WETLAND MANAGEMENT GUIDELINES

Building capacity and supporting effective management of wetlands within South African municipalities

Preliminary version

Developed as part of the Local Action for Biodiversity (LAB): Wetlands SA project

ICLEI Local Governments for Sustainability

CBC Cities Biodiversity Center

LAB Local Action for Biodiversity AN ICLEI – IUCN PROGRAMME

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SANBI Biodiversity for Life South African National Biodiversity Institute

Working for Wetlands

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ABBREVIATIONS AND ACRONYMS

BMP	Best Management Practice
BP	Bioregional Plan
BSP	Biodiversity Sector Plan
CARA	Conservation of Agricultural Resources Act (No. 43 of 1983)
CBA	Critical Biodiversity Area
CMA	Catchment Management Agency
CMS	Catchment Management Strategy
DEA	Department of Environmental Affairs (National)
DWS	Department of Water and Sanitation (National)
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
EMF	Environmental Management Framework
ESA	Ecological Support Area
GI	Green Infrastructure
ICLEI AS	ICLEI Africa Secretariat
ICLEI CBC	ICLEI Cities Biodiversity Centre
IDP	Integrated Development Plan
IEMP	Integrated Environmental Management Plan
IWMP	Integrated Waste Management Plan
IWRM	Integrated Water Resource Management
IWRMP	Integrated Water Resource Management Plan
MPRDA	Mineral and Petroleum Resources Development Act (No. 28 of 2002)
MSA	Municipal Systems Act (No. 32 of 2000)
NEMA	National Environmental Management Act (No. 107 of 1998)
NEM: BA	National Environmental Management: Biodiversity Act (No. 57 of 2003)
NEM: ICMA	National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008)
NEM: PAA	National Environmental Management: Protected Areas Act (No. 57 of 2003)
NEM:WA	National Environmental Management: Waste Act (No. 59 of 2008)
NWA	National Water Act (No. 36 of 1998)
NWRS	National Water Resource Strategy
SEA	Strategic Environmental Assessment
SPLUMA	Spatial Planning and Land Use Management Act (
SCP	Systematic Conservation Plan
SCA	Systematic Conservation Assessment
TEEB	The Economics of Ecosystems and Biodiversity
WMA	Water Management Area
WRM	Water Resource Management
WSA	Water Services Authority
WSDP	Water Services Development Plan
WUL	Water Use Li cense
WULA	Water Use License Application

INTRODUCTION

The work of ICLEI-Local Governments for Sustainability

ICLEI – Local Governments for Sustainability is the leading global network of over 1,500 cities, towns and regions committed to building a sustainable future.

By helping the ICLEI Network to become sustainable, low-carbon, ecomobile, resilient, biodiverse, resource efficient, healthy and happy, with a green economy and smart infrastructure, we impact over 25% of the global urban population.

ICLEI Africa's work is conducted by a dynamic and passionate team of professionals that seek to work with cities to ensure a more sustainable future, with a specific focus on urban biodiversity matters.

In order to strengthen the role cities and local governments play in the pursuit of greater sustainability through the collaborative design and implementation of integrated urban development and effective biodiversity management, the ICLEI Cities Biodiversity Center (ICLEI CBC) was created in 2009. ICLEI CBC aims to create BiodiverCities, which promote urban biodiversity for the many benefits they offer, including human wellbeing, poverty alleviation, habitat conservation, air and water quality, climate change adaptation and mitigation, food provision, fortified infrastructure resilience, and happiness of citizens. BiodiverCities are aware that ecosystem services contribute towards many essential municipal services, as well as towards the local economy, sustainability and social well-being of their cities. Biodiversity in cities provides a critical contribution towards achieving the global biodiversity targets. It buffers further biodiversity loss, improves the urban standard of living, and provides local opportunities for global education and awareness.

The ICLEI CBC is located in Cape Town, South Africa, embedded in the Africa Regional Office of ICLEI.

Project Background

The Local Action for Biodiversity: Wetlands South Africa (LAB: Wetlands SA) project is a United States Agency for International Development (USAID) funded project, implemented by ICLEI – Local Governments for Sustainability (Africa Secretariat), hereafter referred to as "ICLEI".

The LAB: Wetlands SA project is currently being implemented in nine (9) district and two (2) metropolitan municipalities across South Africa. The aim of the project is to protect priority natural wetland resources, thus enabling the supply of ecosystem services and promoting resilient communities under a changing climate within South Africa. Through the project, ICLEI aims to improve local government knowledge and understanding of the value of wetlands, initiate the process of integrating wetlands and ecosystem

services into local government planning and decision making and to implement and pilot on the ground wetland projects within the participating municipalities.

ICLEI has appointed Eco-Pulse Consulting CC to develop 'Local Wetland Management Guidelines'. These guidelines are a component of a series of project outputs designed to support South African municipalities with improving wetland management going forward. For further information on the project, please refer to the LAB: Wetlands SA project website: http://cbc.iclei.org/project/lab-wetlands-sa/

Setting the Scene: Understanding wetland management in the South African context

Human development relies greatly on the services and benefits provided by nature, referred to as ecosystem services (see **Figure 1**).

Figure 1 Summary of the typical ecosystem services provided by natural ecosystems.

In rapidly urbanising developing countries like South Africa with a high proportion of low income residents, high levels of poverty, and a general lack of appropriate water and sanitation infrastructure, reliance on ecosystem services is relatively high and the degradation of natural ecosystems can negatively impact human well-being and in turn act as a barrier to socio-economic development[1] (see **Box 1**). Intact and functional ecosystems and their ecosystem services also contribute to the increased resilience of societies in the face of the effects of global warming and climate change (see **Box 2**). These effects include elevated temperatures, increased intensity and frequency of storm events and flooding, and increased frequency and duration of drought.

Box 1: Ecosystems and ecosystem services

An **ecosystem** is a group of plants, animals and other organisms interacting with each other and with non-living components of their environment. **Ecosystem services** are the benefits that people, society and the economy receive from nature[2].

Box 2: Climate change and global warming

At present, the global climate is undergoing relatively rapid changes. The changes are associated with global warming that is being accelerated by increased greenhouse gas emissions from human development, most notably from the burning of fossil fuels for power generation since the industrial revolution. Greenhouse gases are gasses that trap heat in the atmosphere like Carbon dioxide (CO_2) and methane (CH_4).

In urban settings in particular, the value of healthy and functioning ecosystems in reducing the impacts of climate change is increasingly being recognized. Additionally, the amenity and cultural benefits provided by natural environment are also starting to be recognized as important in enhancing the livability of urban environments; especially since the world is becoming more urban and will continue to do so. A preliminary economic valuation of the ecosystems provided by intact and functional ecosystems in South Africa[3] concluded that:

> "…maintaining untransformed natural systems generates substantial value equivalent to at least **7% of the country's GDP (R4014bn in 2015)**, either in the form of inputs to productive activities and welfare or the losses avoided by retaining these systems. This is more than three times the value of the agricultural, forestry and fishing sector (2.2%). This is a conservative and incomplete estimate."

Wetlands ecosystems in particular are increasingly being recognized as highly valuable natural assets that provide a wide range of ecosystem services to society in support of a number of important agendas such as: (i) biodiversity maintenance, (ii) water resource management, (iii) disaster management and climate resilience / adaptation, and (iv) direct use goods and cultural / amenity services to people. In urban contexts in particular, their ability to filter and improve the quality of water and reduce the intensity

[1] Roberts et al., 2012; Millennium Ecosystem Assessment, 2005
[2] Russi et al., 2013
[3] Turpie et al., 2017

of floods are considered valuable services in supporting biodiversity, water resources, public health and disaster risk management municipal objectives. Similarly, such services are important to rural and less developed areas where infrastructure is lacking and people are more reliant on the direct goods and services of wetlands.

Growing awareness of the benefits provided by wetlands and other functional ecosystems has resulted in the emergence of alternative approaches to development planning and infrastructure provision that considers the importance of freely available 'ecological infrastructure' and green infrastructure' (see **Box 3**), with wetlands recognized as important components in urban settings. It is important to note however that in the South African context, with far less developed built or 'grey' / 'hard' infrastructure compared to developed / affluent countries, the use and implementation of green infrastructure will still need to be weighed against the effectiveness of grey infrastructure to achieve municipal water, sanitation and health service objectives[4]. In rapidly urbanizing contexts with intense development pressure, high demand for water and sanitation services, and limited space, wetlands and other green infrastructure are easily overwhelmed and undermined by the stormwater (surface runoff generated from rain) and pollutants generated by urban land uses, and thus need to be carefully managed.

The following statements from the World Water Development Report 2018[5] emphasizes that the use of a combination of both grey and green infrastructure can work effectively:

- "There are a few examples where either nature-based solutions or grey (built) infrastructure is the only option to improve water availability, both should be considered, designed and operated in harmony"
- "In most cases green and grey infrastructure can and should be working together".

[4] Muller, 2018
[5] WWAP & UN-Water, 2018

Figure 2 An example of a typical modified wetland located within an urban setting[6].

Box 3: What is the difference between 'Ecological Infrastructure' and 'Green infrastructure'

Ecological infrastructure is "naturally functioning ecosystems that generate or deliver valuable services to people. It is the nature-based equivalent of built infrastructure, and is important for providing services and underpinning economic development"[7]

Green infrastructure (GI) is defined as a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services[8]. This definition includes three important aspects: the idea of a network of areas, the component of planning and management, and the concept of ecosystem services[8]. In this sense, GI integrates the notions of ecological connectivity, conservation and multi-functionality of ecosystems[9].

Despite increasing recognition of the value of wetlands, and South Africa's progressive environmental and water resource legislation and associated natural resource management strategies founded on the principles of sustainable development (see Box 4), rates of wetland loss and degradation has been and continues to remain high. Today wetlands are the most threatened of all South Africa's ecosystems with

[6] Photo taken by Douglas Macfarlane
[7] SANBI, 2016
[8] Liquete et al., 2015
[9] Mubareka et al., 2013

48% of wetland ecosystem types critically endangered and most loss occurring in urban and commercial agricultural contexts[10].

Box 4: Key terms in the sustainable development paradigm:

- **Sustainable development** – Development that meets the needs of the present generations without compromising the ability of future generations to meet their own needs[11]. Sustainable development is the process that is followed to achieve the goal of sustainability[12].
- **Environmental sustainability** – A policy goal for all human activities and governance that seeks to ensure that the present levels of human development do not compromise the functioning and viability of the earth's critical life-supporting systems for present and future generations[14].

Part of the problem is the lack of effective wetland management at the local government level, in particular the lack of integration of wetland management objectives into municipal planning, policies, budgeting, decision making processes and operations that influence development and its regulation. South African municipalities and cities face complex political, social and economic challenges and generally have less capacity to address environmental problems[13]. The immediate need to address socio-economic issues places substantial pressure on biodiversity and ecosystem maintenance (**Box 5**), protection and management thereof; and such socio-economic issues are generally prioritized at the expense of biodiversity and ecosystem conservation and managment[16].

Box 5: What is biodiversity?

Biodiversity (or biological diversity) is the variety of all life and its processes[14]. It includes the variety of all organisms, the genetic differences among them, the communities and ecosystems in which they occur, and the ecological and evolutionary processes that keep them functioning[17]. This includes all species, habitats and ecosystems and the connections between these[17].

In South Africa the efforts to mainstream natural resource / environmental management (see **Box 6**) into local government has been largely confined to the major metropolitan municipalities with little emphasis or support given to small municipalities[15].

Box 6: What does the 'mainstreaming' of the environment mean?

"Mainstreaming" the environment into local government refers to the integration of environmental issues and considerations into local government policies, plans and programmes[16]. Mainstreaming of the environment has a number of components, including[17]:

- The integration of environmental considerations and sustainable use principles into policies, plans and programmes (strategic planning tools).

[10] SANBI, 2011
[11] http://www.iisd.org/topic/sustainable-development
[12] DEAT, 2008
[13] Shih & Mabon, 2017
[14] eThekwini Municipality, 2012
[15] UNDP, SANBI, DEA & GEF, 2014; Sowman & Brown, 2006
[16] SALGA & DEA, 2016

- Mainstreaming on the ground in production and operational systems, especially those related to natural resource use and management.
- The integration of environmental values into the enabling environment (including legislation, policy, planning and capacity building).
- The integration of environmental considerations without deliberate intervention (for example, through market mechanisms).
- The use of a broad range of tools, including protected areas, buffer zones and ecological corridors, as well as incentives, subsidies and direct payments.

The current barriers and challenges to the mainstreaming of natural resource management and biodiversity conservation into local government planning and operations are illustrated in **Figure 3** below:[17]

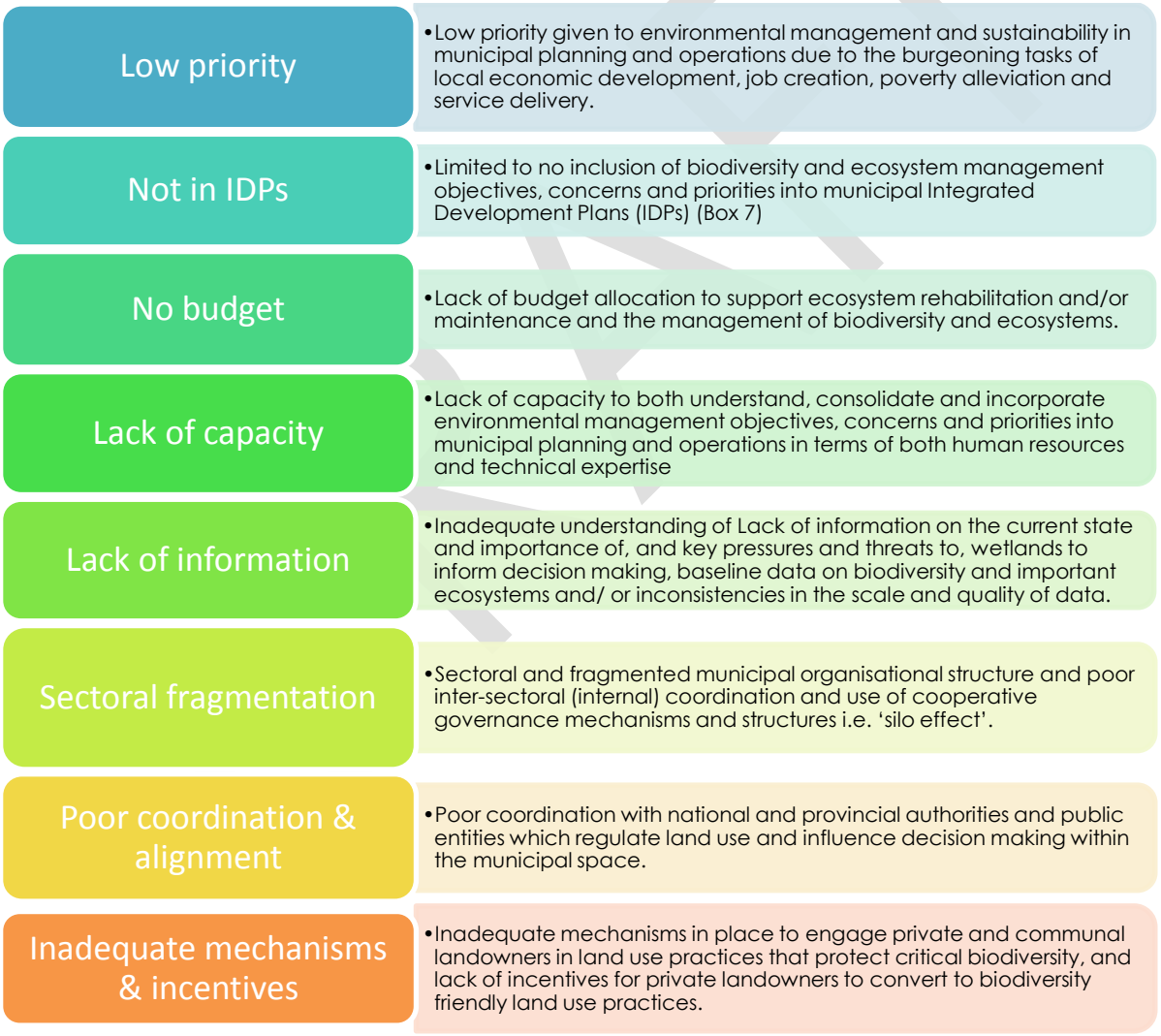

Figure 3 Barriers and challenges to the mainstreaming of environmental and biodiversity management into local government.

[17] UNDP, SANBI, DEA & GEF, 2014

Box 7: Integrated Development Plan (IDP)

IDPs are the principal strategic planning instrument for local government that guides and informs all planning and development, and all decisions with regard to planning, management and development[18].

[18] Sowman & Brown, 2006

HOW TO USE THE GUIDELINES

Rationale and Purpose of Guidelines

These guidelines aim to assist municipalities in tackling the above listed barriers and challenges by providing guidance on:

- the value of wetlands to municipalities,
- the mandates and powers of municipalities related to wetland management,
- how to develop a strategy to improve wetland management,
- how to develop a wetland inventory,
- how to prioritize important wetlands and wetland interventions,
- the value of, and the process for, restoring and enhancing wetland values,
- how to better manage impacts to wetlands as part of development application reviews,
- how to setup wetland monitoring and enforcement capacity, and
- how to proactively incorporate wetland management objectives into municipal planning.

The objective of the above-listed tasks is to assist municipal officials in enacting effective and sustainable wetland management within their jurisdictions, with the ultimate aim of achieving the following outcomes where applicable to the municipal context:

- Wetland biodiversity conservation.
- Improved climate resilience / adaptation and disaster management.
- Improved water resource management.
- Improved health for citizens.
- Improved amenity value and 'livability' of urban environments. Maintaining livelihoods dependent on wetland resources.
- Maximizing green job opportunities.

This guideline is specifically aimed at capacitating local government staff with little background in wetland management including town planners, engineers, environmental officers, municipal administrators, department managers and policy makers. With the use of this guideline, the civil servant will feel empowered to make a positive impact on wetland management and on the citizens of the municipality that benefit from the services that wetlands offer.

Structure and Content of Guidelines

This guideline is structured as follows:

Part 1 – The value of wetlands
This section introduces the reader to wetland ecosystems and highlights the value of wetlands to municipalities. This section articulates the value of wetlands in assisting municipalities in meeting their objectives for water resource management, disaster risk management, climate resilience / adaptation, meeting basic human needs, supporting livelihoods, enhancing public amenity, conserving biodiversity and creating green jobs.
Part 2 – Legislative, policy and institutional context for wetland management
This section situates municipal wetland management within the broader policy, legislative and institutional context and unpacks the mandate, responsibilities and opportunities for wetland management at the local government level.
Part 3 – Taking stock of wetland management
This section provides guidance on, and a framework for, assessing the current wetland management situation of a municipality and developing a strategy and action plan to improve and strengthen wetland management practices at the municipal scale.
Part 4 – Developing a wetland inventory and undertaking wetland prioritization
This section provides guidelines for developing a baseline wetland inventory for the municipality and undertaking wetland prioritization. Being a specialist process, the guidelines focus on the broad level steps and tasks to be undertaken and summarizes the key objectives, methods and outcomes of the wetland inventory and prioritization processes.
Part 5 – Restoring and enhancing wetland values
This section provides an overview of the benefits and relevance of wetland rehabilitation and enhancement to municipalities. Reasons for municipalities taking a proactive role in wetland rehabilitation are discussed and an overview of the rehabilitation planning process is provided.
Part 6 – Guidance for managing development impacts on wetlands
This section provides a broad review of current best management practices (BMPs) for the purposes of assisting municipal officials in the interrogation of development applications in terms of Spatial Planning and Land Use Management Act (No. 16 of 2013) (SPLUMA), and stakeholder review processes for the National Environmental Management Act (No. 107 of 1998) (NEMA) Environmental Authorisation and the National Water Act (No. 36 of 1998) (NWA) Water Use License stakeholder applications. An application review protocol is also provided.
Part 7 – Guidelines for establishing compliance, enforcement and monitoring functions
This section provides broad guidance on the development and implementation of a municipal wetland monitoring programme and a compliance monitoring and enforcement system.
Part 8 – Guidelines for mainstreaming wetland management into municipal planning
This section provides guidance on how best to incorporate wetland management objectives into municipal planning, namely the Integrated Development Plan (IDP), Spatial Development Framework (SDF) and Land Use Scheme (LUS), which together set the context for social and economic development in the municipality. This section focuses on ensuring that wetland management is entrenched in development planning through bridging the gap between social needs and wetland service provision and identifying available wetland

management mainstreaming planning tools and key wetland management related programmes and projects.

1. THE VALUE OF WETLANDS

This section introduces the reader to wetland ecosystems and highlight the value of wetlands to municipalities. This section articulates the value of wetlands in assisting municipalities in meeting their objectives for water resource management, disaster risk management, climate resilience / adaptation, meeting basic human needs, supporting livelihoods, enhancing public amenity, conserving biodiversity and creating green jobs.

1.1 What is a wetland?

Box 8: Legal definition of a wetland

In terms of Section 1 of the National Water Act (No. 36 of 1998) (NWA), wetlands are legally defined as: "**land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil**."

Wetlands are defined by the presence of unique soils and vegetation that do not occur in terrestrial and purely aquatic environments (**Box 9**). Wetland soils are referred to as hydric soils (**Box 10**) that develop under anaerobic conditions (condition where oxygen is virtually absent from the soil). Wetlands are also typically characterized by relatively large and dense stands of plants sticking out of shallow water or wet soil. Plants adapted to such waterlogged conditions are referred to as hydrophytes (**Box 11**). Wetlands are distinct from true aquatic ecosystems like river ecosystems, which are characterized by fast flowing water within channels, and lake ecosystems, that are flooded to great depth; both of which are not primarily characterized by the occurrence of hydric soils and hydrophytes.

Box 9: What are aquatic ecosystems?

An aquatic ecosystem is where a defined group of plants, animals and other living organisms interact with each other and with non-living components in the water column. Aquatic ecosystems can be broadly divided into freshwater (rivers and lakes) and marine ecosystems. Wetlands are often included as a unique transitional ecosystem type under the umbrella of aquatic and/or freshwater ecosystems.

Box 10: Hydric soils

The prolonged waterlogging and saturation of soils results in the occurrence of anaerobic conditions (no molecular oxygen present) and the formation of distinct soil features like the loss of soil colour (called 'gleying') and mottles. The loss of soil colour is a result of the reduction of mineral oxides in the soil under saturated soil conditions and mottles are concentrated mineral oxide deposits that precipitate out of solution during the drying of the soil in the dry season. Soils characterized by these features are referred to as hydric soils[19].

[19] Collins, 2005, DWAF, 2005

Box 11: Hydrophytes

Hydrophytes are plants that can survive and reproduce in anaerobic soil conditions. Plants require oxygen to live and typically take-up oxygen from the soils via their roots. Such oxygen is absent for all or part of the year in hydric soils. Thus, hydrophytes have evolved special features / adaptations that enable oxygen to be taken from the atmosphere via their leaves and transported internally. For this reason leaves and stems of wetland plants are often hollow and/or spongy.

Figure 4 Saturated, grey wetland soils[20].

Figure 5 Brightly mottled wetland soils[21].

[20] Photo taken by Adam Teixeira-Leite

Figure 6 Dense emergent wetland vegetation[21].

Figure 7 Dense herbaceous wetland vegetation[22].

A wide variety of wetlands occur across South Africa. These can be classified into six (6) broad types, namely floodplain wetlands, un-channeled valley bottom wetlands, channeled valley bottom wetlands, seeps, depressions and wetland flats[23] (**Figures 8 & 9**). Owing to the large variations in climate and topography across South Africa, vegetation and habitat associated with these wetland types vary tremendously from subtropical reed beds and tall swamp forests to arid salt pans, which all support unique and varied animal life.

[21] Photo taken by Douglas Macfarlane
[22] Photo taken by Ryan Edwards
[23] Ollis et al., 2013

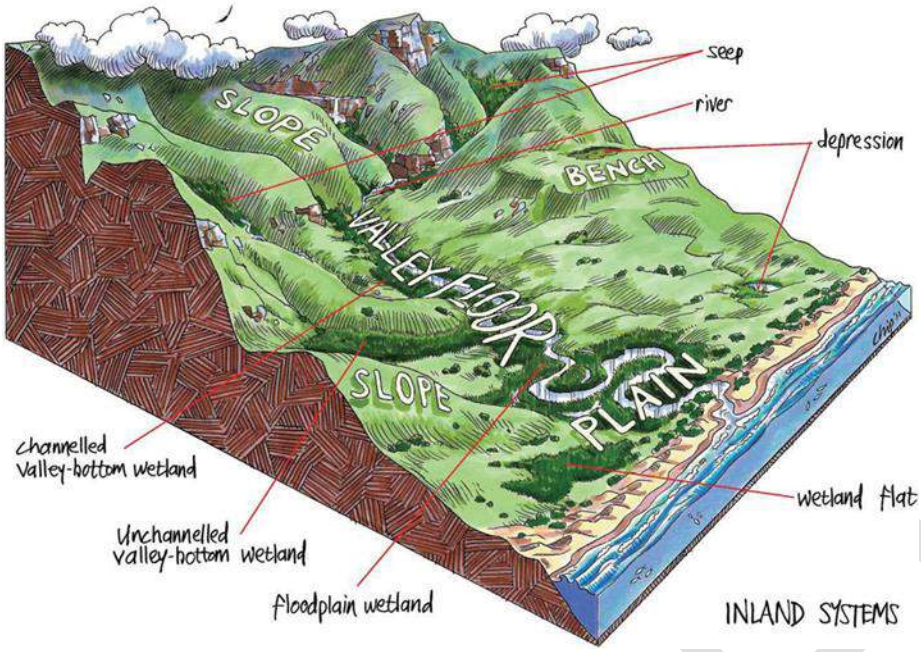

Figure 8 : South African wetland hydro-geomorphic types[24].

[24] Ollis et al., 2013

Floodplain wetland, Wilge River, Free State[25]

Un-channeled valley bottom wetland, Lesotho[26]

Channelled valley bottom wetland, Lesotho[26]

Seep, Golden Gate National Park, Free State[26]

Depression wetland, Eastern Cape[26]

Wetland flat, iSimangaliso Wetland Park, KZN[26]

Figure 9 South African wetland hydro-geomorphic types in pictures.

[25] Photo taken by Douglas Macfarlane.

[26] https://goodmorningworld.de/wp-content/uploads/2017/04/Suedafrika-Safari-iSimangaliso-Wetland-Park-10.jpg

1.2 What is the extent and state of wetlands occurring in SA?

Wetlands mapped in South Africa to date cover a total area of 2.9 million ha or 2.4 % of the country's surface area[27].This low extent of coverage is largely attributable to climatic conditions that are not conducive to the persistence of surface water[28]. As wetlands need water to exist, they tend to be grouped in the moister regions of the country with higher prevalence in the wetter provinces like the Western and Eastern Cape, KwaZulu-Natal, Gauteng and Mpumalanga.

The National Biodiversity Assessment: Freshwater Component[28] related to wetland ecosystems concluded that wetlands are the most threatened of all South Africa's ecosystems, with **48% of wetland ecosystem types critically endangered** as shown in **Figure 10** below (see **Box 12**).

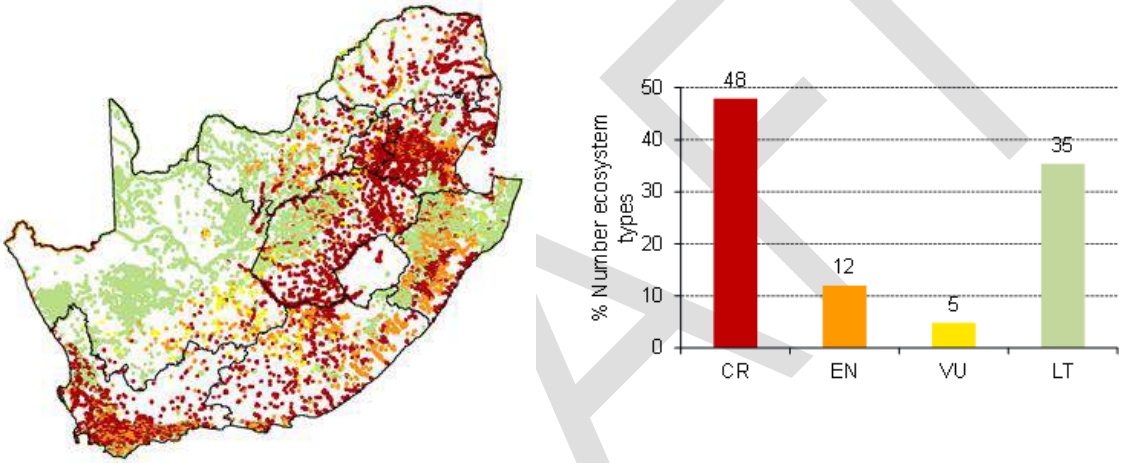

Figure 10 Map of South African wetlands shaded according to national threat status with corresponding threat status graph indicating threat status proportions as a percentage.

The majority of wetland loss and degradation coincides with areas of intense land use pressure such as urban and industrial development as well as commercial agriculture. In addition, levels of protection of wetland ecosystems are relatively low.

[27] Driver et al., 2012
[28] Dini & Everard, 2016

Box 12: Threatened ecosystems and conservation threat status categories[29]

A **threatened ecosystem,** as defined in the National Biodiversity Assessment[30], is an ecosystem type that has been classified as Critically Endangered, Endangered or Vulnerable (as defined below), based on an analysis of ecosystem threat status. A threatened ecosystem has lost or is losing vital aspects of its composition, structure or function.

The relevant conservation status categories and their descriptions are as follows:

- Critically endangered (**CR**) – Very little of its historical extent left in good ecological condition. Most of the historical extent of the ecosystem type is in fair or poor ecological condition. The ecosystem type is likely to have lost much of its natural structure and functioning, and species associated with the ecosystem type may have been lost.
- Endangered (**EN**) - An ecosystem type that is close to becoming Critically Endangered, i.e. that has little of its historical extent left in good ecological condition and is likely to have lost much of its natural structure and functioning.
- Vulnerable (**VU**) – An ecosystem type that still has the majority of its historical extent left in good or fair ecological condition, but has experienced some loss of habitat or deterioration in condition. The ecosystem type is likely to have lost some of its structure and functioning, and will be further compromised if it continues to lost natural habitat or deteriorate in condition.
- Least Threatened (**LT**) – An ecosystem type that has experienced little or no loss of natural habitat or deterioration in condition.

1.3 What factors affect wetland form and function?

Wetlands are primarily environments characterized by a surplus of water at or close to the surface of the earth[31]. This surplus of water is driven by the interaction of the wetland's water supply from its catchment (**Box 13**) and the shape and roughness of the wetland that typically slows downs and spreads out water, creating shallow waterlogged conditions. Wetlands are also places where sediment accumulates due to the low energy conditions. The word "sediment" is typically associated with the silt and mud that turns water grey or brown[32]. For this reason, wetlands are equally impacted by activities in the catchment that alter water supply characteristics as by activities that occur within wetlands. This means that even developments that avoid wetlands can have measurable and significant impacts through altering catchment water supply and drainage characteristics (volumes and patterns of flow). A simplified schematic of the key components of wetland ecosystems and their interrelationships is provided in **Figure 11** below.

[29] SANBI, 2016
[30] Driver et al., 2011
[31] Ellery et al., 2008

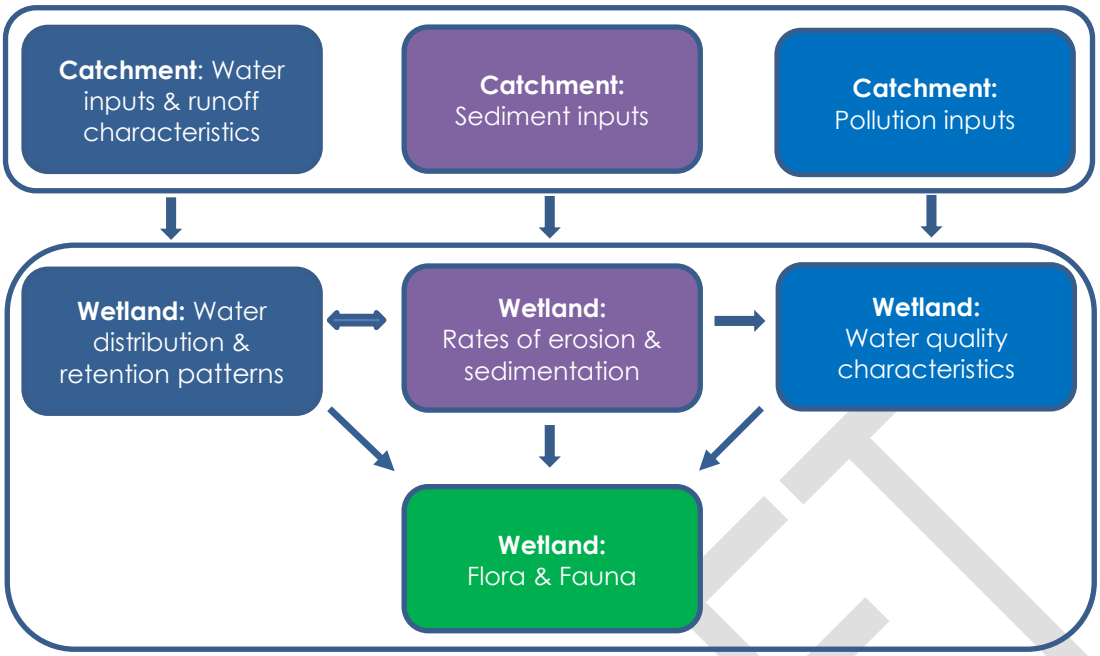

Figure 11 Schematic of the key components of wetland ecosystems and the interrelationships.

Box 13: Catchment

A catchment is the land area from which water runs off into a specified wetland or aquatic ecosystem i.e. a drainage basin[32].

1.4 Why are wetlands important?

Wetlands are truly unique ecosystems and are recognized as among the world's most productive and valuable ecosystems. Despite covering only 6.5% of the Earth's land surface, wetlands provide a disproportionately high 40% of global ecosystem services[33]. According to the 'The Economics of Ecosystems and Biodiversity' (TEEB) for water and wetlands[34], wetlands have among the highest value per hectare per year, exceeding temperate forests and grasslands. They play a fundamental part in local and global water cycles and are at the heart of the connection between water, food, and energy; a challenge for our society in the context of sustainable management and development[35].

In the municipal context, wetlands represent ecological infrastructure that can contribute to a number of key municipal functions and objectives, as illustrated in **Figure 12** and discussed further below.

[32] Ollis et al.,2013
[33] Zedler and Kercher, 2005
[34] Russi et al., 2013
[35] Clarkson et al., 2014

Figure 12 Dashboard of key municipal aspects and objectives that wetland management can contribute towards.

1.4.1 Contribute to water resource management

Water resource management:

South Africa is a water-stressed country whose socio-economic development places enormous pressure on water resources. With predicted population growth and associated urban and agricultural expansion, in conjunction with the predicted effects of climate change, pressure on water resources is going to continue to increase. The proper protection and management of water resources is thus critical to all current and future levels of human development. An overview of the water resource management framework entrenched in the NWA (1998) is summarized in **Box 15** below.

Box 15: Water resource management framework in South Africa

With the promulgation of the NWA (1998), a water resource was redefined as the entire aquatic ecosystem and not merely the water it provides[19]. Water is now seen as being inseparable from the aquatic ecosystems that store, use and convey it. This interpretation comes from the acknowledgement that the quantity and quality of water is critically dependent on the integrity of aquatic ecosystems and the maintenance of key ecosystem functions. The implication of this perspective is that the 'total water resource' consists of a useable component and a reserve component. The reserve consists of the 'basic humans needs reserve' and the 'ecological reserve'. The basic human needs reserve provides for the essential needs of individuals served by the water resource in question and includes water for drinking, for food preparation and for personal hygiene (NWA, 1998). The ecological reserve the quantity and quality of water required to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource[19]. Within this framework, the reserve requirements must be met before any allocation of water

for productive use is made[19]. The useable component referred to as the 'total allocatable resource' is the quantity and quality of water which remains in excess of the reserve that can be distributed amongst competing[19].

Out of this perspective has come a goal orientated approach to water resource management (WRM) that seeks to define the desired future state of the resource through classification, reserve determination and setting resource quality objectives (RQOs), together referred to as 'Resource Directed Measures'. In classification, the vision for the future of the resource is expressed in terms of four Ecological Management Categories (EMCs) from A to D in order of decreasing levels of protection for, or increasing levels of risk to, aquatic ecosystems and their components[19]. The chosen EMC then determine the reserve and RQOs.

Wetlands are considered to be important ecological infrastructure supporting water resource management in South Africa. This is done through steam flow regulation, nutrient and toxicant removal and sediment trapping. (**Figure 13**).

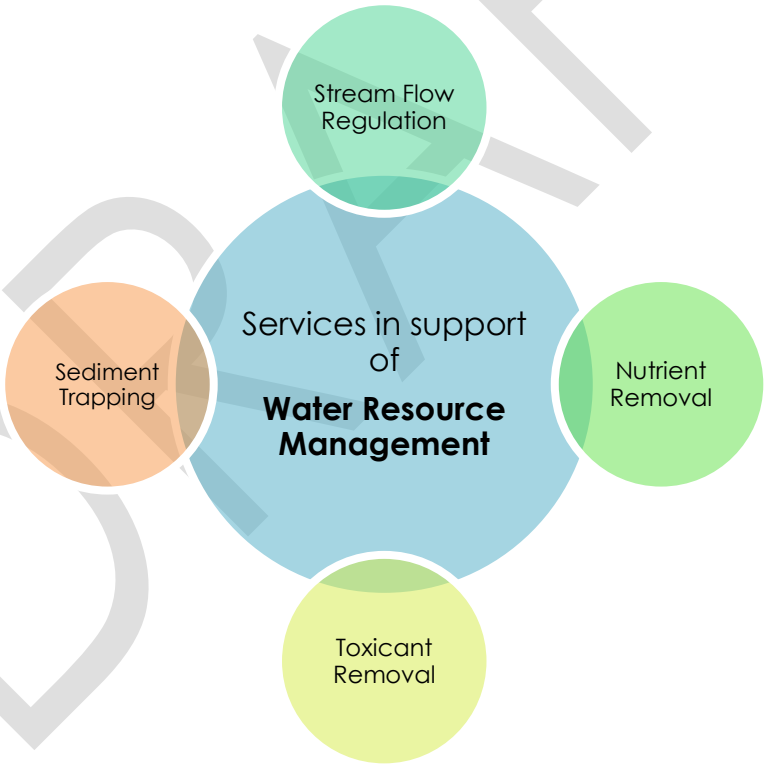

Figure 13 Diagram indicating the key wetland ecosystem services that support water resource management objectives.

Stream flow regulation services:

Wetlands store and release flows that may sustain surface flows and can recharge groundwater during low flow periods. This service is referred to as 'streamflow regulation' or more specifically 'base flow maintenance' (see **Box 16**). Base flows are critical to the maintenance of aquatic and wetland ecosystems, habitat and species as well as the quantity and quality of water conveyed and discharged by these systems. It is recognized, however, that wetlands are users of water through evaporation and transpiration and do not generate water[36]. Thus, wetlands actually reduce the quantity of flows. Nevertheless, in certain circumstances the regulation and delayed release of water from wetlands can contribute to streamflow maintenance and drought resilience. Such a service is becoming increasingly important with the shifts in drought timing, duration and intensity anticipated with climate change. Upstream and headwater wetlands in particular are increasingly being recognized as playing important roles in maintaining local water resources in this regard. It is important to note that this ecosystem service is still a poorly understood phenomenon in scientific literature.

Box 16: What is base flow?

The portion of stream flow that is generated by the seepage of water from the ground into a channel slowly over time[37]. It is the primary source of running water in a stream channel during the dry season or dry periods.

Water quality enhancement (filtering) services: nutrient and toxicant removal

Owing to their low-lying positions in the landscape and being located at the land–water interface, wetlands are recipients, conduits (transporters) and sinks of sediment, nutrients and toxicants washed in from upslope and the catchment[38]. Their topographical location in combination with their typical low energy, waterlogged and densely vegetated conditions promotes the operation of a number of biogeochemical (**Box 17**) and mechanical (settling) processes that filter water flowing through wetlands and ultimately contribute to improved water quality for fish, wildlife and people. This is why wetlands are often called 'nature's kidneys'. However, being a sink of nutrients can also create ecological problems for wetlands, especially where elevated nutrient levels result in the expansion of invasive aquatic species like Water Hyacinth (*Eichhornia crassipes*) and Bulrush (*Typha capensis*). It is also important to note that wetlands are most effective at removing pollutants when the residence time (see **Box 18**) of water flowing through wetlands is sufficiently long enough to allow for the pollutant removal processes to occur. This is largely a factor of wetland slope, length and degree of flow concentration (i.e. low flow pattern). Please refer to the case study of the rehabilitation of the Zaalklpaspruit wetland system in **Annexure A1** where the positive water quality enhancement benefits of wetland processes have been confirmed through scientific monitoring.

[36] Kotze et al., 2009
[37] Kleynhans et al., 2008
[38] Zedler & Kercher, 2005

Box 17: Biogeochemical processes

Refers to the cycling of nutrients and toxicants by an interaction physical, chemical and biological processes in an ecosystem[39].

Box 18: What is 'residence time' in wetland science?

The length of time it takes for a certain quantity of water to flow through a wetland.

It is important to note that wetlands are not a 'silver bullet' to water quality issues and often cannot cope with the large pollutant loads in urban and commercial agricultural contexts. Thus they should not be considered alternatives to conventional built / grey waste water treatment infrastructure that have the capacity to treat elevated pollutant loads. Rather wetlands in urban settings can be used to complement and enhance conventional infrastructure and built environments with the aim of lowering impacts to downstream aquatic ecosystems and water resources, retaining higher levels of natural functions / services in the landscape, and ultimately contributing to the improved water resource management at the catchment scale. In an effort to capitalize on the passive water treatment capacities of wetland environments, the design and implementation of engineered enhanced and/or constructed wetlands that can filter elevated pollutant and sediment loads is increasingly being adopted as part of urban drainage systems by municipalities in an effort to buffer downstream water resource and communities from water pollution risks. Please refer to the case study of the establishment of a constructed wetland on the Olifantsfontein Wetland in **Annexure A2**.

Sediment trapping:

Whilst sediment trapping is considered to be a water quality enhancement service in itself, the type of sediment trapping services provided by wetlands are also important for increasing the lifespan of downstream dams (and thus increasing water supply), with substantial cost savings to the public and private water supply systems.

It should be noted however that high sediment loads can also cause damage to wetlands in the form of vegetation smothering and burial, and changing the topographical profile. Therefore upstream catchment management is critical in order to maximize the sediment trapping capabilities of wetlands and subsequently enhance the longevity of downstream built infrastructure such as dams.

Benefit to municipalities:

There is no clearly defined mandate for municipalities to undertake water resource management. Legally water resource management is the mandate of national government (Department of Water & Sanitation - DWS) and Catchment Management Agencies (CMAs) (Please refer to Section 2 that discusses the legal framework for wetland management in more detail). However, municipalities have a broad constitutional mandate and responsibility to ensure a safe and healthy environment (the 'environmental right') and for the sustainable provision of their services and functions including water and sanitation provision where the municipality is a Water Services Authority (WSA) under the Water Services Act (No.

[39] Inglett et al., 2008

108 of 1997), and stormwater management, as well as ensuring sustainable land development within their jurisdiction. If wetland condition and functionality is maintained and/or improved in the landscape, the above-mentioned water quality enhancement services provided by wetlands can contribute to the reduction in the impacts to water resources resulting from municipal functions as well as the buffering of water resources against human development activities. The preservation of these services in the landscape can also potentially reduce infrastructure (water treatment, dam maintenance), social (health risks) and environmental (rehabilitation) costs to municipalities, particularly in urban areas. Thus, by actively managing and rehabilitating wetlands, and by including wetlands and water resources (and their catchments) within municipal development and spatial / land use planning, municipalities can achieve improved water resource management. Ultimately, this can assist municipalities in achieving their 'environmental right' and sustainability mandates.

1.4.2 Contribute to disaster risk management and climate resilience

Disaster management:

Due to poor development practices of the past, and the continuation of such practices into the present, urban development has traditionally encroached into watercourses, including wetlands and floodplains, which provide valuable flat land for urban development and agriculture. In parallel to this development process, there has been substantial catchment land cover hardening and a traditional stormwater management policy of rapid collection and removal that has substantially increased the severity and magnitude of floods. These historical developmental activities have resulted in flooding being a significant issue to most municipalities, and an issue that municipalities are now legally required to manage and remedy. Furthermore, with climate change, it is generally accepted that extreme weather events worldwide as well as in South Africa are likely to increase in frequency and intensity, which will increase the risk of floods to human life and property, as well as the costs of flood management and flood damages to municipal infrastructure, particularly within urban areas.

In this regard, wetlands are becoming increasingly recognized as important ecological infrastructure in support of municipal disaster risk management and climate adaptation / resilience through the provision of key ecosystem services like flood regulation / attenuation. Apart from flood attenuation, wetlands can also play a role in disaster risk management by acting as fire breaks and refuges (Refer to **Figure 14** below).

Figure 14 Diagram indicating the key wetland ecosystem services that support municipal disaster risk management objectives.

Flood attenuation services:

The typically gentle topography and dense vegetation associated with wetlands, particularly floodplain wetlands, act to slow down surface runoff and spread out floodwaters thereby reducing severity of floods[40]. This ecosystem service is commonly referred to as 'flood attenuation'. It is important to note however that flood attenuation ability varies with position in the catchment and that wetlands may not always attenuate floods to the desired extent. Please refer to the case study of the Piesang River floodplain rehabilitation project included in **Annexure A3** that models the impact of the rehabilitation project on flood hydrology in the Piesang / uMhlangane River catchment in the eThekwini Municipality.

Fire management and refuge services:

Wetlands can both mitigate fire risk as well as pose a fire risk. Wetlands are typically characterized by higher soil moisture conditions that result in less severe die-backs of herbaceous vegetation in the dry season and ultimately lower available fuel loads relative to the surrounding dryland environments. Wetlands are also often associated with fire resistant woody vegetation that is resistant to combustion. However, where herbaceous wetlands do dry out periodically, the high biomass (dense and tall vegetation) of wetlands can generate substantial fuel loads. Furthermore, peat is combustible when dry and as such the drying out of peatlands (**Box 20**) makes substantial fuel loads available. In these cases wetlands pose a serious fire risk in themselves. It is also important to note that such drying out is usually a consequence of human activities that affect wetland hydrology, highlighting that human impacts to wetlands can increase fire risk. However, the periodic drying out of wetlands is also a natural phenomenon in South Africa during drier periods or droughts.

[40] Kotze et al., 2009

Box 20: Peat and peatlands

Peat is partially decomposed organic matter. Peatlands refer to those wetland ecosystems characterised by the accumulation of organic matter (or peat) derived from dead and decaying plant material under conditions of permanent water saturation[41]. Owing the semi-arid to arid climate of Southern Africa, peatlands are very rare and unique wetland types in Southern Africa[42].

In addition, the fact that wetlands generally form along drainage lines (which are usually linear), in conjunction with the above factors means that wetlands have the ability to act as effective natural fire breaks in the landscape, as well as providing important fire refuge to humans and animals during fire events.

Benefits to municipalities:

Municipalities have mandates and responsibilities for stormwater management, pollution control and environmental / public health and disaster risk management. Effective management of wetlands and their ecosystem services can contribute to assisting municipalities in achieving their mandates and responsibilities for disaster management. As wetlands are naturally occurring and have the ability to reduce disaster risk, investing in the management and rehabilitation of wetland ecological infrastructure in support of flood and fire management is a cost effective and proactive approach to disaster management that alone or in conjunction with traditional hard infrastructure, can reduce the severity of floods and fires and increase the resilience of local communities[43].

Furthermore, in densely populated urban settings with fully developed catchments and the encroachment of urban development up to wetland edges, wetlands can actually increase the lateral extent of flooding. In such settings this often results in flooding issues for local residents, particularly where wetland channels are filled-up with sediment and/or dense vegetation. Thus the objective of reducing localized flood risks as part of urban stormwater management can actually contribute to increasing flood risks downstream. This points to the need to consider strategic rehabilitation of wetlands for urban flood management purposes in areas that still have sufficiently sized floodable land. Otherwise planned retreat of urban development from wetlands will be required in conjunction with wetland rehabilitation. In this regard the design and implementation of engineered enhanced and/or constructed wetlands that can withstand intense urban flows and sediment inputs is increasingly being adopted as part of urban flood and disaster management planning. Please see the following case studies included in **Annexure A**:

- **A3** – The rehabilitation of the Piesang River floodplain in KwaMashu, KwaZulu-Natal
- **A4** – The Atlaspruit wetland rehabilitation and flood relief scheme in Boksburg, Gauteng

[41] WRC, 2010
[42] Grundling & Grobler, 2005
[43] Kumar et al., 2017

1.4.3 Support and maintain biodiversity

Owing to the unique characteristics of wetlands, being transitional between terrestrial and aquatic environments, they provide important habitat and subsequently support a wide variety of plants and animals uniquely adapted to take advantage and thrive in such conditions. Although plant diversity in wetlands is often comparatively low compared to other ecosystem types like fynbos and grasslands, wetlands support a comparatively large number of rare and endemic species, and often support uniquely large populations of resident and migratory animals like birds, a phenomenon that is linked to their high productivity (**Box 22**) and refuge value.

Box 22: Ecosystem productivity

In ecology, productivity refers to the rate of generation of biomass in an ecosystem[44].

Benefits to municipalities:

As part of their constitutional mandate to preserve the environment for future generations and ensure municipal decisions and actions are ecologically sustainable, most metropolitan municipalities now take an active role in biodiversity conservation and management within their jurisdictions. This is because municipal development and land use planning and regulatory decisions have significant impacts on biodiversity maintenance and ecological sustainability. As wetlands are typically highly threatened, particularly in urban settings, wetland management and preservation is important to achieving municipal biodiversity conservation goals and targets.

Furthermore, in urban and commercial agricultural settings where the only remaining undeveloped land is often located along valley lines, wetlands act as important refugia (**Box 23**) for local animal biodiversity and play important ecological roles in the development and functionality of municipal and city open space systems. As municipal open space systems and green corridors are becoming increasingly important spatial planning tools in municipal urban planning that assist in the mainstreaming of biodiversity objectives into municipal planning, the value of wetland management and preservation to municipal biodiversity conservation goals is further elevated.

Box 23: Refugia

In biology, a refugium is a location which supports an isolated or relict population of a once more widespread species[45].

1.4.4 Contribute to basic human needs and livelihoods

Provisioning services provided by wetlands are perhaps the most significant in terms of sustaining fundamental human needs, reducing poverty and supporting people's livelihoods[46]. Even the smallest

[44] Wikipedia (Accessed 19 March 2018) - https://en.wikipedia.org/wiki/Productivity_(ecology)
[45] Wikipedia (Accessed 19 March 2018) - https://en.wikipedia.org/wiki/Refugium_(population_biology)
[46] International Water Management Institute (IWMI), 2014

wetland can be a vital resource for people living nearby, providing water for domestic use, crops and livestock, or a source of food and fish[25]. These can be life-saving 'safety nets' in arid and semiarid regions, often being the only source of water and food in the dry season[25]. Provisioning services typically provided by wetlands are illustrated in **Figure 15**:

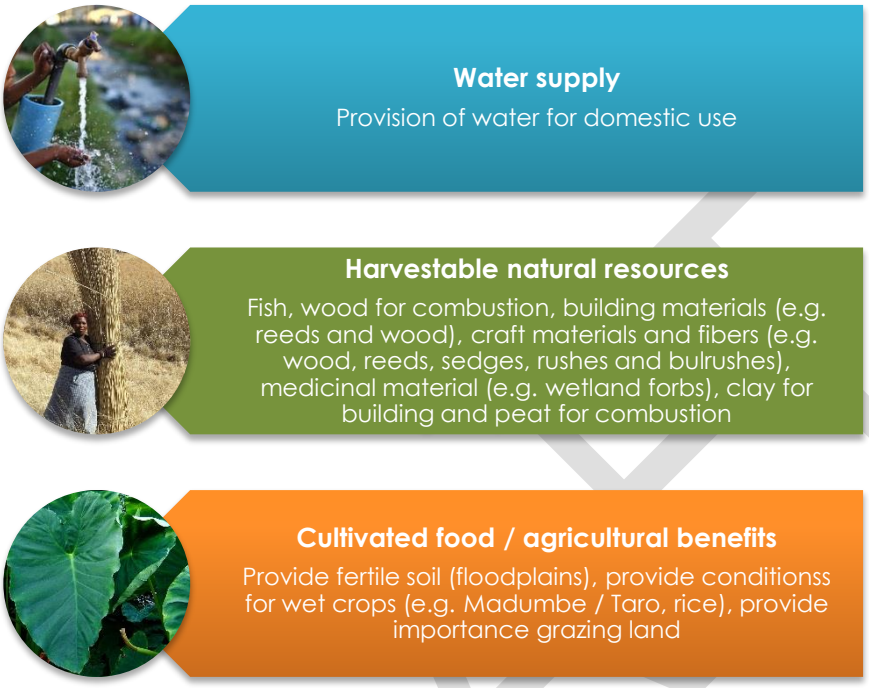

Figure 15 Diagram indicating the key provisioning services supplied by wetlands that support meeting basic human needs and sustaining livelihoods.

