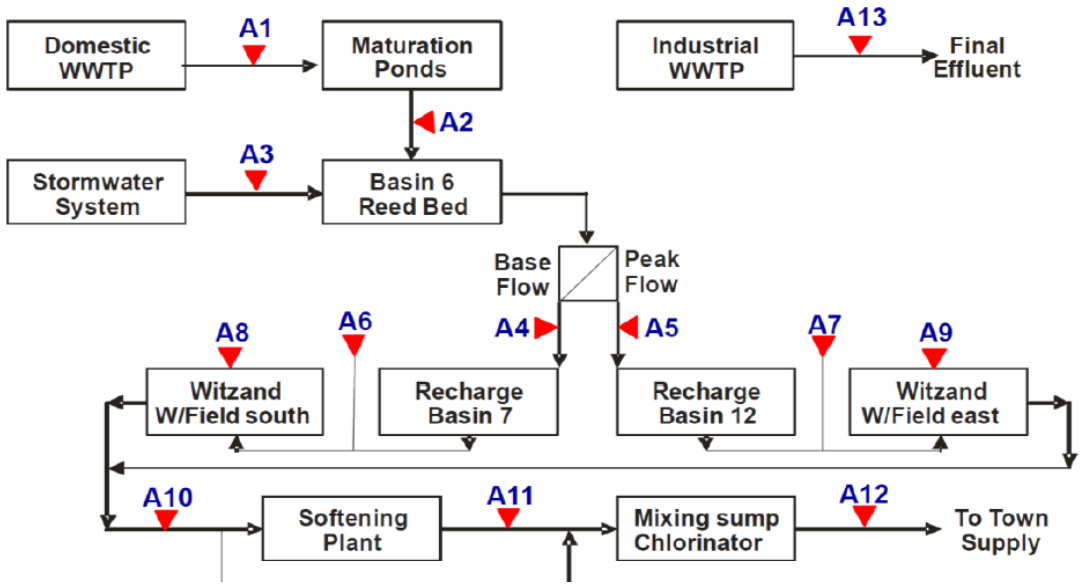


Figure 20: Atlantis Managed Aquifer Recharge Scheme

Source: Braune and Sumaya, 2021.

ANNEXURE Q: AN EXAMPLE OF A DATA-GATHERING TEMPLATE.

Table 10: An example of a data-gathering template.

Activity				
Objective				
Project location				
Monitored by				
Monitoring Phase	**Date**	**Observations/notes**	**Issues Identified**	**Actions Taken/recommendations**
Before Rehabilitation				
During Rehabilitation				
After Rehabilitation				