Figure 16 Wetland reed harvesting near Murphy's Rust, Free State province[47].

[47] Photo taken by Douglas Macfarlane.

Figure 17 Cut wetland grass for weaving in Lesotho[48].

Figure 18 Use of a wetland for grazing near Murphy's Rust, Free State province[52].

As an example, an assessment of the value of the provisioning services provided by the Manalana Wetland in the Cragieburn Village in the Bushbuckridge Local Municipality in the Mpumalanga Province of South Africa[49] found that the wetland system provides critically important food provision and livestock grazing benefits, as well as significant harvestable resource and water provision benefits. Please refer to the case study in **Annexure A5** for more detail on the benefits and services provided by the Manalana Wetland and the benefits of rehabilitation to secure such benefits.

[48] Photo taken by Douglas Macfarlane.
[49] Pollard et al., 2005; Pollard et al., 2009

Benefits to municipalities:

Addressing the economic, developmental and spatial / geographical injustices of apartheid land policy and planning is a 'mammoth' task. As part of this challenging task, municipalities have been given the constitutional mandate to provide basic services to their populations, especially previously disadvantaged communities. However, despite two decades having passed since the democratic election of the African National Congress (ANC) and the abandonment of racially discriminatory policies, many rural areas and poor areas on the outskirts of cities still lack basic services, or lack an acceptable quality of basic services, due to slow progress in basic infrastructure rollout, poor infrastructure planning and poorly maintained infrastructure[50]. This is largely due to the lack of financial resources to fund the establishment and maintenance of the required service infrastructure, especially for the smaller municipalities, and a lack of human capacity and skills to deal with the complex problems and constraints of achieving acceptable levels and qualities of service provision, particularly in rural areas[51]. This means that rural populations across the country still rely heavily on the natural resources for subsistence and the sustaining of livelihoods. Similarly poor urban residents are also often forced to fall back on subsistence cultivation on undeveloped patches of land (which is often associated with rivers and wetlands) and the sourcing of domestic water from polluted urban rivers and wetlands. The most significant natural resources used by rural and poor people include arable land for subsistence and commercial crops, grazing land, water and harvestable resources, which all act as a safety-net when municipal services are absent or fail. As has been discussed above, the management and rehabilitation of wetlands in rural settings can have significant social benefits for vulnerable communities and indirectly assist municipalities in achieving basic service provision.

1.4.5 Cultural benefits

Wetlands can also deliver significant non-material benefits. In South Africa, wetlands are recognized as having cultural significance for an array of different local cultures. Wetlands not only provide several culturally significant plants species (for medicine, food and craft) significant for cultural ceremonies but they also act as places of special cultural significance in of themselves (e.g. where baptisms or cleansing ceremonies take place)[52].

Wetlands also have value as sites for tourism and recreation as they are generally visually appealing and usually have an abundance of wildlife. [28]. In urban settings in particular, the preservation of wetland corridors can improve the aesthetics and amenity value of urban areas and contribute to improving the livability of urban spaces. Urban green spaces within which wetlands can occur also hugely to local property values. For example, coastal areas, where wetlands are prominent, are estimated to be worth up to R200 million per km in terms of property value alone[53].

[50] StatsSA, 2016
[51] Mothetha et al., 2013
[52] Kotze et al., 2009
[53] Turpie et al., 2017

Being transitional ecosystems and having the ability to provide relatively high levels of ecosystem services in support of human development, wetlands are also of high educational and research value.

Benefits to municipalities:

As most of South Africa's wetlands are associated with drainage lines, wetlands are often associated with the last remaining patches of undeveloped land in urban areas, although they are typically degraded due to intense indirect catchment impacts and direct encroachment impacts. Thus the rehabilitation and management of wetlands can result in measurable amenity benefits to surrounding communities that lack recrrational spaces, which can assist municipalities in meeting their mandates for providing recreational spaces and improving quality of life.

1.4.6 Contribute to job creation

With the increasing recognition of wetlands as being important ecological infrastructure that can assist municipalities in achieving sustainable service provision and development objectives, coupled with the fact that wetland degradation has been substantial throughout South Africa, the push to invest in the restoration and rehabilitation presents an opportunity to create employment for low- and semi-skilled people. Wetland rehabilitation programmes and projects present an opportunity to upskill people in the field of wetland rehabilitation and management. Such additional skills form part of the greater emerging field of natural resource management and ecological and green infrastructure provision and management. Job creation programmes linked to wetland rehabilitation are already being implemented at the national government level through the Expanded Public Works Programme (EPWP), specifically the Working for Water and Working for Wetlands Programmes (**Box 24**).

Box 24: Working for Water and Working for Wetlands Programmes

The Expanded Public Works Programme (EPWP) is aimed at providing poverty and income relief through temporary work for the unemployed to carry out socially useful activities. The work of the EPWP has tended to focus more on delivering person-hours worked, and less on the associated benefits such as biodiversity conserved. This project will support opportunities to make this programme more strategic by making the jobs more permanent and greener – and increasing the focus on quantifying and enhancing contributions to biodiversity conservation.

Other job creation opportunities associated with wetlands include those generated through the formal protection and management of important wetlands and those associated with tourism and recreational activities. The formal protection and management of important wetlands requires substantial human resources that are often limited. Linked to protection and management, intact wetlands can provide important tourism and recreational benefits with economic spin offs for surrounding local residents e.g. tourism accommodation, nature guides, bird guides etc.

Benefits to municipalities:

For the reasons discussed above wetland protection and management projects at the municipal level can create measurable low skilled and semi-skilled green jobs.

Municipalities in particular are well placed to initiate such projects within their jurisdictions in an effort to achieve their sustainability and resilience objectives as well as create much needed low and semi-skilled jobs as part of meeting their economic developmental objectives.

2. LEGISLATIVE, POLICY & INSTITUTIONAL FRAMEWORK FOR WETLAND MANAGEMENT IN SOUTH AFRICA

This section situates municipal wetland management within the broader policy, legislative and institutional context and unpacks the mandate, responsibilities and opportunities for wetland management at the local government level.

2.1 Are wetlands protected and are activities that affect them regulated?

Wetlands as an ecosystem type are not formally protected by law (**Box 25**), but their alteration is regulated by the water use licensing process of the National Water Act (No. 36 of 1998) ('NWA'), the environmental authorization process of the National Environmental Management Act (No. 107 of 1998) ('NEMA') and the regulated activity permission process of the Conservation of Agricultural Resources Act (No. 43 of 1983) ('CARA'). Detail on all the legislative requirements related to wetlands is provided in **Annexure B1;** a summary is provided in **Table 1** below.

Box 25: Protected ecosystems

Protected ecosystems are defined in the NEM:BA as "ecosystems that are of high conservation value or of high national or provincial importance, although they are not listed [as Critically Endangered, Endangered or Vulnerable]" (Section 52(2)(d)). There is no ecological definition of a "Protected ecosystem" – this concept exists only in legal terms[54].

Table 1. Summary of domestic policies and legislation relevant to wetland management at the local government scale.

Legislation and Policy	Relevance to Wetland Management
Constitution	Section 24 of the South African Constitution outlines the "environmental right" of all citizens of South Africa. This right entitles everyone to an "environment that is not harmful to their health or well-being"; and "to have the environment protected for the benefit of present and future generations, through reasonable legislative and other measures that prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development". The definition of the environment encompasses wetlands.

[54] SANBI, 2016

Legislation and Policy	Relevance to Wetland Management
National Environmental Management Act (No. 107 of 1998) ('NEMA')	NEMA is the primary environmental legislation developed in terms of the Constitution which guides the management of the environment (including wetlands) in South Africa. It includes environmental principles which must form an integral part of all decision making that affects the environment (including wetlands). NEMA also prescribes a general duty of care not to cause significant pollution or degradation of the environment (including wetlands), and where harm is unavoidable, to take measures to clean up and rehabilitate. In the event of an emergency which affects a wetland, response procedures are prescribed. Importantly, NEMA formally regulates various human activities that negatively impact the environment, including wetlands, through publishing listed activities that require Environmental Authorization prior to such activities commencing, and the establishment a regulatory application framework including Environmental Impact Assessment (EIA). A number of listed activities relate specifically to activities within and in the proximity to wetlands.
National Environmental Management: Biodiversity Act (No. 57 of 2003) (NEM:BA)	NEM:BA provides various measures for the protection of biodiversity, including the control of activities affecting threatened or protected species and ecosystems and activities involving alien and invasive species. Various planning tools are provided for, including bioregional plans and biodiversity management plans. IDP's must align with national biodiversity framework and bioregional plans.
National Biodiversity Framework	A framework published in terms NEM:BA to coordinate and align the efforts of the many organisations and individuals involved in conserving and managing South Africa's biodiversity, in support of sustainable development[55]. Municipal IDP's must be aligned with the Framework.
National Environmental Management: Protected Areas Act (No. 57 of 2003) (NEM:PAA)	The purpose is to effect a national system of representative protected areas to preserve the country's biodiversity, natural landscapes and seascapes, including wetlands and wetland dependent species, and manage such areas in a sustainable manner.
National Environmental Management: Waste Act (No. 59 of 2008) (NEM:WA)	Through the regulation of waste management, including disposal of waste, water resources are protected. Dumping of waste and various other activities which may affect wetlands are prohibited. Municipalities will require waste management licenses for their own waste management activities. Furthermore, Section 4(a) of the Act states that municipalities are required to prepare Integrated Waste Management Plans (IWMPs) and submit this to the relevant MEC for approval. The approved IWMP should then be incorporated into the municipal Integrated Development Plan (IDP).

[55] SANBI (2016)

Legislation and Policy	Relevance to Wetland Management
National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008)	NEM:ICMA provides for various mechanisms to regulate activities in the coastal zone, including coastal wetlands situated within the zone. Where a wetland falls within the coastal protection zone, additional considerations are relevant in making a decision whether to grant an environmental authorisation. Municipalities are required to adopt coastal management programmes, which will include coastal wetlands. Municipalities are responsible for formulating estuary management plans (except estuaries which straddle municipal or provincial boundaries).
Environmental Conservation Act (No. 73 of 1989)	This Act has been superseded by NEMA. However, a Section 31A directive can still be used by the competent authority, local authority or government institution to legally instruct a person that is causing / has caused damage to the environment (including wetlands) to: (a) to cease such activity; or (b) to take such steps as the Minister, competent authority, local authority or government institution, as the case may be, may deem fit, within a period specified in the direction, with a view to eliminating, reducing or preventing the damage, danger or detrimental effect.
National Water Act (No. 36 of 1998) ('NWA')	The NWA regulates water use and protection of water resources, including wetlands. Water uses which ordinarily require a water use license or compliance with a general authorisation include, but are not limited to: Taking water from a water resource (e.g. abstraction from a wetland); impeding or diverting the flow of water in a watercourse; altering the bed, banks, course or characteristics of a wetland; and discharging water containing waste into a water resource. The NWA Duty of Care and Emergency Incident provisions will apply to incidents which affect wetlands.
National Water Resource Strategy (NWRS)	One of the core objectives of the NWRS is to ensure that water is protected, used, developed, conserved, managed and controlled sustainably and equitably. The latest revision of the NWRS in 2013 emphasized wetlands in the principles for key water resources protection. Also, wetland buffers are mentioned as critical ecological infrastructure, although it is recognized that the debate on what the delineation of a buffer zone should be and to what extent land use should be restricted in these zones is site dependent.
Water Services Act (No. 108 of 1997)	The Act is underscored by the following principles: • Recognizing the rights of access to basic water supply and basic sanitation necessary to ensure sufficient water and an environment not harmful to health or well-being. • Acknowledging that there is a duty on all spheres of Government to ensure that water supply services and sanitation services are provided in a manner which is efficient, equitable and sustainable.

Legislation and Policy	Relevance to Wetland Management
	• Recognizing that the provision of water supply services and sanitation services, although an activity distinct from the overall management of water resources, must be undertaken in a manner consistent with the broader goals of water resource management. Thus, all water service authorities (WSAs), which are often municipalities, are required to ensure the sustainable provision of basic water supply and sanitation services with the aim of safeguarding resources for future generations. This includes ensuring that impacts to wetlands are minimized to acceptable levels. As part of this Act the WSA is required to prepare a Water Services Development Plan (WSDP) that should feed into the IDP and be subjected to annual review.
Conservation of Agricultural Resources Act (No. 43 of 1983) ('CARA')	Regulations published in terms of CARA regulate the use of wetlands situated on agricultural land in order to protect natural agricultural resources, including the soil, water sources and vegetation. Permission is required to undertake specific activities, including cultivation, which affect wetlands.
Mineral and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA)	The Act provides for the regulation of the prospecting for and extraction of mineral and petroleum resources. In particular the Act provides regulations for environmental management, and pollution control and waste management for all phases of mining activities. In this regard, impacts to wetlands are required to be identified, assessed and adequately mitigated prior to issuing mining permits and rights.
National Forests Act (No. 84 of 1998)	This Act is underpinned by sustainable forest use and management and provides for the protection of certain forests and trees. The conservation of biological diversity, ecosystems and habitats, and natural resources, especially soil and water, are key components of sustainable forest management in terms of the Act. The Act prohibits the destruction of natural forests (including riparian and swamp forests) without a formal license and regulates use of forests (including riparian and swamp forests). In particular, the cutting, disturbance, damage or destruction of any indigenous tree occurring in a natural forest (including riparian and swamp forests) cannot commence without acquiring a license.
Spatial Planning and Land Use Management Act (No. 16 of 2013)	SPLUMA is the framework legislation regulating land use planning in South Africa, and municipalities will need to plan and grant land use approval in accordance with it. SPLUMA sets out a number of development principles which apply to municipalities when regulating the use and development of land, and must guide a municipality in policy preparation. IDP's are prepared in accordance with SPLUMA and must include specific environmental components identified in environmental legislation.

Legislation and Policy	Relevance to Wetland Management
Municipal Systems Act (No. 32 of 2000)	The Municipal Systems Act provides the framework for local government functioning, including integrated development planning, community participation and service delivery. In terms of the MSA, municipalities are required to focus on development and service delivery which is financially, socially and environmentally sustainable. Environmentally sustainable development and service delivery should be aimed at ensuring that: • The risk of harm to the environment and to human health and safety is minimised to the extent reasonably possible under the circumstances; • The potential benefits to the environment and to human health and safety are maximised to the extent reasonably possible under the circumstances; and • Legislation intended to protect the environment and human health and safety is complied with.
Disaster Management Act (No. 52 of 2002)	The purpose of the Act is to provide for an integrated and co-ordinated disaster management policy that focuses on preventing or reducing the risk of disasters, mitigating the severity of disasters, emergency preparedness, rapid and effective response to disasters and post-disaster recovery. In particular the Act prescribes the development of disaster management plans at national, provincial and municipal scales. Wetlands as ecological / green infrastructure can potentially contribute to flood mitigation and water quality improvement / buffering strategies and plans to be included in the disaster management plans.
National Veld and Forest Fires Act, 101 of 1998	Where the burning of fire breaks includes burning reeds in wetlands, the requirements of this Act must be also complied with.
World Heritage Convention Act, 49 of 1999	The WHCA provides for the declaration of world heritage sites, which may include wetlands. The development implication will be the restrictions on development imposed in the management plans and Regulations for each site.

2.2 What is the national government mandate for wetland management?

Explicit legal mandates for natural resource management, including wetland management, have been provided to the National Department of Water & Sanitation (DWS) and the National Department of Environmental Affairs (DEA) through the NWA and NEMA respectively.

The DWS has been given the explicit legal mandate for managing, conserving and regulating activities that affect water resources, including wetland ecosystems, in terms of the NWA (1998). The NWA provides for the establishment of Water Management Areas (WMAs) (**Box 26**) 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 to involve local communities[56].It is envisaged that over time the water resources within every WMA will be managed by its own CMA, who will have their own board(s). CMAs will be responsible for protection of water resources and developing a Catchment Management Strategy (CMS) for their WMAs. It is envisaged that CMAs will be the first point of contact for a municipality to guide inputs in IDPs. At the time of writing of this Guideline, the Incomati Usuthu CMA and the Breede-Gouritz CMA are the only CMAs that are fully operational, although others have already been established. The key policy document related to the achievement of this mandate is the National Water Resource Strategy (NWRS). As part of the NWRS, the country has been divided into 19 WMAs.

It is also important to note that the NWA requires that the establishment of a CMA and the development of a CMS include all key role players and stakeholders (see **Box 27**). Therefore it is envisaged that local and district municipalities would play active roles in the operation of CMAs that encompass their jurisdictions, and in some cases where municipalities are WSAs, they would be a member of the governing board of the CMA. Similarly, CMAs are required to involve local and district municipalities in the development of the CMS, which also places an obligation on local authorities to play an active role in this process[57].

Box 26: Legal definition of a Water Management Area (WMA) in the NWA

Section 1(xxv): "Water 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".

Box 27: Legal excerpts related to stakeholder involvement in CMAs

Chapter 2 – Catchment Management Strategies

Preamble: "In the process of developing this strategy, a catchment management agency must seek co-operation and agreement on water-related matters from the various stakeholders and interested persons."

9. "A catchment management strategy must -

(g) enable the public to participate in managing the water resources within its water management area; (h) take into account the needs and expectations of existing and potential water users."

10. (2) "In developing a catchment management strategy, a catchment management agency must consult with - (b) any organ of state which has an interest in the content, effect or implementation of the catchment management strategy."

Chapter 7 – Catchment Management Agencies

[56] Haigh et al., 2008

[57] DWAF, 2007

Preamble: "The purpose of establishing these agencies is to delegate water resource management to the regional or catchment level and to involve local communities, within the framework of the national water resource strategy."

79. (4) "In performing its functions a catchment management agency must - (b) strive towards achieving co-operation and consensus in managing the water resources under its control."

80. "Subject to Chapter 2 and section 79, upon the establishment of a catchment management agency, the initial functions of a catchment management agency are –

(d) to promote the co-ordination of its implementation with the implementation of any applicable development plan established in terms of the Water Services Act, 1997 (Act No. 108 of 1997); and

(e) to promote community participation in the protection, use, development, conservation, management and control of the water resources in its water management area."

Part 2 preamble: "The board of a catchment management agency will be constituted in such a way that interests of the various stakeholders are represented or reflected in a balanced manner, and the necessary expertise to operate effectively is provided.

81. (1) "The members of a governing board of a catchment management agency must be appointed by the Minister who, in making such appointment, must do so with the object of achieving a balance among the interests of water users, potential water users, local and provincial government and environmental interest groups."

81. (2) "Notwithstanding subsections (3) to (9) the Minister must, from time to time, determine the extent to which relevant local governments should be represented on the governing board of each catchment management agency."

The National Department of Environmental Affairs (DEA) has been given the following legal mandates:

- Environmental management and the regulation of activities that affect the environment and ecosystems, including wetland ecosystems, within the framework of sustainable development, in terms of NEMA. The key policy document related to the achievement of this mandate is the provincial Environmental Implementation Plan (EIP) and the departmental Environmental Management Plan (EMP).
- To effect a national system of representative protected areas to preserve the country's biodiversity, natural landscapes and seascapes, including wetlands and wetland dependent species, and manage such areas in a sustainable manner, in terms of the National Environmental Management: Protected Areas Act (No. 57 of 2003) (NEM:PAA).
- To provide for the management, conservation and sustainable utilization of biodiversity within South Africa, including wetlands and wetland dependent species, in terms of the National Environmental Management: Biodiversity Act (No. 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 minimizing 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 (No. 59 of 2008) (NEM:WA). The key policy document related to the achievement of this mandate is the National Waste Management Strategy (NWMS).

- 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 wetland ecosystems, within the framework of sustainable development, in terms of the National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008).

Other parties that have indirect roles and responsibilities related to wetland management are:

- Department of Mineral Resources (DMR) – Mineral and Petroleum Resources Development Act 28 of 2002 (MPRDA).
- Department of Agriculture, Forestry & Fisheries (DAFF): Forestry Directorate – National Forests Act (No. 84 of 1998).
- Department of Agriculture, Forestry & Fisheries (DAFF): Agricultural Directorate – Conservation of Agricultural Resources Act (No. 43 of 1983) (CARA).

2.3 What is the local government mandate for wetland management?

Local government has a mandate for wetland management as part of their wider mandates for environmental management and sustainable development, **but such a mandate is broad and not clearly set out in legislation and policy[58]**. Whilst there is no explicit mandate for local municipalities to manage, conserve and regulate the activities that affect wetlands in their jurisdiction, there is a broad but clear mandate for local governments to ensure that their plans, strategies, frameworks, programmes and day-to-day operations and provision of services (i.e. execution of scheduled functions) adhere and give effect to the following principles and objectives[49]:

- Promote and ensure / achieve a safe and healthy environment that is not harmful to human health and well-being (Constitution, MSA).
- Promote and ensure / achieve environmental sustainability through ensuring ecologically sustainable development, natural resource use, land use and service provision (Constitution, MSA, SPLUMA, NEMA, NWA).
- Minimise negative environmental and natural resource impacts (SPLUMA, NEMA, NWA).
- Promote and ensure the conservation and protection of the environment for the benefit of present and future generations (Constitution, NEM:PAA, NEM:BA).
- Prevent and/or mitigate the occurrence or re-occurrence of disasters (Disaster Management Act).

A list of constitutionally mandated functions is included in **Annexure B2**.

It is also important to note that South Africa is a signatory to a number of international agreements relating to biodiversity and to wetlands, such as the United Nations Convention on Biological Diversity (CBD) and

[58] SALGA & DEA, 2016

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.

2.4 Linking functions and powers of local government with opportunities for enhancing wetland management

A municipality has different roles with which it can execute or facilitate improved wetland management[59]:

- **The municipality's self-governance**; adapting its own operations in terms of stormwater management of its urban areas, municipal waste control and waste water management, to improve on upstream impacts on wetlands. Rehabilitation and protection interventions can also improve on wetland management.
- **The municipality as provider**; with municipalities owning wetlands as part of city parks or conservation servitudes / protected areas and/or conservancies, the city provides the various functions of a wetland to its community and can make them more or less accessible. It can start educational centres at its wetlands to add to awareness raising.
- **The municipality as creating an enabling environment**; to get citizens and companies to change their attitude to wetlands the municipality can be active in awareness campaigns to prevent pollution and encroachment, to engage stakeholders in IDP formulation, to engage with land owners on the difference they can make, to coordinate the setup of catchment / wetland forums, to engage with learning institutions. While the municipality might not be obliged to do this, it might be a very effective way to improve on wetland management with limited costs.
- **The municipality governing by authority**; with the development of the IDP decisions are made on catchment management which are implemented by authority, in the approval of development plans, in line with the SDF. Moreover, the municipality can formulate by-laws, can set rates for wetland or river management and can impose fines and use police presence or security to make sure that the laws are implemented.
- **The municipality as stakeholder**; the municipality is a stakeholder who is involved in the formulation of district and provincial development plans as well as in catchment management strategies. It also has a role in ensuring that other departments and the CMA fulfill their mandates in the municipality. The municipality is also a stakeholder in Environmental and Social Impact Assessments and in Water Use License Applications and can fulfill an active role in reacting to those.

A summary of all of the powers and functions provided to municipal governments in terms of the Acts listed in **Table 1** is provided in **Table 2** below[60].

[59] Inspired by Sustainable Cities management, provided by Lund University, with the stakeholder bullet added to the usual list.
[60] SALGA and GTZ South Africa, 2006

Table 2. Summary of municipal powers and functions with implications and opportunities for wetland management.

Municipal Functions and Powers	Implications for Wetland Management	Opportunities to Improve Wetland Management
Municipal Powers		
Development of Integrated Development Plans and allocation of budgets: Every five years the Municipality coordinates the development of an Integrated Development Plan with a Spatial Development Framework (SDF). The IDP is set up with stakeholders but coordinated by the Municipality. The council approves this plan which guides how development should take place in the area. All projects and planning should happen within the framework of the IDP. Every year a municipal budget must be passed that sets down how money will be raised and spent, in line with the IDP objectives.	• The IDP and SDF guide the approval of land uses and urban development, which is important for wetland management i.e. direct and indirect (catchment) impacts. . • The IDP has a lot of influence on how the catchments of wetlands are developed. • Municipality can decide on key projects and the amount of funds to allocate with justification.	• Can put emphasis in its IDP and SDF on spatial plans and activities that benefit wetland management. • Can approve programmes and projects and associated budgets as part of the IDP that will contribute to improved wetland management. • Can develop SDFs and Land Use Schemes (LUSs) that incorporate strategic wetland priorities.
Develop and Pass by-laws: Local laws and regulations about any of the functions they are responsible for. By-laws may not contradict or over-rule any national laws. E.g. Section 32(1) of SPLUMA states that "A municipality may pass by-laws aimed at enforcing its land use scheme."	By-laws that influence the flows and pollution in the upstream catchment, or that regulate buffer zones.	• Introduce additional controls to protected wetlands. • Integrate wetland management and protection into existing by-laws (e.g. stormwater by-laws, river corridor by-laws). • Establish by-laws for unlawful activities in an effort to regulate common unlawful activities.
Impose rates and other taxes: Property rates are a form of tax that municipalities can place on the value of properties. It is an important source of income.	This power allows the municipality to create financial incentives to manage and conserve wetlands through the municipal rates and tax system.	• Develop rates-based incentives for land owners who commit to undertaking land management in line with wetland management objectives. • Develop tax-based incentives for land owners who commit to undertaking land management in line with wetland management objectives.
Impose fines: For anyone who breaks municipal by-laws or regulations, for example traffic fines, littering or library fines.	The imposition of fines for environmental non-compliance or contraventions could disincentive certain common unlawful activities like dumping and sand mining.	• Opportunity to strengthen enforcement and control of illegal activities.

Municipal Functions and Powers	Implications for Wetland Management	Opportunities to Improve Wetland Management
Municipal Functions		
Municipal planning: The development plans of a municipality (e.g. Integrated Development Plans - IDPs) are the basis for directing and managing land use approval and infrastructure provision, and they should help plan for public investment whether the particular service is provided directly by the municipality or by province.	Development and spatial planning sets the framework for all development within the municipality. Thus, the degree to which wetlands are incorporated into these plans has important implications for effective wetland management and development conflicts.	• Incorporate wetland management objectives and concerns into the municipal IDP through the identification and development of strategic programmes and projects. Such incorporation will need to align with strategic priorities and sectoral municipal functions. • Incorporate wetland management priorities and objectives into the municipal SDF. This would be achieved by packaging municipal wetland assets in various spatial formats ranging from (i) critical biodiversity areas (CBAs) or Ecological Support Areas (ESAs) as part of conservation / biodiversity plans, (ii) open space networks and/or (iii) priority wetlands identified as part of catchment management strategies and/or green infrastructure inventories. • Incorporate wetland management objectives into the municipal LUS and develop a formal environmental overlay for LUS.
Land use and land development management and regulation: in terms of SPLUMA, municipalities must regulate land use and development planning according to the a municipal land use scheme and have the authority to approve land use and land development applications and grant land use and development rights.	Local officials can play an important role in ensuring development and land use applications in their jurisdiction include effective wetland management controls and minimize impacts to wetlands.	• Apply best management practices to the design, implementation and operation of development and land use applications. • Setup a development application inquiry system and application review protocol.

Municipal Functions and Powers	Implications for Wetland Management	Opportunities to Improve Wetland Management
Infrastructure and basic services: Stormwater infrastructure design, management and maintenance, water and sanitation, electricity and gas reticulation, refuse removal, municipal roads, municipal public transport, street lighting, among others.	• Impacts of abstracting water from wetland catchments and reducing flows – in the case of the municipality being a Water Service Authority (WSA). • Flow and water quality impacts to wetlands as a result of the discharge of treated waste water into wetland catchments and wetlands directly. • Impacts of failing or malfunctioning sewerage infrastructure on wetland water quality. • Impacts of the inappropriate design of municipal stormwater systems and/or a lack of stormwater infrastructure maintenance or capacity. • Impacts of linear infrastructure crossing wetlands e.g. roads, powerlines, pipelines.	• Wetlands that are on property owned by the municipality, or upstream river corridors that are owned by the municipality, can be managed in a way that benefits functioning, weighing the costs and benefits of different functions (ecological functioning, biodiversity, recreation, water resources, flood attenuation). • Include important wetland areas (and their catchments) in municipal infrastructure and services planning through incorporation in the municipal IDP and the SDF. This will include understanding the importance of wetlands in the municipality in terms of contributing to municipal services like stormwater management and disaster management i.e. green infrastructure. • Apply best management practices to the design, implementation and operation of municipal infrastructure and service provision including sustainable drainage practices (stormwater management), waste water management, solid waste management and linear infrastructure corridors (e.g. transport, sewer and power distribution corridors). • Understand and monitor negative impacts on wetlands by municipal infrastructure and service provision and evaluate against strategic goals at catchment and wetland scales.

Municipal Functions and Powers	Implications for Wetland Management	Opportunities to Improve Wetland Management
Social and welfare services: Public parks and associated recreational facilities, beaches and amusement facilities, recreational water use, child care facilities, municipal health services.	These activities generally could result in measurable but small negative impacts to wetlands, but in turn they could also significantly benefit from the introduction of wetlands into the local environment.	• Include important wetland areas in social and welfare services planning through incorporation in the municipal IDP and the SDF. This will include identification of opportunities to use wetlands to improve the amenity value of parks, recreational facilities, environmental education and social and welfare services while also performing other valuable functions and services. • Develop a municipal open space system and include and manage wetlands as part of this system. • Apply best management practices to the design, implementation and operation of municipal services to maximize on amenity value to residents (e.g. recreation, outdoor education, etc.) and minimize negative impacts to wetlands.

3. TAKING STOCK OF WETLAND MANAGEMENT

This section provides guidance on, and a framework for, assessing the current wetland management situation of a municipality and developing a strategy and action plan to improve and strengthen wetland management practices at the municipal scale.

Prior to developing and implementing a Wetland Management Strategy and/or Action Plan within a municipality, it is important to first take stock of the wetland management status quo. This is typically done through a review of basic wetland information and the drivers and pressures affecting wetlands in the municipality. ICLEI Africa, through the LAB: Wetlands SA project, have assisted a range of Municipalities with this step by compiling 'Wetland Reports' which include important baseline information on wetlands and set the scene for further planning. These 'Wetland Reports' can be used as an example for other Municipalities and are available for download here: http://cbc.iclei.org/project/lab-wetlands-sa/.

The logical next step, involves the development of a Wetland Strategy and Action Plan (WSAP) to direct management interventions. A WSAP is a Local Biodiversity Strategy and Action Plan (LBSAP) that focuses specifically on wetlands. It provides a high level plan that is supported by specific actions for implementation to guide and direct the measures, interventions, activities and projects needed to ensure the effective protection, sustainable use and efficient management of wetlands in the Municipality over a specific time period of between approximately 5 to 10 years. A WSAP is developed by the Municipality and its stakeholders to ensure buy in from all interested and affected parties and adopted by the Municipality to get commitment for implementation. It is more than a mere checklist of activities and outputs over multiple years as it provides the Municipality and local community with a cohesive and clear roadmap of "where we are now", "where we want to be" and "how we will get there" with regard to the protection, sustainable use and management of wetlands. The various elements of a WSAP together with guidelines on how to develop one, are included in the ***Local Action for Biodiversity: Wetlands Strategy and Action Plan Guidelines*** (ICLEI Africa, 2017) available for download here: http://cbc.iclei.org/project/lab-wetlands-sa/.

Whether wetland priorities are formally documented through a WSAP or integrated into a broader Local Biodiversity Strategy and Action Plan (LBSAP), there are a range of priority focal areas that should be considered. These focal areas can be broadly packaged into 6 themes as indicated in **Figure 19** below.

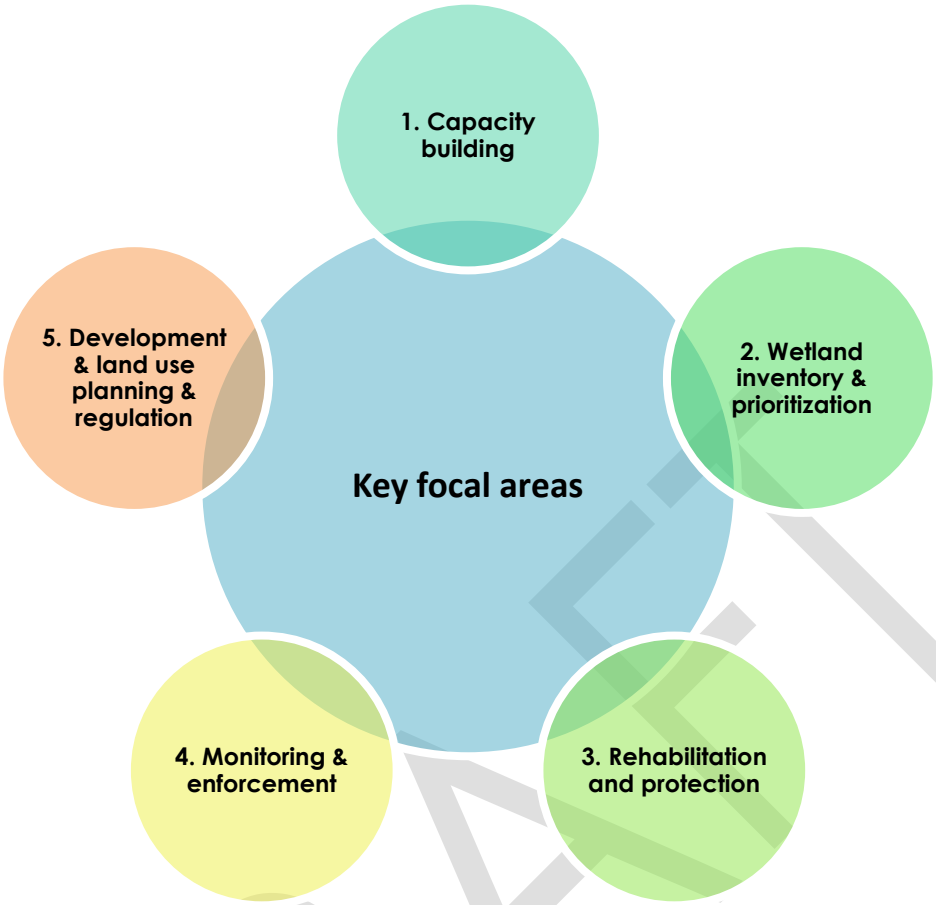

Figure 19 Focal areas that need to be considered when developing an action plan for wetland management.

Whilst the action plan for each municipality will need to be informed by local context, there are a number of high-level opportunities that are likely to be common across most municipalities. These are captured in **Table 3** below and should be used as a reference point when developing local wetland strategy and action plans.

Table 3. High-level opportunities to be considered in the formulation of a wetland management action plan.

Mainstreaming Initiative	Strategic Action
1. Capacity building	1.1. Establish an **environmental section/ department** with suitably qualified environmental scientists to address wetland management and broader sustainable development imperatives.
	1.2. Build **capacity of key personnel** in wetland management and mitigation (e.g. through attending appropriate wetland training courses and the National Wetlands Indaba).
	1.3. Actively **engage with the broader wetland fraternity** through Provincial Wetland Forums and South African Wetland Society (http://society.sawetlands.org).

Mainstreaming Initiative	Strategic Action
	1.4. Create broader **awareness for wetland management** through communication, education and public awareness initiatives
	1.5. Actively **engage with key sectors, developers and land owners in municipality** that are having, or stand to have, significant impacts on wetlands. This can be achieved through the setting up local area 'environmental sustainability' or 'environmental management' committees, and/or local area / region partnerships to facilitate the inclusion of best management practices and/or the identification of key wetland management opportunities in strategic planning.
2. Wetland inventory and prioritization	2.1. Establish a sufficiently detailed and scientifically defensible **baseline wetland inventory.**
	2.2. **Prioritize wetlands** to further inform conservation and management priorities and guide rehabilitation efforts.
3. Rehabilitation and protection	3.1 Develop and implement **rehabilitation plans** for priority wetlands.
	3.2 Seek **formal protection** of priority wetlands through appropriate legal mechanisms (e.g. Ramsar, NEM:PAA).
	3.3 Capitalize on opportunities provided by **wetland offsets** to protect and enhance priority wetland systems.
	3.4 **Manage and maintain formally protected wetlands** owned by the municipality.
	3.5 Initiate and/or support **biodiversity stewardship** projects that seek to protect and manage natural assets, including wetlands.
	3.6 Seek **complimentary support** from other governmental departments, agencies, non-profit organization, and community groups which are contributing to wetland management goals.
	3.7 Consider the use of **economic instruments like rates rebates, special taxes, fines / penalties, permits and other incentives** to promote the protection and management of priority wetlands.
	3.8 Develop **partnership with key land holders in the municipality** and provide **incentives** for them to engage in land-use activities that protect critical wetland biodiversity and support the Government's green jobs agenda.
4. Monitoring and enforcement	4.1 Ensure that **municipal by-laws** are tailored to promote wetland protection and management.
	4.2 Establish an **environmental compliance and enforcement function** and system for the municipality.
	4.3 Develop and implement a **priority wetland ecological monitoring programme** for the municipality.

Mainstreaming Initiative	Strategic Action
	4.4 Involve **communities, community groups and the public** at large in monitoring efforts of environmental resources. Encourage reporting of illegal use or destruction of environmental resources (such as pollution, destructive uses, illegal harvesting, etc.) by community groups and individuals.
5. Development and land use planning and regulation	5.1 **Identify strategic projects and programmes** that support or contribute to improved wetland management through the IDP process.
	5.2 **Integrate wetland best management practices and wetland priorities** into municipal scale sectoral plans e.g. disaster management plan, integrated waste management plan, water services development plan.
	5.3 Ensure that wetlands are included as part of the **environmental layer** of SDFs.
	5.4 Include wetlands in an **environmental overlay** as part of the Land Use Scheme.
	5.5 Ensure that wetlands are appropriately integrated in **environmental zones** as part of the Land Use Scheme.
	5.6 Ensure that **environmental input** is entrenched within the municipal land development application inquiry and review system.
	5.7 Ensure that **best-management-practices** are integrated into the design and implementation of all development projects so as to mitigate impacts on wetlands.
	5.8 Include additional safeguards to development by fine-tuning regulations for developments affecting wetlands as part of an **Environmental Management Framework** (EMF).
	5.9 **Identify local CMAs and catchment management forums** as part of WMA water resource management and actively participate in such forums.
	5.10 **Identify and collaborate with neighboring municipalities as part of integrated water resource management / integrated catchment management**, where catchments overlap and where such collaboration is relevant and beneficial.

The remainder of this document serves to provide further guidance on how more effective wetland management can be achieved in many of these areas. As such, it serves to provide guidance on the "how", which is ultimately a key question in any action plan.

4. GUIDELINES FOR DEVELOPING A WETLAND INVENTORY AND UNDERTAKING WETLAND PRIORITIZATION

4.1 Developing a Baseline Wetland Inventory

This section provides guidelines for developing a baseline wetland inventory for the municipality and undertaking wetland prioritization. Being a specialist process, the guidelines focus on the broad level steps and tasks to be undertaken and summarizes the key objectives, methods and outcomes of the wetland inventory and prioritization processes.

"You can't manage what you can't measure… Unless you have an idea how many, how big and of what type they are, where they are on the map and what pressures are being exerted on them, you cannot begin to manage wetlands."[61]

A wetland inventory is a consolidation of important information relating to wetlands within a defined study area. An inventory consists of a wetland map providing an indication of the location and extent of wetlands, and related information and datasets describing the nature, state and importance of wetlands. This is typically created as a GIS layer but can also be created manually using a map and a related table of attributes to describe each wetland area.

Developing a wetland inventory is a logical first-step to improving wetland management as it provides the data necessary to start including wetland management in development planning, spatial planning and decision making. Developing such an inventory is no small task, and should be approached in a structured manner. In this regard it is important to note that **developing a baseline wetland inventory of acceptable resolution is a specialized process that should be undertaken by a wetland assessment practitioner with suitable experience in the latest techniques and methods of desktop wetland mapping**. To source suitable wetland assessment practitioners, the municipality should contact the South African Wetland Society (SAWS) or the provincial wetland forum to get a list of suitably qualified practitioners. SAWS secretariat contact details are: Marc de Fontaine, +27 (0)11 682-0264, marcdef@randwater.co.za SAWS webpage: http://society.sawetlands.org/

Very useful guidance for the development of a wetland inventory is provided in the Ramsar Handbook 15: Wetland Inventory (https://www.ramsar.org/document/handbook-15-wetland-inventory)[62], and can be used by Municipalities to help work through a structured framework when planning and developing a wetland inventory (**Table 4**). More specifically, such a framework can assist municipal officials in developing comprehensive and context specific terms of references for the development of a wetland inventory for wetland assessment practitioners, as well as assist in the facilitation, management and review of this process.

[61] Dickens et al., 2003
[62] Ramsar Convention Secretariat, 2010

Table 4. A structured framework for planning a wetland inventory.

Step	Guidance
1. State the purpose and objective	State the reason(s) for undertaking the inventory and why the information is required, as the basis for choosing a spatial scale and minimum data set.
2. Review existing knowledge and information	Review the published and unpublished literature and determine the extent of knowledge and information available for wetlands in the region being considered. Also assess the current institutional, financial and staff situation to address the purpose and objective of step 1. This could be done by municipal officials if there is capacity or a specialist could be appointed to assist in establishing the wetland inventory status quo and developing a terms of reference for further inventory development.
3. Assess the feasibility & cost effectiveness	Effective and efficient desktop wetland mapping requires high resolution satellite imagery or aerial photography and topographical contour information, as well as the appointment of a wetland specialist to undertake the desktop mapping. Therefore, it will be important to determine whether the costs of data acquisition and analysis are within budget and that a budget is available for the program to be completed.
4. Review existing inventory methods	Review available methods and seek expert technical advice to: a) choose the methods that can supply the required information; and b) ensure that suitable data management processes are established. This is typically undertaken by a wetland specialist.
5. Determine the scale and resolution	Determine the scale and resolution required to achieve the purpose and objective defined in Step 1. This should be determined as part of the confirmation of the terms of reference for development of the wetland inventory to be undertaken by a wetland specialist. As mentioned for Step 2 above, this could be confirmed by municipal officials if there is capacity or a specialist could be appointed to assist in establishing the required scale and resolution as part of developing a terms of reference for further inventory development.
6. Establish a core or minimum data set	Identify the core, or minimum, data set sufficient to describe the location and size of the wetland(s) and any special features. This can be complemented by additional information on factors affecting the ecological character of the wetland(s) and other management issues, if required. This is typically undertaken by a wetland specialist.
7. Establish a classification system	Choose a habitat classification that suits the purpose of the inventory e.g. SA HGM classification[63] and/ or NFEPA wetland vegetation group classification. This is typically undertaken by a wetland specialist.
8. Choose an appropriate method	Choose a method that is appropriate for a specific inventory based on an assessment of the advantages and disadvantages, and costs and benefits, of the alternatives. This is typically undertaken by a wetland specialist.
9. Establish a data management system	Establish clear protocols for collecting, recording and storing data, including archiving in electronic or

[63] Ollis et al., 2013

Step	Guidance
	hardcopy formats. This should enable future users to determine the source of the data, and its accuracy and reliability. At this stage it is also necessary to identify suitable data analysis methods. All data analysis should be done by rigorous and tested methods and all information documented. The data management system should support, rather than constrain, the data analysis. A meta-database should be used to: a) record information about the inventory datasets; and b) outline details of data custodianship and access by other users. This is typically undertaken by a wetland specialist.
10. Establish a time schedule and the level of resources that are required	Establish a time schedule for: a) planning the inventory; b) collecting, processing and interpreting the data collected; c) reporting the results; and d) regular review of the program. Establish the extent and reliability of the resources available for the inventory. If necessary make contingency plans to ensure that data is not lost due to insufficiency of resources.
11. Establish a reporting procedure	Establish a procedure for interpreting and reporting all results in a timely and cost effective manner. The report should be succinct and concise, indicate whether or not the objective has been achieved, and contain recommendations for management action, including whether further data or information is required. This is typically undertaken by a wetland specialist.
12. Establish a review and evaluation process	Establish a formal and open review process to ensure the effectiveness of all procedures, including reporting and, when required, supply information to adjust or even terminate the program.

Step 1 – State the purpose and objective

The main purpose of establishing a wetland inventory is to facilitate the mainstreaming of wetlands into broader, strategic sector plans and assessments for inclusion into IDPs and SDFs. Such sector plans include environmental sector plans, catchment management strategies / water resource management strategies and green infrastructure strategies. These strategic planning tools are discussed in Section 8.

Additional reasons for developing a wetland inventory are varied but typically include:

- Identifying the **location and extent of wetlands,** referred to as a wetland map or layer.
- Understanding the status of wetlands in terms of their **condition and conservation status**, as well as the **key pressures, threats and risks** to these systems.
- Understanding the **importance of wetlands in terms of biodiversity maintenance and the provision of ecosystem goods and services** in support of municipal water resource management and disaster risk management, and in support of livelihoods and cultural values. With regards to ecosystem services, both the level of supply of, and demand for, such services is important to understand as part of wetland inventory (**Box 27**).
- Establishing a **baseline for measuring future change in wetland area, function and values**.
- Identifying **wetland priorities for management, conservation or rehabilitation interventions**.

Box 27: Wetland ecosystem service 'supply' and 'demand' concepts

The importance of an ecosystem services is influenced by the supply of and demand for the service. Supply refers to relative effectiveness or ability of the wetland to provide a service irrespective of contextual factors. Demand refers to the opportunity for the realization of the provided service in terms of contextual risk and service demand factors.

There may also be additional reasons for developing a wetland inventory, but whatever the rationale, a clear statement of the purpose(s) will assist in making decisions about the methods and resources needed to undertake the inventory.

Step 2 Review existing knowledge and information (can be done in-house)

The National Wetlands Inventory (NWI) and the National Freshwater Ecosystem Priority Areas (NFEPA) Project[64] datasets provide key staring points for a development of a municipal inventory and a rudimentary understanding of the location, extent, condition and importance of wetlands within the municipality. This review can be undertaken by municipal officials where a formal specialist wetland inventory assessment has yet to be commissioned or completed. The documentation and spatial datasets can be downloaded from the **SANBI BGIS website**: http://bgis.sanbi.org/Projects/Detail/48.

In order for municipal officials to undertake a review of existing spatial datasets, they will need to use a Geographic Information System (GIS) and will need basic competency in such. If there is no GIS license available, the review and collation of available spatial datasets can be undertaken using a free GIS software package like QGIS. QGIS can be downloaded from the following link: https://www.qgis.org/en/site/forusers/download.html. The municipal officials given the responsibility for the interrogation of available spatial data will need to have been trained or undertake training in the use of the selected GIS package. QGIS courses are currently undertaken by:

- EduAction - GIS Solutions - Email: frank@gis-solutions.co.za, Web: gis-solutions.co.za, Tel: +27-31-2615922, Cell: +27-82-5115795
- Kartoza - http://kartoza.co.za/en/training-courses/, Email: info@kartoza.com, Tel: +27 (0)21 880 0990 / +27 (0)73 768 8108 / +27 (0)87 809 2702 Fax: +27 (0)86 564 4056

Key questions for municipal officials to answer as part of the review of existing data and establishing a rudimentary baseline are:

1. **What is the location and extent of wetlands within the municipality as indicated by available wetland layers?**

Considerable strides have been made to develop a national wetland map for South Africa referred to as the National Wetland Map Version 4 (NWM 4). Whilst the accuracy of such mapping is variable across the country, this provides a useful starting point for any local initiative. The NWM is currently being managed by the National Department of Environmental Affairs (DEA). The currently available NWM 4

[64] Nel et al., 2011

dataset has been integrated into the NFEPA wetlands dataset[65] referred to as 'NFEPA Wetlands 2011' (Figure 20). Much of this information is housed on SANBI Biodiversity GIS (BGIS) website: http://bgis.sanbi.org/, and provides a useful starting point for developing a local wetland inventory. The 'NFEPA Wetlands 2011' dataset can be downloaded from: http://bgis.sanbi.org/SpatialDataset/Detail/395. An updated version of the NWM (Version 5) is expected to be made available in June 2018. Available provincial wetland maps ca also be downloaded from the BGIS site. A search for available provincial wetland datasets can be undertaken at: http://bgis.sanbi.org/SpatialDataset.

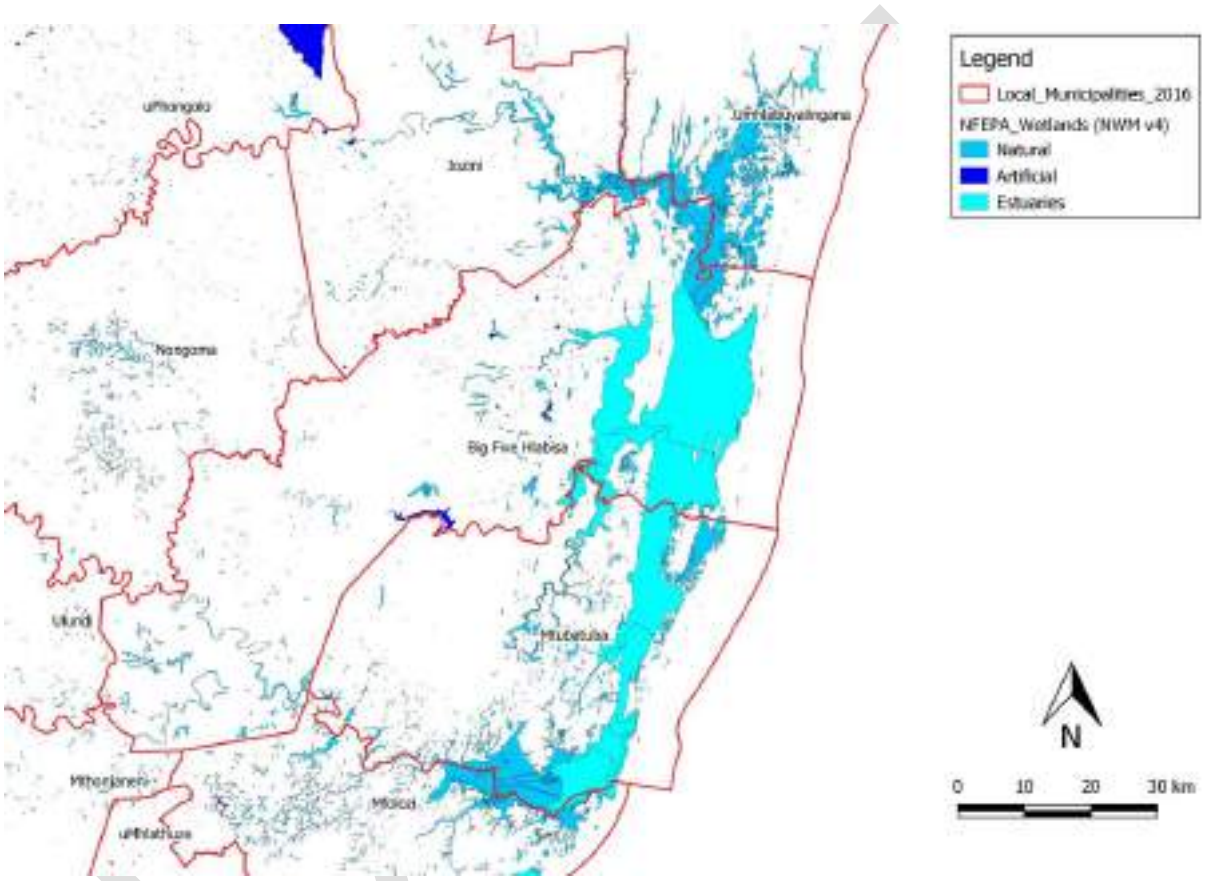

Figure 20 A snapshot of wetland mapping undertaken within the local municipalities in the wetland-rich Northern Zululand region of KwaZulu-Natal province undertaken as part of the NWM 4.

2. Are there 'Wetland FEPAs' and 'wetland clusters' within the municipality?

Wetland FEPAs (Wetland Freshwater Ecosystem Priority Areas) and wetland clusters represent the two key priority wetland layers within the NFEPA project and give a coarse indication of potential wetland priorities in the municipality. Wetland FEPAs are the wetland units considered important for meeting national wetland ecosystem biodiversity targets and supporting sustainable use of water resources[72] (**Box 28**). Wetland clusters are groups of wetlands embedded in a relatively natural landscape that allows for

[65] Nel et al., 2011

important ecological processes such as migration of frogs and insects between wetlands[60]. The 'Wetland Clusters 2011' dataset can be downloaded from: http://bgis.sanbi.org/SpatialDataset/Detail/396.

Box 28: What are FEPAs and how are they determined[73]:

FEPAs are strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. FEPAs were determined through a process of systematic biodiversity planning and involved collaboration of over 100 freshwater researchers and practitioners. FEPAs were identified based on a range of criteria dealing with the maintenance of key ecological processes and the conservation of ecosystem types and species associated with rivers, wetlands and estuaries.

3. Are there River FEPAs and Strategic Water Source Areas (SWSAs) within the municipality, and are there wetlands within these areas?

River FEPAs are those river reaches required to achieve biodiversity targets for river ecosystems and threatened/near-threatened fish species, and were identified in rivers that are currently in a good condition (A or B ecological category)[66]. Wetlands in the sub-quaternary catchments of River FEPAs should also be considered potentially important. Similarly wetlands located within SWSAs (see Box 14 earlier) should also be considered potentially important. The relevant links are as follows:

- 'River FEPAs 2011' - http://bgis.sanbi.org/SpatialDataset/Detail/398.
- Strategic Water Source Areas (SWSAs) Blobs 2013 - http://bgis.sanbi.org/SpatialDataset/Detail/505.
- Strategic Water Source Areas (SWSAs) Polygon 2013 - http://bgis.sanbi.org/SpatialDataset/Detail/504.

4. Are there threatened wetland vegetation types within the municipality?

National wetland vegetation groups have been generated for the country as a part of the NFEPA project based on the national vegetation map[67]. A threat status assessment of these wetland vegetation groups has been undertaken and should be interrogated to identify threatened vegetation groups within the municipality and whether intact and functional wetlands occur within these threated groups. The NFEPA 'Wetlands Vegetation 2011' dataset can be downloaded from: http://bgis.sanbi.org/SpatialDataset/Detail/401.

Additional local datasets may also exist that can be used to inform the mapping process, and may considerably reduce the time required to complete a comprehensive wetland inventory if undertaken at an appropriate scale and resolution.

Step 3 Assess the feasibility and cost effectiveness of the project

Ultimately, the accuracy and usefulness of the information collected will depend on the experience and competence of the individual or service provider who undertakes the mapping, accuracy of contour

[66] Driver et al., 2011
[67] Mucina & Rutherford, 2006

data, resolution of aerial photography and the scale at which mapping undertaken. Whilst sufficient capacity may exist to undertake this assessment in house, this is unlikely to be the case in most instances since accurate interpretation requires a strong understanding of the drivers and processes that give rise to wetland formation. For this reason **it is recommended that the inventory should be undertaken by a specialist wetland assessment practitioner with good knowledge of the local area.** A key aspect that needs to be considered however, is the availability of funds and the timeframe for the assessment. Given the importance of developing a sound baseline, preference should be given to systematically building up an accurate wetland inventory over a number of years rather than undertaking a low accuracy assessment if budget constraints are an issue.

Step 4 Review existing inventory methods

Selection of an appropriate method will depend on the purpose and objectives of the assessment and the spatial resolution of mapping required. Considerable learnings have however emerged from the development of a national wetland inventory. Traditionally remote sensing using satellite imagery and modelling approaches in GIS were employed but these have proved to produce coarse resolution and relatively inaccurate wetland mapping. As a result, there has been a shift to the reliance on expert-based mapping using aerial photography and available contour data for the development of desktop wetland mapping for regional inventories. **Consultation with experts, and other Municipalities who have already completed wetland inventories, is therefore recommended when considering what method to follow.** Key wetland inventory tasks with associated approaches and methodologies are summarised in **Table 5**.

Table 5. Summary of wetland inventory approaches and methods relevant to the municipal scale.

Wetland Inventory Task	Approach / Methodology
i. Developing a wetland map at 1:5000 scale or less for priority / focal areas	• 'Eye-balling' along drainage lines / valley lines in a systematic manner using a combination of high resolution aerial photography and high resolution contour information with a contour interval of ≤2m, in a GIS. • Stereoscopic analysis of black and white photo mosaics[68]. The black and white photos are observed through a stereoscope which provides high resolution and three-dimensional detail[59]. • As part of the desktop mapping process outlined above, field verification of strategic sample sites will need to be undertaken to confirm the desktop mapping accuracy and confidence. The findings of infield verification will need to be fed back into the mapping process.
ii. Developing a wetland map at 1:10000 scale for non-priority / non-focal areas	'Eye-balling' along drainage lines / valley lines in a systematic manner using a combination of high resolution aerial photography and high resolution contour information with a contour interval of ≤2m.

[68] Thompson et al. 2002; Dickens et al., 2003

Wetland Inventory Task	Approach / Methodology
iii. Hydro-geomorphic type as per the national wetland classification system[69]	Same approach and methods as for developing a wetland map for priority / focal areas above.
iv. Wetland vegetation type as per the NFEPA Wetland Vegetation Group	A coarse, preliminary indication of wetland vegetation can be undertaken by integrating the NFEPA wetland vegetation group dataset with the latest available and/or finest resolution available land cover dataset. Where untransformed land cover overlays the desktop wetland mapping, such wetland areas can be considered to be potentially intact and characteristic of the regional wetland vegetation group.
v. Present ecological state (condition) and trajectory of change (**Box 29**)	Revised Level 1 WET-Health Method currently being developed as part of a WRC project which assesses PES using land cover data.
vi. Present ecological or biodiversity importance (**Box 29**)	The ecological or biodiversity assessment should involve the systematic integration of threat status assessments for existing wetland vegetation or ecosystem types with the latest available land cover and threatened species distribution and habitat preference information. These two datasets indicating preliminary / potential importance must be confirmed and refined by integrating these datasets with the desktop wetland PES assessment and/or the latest available land cover dataset. Where the desktop wetlands are mapped as being untransformed or being low to moderately modified, such wetland areas can be considered to be intact and characteristic of the regional wetland vegetation group, and/or provide habitat for the relevant threatened species. For the priority areas, the presence of intact wetlands will need to be verified and refined based on a review of aerial photography. For highly threatened vegetation types, field verification of potentially intact wetlands might be necessary to confirm vegetation condition and the presence of the threatened type.
vii. Present functional importance (importance in terms of ecosystem goods and services.) – refers to importance in terms of the provision of ecosystem services and goods to society.	Desktop ecosystem services importance should be informed by datasets that provide an indication of the potential supply factors, namely the HGM type and wetland PES, and potential demand factors like catchment land use intensity, level of transformation and water quality. In this regard, it is recommended that the desktop HGM type and wetland PES datasets will be integrated with the quinery catchment ecosystem service demand datasets generated by the National

[69] Ollis et al., 2013

Wetland Inventory Task	Approach / Methodology
	Wetland Rehabilitation Prioritization assessment[70]. For wetland areas assessed as being of high importance, field verification of such wetlands might be necessary to confirm the desirable functional characteristics.
viii. Intervention priorities for rehabilitation and/or protection – refers to those wetlands where important gains in ecosystem services and biodiversity conservation can be achieved.	Municipal catchment prioritization exercise should be conducted in line with the approach of the national catchment prioritization assessment undertaken for Working for Wetlands[78]. This is a prioritization from an ecological perspective. Other financial and socio-economic aspects are included in the later prioritization. Once priority catchments have been identified, the desktop mapped wetlands occurring within the prioritized catchments within the municipality will need to be assessed for rehabilitation potential at the desktop level. The recommended approach is to systematically identify wetlands with rehabilitation potential through a review of available satellite imagery or aerial photography. Once preliminary priority wetlands have been identified, further detailed assessments will be undertaken to refine the prioritisation process

Box 29: Present Ecological State (PES) and Present Ecological Importance

- PES refers to the deviation in the state of the drivers and biotic components of the ecosystem from a hypothetical reference state[71].
- Ecological importance refers to importance in terms of maintaining biodiversity and/or contributing to biodiversity conservation.

Step 5 Determine the scale and resolution

The choice of scale is related to the size of the geographic area involved and to the accuracy required and achievable with available resources. Fine-scale inventories are typically required at a municipality scale, with mapping being undertaken at a 1:10 000 or finer scale. Where possible, mapping should however be undertaken at a 1:5 000 scale, and be informed by local knowledge including an appropriate ground-truthing exercise. An overview of the different levels of assessment that can be applied when developing a wetland inventory is provided in **Table 6**.

[70] Macfarlane & Atkinson, 2015
[71] Macfarlane et al., 2008

Table 6. Overview of different levels of assessment that can be applied when developing a wetland inventory.

	BASIC	INTERMEDIATE	DETAILED
Overview	Large mapping area/low spatial detail/low level of attribute information	Medium mapping area/ moderate spatial detail/ moderate level of attribute information	Small mapping area/high spatial detail/comprehensive attribute information
Mapping Scale	1:100 000 to > 1:250 000	1:10 000 to 1: 100 000	1: 5 000
Minimum Mapping Unit	6.25ha *(250m x 250m)* to >40ha *(635m x 635m)*	0.5ha *(70m x 70m)* to 6.25ha *(250m x 250m)*	<0.01ha *(10m x 10m)* to 0.5ha *(70m x 70m)*
Main Survey Technique	Primarily desktop, however could be field survey of wetland presence/absence	Desktop and field	Primarily field, supported by desktop
Attribute Information	Certain basic attributes can be captured: Wetland ID/name/size; Source data; Wetland Mapping method; Independent verification; Natural/artificial	All attributes under Basic plus additional attributes: Regional Setting; Landscape unit, Wetland Hydro-geomorphic type	All Basic and Intermediate attributes, plus additional attributes: Wetting Regime; Wetland Characteristics; Ecological Condition; Ecological Importance; Ecological Reserve
Potential Image Source	LANDSAT (30/15m pixel) SPOT4 (20/10 m pixel)	SPOT5 (10/5m pixel) RAPID EYE (5m pixel) IKONOS (4/1m pixel) Aerial photography (<1m) Google Earth	GEO-EYE (1.6/0.4m pixel) WORL VIEW (1.8/0.5m) QUICKBIRD (2.4/0.6m) Aerial photography (<1m) Google Earth
Potential Applications	Presence/absence. Simple wetland boundary delineation, accuracy levels not adequate for land-use decision-making	For detailed conservation planning as well as presence/absence, but not suitable for more complex wetland threat applications	Detailed wetland information required by regulatory processes. Detailed wetland threat studies
Examples	National Wetland Map version 1	Spatial Development Frameworks (SDFs), Environmental Management Frameworks (EMFs), Conservation Plans, and other spatial planning activities such as town planning	Environmental Impact Assessments (EIAs), Water Use License applications (WULAs); site-specific Reserve Determinations; site-specific management plans

Step 6 Establish a core or minimum data set

The data collected as part of a wetland inventory may range from simply mapping the extent of wetlands through to information on type and condition or more detailed information on plant communities, land uses and impacts and pressures affecting wetlands. This choice depends on the purpose of the inventory, but minimum information collected would typically include the HGM type of wetland based on the national wetland classification system. At the municipal scale, additional

information on wetland state, importance, land use pressures, and rehabilitation priorities is critical – see 'Step 1 – State the purpose and objective' above.

Step 7 Establish a classification system

A national wetland classification system[72] has been developed for South Africa and should be used as the basis for any wetland inventories. The manual can be downloaded from: https://www.sanbi.org/sites/default/files/documents/documents/sanbi-biodiversity-series-wetlands-classification-no-22.pdf. This allows data collected from different sources to be consolidated into a composite dataset, which should ultimately feed into the NWI. Refer to **Table 5**, task (iii) above.

Step 8 Choose an appropriate method

Whilst remote-sensing and modelling approaches (**Box 30**) may be useful for mapping wetlands at a national or provincial scale, this is generally not appropriate for municipal-scale mapping purposes where more accurate mapping is required. The most important question here, is the level of ground-truthing required to inform the wetland mapping process and to verify the results of the assessment. Where additional attribute information is collected (e.g. HGM type / PES), an appropriate method also needs to be selected and should ideally be informed by best available tools and guidelines. See relevant mapping approaches and methods in **Table 5** above.

Box 30: Remote sensing

Broadly, remote sensing is the process of obtaining information about an object, area or phenomenon without coming into direct contact with it[73]. More specifically, remote sensing includes all methods of obtaining information about the earth's land and water surfaces using images acquired from an overhead perspective, using electromagnetic radiation in one or more regions of the electromagnetic spectrum, reflected or emitted from the earth's surface[74].

Step 9 Establish a data management system

"The housing and dissemination of wetland information is a vital component of the overall wetland inventory in that a well-structured, reliable, and accessible database lays the foundation for appropriate analysis, monitoring, and decision making of wetlands in South Africa"[24].

Before setting up a wetland database, contact the Project manager of the National Wetland Inventory Initiative at the Department of Environmental Affairs (DEA) to ensure that your database is as compatible as possible with the national level database (contact Namhla Mbona – n.mbona@sanbi.org.za; 012-8435284). Your database should also be compatible with the overall IT systems used by the municipality for its activities to effectively integrate your wetland data into the operations and decisions made by the municipality. It is envisaged that all mapping will be undertaken in GIS and that all inventory information

[72] Ollis et al., 2013
[73] Patra, xxxx
[74] Campbell, 1996

will be included in the attribute data for the GIS wetland mapping shapefile(s). It will be important that all GIS data is accompanied by metadata and contextual information.

Step 10 Establish a time schedule and the level of resources that are required

It is necessary to determine the time schedule for planning the inventory, as well as for collecting, processing and interpreting the data collected during an inventory. This is particularly important if the inventory is being built up systematically over an extended time frame, or if the inventory involves various phases of data collection and processing. Where possible, a pilot testing phase should be undertaken to test out the methods and evaluate expected outcomes before proceeding with full-scale implementation.

Step 11 Establish a reporting procedure

Formally documenting progress made, together with the methods applied and the outcomes of the assessment are critical to the inventory process. Reporting requirements must therefore be clarified to relevant parties to ensure that expectations are met.

Step 12 Review and evaluate the inventory

Once an inventory has been completed, this should ideally be reviewed and evaluated in order to illustrate both the strengths and the weaknesses of the inventory, including necessary reference to the accuracy of the data set. Such an evaluation can be undertaken by an independent wetland assessment practitioner or in-house if there is capacity. The evaluation can also be used to justify a request for funding for additional work that may still be required. If the inventory has been a success and achieved its purpose and objective, this should be clearly stated and the program brought to an end. Conversely, if the inventory has not achieved its purpose and objective, this also should be clearly stated along with a recommendation as to whether it should continue, possibly in a revised form, or halted. Evaluation is best undertaken by strategic infield verification of the desktop inventory data. This should be done by a wetland assessment practitioner.

4.2 Wetland Prioritisation

Whilst a wetland inventory provides a very useful starting point to inform wetland management, this should ideally be enhanced through a prioritization process that helps to inform decision making and target management interventions. Such a process has been undertaken nationally through the NFEPA process that sought to identify strategic spatial priorities for conserving the country's freshwater ecosystems and supporting sustainable use of water resources. Such a map can provide an initial starting point for identifying priority wetlands but is regarded as being too coarse in resolution and inaccurate at finer scales in many parts of the country. As such, a regional or local-scale prioritization process is typically required to better inform planning and management at a municipal scale. As for the development of the wetland inventory (Section 4.1), **wetland prioritization should be undertaken by a wetland assessment practitioner with experience in wetland prioritization.**

It is important to recognise that prioritization may be undertaken for various reasons, at different scales and to inform different kinds of interventions from catchment management through to conservation efforts and rehabilitation planning. Whilst it is not possible to provide a one-size-fits-all approach to prioritization, some of the principles and approaches to prioritization have been discussed at the Wetland Imbizo on Prioritization, hosted by the Department of Water and Sanitation in October 2017. This generally supported the broad approach to prioritization set out in the WET-Prioritise framework[75] which has been expanded on in Table 7 below.

Table 7. Step-wise prioritization approach.

Step	Guidance
1: Setting aims and objectives	This is the logical first step in the process, and requires one to specifically consider the rationale for prioritization. From a municipal planning perspective, typical priorities could include (i) prioritizing areas for protection from development; (ii) (ii) prioritizing areas to enhance functional values (e.g. water quality enhancement or recreation) to support municipal service delivery; or (iii) (iii) prioritizing areas to monitor the state of wetlands in the municipality. In many cases, it may be useful to consider multiple objectives, and to then develop an approach to integrate priorities into a consolidated dataset to inform planning. Prioritization can also depend on 'windows of opportunity' such as ongoing or future developments in an area which need guidance or which make financial resources available.
2: Identifying the appropriate spatial scale	Defining the scale of assessment is critical to the assessment process as this ultimately dictates the accuracy of input data required. A phased approach is one that should be considered here, which typically aims to prioritise focal areas first (e.g. catchments), within which more detailed prioritization is then undertaken.
3: Collating available information	The most important input dataset to any wetland prioritization process, is the wetland inventory. As such, the most up-to-date wetland dataset should ideally be sourced, and where it is lacking, resources should first be allocated to developing such an inventory as described in Section 4.1 above. Additional datasets will then need to be consolidated, depending on the objective of the assessment. This may include a range of datasets pertaining to the themes of interest such as: • Conservation value;

[75] Rountree et al, 2008

Step	Guidance
	• Functional (ecosystem services) value; • Social importance; • Partnerships; • Ownership; • Open space planning; • Infrastructure (sewerage, stormwater). Once potential data sources have been identified, these need to be sourced, consolidated, formatted or mapped at a resolution appropriate to inform the specific assessment. This process may be a time-consuming and costly exercise, so available information should be used as far as possible. This typically requires consultation with various data custodians such as SANBI, Provincial Conservation Agencies and the like.
4: Developing prioritization criteria	Once available datasets have been consolidated, these need to be prioritised through an appropriate decision-making framework. A range of different options exist here, and it is important that consideration be given to the relevance and accuracy of the dataset when considering how to integrate the datasets which is typically undertaken by applying weightings to input datasets through GIS analysis. This process should ideally be informed by key stakeholders with a clear understanding of the desired objectives of the prioritization exercise.
5: Screening the pool of all possible sites to develop a candidate list	Once initial prioritization has been undertaken, the data needs to be interrogated, which is best achieved through expert input. If the results are not defensible, further manipulation of input data or prioritization criteria may be required to ensure that meaningful outputs are achieved. Ultimately, this process can help to identify a suite of potential candidate priority sites.
6: Prioritizing candidate sites	Once an initial candidate list has been identified, these should ideally be verified through a combination of desktop interrogation, expert input and/or site visits. This will serve to improve the confidence in the final list of priority sites and any further planning that may be required.
7: Assessing the potential of prioritized sites to meet the aims and objectives of the project	Depending on the level of assessment undertaken, initial prioritization will then give rise to a further round of planning aimed at assessing the potential of target areas to meet the desired aims and objectives. In the case of rehabilitation planning, this would entail detailed site visits to assess the rehabilitation potential of individual sites, evaluate potential risks and establish the willingness of landowners to support wetland rehabilitation initiatives. In other instances, it may help to

Step	Guidance
	direct monitoring activities or site visits to confirm the extent of threats or values.

Please refer to the case study of the Amathole District Municipality desktop wetland mapping and prioritization assessment undertaken by Eco-Pulse in conjunction with ICLEI and Amathole included in **Annexure A6**.

5. REHABILITATING AND ENHANCING WETLAND VALUES

This section provides an overview of the benefits and relevance of wetland rehabilitation and enhancement to municipalities. Reasons for municipalities taking a proactive role in wetland rehabilitation are discussed and an overview of the rehabilitation planning process is provided.

5.1 What is wetland rehabilitation and enhancement?

Wetland rehabilitation refers to the process of assisting in[76]:

- **the recovery of a degraded wetland's health / integrity and ecosystem service delivery** by reinstating key natural ecosystem drivers / driving forces (e.g. hydrology, levels of erosion and sedimentation, and water quality) and where necessary assisting in ('kick-starting') the re-colonization of natural biotic communities; or
- **halting the decline in health of a wetland** that is in the process of degrading, so as to maintain its health and ecosystem service delivery.

Rehabilitation aims to imitate natural processes and reinstate the natural ecosystem drivers to assist in the recovery and/or maintenance of the system that is comparable in critical ways to the original (or reference) state / condition of the wetland. It is important to note that rehabilitation generally falls short of replicating the full diversity and complexity of a natural non-degraded system[77]. Rehabilitation does however help to restore some resemblance of ecological functioning in an impacted landscape, to avoid on-going negative impacts, and/or to provide some sort of aesthetic fix for a landscape, which is if benefit to municipalities (e.g. water purification, flood attenuation, stream flow regulation etc.)[78].

In some circumstances where improvements in functions and ecosystems services over and above those provided by original state conditions, or that required to remediate planned impacts is desirable, rehabilitation can involve enhancement of such functional aspects towards an alternative desired state[79] i.e. a state that is more desirable than the original state in certain circumstances.

The term 'wetland restoration' is often used interchangeably with 'wetland rehabilitation'. However, the term restoration can be differentiated from rehabilitation in that it attempts to reinstate the original / natural state ecological function and biotic community composition as far as practically possible.

Although not discussed as part of this section, it is also important to mention the concept of wetland creation or establishment. Wetland creation is an emerging field that builds on wetland restoration and rehabilitation and involves creating and establishing wetlands where they did not occur previously.

[76] Russel, 2009
[77] DEA et al., 2013
[78] Macfarlane et al., 2016
[79] Dufour & Piegay, 2009

5.2 Why restore and enhance wetland values?

As outlined in Part 1, intact and functional wetlands represent naturally occurring and free ecological infrastructure that can assist in meeting a number of municipal objectives including sustainable water and sanitation service provision (i.e. water resource management), stormwater and disaster risk management, biodiversity maintenance and conservation resulting in basic human needs being provided for, sustainment of human livelihoods, and adding cultural and amenity value to communities.

Despite increasing recognition of the values that wetland ecosystem services provide to municipalities, cumulative wetland loss and degradation in South Africa remains high, especially in urban, commercial agricultural and mining contexts. For this reason, municipalities are advised to take a proactive role in identifying, prioritizing and implementing wetland rehabilitation within their jurisdictions, as well as identifying opportunities to enhance important wetland values. This in line with the National Water Resource Strategy[80]:
http://www.wrc.org.za/SiteCollectionDocuments/Acts%20for%20govenance%20page/DWS%20National%20Water%20Resources%20Strategy%202LinkClick.pdf.

Within the municipal context, there are a number of reasons to rehabilitate and enhance wetlands. These are summarized in **Table 8** below with key role players and potential roles for municipalities.

Table 8. Reasons for undertaking wetland rehabilitation and key role players.

Reasons for undertaking rehabilitation	Responsible Party and Municipal Role
1. **To rehabilitate wetlands** impacted by historical and current human development.	This can be initiated and implemented by the municipality alone or in strategic partnerships with national or provincial government, conservation organizations or private developers or land owners. In addition, wetland rehabilitation can form part of one or more departmental / sectoral responsibilities e.g. urban stormwater and flood management, water and sanitation services provision, public open space management etc.
2. **To reinstate or enhance lost values** in support of improved water resource management and disaster risk management.	This can be initiated and implemented by the municipality alone or in strategic partnerships with national or provincial government, conservation organizations or private developers or land owners. In addition, wetland rehabilitation can form part of one or more departmental / sectoral responsibilities e.g. urban stormwater and flood

[80] DWS, 2013

Reasons for undertaking rehabilitation	Responsible Party and Municipal Role
	management, water and sanitation services provision, public open space management etc.
3. **To reinstate or enhance lost values** in support of meeting basic human needs, sustaining livelihoods and/or enhancing cultural values.	This can be initiated and implemented by the municipality alone or in strategic partnerships with national or provincial government, conservation organizations or private developers or land owners.
4. **To mitigate residual impacts** to wetlands resulting from development proposals. Residual impacts are those that remain after all practical mitigation measures have been implemented.	Such rehabilitation is undertaken by the project proponent / applicant / developer. The municipality can play a key role in motivating for such rehabilitation as part of achieving their broader objectives.
5. **To offset significant residual impacts** to wetlands resulting from development proposals. Wetland offsets are interventions designed to compensate for anticipated significant residual negative impacts on wetlands.	Such rehabilitation is undertaken by the project proponent / applicant / developer. The municipality can play a key role in motivating for such offsets as part of achieving their broader objectives.

5.3 Identifying wetlands for rehabilitation

As part of municipal wetland rehabilitation initiatives and programmes, it is important that wetland rehabilitation priorities are identified and selected in a structured and systematic manner. Wetland rehabilitation projects can be relevant to and initiated by different departments including environmental planning / management, stormwater management, water and sanitation, and/or parks and recreation departments. For the environmental planning / management department, wetland rehabilitation prioritization should focus on achieving wetland ecosystem and biodiversity conservation objectives. For the water and sanitation department, wetland rehabilitation prioritization should focus on achieving water resource management objectives and enhancing municipal green infrastructure. For the stormwater management department, wetland rehabilitation prioritization should focus on achieving disaster risk management and climate resilience objectives and enhancing municipal green infrastructure. For health and economic / rural development departments, wetland rehabilitation prioritization should focus on improving and/or sustaining the ecosystem services supporting basic needs and livelihoods and the effect on property and tourism values. For the parks department, wetland rehabilitation should focus on the improvement of recreational values. Such a prioritization process should be a **single, integrated and co-operative process between all relevant departments, guided by or integrated in the IDP's Spatial Development Framework**. Private sector, citizens and learning institutions can participate and collaborate, and it is important to coordinate how this will be done.

Current best practice wetland rehabilitation prioritization practice involves the following steps:

1. Catchment prioritization is based on a number of prioritization criteria relevant to departmental objectives. For the national catchment prioritization assessment for the Working for Wetlands Programme (Macfarlane & Atkinson, 2015), national wetland prioritization criteria includes land cover, river and wetland PES, river and wetland EIS databases, water quality databases and the presence of dams, which could serve the environmental planning and sustainability department.
2. Once priority catchments are identified, the desktop mapped wetlands occurring within the prioritized catchments will need to be assessed for rehabilitation potential at the desktop level. The recommended approach is to systematically identify wetlands with rehabilitation potential through a review of available satellite imagery or aerial photography. Once identified, wetlands should then prioritized at a desktop level based on criteria relevant to the various rehabilitation objectives. For example, the criteria identified as part of the national wetland prioritizationis[81]:
    - Rehabilitation potential;
    - Level of engineering input required;
    - Conservation context and importance;
    - Alignment with other conservation initiatives;
    - Opportunity for enhancing key wetland ecosystem goods and services; and
    - Land ownership.
3. Once preliminary priority wetlands have been identified, further detailed assessments will need to be undertaken to refine the prioritisation process. This includes desktop mapping of wetland impacts, the sourcing of land owner details, the undertaking of site visits with municipal staff to collect information on priority wetlands, refining of the delineation, and engagement with landowners to obtain their commitment to rehabilitation and further planning.

5.4 Planning wetland rehabilitation and enhancement activities

5.4.1 Assembling a specialist wetland rehabilitation project team

The first step in undertaking an efficient and successful wetland rehabilitation process is to assemble a project team that has suitable experience in the wetland rehabilitation projects. Wetland rehabilitation is a highly specialized focus and a rehabilitation team should include the following:

- Professionally registered natural scientist with relevant experience in wetland rehabilitation (i.e. a minimum of 5 years worth of experience).
- Professionally registered civil and/or agricultural engineer with relevant experience in wetland rehabilitation (i.e. a minimum of 5 years worth of experience; choice for civil or agricultural dependent on the circumstances).

[81] Macfarlane & Atkinson, 2015

Depending on the rehabilitation objectives, professionally registered plant ecologists or horticulturalists with relevant experience in wetland rehabilitation may need to be included to provide re-vegetation input.

5.4.2 Rehabilitation Planning Process

Once an appropriate specialist rehabilitation team has been assembled, the rehabilitation process can commence. The rehabilitation process essentially involves the following steps:

1. Identification and understanding of causes of wetland system degradation: upstream, downstream or in the wetland itself.
2. Identification of practical, feasible and reasonable rehabilitation objectives/goals to address degradation based on context.
3. Identification of rehabilitation interventions to achieve the objectives/goals.
4. Location and design of rehabilitation interventions including engineered hydrological interventions, re-vegetation, alien plant removal and species re-introductions.
5. Compilation of intervention implementation management plans and method statements.
6. Compilation of rehabilitation ecosystem monitoring programme.

5.4.3 Understanding the Causes of Degradation

For the most part, wetland rehabilitation will involve the remediation of indirect impacts of activities at project and catchment scales, most notably erosion, sedimentation impacts driven by:

- catchment surface runoff and flood peak changes driven by land cover alteration,
- direct flow modification activities like flow diversion and concentration / canalisation at wetland crossings or where partial wetland encroachment occurs,
- excess and return flow discharges from waste water treatment and/or mining activities, and
- overgrazing and poor land use practices within the wetland and/or wetland's catchment.

Figure 21 Active headcut and gully erosion within a wetland in the Upper Wilge River catchment, Free State province[82].

Figure 22 Wetland vegetation burial and smothering as a result of flood deposits and debris within an urban wetland in Umlazi, Durban[83].

Wetland rehabilitation is also applicable to the non-permanent physical destruction and modification of wetlands by short to long-term temporary activities that will be decommissioned at some point in the future. Such temporary activities are typically associated with the establishment of pipelines within underground trenches across wetlands, accidental wetland encroachment in the form of infilling or smothering with materials, compaction by heavy machinery during construction and operational activities and mining activities within wetlands.. Permanent wetland infilling as a result of pipeline establishment, wetland encroachment and compaction cannot be restored or rehabilitated, and the indirect impacts of flow reduction and regulation activities like upstream dams cannot be rehabilitated onsite. In terms of mining, rehabilitation can occur during mine operation and after the decommissioning phase. During open cast mineral extraction, it is generally best practice to rehabilitate behind the open cast working front as the activities roll over.

It is important to note that not all wetland ecosystem change is human induced and in some circumstances wetland change, usually erosion, is a natural process[84]. Rehabilitation in such settings may involve spending substantial resources working against the forces of nature, which is not desirable in the South African context with relatively scarce financial resources for wetland rehabilitation[96].

Thus, **the understanding of the causes of wetland erosion in particular is critical to effective wetland rehabilitation planning**.

[82] Photo taken by Douglas Macfarlane
[83] Photo taken by Ryan Edwards
[84] Ellery et al., 2008

5.4.4 Rehabilitation Goals and Objectives

Clearly defining the desired outcomes of rehabilitation is the most important component of rehabilitation planning as it sets the expectations, drives detailed plans of action and determines the kind and extent of post-project monitoring[85]. These need to be tailored for each project in line with the reasons for the rehabilitation, the realistic achievable outcomes and the expectations of regulators and key stakeholders[97]. Desired outcomes are typically expressed in term of goals, objectives and targets[97] (**Figure 23**)

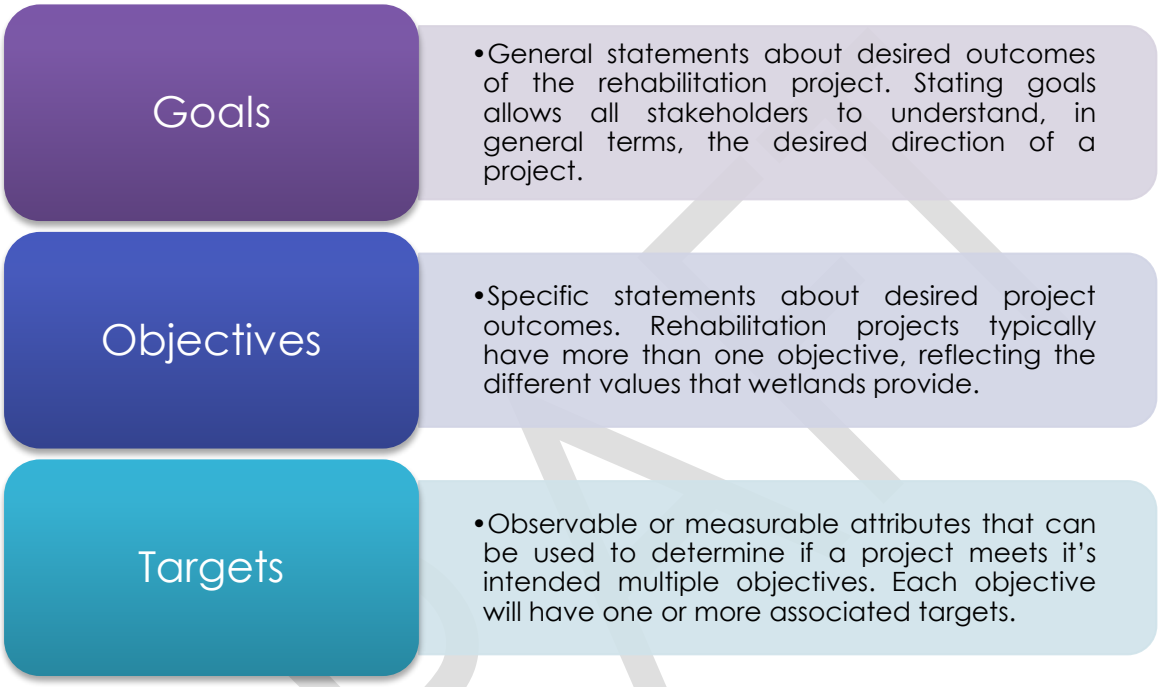

Figure 23 Definitions of goals, objectives and targets in wetland rehabilitation.

It is important to note that due to the uncertainties associated with restoration and rehabilitation outcomes, it is important that realistic goals and objectives are formulated that have a reasonably high confidence of success rather than ideal or original state (restoration) objectives that are often impossible to achieve.

5.4.5 Selection & Design of Rehabilitation Interventions

The typical wetland rehabilitation interventions utilised in South Africa include[86]:

- **Catchment land use and infrastructure management** – stormwater management, sediment management, sewage management. Usually applied when catchment management is the major driver of wetland change, which is typical of urban catchments with little or poor stormwater management measures / interventions. Also applicable to catchments under

[85] Macfarlane et al., 2016
[86] Russell, 2009

commercial agriculture and peri-urban / rural areas with highly erodible soils.

- **Earthworks – backfilling, excavation and reshaping**. Usually used when wetlands have been extensively drained for cultivation, where drains or gullies are shallow and can be backfilled, or where there are opportunities to widen and reshape wetlands to improve the supply of wetland ecosystem services and/or increase the extent of wetland habitat.
- **Diversion and flood protection berms** (earth or concrete). Berms in rehabilitation are typically used to divert water / flow away from areas sensitive to erosion (e.g. headcuts), areas that may undermine rehabilitation objectives (e.g. reduce erosion risks associated with water re-entry into channels) and/or areas that may experience increased flooding as a result of rehabilitation (e.g. houses and infrastructure).
- **Channel plugs and control structures – berms, weirs, walls / sills** (timber, earth, rock, gabions or concrete). These structures are typically used to plug or backflood artificial drains or gullies within wetlands and force water out of channels with the purpose of spreading out flows across the width of the wetland.
- **Headcut stabilisation structures** – weirs, chutes, drop-inlet (gabions or concrete). These structures are used to stabilise headcuts within wetlands and halt the headward migration of erosion.
- **Fishways / fish ladders** – Any natural or artificial device that enables fish and other aquatic organisms to overcome structures in streams and rivers that obstruct their natural migrations[53]. Where natural wetland channels provide habitat to and are conduits for local fish populations, particularly fish species of conservation concern, the establishment of channel plugs and instream control structures will act as barriers to fish movement and lead to instream habitat fragmentation. In such cases, fishways and fish ladders will need to be installed as part of the design of the plugs and control strictures.
- **'Soft' bio-engineering applications** – targeted re-vegetation, vegetative material, geotextiles. These applications are typically used to stabilise soils for preparation for re-vegetation and improve the success of re-vegetation.
- **Active re-vegetation** – seeding and active planting methods. Active re-vegetation is applicable in all rehabilitation circumstances to stabilise wetland soils and reinstate wetland fucntjonal and habitat characteristics.
- **Alien plant eradication** – mechanical, herbicide treatment, biological treatment. This is applicable to all wetlands that have been invaded by alien invasive vegetation due to past disturbance, a lack of management and/or direct or indirect hydrological impacts that reduce the levels of soil saturation, which reduces the wetland's ability to resist alien invasive plant invasion and proliferation.

Figure 24 Concrete drop inlet weir for headcut stabilisation[87].

Figure 25 Hyson-cell geo-chute with concrete baffles for headcut stabilisation in a seep, Free State[88].

[87] Ref??

[88] Photo taken by Adam Teixeira-Leite

Figure 26 Concrete weir plug within a drain in the Hlatikhulu wetland in KwaZulu-Natal[89].

Figure 27 Gabion weir plug within a drain, Golden Gate National Park, Free State[90].

In this regard, the reader is referred to ***WET-RehabMethods: National guidelines and methods for wetland rehabilitation*** (Russell, 2009), which is the current best reactive guideline for wetland rehabilitation planning that includes detailed descriptions and design guidelines for the most of the above-listed interventions. The document can be downloaded from the Water Research Commission (WRC) Knowledge Hub webpage. The download link is:
http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20658-16.pdf

Another useful guideline for rehabilitation in mining landscapes is: ***Wetland Rehabilitation in Mining Landscapes: An Introductory Guide – WRC Report No. TT 658/16*** (Macfarlane et al., 2016). The document can be downloaded from the Water Research Commission (WRC) Knowledge Hub webpage. The download link is:

[89] Photo taken by Douglas Macfarlane
[90] Photo taken by Adam Teixeira-Leite

http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20658-16.pdf

5.5 Legislative requirements of wetland rehabilitation and enhancement

Prior to undertaking any wetland rehabilitation activities, national environmental and water legislation places certain legal obligations on the party wishing to rehabilitate a wetland. This includes obtaining an Environmental Authorization (EA) under NEMA as well as obtaining a Water Use License (WUL) under NWA.

An independent environmental consultant will need to be appointed to complete the applications for an EA and WUL. **It is important to note that rehabilitation work may only commence after an EA and WUL have been granted by the relevant authorities.** This process can take some time (in some cases up to two years) and thus should be undertaken well in advance of the intended rehabilitation commencement date.

6. GUIDANCE FOR MANAGING DEVELOPMENT IMPACTS ON WETLANDS

This section provides a broad review of current best management practices (BMPs) for the purposes of assisting municipal officials in the interrogation of development applications in terms of SPLUMA, and stakeholder review processes for NEMA Environmental Authorisation and NWA Water Use License stakeholder applications. An application review protocol is also provided.

6.1 The role of local government in evaluating development applications

The power and mandate of municipalities, provided by SPLUMA, to regulate and approve 'greenfields' and 'brownfields' development (**Box 31**) and land use applications within their jurisdictions presents a key entry point for the inclusion of wetland management objectives into municipal land use and development planning. In addition, municipalities are key commenting authorities / stakeholders in both NEMA environmental authorization and NWA water use license application processes within their jurisdictions, which provides additional points of entry for the inclusion of wetland management concerns and objectives into development proposals. At each of these stages municipal officials can interrogate adherence to best practice environmental mitigation and management and promote improved wetland management. Please note that these best management practice (BMP) guidelines have been tailored to specifically inform greenfields development applications. Although the best management practices provided in this section are not always relevant to brownfields development that are often constrained in terms of location and land use type, the principles of wetland impact avoidance, minimization and remediation are still applicable to brownfields development. It is also important to note that the best management practices for brownfields development often focus more on improving and rehabilitating wetlands and minimizing land use risks that can't be avoided as far as practically possible.

Box 31: The difference between 'greenfields' and 'brownfields' development

Greenfields development refers to the development of greenfield land, which is undeveloped land that does not require remediation prior to development. In contrast brownfields land is previously developed land that is currently not in use (i.e. abandoned, vacant, derelict or contaminated) and that requires remedial action prior to redevelopment[91].

In light of this, **it is critically important that the responsibility for evaluating the environmental aspects of applications is formally delegated and that such officials have the required capacity to comment effectively on such applications.** In order to assist municipal officials in this, this section provides a summary of the key best practice wetland management principles and practices that support wetland management.

[91] Potts & Cloete, 2012

6.2 How are wetlands impacted by human development?

Before providing information on best practice management measures related to wetlands, it is important that government employees reviewing development applications have a basic understanding of how development activities impacts wetlands.

At the broadest level, wetland impacts can be categorized based on whether the impacts are the result of activities within the wetland or activities within the wetland's catchment. A summary of the types of wetland impacts with the relevant impact-causing activities is provided in **Table 9**.

Table 9. List of key wetland impact groups with relevant impact-causing activities.

Impacts resulting from within-wetland activities	1) **Physical destruction and infilling of wetland habitat** - Vegetation clearing, earthworks, infilling, hardening / development, stormwater management, cultivation
	2) **Physical modification of wetland flow and habitat** - Vegetation clearing, earthworks, temporary modification and rehabilitation
	3) **Indirect flow, erosion and sedimentation impacts** - Establishment of agricultural drains, diversion drains, by-pass diversions, road culverts, dams, vegetation clearing and earthworks
	4) **Habitat fragmentation, connectivity and edge disturbance impacts** - Vegetation clearing, earthworks, infilling, hardening / development, land use operational activities
	5) **Water Pollution Impacts** - Mining, agriculture and urban land uses
Impacts resulting from catchment activities	1) **Indirect flow, erosion and sedimentation impacts (as a result of catchment land cover and surface runoff alteration)** - Vegetation clearing, earthworks, infilling, hardening / development, stormwater management
	2) **Flow reduction impacts** - Establishment of dams, abstraction from watercourses, establishment of land uses with high water demands e.g. high water demand crops
	3) **Land use water quality impacts** - Urban stormwater management, mining water management, acid mine drainage, hazardous materials storage, handling & transport
	4) **Return flow discharge water quantity impacts** - Treated waste water / effluent discharge, mine water discharges, acid mine drainage
	5) **Return flow discharge water quality impacts** - Treated waste water / effluent discharge, mine water discharges
	6) **Habitat fragmentation, connectivity and edge disturbance impacts** - Vegetation clearing, earthworks, infilling, hardening / development, land use operational activities)

Figure 28 Sediment deposition and wetland vegetation burying within a wetland in Umlazi, Durban[92].

Figure 29 Artificial drainage channels established within the Balamhlanga Pan near Jozini, KwaZulu-Natal[93].

[92] Photo taken by Ryan Edwards
[93] Photo taken by Douglas Macfarlane

Figure 30 Dirt road established across a wetland in Cato Ridge in KwaZulu-Natal[94].

6.3 Managing impacts to wetlands

It is critically important for local government officials involved in the consideration of development applications within their jurisdictions to have a basic understanding of the best management planning practices related to wetland management. This will enable employees to be proactive in the consideration of applications and ultimately assist in achieving sustainable wetland management. Municipal staff involved in project design and reviewing of development applications have an opportunity and responsibility to influence decision making so as to minimize impacts to wetlands. If this responsibility is not take seriously, developments will continue to impact negatively on wetland ecosystems and undermine the important services that they provide.

6.3.1 Understanding the Project Planning Process

Appropriate and informed input by municipal officials undertaking development application reviews and approvals can play a critical role in upholding the principles of sustainable wetland management in the long-term, especially where incorporation of wetland management objectives into municipal planning has been limited. Thus, an understanding of the development project planning process is important. The typical project planning process is illustrated in **Figure 31**.

[94] Photo taken by Ryan Edwards

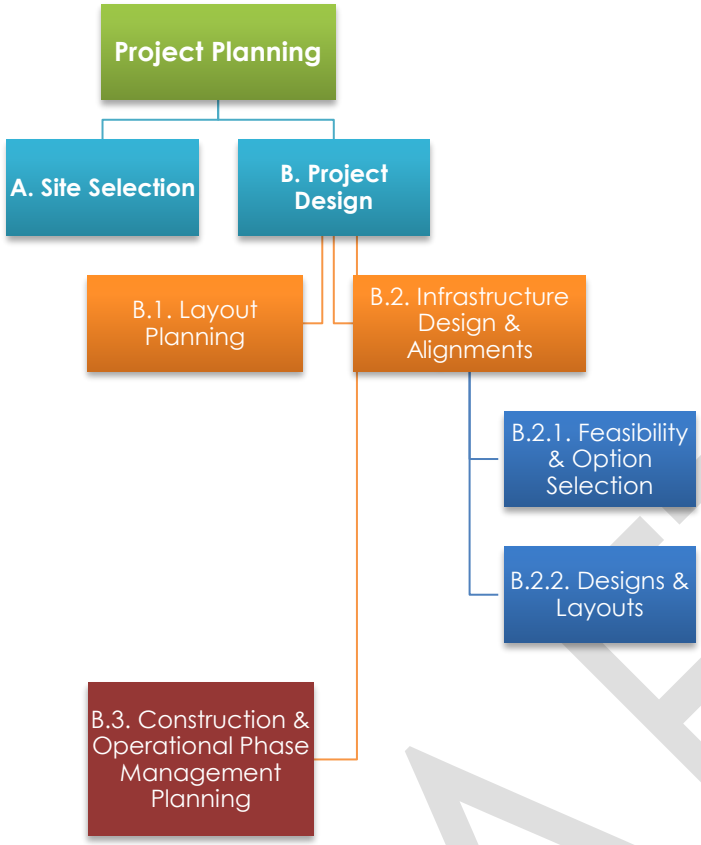

Figure 31 Basic diagram indicating project planning sequence and components.

A. Site Selection:

Site selection is the first step in development planning and typically involves the identification and purchase of a property to achieve the intended development objectives. It is important to note that in many cases the developer has been the long-term owner of the property in question but now intends to change the land use / development rights provided by the zoning.

B. Project Design:

Once the site is selected and secured, project design is initiated. The first steps in project design involves an assessment of engineering services feasibility by a civil engineer (B.2) and the development of a layout plan / site development plan by a town planner (B.1). Both processes are typically iterative and dynamic, influenced by the identification of development constraints and opportunities as the planning process unfolds. If the engineering services feasibility study findings are favourable, site development / layout plans are developed by the town planner, infrastructure options are selected (e.g. sanitation option) (B.2.1) and preliminary engineering services design and layouts are prepared (B.2.2). Once the layout plan and infrastructure designs are finalised, management planning commences that involves the identification and selection of construction methods and operational requirements (i.e. management, maintenance and monitoring requirements) (B.3).

6.3.2 The 'Mitigation Hierarchy' Planning Framework

The mitigation hierarchy is regarded internationally as the best practice framework for environmental planning and managing environmental impacts. It is a set of prioritized, sequential steps that are applied to anticipate, avoid and reduce the potential negative impacts of project activities on the natural environment[95]. It involves a sequence of four key components – **avoidance, minimisation, remediation and offset** as illustrated in **Figure 32**.

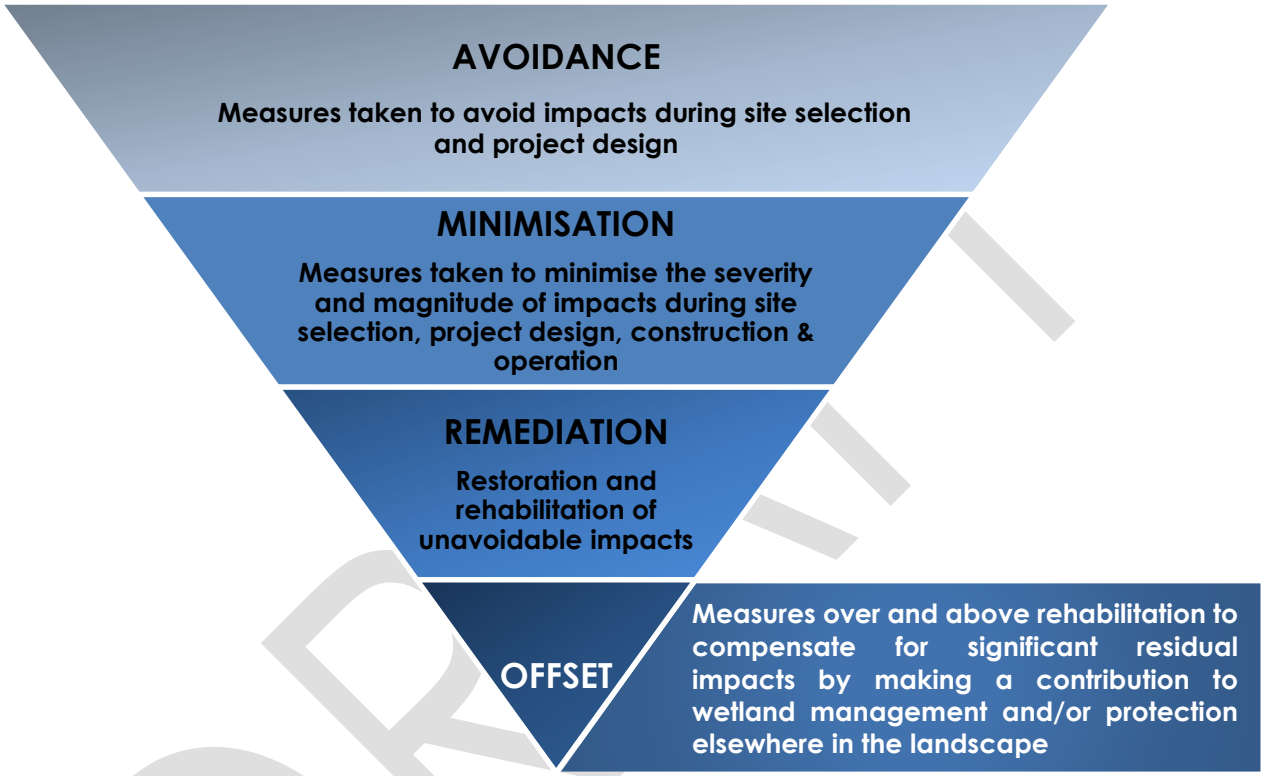

Figure 32 Diagram illustrating the 'mitigation hierarchy'.

'Avoidance'; and **'Minimization'** are the preventive components, whilst **'Remediation'** and **'Offset'** are the remediative components[108]. Options for the preventive components (avoidance and minimization) occur primarily, but not exclusively, early on in the project planning cycle as part of site selection and project design. Avoidance is often the most effective way of reducing potential negative impacts and its proper implementation requires wetlands to be considered in the pre-planning stages of the project[108]. The remediative components (remediation and offsets) occur later in the project planning process after project design[108].

It is important to note that in the 'Mitigation Hierarchy' Planning Framework preventive measures are always preferable to remediation measures[108]. Careful implementation of the early components of the

[95] The Biodiversity Consultancy, 2015

mitigation hierarchy will reduce the project's liability for rehabilitation and offsets measures[96]. This is important as these later mitigation components may often (but not always) encounter the following[109]:

- Increasing technical, social and political risks (e.g. technical failure of rehabilitation, or political failure of a biodiversity offset).
- Increasing uncertainty of costs, and risk of cost escalation.
- Increasing costs per unit of biodiversity and ecosystem services.
- Increasing requirements for external stakeholder engagement and specialist expertise.
- Decreasing opportunity to correct mistakes.
- Decreasing confidence and trust among key stakeholders.

6.3.3 Incorporation of Wetland Management Objectives into Site Selection

Site selection is typically undertaken in the project screening and pre-feasibility stage before stakeholder and authority input. Ideally the selection of the preferred site should be an iterative process between assessing site technical feasibility and potential wetland impacts. However, with the exception of large and continuous projects, like large infrastructure projects, environmental and wetland screening in development site selection and pre-feasibility planning are rarely ever undertaken in South Africa. Site selection is typically driven by existing private or public land ownership patterns, land price and availability in the real estate market, and traditional town planning and engineering feasibility factors. Environmental factors are typically given little consideration at this stage unless there is prior knowledge of a significant natural resource onsite by the land owners or local or wider community. Nevertheless, **where significant impacts to wetland are anticipated, site selection is an important tool in avoiding and/or minimizing impacts.**

The first step in the planning process and arguably the most important aspect of avoidance is to **ensure that the site chosen avoids measurably impacting important wetland ecosystems and associated resources directly and indirectly.** In order to incorporate wetland management concerns into this planning stage, a wetland risk or impact screening process should ideally be undertaken by a wetland assessment practitioner. This is a particularly important process where a development could have a direct and considerable impact on wetland ecosystems and biodiversity. The purpose of this process should be to confirm the biodiversity conservation, water resource management and disaster risk management objectives for the affected wetlands and catchments for each site alternative if available, and to broadly confirm at a desktop level the location, extent, condition, importance and sensitivity of wetlands that stand to be negatively affected at each site. The wetland risk or impact screening process should be a desktop exercise with rapid infield verification of desktop findings. Refer to **Box 32** for a description of the recommended terms of reference for a wetland risk / impact screening assessment.

In the case of a wetland being threatened if land use / development rights are changed, the municipality can play a more active role in site selection than is usually the case, by trying to convince developers to

[96] The Biodiversity Consultancy, 2015

exchange land for other land, possibly municipality owned. This active land management role of municipalities is not yet common in South Africa but represents an opportunity to protect wetlands.

Box 32: Terms of reference of a 'wetland risk / impact screening assessment':

- Review of available wetland spatial datasets and inventories to assist in the identification of possible wetlands.
- Map and classify all potential wetlands that may occur within each of the properties at a desktop level.
- Assess the preliminary importance and sensitivity of the mapped wetlands by undertaking a review of the relevant national, provincial and municipal conservation and water resource management plans, in combination with substantiated professional opinion.
- Rate and rank sites in terms of wetland risk / impact and provide recommendations regarding the preferred sites from a wetland management perspective.
- Meet with the project design team to discuss options and potential implications for project.

In line with the avoidance step of the mitigation hierarchy, project sites or locations that will impact most negatively on wetlands should be screened out in favour of options that pose a lower risk. If a site with potentially significant wetland impacts is selected as the preferred option, then the developer will need to provide justifiable and acceptable motivation.

It is also important to note that the larger and more contentious the project (i.e. the more significant the potential impacts), the more rigorous the site selection process needs to be. For example, broad and high-level screening may be acceptable for developments with impacts of low significance whereas the siting of a nuclear power station might involve an intensive and extensive site alternatives assessment involving intensive and cross-disciplinary infield specialist assessments.

6.3.4 Incorporation of Wetland Management Objectives into Project Design

The municipality can, with its environmental department, play an active role in discussions with the urban planner and civil engineer, in making them aware of considerations from a wetland management perspective (or rather catchment management perspective as a whole), preferably in the initial stages of project design. The need for such an intervention could be triggered by the distance to a wetland. While the developer may have hired their own wetland assessment practitioner, in case the issues around wetland are complicated or the stakes are high, it may make sense for the municipality to arrange its own expertise to discuss the project design.

Ideally the formulation of project design should be an iterative process between assessing different layout and infrastructure options and potential wetland impacts. This process will involve the following steps:

- Undertaking of a wetland assessment to confirm the baseline wetland environment, particularly the importance of the wetlands to be affected.

- Incorporating the wetland assessment findings into the project design in line with the mitigation hierarchy framework.

(i) Confirmation of the baseline wetland environment

Once the preferred site is selected, a specialist wetland assessment should be undertaken to inform project design. Such an assessment must be undertaken by a suitably qualified and experienced private wetland assessment practitioner (see **Box 33**) to inform the project design process.

Box 33: Legal requirements for wetland assessment practitioners:

All independent specialist scientists undertaking wetland scientific assessments are required to be registered as a professional natural scientist by SACNASP in the relevant field of practice. This is a requirements of the Natural Scientific Professions Act (No. 27 of 2003). To acquire professional registration, the practitioner must have suitable experience (at least 3-5 years) in the application of the methods of data collection, analysis and interpretation related to wetland assessments or research. If not, the practitioner must be supervised by such a person. To find suitably qualified and experienced wetland specialists, it is recommended that the SAWS secretariat be contacted (Marc de Fontaine, +27 (0)11 682-0264, marcdef@randwater.co.za, http://society.sawetlands.org/secretariat.htm.

SACNASP can also be contacted for a list of registered professionals. A database of registered scientists is located at: http://www.sacnaspregister.co.za/search/

A specialist wetland assessment will typically cover a broad spectrum of issues which need to be reported on as part of the environmental authorisation or water use license application process. While the scope of work may vary from project to project, the typical aspects that need to be addressed in the wetland assessment are shown in **Figure 33**[97].

[97] Ollis et al., 2014

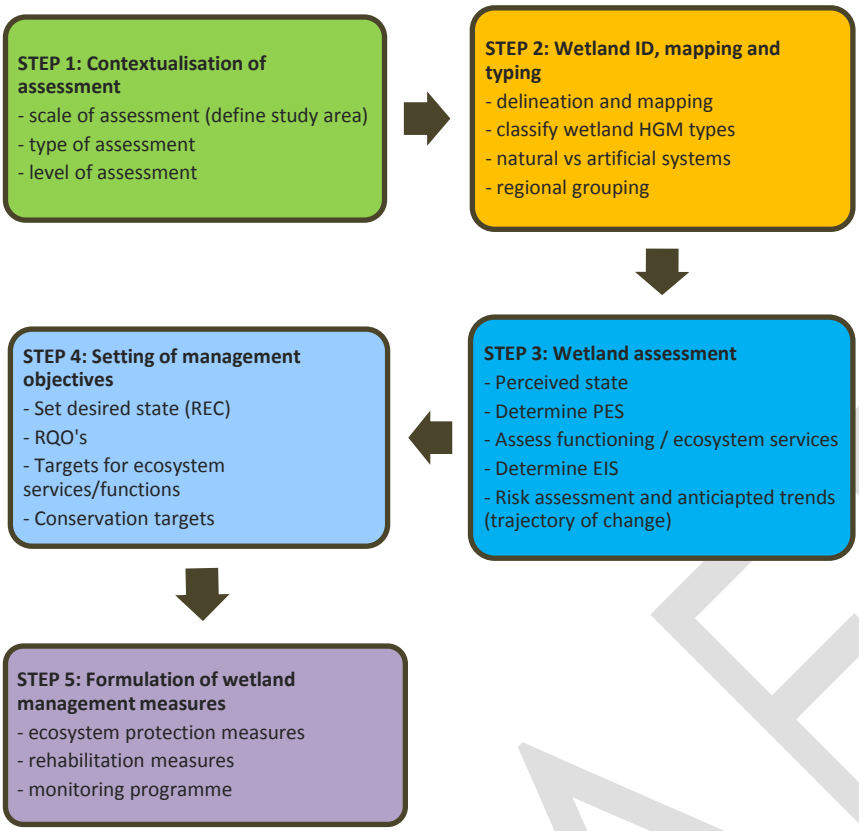

Figure 33 Proposed decision-support framework for wetland assessment in SA[98].

(ii) Incorporating the findings of the wetland assessment into project design

The key deliverables of the baseline wetland assessment that will need to be fed into the project design process is a wetland delineation map with associated importance and sensitivity ratings often referred to as a 'wetland importance / sensitivity map', including recommended buffer zones. Once this wetland map is prepared, development planning and project design should proceed in a stepwise manner in line with the mitigation hierarchy.

Mitigation Hierarchy Step 1 – Avoidance:

The first environmental planning step in the project design process is 'avoidance', particularly of direct impacts to wetlands. The purpose of the avoidance step is to ensure that all options to avoid significant wetland impacts and direct encroachment are fully explored before proceeding to minimising unavoidable and potentially significant impacts. Avoidance through project design takes place when designing the layout and organisation of land uses, facilities and infrastructure; selecting the type of infrastructure; and deciding on the construction and operational processes and the mode of operation[99].

Firstly, the development planning process must start with the development of a layout / development plan or alignment / route plan (in the case of linear projects) that attempts to avoid all of the delineated wetland features. As part of avoidance step, all wetlands should ideally be considered no-go areas and

[98] Ollis et al., 2014
[99] The Biodiversity Consultancy, 2015

development activities focussed outside of these areas. If such an option is both economically and technically feasible, then a 'win-win' solution is possible. However, if such an option is found to be economically and/or technically unfeasible for well-substantiated reasons, then the development plan may need to allow for some encroachment into one or many of the wetland features. If this is the case, then the next step in the framework is to minimise the significance of such encroachment and avoid high importance units / systems. It is often helpful to the process to identify a number of environmental compromise options that could be considered acceptable and of low significance with practical and reasonable mitigation in order to assist the developer / applicant in the development planning process. Typically it is proposed that a number of development scenarios be investigated in chronological order from lowest to highest impact / risk based on the findings of the importance and sensitivity assessment of the delineated wetlands. An example of the hypothetical planning scenarios is provided in **Box 34**.

Box 34: Hypothetical planning scenarios to assist in planning:

- **Best case wetland management option** – No wetland and recommended buffer zone encroachment.
- **Buffer encroachment only scenario 1** – No wetland encroachment and some encroachment into the buffer zones of watercourses of low to moderate importance (reduction to a minimum of 15m buffer zones), but the maintenance of all recommended minimum buffer zones to watercourses of moderately-high importance or higher.
- **Buffer encroachment only scenario 2** – No wetland encroachment and notable encroachment into the buffer zones of watercourses of low to moderate importance (reduction to <15m buffer zones), and the maintenance of all recommended minimum buffer zones to watercourses of moderately-high importance or higher.
- **Potentially acceptable wetland encroachment scenario 1** – Some encroachment into the wetlands of low importance only, but the maintenance of all recommended minimum buffer zones to watercourses of moderately-high importance or higher.
- **Potentially acceptable wetland encroachment scenario 2** – Some encroachment into the wetlands of low to moderate importance only, but the maintenance of all recommended minimum buffer zones to watercourses of moderately-high importance or higher.

With the strict application of the mitigation hierarchy, the developer must investigate each of the above-listed development scenarios in chronological order and can only move onto the investigation of the next scenario once the preceding scenario is found to be technically and/or economically unviable for clear and well-substantiated reasons. Ideally, it is advisable that the key stakeholders are also involved in this process so that in principle agreement for each step in the process can be achieved. Any further encroachment beyond that proposed as part of planning scenarios must only be investigated after all of the above scenarios have been fully considered and confirmed to be unviable for the purposes of the project.

Mitigation Hierarchy Step 2 – Minimisation:

Once the avoidance process has been fully explored and the applicant has provided motivation and substantiation for proposed wetland encroachment and/or potential measurable indirect impacts, the applicant must make every effort to reduce / minimise the potentially significant ecosystem impacts of the proposed activities through 'tweaking' layouts, investigating alternative technologies and adapting designs wherever possible (e.g. implementing alterative waste disposal options and technologies, installing culverts on roads, or installing bird flight diverters on power lines, etc.) and through implementing best practice construction phase and operational phase mitigation measures.

It is important to note that minimization and avoidance are closely related and often overlap and/ or occur concurrently in project design[100]. Whether a measure is categorized as one or the other may depend on circumstances and scale[114]. Minimization, however, does not offer the same ecological certainty that avoidance does[84].

6.3.5 Selected Best Management Practices for Wetlands

A wide range of best management practices have been developed to minimize direct and indirect impacts on wetland ecosystems. These are discussed as follows.

1. Buffer Zones

A buffer zone is "*A strip of land with a use, function or zoning specifically designed to protect one area of land against impacts from another.*"[101]. Buffer zones can perform a wide range of functions that assist in supporting and maintaining wetland, namely:[115]

- maintaining basic aquatic processes (e.g. maintain channel stability, control microclimate and water temperature, flood attenuation and maintain general wildlife habitat);
- reducing impacts on water resources from upstream activities and adjoining land uses;
- providing habitat for aquatic and semi-aquatic species;
- providing habitat for terrestrial species; and
- a range of ancillary societal benefits

Box 35: Summary of roles and associated functions provided by buffer zones

Reducing impacts from upstream activities and adjoining land uses:

- Storm water attenuation
- Sediment removal
- Removal of toxics
- Nutrient removal
- Removal of pathogens

Meeting life-need requirements for aquatic and semi-aquatic species:

[100] The Biodiversity Consultancy, 2015
[101] Macfarlane & Bredin, 2016

- Provision of habitat for aquatic species
- Screening of adjacent disturbances
- Habitat connectivity

Providing habitat for terrestrial species:

- Provision of habitat for terrestrial species
- Habitat connectivity

Ancillary societal benefits:

- Reducing flood risk
- Enhancing visual quality
- Controling noise levels
- Improving air quality
- Providing recreational opportunities
- Economic benefits

Buffers zones are thus an important and established wetland management tool for avoiding and minimising the disturbances to wetlands from adjacent human land uses.

Within the National Buffer Guideline Framework[102] there are two types of buffer zones, (i) a water resource buffer zone and (ii) a biodiversity or ecological buffer zone. The purpose of a water resource buffer zone is to buffer the water resource from impacts and disturbances like increased runoff, erosion, sedimentation and pollution. The purpose of a biodiversity or ecological buffer zone is to cater for the ecological requirements of the affected ecosystem or biota living in or utilising the habitat and/or to minimise edge disturbances like noise and light pollution. The areas can overlap.

Key best practice buffer design principles and objectives are:

- Minimization of the amount of sediment, nutrients and toxicants reaching wetlands factoring in the characteristics of the buffer zone (slope, roughness, vegetation cover, infiltration) and the importance and sensitivity of the receiving wetland.
- Maintenance of ecological processes and lifecycle requirements critical to the survival of wetland plants and animals.
- Minimization of the direct and indirect human ecological nuisance and disturbances to wetland plants and animals.

For the determination of the appropriate buffer zone widths for different land uses, receiving environment sensitivities and topographical settings, the reader is referred to the wetland buffer zone determination tool that has been developed as part of the ***Preliminary guideline for the determination of buffer zones for rivers, wetlands and estuaries*** – **WRC Report No. TT610-14** (Macfarlane & Bredin, 2016). This guideline is considered the current best practice guideline for determining the buffers to wetlands in South Africa.

[102] Macfarlane & Bredin, 2016

The document can be downloaded from the Water Research Commission (WRC) Knowledge Hub webpage. The download link is:
http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20610-1-14.pdf

Despite the range of functions potentially provided by buffer zones and the often prescriptive application of buffer zones in development planning, buffer zones are far from a "silver bullet" that addresses all water resource related problems[117]. In particular, buffer zones can do little to address some impacts such as hydrological changes caused by stream flow reduction activities or changes in flow brought about by abstractions or upstream impoundments[103]. Buffer zones are also not the appropriate tool for militating against point-source discharges (e.g. stormwater discharges and sewage outflows), which can be more effectively managed by targeting these areas through specific source-directed controls[117] – see stormwater management design measures. Contamination or use of groundwater is also not well addressed by buffer zones and requires complementary approaches such as controlling activities in sensitive groundwater zones[117]. The role that buffers can play must therefore be well understood when applying the buffer guidelines[117].

2. Stormwater Management

Stormwater management is the controlled collection, conveyance and discharge of surface water generated by human landscapes, particularly urban land uses. Stormwater management arises from the need to transform and harden natural landscapes and alter surface runoff patterns as part of development, which typically reduces the natural permeability and rates of infiltration of the landscape and increases the rate and volumes of surface runoff.

It is important to note that all development types that involve the modification and transformation of measurable areas of land cover including mining, agriculture, industrial, retail / commercial and residential development are required to manage drainage and stormwater, and prepare stormwater management plans as part of project civil engineering design and environmental impact and risk assessments.

a. Urban drainage and stormwater management

Until relatively recently, stormwater management in the urban areas has focused on collecting and conveying runoff to the nearest watercourse as rapidly as possible to avoid flood nuisances. This approach substantially alters the hydrological response of a site (**Figure 34**), often with damaging consequences on the receiving environment. The following are the commonly associated implications for wetland management:

- The time taken for surface runoff to reach watercourses (referred to as the 'time of concentration') is measurably reduced which contributes to increased flood peaks and associated increased rates of erosion and sedimentation within wetlands (see **Figure 35**).

[103] Macfarlane & Bredin, 2016

- Reduced rates of infiltration reduces groundwater recharge and the volume of interflows (subsurface flows), which can alter the volume and timing of water inputs. This can be significant for wetlands such as seeps that are fed predominantly by subsurface flows.
- Circumvention of the natural filtering capacities of the landscape. This in conjunction with limited to no consideration and treatment of pollutants washed off urban surfaces in stormwater management systems results in surface water quality deterioration.
- The combined impacts of increased flooding, erosion and pollution, results in the degradation in wetland habitat, loss of wetland functioning and a reduction in the ability to support natural levels of biodiversity.

These effects are compounded as more of the catchment is developed and open space is lost. The common practice of stormwater attenuation is not sufficient on its own to mitigate the negative effects on urban rivers and wetlands, and this method is no longer considered best practice.

In South Africa, rapid rates of urbanisation present additional challenges for urban rivers and wetlands. The demand for housing typically exceeds supply with unplanned densification of formal housing areas resulting in overloading on solid waste and sanitation services, and often the illegal adaptation of stormwater systems. In addition, informal settlements become permanent, and largely unserviced. All of this results in high loads of sewage and litter in drainage networks that have damaging effects on the stability, water quality and ecology of urban river and wetland systems.

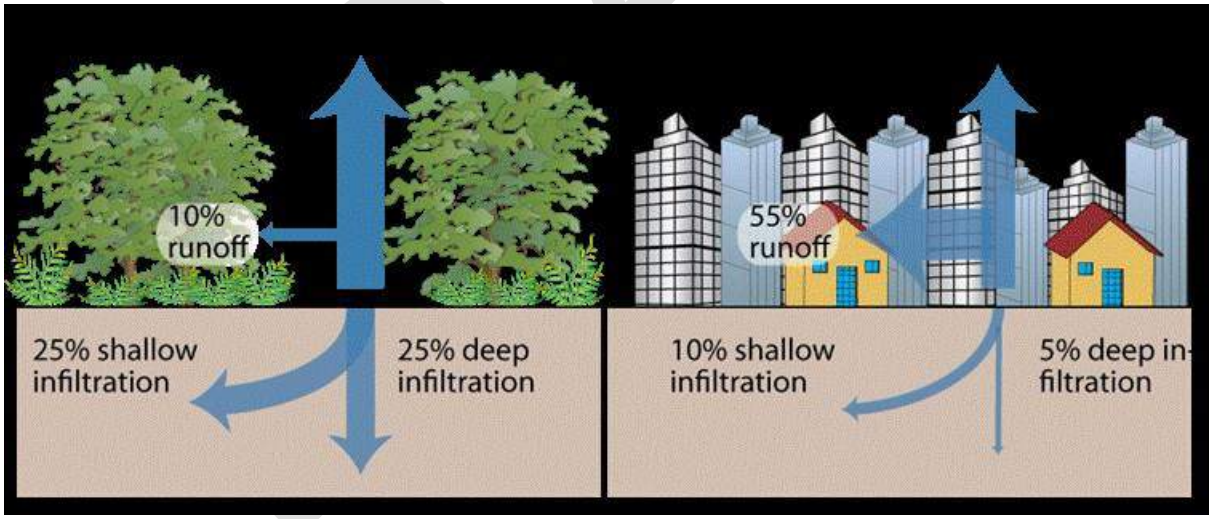

Figure 34 Typical pre- and post-development runoff scenarios with the conventional approach to stormwater management[104].

[104] http://factsheets.okstate.edu/documents/bae-1758-understanding-stormwater-runoff-and-low-impact-development-lid/

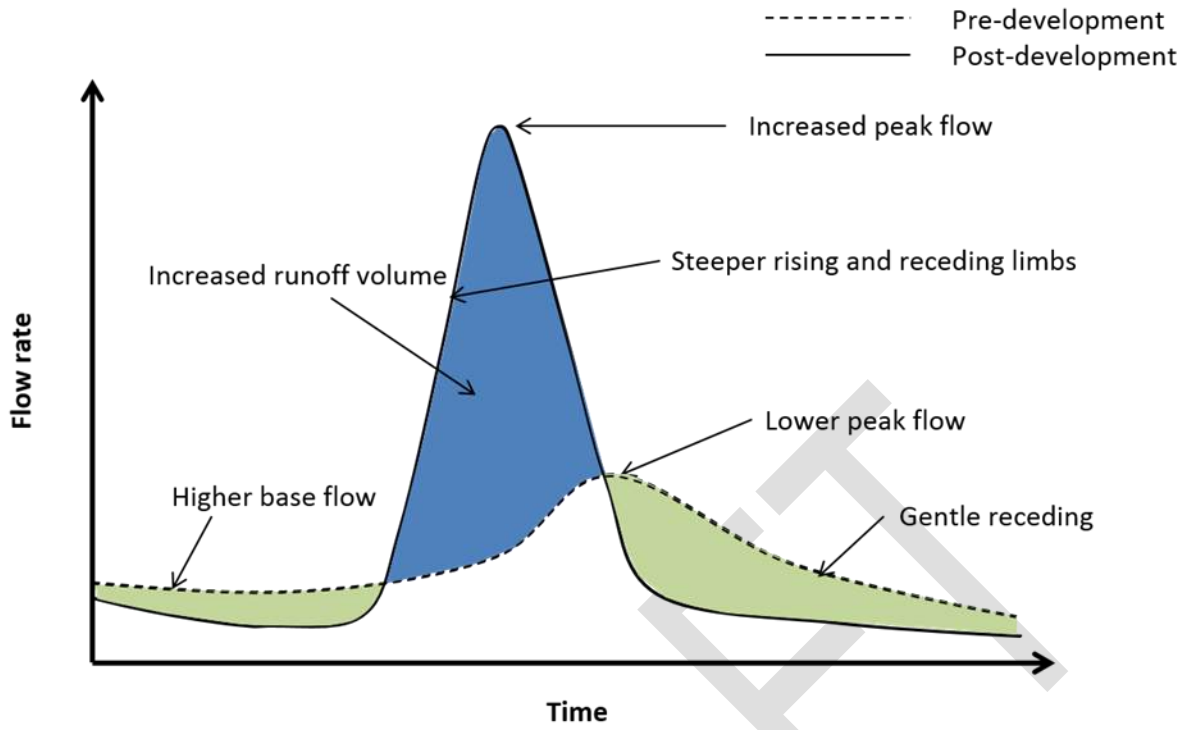

Figure 35 Hydrographs of pre- and post-development, without sustainable drainage measures[105].

Sustainable drainage best practice

International best practice for stormwater planning and management now adopts the principles of sustainable drainage which seeks to mimic the natural hydrological cycle[106]. Referred to variously as Water Sensitive Urban Design (WSUD), Sustainable Drainage Systems (SuDS) and Low Impact Development (LID)[120], the approach seeks to manage runoff volume and quality (and no longer just the peak flow). The principle of stormwater retention (volume) as opposed to attenuation (peak flow) takes priority. This promotes infiltration and filtration above storage, and encourages the use of natural features, including wetlands, rather than conventional hard engineered facilities. This approach provides opportunity for enhanced amenity, and the maintenance of biodiversity[120].

The adoption of SuDS tends to vary between municipalities and is influenced by such factors as climate, topography, geology, receiving environment and even institutional structures, among others. However there is a common baseline of the kinds of facilities employed and these are described for South African applications by Armitage, et al. (2013). A summary of the facilities is given in **Table 10**.

Table 10. Typical SuDS facilities[107].

[105] www.WSUD.co.za
[106] Armitage et al., 2013
[107] Armitage et al., 2013

Source Control	Local Control	Regional control
Green roofs†	Filter strips†	Detention (attenuation) ponds
Rainwater harvesting	Swales†	Retention Ponds†
Soakaways	Infiltration trenches	Constructed wetlands†
Permeable pavements	Bio-retention areas†	
	Sand filters	
† SuDS facilities that typically support vegetated and ecological systems		

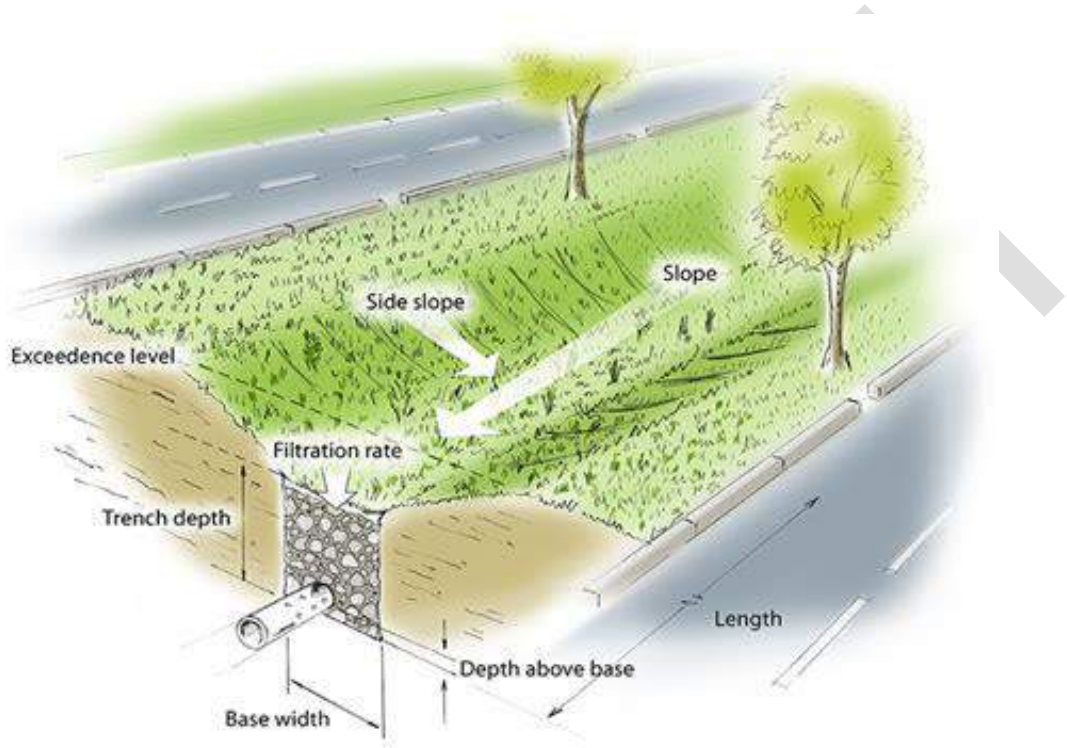

Figure 36 Diagram of grassed stormwater swale system[108].

[108] http://help.xpsolutions.com/download/attachments/5079134/XPD2015.v3-SWC-Dryswale.jpg

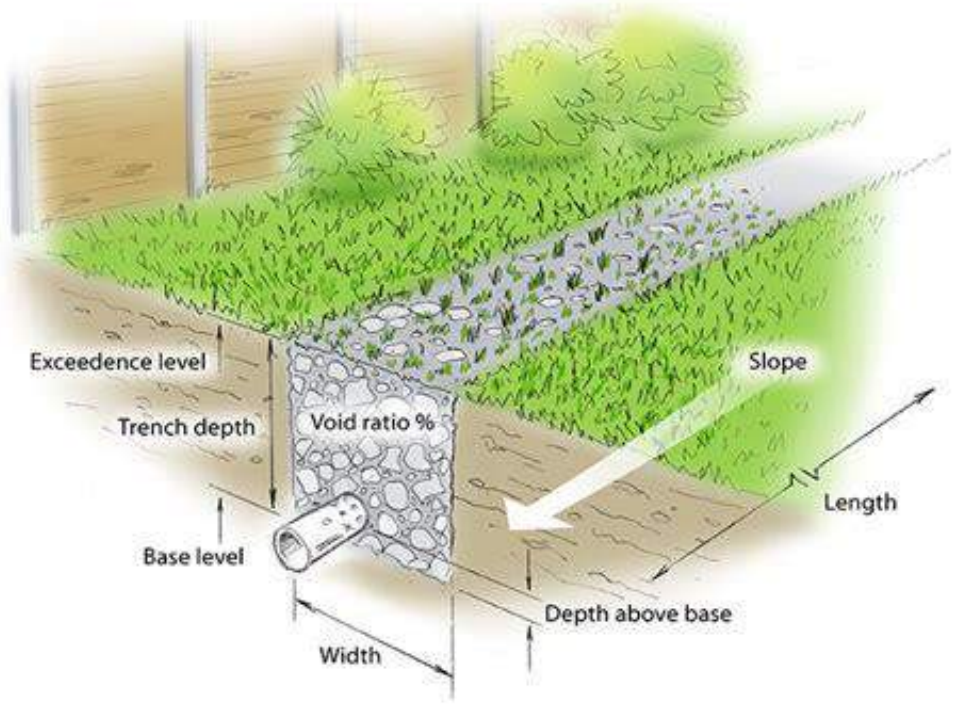

Figure 37 Diagram of stormwater infiltration trench system[109].

Figure 38 Diagram of stormwater bio-retention system[110].

[109] https://help.xpsolutions.com/download/attachments/5079134/XPD2015.v3-SWC-Infiltration_Trench.jpg?version=1&modificationDate=1448912521000&api=v2

[110] http://help.xpsolutions.com/download/attachments/5079134/XPD2015.v3-SWC-Bioretention.jpg

Figure 39 Example of a stormwater detention pond[111].

Figure 40 Example of a stormwater retention pond[112].

[111] https://www.platinumlakemanagement.com

[112] https://www.constructionspecifier.com/wp-content/uploads/2014/04/Barnum-Park-Void-Structured-Concrete-May-15-2013-135.jpg

Figure 41 Example of a constructed stormwater wetland[113].

These are categorised according to scale; Source control is usually on site, Local control would be typically in the neighbourhood, and Regional control would typically be strategic facilities in the catchment. However the rules of application are not intended to be hard and fast and creative applications are encouraged. Inherent in the SuDS approach is the importance of the "treatment train" where stormwater management objectives are achieved by a number of facilities placed in series rather than placing reliance on a single facility alone. This allows the selection of the appropriate treatment facilities, but is also allows for SuDS facilities to be more easily accommodated in the landscape of a site.

The performance of all SuDS facilities in the treatment train is also important. This will have bearing on urban wetlands that are employed to perform stormwater functions. If downstream systems are reliant on the long-term performance of the wetland then this will have bearing on the long-term management of the wetland which may differ, or be in addition to, the ecological function of the wetland. Similarly, wetlands incorporated in treatment trains may rely on the performance of upstream facilities for their ecological stability. These management regimes need coordination and reliable maintenance.

Wetland management in the era of SuDS

The principles of sustainable drainage are now generally accepted as international best practice. These are slowly finding traction in South Africa and are starting to be picked up at an institutional level but will still take some time before they become mainstream. It will also take time for the cumulative effects of

[113] http://stormwater.wef.org/wp-content/uploads/2014/02/Barnum-Park-1.jpg

SuDS interventions to begin having a measurable effect on urban rivers and wetlands, especially within existing urban and metropolitan centres where the introduction of SuDS may be reliant on land redevelopment rather than a retro-fit programme. The latter will require an unusually bold long-term vision.

Hence, although SuDS will be an important part of Green Infrastructure plans, and a good vehicle for the protection of urban wetlands in the short-term (e.g. at policy level, bylaws, etc.), SuDS may not show much physical presence for some time to come, unless more active transition management is introduced. Instead, urban streams and rivers are the most likely sites for short-term interventions to address catchment problems that SuDS will only address in the long-term. These interventions typically appear as rehabilitation plans, stream stabilisation plans, litter traps and sediment traps, and more recently as constructed wetlands for pollution treatment. Wetlands often appear as part of the solution in many of these projects.

Therefore, in the short-term, urban wetlands remain potentially vulnerable to land development and poor drainage conditions, but at the same time the opportunities for wetlands as part of stormwater management include:

- Stabilising disturbed urban river systems, and
- Being key components of short-term mitigation solutions (flood mitigation, climate change mitigation, pollution mitigation, etc.) in urban river networks.

Further reading:

The reader is referred to the ***The South African Guidelines for Sustainable Drainage Systems – WRC Report No. TT 558-13*** (Armitage et al., 2013), which is considered the current best practice guideline for stormwater management in South Africa. The document can be downloaded from the Water Research Commission (WRC) Knowledge Hub webpage. The download link is:
http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20558-13.pdf

b. Agricultural land use drainage and stormwater management

Owing to the large extent of agricultural land and the exposure of large areas of bare soil to the elements during and after planting and harvesting, commercial agricultural land uses increase the volume and velocity of surface runoff and are characterized by measurable increases in the rates of erosion and sedimentation. These effects in turn result in increased flood peaks, erosion and sedimentation within watercourses like wetlands. Furthermore, the application of considerable volumes of fertilizer, herbicides and pesticides, results in surface water quality deterioration as a result of the entrainment (to pick and carry along in moving water) of agricultural contaminants in runoff that is washed into watercourses. The most common contaminants are sediment, nutrients, herbicides, pesticides and bacteria[114].

[114] Cooper & Moore, 2003

Similarly, in grazing land and pastureland, overgrazing can reduce the density and cover of vegetation which can result in increased surface runoff concentration and erosion, ultimately resulting in increased floodpeaks and associated rates of erosion and sedimentation within wetlands.

The key stormwater management design principles to consider for agricultural land uses are:

- Minimization of soil loss and erosion from agricultural land.
- Minimization of surface runoff diversion and concentration. Where such control is necessary, flows will need to be attenuate and/or temporarily detained.
- Minimization of quantities of nutrients, herbicides and pesticides washed off agricultural land into rivers, streams and wetlands.

There are a number of key agricultural land management practices that can be implemented to reduce the impacts of erosion, sedimentation and pollution, namely:

- For cultivated land:
    - No tillage – Mechanical soil disturbance is minimized and permanent organic soil cover consisting of a growing crop or mulch residue is maintained[115].
    - Conservation tillage – The practice of leaving a blanket of crop residue from the previous harvest on the soil surface[116].
    - Contour banks – Banks or berms constructed along contours on a slight gradient at intervals downs the slope in order to intercept runoff generated by exposed / bare surfaces and allow for its safe disposal[130].
    - Bench terracing – This involves the wholesale reshaping of the land profile into a series of stepped benches with a lateral gradient towards a suitable discharge point[130].
- For timber land (only during planting time and after harvesting):
    - Spreading of residue or plantation slash from the harvested crop over the surface as a mulch instead of windrowing it in strips down the slope[130].
    - Scheduling of replanting and re-establishment of plantation in the low rainfall erosivity months of the year[130].
    - Establishment of contour panels across the slope for both new and re-established plantations.

  For grazing land adhere to the grazing capacity norms for each veld type. They are available from the Local Extension Offices of the Department of Agriculture in each province, and from the National Department of Agriculture as well[130].

For more details in this regard, the reader is referred to Chapter 5 of ***WET-Rehab Methods: National guidelines and methods for wetland rehabilitation – WRC Report No. TT 341/09*** (Russell, 2009) describing catchment area conservation measures. The document is part of the Wetland Management Series and can be downloaded from the Water Research Commission (WRC) Knowledge Hub webpage. The download link is:

[115] Mchunu et al., 2011
[116] Russell, 2009

http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20341%20web%20NEW.pdf

c. Mining land use drainage and stormwater management

Mining is a highly intensive land disturbance activity that typically involves extensive earthworks and earth moving activities, and the alteration and transformation of large areas of land for mineral extraction. Mining activities are known to generate considerable amounts of contaminated stormwater runoff driven by the settling of particulate matter from mining activities that are washed off surfaces during rainfall events.

For this reason the current best practice water quality management intervention for mines is the separation of the water management and drainage system into clean and dirty water management systems and the isolation of the dirty water management system from the surrounding environment through the use of a network of artificial berms and ditches that drain into pollution control dams, and the reuse of the waste water in mine operations.

However, the downside of such measures is that the pollution control dams will capture surface and subsurface flows and effectively remove a portion of the catchment from contributing to streamflow and ultimately reduce streamflows downstream. In addition, the timing and pattern of flows peak flows and floods will also be altered through the attenuating effect of the dams. This means that the avoidance of downstream flow related impacts is unavoidable in favor of avoiding water quality impacts.

The key stormwater management design principles to consider for mining land uses are:

- Minimization of the extent of mining within the catchments of highly important and sensitive wetland ecosystems.
- Minimization of the size of dirty water area footprint and the size of the pollution control dams to reduce downstream flow impacts.
- Minimization of the amount of clean water intercepted and captured in the mine dirty water system to reduce downstream flow impacts.
- Avoidance of the discharge of untreated contaminated stormwater into groundwater and watercourses. In this regard, all untreated contaminated stormwater should be contained and reused.

In this regard, the reader is referred to the ***DWAF Best Practice Guidelines for Water Resource Protection in the South Africa Mining Industry*** Series (**Box 36**) that can be downloaded from the Department of Water & Sanitation documents webpage (http://www.dwa.gov.za/Documents/Default.aspx).

Box 36: Suite of guidelines included in the '*DWAF Best Practice Guidelines for Water Resource Protection in the South Africa Mining Industry*' series:

- Activity Guidelines (A):
  - A1. Small-scale mining
  - A2. Water Management for Mine Residue Deposits
  - A3. Water Management in Hydrometallurgical Plants
  - A4. Pollution Control Dams
  - A5. Water Management for Surface Mines
  - A6. Water Management for Underground Mines
- Water Management Hierarchy Guidelines (H):
  - H1: Integrated Mine Water Management
  - H2: Pollution Prevention and Minimization of Impacts
  - H3: Water Reuse And Reclamation
  - H4: Water Treatment
- Guidelines for general water management strategies, techniques and tools (G)
  - G1. Storm Water Management
  - G2. Water and Salt Balances
  - G3. Water Monitoring Systems
  - G4. Impact Prediction
  - G5. Water Management Aspects for Mine Closure

3. Waste Water Management

Waste water management systems include the collection, transport, storage, treatment and disposal of all waste water that can cause measurable adverse effects to freshwater ecosystems. 'Waste' is defined in Section 1(xxiii) of the National Water Act (1998) *as* including "*any solid material or material that is suspended, dissolved or transported in water (including sediment) and which is spilled or deposited on land or into a water resource in such volume, composition or manner as to cause, or to be reasonably likely to cause, the water resource to be polluted*". Waste water is specifically defined in Government Notice No. 399 (26 March 2004) published in terms of Section 39 of the National Water Act (1998) as: "*water containing waste, or water that has been in contact with waste material*". As per the same notice waste water is subdivided into three distinct waste water categories (**Box 37**):

Box 37: Definitions of different types of waste water defined in : Government Notice No. 399 (26 March 2004):

"**domestic waste water**" means wastewater arising from domestic and commercial activities and premises, and may contain sewage.

"**biodegradable industrial waste water**" means wastewater that contains predominantly organic waste arising from industrial activities and premises including-

(a) milk processing;
(b) manufacture of fruit and vegetable products;
(c) sugar mills;
(d) manufacture and bottling of soft drinks;
(e) water bottling;
(f) production of alcohol and alcoholic beverages in breweries, wineries or malt houses;
(g) manufacture of animal feed from plant or animal products;
(h) manufacture of gelatine and glue from hides, skin and bones;
(i) abattoirs;
(j) fish processing; and
(k) feedlots.

"**complex industrial waste water**" means wastewater arising from industrial activities and premises, that contains-
a) a complex mixture of substances that are difficult or impractical to chemically characterise and quantify, or
b) one or more substances, for which a wastewater limit value has not been specified, and which may be harmful or potentially harmful to human health, or to the water resource (identification of complex industrial wastewater will be provided by the Department upon written request);

Throughout South Africa, the inefficient and inappropriate storage, transport, treatment and disposal of waste water poses a serious threat to wetland ecosystem integrity and biodiversity. In urban areas the most prominent waste water treatment and disposal threats and risks to wetlands are:

- The controlled discharge of poorly (below acceptable standard) treated waste water from small and large state and privately owned waste water treatment works (WWTWs) that are over capacity, poorly operated, poorly maintained and/or inappropriately designed (**Box 38**).
- The controlled discharge of poorly (below acceptable standard) treated waste water from municipal solid waste and hazardous (industrial) waste landfill WWTWs that are over capacity, poorly operated, poorly maintained and/or inappropriately designed (**Box 38**).
- Surcharging and leaking sewer infrastructure, particularly in informal and low income residential areas with a lack of solid waste disposal and sewerage infrastructure maintenance services is a significant pollution impact in all urban areas within South Africa (**Box 39**).
- The cumulative effect of inefficient, malfunctioning and/or poorly maintained septic tank systems in peri-urban and dense suburban areas within no waterborne sewer network (**Box 40**).

Outside of urban areas, the most prominent waste water treatment and disposal threats and risks to wetlands are:

- Leakages and spillages from outdated, poorly designed and/or poorly maintained agricultural and mining waste water storage facilities.
- The discharge of poorly treated agricultural and mining waste water by outdated, poorly designed and/or poorly maintained treatment processes and technologies.

- Lack of treatment of agricultural facility waste water generated by the washing of the facilities, particularly abattoirs, dairies and chicken farms.
- The lack of containment and / or the controlled and uncontrolled discharge of untreated acid mine drainage from existing mining activities and from closed / defunct mines.

Box 38: Treatment performance of Waste Water Treatments Works (WWTWs):

Poor treatment performance of municipal and privately operated WWTWs is prevalent across South Africa, particularly for small treatment plants (referred to as package treatment plants located in small or poor communities[117]. A package plant is any onsite, waterborne, domestic wastewater treatment system; whether it consists of one or many modules; with a total capacity less than 2 000 m^3 /day[118]. It typically includes equipment largely constructed and packaged off site and brought onsite for installation[132].

A number of studies and surveys conducted in South Africa have confirmed that about 50% of small treatment plants are not producing the desired water quantity or quality[119]. The primary reasons for the failure of these plants include inappropriate technology, design and construction; mechanical breakdown; and most notably a critical shortage of trained, skilled and experienced process controllers and mechanical/electrical maintenance staff[133]. The high variability of influent domestic wastewater also poses a serious operational challenge to operators exacerbated by the general lack of operational skills[133]. The lack of skilled process controllers and maintenance staff is also a key factor in the poor performance of larger regional municipal WWTWs.

Box 39: Sewage transport water quality risks:

Water quality risks are also present for sewage transport. Sewage is transported and conveyed in pipelines, primarily via gravity. Sewer pipes often leak at joints and manhole connections when blockages create high pressures within the pipes causing sewage to be forced out of cracks and joints. In addition, manholes also overflow during pipe blockages at points below the manhole. Reasons for blockages include the flushing of foreign objects into the system by local residents, inadequate design and/or poor construction. Furthermore, pump stations are often required when topography is not sufficient to allow for gravity driven conveyance. Pump stations and their emergency storage facilities can over flow if electrical supply to the pump is unstable or irregular or if there are malfunctions due to lack of maintenance.

Box 40: Septic tank water quality risks:

In certain old peri-urban and rural areas, septic tank and soakaway systems are used and continue to be proposed as the preferred sanitation option. At low densities with suitable soil conditions, such systems appear to pose relatively low pollution risks, especially if owners have the financial means to maintain the system. However, in high density residential areas characterized by aging systems and a

[117] Snyman et al., ???
[118] van Niekerk et al., 2009
[119] Momba et al., 2008

lack of regulation, the cumulative effects of reduced or poor septic tank treatment performance has measurable negative impacts on local watercourse water quality. In poor residential and rural areas where residents lack financial resources and expertise to service the systems, system failure is more prevalent with resultant water quality impacts.

The waste water management design principles to consider are:

Waste water treatment works (WWTWs):

- Minimization of the levels and concentrations of pollutants discharged into watercourses by WWTWs as far as practically possible factoring in the ability, capacity and sensitivity of the downstream freshwater ecosystems to assimilate the additional flows and physico-chemical constituents. The treatment process and technology should be designed to effectively remove all target pollutants that pose a threat to biological systems.
- Minimization of impacts of WWTW discharges on flow regimes of receiving watercourses.
- Avoidance and/or minimization of impacts to highly important and sensitive wetland ecosystems.
- Minimization of the risk of waste water management and treatment failures and malfunctions. This is related to the treatment option, the method of disposal, the appropriateness of the site conditions, the level of expertise required to operate, and the financial ability to ensure maintenance.
- Ensure suitable safety, emergency and monitoring measures are installed in line with the anticipated risks.
- Maximization of the reuse of treated waste water wherever possible while also taking into account impacts on the flow regimes of the receiving watercourses.

Decentralized sewage disposal systems (septic tanks, pit latrines):

- Ensure that suitability of environmental conditions are factored into the design.
- Avoidance and/or minimization of impacts to highly important and sensitive wetland ecosystems. This will involve the siting of potential point source risks suitable distances away from important wetland ecosystems.
- The social acceptability of the selected waste water management and disposal options by the affected community must be considered.

Hazardous waste management and disposal:

- Minimization of the risk of the uncontrolled or accidental discharge / leakage of hazardous waste water into the freshwater environment. Ideally, no hazardous waste water should be discharged into the freshwater environment and design should ensure a high confidence in achieving this objective. If discharge is proposed, the waste water will need to be treated to a very high quality using the best available technologies (see WWTW design principles above).
- Avoidance and/or minimization of impacts to highly important and sensitive wetland ecosystems. This will involve the siting of potential point source risks suitable distances away from important wetland ecosystems.
- Ensure suitable safety, emergency and monitoring measures are installed in line with the anticipated risks.

Agricultural waste water management systems:

- Minimization of the levels and concentrations of pollutants discharged into watercourses by agricultural activities.
  - For typical cultivation activities this will include minimizing the use of nutrients, herbicides and pesticides as far as practically possible, establishing buffer zones to intercept diffuse flows (i.e. when water flow is not concentrated within a distinct channel but is rather spread as sheet flow on the surface or as seepage below the ground surface[120]), and created constructed wetlands at strategic locations to protect downstream wetlands.
  - For agricultural activities characterized by large volumes of wash water for hygienic purposes like piggeries, dairies, chicken farms, formal waste water treatment will be required prior to discharge to the freshwater environment (see WWTW design principles above).
- Avoidance and/or minimization of impacts to highly important and sensitive wetland ecosystems. This will involve the siting of potential point source risks suitable distances away from important wetland ecosystems.

A consolidation of the best practice design measures for waste water management, treatment and disposal is included in **Annexure C1.** Relevant best practice design guidelines and manuals are listed as follows:

- ***Process Design Manual for Small Wastewater Works*** (Nozaic & Freese, 2009). http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20389%20Municipal%20Wastewater%20Management.pdf
- ***Guideline document: Package plants for the treatment of domestic wastewater*** (van Niekerk et al., 2009), http://www.dwa.gov.za/Dir_WQM/docs/GuidelineDocWEB.pdf
- ***Guidelines for the Improved Disinfection of Small Water Treatment Plants***. http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20355-Potable%20water%20supply-web.pdf
- ***DWAF Best Practice Guidelines for Water Resource Protection in the South Africa Mining Industry.*** *http://www.dwaf.gov.za/Documents/Other/WQM/BPG_G1StormWaterAug06.pdf*
- ***Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste*** (DWAF, 1998), http://www.dwa.gov.za/Dir_WQM/docs/Pol_Hazardous.pdf

4. Hazardous Materials Management

Hazardous materials management includes the storage, handling and transport of hazardous products. These activities pose a serious risk to wetlands in close proximity to such facilities and features. Such activities include storage and processing of hazardous materials as part of industrial processes, and the transport of hazardous products within pipelines e.g. petroleum and oil.

The key hazardous facility design principles to consider are:

[120] Ollis et al., 2013

- Minimization of the risk of the uncontrolled or accidental discharge / leakage of hazardous products into the freshwater environment.
- Avoidance and/or minimization of impacts to highly important and sensitive wetland ecosystems. This will involve the siting of potential point source risks well away from important wetland ecosystems.
- Ensure suitable safety, emergency and monitoring measures are installed in line with the anticipated risks.

A list of some best practice measures related to minimizing the impacts of hazardous materials and waste to wetlands is provided in **Annexure C1.**

5. Water Supply & Agricultural Irrigation Projects

Water supply projects include all infrastructure required to deliver potable water to the public, namely supply dams, abstraction infrastructure (weirs), water treatment plants and water pipelines. Such projects involve flow impoundment, and the abstraction, treatment and distribution of significant volumes of water from rivers, as well as abstraction from groundwater resources.

Irrigation projects involve the abstraction of water for crop irrigation purposes and usually involve the establishment of in-stream dams for abstraction purposes. Abstraction volumes can be significant.

Flow regulation by dams typically results in reductions in peak flows and sediment inputs. Such impacts are significant for floodplain wetlands that are dependent on flood flows and associated sediment for their vitality. Dams typically also result in reduced low flows to wetlands where base flows are intercepted with minimal release. In some circumstances however, increased low flow discharges can occur where surplus water is released during low flow periods. The reductions in low flows has significant impacts on permanently saturated un-channelled valley bottom wetlands dependent on a continuous supply of water to spread out diffusely across the valley bottom.

Similarly, abstraction of water for potable water or agricultural purposes removes the water from the wetland's catchment or groundwater thus reducing the volume of water inputs with implications of the timing, duration and levels of waterlogging.

For those wetlands that have strong linkages to groundwater, and are often predominantly fed by groundwater, abstraction from this groundwater water resource will reduce the volume of water inputs to the wetland.

The key water supply project design principles to consider are:

- Minimization of the impacts to wetland flow regime including duration and frequency of high flows and low flows. In this regard, the design of the dam and/or abstraction system must take into account the wetland's flow requirements i.e. reserve, in terms of quantity, quality and pattern (seasonal variation). Reserve determination studies will need to be undertaken to inform project design (see **Box 41**).

- Avoidance and/or minimization of indirect impacts to highly important and sensitive wetland ecosystems. This will involve the siting of dams outside of important wetland catchments, particularly those wetlands predominantly fed by surface water inputs.

Box 41: Reserve determination

The objective of Reserve determination, whether this is for a river, estuary or wetland, is to estimate how much water, and of what quality, should remain in the system. This is usually estimated using the naturally occurring flow as a reference. Four levels of Reserve determination have been designed to accommodate the need for assessments involving varying levels of detail and confidence. These four levels of Reserve determination require different lengths of time and levels of specialist and stakeholder input to complete.

Relevant documents:

- **Considerations for the Design of River Abstraction Works in South Africa - WRC Report No. TT 260/06** (Basson, 2006) http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20260-06.pdf
- **Manual for the Rapid Ecological Reserve Determination of Inland Wetlands (Version 2.0) – WRC Report No. 1788/1/12** (Rountree et al., 2013) - http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/1788-1-13.pdf

6. Road Crossings

The crossing of wetlands by roads can have considerable direct and indirect impacts on wetlands. A list of crossing types is provided in **Box 42**. The main impacts are typically the infilling of wetland under the road footprint, which is usually small in extent being a linear activity, and wetland flow modification in the form of flow concentration, diversion and/or impoundment. The key wetland flow impacts are increased velocities as a result of flow concentration through culverts, which results in increased rates of erosion and sedimentation, and a reduction in the spreading of flows across the wetland below crossings, which results in a reduction in the levels of waterlogging. It is also important to note that the alignment of the road crossing can also result in significant changes, particularly when aligned with sensitive local features.

Box 42: The types of wetland road crossings

- Bridges – Wetland bridge crossings typically span a wetland but may require piers be established within the wetland.
- Fill crossings with pipe or box culverts – Involves the establishment of fill road platform within wetland and the diversion of water through the fill using pipe or box culverts.
- Pipe or box culverts (only) – Involves the establishment of a series of pipe or box culverts across the width of the wetland on which the road surface is established.

- Low level crossings – Establishment of concrete or rock fill crossing within the wetland with the diversion of low flows through pipe culverts and high flows over the top of the road surface.

Best practice road design measures are those that minimize both the extent of wetland habitat destroyed and the impacts to wetland flow characteristics. The key design principles for wetland road crossings are:

- Avoidance of sensitive local wetland features.
- Minimisation of the extent of wetland under the road footprint, particularly intact wetland.
- Minimization of the change in wetland flow velocity for all flow regimes.
- Minimization of the change in wetland flow distribution across the wetland for all flow regimes.

The design option that best meets the above principles is a spanned bridge. However, in certain settings the cost of such an option would likely be unfeasible and impractical. Bridges should ideally be the preferred option in cases where the wetlands to be crossed are very important and/or sensitive. The next best crossing option is a road fill crossing with the establishment of box culverts across the entire width of the wetland. Although this option will result in higher levels of habitat destruction when compared to bridges, the impacts to wetland flow are minimized. Both options also maintain faunal movement and minimize road fragmentation impacts.

A list of some best practice measures related to avoiding and minimising the impacts of roads on wetlands is provided in **Annexure C2**.

7. Pipeline Crossings

Pipelines that cross wetlands are typically established underground 1-2 m below the wetland surface. Such establishment involves the temporary excavation of trenches across the wetland in which the pipelines are placed. This requires that the wetland vegetation and topsoil be stripped or grubbed and flow piped over the trench. Typical impacts to wetlands include the removal of wetland vegetation within the construction corridor, temporary flow impoundment upstream of the trench, and increased flow velocities as a result of the concertation of flows in pipes over the trench, which increases the risk of erosion and sedimentation. Once the pipeline is established, the trench is backfilled and the wetland rehabilitated. As such underground pipeline crossings do not constitute permanent wetland loss. Although not common, pipelines can be spanned (bridged) across wetlands on plinths of varying height. During construction the impacts are less intensive but a construction corridor still needs to be cleared and water diverted away from the construction working areas. The impacts of pipe bridges are also more permanent due to the establishment of concrete plinths in the wetland.

Best practice pipeline crossing design measures are those that minimize both the extent of wetland habitat disturbed and the impacts to wetland flow characteristics. The key design principles for wetland pipeline crossings are:

- Avoidance of sensitive local wetland features.

- Minimisation of the extent of wetland within pipeline construction corridor, particularly intact wetland.
- Minimization of the change in wetland flow velocity for all flow regimes.
- Minimization of the change in wetland flow distribution across the wetland for all flow regimes.

The best practice design option is dependent on the importance and sensitivity of the wetland being crossed. Generally, trenched pipeline crossings are generally preferred over bridged crossings due to the temporal nature of the impacts and the possibility of effective rehabilitation with no long-term flow impacts. However in some circumstances a bridged option may be preferred especially if there are already existing bridges and crossings that the pipeline can be attached to.

A list of some best practice measures related to avoiding and minimizing the impacts of pipelines on wetlands is provided in **Annexure C2**.

8. Powerline Crossings

The establishment of powerlines across and in close proximity to wetlands can result in significant wetland habitat and species impacts. Key potential wetland impacts include direct encroachment by powerline pylons, towers and poles, the clearing of servitudes, the crossing of wetlands by service roads along the servitude, and an increase in local wetland bird mortality due to powerline collisions and electrocutions.

Best practice powerline crossing design measures are those that minimize both the extent of wetland habitat disturbed and local wetland bird mortality. The key design principles for wetland powerline crossings are:

- Avoidance of sensitive local wetland features including breeding and roosting sites for threatened wetland bird species.
- Avoidance of wetlands all together by powerline pylons and poles.
- Avoidance of woody wetland vegetation types so that there is no need to clear vegetation under the servitude.
- Minimization of the extent of wetland within the powerline servitude.

A list of some best practice measures related to avoiding and minimizing the impacts of powerlines on wetlands is provided in **Annexure C2**.

9. Management Planning – Construction Methods

In general, mitigation applied to the construction and establishment of development activities is considered impact minimization; and construction phase mitigation planning generally proceeds after the project design has been finalised and the avoidance step has been completed. However, in some circumstances where construction phase wetland ecosystem functioning and wetland biodiversity impacts are likely to be significant, the selection and planning of construction methods is critical to reducing, and in some circumstances avoiding, significant wetland impacts. Construction phase impacts typically pose measurable threats to wetland ecosystem functioning and biodiversity when large areas

of land are going to be development adjacent or in close proximity to wetland areas. Poor or inadequate construction methods, particularly stormwater management and erosion control, can result in significant wetland erosion and sedimentation impacts with resultant habitat and ecosystem degradation and biodiversity impacts onsite and downstream.

There are presently no available best wetland management practice guidelines for construction activities. Nevertheless, construction phase mitigation measures are generally well known in South African environmental management practice because such measures form the bulk of Environmental Management Programmes (EMPs) that are a requirement of Environmental Authorizations under NEMA, and Integrated Waste Water Management Plans (IWWMPs) that are a requirement of Water Use License Applications under NWA.

In the case of wetland management, the most critical construction phase mitigation aspects to include are:

- Contractor staff environmental education, training and induction.
- Construction work phasing plan (minimizes unnecessary clearing of larger areas).
- Plant harvesting or rescue (if applicable).
- No-go area (wetland and buffer zone) and construction working area demarcations.
- Temporary access and haulage road alignments and designs.
- Detailed method statements for all authorized / licensed work within wetlands e.g. encroachment, crossings etc.
- Stormwater management and erosion and sediment control.
- Dust management.
- Noise management.
- Soil and water pollution prevention (storage, handling and disposal of dangerous goods or hazardous substances).
- Soil and water pollution incident management.
- Solid waste management.
- Alien plant control.
- Construction phase rehabilitation.
- Monitoring programme.
- Compliance monitoring by an independent Environmental Control Officer (ECO).

10. Management Planning – Operational Activities

In general, mitigation applied to the operation of development activities is considered impact minimization. Operational phase mitigation planning generally proceeds after the project design has been finalised and focusses on the management and monitoring of operational activities and processes, and the maintenance of infrastructure, which are often critical to minimising the significance of impacts. However, in some circumstances the mode of operation can be considered a project design decision, particularly if there are a number of alternative modes and methods of operation (e.g. mining).

Maintenance of a wetland that has an upstream catchment with human influence can include:

- Cleaning out of debris and floating litter.
- Removal of alien invasive vegetation (water hyacinth, excessive Bulrush or Common Reed.
- Control of pests.
- Prevention of blockage of outlets.
- Maintenance of infrastructure (rehabilitation intervention measures as well as recreational facilities).
- Dredging of excessive sediment and silt.

The design can be such that the maintenance is minimized, for example by designing for litter traps at the inflows of a wetland. Maintenance requirements are often underestimated in the design phase. Altered / rehabilitated aquatic ecosystems do not perform like un-impacted ones[121].

6.3.6 Impact Remediation (Rehabilitation)

In the context of development planning and the mitigation hierarchy, wetland restoration and rehabilitation refers to the measures taken to restore or improve the condition of wetland ecosystems and the associated supply of ecosystems services following exposure to project impacts that are unavoidable and cannot be adequately minimized[122]. Such impacts are referred to as residual impacts, which are impacts that remain after all practical mitigation measures have been implemented[123].

Restoration and rehabilitation is the most important remediative component of the mitigation hierarchy because it aims to reverse impact damage directly, and arrive at a desired improved state[136]. Restoration and rehabilitation therefore has the potential to reduce the liabilities associated with residual impacts[136]. However, restoration and rehabilitation is generally more challenging and uncertain than avoidance and minimization and can also be expensive[136]. The key constraints and disadvantages of restoration and rehabilitation are summarized in **Box 44** below.

Box 44: Key constraints and disadvantages of restoration and rehabilitation are:[136]

- Generally has a lower certainty of success than avoidance and minimization.
- Restoration of natural ecosystems is poorly understood, and can be challenging, slow and expensive; it can be complicated by logistical, social and political constraints.
- Restoration may not be an advisable option for 'irreplaceable' or 'vulnerable' ecosystems and species (e.g. old growth forest, some locally endemic species) due to the uncertainty of outcomes and time lag for success.
- Requires early planning to ensure that adequate baseline information for the impact site is collected to inform feasible restoration goals and practice.
- May require changes to initial plans in order to avoid or minimize impacts on the least restorable areas or features.

[121] Haskins et al.,2012
[122] The Biodiversity Consultancy, 2015
[123] SANBI & DWS, 2014

- May require long-term management interventions and costs to ensure that the site remains on the correct trajectory for the required outcome (costs eventually diminish once restored areas are self-sustaining).
- Likely to be less cost-effective (for achieving a particular result) than earlier steps in the mitigation hierarchy.
- Costs may be hard to predict unless a nearly identical project in same environment exists.
- Although loss-gain quantification may be more straightforward than with offsets, restoration often requires long time frames to achieve outcomes.
- The scientific basis for optimal restoration practice is often complex.
- Requires expert consultation to derive feasible goals and implementation plans.
- It is practically impossible to fully return a site to its pre-disturbance state, especially in terms of species composition.
- General rehabilitation that does not address specific ecosystem and biodiversity values of concern may be important for stakeholders, regulatory compliance and reputation, but does not count as the application of restoration in the mitigation hierarchy.
- Restoration needs closer monitoring than other mitigation activities due to unpredictable recovery trajectories and uncertain effectiveness of techniques.

Please also refer to **Section 5** earlier for guidelines on wetland rehabilitation.

6.3.7 Offset Planning

Wetland offsets are permanent and measurable conservation outcomes resulting from actions designed to compensate for anticipated significant residual negative impacts (**Box 45**) on wetlands[124]. The goals of wetland offsets are to achieve 'no net loss' and preferably a net gain with respect to the full spectrum of functions and values provided by wetlands[138]. Wetland offsets are aimed specifically at compensating for significant residual impacts on wetlands after all appropriate and feasible steps have first been taken to avoid, minimize and remediate impacts as per the mitigation hierarchy[138]. Wetland offsets should only ever be a last resort option and not be applied as the sole or first mitigation option[138].

Box 45: What is a significant impact?

In terms of Government Notice GNR 326 of the EIA Regulations (2017) published in terms of NEMA, a 'significant impact' is defined as: "an impact that may have a notable effect on one or more aspects of the environment or may result in non-compliance with accepted environmental quality standards, thresholds or targets and is determined through rating the positive and negative effects of an impact on the environment based on criteria such as duration, magnitude, intensity and probability of occurrence."

(i) Best practice wetland offset guidelines

[124] SANBI & DWS, 2014

Considering that the South African socio-economic context is characterized by considerable unemployment, poverty and inequality, as well as a stuttering economy, there is a strong political desire for development at scale and often at all costs. Inevitably this need to expand development and urbanization results in direct and indirect impacts to wetlands, particularly within and on the outskirts of existing urban areas. As a result, wetland loss and destruction is typical of most greenfield urban development applications and offsets are increasingly becoming part of development proposals. It within this context that SANBI & DWS published the ***Wetland Offsets: A best practice guideline for South Africa*** (SANBI & DWS, 2014) - http://biodiversityadvisor.sanbi.org/wp-content/uploads/2014/09/Wetland-Offset-Guidelines-Version-7-For-stakeholder-comment.pdf

The purpose of this guideline is to:

- Standardise criteria, procedures and processes on how to design and implement offsets for residual negative impacts on wetlands.
- Describe the goals and principles of wetland offsets.
- Provide a standardised method for calculating appropriate offset requirements.
- Provide guidance on selection of appropriate sites for wetland offsets and offset mechanisms.
- Provide a standardised method for calculating whether or not a proposed offset is sufficient and appropriate.

The offset guideline is specifically designed for application where significant, large-scale residual wetland impacts are encountered (e.g. large scale infrastructure projects and opencast mining)[139]. The document nevertheless provides an equally useful framework to inform wetland offset design and implementation in other contexts where there are smaller, but still significant, residual impacts[125].

(ii) Impact Significance Assessment

Impact significance is defined broadly as a measure of the desirability, importance and acceptability of an impact to society[126]. Thus, just knowing the extent and intensity of ecosystem change (often referred to as impact magnitude or intensity) as a result of human activities is not sufficient for the assessment of significance because it does not factor in the importance or value of the ecosystem being impacted. The assessment of significance thus requires that the degree of change to ecosystems be interpreted in terms of the degree of change to aspects that are valued by society, namely water resources, climate resilience and disaster management, and biodiversity. Ultimately it's the degree of change in these aspects of value that determine the significance of an impact.

A framework for subdividing wetland impacts according to the ultimate consequences to resources of value has been developed in the National Wetland Offset Guidelines[139] for the purposes of impact quantification and offset target calculation. The following adapted framework provides an important contribution to framing the assessment of the significance of impacts to wetlands (**Figure 42**)[139]:

[125] SANBI & DWS, 2014
[126] Lawrence, 2007

- **Impacts to Regulating Services:** This refers to direct and indirect impacts to key regulating ecosystem services that support water resource management, climate resilience and disaster / risk management.
- **Direct Goods & Services**: The emphasis here is specifically on understanding and assessing the impacts on provisioning (water supply, harvestable natural resources, cultivated foods or food for livestock) and cultural services available to local communities, as an indication of the ultimate impacts to the livelihoods, health and safety of people and communities.
- **Impacts to Ecosystem Conservation**: The focus here is specifically on understanding the significance of impacts in relation to the ability to meet ecosystem or habitat conservation targets. This is informed by an understanding of conservation significance of the ecosystem or habitat that is influenced by factors such as ecosystem threat status, regional conservation context, condition of habitat, and connectivity to other intact habitats.
- **Impacts to Species Conservation**: The focus here is specifically on species of conservation concern that are listed as rare or threatened in Red Data Lists or protected under national or provincial legislation.

Figure 42 Key components to be taken into account when assessing impact significance.

(iii) Methods of achieving offsets:

Within the offset guideline framework, there are five (5) ways of achieving offsets as illustrated in **Figure 43** and described in **Table 11** below[127].

[127] SANBI & DWS, 2014

Figure 43 Diagram of the different ways of achieving wetland offsets.

Table 11. Summary and description of the ways of achieving offsets.

Offset Action	Description
Protection	This refers to the implementation of legal mechanisms (e.g. declaration of a Protected Environment or Nature Reserve under NEMPAA, a legally binding conservation servitude, or a long term Biodiversity Agreement under NEMA) and putting in place appropriate management structures and actions which ensure that the value of the wetland offset is maintained.
Rehabilitation (of offset wetland)	Involves the manipulation of the physical, chemical, or biological characteristics of a degraded wetland system in order to repair or improve wetland integrity and associated ecosystem services. Where an offset is undertaken through rehabilitation, long term protection and suitable management to maintain the full value of the offset wetland is required.
Averted loss	Refers to physical activities which prevent the loss or degradation of an existing wetland system, its ecosystem services and its biodiversity, where there is a clearly demonstrated threat of decline in the system's condition, ability to provide ecosystem services or contribute to overall water resource management objectives. Long term protection and suitable management to maintain the full value of the offset wetland is required.
Establishment	This activity involves the development (i.e. creation) of a new wetland system where none existed before by manipulating the physical, chemical, or biological characteristics of a specific site. Successful establishment

Offset Action	Description
	would result in 'gains' in wetland area, functions and possibly biodiversity values. Long term protection and suitable management to maintain the full value of the offset wetland is required.
Direct compensation	Direct compensation involves compensating affected parties for the ecosystem services lost as a result of development activities. This is ideally done by providing an equivalent substitute form of asset or in some cases may take the form of monetary compensation. In general, direct compensation is not a desired offset mechanism, but it may contribute to an integrated offset approach which ensures overall no net loss through a range of mechanisms.

Furthermore, the achievement of offsets should consider the following guiding principles[128] included in **Box 46**. Any offset process must be interrogated according to these principles.

Box 46: Guiding principles wetland offsets[142]:

- **No net loss** - Unavoidable loss should be offset through securing sufficiently improved condition of other wetlands through rehabilitation activities, and improving the overall security and sustainability of the wetland network through averted loss, improved management and long-term protection of wetlands. It does not take a literal interpretation which would require that where wetlands are lost that new ones need to be established.
- **Adherence to the mitigation hierarchy** - An offset compensates for significant adverse impacts that remain after appropriate avoidance, minimisation and on-site rehabilitation options have been exhausted. Offsets should only be considered once all feasible and effective actions and project alternatives to avoid, minimise and rehabilitate damage have been taken into account.
- **Limits to what can be offset** - There are situations where residual impacts cannot be fully compensated for by a wetland offset because of the significance of the impact (e.g. on a highly threatened wetland type) or the value of the wetland affected (e.g. a wetland type that is unique or restricted in distribution). There are thus limits to what can be offset.
- **Landscape and catchment context** - Landscape and catchment context should be taken into account to ensure that any offsets are sustainable and result in an optimum overall outcome
- **Like-for-like** - This principle refers to the targeting, through offset activities, of the same wetland type as the one impacted by development. Offset policies tend to favour like-for-like offsets although out-of-kind offsets should be used where they provide greater or more sustainable water resource and conservation benefits than like-for-like options.
- **Additional conservation outcomes** - Offsets need to be a new contribution to conservation outcomes, i.e. over and above what would have occurred without the offset in place.

[128] SANBI & DWS, 2014

- **Stakeholder participation and transparency** - The design and implementation of offsets should be undertaken in an open and transparent manner, providing for stakeholder engagement, respecting recognised rights, and seeking positive outcomes for affected parties
- **Equity** - A wetland offset should be designed and implemented in an equitable manner, which means the appropriate sharing among stakeholders of the rights, responsibilities, risks and rewards associated with a project and offset in a fair and balanced way, while respecting legal and customary arrangements.
- **Long-term outcomes** - Offset outcomes need to last at least as long as the project's residual impacts and preferably in perpetuity. This requires that legal and financial assurances are in place to ensure that sites are legally protected and effectively managed to ensure they maintain their value as an offset. Adaptive management is required in the long term, including appropriate management planning, supportive monitoring and evaluation. Offsets must be measurable, auditable and enforceable, through explicitly worded conditions, covenants and/or contracts.

(iv) Offset Process

The offset process typically involves the following broad tasks:

- Quantify residual impacts , assess significance and confirm the need for an offset.
- Calculate offset target and confirm.
- Select offset site, evaluate and confirm.
- Secure the offset site through either purchase or long-term lease agreement.
- Compile rehabilitation and management plans including an estimate of the costs of implementation and management.
- Develop an ecological monitoring programme including undertaking a baseline habitat assessment.
- Confirm protection status and management structure.
- Facilitate agreement on financial obligations and the associated funding mechanisms with relevant authorities and stakeholders to ensure effective rehabilitation, management and monitoring for the required term. The minimum required term for the funding of the management of biodiversity offsets is 30 years[129].
- Secure necessary legal agreements to implement offset.

It is envisaged that the sustainability of the wetland offsets will be verified as part of this NWA water use license authorisation approval process regulated by the DWS. If a wetland offset is required, relevant conditions will be included in the license authorisation. Should wetland offsets not be a viable compensation measure (as determined by these investigations) or if the applicant is unwilling to commit to the required wetland offset measures, then the water use authorisation will be refused.

[129] DEA, 2017

6.4 Application Review Protocol

Firstly, it is important that some sort of system is setup for all sectoral departments of a municipality to review and provide input into development applications received in terms of SPLUMA, NEMA and/or NWA. The following actions are proposed:

1. Setup an environmental inquiry system attached to the interrogation and review of all land development applications. As part of all formal correspondence on the applications, a section on environmental matters must be included, that should include wetland aspects if relevant.
2. Assign staff members the responsibility of interrogating applications in terms of environmental aspects, including wetland management, as part of the above processes. The selected staff members should receive basic training in environmental legislation, particularly NEMA and NWA.
3. Develop a watercourse flagging protocol as part of all application reviews in terms of environmental matters. In this regard utilize the municipal wetland map generated as part of the baseline wetland inventory (see Section 5 earlier) in GIS as the key wetland management tool to flag potential conflicts of development applications with wetlands. The selected staff members should receive basic training in the use of GIS for this purpose.

The following protocol is proposed for the interrogation and review of all land development applications received in terms of SPLUMA, NEMA and NWA (**Table 12**). The protocol consists of a list of the following key questions:

Table 12. Application review protocol structured into key questions.

APPLICATION REVIEW PROTOCOL FOR WETLANDS
1. Site Selection
1.1. Are there any wetlands within or in close proximity to the proposed development footprint or site?
1.2. What factors were considered in the selection of the preferred development site?
1.3. Has the proponent considered wetland management concerns and objectives in the selection of their preferred development site?
1.4. If measurable risks / impacts to wetlands are anticipated, has the proponent investigated all feasible alternative sites to lower such risks / impacts?
2. Project Design – Layout Planning
2.1. Are there any wetlands within or in close proximity to, or immediately downstream of, the proposed development footprint or site?
2.2. If yes, have the wetlands been formally delineated and assessed by a professionally registered and suitably experienced wetland scientist?
2.3. Are there wetlands of high importance and/or sensitivity within the study area or immediately downstream as confirmed by a professionally registered and suitably experienced wetland scientist?
2.4. Have the wetlands been incorporated into the development layout plan as non-development / open space areas?

APPLICATION REVIEW PROTOCOL FOR WETLANDS
2.5. Have adequate buffer zones between the proposed development land uses and the wetlands been determined by a professionally registered and suitably experienced wetland scientist using the national wetland buffer guideline?
2.6. Have these buffers been incorporated into the development layout plan?
2.7. If wetland encroachment or destruction is proposed, has the proponent investigated all feasible alternative project design options to avoid such encroachment and is a well-reasoned motivation and substantiation for such encroachment provided?
2.8. If the proposed development will involve extensive land cover transformation, have the impacts to catchment hydrology been factored into the layout design? i.e. does the layout plan accommodate / integrate stormwater management structures and interventions?
3. Project Design – Infrastructure Design & Alignment
3.1. Does the proposed stormwater management system align with SuDS design principles and have an acceptable impact on local wetlands?
3.2. Has the applicant / proponent considered and investigated all feasible and relevant best practice waste water management measures and have these been included in the project design?
3.3. If return flow discharges are proposed into wetlands, has the proponent investigated all feasible design options to avoid such discharges and is a well-reasoned motivation and substantiation for such discharges provided?
3.4. Has the location and siting of the return flow discharge point(s) taken into account the importance and sensitivity of the onsite and local wetlands?
3.5. If the establishment of a dam or abstraction point within or upstream of a wetland is proposed, has the proponent considered ecological flow and reserve requirements of the affected wetlands?
3.6. Has the location and siting of dam and/or abstraction points taken into account the importance and sensitivity of the onsite and local wetlands?
3.7. Has the number of road and pipeline crossings of wetlands been minimized as far as practically possible?
3.8. Has the distance between all pollutant point sources and wetland been maximized?
3.9. Have all mitigation measures to reduce the risk of pollutant point sources to wetlands been investigated and incorporated into the design?
4. Project Design – Construction Methods
4.1. Is the preparation of a formal construction phase stormwater management plan necessary?
4.2. Do the selected construction methods effectively reduce sediment and erosion impacts to wetlands?
4.3. Will adequate buffer zones be retained during the construction phase to reduce erosion, sediment and pollution impacts to wetlands?
4.4. Have stringent wetland and no-go demarcation measures been recommended as part of the pre-construction phase planning and establishment?

APPLICATION REVIEW PROTOCOL FOR WETLANDS
4.5. Have stringent construction / working area demarcation measures been recommended as part of the pre-construction phase planning and establishment?
4.6. Have prescribed access roads and haulage routes for the construction phase been determined?
5. Project Design – Operational Activities
5.1. Where potentially significant risks and impacts are planned to be minimized through management controls, have stringent operational management, maintenance and monitoring programmes been compiled?
6. Impact Assessment
6.1. If impacts to wetlands are likely to be significant, has the significance of impacts to wetlands been formally assessed by a wetland assessment practitioner?
6.2. If significant impacts to wetlands are likely to occur as confirmed by a wetland assessment practitioner, has the residual impact been assessed and quantified to inform the need for remediation actions like onsite rehabilitation or offsets?
6.3. If significant impacts to wetlands are likely to occur as confirmed by a wetland assessment practitioner, has the mitigation hierarchy has been applied to the project planning and design?

7. GUIDELINES FOR ESTABLISHING COMPLIANCE, ENFORCEMENT AND MONITORING FUNCTIONS

This section provides broad guidance on the development and implementation of a municipal wetland monitoring programme and a compliance monitoring and enforcement system.

In the South African context of poor on-the-ground environmental regulation, the development of local municipal capacity to assist national and provincial departments in monitoring compliance of private and public entities with conditions of authorizations and licenses, and to monitor key wetland impacts and priority wetlands, is critical to achieving effective wetland management. Related to this, establishing the powers to enforce correction and remediation of unlawful impacts to wetlands is also important. This section provides guidelines on the following key actions:

- Establishing compliance monitoring capacity.
- Establishing a compliance monitoring and enforcement strategy.
- Establishing a municipal wetland monitoring programme.

7.1 Establishing Monitoring Capacity

The first step in establishing monitoring capacity is to capacitate existing staff or hire new staff for the purpose of environmental compliance monitoring and enforcement. As has already been mentioned, the funds for this purpose can be motivated for as part of the IDP process. For those municipal staff members given a compliance monitoring and enforcement job description, they should undertake training to be designated as Environmental Management Inspectors (EMIs).

Section 31B and 31C of NEMA (as amended 2005) makes provision for the designation of an Environmental Management Inspector (EMI) by the minister of the national DEA or MECs, and they have the discretion to decide which officials to designate[130]. To be eligible for EMI designation, an official (only officials may be designated) must complete "any relevant training course approved by the Director-General" (see EMI regulations[144]. At present, this course is the EMI Basic Training Course. See the EMI basic training webpage on the DEA website – https://www.environment.gov.za/projectsprogrammes/emi/basictraining.

EMIs are ranked according to 5 categories as summarized in **Table 13** below.

Table 13. EMI ranking system.

Ranking Grade	Powers in terms of section 31D(3)
Grade 1	All the powers given to environmental management inspectors under the Act.
Grade 2	All the powers given to environmental management inspectors under the Act, except for the power under section 31L of the Act.

[130] DEA webpage - https://www.environment.gov.za/projectsprogrammes/emi/becomingemi

Ranking Grade	Powers in terms of section 31D(3)
Grade 3	All the powers given to environmental management inspectors under the Act, except for the power under sections 31H(5) and 31L of the Act.
Grade 4	All the powers given to environmental management inspectors under the Act, except for the power under sections 31H(1)(b), 31H(5), 31I(3) 31J, 31L and 34G(2) of the Act.
Grade 5	Powers in terms of section 31H, section 31I(3) and section 31J of the Act only.

It is important to note that EMIs are not empowered to prosecute cases in court. All cases continue to be handed over to the National Prosecuting Authority (NPA) for prosecution[131]. The EMIs therefore work closely with prosecutors country wide to ensure the successful prosecution of offenders[145].

7.2 Establishing a Compliance Monitoring and Enforcement Strategy

7.2.1 Legislative Context

Whilst South African legislation ranks up with some of the best in the world, actual environmental enforcement remains a problem in South African environmental law[132]. This is attributed partly to the lack of capacity and insufficient resources within national and provincial government to undertake enforcement[146]. It may also be a consequence of the continued use of so-called 'command and control' approaches to environmental enforcement, as environmental regulation does not provide sufficient incentives to encourage sustainable industrial practices by way of self-regulation[146]. The predominant 'command and control' mechanism for enforcement is the criminal sanction[146]. Whilst criminal sanctions may play an important deterring role, they have largely been ineffective in South African environmental law mainly because the penalties for environmental damage are seldom severe enough to deter polluters, and prosecutions are rare due to a lack of capacity and expertise[146].

Enforcement of environmental laws was given a significant boost in 2005 with the establishment of the Environmental Management Inspectorate, popularly known as the "Green Scorpions"[133]. Its member institutions include: the Department of Environmental Affairs (DEA), South African National Parks (SAN Parks), Isimangaliso Wetland Park, all nine provincial environmental departments, four provincial conservation agencies and even a few municipalities. All of which cooperate on the monitoring and enforcement of compliance with NEMA and its subsidiary laws covering protected areas, biodiversity, waste, air quality and coastal management[147]. They share standard training, standard operating procedures, a logo and a newsletter, an annual EMI Lekgotla (national conference) and quarterly meetings[147]. They also report results in a standard format into the annual National Environmental Compliance and Enforcement Report[147].

[131] DEA webpage - https://www.environment.gov.za/projectsprogrammes/emi
[132] Feris, 2006
[133] Centre for Environmental Rights, 2015

The legal powers of EMIs are as follows:

- **Routine inspections**: entering business premises to check compliance; seizing evidence.
- **Investigations**: questioning witnesses; inspecting, copying and removing documents; inspecting and removing articles or substances; taking photographs; taking samples; removing waste.
- **Enforcement**: search and seizure, roadblocks, arrest.
- **Administrative powers**: compliance notices.
- **Cancellation of and disqualification for permits**: the court convicting a person of an offence may withdraw any permit or authorisation if the rights under that permit had been abused, or disqualify that person from obtaining a permit or other authorisation for up to five years, and order that all other permitting authorities be notified of such disqualification

Despite these developments many environmental crimes and violations still go unpunished, and in the absence of effective deterrence, continue to be committed[134]. The reasons for this are many and varied, and require a broad range of interventions. The majority of these are listed in the 'Full Disclosure' report on environmental compliance in South Africa compiled by the Centre of Environmental Rights[148] (see **Box 47**).

Box 47: Why do environmental crimes continue to both occur and go unpubished?[148]

1. **No legal mandate over environmental compliance of mining operations, or for laws relating to water**, as this is the purview of officials in the Department of Mineral Resources (DMR), and the Department of Water & Sanitation (DWS) respectively. Both these departments have declined the opportunity formally to participate in a single Environmental Management Inspectorate, therefore are largely missing out on a decade of learning and networking painstakingly done by environment authorities.
2. **Lack of immediate and predictable enforcement** – The way that authorisations are traditionally drafted by licensing authorities makes compliance monitoring very difficult, and the asymmetry of information between the operator of an industrial facility and the often relatively junior officials with limited technical expertise doing inspections across a range of different types of facilities makes it too easy for companies to avoid detection of violations, or to tie authorities up in lengthy and complex disputes about whether violations have in fact occurred. If an enforcement response cannot be immediate and predictable, companies will continue to take risks with violations.
3. **Reliance in criminal prosecution** – South African environmental laws still rely almost exclusively on criminal prosecution as the route to punishment for environmental violations. Criminal prosecution of environmental crimes is slow and difficult, particularly in an already overburdened criminal justice system. Criminal prosecution requires collecting evidence that will withstand the burden of proof required in criminal cases, namely beyond reasonable doubt. It also, crucially, requires the cooperation of both the South African Police Service and individual prosecutors in the National Prosecuting Authority, many of whom are not well-acquainted with environmental laws. It also requires judges and magistrates who are willing to impose maximum penalties for crimes that are often not, in our socio-political context, considered particularly serious. Despite a significant

[134] Centre for Environmental Rights, 2015

increase in maximum criminal penalties for environmental crimes in the past 10 years (the maximum criminal penalty for some crimes in environmental law is now as much as R10 million or 10 years in prison), regional magistrates accustomed to seeing violent crime remain reluctant to impose maximum penalties for environmental crimes. South Africa is not alone in this – even in the United Kingdom, where conviction rates for environmental crimes exceed 90%, this problem occurs. Most international jurisdictions are therefore either in the process of shifting away, or have already undertaken the shift away from, criminal penalties to an administrative or civil penalty system for environmental violations. A criminal enforcement programme must always be retained for the most egregious and intentional of environmental crimes. But empowering a regulatory authority, or even an independent tribunal, with the power to impose immediate monetary penalties that truly reflect the cost of those violations to society is considered the only way to incentivize greater compliance amongst South African corporates.

4. **Problematic Section 24G rectification process** – Environmental regulations in South Africa continue to be plagued by an inappropriate provision in the National Environmental Management Act (section 24G) that allows companies that have commenced activities without the required authorisation to obtain the authorisation after the fact. The procedure for ex post facto authorisation is quicker, and often cheaper, despite the fines imposed, than the application process for a proper authorisation. Most of these fines are too small even to require disclosure to shareholders, and certainly do not compensate for the time and profit gained by the violator through its illegal activity by by-passing the environmental impact assessment requirements, including the commissioning of expert studies and the required public participation processes. These fines are paid directly to government departments (in 2013/14 alone, R5 931 000 was paid to authorities in fines), and in an environment where budgets are continuously decreased, this provision creates an incentive for regulators to process as many of these after-the-fact applications as possible.
5. There is still very **limited transparency around compliance with environmental laws in South Africa.** Despite the 2014 Supreme Court of Appeal judgement against ArcelorMittal South Africa, a case in which the Vaal Environmental Justice Alliance was represented by the Centre for Environmental Rights, where the Supreme Court of Appeal acknowledged and confirmed obligations of South African corporates to report environmental impacts not only to the state, but also to affected communities and civil society, companies remain skittish about sharing information beyond their express reporting duties to the state. The only way to mitigate the impacts of the limited capacity within the state to verify those reports and to respond to reports of violations is to require companies to publish their impacts in an easy and accessible format that allows communities and civil society organisations publicly to hold those companies to account when government cannot. In the current economic climate, when companies are cutting back on all expenditure that they consider to be "non-essential", it is even more important for enforcement action to be swift and meaningful. Attempts to "save" costs on matters relating to environmental impacts – by cutting back on capital expenditure, by reducing environmental staff, and by reducing expenditure on appropriately qualified external environmental expertise, now means that serious environmental

violations and incidents are more likely to occur in the future. To ensure that the environmental regulatory system gives effect to the Constitutional environmental right, we need, at the very least:

a. enough trained, experienced and resourced compliance inspectors and investigators in all relevant government departments;
b. better quality and more monitorable authorisations;
c. a comprehensive new system of administrative penalties for environmental violations, coupled with a complete overhaul of section 24G of the National Environmental Management Act;
d. consistent, regular, integrated and public reporting of compliance and enforcement results; and
e. far greater public transparency of licences and compliance data.

Directives:

An important aspect of environmental enforcement to date has been the use of legal directives such as[135]:

- **Section 28 of the NEMA**
- **Section 31A of the ECA**
- **Section 19 of the NWA**
- **Section 45 of the MPRDA**

These provisions establish a duty of care and empower competent authorities to direct transgressors to take a number of steps to remedy harm to environment[149].

Compliance Notices:

In 2005 the NEMA Amendment Act was promulgated which created a new enforcement section[149]. The key change was that the Minister of the DEA and Members of the Executive Council (MECs) of provincial departments responsible for the environment may now appoint EMIs tasked with the monitoring and enforcement of certain environmental legislation[149]. In exercising this mandate, EMIs have a new administrative remedy at their disposal, namely compliance notices[149]. The overall aim of a compliance notice is to bring non-compliant actors into compliance with environmental legislation or with the conditions of permits, authorisations or other regulatory instruments[149]. Given the wide ambit of section 31L(1)(a), there is no reason why EMIs cannot issue a compliance notice to enforce section 28(1) of NEMA: "*Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment.*" Such a person includes the owner of land or premises, a person in control of land or premises or a person who has a right to use the land or premises. This power is of particular importance in light of the view that non-compliance with a section 28(4) directive is not deemed to be an offence in terms of the Act[149]. Non-compliance with a compliance notice, however, is an offence[149]. Thus, using a

[135] Feris, 2006

compliance notice to direct a transgressor to comply with section 28(1) provides some teeth to environmental compliance and enforcement[136].

Penalties:

Most environmental laws provide for penalties specific to the law, including:

- **NEMA**, which provides that anyone criminally convicted of an offence under a statutory provision listed in NEMA Schedule 3 can be subject to civil liability (section 34(1), NEMA). Fines can also be imposed for certain offences, for example a contravention of the environmental duty of care can invoke a fine of up to R1 million and/or one year's imprisonment. The contravention of a condition in an environmental authorisation, or a failure to obtain such an authorisation can invoke a fine of up to R5 million and/or ten years' imprisonment (sections 28 and 24 F, NEMA):
- **NEM: WA**: provides for a penalty of up to R10 million and/or ten years' imprisonment for failing to obtain or contravening a WML.
- **NEM: BA** provides for a penalty of up to R10 million and/or ten years' imprisonment for failing to obtain or contravening the conditions of a permit granted under the act. For an offence relating to a threatened or protected species the penalty may be increased to as much as three times the value of that species, whichever value is the greater.
- **NEM: PA** provides for penalties as high as R5 million and/or five years' imprisonment for contravention of the act. Civil liability can also arise from an action that has a detrimental impact on the environment. However, the person/entity who seeks damages must prove that the person/entity who committed the action that resulted in the financial loss was negligent.
- **NWA** - Anyone who commits an offence under the NWA is liable on first conviction to a fine R60,000 in a district court or R300,000 in a regional court or imprisonment for up to five years, or both (section 151(2), National Water Act). In addition, they can be liable for the costs of remediation. Subsequent convictions are subject to the same fine or imprisonment for up to ten years, or both.

At present, municipalities have not been given the authority to enforce environmental and water resource laws. Authority for such tasks has been given to national and provincial government only. The only legal basis that a municipality has to issue a directive or compliance notice is in terms of Section 31A of the ECA and in terms of Section 31B and 31C of NEMA is if a municipal official is designated as an EMI. Generally, in order to assist with enforcement, municipal officials would need to work and co-operate with the relevant national and provincial departments.

7.2.2 Developing a compliance monitoring and enforcement strategy

Considering the above, each municipality should develop a strategy to improve compliance monitoring and enforcement. The core focus of the strategy will be to identify practical ways of improving the identification and flagging of unlawful activities. This can be achieved by the following actions:

[136] Feris, 2006

1. **Develop community compliance networks** – As the number of staff involved in compliance monitoring is typically limited, a key component of such a strategy will be to involve communities, community groups, wetland forums and the public at large in monitoring efforts of environmental resources. Community groups and individuals will need to be encouraged to report the illegal use or destruction of environmental resources (such as pollution, destructive uses, illegal harvesting, etc.). It will also be important to use community structures (churches, schools, etc.) and popular social media platforms (Facebook, Twitter, etc.) to raise awareness and facilitate the reporting process. In this regard please refer to case study on the effective monitoring of the Liesbeek River by the public in Cape Town included in **Annexure A7**.

2. **Identify strategic wetland monitoring priority areas** where wetland loss is currently occurring at unsustainably high levels, where important wetlands are facing considerable threat and pressure and/or where unlawful encroachment and modification of wetlands is regularly occurring (e.g. and mining within the eThekwini Municipality). For those high risk developments that have received formal authorization and/or licenses, the conditions of such approvals must be interrogated and regularly followed-up on as part of the compliance monitoring strategy.

Creation and enforcement of municipal by-laws

There is an opportunity to establish 'green' by-laws to regulate environmental compliance of development activities within the municipality. The authority to fine could give the environmental department of a municipality considerable weight in regulating unlawful activities as well as create disincentives for unlawful activities. To date there is limited information on how to establish such 'green' by-laws.

7.3 Establishing a Wetland Monitoring Programme

The municipality will need to appoint a wetland assessment practitioner to develop a municipal wetland monitoring programme. This programme should align with and ideally feed into the National Wetland Monitoring Programme (NWMP) for the country, which is in the process of being established. The reader is referred to: ***The Design of a National Wetland Monitoring Programme Implementation Manual, Volume 2 – WRC Report No. 2269/2/16*** (Sustento Development Services, 2016) – http://www.dwa.gov.za/iwqs/rhp/wetlands/documents/Wilkinson_2016_The_Design_of_a_National_Wetland_Monitoring_Programme_Implementation_Manual_Volume_2.pdf.

Box 45: National Wetland Monitoring Programme[137]

The NWA provides a mandate to the DWS to monitor the use of water resources and the health of aquatic ecosystems, including wetlands. To address this mandate, DWS has established the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP), which currently focusses on reporting the State of South African Rivers, through the River Health Programme (RHP), and estuaries, through

[137] Sustento Development Services, 2016

the Estuaries Monitoring Programme. For the NAEHMP to be able to report on the health of wetlands, a separate programme is required. The NWMP focusses specifically on this need.

The NWMP is based on a three-tiered hierarchical framework that allows assessment and monitoring of wetland at different spatial scales. The three Tiers of the framework are:

- **Tier 1: National level desktop assessment** – Use existing spatial datasets. The purpose of Tier 1 is to (i) report on the National indicators and (ii) provide information and data to prioritise wetlands for rapid assessment in Tier 2.
- **Tier 2: Rapid assessment of prioritised wetlands** – Undertake rapid field assessments. The purpose of Tier 2 is to (i) ensure that over time, an increasing extent of wetlands have undergone a rapid assessment, (ii) verify the desktop information provided from Tier 1 for each of the prioritised wetlands, (iii) ascertain the baseline for the Tier 2 indicators for each wetland, (iv) prioritize a sub-set of the wetlands for monitoring in Tier 3.
- **Tier 3: Detailed monitoring of a proportion of Tier 2 wetlands** – The purpose of Tier 3 is to (i) ensure over time, prioritised monitoring wetlands have been identified and on-going wetland specific monitoring of indicators are being carried out, (ii) build on existing information and monitoring, efforts to develop a core set of national biological indicators and indices for use throughout wetlands of South Africa, and (iii) contribute to research and knowledge of the links between the wetland indicators/indices and the state of the wetland.

Objectives:

In line with the NWMP, the objectives of the municipal wetland monitoring programme should be to:

- meet international wetland reporting and monitoring obligations (i.e. Ramsar requirements);
- meet national wetland legislative monitoring and reporting obligations, as mandated;
- assess, monitor and report on the general condition and functioning of wetlands (i.e. "state of the wetlands");
- monitor the provision of ecosystem services by wetlands;
- support the estimation of changes in the socio-economic value of wetlands;
- provide data to support timeous intervention or corrective action with regard to threatened wetlands; and
- to guide and inform future wetland conservation and rehabilitation initiatives.

Refining the NWMP Approach:

The 3-tier approach proposed as part of the NWMP should be adhered to in the development of the municipal wetland monitoring programme with the following refinements:

- The extent of wetlands for Tier 1 should be informed by the municipal wetland map generated part of the base wetland inventory. The NWI map is too coarse for the purposes of a municipal monitoring programme.
- The wetland importance and priotisation assessments of Tiers 1 and 2 should be informed by the assessments already undertaken as part of the development of the baseline wetland inventory,

municipal catchment management strategies (CMSs) and/or systematic conservation plans / assessments (SCPs / SCAs), if they are of finer detail.

- The selection of the wetlands to monitor as part of Tier 3 should include but not be limited to key reference or near-reference sites. Other priority wetlands to monitor include:
  - key functional priorities that contribute to water resource management, climate resilience and/or disaster / risk management,
  - key wetland priorities undergoing rehabilitation in an effort to improve wetland resource sustainability; and
  - regionally and/or locally unique wetlands.

Tier 3 Monitoring Protocols:

All Tier 3 wetlands should monitored every three to five years, depending on financial resources and the degree of variability in the data from each field visit. In the NWMP guidelines, the approach for Tier 3 monitoring is outlined and monitoring protocols provided. An outline of the key aspects to monitor is provided as follows:

- The eight Tier 2 indicators should be re-evaluated on each occasion. For these re-assessments, a Level 2 Wet-Health Assessment (Macfarlane et al., 2008) should be conducted for the Present Hydrological, Geomorphological and Vegetation State criteria to refine the findings of the Level 1 assessments performed on Tier 2 wetlands.
  - Ecosystem services
  - Water quality
  - Alien invasive plants
  - Aquatic invertebrates
  - Diatoms
  - Amphibians
  - Water birds
  - Water quality
  - Fish

For municipal scale monitoring, the Tier 3 monitoring approach and protocols should be adhered to with the following refinements:

- Monitoring programmes will need to be tailored to the particular aspects of importance of the wetlands being monitored. In this case distinct monitoring programmes should be developed for the following priority wetlands:
  - Wetlands that are important in terms of biodiversity maintenance (rare, unique, diverse) and that are in good condition.
  - Wetlands that are important in terms of the provision of regulating services that support water resource management objectives.
  - Wetlands that are important in terms of the provision of regulating services that support climate resilience, disaster management and risk management objectives.
  - Wetlands that are important in terms of the provision of provisioning and/or cultural services that communities rely on to meet their economic and/or social needs.

- For the monitoring of ecosystem regulating ecosystem services, the Level 2 WET-EcoServices assessment tool[138] should be ultilised rather than the method proposed in the guidelines.
- The need to assess aquatic invertebrates, diatoms, amphibians, water birds and fish is not always relevant or applicable and the need for such assessments should be well-substantiated.

[138] Kotze et al., 2009

8. MAINSTREAMING WETLAND MANAGEMENT INTO MUNICIPAL DEVELOPMENT AND LAND USE PLANNING

This section provides guidance on how best to incorporate wetland management objectives into municipal planning, namely the Integrated Development Plan (IDP), Spatial Development Framework (SDF) and Land Use Scheme (LUS), which together set the context for social and economic development in the municipality. This section focuses on ensuring that wetland management is entrenched in development planning through bridging the gap between social needs and wetland service provision and identifying available wetland management mainstreaming planning tools and key wetland management related programmes and projects.

8.1 Planning Policy Context

Before providing guidance on developing a method to incorporate wetland management objectives into the municipal IDP and SDF, it is important to understand the broader municipal development planning and policy context. A number of frameworks guide municipal planning and development at the national, provincial and municipal level. They are detailed in **Figure 44**.

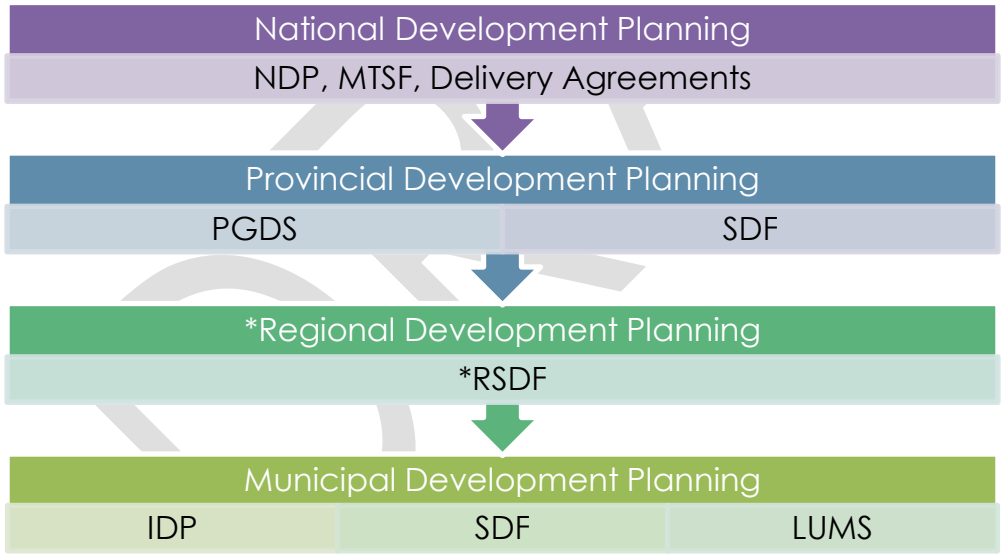

Figure 44 Broad development planning context of the municipality (*optional).

National Development Plan (NDP)

The overarching development framework for the country is set by the National Development Plan (NDP) 2030. The NDP is a broad strategic framework for development that aims to eliminate income poverty and reduce inequality by 2030. The NDP recognises the importance of natural resources and the need to protect the environment whilst benefiting from mineral resources. In particular the principles of sustainability and resilience to climate change are highlighted as broad priorities.

Medium Term Strategic Framework (MTSF) – Outcome 10: protect and enhance our environmental assets and natural resources

The Medium Term Strategic Framework (MTSF) is a framework that provides prioritisation for the government's programme of work in a particular electoral mandate in line with the NDP priorities and is a key input in determining national budget allocations[153]. The MTSF for the period of 2014-2019 provides a framework for implementing South Africa's transition to an environmentally sustainable, climate change resilient, low-carbon economy[153]. The Government's main priorities for the period are reflected in final budget allocation priorities and phasing of the implementation of the delivery agreements[139].

Provincial Growth and Development Strategy (PGDS)

The PGDS provides an overall framework and plan for developing the economy and improving services in the province. The PGDS is not mandatory but nonetheless provides a collaborative framework to drive implementation within a province[140].

Provincial Spatial Development Framework (PSDF)

The PSDF is a mandatory planning instrument mandated by SPLUMA (No. 16 of 2013) to establish a cooperative governance framework for spatial planning and land use management within its area of jurisdiction[82]. Relevant to wetland protection, the PSDF should delineate the intended pattern of land use development including identification of areas where development is not appropriate or should be limited (SPLUMA No. 16 of 2013, 16(b)). Please refer to the SDF Guidelines[154] for further guidance on PSDFs that can be downloaded from:
http://www.ruraldevelopment.gov.za/phocadownload/spatial_Planning_Information/SDFG_Final%20Draft.pdf

Regional Spatial Development Framework

In contrast to PSDFs and MSDFs, it is important to note that a RSDF is a discretionary planning instrument that extends beyond jurisdictional boundaries and encompasses functional inter and intra-provincial spatial regions. Regional SDFs are thus only prepared for specific purposes and in response to unique circumstances that manifest across administrative boundaries[82]. Relevant to wetland protection, the RSDF should *"indicate desired patterns of land use in the area and provide basic guidelines for spatial planning, land development and land use management"* (SPLUMA). Please refer to the SDF Guidelines[154] for further guidance on RSDFs.

Integrated Development Plan (IDP)

Every municipality is required to produce an IDP (as per the MSA) that is intended to be the principal strategic planning instrument which guides planning and development, and informs budgeting and management decisions in local authorities over a five-year period[141]. The IDP seeks to integrate sectoral strategies in order to achieve the optimal allocation of scarce resources between sectors and

[139] SANBI, 2014
[140] DRDLR, 2014
[141] Sowman & Brown, 2006

geographic areas, and across the population, in a manner that promotes sustainable growth, equity and empowerment of the poor and marginalised[156].

Municipal Spatial Development Framework

The MSDF is a framework that seeks to influence the overall spatial distribution of current and future land use within a municipality in order to give effect to the vision, goals and objectives of the municipal IDP, and therefore is an integral part of the IDP. However, the SDF has a longer time horizon than an IDP and therefore the SDF should provide the long-term spatial context for the IDP and spatial strategy for the municipality[142]. Please refer to the SDF guidelines[156] for further guidance on MSDFs.

Land Use Management System (LUMS)

The LUMS defines the processes for land development and how land is used. It is a tool used to implement the strategic plans mentioned above. This includes various legal and regulatory mechanisms used to direct land use and land development[156]. Wetland protection can be promoted through the regulations stipulated within the LUMS by setting appropriate rules to avoid undesirable effects of incompatible land uses and promoting compatible land uses adjacent to wetlands.

8.2 Key Mainstreaming Planning Tools

Effective mainstreaming of wetland management objectives into municipal development and land use planning requires that:

(i) the location, extent and importance of wetlands be identified and included in all sectoral planning that affects wetlands,
(ii) that wetland spatial priorities, management strategies and management interventions / actions be systematically identified and well-substantiated, and
(iii) that this information be packaged in a way that allows for effective input into the IDP, SDF and LUMS.

Wetland baseline assessment and prioritization tools:

Firstly, baseline information on the location, extent, condition and importance of wetlands is required. Such information is best packaged as part of the development of a municipal wetland inventory (MWI). Guidelines for the development of a MWI are provided in **Section 4.1**. A MWI is an important tool in establishing the baseline picture of wetlands within the municipality and identifying important wetlands and wetlands that require rehabilitation and management intervention. MWI importance assessments can be supplemented with a formal wetland prioritization assessment (WPA) (See **Section 4.2**) and a systematic conservation assessment (SCA) that provides a more rigorous and systematic approach to identifying municipal wetland priorities. These assessments are critical starting points for mainstreaming however, the baseline wetland information generated by this process lacks strategic and integrated wetland management planning and cross-sectoral integration that are required for effective

[142] DRDLR, 2014

incorporation into IDPs, SDFs and LUSs. Ultimately, the purpose of the MWI, WPA and SCA is to provide baseline information for input into key sectoral and multi-sectoral / integrated plans. Descriptions of the purpose of these baseline assessment / prioritization tools and their potential role in mainstreaming wetland management are provided in **Table 14**.

Planning tools:

The effective incorporation of the findings of the municipal wetland inventory and prioritization exercises into the varied internal (inter-departmental / sectoral) and overarching (IDP, SDF & LUS) planning processes of the municipality is arguably the most important task in achieving sustainable wetland management. In this endeavor, there are a number of environmental planning tools that can assist municipal officials and departments in packaging and mainstreaming wetland management information into the municipal IDP, SDF and LUS, as shown in **Figure 45**. This list includes a combination of tools that can be authored by the municipality if there is sufficient in-house capacity (commissioned projects) and tools that are authored by other government departments or organisations (e.g. provincial government, SANBI, etc.) with or without the help of private specialist consultants. **Ultimately, it is recommended that all wetland information and strategies be incorporated into a single environmental sector plan** that includes an Integrated Environmental Management Plan (IEMP) for packaging information for inclusion in the IDP (e.g. strategies, plans and programmes) and an Environmental Management Framework (EMF) for packaging the wetland spatial priorities and strategies into a single wetland priority layer including land use guidelines. The planning tools (**Table 14**) are described in terms of their role in mainstreaming wetland management.

Figure 45 Key planning tools to assist in wetland management mainstreaming.

It is important to note that it is unlikely and often unnecessary for a municipality to develop all the planning tools noted in **Table 14**. Rather **a municipality would typically choose the most appropriate tools for its environmental and municipal contexts, depending on available resources**. For example, a well-resourced large metropolitan area located in a biodiversity hotspot would likely use most of these tools, whereas a smaller municipality with fewer resources in an area characterized mainly by 'least concern' or 'not threatened' areas is likely to refer to the wetland prioritization tools and develop a SoE Report or IEMP/EMF to substantiate IDP and SDF goals. It is also important to note that the 'take-up' and use of some of the listed integrated planning tools by municipalities has been limited to date, particularly catchment management strategies (CMSs) and integrated water resource management plans (IWRMPs). The development and implementations of these planning tools is still in its infancy and thus the best approaches and methods still need to be tested and verified.

Table 14. Summary of key prioritization tools to assist wetland management mainstreaming (for more info refer to Section 4.2).

PRIORITIZATION TOOLS			
	Mainstreaming Tools	**Purpose**	**Mainstreaming Benefits**
1	**Baseline wetland inventory and wetland prioritization**	The purpose of the wetland inventory is to map the extent, state and importance of wetlands within a municipality so as to inform all wetland management and water resource management related conservation and management plans and assessments, and urban open space systems e.g. SCP / SCA, CMS and wetland rehabilitation planning. It is not a legal requirement. This should be initiated by the municipal environmental planning / management department. Please refer to Section 4 for guidance on establishing a wetland inventory and undertaking wetland prioritization.	• This layer of information forms the foundation for all wetland management planning in the municipality. • If sufficiently detailed and of fine resolution, this tool can form the basis of wetland biodiversity planning (SCP / SCA, BSP, BP), catchment management planning, SEAs, SoE Reports, and the Environmental Sector Plans – IEMP and EMF. • This tool can form the basis of programmes and projects related to wetland management for the municipality. • The tool is less costly than undertaking a SCP / SCA, and focusses on all dimensions of wetlands, not just biodiversity. • In under resourced municipalities, the information generated by this tool can be packaged to form the basis of all inputs into the IDP and SDF.
2	**Systematic Conservation Plan (SCP) / Systematic Conservation Assessment (SCA)**	SCP / SCA is a spatial plan that identifies CBAs and ESAs using the principles and methods of systematic biodiversity planning[143] (see Box 46). This should be initiated by the municipal environmental planning / management department.	• SCPs / SCAs provide a systematic and defensible framework for identifying important wetland resources from a biodiversity conservation perspective. However, the importance of wetlands in terms of functional / ecological infrastructure aspects cannot be fully assessed and integrated with this tool. There is some scope to include wetlands of functional importance as ESAs only. • Fine scale plans can provide detailed information on the wetland areas that need to be conserved in order to meet ecosystems or vegetation type conservation targets. • The development of SCPs / SCAs is costly and time consuming, and may not be an efficient use of resources in the short term in certain less developed municipal contexts. Nevertheless, in the long term, SCPs / SCAs should be developed to inform BSPs and BPs. • SCP/SCA for your area may be obtained from the **BGIS website**. - http://bgis.sanbi.org/

[143] SANBI, 2016

Table 15. Summary of key planning tools to assist wetland management mainstreaming.

PLANNING TOOLS			
	Mainstreaming Tools	**Purpose**	**Mainstreaming Benefits**
1	**State of the Environment (SoE) Reporting**	• A State of the Environment Report (SoER) is a description and discussion of the condition of the environment. It provides information to inform decisions for sustainable management, and measures the impact of these decisions on the environment[158]. • It is important to recognize that the SoE Report is not an end in itself. It is part of a broader process aimed at achieving sustainable resource management, through providing accurate and relevant information to the correct target audience, and influencing decisions through effective communication[158]. • SoE reporting is often incorporated into EMF, IEMP, SEA or BSP / BP. • The 'PSIR' (Pressure, State, Impact, Response) framework is commonly used in South Africa for SoE reporting[158] (**Box 47**). • This should be initiated by the municipal environmental planning / management department. Please refer to the State of the Environment Reporting Guidelines for municipalities (DEAT, 2005)[158]: http://soer.deat.gov.za/dm_documents/Annexure_34_Local_Authority_SoE_Guideline_Final_93JOQ.pdf	• SoE Reporting can be used as a tool to consolidate all available wetland conservation plans and assessments in a systematic manner for inclusion in the environmental sector plan (i.e. IEMP & EMF), which is the key environmental sector input into the IDP. • For less-developed and under resourced municipalities, SoE reporting may be a useful tool to package baseline wetland information for inclusion in the IDP process, rather than undertaking more costly environmental sector plans like IEMPs and EMFs. • The SoE team can identify the needs of IDP managers (e.g. community consultation, cross-sectoral analysis) and look for ways of making a helpful synergistic contribution[144]. • SoE Reporting assists in raising awareness of principles of sustainable development across all sectors and up through the hierarchical tiers of government[158]. • SoE reporting provides and distributes some of the information needed to meet NEMA requirements related to the dissemination of information on the state of the environment. • The SoE reporting provides recommendations that can be translated into substantiated projects or into concrete, documented improvements to the plans of other sector departments.
2	**Biodiversity Sector Plan (BSP)**	• BSPs map the location and spatial extent of CBAs and ESAs within a region in order to inform land use planning. • BSPs provide the spatial framework and policy recommendations for the drafting of a bioregional plan by identifying priority areas for conservation action and the establishment of Protected Areas, as required in terms of Chapter 3 of the NEMBA[145]. • BSPs serve as the primary source of information on biodiversity for land and resource use decision-making	• BSPs provide a systematic and defensible framework for identifying important wetland resources from a biodiversity conservation perspective. This is typically based on the SCP / SCA. • BSPs provide policy guidelines related to wetland management to help planners identify appropriate development zones, the controls for these designated areas, provide an indication of appropriate land-use within each area, and provide compatible and incompatible land uses. • BSPs package information in a way that facilitates the

[144] DEAT, 2005

[145] Maree & Fromans, 2010

PLANNING TOOLS			
	Mainstreaming Tools	**Purpose**	**Mainstreaming Benefits**
		and forward planning processes, such as EMFs, SDFs) and IDPs[146]. • This should be initiated by the municipal environmental planning / management department, and can be supported by the parks department. For an example see the Biodiversity Sector Plan for the Saldanha Bay, Bergrivier, Cederberg and Matzikama Municipalities: http://www.fewlbnexus.uct.ac.za/sites/default/files/image_tool/images/91/BIODIVERSITY%20SECTOR%20PLAN%20WEST%20COAST.pdf	integration and mainstreaming of biodiversity priorities into spatial planning and can assist in integrating important wetland areas into a municipal SDF as well as recommending wetland management interventions. • It is important to note that the development of BSPs is costly and time consuming, and may not be an efficient use of resources in the short term in certain less developed municipal contexts. Nevertheless, in the long term, BSPs should be developed to inform bioregional plans. • BSPs for your area may be obtained via the BGIS website.
3	**Bioregional Plan (BP)**	• Like BSPs, BPs map the location and spatial extent of CBAs and ESAs within a region and provide land use guidelines for these priority areas. BSPs are the precursor to the BPs. • BPs are a legislative requirement under NEM:BA and once published, municipalities are legally required to consider them during spatial planning. • This should be initiated by the municipal environmental planning / management department, and can be supported by the parks department. For examples see the Nelson Mandela Bay Municipality Bioregional Plan: http://www.nelsonmandelabay.gov.za/datarepository/documents/Atvli_400919-3%20NMBM%20Final%20Bioregional%20Plan%20-%2013November2014.pdf, and the Mopani District Municipality Bioregional Plan: http://www.nuleafsa.co.za/wp-content/uploads/2016/02/Mopani-Bioregional-Plan_SANBI.pdf	• BPs provide a systematic and defensible framework for identifying important wetland resources from a biodiversity conservation perspective. • BPs provide guidelines related to wetland management to help planners identify appropriate development zones, the controls for these designated areas, provide an indication of appropriate land-use within each area, and provide compatible and incompatible land uses. This provides a substantiated framework for the inclusion of wetland management objectives into the IDP. • Being a legislative requirement under NEM:BA, CBAs and ESAs are given considerable weight in spatial planning through the establishment of land use guidelines. • BSPs package information in a way that facilitates the integration and mainstreaming of biodiversity priorities into spatial planning and can assist in integrating important wetland areas into a municipal SDF as well as recommending wetland management interventions.

[146] Maree & Fromans, 2010

PLANNING TOOLS			
	Mainstreaming Tools	**Purpose**	**Mainstreaming Benefits**
			• It is important to note that the development of BSPs is costly and time consuming, and may not be an efficient use of resources in the short term in certain less developed municipal contexts. Nevertheless, in the long term, BSPs should be developed to inform bioregional plans. • BSPs for your area may be obtained via the BGIS website: http://bgis.sanbi.org/
4	**Strategic Environmental Assessment (SEA)**	• This is a planning tool for the assessment of the environmental impacts of policies, plans, programmes and projects that can be undertaken at the SDF or IDP planning stage. In so doing it is essentially a mainstreaming tool to include environmental aspects in such plans. • In terms of the Local Government: Municipal Planning and Performance Management Regulations 21 (published in terms of section 120 of the Municipal Systems Act), SDFs should include a SEA which must be aligned with those of neighbouring municipalities. • A municipal SEA identifies areas where particular development types can occur and "red-flags" or cautions against development in sensitive areas. In so doing SEAs can provide a framework with which to assess the opportunities and constraints related to the competing agendas of wetland management and social and economic development. • This should be initiated by the municipal environmental planning / management department with support from the town / spatial planning and economic planning departments. For additional information see the DEAT SEA guidelines: https://www.environment.gov.za/sites/default/files/docs/series10_strategic_environmental_assessment.pdf, and the Knysna Municipality SEA: http://www.knysna.gov.za/downloads/isdf/ISDF_DraftStrategicEnvironmentalAssessment-0416.pdf	• SEA provides an integrated and defensible sustainability-based assessment of the impacts of existing and future development and spatial plans on wetlands and their ecosystem services. The ability of SEA to achieve this is substantially improved if informed by fine resolution and comprehensive assessments like CMSs, BPs, BSPs and SCPs / SCAs. • The assessment of sustainability allows for the substantiation and prioritisation of wetland management interventions and land use decisions and controls with significant implications for wetland management. • If there is poor quality or coarse resolution information on wetlands in the municipality, the SEA can be used as a vehicle to develop and/or refine the municipal wetland inventory to better inform the IDP process and municipal conservation planning. The level of detailed required for data capture will vary from 1:1000 – 1:5000 scale. • SEA can also be a vehicle to substantiate the need for and initiate municipal catchment management strategies, which are critical in municipal water resource and risk management planning, particularly for urban areas. • It is important to note that the development of SEAs is costly and time consuming, and may not be an efficient use of resources in the short term in certain less developed municipal contexts.

PLANNING TOOLS			
	Mainstreaming Tools	**Purpose**	**Mainstreaming Benefits**
5	**Catchment Management Strategy (CMS)**	• Integrated catchment management deals with the management of municipal 'drainage systems'[147]. The drainage system comprises a complex mix of constructed / built infrastructure (underground pipes and culverts, lined and unlined canals, etc.) and "natural" features (springs, rivers, wetlands, etc.) with diverse functions (stormwater management, recreation, nature and biodiversity conservation, wastewater effluent conveyance, water supply, etc.)[161]. • The purpose of integrated catchment management for urban drainage systems is to: (i) reduce the risks of floods to public health, public safety and property; (ii) reduce the risks of water pollution to public health; (iii) minimize the impacts to, and improve the state of, aquatic ecosystems (rivers, wetlands and estuaries); and capitalize on the recreational and amenity value of drainage systems in order to improve urban living enviromemnts[161]. • Catchment management therefore requires a multi-sectoral approach to management dependent on the cooperation of various service delivery units within the municipality to achieve desired outcomes e.g. stormwater management, disaster management, water services, sanitation services, environmental management, roads, solid waste management, parks and recreation, urban / spatial and economic planning, health and housing [161]. • The catchment management process addresses the needs of a catchment in terms of both land and water uses, and their optimization[148]. The protection of the quantity and quality of water available for supply purposes is the primary objective when considering catchments on a regional scale, which is the	• Wetlands form key components of a municipality's sustainable drainage system because they support the objectives of catchment management i.e. flood attenuation, water quality enhancement, etc. Thus, the development of a CMS will most likely involve the consolidation and packaging of key wetland information and the inclusion of wetland management and rehabilitation in the strategies, plans and programmes of the CMS. • A municipal CMS provides an integrated and defensible sustainability based framework within which wetland resources will be one of the key components for a healthy or functional urban hydrological system. Therefore a CMS will be an important vehicle for identifying and assessing important wetland resources, as well as classifying and setting the levels of wetland resource use and the management interventions required to ensure the objectives of biodiversity conservation, water resource management and disaster / climate resilience management are achieved in the long-term. Thus, CMS provides substantial weight and substantiation to the inclusion of wetland resource priorities in the IDP and SDF. • A benefit of municipal CMSs, like the one undertaken by the City of Cape Town[161], is that it can be tailored to feed directly into the development of the IEMP and IDP i.e., the direct translation of strategic focal areas, plans and programmes of the CMS into the IDP. • CMSs developed by municipalities can provide well-substantiated and more rigorous input into broader WMA CMSs developed by CMAs, which would assist CMAs in achieving their objectives. • CMSs are also critical in planning development control and in particular setting long-term "catchment recovery" goals that anticipate a vision for water resource protection and healthy urban river systems. • An integrated municipal CMS will be key to planning

[147] City of Cape Town, 2002
[148] Obree, 2004

PLANNING TOOLS			
	Mainstreaming Tools	**Purpose**	**Mainstreaming Benefits**
		responsibility of the DWS and CMAs[162]. However, in the case of smaller urban catchments, catchment management focuses on minimizing and addressing the impacts of urbanization on the natural drainage systems, to provide drainage and prevent flooding (due to increased runoff), prevent pollution (to avoid health risks and maintain ecological functioning) and to protect river and wetland corridors (as important natural features providing various benefits to society)[149]. • Municipalities can initiate and undertake their own CMSs in key strategic or priority catchments within their jurisdictions, and can partner with neighboring municipalities where such catchments overlap. Municipalities should also be supported by the DWS and/or relevant CMA in this regard, especially where such catchments are of regional or national importance in terms of water resource management. • It is important to note however, that limited municipal CMSs have been implemented across the country and take-up of this tool has been limited to date. The concept of urban catchment management is relatively new and is still being translated from abstract concept into practical action[150]. • Therefore they may not be available in the short term but they should be encouraged for effective wetland management. CMSs are not a legal requirement at present. • The planning for and implementation of catchment management requires effective inter-departmental cooperative governance, and in some cases the support of the DWS. • The development of the CMS should be initiated by either the environmental planning / management	sustainable drainage measures and Green Infrastructure, both of which will incorporate wetland systems. • It is important to note that the development of CMSs is costly and time consuming, and may not be an efficient use of resources in the short term in certain less developed municipal contexts. Nevertheless, in the long term, CMSs should be developed to inform the various sectoral objectives.

[149] Obree, 2004
[150] City of Cape Town, 2002

PLANNING TOOLS			
	Mainstreaming Tools	**Purpose**	**Mainstreaming Benefits**
		department or stormwater management department. However, the strategy will need to be developed in conjunction with disaster management, water services, sanitation services, solid waste management, parks and recreation, urban / spatial and economic planning, health and housing. For some guidance please refer to the City of Cape Town Catchment, Stormwater and River Management Strategy 2002 – 2007: http://resource.capetown.gov.za/documentcentre/Documents/Bylaws%20and%20policies/Catchment%20Stormwater%20and%20River%20Management%20Strategy%20Final%20Draft%20Policy%20-%20approved%20on%2031%20July%202002.pdf	
6	**Municipal Integrated Water Resource Management Plan (IWRMP)**	• IWRMP is a plan aimed at dealing with the socio-economic, technical, financial, institutional, political and environmental issues as they pertain to management of the water resource at a local level[151]. • The intention of the IWRMP is to provide an all-encompassing 'Water Management Plan' that serves either as a standalone report or as a supplement to the Water Services Development Plan (WSDP) and Integrated Waste Management Plan (IWMP)[152]. An IWRMP should then complement the WSDP and IWMP but without duplicating the information in either plan[166]. • The plan also serves as a framework to ensure efficient, appropriate, affordable, economical and sustainable use and development of water resources by local government and includes the management of wastes that have the potential to impact on the water resource[153]. • The IWRMP has the potential to set the management	• The aim of IWRMPs is to achieve improved water resource management and water resource sustainability. This typically requires improved wetland management and as such improved wetland management should form part of all IWRMPs. • IWRMPs can provide a systematic process to prioritize municipal wetlands in terms of supporting water resource management, can facilitate the integration of best management practices into various sectors at various scales of the municipality that affect water resources, and can provide substantiation for wetland management interventions that would support and/or improve water resource quality. Thus, IWRMPs can be a key tool in mainstreaming wetlands where IWRMPs are integrated into IDPs and municipal CMSs. • The development of an IWRMP and the implementation of IWRM cannot be done in isolation. These tasks require effective inter-departmental cooperation and must be

[151] Burke 2007
[152] DWAF, 2007
[153] Haig et al., 2008

PLANNING TOOLS			
	Mainstreaming Tools	**Purpose**	**Mainstreaming Benefits**
		and regulatory framework for different catchments and water resources to inform all water use planning and regulation, and assist the municipality in aligning its water management functions with broader CMSs of the relevant WMAs developed by the regional CMAs[168]. • In instances where a CMA has not been established or where a regional CMS has not yet been developed, it is envisaged that the IWRMP will provide valuable input into the development of the regional CMS and/or municipal CMSs[168]. • For the smaller municipalities that are not WSAs and therefore do not require to develop a WSDP, the IWRMP can serve as a tool for these municipalities to better manage water resources within their area of jurisdiction in conjunction with the CMA if established[168]. • While the IWRMP encapsulates the strategic objectives and related roles and responsibilities directed towards sustainable (social, economic and environmental) development, IWRM is not a legal requirement and is likely to retain its low profile among municipal managers and officials until such time as it is a funded municipal mandate, which will require a change in legislation[168]. • This should be initiated by the municipal environmental planning / management department in conjunction with water and sanitation, stormwater management, town / spatial planning and economic planning departments. Please refer to the Integrated Water Resource Management Plan (IWRMP) Guidelines[154]: http://www.pacificwater.org/userfiles/file/IWRM%20Planning%20Guidelines%20for%20Local%20Authorities.pdf	undertaken in conjunction with other municipalities within the WMA or catchment, the relevant CMAs, and the DWS. Thus IWRMPs can facilitate improved co-operative governance that is acknowledged as necessary to achieve effective water resource management and by association wetland management. Such integrated planning could have a number of wetland management benefits where wetlands are affected by activities initiated and operated at different governmental levels outside of the municipality's responsibilities. • In particular, IWRMPs can play an important role in facilitating the integration of municipal water and sanitation objectives into water resource planning with other municipal departments, and ultimately facilitate the inclusion of water resource and wetland management objectives and best management practices onto water and sanitation planning operations.

[154] DWAF, 2007

PLANNING TOOLS			
	Mainstreaming Tools	**Purpose**	**Mainstreaming Benefits**
7	**Integrated Environmental Management Plan (IEMP) (or Environmental Sector Plan)**	• Has also been referred to as an Integrated Municipal Environmental Programme (IMEP). • An IEMP is a strategic document that translates national and regional environmental policy and plan directives and local environmental priorities into a plan of action to achieve environmental protection and management that supports the municipality's sustainable development objectives[155]. • IEMPs are usually developed to provide municipalities with a coherent statement of environmental sustainability priorities and responsibilities, and strengthen environmental sustainability input into the municipal IDP[156]. • The IEMP and is intended to act both as an overarching policy and implementation framework at the local level[91]. • The preparation of an IEMP is not a specific statutory requirement for municipalities. • An IEMP can be considered an environmental sector plan that is best suited for packaging all strategic environmental priorities and environmental management strategies, including wetlands, for inclusion in the IDP. • The policy framework of the IEMP needs to be integrated into the Sector Plans of all relevant municipal service sectors, particularly those whose activities play a key role in wetland protection or degradation, e.g. water services, sanitation, environmental health, waste, disaster management and stormwater. • This should be initiated by the municipal environmental planning / management department. For some examples see the Tswelopele Municipality IEMP:	• IEMPs are a vehicle to consolidate and package all environmental related assessments and plans into a single environmental sector plan for incorporation into the IDP. With regards to wetlands this includes integrating information on wetland biodiversity, wetland ecosystems services in support of water resource management and disaster management, and wetland goods in support of social values. • IEMPs promote cross-sectoral integration through the consolidation of the environmental management aspects of all relevant service sector management plans into a single document e.g. integrated waste management plan, coastal zone management plan, disaster management plan, water services plan etc. • Consolidates the findings of the CMS, BSP / BP, EMF and/or SEA, as well as other service sector management plans. • Another benefit of IEMPS is that it can be tailored to feed directly into the development of the IDP i.e., the direct translation of strategic focal areas, plans and programmes of the IEMP into the IDP.

[155] SANBI, 2014
[156] Future Works, 2014

PLANNING TOOLS			
	Mainstreaming Tools	**Purpose**	**Mainstreaming Benefits**
		http://www.tswelopele.gov.za/downloads.php?do=file&id=588, the Buffalo City Metropolitan Municipality IEMP: http://www.futureworks.co.za/wp-content/uploads/2014/05/Draft-SoER-2014.pdf, and the City of Johannesburg Environmental Management Sector plan: http://mfmamirror.s3.amazonaws.com/Documents/01.%20Integrated%20Development%20Plans/2010-11/01.%20Metros/GT001%20City%20of%20Johannesburg/JHB%20Johannesburg%20-%20IDP%20-%20Chapter%208d%20-%200910.pdf	

8	**Environmental Management Framework (EMF) (Environmental Sector Plan into SDF)**	• The study of the biophysical and socio-cultural systems within a defined geographical area to reveal where specific land uses may be practiced and to offer performance standards for maintaining appropriate use of such land. • The purpose of EMF is to function as a support mechanism in the environmental impact assessment (EIA) process and inform decision making regarding land use planning applications for areas of particular interest (G.N.R. No. 806, 2012). • EMF involves the development of maps of important environmental constraints and opportunities, by depicting sensitive and non-sensitive environments within which activities listed in of the Environmental Impact Assessment (EIA) Regulations, 2017 under NEMA, may be triggered. • EMFs do not assign, control or limit existing land-use rights. • EMFs are most suited to developing land use plans for strategic development areas so that developers are given an early indication of potential developable areas and land use types before initiating an EIA. • The EMF is a tool suited to providing a land use framework for a particular area that is usually going to be subjected to intense land use pressure or consists of highly important natural resources that need to be maintained to meet water resource management and/or conservation targets. • An EMF can be considered an environmental sector plan that is best suited for packaging all strategic environmental priorities and associated land use guidelines into the SDF. • This should be initiated by the municipal environmental planning / management department. For some examples see the Stellenbosch Municipality Strategic EMF: https://www.stellenbosch.gov.za/documents/municipal-policy/planning-and-development/1782-stellenbosch-	• From a wetland management perspective, EMFs provide a vehicle for integrating spatial wetland priorities into key environmental priority layers to be included in the municipal SDF (e.g. space requirements, flood management areas, ecological corridors and green infrastructure corridors). • EMF can assist in identifying wetland opportunities and constraints, and development pressures and agendas, in a particular area. • If there is poor quality or coarse resolution on wetlands in the municipality, the EMF can be used as a vehicle to develop and/or refine the municipal wetland inventory to better inform the SDF and municipal conservation planning. The level of detailed required for data capture will vary from 1:1000 – 1:5000 scale. • It is important to note that the development of EMFs is costly and time consuming, and may not be an efficient use of resources in the short term in certain less developed municipal contexts.

PLANNING TOOLS			
	Mainstreaming Tools	**Purpose**	**Mainstreaming Benefits**
		environmental-management-framework-june-2014/file, and the Overberg Municipality Strategic EMF: https://www.overstrand.gov.za/en/documents/strategic-documents/integrated-development-framework-idf/202-overstrand-idf-towards-2050-draft-strategic-environmental-management-framework/file	

Box 46: Some important conservation planning terms[157]

- **CBA** - An area that must be maintained in a good ecological condition (natural or near-natural state) in order to meet biodiversity targets. CBAs collectively meet biodiversity targets for all ecosystem types as well as for species and ecological processes that depend on natural or near natural habitat that have not already been met in the protected area network. One of five broad categories on a CBA map, and a subset of biodiversity priority areas.
- **ESA** - An area that must be maintained in at least fair ecological condition (semi-natural/moderately modified state) in order to support the ecological functioning of a CBA or protected area, or to generate or deliver ecosystem services, or to meet remaining biodiversity targets for ecosystem types or species when it is not possible or no necessary to meet them in natural or near-natural areas. One of five broad categories on a CBA map, and a subset of biodiversity priority areas.
- **Systematic biodiversity planning** – A scientific method for identifying geographic priority areas of biodiversity importance. It involves: mapping biodiversity features (such as ecosystem, species, spatial components of ecological processes); mapping a range of information related to these biodiversity features and their ecological condition; setting quantitative biodiversity targets for biodiversity features; analysing the information using software linked to GIS and developing maps that show spatial biodiversity priorities. The configuration of priority areas is designed to be spatially efficient (i.e. to meet biodiversity targets in the smallest area possible) and to avoid conflict with other land and resource uses where possible.

Box 47: PSIR (Pressure, State, Impact, Response) framework for SoE Reporting[158]

The PSIR framework provides a systematic framework for reporting on the state of the natural environment in a defined regional study area with the purpose of understanding:

- P – the pressures (stresses, threats and agents of environmental change) exerted on ecological systems;
- S – the state / condition of ecosystems, ecological processes and natural resources / assets, and trends in that condition brought about by human or other pressures;
- I – the real or predicted secondary impacts of ecosystem and natural resource degradation; and
- R – the practical and much needed responses and actions required to improve the current situation.

Box 48: Example of the objectives of an IEMP

Purpose of the Buffalo City Metropolitan Municipality IEMP[159]:

- Articulate the BCMM's commitment to environmental protection and sustainability (through a set of aims and objectives).

[157] SANBI, 2016
[158] DEAT, 2005
[159] Future Works, 2014

- Present the Environmental Management Policy Framework of the BCMM that needs to be integrated into all municipal sectors to support the municipality's sustainable development aims.
- Present a clear implementation plan for environmental sustainability projects, programmes and partnerships that need to be developed and implemented to achieve the stated environmental sustainability aims and objectives.

8.3 Incorporating Wetland Management Objectives into the IDP

As the IDP is the primary planning document of a municipality, the inclusion of wetland management objectives into the IDP is a critical step in the effective mainstreaming of wetland management into local government planning and operations.

8.3.1 IDP Process

The Municipal Systems Act (MSA) lists two main principles to be adhered to in the process. Firstly, planning must be developmentally oriented and must support the role of local government as an agent of development[9]. Second, planning must take place within the framework of co-operative governance in that it must be aligned with the plans and strategies of national and provincial government as well as other municipalities[9]. The IDP process typically comprises five (5) sequential stages as illustrated in **Figure 46**.

Figure 46 The IDP project cycle[160].

[160] DPLG & GTZ 2001

8.3.2 Incorporating wetland management programmes and projects in the IDP

In order to effectively manage wetland ecosystems within their jurisdiction, municipalities need human and financial resources to do so. Such resources can only be motivated for through the identification and formulation of programmes and projects in the IDP process that include wetland management actions and/or actions that support wetland management, and a corresponding allocation of funds. Thus, it is the identification of well substantiated programmes and projects that is the most critical task in terms of mainstreaming wetland management into the IDP and municipal planning. **Figure 47** provides a snapshot of the strategy to mainstream wetland management objectives into the IDP.

The risk exists that the environmental sector plan is drawn up by environmental experts or in the environmental department with little cross-sectoral interaction and integration and therefore has no sufficient political weight, or is too costly. One needs to realize that the IDP is a plan that will need to be approved by Council. As explained in the introduction of this guideline, in the context of South Africa, with high socio-economic challenges, wetland management on kits own might not have high political priority. The importance of wetland management for other functions of the municipality should therefore be made clear (refer to Chapter 1 for guidance in this regard). In research on climate change adaptation and mitigation in six hundred cities all over the world[161], the ESRC found that municipalities are motivating for the implementations of strategic projects that contribute to climate resilience using one of more of the following broad arguments that have to do with (1) finances of the municipality (save money, create new economic income, create jobs), (2) security and resilience (e.g. self-sufficiency in energy and water on outskirts of cities), (3) social and environmental justice (improving access to basic services and achieving a more equitable redistribution of services and benefits). This is probably valid for wetland management projects in South Africa as well. The environmental sector plan should therefore have sufficient arguments to connect to the other parts of the IDP and, ideally, should have been developed with the input of all relevant sectors.

Furthermore, IDPs *"should not be seen as municipal plans, but rather as an expression of all of governments and its partners in the local space"*[162]. This is written down for integrated urban developments, but is as valid for rural areas. As is mentioned in various chapters and sources, wetland management is only achievable if partnerships are created with various partners in the public sector, the private sector, citizens and learning institutions. The organization of the formulation of an IDP in which stakeholders really have participated and collaborated, is the start of implementation.

While this section provides a more formal approach to integrating wetland management into IDPs, the next section gives tips and learning points on how to create good partnerships that can improve wetland management.

[161] ESRC, 2012
[162] COGTA, 2016

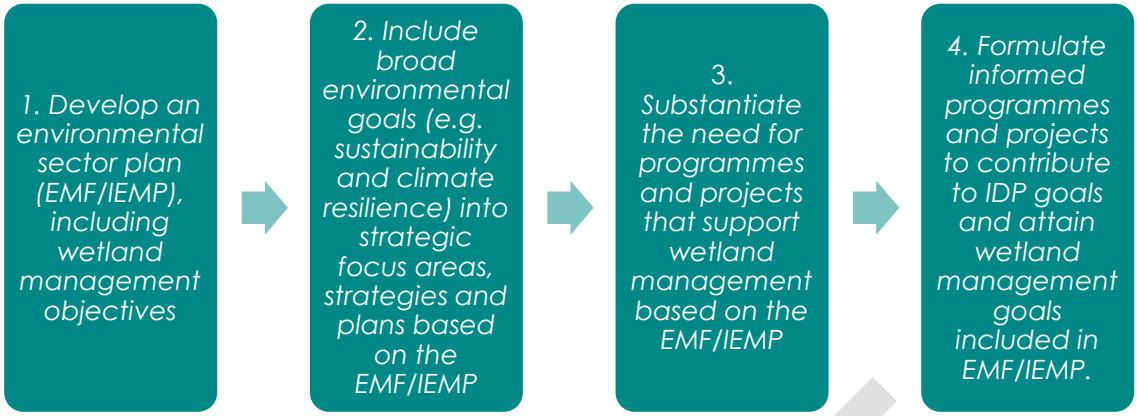

Figure 47 Key steps to mainstreaming wetland management programmes and projects.

What steps need to be taken to ensure programmes and projects that support wetland management are well formulated and accepted?

The purpose of programmes and projects is to enact local development strategies and plans of the IDP. Development strategies and plans are those required to address the priority issues identified as part of the analysis phase (**Figure 46**) and essentially frame the development plan for the municipality. 'Environmental sustainability' is typically identified as a strategic issue and priority for municipalities in line with the overarching sustainability paradigm entrenched in South African law and policy. In addition, 'climate resilience and adaptation' is increasingly becoming a strategic focus area of metropolitan IDPs. However, **it is the degree to which such issues and priorities are translated into concrete plans, programmes and projects that makes the critical difference in whether environmental management, and more specifically wetland management, is effectively mainstreamed into the IDP or not.** The key components of the IDP process into which wetland management objectives need to be incorporated is illustrated in **Figure 48** below.

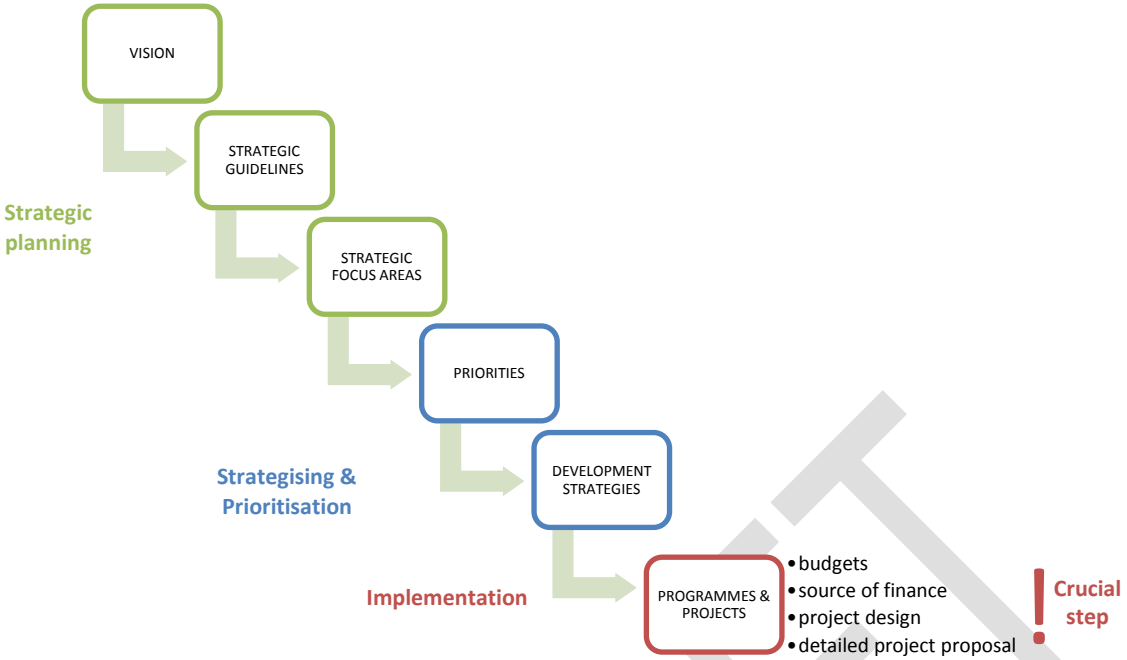

Figure 48 Key components of the IDP document structure where wetland management components need to be incorporated.

Below are the mainstreaming steps broken down in detail:

1.	***Develop an environmental sector plan (EMF/IEMP), including wetland management objectives.***
•	The preparation of an EMF/IEMP is crucial as a gateway for wetland management issues into the IDP. This is required as the IDP environmental goals are typically broad. Detailed wetland management analysis and recommendations should therefore form part of the EMF/IEMP.
•	This tool should be used to consolidate and integrate all information on municipal wetland management across all sectoral functions and responsibilities. In particular, this tool can be used to consolidate the findings of the BSP / BP, EMF, SEA, CMS and IWRMP, as well as other sectoral management plans like WSDPs, IWMPs, coastal zone management plans (CZMPs) and disaster management plans. In so doing, this is one of the few tools that can encourage the formulation of integrated wetland management strategies and strengthen the environmental sustainability input into the municipal IDP.

2.	***Include 'environmental sustainability' and 'climate resilience' in strategic focus areas, strategies and plans***
How is this achieved?	
•	Provide formal input into IDP process and get key environmental goals (e.g. 'environmental sustainability' and 'climate resilience') on the agenda. This is critical because the motivation for programmes and projects and associated budgets depend on whether they contribute to achieving the strategies and plans of the IDP. The inclusion of such themes and objectives are already evident in most municipal IDPs but the degree to which these objectives become

integrated into the planning of other key sectors and/or become concrete development strategies and plans with defined budgets varies. In this regard it is important that the baseline data from the MWI, in particular wetland priorities and wetland areas under significant threat, is integrated into the situation analysis and strategic issue / focus area identification steps of the IDP.

- Engage with and encourage other key sectoral departments such as economic and town planning, stormwater management, disaster management, water and sanitation services, parks and recreation and environmental health departments to motivate for the inclusion environmental goals into the IDP, as these goals affect their strategies and operational budgets as well. Ideally this should be achieved by including these departments in the IEMP development process, as well as the development of CMS and/or IWRMP, which both require cross-sectoral cooperation.
- Putting these themes on the IDP strategy agenda will act as 'gateways' for the development and acceptance of programmes and projects that support wetland management. This process should be supported through the use of available wetland prioritization tools and wetland planning tools.
- In this regard, the IEMP or SoE Reporting represents important consolidated and substantiated inputs into the IDP process. Such documents should provide the necessary situational / contextual information for the analysis phase (**Figure 48**) that will highlight environmental concerns as strategic priorities in the IDP process.

3. Substantiate the need for programmes and projects that support wetland management

How is this achieved?

- Provide the IDP team with background information from reputable sources (RAMSAR, TEEB, UN, World Bank, etc.) supporting the economic, environmental and social rationale for supporting wetland management. For example, see the TEEB water and wetlands report (http://doc.teebweb.org/wp-content/uploads/2013/04/TEEB_WaterWetlands_Report_2013.pdf). This information should make a strong triple bottom line business case as a basis for lobbying for resources. This should be championed by the environmental management department, or those given the responsibility for environmental management.
- Substantiate local need for programmes and projects with quality baseline wetland information for the municipality as well as the analysis of this information in terms of different management objectives like biodiversity conservation (environmental management, parks), water resource management (environmental management, water & sanitation, stormwater, health / pollution control, town planning, economic / infrastructure planning), disaster risk management (stormwater, town planning, economic / infrastructure planning), etc. Substantiation of need is important for assisting the IDP committee in making a decision to approve such programmes, projects and associated budget allocations, and ensuring that such programmes and projects contribute to improved wetland management ultimately address the priority issues.
- Available wetland management information should be packaged in a format that is compatible with the IDP. Key planning tools to assist in the effective substantiation and formulation of strategies, programmes and projects include the environmental sector plan (EMF or IEMP), BSP / BP, CMS and IWRMP. In the absence of the above plans and strategies, the wetland prioritization

assessment and SCP / SCA in conjunction with the development of a Local Wetland Strategy and Action Plan (LWSAP) should be used to substantiate the selection and development of programmes and projects related to wetland management. The WSAP guidelines can be downloaded from: http://cbc.iclei.org/wp-content/uploads/2017/02/WSAP-Guidelines.docx.

- Poor quality or coarse information will limit the strength of motivations for programmes and projects, and possibly limit the effectiveness of the interventions. This may result in either their rejection by the IDP committee or ineffectiveness at meeting both wetland management and strategic planning objectives.
- Ideally, the development of programmes and projects should be undertaken as part of a structured process (i.e. the formulation of the IEMP) and all of the above-mentioned sectoral departments should be included in the process so that there is buy-in for the strategies, plans and programmes of the IEMP, such that these plans will influence planning within the key sectors that matter.

Some examples of the programmes and projects included in IDPs that support wetland management is shown in **Box 49** below.

Box 49: Some examples of programmes and projects that support wetland management included in municipal IDPs

Municipality	Programmes	Projects that could support wetland management
City of Cape Town	Climate change programme	• Biodiversity management project o Securing the protection of a targeted 65% of the Biodiversity Network. o The continued implementation of the Bioregional Plan. o Educational, events and visitor programmes aimed at conservation. • Invasive species management project • Green infrastructure project
	City resilience programme	• Integrated resilience project
eThekwini Municipality	Ensure the long term sustainability of the natural resource base	• D'MOSS (Durban Metropolitan Open Space System) and Finescale Systematic Conversation Planning (SCP) • Large scale programmes for implementation of biodiversity and climate protection, and for green job creation i.e.: o Working on Fire

		o Community Reforestation Programmes • Land acquisition and rezoning to secure critical environmental assets • Regular state of biodiversity reporting • Influence city planning to address environmental sustainability and resilience i.e.: o Strategic Environmental Assessment (SEA) o Durban's 100 Resilient Cities Programme
Kokstad	Watershed investment programme	• Franklin wetlands: Restoring the natural capital • Franklin wetlands: Optimisation of ecosystem services
	Water cycle management programme	• SuDS rollout and subsidizing projects • Waste water treatment: sewage pre-treatment • Waste water treatment: constructed wetland • Waste water treatment: treated effluent reuse
	Open spaces services programme	• Green Heart Park: Design and management • Green Heart Park: Biodiversity Management Plan

4. Formulate informed programmes and projects to improve wetland management

How is this achieved?

Numerous programmes and projects can be formulated depending on the particular context of the municipality. A list of key initiatives that can form part of programmes and projects is provided in **Section 3**, examples touch on the areas of capacity building initiatives, wetland inventory and prioritization, rehabilitation and protection, land use planning initiatives and monitoring and enforcement. The formulation and development of projects and programmes should ideally be backed up by the IEMP/EMF, BSP, BP and CMS.

8.4 Incorporation of Wetland Management Objectives into Spatial Planning

The most effective way to mainstream wetland management into spatial planning at the municipal level is to entrench important wetlands and their associated support areas into the SDF and LUS of a municipality. A strategy to achieve this is presented as follows (**Figure 49**).

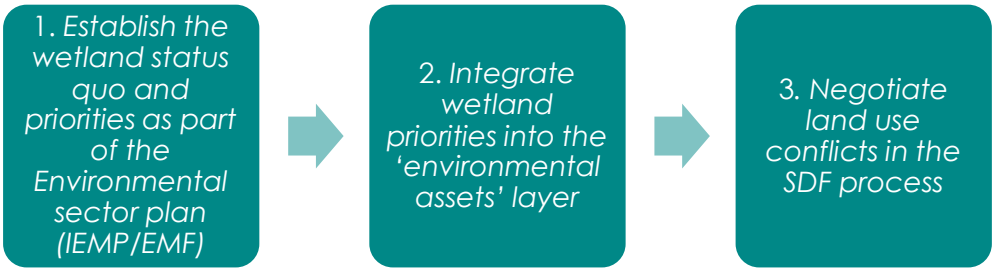

Figure 49 Key steps to mainstreaming wetland management priorities into the SDF.

8.4.1 Mainstreaming into SDF

The SDF Process:

The formulation and adoption of a Municipal SDF is a legal requirement both in terms of the MSA and SPLUMA (for more information see the SDF guidelines (2014)[163]. The SDF is a spatial representation of the desired pattern, form and character of future development within the municipality in line with the goals, strategies and plans of the IDP. In terms of the environmental component, SPLUMA stipulates that the SDF must include "a strategic assessment of the environmental pressures and opportunities within the municipal area, including the spatial location of environmental sensitivities, high potential agricultural land and coastal access strips, where applicable." (Section 21(j) of SPLUMA)

Below are the mainstreaming steps broken down in detail:

1. Establish the wetland status quo and priorities
How is this achieved? • **Compile a wetland inventory including a prioritization assessment (see Section 4)**. The inventory should include information on the location, extent, state and importance of wetlands and support areas within the municipality. This inventory layer will form the basis of the 'wetland layer' to be incorporated into the 'environmental assets' or 'open space' layer for the municipality that is submitted for inclusion in the SDF (For further details refer to Section 4). • **Motivate for fine detail assessments and plans** if considered necessary due to land use conflicts to better measure importance for decision-making. Poor quality or coarse information will limit the strength of motivations and substantiations for inclusion of wetlands and their support areas in the SDF, particularly if there are conflicting sectoral interests like economic development, housing and agriculture. The following spatial planning tools are recommended: o Catchment Management Strategy (CMS) – identifies and integrates all spatial priorities related to sustainable catchment management that integrates water, sanitation and disaster management services. o Biodiversity Sector Plan (BSP) – consolidates fine scale biodiversity information into a single layer.

[163] DRDLR, 2014

- Environmental Management Framework (EMF) – consolidates all environmental management related spatial priorities into recommended land use plans.

2. *Integrate wetland priorities into the 'environmental assets' layer*

How is this achieved?

- **Integrate important wetland areas into an environmental asset or open space layer** that can best spatially represent the important environmental assets of the municipality that require management and protection (see Section 4.2 for wetland prioritisation). Very often the open space layers will include corridors with multiple assets, e.g. stormwater servitudes, green infrastructure, wetlands and others that all share the same space and are impacted by the same hydrological functions. There are two effective tools to integrate the baseline wetland inventory information into a scientifically defensible environmental layer, namely: (i) **catchment management strategy** (CMS) and (ii) **systematic conservation plan or assessment** (SCP / SCA), which will provide a scientific basis for the selection of important wetland assets in terms of regulating ecosystem services in support of water resource management and risk management, and biodiversity conservation priorities e.g. CBAs and ESAs. If funding is not available for development of CMSs and SCPs / SCAs, all wetlands identified as being of value in terms of the inventory importance assessment (this includes all wetlands of moderate importance or higher) (see Section 4.1) and/or as priority wetlands by the prioritization assessment (Section 4.2) should be submitted for inclusion in the environmental assets layer to be included in the SDF. For most municipalities without conservation planning capacity and experience, the development of an environmental assets layer will be a specialist task, one component of which will be the wetland layer.
- **Consolidate outcomes of all wetland importance assessments as part of the development of a Biodiversity Sector Plan / Bioregional Plan** for the municipality, which will give legal weight to the inclusion of wetland priorities and associated land use management guidelines in the SDF and LUS. The only limitation is that BSPs and BPs is that the functional / ecological infrastructure aspects of wetlands cannot be fully assessed and integrated with this tool. There is however some scope to include wetlands of functional importance as ESAs only. Thus, BSPs allow for the inclusion of wetlands into the final biodiversity layer and ultimately the SDF, although important functional wetlands will only be given ESA status, which could influence land use guidelines and levels of protection.

3. *Negotiate land use conflicts in the SDF process*

How is this achieved?

- **Negotiate conflict between the spatial wetland priority areas and other sectoral priority areas** (e.g. housing or economic development) as part of the finalization of the SDF. Such negotiations require clear and well-reasoned substantiations for the priority areas so that the competing options can be effectively evaluated and trade-offs can be determined if necessary.
- **Develop finer scale plans to allow competing land uses to co-exist with appropriate mitigation and controls.** Allowance for such is made in Section 21(l)(i) of SPLUMA. This is required as the SDF

often lacks the detail required for effective fine scale negotiation around competing land uses and trade-offs.

- **Undertake a Strategic Environmental Assessment (SEA) process to assess the impacts and sustainability of the SDF.** In theory, this is an effective tool to facilitate negotiation between competing land uses and enable decision makers to make informed decisions. This is a legal requirement in terms of The Local Government: Municipal Planning and Performance Management Regulations (2001). As part of this process it will be important to assess adherence to sustainability and determine sustainability thresholds in terms of biodiversity and ecosystems services at the municipal level. The CMS and SCP / SCA planning tools are appropriate to assist in this regard.
- **Incorporate degraded wetlands into the wetland priority layer in areas with substantial transformation of natural systems.** It is important to note that in contexts where wetland loss and transformation has been substantial and critical sustainability thresholds have been contravened, the rehabilitation of wetlands should be the overarching management policy. This is required in order to secure sustainable levels of ecosystem services for the citizens of the municipality and future generations. It is thus critical that degraded wetlands in such areas be incorporated into the wetland priority layer for inclusion in the SDF and targeted for future wetland rehabilitation. This can be achieved either through the desktop wetland importance assessment component of the baseline wetland inventory (see **Section 4**) or through the undertaking more intensive and systematic plans like a CMS and/or SCP / SCA.
- **Obtain wetland offsets if loss is unavoidable**. In circumstances where wetland loss is unavoidable due to conflicts with a priority development zones, and cumulative wetland loss has been substantial in the region, strategic wetland offsets will need to be undertaken to ensure that there is still a local or regional net-gain in wetland area in line with the principle of sustainability. This is explained in **Section 6.3.7**.

8.4.2 Mainstreaming into the development and application of the Land Use Scheme (LUS)

LUS Establishment Process:

In terms of SPLUMA, every municipality is legally required to adopt and approve a single land use scheme (LUS) for its jurisdiction that includes categories for land use zoning and regulations. This LUS must give effect to and be consistent with the municipal SDF and determine the use and development of land within the municipal area. A LUS is a critical component of the integrated spatial planning system and deals with zoning and built form controls. The LUS must include scheme regulations setting out the procedures and conditions relating to the use and development of land in any zone, and a map indicating the zoning of the municipal area into land use zones.

Key Mainstreaming Tools:

The reality is that most of the important wetlands within municipalities will occur within defined parcels of municipal, private and tribal trust land that are not zoned for conservation or recreational purposes, and which presently confer various development rights to the land owners. This increases protection and

management difficulties. Even for wetland priorities occurring on public land, such land may have incompatible zoning with the management and protection of wetland priorities, e.g. earmarked as a strategic economic growth node. The key wetland management mainstreaming strategy in this regard is to ensure that the zoning type and controls of land associated with wetland priorities are compatible with the maintenance and conservation of such priorities. Inappropriate land use zoning and development rights for sites with priority wetland areas will result in unnecessary inter-departmental and/or project proponent conflicts and may contribute to continued and unsustainable wetland degradation. Important mainstreaming tools to assist with the incorporation of wetland priorities and management into LUS development and application are discussed below:

Table 16. Summary of key mainstreaming tools and actions for LUMS.

Mainstreaming Tool / Action	Description
Catchment Management Strategy (CMS)	• CMS is an effective and systematic process for identifying land use management guidelines at local and regional catchment scales for achieving water resource, disaster risk management and recreational objectives. Such guidelines would be based on the desired vision and state for each catchment unit and set the framework for the level of wetland resource use from low to high intensity use. • In time it is anticipated that municipal CMS will become a key input into land use decisions and schemes, although at present there is no legal obligation for municipalities to include the outcomes of CMS in LUS. There is however an opportunity to include the wetland priority outputs of CMS into the Bioregional Plan as way to mainstream such priorities into LUS.
Biodiversity Sector Plan (BSP) / Bioregional Plan (BP)	Once approved, municipalities are legally required to consider the location and extent of BSP/BP wetland priorities, as well as their associated land use controls. This is an effective way to mainstream wetland management objectives into the LUS that directly influences development planning on the ground and constrains development rights. To be more specific, although the BSP / BP will not amend the LUMS in terms of zoning of existing parcels, it will limit potential development for future subdivisions and rezonings. This is particularly relevant for greenfield development.

Mainstreaming Tool / Action	Description
Land use zoning, zoning controls and the creation of new conservation/ environmental zones	Careful attention to the type of land use designation associated with wetland priority areas needs to be considered and negotiated as part of the SDF and finer scale spatial plans. In this regard two options are available: • **Develop special environmental zones in the LUS** for land uses with priority environmental assets to differentiate land with the different management purposes e.g. (i) conservation zones, (ii) functional zones for regulating services and green infrastructure, (iii) public open space – public amenity and recreation. The municipality will then need to negotiate with land owners around the subdivision of their properties to incorporate these special environmental zones. Regulations for these zones will need to be developed at subdivision stage. • **Compatible zoning.** Where rezoning to special environmental zones is not feasible, ensure that the zoning of land parcels in proximity to wetland priorities are compatible with wetland management objectives: o **Reduced density and intensity** of land use zones, e.g. public or private open space, or low density housing. o **Special land use controls** restrict the development of a given property. These can be registered against the title, e.g. conservation servitudes (see **Box 50**). Note that land use guidelines from the SDF, Bioregional Plan and other planning document tools are consulted in the preparation of special land use controls. These tools are applicable particularly in greenfield development or in large brownfield redevelopment.
Environmental overlay zone	This is a key management tool which involves the formal incorporation of an environmental priority overlay with the LUS. This will ensure that all property owners and property developers are provided with a clear and unambiguous indication of the spatial extent of environmental constraints associated with their properties, as well as ensure that development expectations are realistic, development conflicts are reduced and project-level development planning is better informed. Please refer to the case study on the integration of the Durban Metropolitan Open Space System (D'MOSS) into the eThekwini Municipality LUS included in **Annexure A8**. This tool is particularly useful in areas where future subdivision and rezoning are uncommon or unlikely, but it can be extended to greenfield areas as well.
Establish financial incentives for land use management and property development in line with wetland management and conservation purposes	• Institute a **rates reduction system** for land owners who assist in conserving and managing priority wetlands (see **Box 51**). A rates concession could be provided where the land owner commits to formally protect and manage the valuable onsite wetlands (e.g. eThekwini's environmental rates certificate). • **Institute special rating areas** for the communal management of important wetlands. (See **Box 51**). This tool is particularly applicable to greenfield development but it can be also used in brownfield situations where significant environmental assets still exist.
Ensure representation of environmental official in	SPLUMA stipulates that a Municipal Planning Tribunal (MPT) needs to be setup to review and approve all development and land use applications in a municipality. Having an environmental representative on the MPT will assist in improving informed

Mainstreaming Tool / Action	Description
Municipal Planning Tribunal (MPT)	consideration of environmental management objectives in such application review and approval processes.

Box 50: Tools used by the eThekwini Environmental Planning and Climate Protection Department (EPCPD) to secure and formally protect environmentally sensitive areas in the City include:

- **Conservation servitude**: The eThekwini Municipality defines a conservations servitude as: "…a servitude registered over a property, normally in favour of the local authority, expressly for the purpose of protecting the biodiversity and/or environmental goods and services found on that property. The servitude diagram would normally be prepared by a land surveyor."[164]A conservation servitude is sometimes called a non-user conservation servitudes or NUCS. The area affected by the servitude remains in the ownership of the land owner and can be used for purposes that do not compromise the integrity of the natural environment[165].
- **Land acquisition**: In some restricted instances, threatened or important areas are protected through acquisition[181]. Land acquisition is regarded as an important method for securing environmentally significant areas[182]. This is achieved by either purchasing the property from the owner at an agreed upon value or by property owners donating their land to the eThekwini Municipality[181].
- **Environmental zone**: A property or portion of a property with important environmental features can be rezoned to an environmental zone e.g. eThekwini 'Environmental Conservation Reserve' that is managed as part of the Municipality's natural resource management programmes[182].
- **Nature Reserve or Protected Area Proclamation**: An important parcel of land can be proclaimed as a nature reserve or protected area in terms of NEM: PAA. This affords the asset the highest form of legal protection.

Box 51: Rates reduction incentives

Municipal rates paid on properties is typically calculated based on the property valuation undertaken by the municipality. Thus, the property valuation system could be amended / revised to include valuation reductions for land owners who commit to formally secure the relevant portion of their property as a conservation land use[166]. Property values could be further reduced if the land owner also commits to manage the important area for a prescribed length of time (e.g. 30 years). For example, the eThekwini Municipality has made provision for the issuing of 'environmental rates certificates' that exempt the land owners from paying rates on areas included in the Durban Metropolitan Open Space System (D'MODSS)[182]. The eThekwini Municipality have also instituted the use of 'special rating areas' (SRAs) for conservation purposes. For SRAs, funding for management is typically provided by the land owners through a levy system and 'top up' contributions from the municipality[182].

[164] EPCPD, 2011
[165] EPCPD, 2012
[166] Boon et al., 2016

8.5 Creating partnerships for the benefit of wetland management

For wetland management partnerships are required:

- within the municipality between different departments such as: environmental management, roads, stormwater, solid waste, parks and recreation, water, sanitation, health, town planning, economic planning etc.;
- with government partners such as the provinces, the DWS, the CMA;
- with citizens who are affected, for whom opportunities can be created or who are already active in nature interests;
- with companies, which influence the wetland, which might benefit by better wetland management, which might be willing to contribute in nature or cash;
- with learning institutions, who can help to monitor the wetland and the processes around decision making, as well as come up with solutions.

Four paraphrases in **Box 53** illustrate show that there can be missed opportunities in wetland management, in terms of content and in terms of process. Well intending civil servants and private partners ended up with wetlands that are not in the desired state that they would like to have them.

Box 53: Paraphrases on experiences with particular wetlands in South Africa

The quotes below are to be considered as from fictitious characters and not to be seen as real quotes, although inspired by real South African cases they might not completely reflect reality.

Frustrated developer

Paraphrase of a large commercial property owner and developer in a metropolitan area:

"The wetland area, with a litlle dam lake, had a bad odour so close to our shopping centre restaurants. I have tried to reach the municipality in many ways. At our own cost, we have added enzymes to the water in order to get the odours away. This did not solve the problem. There is a leaking sewerage pipe in the catchment area which is causing a pollution problem that we as shopping centre owners cannot solve. The wetland falls under City Parks and they say they just want to maintain the wetland as it is, but that does not solve the pollution problem. We now have permission to infill the wetland and offset it with a dam somewhere downstream. We were willing to invest, and we had capable service providers in wetland management, but there seemed to be no cooperation from the City."

Disappointed initiator

Paraphrase of a manager parks and graveyards in a small town:

"I am a horticulturist. But when I saw this neglected wetland in the middle of this small town, with the factories around it on one hand and the low density houses on another, and close to the township schools, I thought this is a unique opportunity for creating environmental awareness and a nice park. We applied for funding from DEA and they provided us with an excellent building for education on wetland management as well as a renovation of the park. The plan did not make it into the IDP, but the building was built and the municipality contributed with staff. The challenge is however that the

depression wetland is still very much polluted by the stormwater runoff from the factories, so there are birds but hardly any fish. There is a beautiful building but no budgets for educational material."

Recipient of the maintenance challenges

Paraphrase of a water quality and river corridor expert in a metropolitan area:

"The floodplain wetland was rehabilitated. Although originally done for flood protection, the added aesthetical value was the big benefit that increased property values and recreational opportunities. The project won prices. Studies showed it even made cost-benefit sense. However, now, almost ten years later, there are un-intended consequences. The increased width created sediment built up. This resulted in shallower waters and therewith favoured reed growth. Reed growth became invasive, out-competing the indigenous species and reducing habitat and biotic diversity. We had underestimated the amount of maintenance needed. Machine intervention was required, but that was considered environmentally undesirable. The wetland was rehabilitated, but of course is not the exact natural situation. The maintenance needed was grossly underestimated when it was rehabilitated. There are lessons to be learned from this example of rehabilitation. Now we seem to still make the same mistakes in other locations in the municipality."

Executor of political orders

Paraphrase of a head of department stormwater management in a metropolitan area:

"The problem was created by lack of wetland management in the neighbouring municipality, as well as lack of sanitation and urbanisation without good stormwater drainage. This created polluted water and polluted sediment to come into our municipality. Tremendous amounts of silt were trapped by a weir. This was supposed to be an urban lake and wetland, with restaurants around it. The business chamber complained to the politicians and it became the mayor's top priority. As civil servants we had to solve it. We interacted with the neighbouring municipality, but they had no means to do something there. So we funded designs and feasibilty studies for intervention measures in our own municipality, with silt traps, litter traps and treatment wetlands. The study and detailed designs were done, but under a new political dispensation the urgency to execute it was gone."

From the examples above, from project experiences in integrated water management, and from general knowledge on transition and process management related to the physical environment, the following tips for creating partnerships can assist municipalities:

1. **Use 'windows of opportunity':** Windows of opportunity are limited periods of time during which something can be achieved. For example, if a developer, such as the 'frustrated developer' above, actively approaches the municipality to improve on wetland management, the municipality should use that opportunity before the developer's decisions change. Another example is when certain developments are planned in parts of the municipality that may threaten or improve wetland management. These are the windows of opportunity that the municipality should make use of where they can guide the priorities on which high level opportunities to first take action on, for parts of the municipality. There are examples of developers going ahead with their own plans or not protecting

natural resources or not investing in natural resources management, simply because the municipality was not yet 'ready' to be pro-active at that stage. 'Windows of opportunity' can result in critical turning points in water management in general[167]. They can be event related, like a drought or flood, or a pollution disaster. They can also be more personal or political. A mayor/premier who has committed to improved natural resources management in a national or international forum, might want a flagship project within his / her municipality. When wanting to improve on wetland management, an analysis of forces in favour (driving forces) or against (restraining forces) intended improvements in wetland management is therefore important (i.e. Force Field Analysis[168]).

2. **Give room to potential 'champions':** The persons that inspired the characters of the 'disappointed initiator' and the 'recipient of maintenance challenges' were both young enthusiastic civil servants who are passionate about environmental management and are knowledgeable and enthusiastic. They both have the potential to create partnerships of collaboration, as they are "T-shaped"[169] with a good knowledge of their own discipline but also capable of building bridges. They took initiatives, they learned from mistakes. It is important to recognize these talents in a municipality and give them room to develop partnerships. Building partnerships is not a procedure that can be followed, it requires certain freedoms to act and adjust along the way. Only when there is given room for personal growth, such talents will stay with the municipality. Personal growth is also essential for holistic resource management[170] which wetland management definitely requires.

3. **Together create visionary goals:** The risk of applying these wetland guidelines and following the official routes for IDP processes, is that possible beneficial partners do not feel triggered to take action. It is important that stakeholders / potential partners to together create visionary goals, which can be facilitated through the municipality (possibly with external facilitators). These goals should have three characteristics[171]: (1) 'connecting'; different actors needed are each recognizing a role for themselves in addressing the goals; (2) 'inspiring'; they give energy, they can be used in public communication; (3) 'productive'; they can lead to real actions and results. For example, getting back a bird or fish species, or creating a walking path, can be visionary goals. The 'executor of political orders', when again approaching his neighbouring municipality or trying to convince is own council, could start with suggesting a visionary goal for the joint river system.

4. **Build in room for experiments:** The normal civil servant who is committed to his role and responsibility in terms of the law, might be tempted is to have the ambition to do everything correctly from the start for the whole municipality, with an inventory of all challenges and prioritization of many actions throughout the municipalities. But such an approach has the risk of (1) the challenge tackled might be too large to 'swallow', (2) there is no pilot to create a process of learning on how to set up partnerships, (3) budgets needed are large, (4) before anything has physically improved, much time

[167] Brouwer, 2015
[168] Lewin, 1943
[169] Hansen,2009
[170] Savory, 1988
[171] Lamberigts and Schipper, 2016

has elapsed, (5) there is no showcase to inspire other potential partnerships. In particular in urban environments, it is now becoming common to create areas for creating experiments of partnerships between private sector, research and learning institutions, citizens and municipalities on how to move to a greener economy, with wetland management being one component. Such experiments are called urban living labs, as a form of collective urban governance and experimentation to address sustainability challenges and opportunities created by urbanisation[172]. To make experiments work, the civil servants need to dare to take paths that have not yet been 'walked' before, as it is an experiment. There might be failures on the way, but when these can be considered learning points, they can also be celebrated.

5. **Do what is promised:** Building partnerships to solve societal problems takes time to build trust. The municipality should be a trustable partner, otherwise external partners get disappointed and momentum is lost. The internal institutional challenges within the municipality need not become too much of a burden for external partners. The municipality should be open about certain issues still needing internal attention, and should be careful to make promises to external parties that the municipality cannot execute. Once promised, do what is promised. The IDP is such a promise.

6. **Use the different roles of municipalities:** As described in Section 2.4, a municipality has different roles it can use to improve wetland management: The municipality's self-governance; the municipality as provider; the municipality as creating an enabling environment; the municipality governing by authority. If these roles are not supporting each other (for example if the municipality is creating wetland forums but doing nothing to enforce relevant by-laws), credibility is lost. Also, what seems impossible in the one role, could become possible using another role. The 'recipient of maintenance challenges' in the box above did not have sufficient budget for maintenance, but could possibly have facilitated the setup of a joint community forum with financial contributions to maintenance from the neighbouring complexes. Examples of companies and citizens taking such initiatives are there such as futurecityfourways.co.za (not specifically on natural resources management) and Friends of the Liesbeek (www.fol.org.za). Involving the surrounding community and companies, might also have helped the 'disappointed initiator'.

7. **Design a process of dialogue and progress:** Working with a real wetland, with different stakeholders that can contribute to its management, is not about following a legal procedure such as for an Environmental Impact Assessment. It requires the design of a process. So in preparation it requires a process design, and a process that can be adapted along the way. It therefore requires thinking about initiators, stakeholders, decision makers, affected parties. It requires thinking about roles and responsibilities, about incentives, finances, milestones, recognition of issues, real reasons for collaboration. Stakeholder engagement and partnership creation to change physical environments for the better is a growing field for advisory services and research, with new ways of communication and engagement as well. Professional service providers specialized in this field, or self-study, might help.

[172] Voytenko et al., 2016

Creating partnerships takes time over which trust needs to be built and partners need to find their own roles. It takes courage, determination, patience and hard work. But then really changes on the ground can be realized, for the benefit of wetlands and their uses.

9. CONCLUSION

These guidelines have identified and provided guidance on the best ways to improve wetland management at the municipal scale. With wetland management being a cross-sectoral activity, affecting and being affected by many different aspects of municipal governance, these guidelines cover a broad range of issues and spheres from developing a wetland inventory to steps to incorporate wetland management concerns and objectives into municipal development and land use planning. The level of detail that each of these issues and aspects is covered varies with the ultimate aim of the document to strike a balance between providing useful strategic information to empower municipal employees while not becoming a prescriptive technical manual. Ultimately it is intended that the information in this document would provide a clear, useful and easy to access / use repository of information that would assist municipal officials in effective wetland management within their jurisdictions.

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11. ANNEXURES

Annexure A: Case Studies

A1: The rehabilitation of the Zaalklpaspruit wetland system and the water quality enhancement benefits

A2: Kaalspruit: A symptom of rapid urbanization – The use of the Olifantsfontein Wetland as a strategic urban surface water treatment facility

A3: The Piesang River Floodplain Rehabilitation Project: Planning and evaluation to date

A4: Atlaspruit Wetland Rehabilitation and Flood Relief Scheme – Wetland lost as part of urbanisation partly reinstated to enhance ecological function, improve public open space, and reduce flood risk

A5: The importance of wetland ecosystem services provided by the Manalana Wetland and the importance of safeguarding these benefits through rehabilitation

A6: Amathole District Municipality wetland mapping and prioritization

A7: The public monitoring of the Liesbeek River in the City of Cape Town

A8: The integration of the Durban Metropolitan Open Space System (D'MOSS) into the eThekwini Municipality Land Use Scheme

Annexure B: Summaries of Key Legislation & Mandates

B1: Description and summary of legislation regulating activities that impact wetlands

B2: List of constitutionally mandated functions

Annexure C: List of Best Management Practices (BMPs)

C1: Waste water management BMPs

C2: Wetland crossing BMPs

Annexure D: List of Key Guidelines, Resources and Tools

Annexure A

The rehabilitation of the Zaalklpaspruit wetland system and the water quality enhancement benefits

This case study is based largely on the the following publication:
Oberholster, P. J., De Klerk, A. R., Chamier, J., Cho, M., Crafford, J., De Klerk, L. P., Dini, J. A., Harris, K., Holness, S. D., Le Roux, W., Schaefer, L., Truter, J. C. and Van Deventer, H. 2016. ***Assessment of the Ecological Integrity of the Zaalklapspruit Wetland in Mpumalanga (South Africa) Before and After Rehabilitation: The Grootspruit Case Study***. Report to the Water Research Commission. WRC Report No. 2230/2/16.

The study area

The Zaalklapspruit Wetland is located along the Grootspruit River situated approximately 15km east of Emalahleni in the Mpumalanga Province[1]. The wetland is in the Olifants Water Management Area (WMA) and is found in the B20G Quaternary Catchment[1]. The Grootspruit River is a right-bank tributary to the Zaalklapspruit River[1]. The Zaalklapspruit River is a right-bank tributary of the Wilge River, which is a left-bank tributary of the Olifants River. **Figure A1-1** indicates the location of the Zaalklapspruit Wetland in relation to the Zaalklapspruit River and upstream coal mining operations

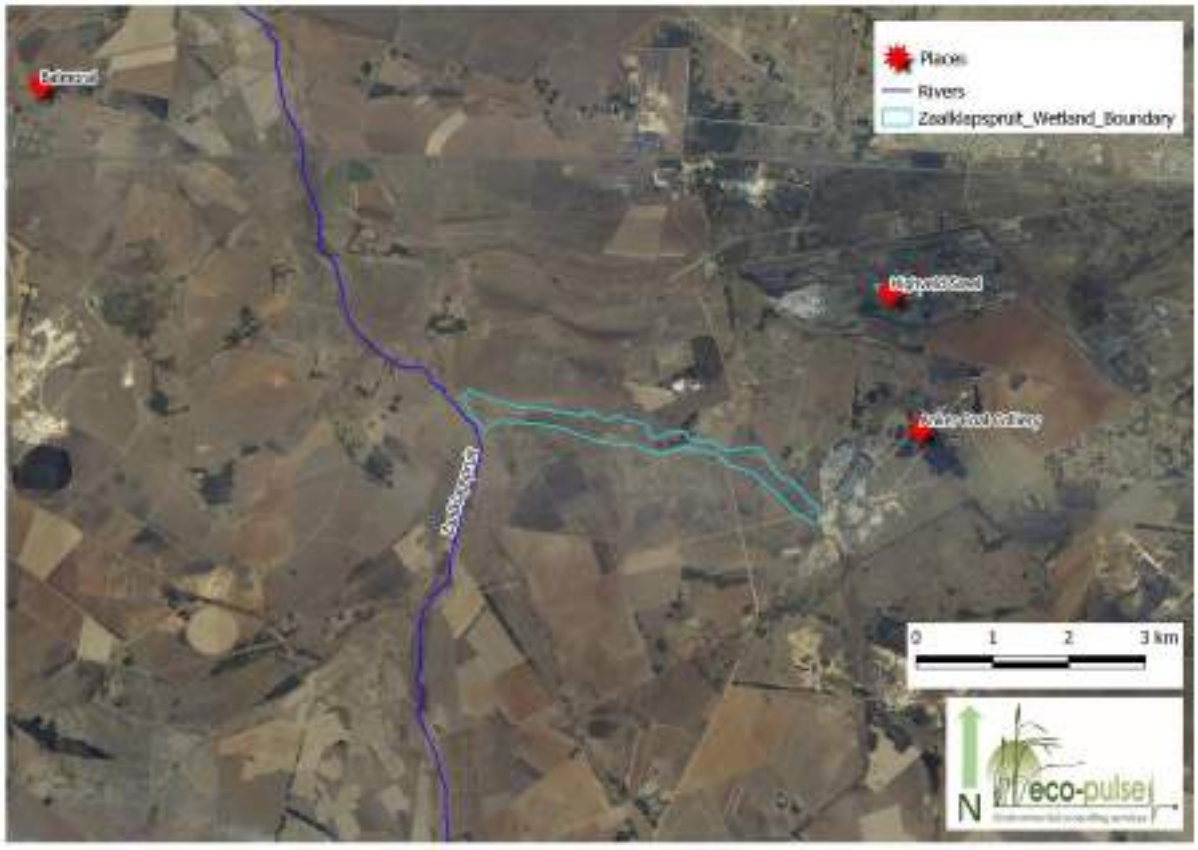

Figure A1-1. Map indicating the location of the Zaalklapspruit Wetland in relation to the Zaalklapspruit River and upstream coal mining operations.

[1] Oberholster et al., 2016

The wetland system comprises a series of un-channeled and channelled valley bottom wetlands that have been substantially impacted by agricultural and mining activities[2]. The main wetland impacts include[2]:

- Decreased wetland flooding, decreased rates of soil saturation and increased soil desiccation within the channeled wetland sections as a result of the incision and widening of the main channel (**Figure A1-2**), and the excavation of artificial drainage channels within the wetland by farmers to reduce near-surface soil saturation and allow for the cultivation of these areas. Increased channel incision is assumed to be the result of the alteration of channel velocities and discharges driven by agricultural drainage, mining runoff and acid mine drainage and flow concentration through road crossings.
- Degradation of wetland water quality as a result of acid mine drainage from upstream coal mines.

Figure A1-3 provides a spatial illustration of the impacts to wetland hydrology.

Figure A1-2. View down central incised channel which prevents contaminated water from being distributed across the wetland.

[2] Eco-Pulse, 2013

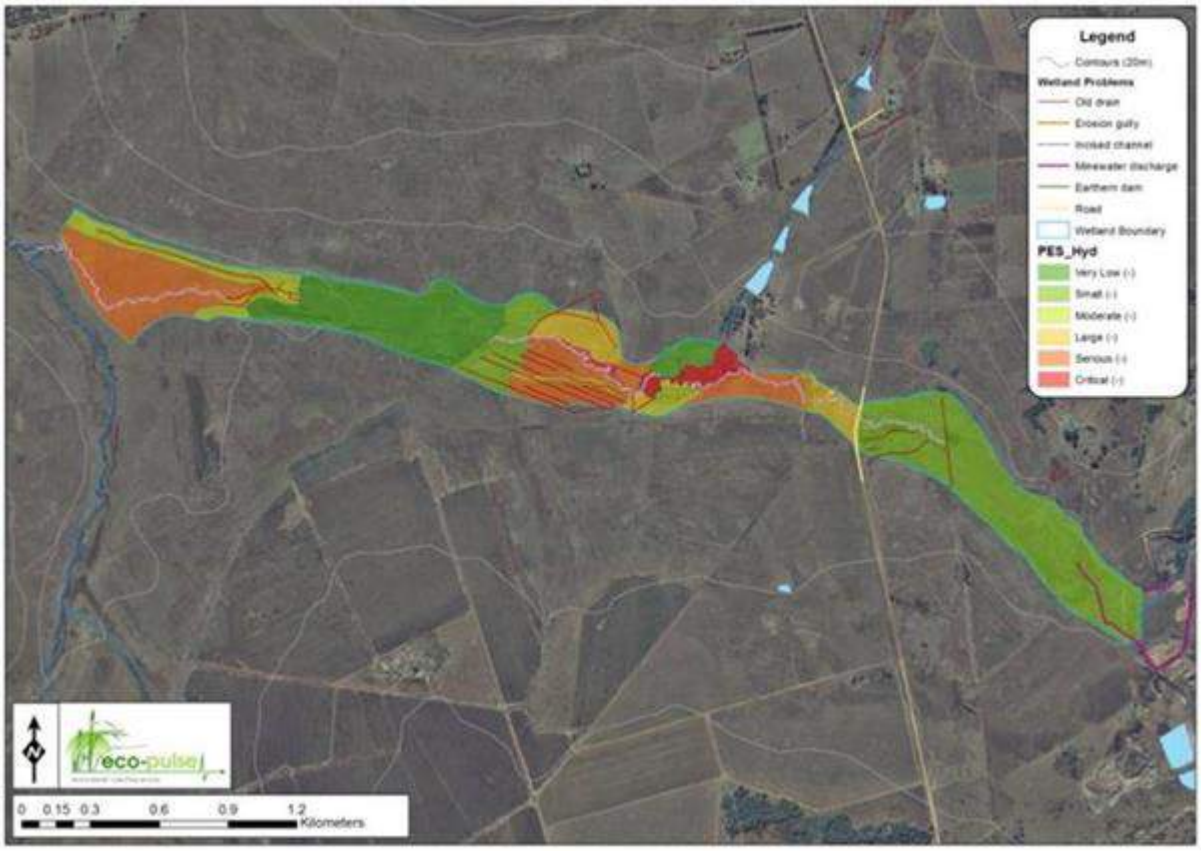

Figure A1-3. Map indicating the impacts to wetland hydrology prior to rehabilitation[3]

Overview of the rehabilitation project

The Zaalklapspruit Wetland system was selected as a mining-related wetland rehabilitation demonstration project by SANBI, Department of Environmental Affairs (Working for Wetlands) and the CSIR with funding from the coal mining sector through the Coaltech Research Association. The aim of this project was to determine whether rehabilitation would improve the wetland's ability to reduce the levels of coal mining pollutants reaching the Zaalklapspruit River. This rehabilitation project forms part of a larger research project focusing on developing mechanisms for limiting and mitigating the impact of coal mining on wetlands and providing guidelines to the coal mining industry and regulators in this regard.

As part of the rehabilitation planning process it was agreed that the desired characteristics of the wetland was diffuse flow patterns, shallow surface water depths and vigorous plant growth[4]. These characteristics are predicted to maximize the trapping and removal of mine water pollutants. A particular channeled section of the wetland was found to have good rehabilitation potential in this regard as shown in **Figure A1-3**. 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[5]. This entailed the construction of a series of concrete weirs down the central channel and the

[3] Eco-Pulse, 2013
[4] Macfarlane et al., 2016
[5] SANBI, 2013

construction of supplementary concrete walls, earthen berms and earthworks in the broader wetland system[6] (see **Figure A1-3**).

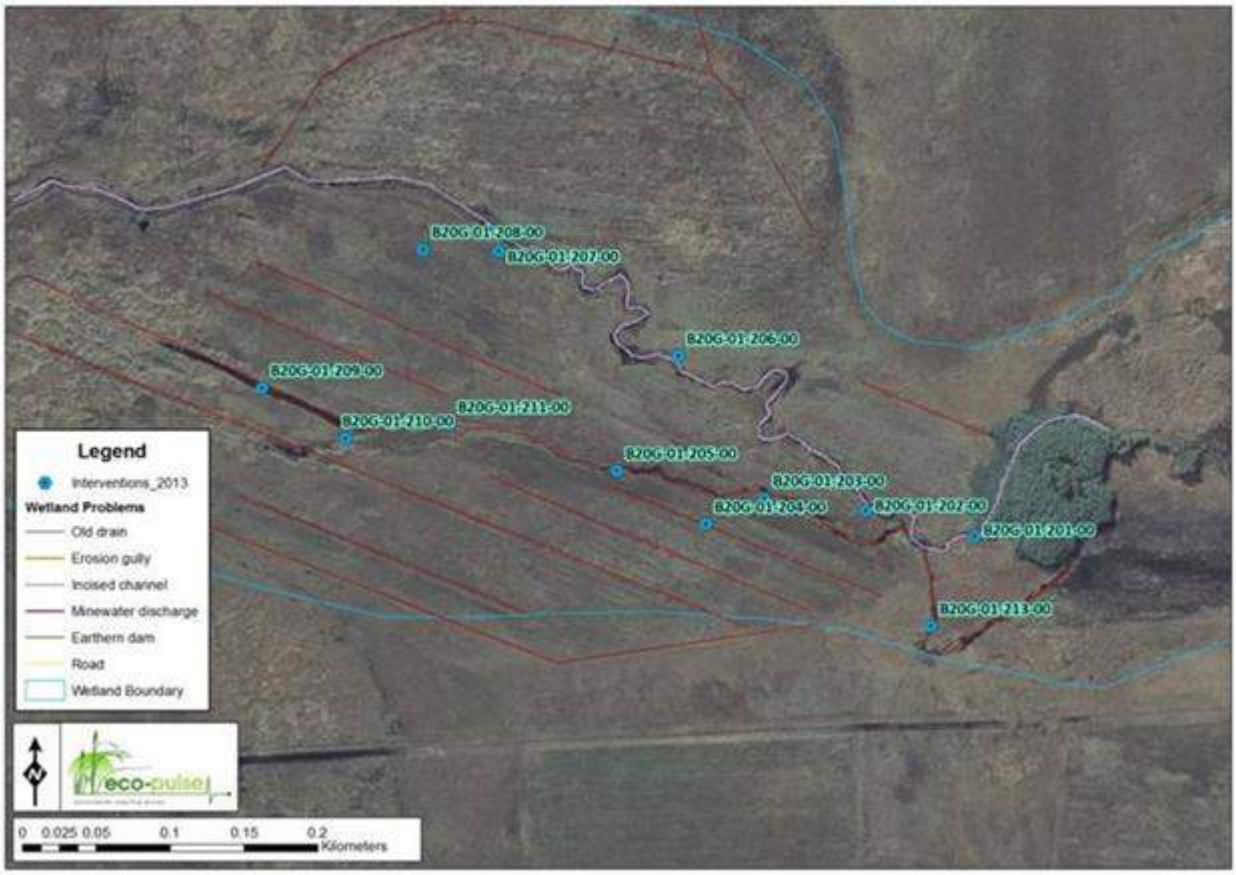

Figure A1-3. Map indicating the location of the incised channel and associated impacts in relation to planned rehabilitation interventions[7].

[6] SANBI, 2013
[7] Eco-Pulse, 2013

Figure A1-4. View over one of the rehabilitation structures which has served to significantly increase the distribution and retention of water in the wetland.

Water quality monitoring findings[8]

As part of the research project, water samples were collected at sites upstream and downstream of the rehabilitated wetland area. The physical parameters (pH, conductivity, dissolved oxygen, turbidity) of the water samples were analysed in the field and the chemical analysis (major ions, metals, nutrients) undertaken by an accredited laboratory5. Water samples were also collected from a single benchmark / reference site upstream of the wetland system that is not affected by mining activities.

The most significant pollutants and parameters associated with acid mine drainage (AMD) that were analyzed included: sulphate (SO4), total dissolved solids (Tds), pH, arsenic, alkalinity, chlorophyll a (Chl a), aluminum (Al), manganese (Mn), iron (Fe) and chloride (Cl).

Within the first year following rehabilitation, monitoring undertaken by the CSIR showed remarkably positive outcomes, namely:

- The pH and alkalinity were increased (acidity reduced) to levels in the natural freshwater range, where many of the metals become insoluble and precipitated out of the water column.
- The sulphate concentration decreased by 65% (1210 mg/L[9] to 473 mg/L).
- The total dissolved solids decreased by 50% compared to pre-rehabilitation levels (1048 mg/L to 525 mg/L).

[8] Oberholster et al., 2016

[9] Milligrams per litre

- The arsenic concentrations have been reduced to below the detection limit. Arsenic serves as an indicator parameter for the presence of toxic heavy metals (metalloids), due to its widely known toxic impacts on human health5.
- The median aluminium concentration decreased from 4 770 µg/L to below the detection limit.
- Chl a concentration improved significantly from 0.3 µg/L. to 1.0 µg/L. The chl a concentrations are indicators of organic biomass activity in the water.
- The median aluminium concentration decreased from 4 770 µg/L to below the detection limit after remediation of the downstream area.
- Iron concentrations decreased by more than 90%.
- Median manganese concentrations decreased from 8 675 µg/L to 417 µg/L after rehabilitation.
- Decreases in the metal concentrations are most likely due to the observed increase in pH as well as alkalinity.
- The chloride concentrations determined before and after rehabilitation are similar. Surface flow wetlands have been proven to be ineffective in the treatment of elevated chloride concentrations.

From these results it is was concluded that rehabilitation of the wetland area improved the water quality by:

- Increasing the pH, alkalinity and Chl a concentrations;
- Decreasing the metal concentrations in the surface water; and
- Reducing the sulphate and TDS concentrations.

This was achieved by spreading out flow, creating shallow waterlogged and flooded conditions characterized by anaerobic and aerobic conditions and increasing the contact time of water with the wetland substrate. The longevity of the positive response of the water quality will rely strongly on the continued presence of sulphur reducing bacteria (SRB). For the bacteria to survive they require anaerobic conditions, adequate supply of sulphate and smaller organic compounds provided by the bed substrate.

The improvements in water quality provided by the rehabilitated wetland were calculated to translate to an economic value of between R2.6 - R11.4 million per year. The benefit is considered high when compared with the R1.7 million invested in rehabilitation at the site.

It is important to note however that little is known about the long-term potential of wetlands to deliver such water quality enhancement benefits in this environment[10]. Longer-term monitoring is being implemented to shed further light on the ability of wetlands to address water quality impacts linked with AMD over longer periods of time. Current literature and theory indicates that the water quality enhancement services provided by wetlands receiving high pollutants loads have a defined lifespan and that such wetlands will eventually become saturated with pollutants such that the wetland will become a conduit for pollutants rather than a filter and a sink[10].

[10] UNEP et al., xxxx

Whilst the initial responses were above expectations, ongoing monitoring has revealed that more could be done to improve rehabilitation outcomes[11]. Whilst the structures function well during summer periods when flows are high, flows again become concentrated over a small portion of the wetland during low flow periods[11]. This is linked to minor topographic variations in the wetland, including old ridges formed during historic cultivation practices[11]. This means that the effective working width of the wetland declines considerably during the dry season, when pollutants are most concentrated[11]. Receding water levels and associated desiccation also means that algal growth needs to be re-initiated during the summer period which could lead to a lag before water quality functions are optimised[11]. These issues will be resolved by making very minor adjustments to spillway heights and undertaking further earthworks to encourage water to spread out further during low flow periods[11]. This illustrates the importance of adaptive management or a learning-by-doing approach in ensuring that rehabilitation benefits are optimized[11].

[11] Macfarlane et al., 2016

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KAALSPRUIT: A SYMPTOM OF RAPID URBANISATION

The use of the Olifantsfontein Wetland as a strategic urban surface water treatment facility.

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The Kaalspruit drains to the Olifantsfontein wetland in the City of Ekurhuleni before joining the Hennops River system in the City of Tshwane.

The population in the 100sq.km urban catchment has more than doubled over the last 20 years. There has been a rapid expansion in backyard shacks placing severe strain on municipal services leading to severe degradation in the receiving river systems.

The complex socio-economic conditions in the catchment have led to the identification of the Olifantsfontein wetland as the ideal site for a strategic solution.

High sediment levels in the stream flow due to:

- Erosion of river banks
- Sand mining on banks

'Dry Weather Flow" in the streams are equivalent to mild to medium strength sewage flow.

- Sewers not designed for high density population.
- "Mining" of sewers for valuables.

High litter loads reduce drainage network capacity, increasing pollution, erosion risk, flood risk and maintenance requirements.

The Solution

Free Water Surface (FWS) Constructed Wetland

The river conditions are too severe for the reinstatement of a naturally functioning wetland. Sediment loads will smother any such system and the high pollution levels reduce dissolved oxygen levels to near zero.

Addressing the causes at source will be complicated by the socio-economic conditions and will be a long-term plan.

The proposed scheme is therefore a treatment plant for sediment, sewage and litter pollution which will protect downstream water resources and habitat in the shorter-term, and will be a protective buffer in the long-term.

The Piesang River Floodplain Rehabilitation Project: Planning and evaluation to date

Overview of the project

The eThekwini Municipality Architecture Department in conjunction with Go Durban and Durban Green Corridor have initiated the Bridge City-KwaMashu Open Space Project with the purpose of enhancing and formalising the remaining recreational and open spaces within KwaMashu. The open space project forms part of a larger development project to stimulate economic development within the area and redress the historic 'apartheid' spatial planning that has left 'hinterland' urban areas like KwaMashu both under-developed and excluded from economic development activities. In this regard, the Bridge City suburb has been identified as an important development node referred to as the 'Bridge City Hub & Precinct' and an important connector within the developing northern corridor of the eThekwini Municipality[1]. The precinct has been earmarked for the location of a new transport interchange development node including additional rail infrastructure and Bus Rapid Transport (BRT)[1]. The new corridor will connect the local and regional community to Pinetown in the south and to new job opportunities in the north[1].

With the critical metropolitan transport connections established, what remains is to ensure that local connections into this transport hub are facilitated[1]. The open space project specifically investigates the role of the 'left over' and derelict open space of the Piesangs River Floodplain and its tributaries in connecting and integrating the surrounding local communities both with each other and with the opportunities that the Bridge City node and its public transport infrastructure has to offer[1]. Ultimately the project intends to re-establish the value of the natural open space of the Piesangs River and its tributaries for the local and surrounding community of KwaMashu in terms of transport, socio-cultural, ecological and economic connectivity[1]. The location and extent of the open spaces that form part of this project is shown in **Figure A3-1**.

[1] Funke et al., 2018

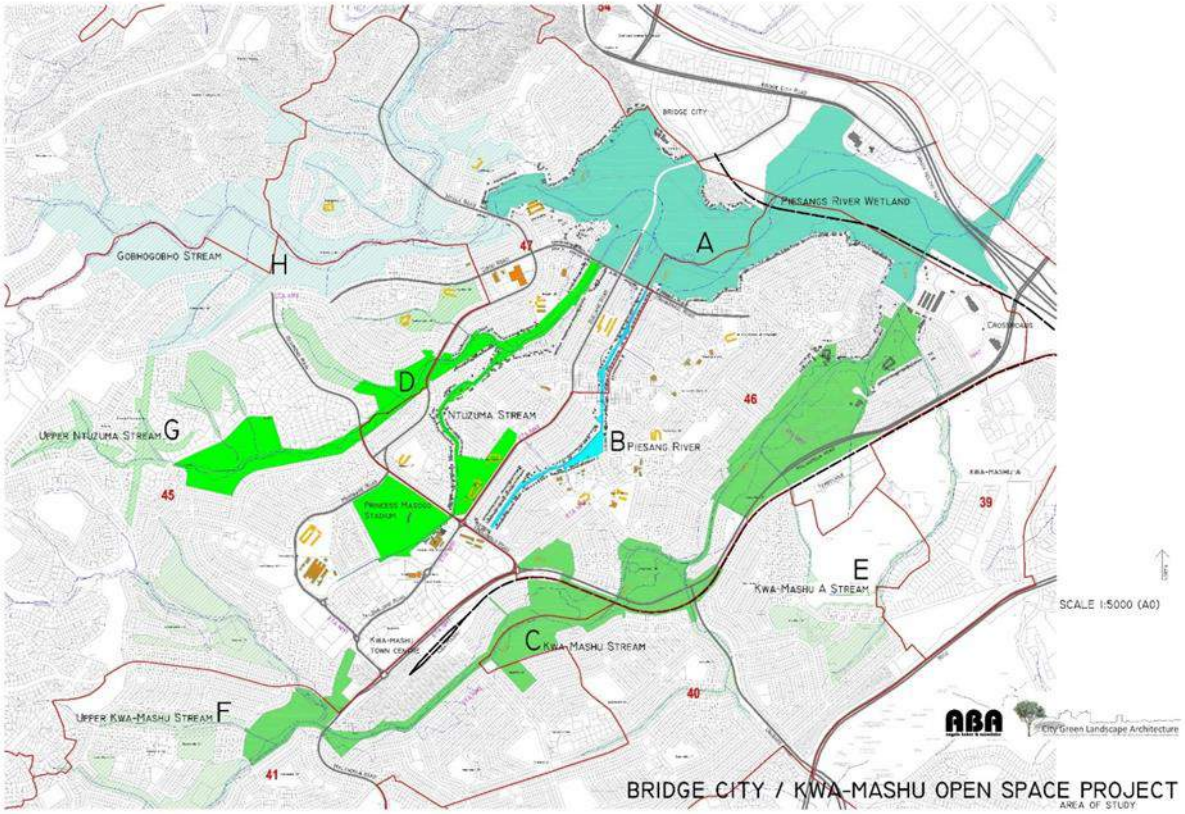

Figure A3-1. Study area for the open space project[2].

The Piesang River floodplain is one of the largest remaining patches of open space in the KwaMashu area and thus forms an integral part of the open space project. The location and extent of the floodplain open space area is shown as Area A in **Figure A3-1** above. The conceptual land use plan and delineated wetland areas for Sub-project A is shown in **Figure A3-2** below.

[2] ABA & City Green Landscape Architecture, 2016

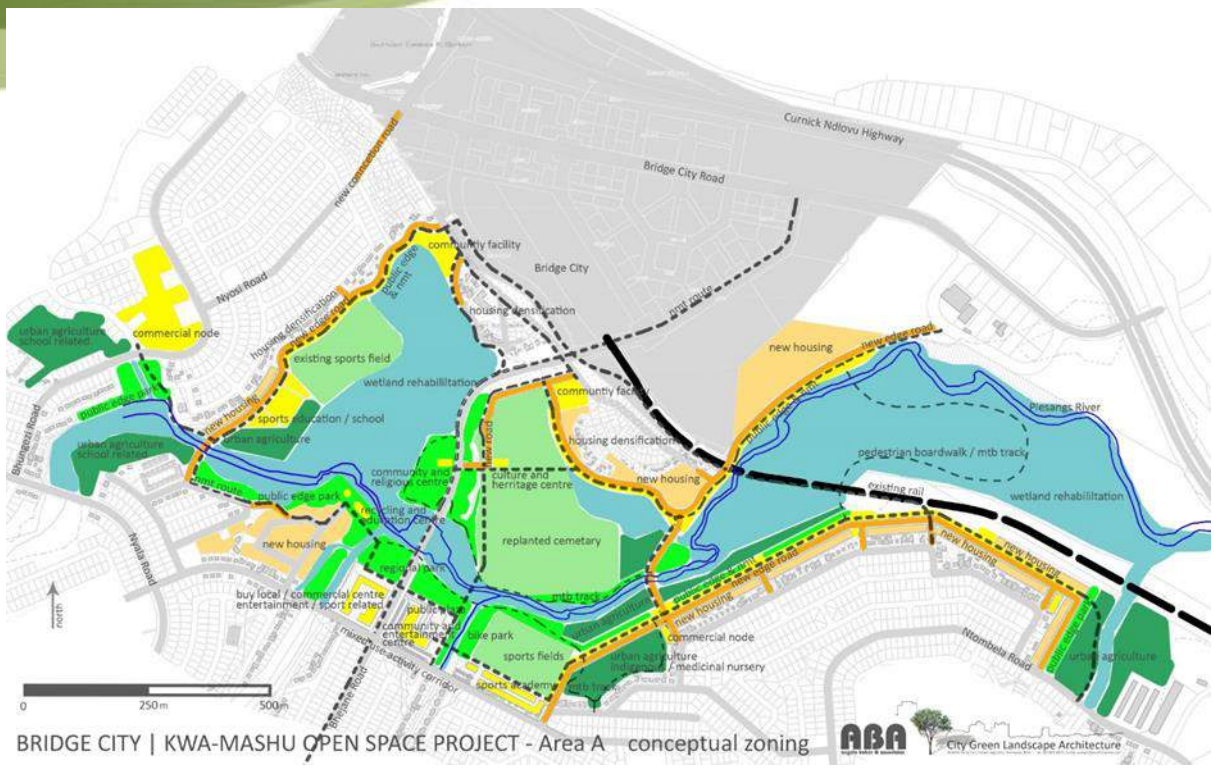

Figure A3-2. Conceptual zoning for Sub-project A[3].

The current extent, state and importance of the wetland and riparian habitats associated with the floodplain were delineated and assessed in 2017 to inform the open space project and rehabilitation planning[4]. In summary the baseline assessment found that the Piesang River floodplain wetland system is critically modified and in a poor state. The majority of the river's catchment has been transformed by urban development with little consideration of sustainable urban drainage systems and practices. Furthermore, large portions of the upstream river and associated feeder streams have been canalised and now function as urban stormwater conduits. As a result, river peaks flows have been substantially increased which has led to considerable channel incision and widening. Being a low gradient floodplain located at a naturally occurring 'bottleneck', rates of sediment deposition on the floodplain has increased exponentially since the onset of urban development in the catchment with recent alluvial deposits on the floodplain predicted to be in excess of 3m deep. Over time, increased alluvial deposition has resulted in the raising of the floodplain surface and the reduction in the size of the channel. This has led to an increase in the lateral extent of large and major floods (1:20 – 1:100 year floods) and the increased flooding of the adjacent residential areas. In 2007, the excavation of a new channel was commissioned by the eThekwini Catchment and Stormwater Management department improve flow conveyance through the floodplain and reduce the flooding of adjacent communities. This excavated channel has incised considerably since being excavated in 2007 and today the floodplain is effectively deactivated with the majority of flows retained within the main channel and by-passing the floodplain. Only major storms (≥1:50yr flood) are predicted to overtop the channel. The majority of the floodplain currently comprises dryland alien thicket.

[3] ABA & City Green Landscape Architecture, 2016
[4] Eco-Pulse, 2017a

It is within this context that the rehabilitation of the floodplain wetland was proposed as a positive step towards improving the provision of ecosystem services and wetland habitat within the greater Piesang-uMhlangane River catchment that are currently below sustainability thresholds and on a negative trajectory. The first phase of the rehabilitation planning was to develop a rehabilitation plan and funding model for the lower section of the floodplain only, the extent of which is shown in **Figure A3-3**. A summary of this rehabilitation planning process and the evaluation of the benefits of the rehabilitation is discussed for the rest of this case study document.

Figure A3-3. Key features of the lower floodplain rehabilitation area.

Photo 1. Main river in the lower reaches looking downstream.

Photo 2. Deactivated floodplain in the upper reaches immediately upstream of the Bridge City railway bridge.

Rehabilitation Plan[5]

Desired state determination

The first component of the rehabilitation planning involved determining the desired state of the floodplain wetland considering the catchment pressures and rehabilitation constraints and opportunities.

Catchment pressures and demand for ecosystem services:

The Piesang River and greater uMhlangane River catchments are highly urbanised. The extensive urbanisation of the catchment in conjunction with the physical modification of streams and rivers (e.g. floodplain and riparian zone infilling, channel straightening, channel canalisation, channel enlargement, channel reinforcement / stabilization) within the catchment has resulted in the substantial and critical degradation of the stream, river and wetland ecosystems within the greater catchment. In addition to the above flow and sediment regime changes, intense urbanisation has resulted in the critical degradation of stream, river and wetland water quality. Pollutant sources are extensive within the uMhlangane River catchment. Ultimately such extensive alteration of ecosystem drivers have resulted in the critical degradation and loss of aquatic and wetland ecological habitat. In addition, such impacts have also increased risks to communities either using or living in close proximity to the downstream rivers and estuaries, particularly flood risks and water quality degradation and associated health risks.

In light of these critical impacts, the key catchment management needs are to (i) reduce the intensity / severity of flood peaks and (ii) improve water quality for the benefit of downstream aquatic ecosystems and communities. As the main drivers of aquatic and wetland ecosystem degradation within the catchment is flow regime modification and water quality degradation, and the major risks to downstream communities are related to floods and poor water quality, flood attenuation and water quality enhancement (nutrient and toxicant removal) services are in greatest demand.

Constraints:

Key constraints identified included:

- Substantially modified and unpredictable peak flow patterns and discharges, and the relatively large size of the upstream catchment, pose significant constraints to the long-term viability of engineered control structures e.g. creating a new base level control structure or an inlet diversion structure. This design constraint meant that the most desirable option was a minimal interventionist solution that sought to work with the current ecosystem drivers and allow for dynamism and self-adjustment.
- In order to reinstate a dynamic floodplain system that would have a high frequency of flooding (i.e. flooded annually) and that does not require engineered control structures, the floodplain would need to be lowered so that it could be regularly operative at the current elevation of the main channel bed. This would require the removal of substantial volumes of alluvial fill. The costs to undertake the earthworks and cart and dispose of the material would be very high and poses a constraint to the financial viability of the project.

Opportunities:

[5] Eco-Pulse & GroundTruth. 2017

Key opportunities identified included:

- The floodplain is characterised by a broad and low gradient valley (relic floodplain) with a stable downstream base level control, which reduces the need for extensive and risky engineered control structures.
- Significant and measurable gains in wetland ecosystem functions / services and habitat with the proposed lowering and reshaping of the floodplain will occur with measurable downstream gains in flood attenuation and water quality enhancement expected.
- The large majority of the lower floodplain is still undeveloped and represents one of the largest riparian areas in the greater catchment. Thus, the floodplain should be considered a strategic rehabilitation priority for catchment and flood management.
- The rehabilitation will form part of the greater Bridge City- KwaMashu Open Space Project, which aims to address past open space planning injustices.
- The rehabilitation project provides an opportunity to consolidate relatively small, piecemeal offset requirements within the greater catchment, particularly the offset requirements associated with the strategic transport projects (e.g. Bridge City Railway and Integrated Rapid Public Transport Network). It is unlikely that a piece-meal approach to meeting individual offset obligations in the greater catchment would be effective and practical.

In light of the above aspects, the desired ecological state of the lower floodplain wetland system was agreed to be an annually activated and dynamic / self-adjusting floodplain wetland system that maximises flood attenuation and water quality enhancement services as far as practically possible, and which supports and maintains the natural geomorphological controls of the system with limited intensive re-engineering.

Rehabilitation Interventions

The following rehabilitation interventions were proposed:

- Lower the floodplain to approximately 0.8m above the elevation of the channel bed through the removal of approximately 271 100 m^3 of alluvium and the reshaping of 16.9 ha of the lowered floodplain surface.
- Active re-vegetation of the floodplain surface, channel banks and riparian zone (flood benches) with appropriate indigenous wetland and riparian vegetation suited to the predicted soils conditions.
- Eradication and control of alien invasive plants.

The predicted post-rehabilitation state of the lower floodplain is illustrated in **Figure A3-4**.

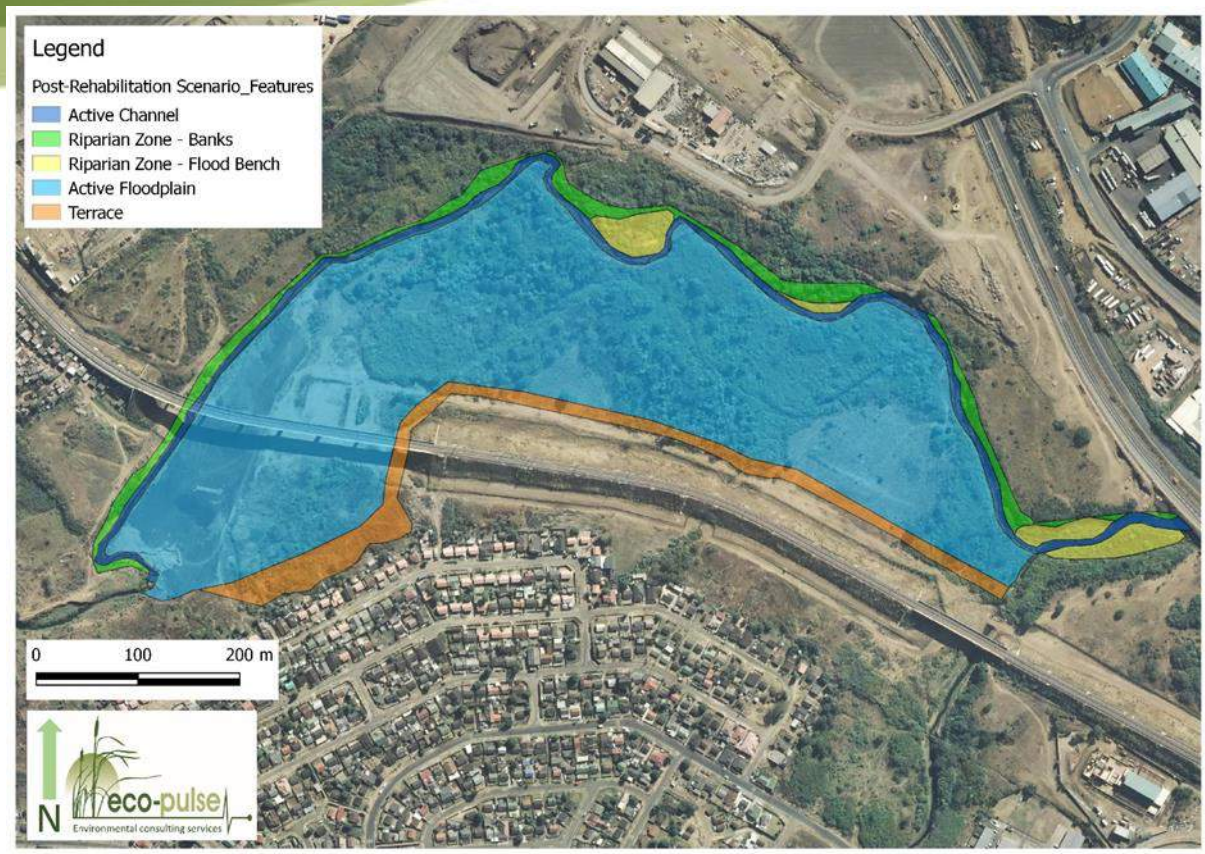

Figure A3-4. Anticipated floodplain features under the post-rehabilitation scenario.

Evaluation of Rehabilitation Gains

Hydrological and hydraulic modelling:
The effect of the rehabilitation on flood hydrology was modelled by GroundTruth Engineering. Hydraulic modelling was carried out using the HEC-RAS 2D hydraulic model to determine the anticipated changes in flow dynamics on the floodplain as a result of the proposed rehabilitation. The modelling was based on a pre-and post-rehabilitation Digital Terrain Model (DTM) derived from a detailed LiDAR survey of the Piesangs River floodplain system, and pre- and post-rehabilitation hydrographs generated using SCS-SA hydrological model.

The modelling results (see **Table A3-1**) indicate that the storm flows attenuated in the post-rehabilitation scenario account for a fairly small percentage of the total storm flow volume for each of the three design flood events – 1 in 2 year, 1 in 10 year and 1in 50 year floods. Although the rehabilitation has seemingly small impacts on the design floods, a delay, or reduction in the flood peaks on site may influence the flood peaks downstream of the site. The eThekwini Coastal Stormwater & Catchment Department confirmed that they are satisfied that these modelled gains indicate measurable benefit in terms of flood management in the local and regional catchment.

Table A3-1. Outflow hydrograph characteristics and resultant attenuation characteristics.

	Return Period (Years)					
	2		**10**		**50**	
Rehabilitation Scenario	Pre	Post	Pre	Post	Pre	Post

Peak Discharge (m^3/s)	66.81	65.69	184.86	187.56	385.28	383.52
Time to Peak (minutes)	370	380	555	550	555	555
Storm Volume (x1000m^3)	1179.55		3331.18		6388.55	
% Total Storm Volume Attenuated	5.16		2.30		1.18	

The hydraulic model was also used to determine water surface elevation changes between the pre- and post-rehabilitated scenarios at specific locations on the site. The modelling suggests that there is likely to be a 1.2 m reduction in the water level (for the 1 in 50 storm event) at a cross section within the upper reaches of the lower floodplain.

The extents of the flood outs and flow velocities were also modelled for the pre and post rehabilitation scenarios for both the 1 in 2 and 1 in 50 year storm events. An illustration of the predicted improvement in the extent of flooding for the 1:2 year return period flood event with rehabilitation is shown in Figures A3-5 and A3-6 below.

Figure A3-5. Modelled 1:2 year flood depths for the pre-rehabilitation scenario.

Figure A3-6. Modelled 1:2 year flood depths for the post-rehabilitation scenario.

Functional and habitat gains assessment:

The supply of regulating ecosystem services[6] and habitat condition were assessed for the pre- and post-rehabilitation scenarios to calculate the potential functional and habitat gains that could be achieved with the rehabilitation. The supply of regulating ecosystems services was assessed using a revised version of the Level 2 WET-EcoServices tool[7] and the habitat condition using the vegetation module of the Level 2 WET-Health tool[8]. The regulating services and vegetation condition scores were generated into functional and habitat hectare equivalents respectively. The predicted gains were then calculated as the difference between present and post-rehabilitated state.

The present functional and habitat hectare equivalents provided by the 20.32ha floodplain wetland is 4.24 and 2.62 respectively. With rehabilitation as proposed in the plan, the functional and habitat hectare equivalents are predicted to be 14.11 and 11.47ha respectively. Thus, a gain of 9.87 functional Ha equivalents and 8.85 habitat Ha equivalents is anticipated. These predicted gains are significant in such transformed catchment where functional and habitat loss has been so severe.

Rehabilitation Funding Strategy

[6] A single regulating services functional value (%) was calculated as the integration of supply scores for flood attenuation, streamflow regulation, sediment trapping, erosion control, nutrient removal, phosphate removal and toxicant removal.

[7] Kotze et al., 2016

[8] Macfarlane et al., 2008

The estimated cost of rehabilitation is R45 060 832.81[9]. This is not financially feasible for the open space project without external funding sources. To both overcome this funding constraint and consolidate local wetland offset obligations into a meaningful offset, the eThekwini Architecture Department are proposing that the outstanding wetland and river offset requirements for developments within the Piesang River catchment and, where applicable, the greater uMhlangane River catchment, be consolidated in order to fund the rehabilitation and long-term management of the Piesang River Floodplain. For this to be achieved, the project needs to be managed holistically, with systematic rehabilitation being implemented in line with the rehabilitation plan developed for the site. In this case, the financial contributions from a number of individual projects with relatively small offset obligations provides an opportunity to aggregate offset requirements and thus enable more significant outcomes to be achieved than what could be achieved on a project-by-project basis. The project concept is therefore for eThekwini to initiate a long-term rehabilitation and management project with monetary contributions paid by developers with offset obligations being used to co-fund project activities.

In this regard, a wetland rehabilitation funding and offset strategy[10] was completed that identified potential offset contributors in the local catchment, calculated the offset requirements of such potential contributors, and converted these contributions into monetary contributions.

To date a number of local development projects have been identified and the offset targets for each calculated. The consolidated offset targets amount to 2.37 functional ha equivalents and 1.75 habitat ha equivalents. As part of the strategy it was deemed reasonable that the financial offset contributions per project be calculated as follows: Offset contribution = Offset target (Ha Eq's) x cost per hectare equivalent gain with rehabilitation and long-term security.

The cost per hectare equivalent gain with rehabilitation and management was calculated as the total cost of both rehabilitating, securing and managing the lower floodplain wetland divided by the area (ha) of the wetland. The total offset costs was calculated to be R55, 960 718.28. The cost per functional Ha equivalent and per habitat Ha equivalent was calculated to be R3, 778 576.52 and R6, 323 245.00 respectively. Based on these figures, the total funds that could be generated by local offset project requirements is R 11 330 252.70.

As there is a significant rehabilitation funding shortfall (±R43, 000 000) when considering the contributions of potential offset contributions only, additional funding sources would need to be secured to ensure the financial viability of the rehabilitation project. The eThekwini Architecture Department have identified two additional funding sources, namely:

- Environmental Landscaping Contribution from land uses within the greater Open Space Project Proposed Project List; and
- Municipal Line Departments contributions.

The landscaping contribution is estimated to be R22, 217 500 once sub-project A is operational, which is likely only to occur in approximately 6 years' time. The estimated contributions from municipal line departments is R24, 000 000 but is also only likely to be available in over 6 years' time. Thus, there is the potential to secure a total of ±R57, 000 000 in the next 6 to 10 years for the project provided that the open space project becomes operational. However, in the short term (0-5year horizon), only the offset contributions (±R11, 000 000) are potentially available for rehabilitation work. For this reason, a

[9] Eco-Pulse & GroundTruth. 2017
[10] Eco-Pulse. 2017b

rehabilitation phasing plan has been developed as outlined in the rehabilitation plan[11] as shown in **Figure A3-7** below.

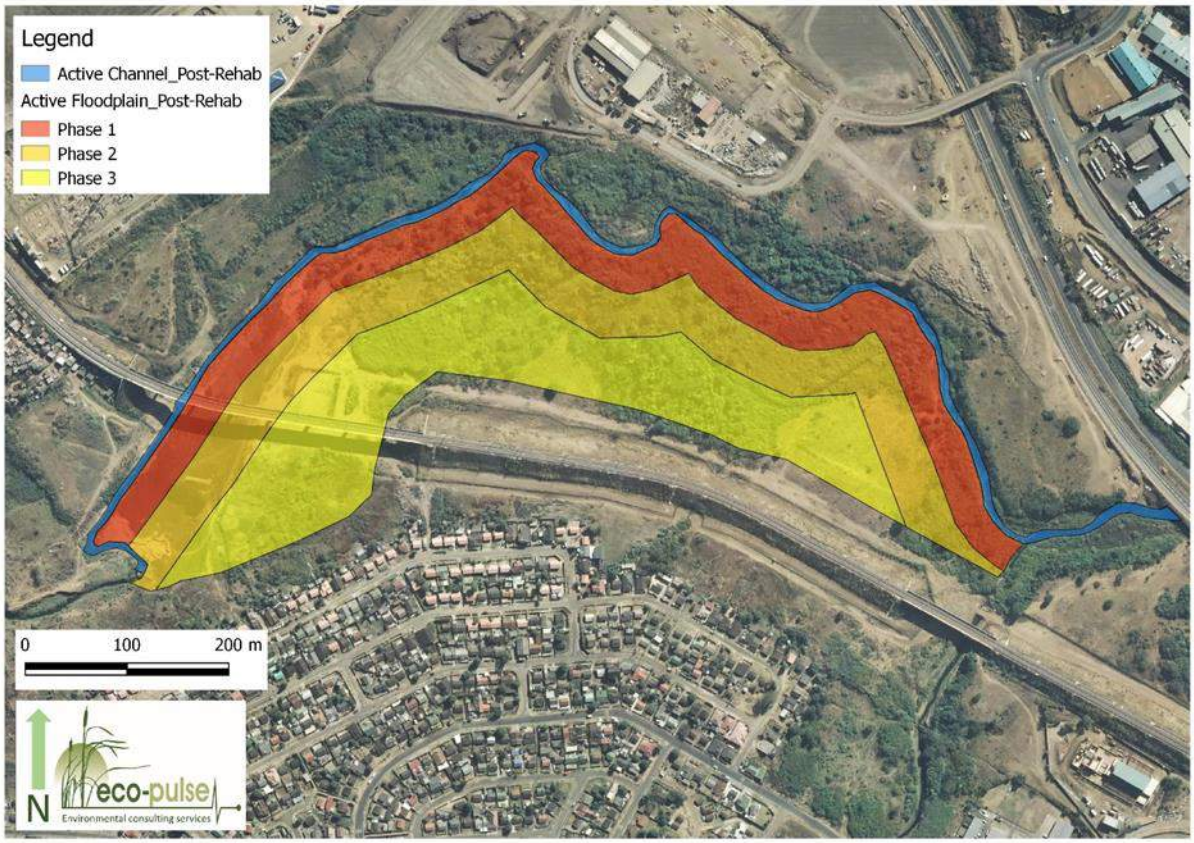

Figure A3-7. Proposed rehabilitation phasing plan.

[11] Eco-Pulse & GroundTruth, 2017

References

ABA & City Green Landscape Architecture, 2016.

Eco-Pulse & GroundTruth. 2017. KwaMashu-Bridge City Open Space Project: Piesang River Floodplain Wetland Rehabilitation Sub-project in KwaMashu, eThekwini Municipality, KwaZulu-Natal. Wetland Rehabilitation Plan for the Lower Section of the Piesang River Floodplain. Specialist Report prepared by Eco-Pulse Consulting and GroundTruth Engineering for ABA. April 2017.

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ATLASPRUIT WETLAND REHABILITATION AND FLOOD RELIEF SCHEME

Wetland lost as part of urbanisation partly reinstated to enhance ecological function, improve public open space, and reduce flood risk.

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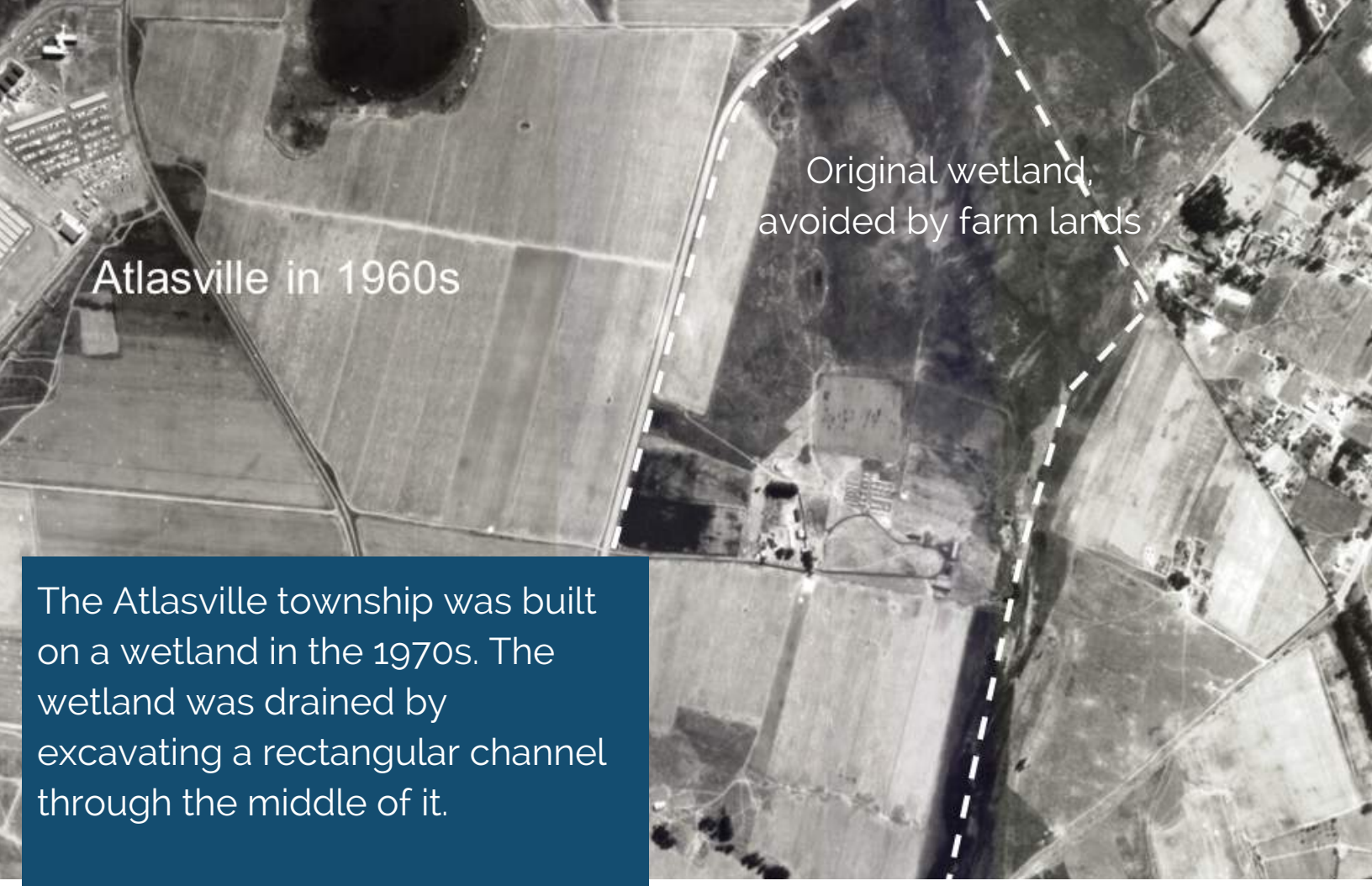
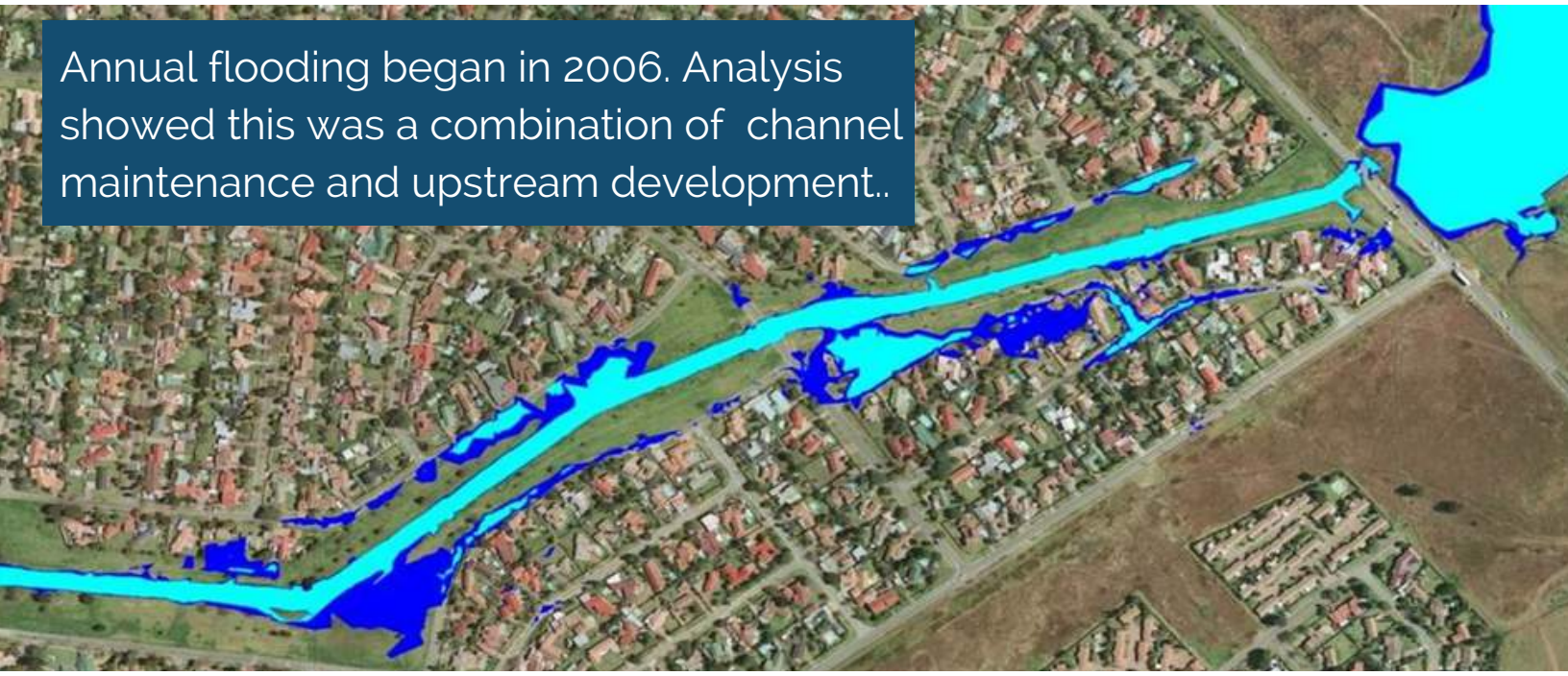


The Atlasville township was built on a wetland in the 1970s. The wetland was drained by excavating a rectangular channel through the middle of it.

The channel was maintained annually with reeds cut (or burnt) and sediment excavated until the late 1990's.

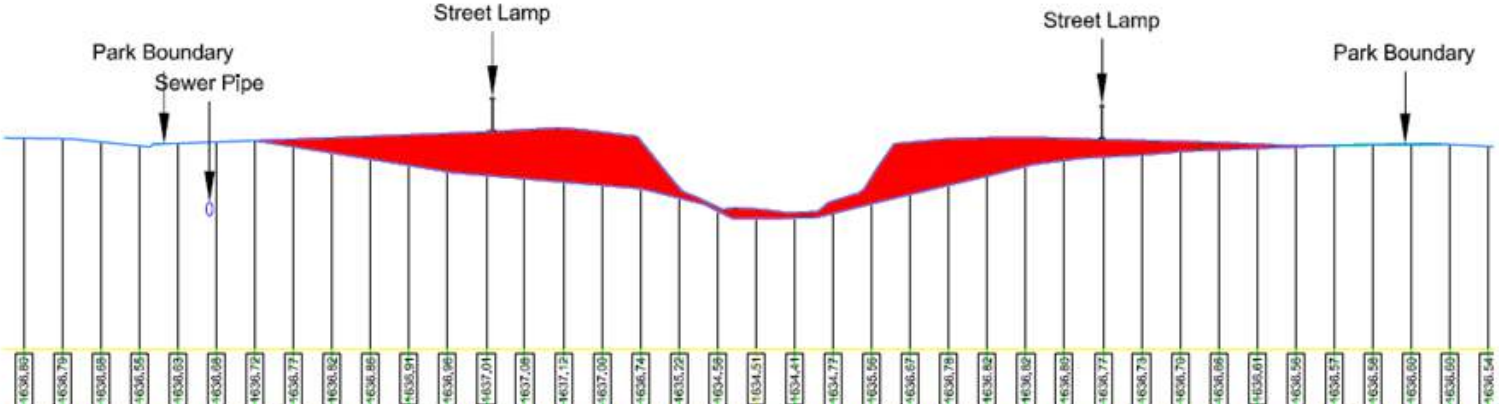
Reed infestation in canalised drain reduces hydraulic capacity.

Emergency flood relief measures led to ecological damage.



Annual flooding began in 2006. Analysis showed this was a combination of channel maintenance and upstream development..

Flooding of residential areas more than once a year.



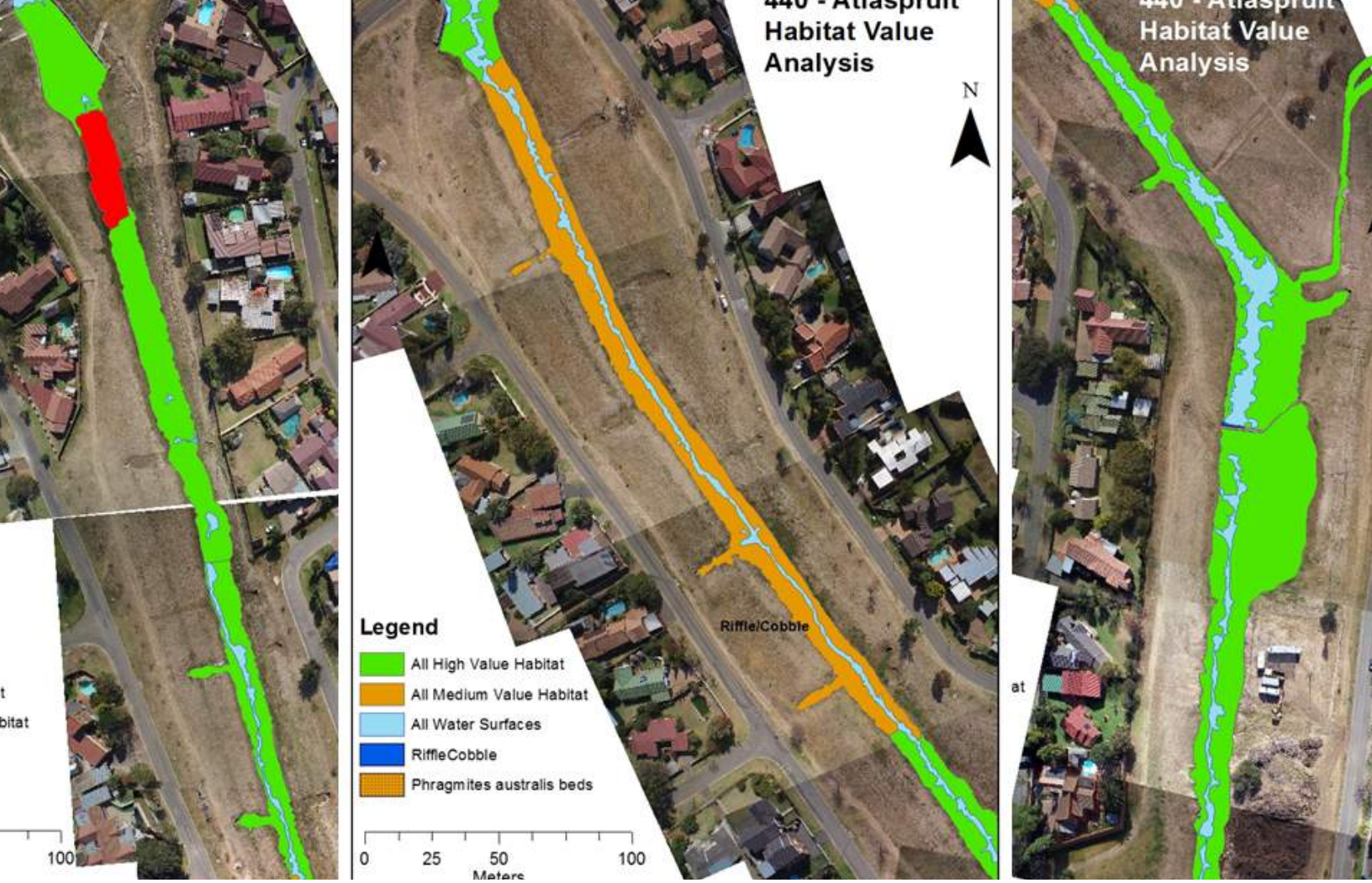
Channel profiling considered hydraulic conveyance, habitat diversity and recreational requirements. In-stream vegetation seeks a mix of open water zones with wetland grasses, sedges, etc.

Reeds (typha and phragmites sp.) need to be kept to a min imum to maintain hydraulic conveyance. This is a critical maintenance requirement.

Extensive earthworks in construction.

Early in-stream re-establishment to mitigate post construction erosion risk.

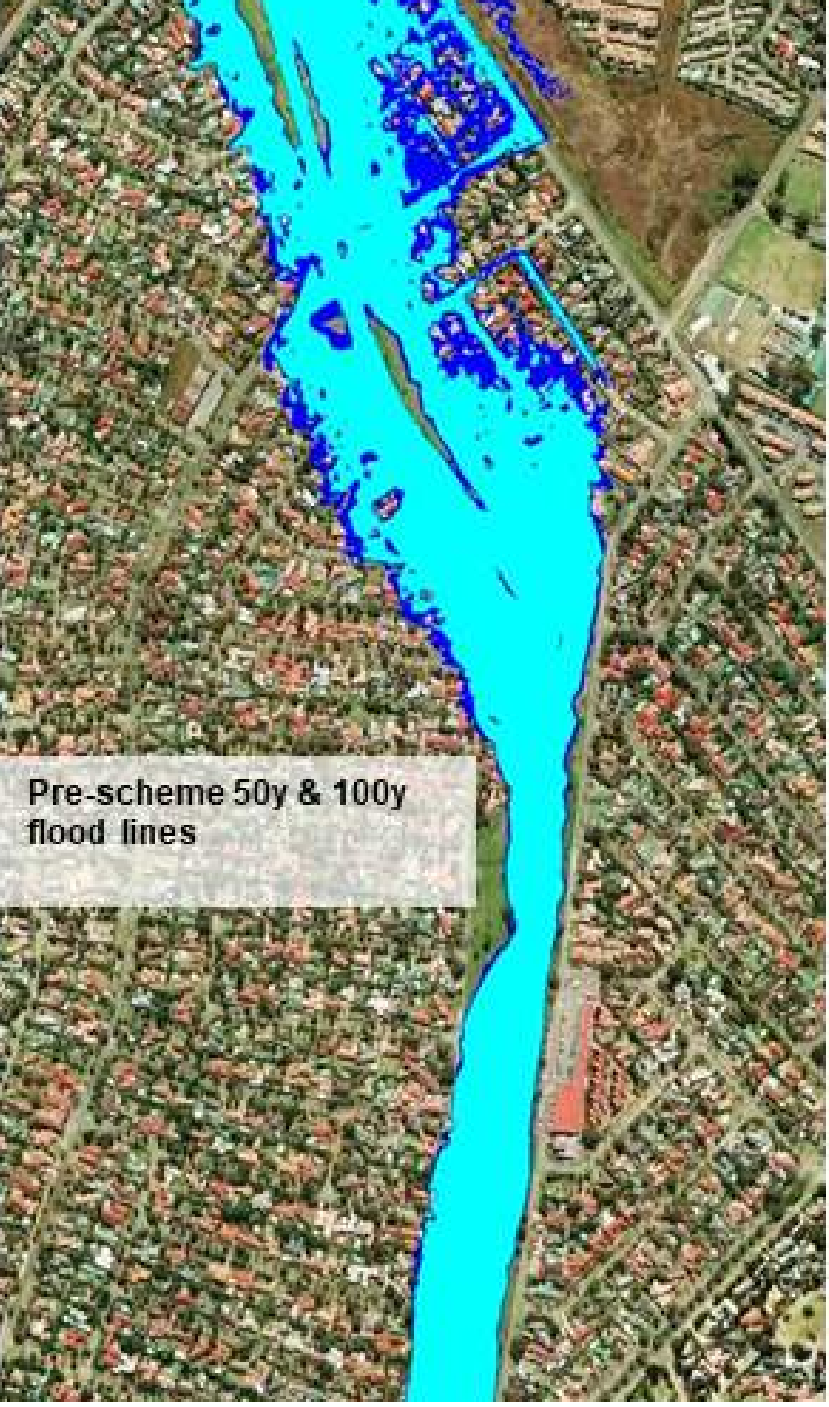
1 year after construction.

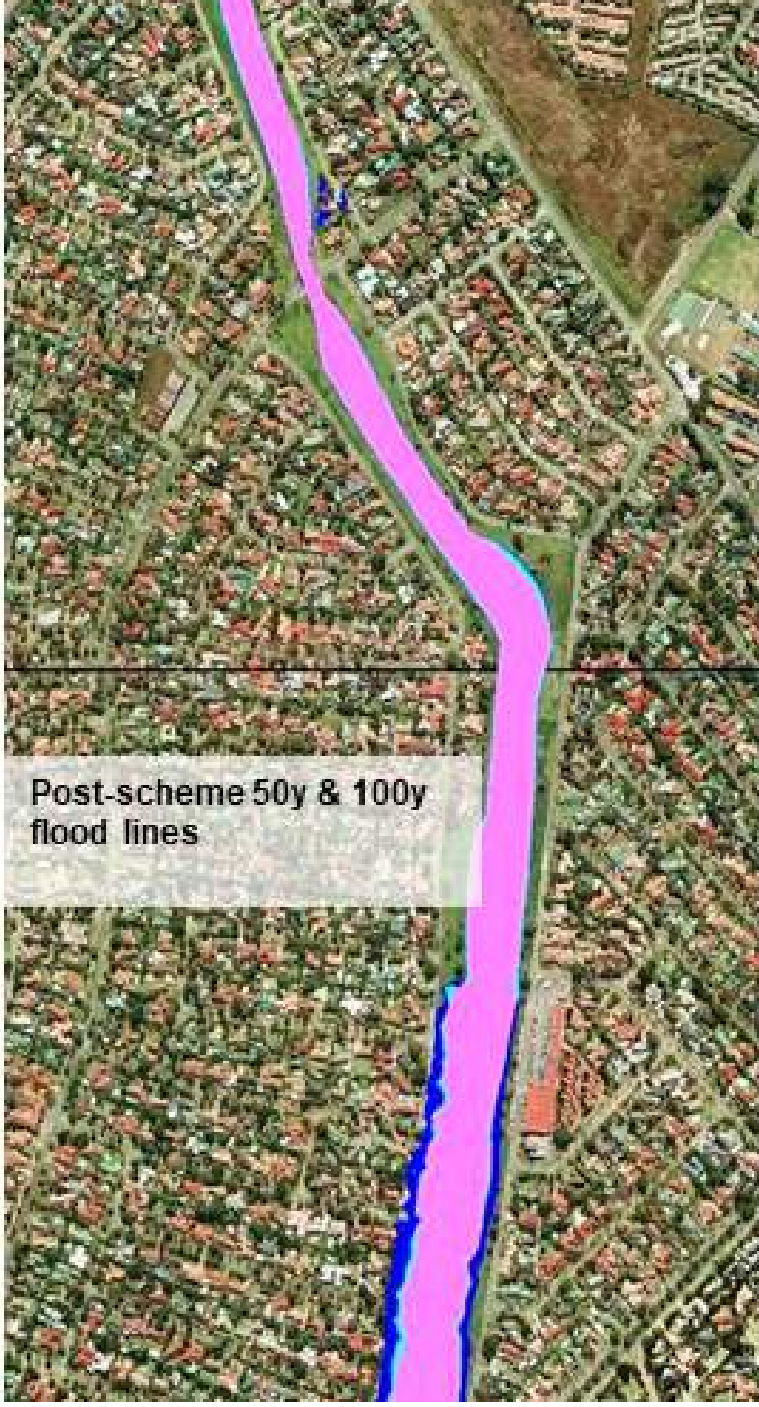


A green Infrastructure scheme

An ecological survey undertaken 2 years after site re-establishment showed marked improvement in ecological condition and habitat diversity. This is largely attributed to the reduction in the dominant reed cover, the introduction of a greater mix of habitat, along with improved dissolved oxygen levels.

In-stream maintenance remains critical, mainly to limit spread of reeds. Inter-departmental co-operation may be required for maintaining municipal river and wetland schemes.





FLOOD PROTECTION

This has been improved from more than 1 in 2 years to 1 in 100 years.

If reed infestation takes hold, the flood protection will be reduced to 1 in 50 years.

PROPERTY VALUES

Early indications from estate agents data suggests a general increase in property values above market trends, particularly along the spruit, but also in streets set back from the spruit.

COMMUNITY APPROVAL

A community survey two years after construction showed a general approval of the scheme, with a clear preference for the Green Infrastructure solution over a grey infrastructure scheme.

There was also a notable increased use of the park.

The importance of wetland ecosystem services provided by the Manalana Wetland and the importance of safeguarding these benefits through rehabilitation

This case study is based on the publication:
Pollard, S. R., Kotze, D. C. and Ferrari, G. 2009. Part 3B: ***Valuation of the livelihood benefits of structural rehabilitation interventions in the Manalana Wetland***. In: Kotze, D. C. and Ellery, W. N. (eds.) 2009. ***WET-OutcomeEvaluate: An evaluation of the rehabilitation outcomes at six wetland sites in South Africa***. Technical report no. TT343/09, Water Research Commission, Pretoria, South Africa.

Setting and wetland characteristics:
The Manalana Wetland in located within the village of Craigieburn village in the Bushbuckridge Local Municipality, Mpumalanga Province. The wetland and the greater village is located on communal land under the Sethlare Traditional Authority and the land is currently owned by the state.

The wetland system is situated in the upper Sand River Catchment in the north-eastern region of South Africa. The wetland system is a tributary to the Motlamogatsana River that becomes the Nwandlamuhari River, which ultimately becomes the Sand River.

The wetland system consists of a relatively small un-channelled 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, as shown in **Figure A5-1**. The wetland system has been substantially affected by gully erosion and headcut migration with both of the HGM units being affected by gully erosion at their downstream ends[1]. Based on the past rates of advancement, it was predicted that the headcuts were likely to soon advance through all of the remaining intact areas unless there was some form of intervention[2].

Land use in the catchment is dominated by peri-urban rural settlement, free-roaming grazing and extensive use of the valley bottom wetlands, particularly for the cultivation of madumbes (Colocasia esculenta), during the wet season. Typically, during the dry season cultivation ceases and both agricultural and indigenous wetland vegetation is burned on plots, whilst fallow stands of indigenous vegetation may remain. Wetland plots consist of steep raised beds and deep drainage furrows.

[1] Kotze et al., 2009a

Figure A5-1. Map indicating the approximate extent of the Manalana Wetland draining from west to east based on the NFEPA wetland dataset.

Socio-economic value of the Manalana wetland[2]:

The remaining intact areas of wetland are heavily utilised by local residents for a variety of activities including cultivation, livestock grazing and reed (sedge) harvesting. In a 2003-2005 survey of the benefits of the Manalana Wetland by Pollard et al. (2005), it was revealed that some 70% of Craigieburn residents were found to use wetlands to meet their livelihood needs. The overriding profile of wetland users is that of women aged 35 to 70, mainly from single-headed households. According to participatory wealth-ranking exercise, some 63% of households were ranked as very poor i.e. no paid work or cash income or occasional paid work but many dependents. Included in this category were a quarter of all households that had no regular income and secured food through what they grew. Equally striking is that 63% have accessed their fields in the last ten years, citing hunger as the key driver. Thus it was concluded that the Manalana Wetland offers an important safety net, particularly for the poor, and is estimated to contribute 40% of the food grown locally.

Wetland impacts and rehabilitation:

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 / migration and gully erosion, two erosion control structures were established to deactivate the active

[2] Pollard et al., 2005; Pollard et al., 2009

headcuts, as shown in **Figure A5-2**. The Rehabilitation project was undertaken by Working for Wetlands and was initiated in 2006 and completed in early 2007.

Figure A5-2. Map indicating the approximate extent of the portion of the Manalana Wetland based on the NFEPA wetland dataset, overlaid with the point locations of the rehabilitation interventions.

Valuation of benefits[3]:

A study to measure and evaluate the benefits of rehabilitation was undertaken by Pollard et al., 2009 as part of the development of the WET-OutcomeEvaluate tool[4]. The objective of the study was to provide an assessment of the livelihood benefits likely to accrue as a result of the implementation of the rehabilitation project. This was done by quantifying the current contribution of the intact portions of the Manalana Wetland to the livelihoods of local households using the findings of the 2005 survey[5]. Most of the analysis focused on the upstream benefits although some attempt was made to capture the downstream benefits associated with rehabilitation. 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. It was assumed that rehabilitation would halt the headcut and secure the wetland upstream, thereby safeguarding these services. In the case of downstream benefits only water for domestic and livestock purposes were examined.

[3] Pollard et al., 2009
[4] Kotze et al., 2009b
[5] Pollard et al., 2005

In this regard, a Cost-Benefit Analysis (CBA) was undertaken. This involved calculating the total use value or total net direct value (TNDV) of the different provisioning services. The total value of the benefits was estimated both upstream and downstream of the structures. The benefits upstream of the structures were found to be substantial while the benefits downstream were smaller by comparison. The key findings of the valuation are summarised as follows:

i. Crops for household consumption:

- For madumbes, the net direct value is R1 274 per household per year and R43 316 for all households above the rehabilitation structures.
- For pumpkins, the net direct value is R873.60 per household per year and R10 483.20 for all households above the rehabilitation structures.
- For maize, the net direct value is R280.80 per household per year and R7 300.80 for all households above the rehabilitation structures.
- Under a best case scenario, the total value of madumbes, pumpkins and maize produced in the wetlands is R74 256.00, R12 579.8 and R9 734.40 respectively for all households above the rehabilitation structures.

Under degraded conditions with no rehabilitation structures, there would be an estimated 75% reduction in revenue due to decreased yield associated with the reduction in wetland area and productivity. The annual value would decline from a conservative estimate of R61 000 to R15 275. Thus the added value of rehabilitation is R45 825 although this could be as high as R81 294.00.

ii. Harvesting of sedges:

The wetland is used for the harvesting of sedges (*Schoenoplectus corymbosus*) for mats, some of which are sold. With rehabilitation in place, the average wetland area under reeds per household is 40 m2. Assuming that 70% of the area is harvested annually, each household would use approximately 28 m2. For the 24 households that reported harvesting of reeds, a total of 224 mats are produced annually with an estimated net value of R2 240 per year. If mats all are sold at the highest price of R70 per mat, the total net value would be R8 960. Under degraded conditions the total net value declines by over 60% to R840 per year. Thus the total added value of the rehabilitation structures is R1 400 per year although this could be as high as R8 120.

iii. Livestock grazing:

Wetlands are important resources for cattle towards the end of the dry-season. The Manalana Wetland is assumed to provide, on a unit area basis, a conservative estimate of 75% more forage than the non-wetland areas. Assuming a bottle-neck period of 4 weeks, an estimated 14 LSU would be sustained on the fodder produced within non-degraded wetland (i.e. under rehabilitated conditions).The replacement value of this fodder is R4 322 yr-1. However, if the safety net value of the grazing provided for the same cattle is considered, then the total net value is estimated at R9 073 yr-1. Additional benefits accrue to non-cattle owning households amounting to R2 974 yr-1. The total safety-net vale is estimated as R12 049. Under a scenario where no rehabilitation intervention has taken place, only 4 LSU would be sustained on the wetland, representing a 71% reduction in the safety net value to R2 722 yr-1 for cattle-

owning households and to R892 yr-1 for non-cattle owning households. The total safety-net value is estimated as R3 614 yr-1. Overall then, the added value of the rehabilitation structure on the provision of fodder to cattle, given as a safety-net value to peoples' livelihoods, is estimated to be R8 435 yr-1.

iv. Water for livestock:

The annual running costs for supplying water to cattle and goats was estimated to be R8 100. At a 10 year life expectancy on infrastructure, the running costs plus the annuitized capital costs amount to a total annual cost of R18 592. This value represents the total net value that the wetland in good condition provides in water for livestock.

v. Water for domestic purposes:

Craigieburn is part of a bulk distribution system for domestic water supply. However, this system is regarded as unreliable and when the system fails, people use the wetlands as a source of water to meet their basic water consumption needs. This includes water for drinking, personal hygiene (washing) and cleaning, as well as for cleaning clothes. Residents report that the water supply system fails, on average, three times a week (43% of the time). For the purposes of the valuation, it was assumed that the water supply fails 29% of the time (twice a week) and that the demand for water from alternative sources during the times of failure is estimated to be 781 978 litres. Based on these assumptions, the replacement cost of buying water from water vendors is estimated to be R15 639 per year or R340 per household. This value represents the total net value that the wetland provides when water supply fails.

Summary of key overall findings:

- Without rehabilitation the overall net benefit of the wetland to peoples' livelihoods declined by approximately 75%.
- The highest value of all the resources was attributed to crops (madumbes, pumpkin and maize collectively) and cattle. However, it is also worth noting that in terms of crops, the degradation of the Manalana Wetland would likely result in a diet more dominated by maize meal, which is the current staple.
- Natural resources are recognised for providing a 'safety-net' in times of shock or stress. In this context, the safety-net factor is central to understanding real value. In terms of livelihoods, this safety-net value of the wetland for water and for grazing by livestock is significant. Both of these essentially offer a free resource to livestock owners that would otherwise have to be bought.
- The fact that the wetland typically has moisture for longer – thereby supporting fodder production and furnishing water supplies for people and livestock – means they become a key resource in times of stress. It is argued that the presence of the Manalana Wetland reduces the lean time, or bottleneck time, allowing some animals to survive – just – until the rains arrive.
- The average net contribution of the wetland to each household using the wetland is R3 466 per year.
- The livelihood contribution to the poorest category households (33%) is substantial given that they have no regular financial income and are entirely dependent on what they grow for food security.

- The conservative estimates used in this study indicate in fact that the investment is worthwhile from all perspectives. Even at the most conservative estimates, NPV is equal to R1 995 885, with benefits more than twice the costs.

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Amathole District Municipality Wetland Mapping and Prioritization

Overview of the project

This project was funded through the LAB: Wetlands SA project that aimed to implement local pilot wetland projects within selected municipalities. The purpose of this specific implementation project was to contribute towards enhancing natural wetland resource management by contributing towards the development of a spatial wetland inventory and developing a rehabilitation plan for a priority wetland in the municipality.

Prioritizing focal catchments for wetland rehabilitation

This approach adopted in this study built on a project that was initially undertaken for the Working for Wetlands programme that aimed to prioritise catchments for wetland rehabilitation at a national scale[1]. This essentially involved an extensive data gathering and processing exercise that aimed to develop a suite of thematic GIS datasets that could be used to inform the prioritization of catchments for wetland prioritization. Datasets were initially screened and grouped into consistent themes in line with the objectives of this prioritization exercise:

Biodiversity value: Importance of catchments for meeting wetland (and broader aquatic) conservation objectives.	
Functional value: Demand for key regulating and supporting services provided by wetlands.	
Rehabilitation potential: Opportunity for wetland rehabilitation within catchments based on wetland characteristics.	

For the purposes of this exercise, data was consolidated at a quinery catchment scale. Weightings were then applied to various input datasets in order to generate maps for each of the themes above. These were then used to create two over-arching priority maps that highlighted priority areas for (i) enhancing biodiversity values and (ii) enhancing functional values provided by wetlands (**Figure A6-1**). A review of the outcomes suggested that sediment risks were a particular concern in the study area, with the assessment highlighting the opportunity to target degraded wetlands upstream of critical water supply dams in order to contribute towards improved water security in the region.

[1] Macfarlane & Atkinson, 2015

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Once the results had been reviewed and checked, these were presented to key municipal stakeholders and officials to discuss the way forward. As part of this process, areas flagged as potential priorities were discussed in more detail, with a specific focus in this case on the catchments directly upstream of the Xilinxa dam that had received the highest priority rating in the assessment (**Figure A6-1**). This dam provides the city of Butterworth and several towns and villages with drinking water. According to news reports, however, levels of supply dams in this region sat as 0.6% for the Xilinxa Dam, 21% for the Toleni Dam and 44% for the Gcuwa Dam in August 2017. This water shortage has had major implications for the Municipality, with the Mnquma Municipality alone, spending an estimated R600 000 a day carting water to Butterwoth, Centane and Ngqamakhwe during the peak of the drought.

Few intact wetlands remain in the catchment, and those that have not been severely impacted by erosion, show signs of erosion which could easily escalate further if not addressed through rehabilitation efforts (**Photo 1 & 2**). Given the importance of the dam downstream and the potential for wetland rehabilitation efforts to halt erosion, enhance sediment retention and help regulate storm flows, stakeholders agreed that this catchment be prioritised for further investigation.

Photo 1. Wetland threatened by head-cut erosion.

Photo 2. Wetland containing a large sediment store and threatened by headward erosion.

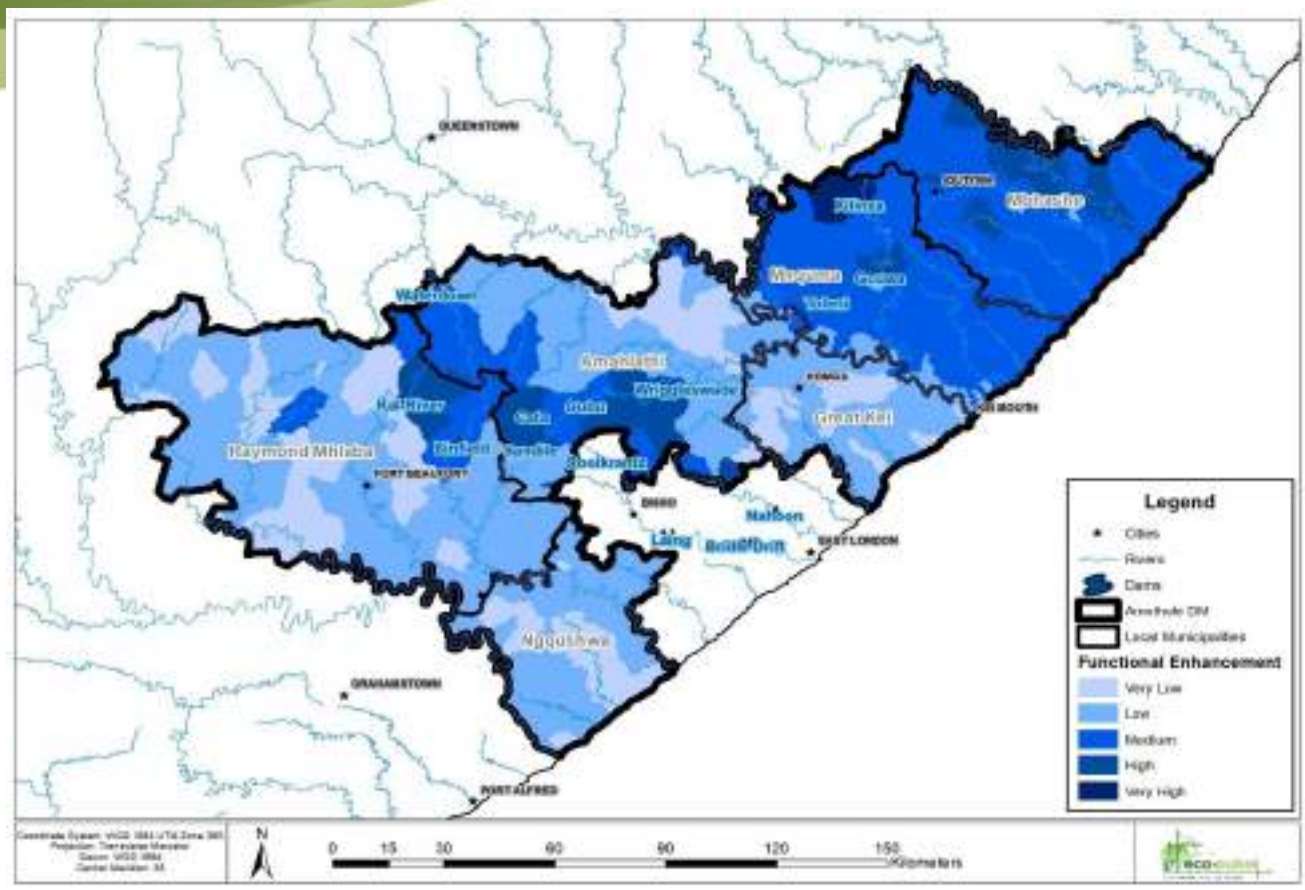


Figure A6-1. One of the maps developed indicating the opportunities for wetland rehabilitation to contribute towards enhancing functional values provided by wetlands[2].

Developing a detailed rehabilitation plan for a priority wetland

Rehabilitation planning followed on from the initial catchment prioritization exercise, and started with desktop mapping of wetlands in the catchment and prioritization of sites for wetland rehabilitation. This involved:

- Desktop prioritization of wetlands by the wetland specialist (**Figure A6-2**);
- Field assessment to evaluate the rehabilitation potential of prioritised sites; and
- Final prioritisation of wetlands based on all available information

A site visit was undertaken with key stakeholders as part of this process in order to confirm the importance of the catchment and to build an appreciation for some of the impacts that could potentially be addressed through the rehabilitation process (**Photo 3**). The site visit also provided good opportunities for collaborative learning and highlighted the potential for additional complimentary initiatives that could be implemented to address some of the concerns noted in the catchment (**Photo 4**).

[2] Eco-Pulse, 2018.

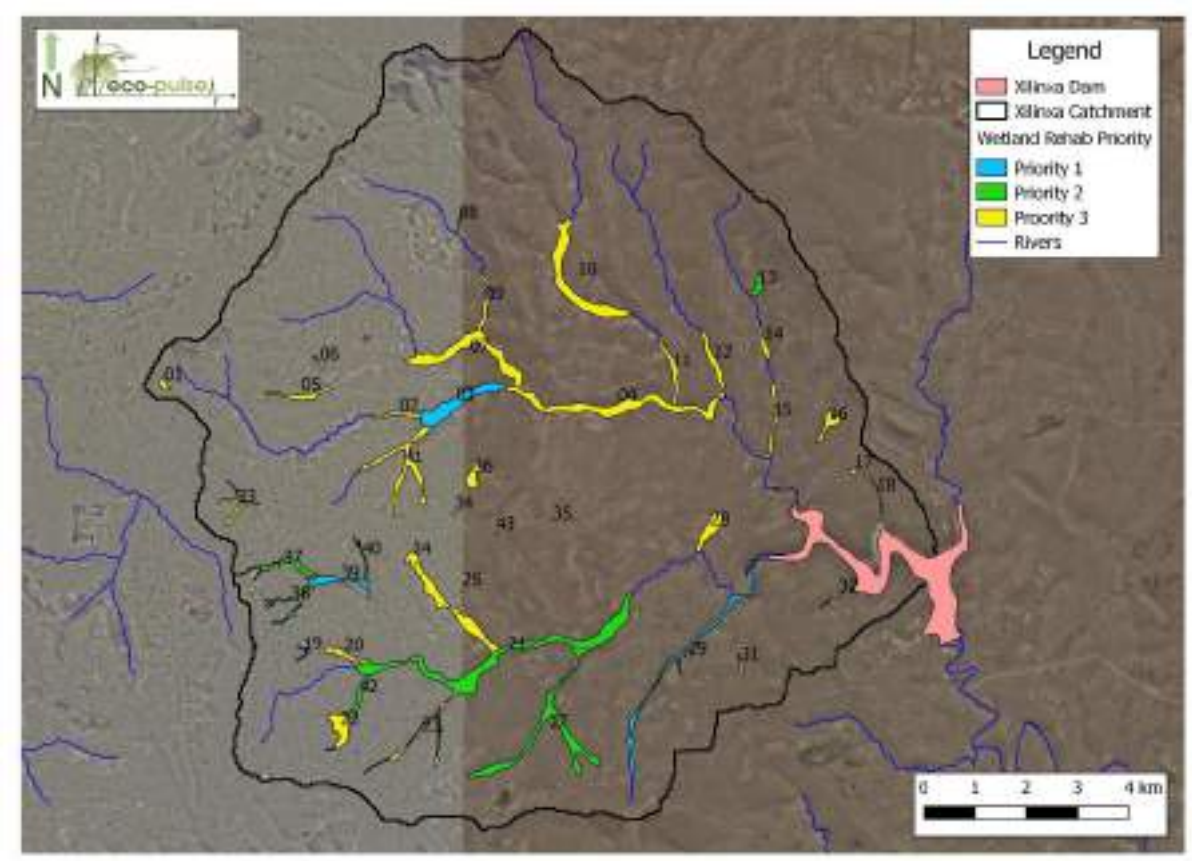


Figure A6-2. Map showing the initial desktop priority ratings for wetlands within the Xilinxa Catchment[3].

Once wetlands had been prioritised, a single wetland was selected for detailed planning (Wetland 03 in Figure A6-2). This was informed by a range of criteria including the rehabilitation potential, anticipated costs of rehabilitation and accessibility of the site. An assessment of the condition of the wetland was then undertaken using WET-Health to help diagnose the causes of wetland degradation and to develop an initial rehabilitation strategy for the site. The specialist wetland ecologist (Eco-Pulse) and civil engineer (GroundTruth) then undertook a second site visit to, confirm rehabilitation objectives and collect information necessary to develop detailed engineering drawings for the site.

[3] Eco-Pulse, 2018

Photo 3. An example of erosion affecting one of the wetlands in the study area.

Photo 4. Discussions with stakeholders as part of the field visit.

A detailed rehabilitation plan was then developed for the site which included photos of intervention sites (**Photos 5 & 6**), detailed designs (**Figure A6-4**), bills of quantities and cost estimates to inform budget planning for the Municipality. Monitoring is an important aspect of rehabilitation, and a basic monitoring plan was also developed to inform the implementation process and to ensure that rehabilitation objectives are achieved.

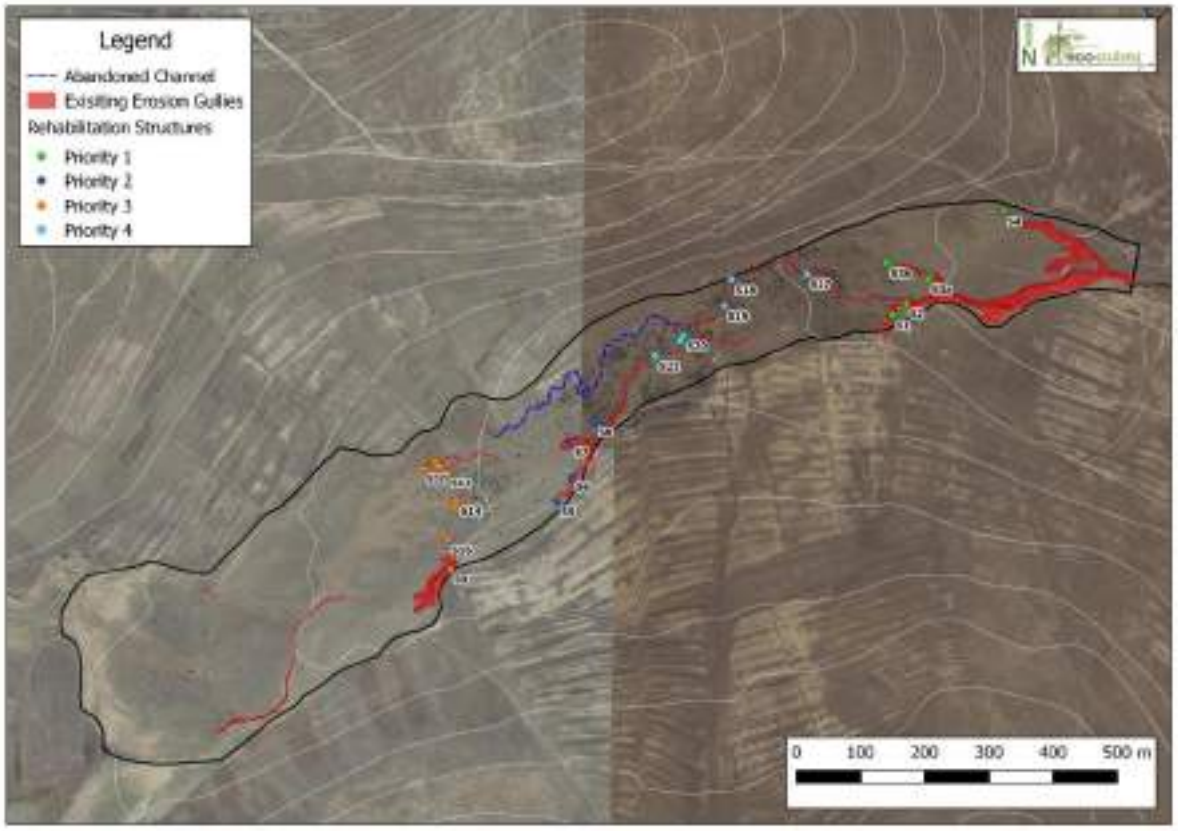
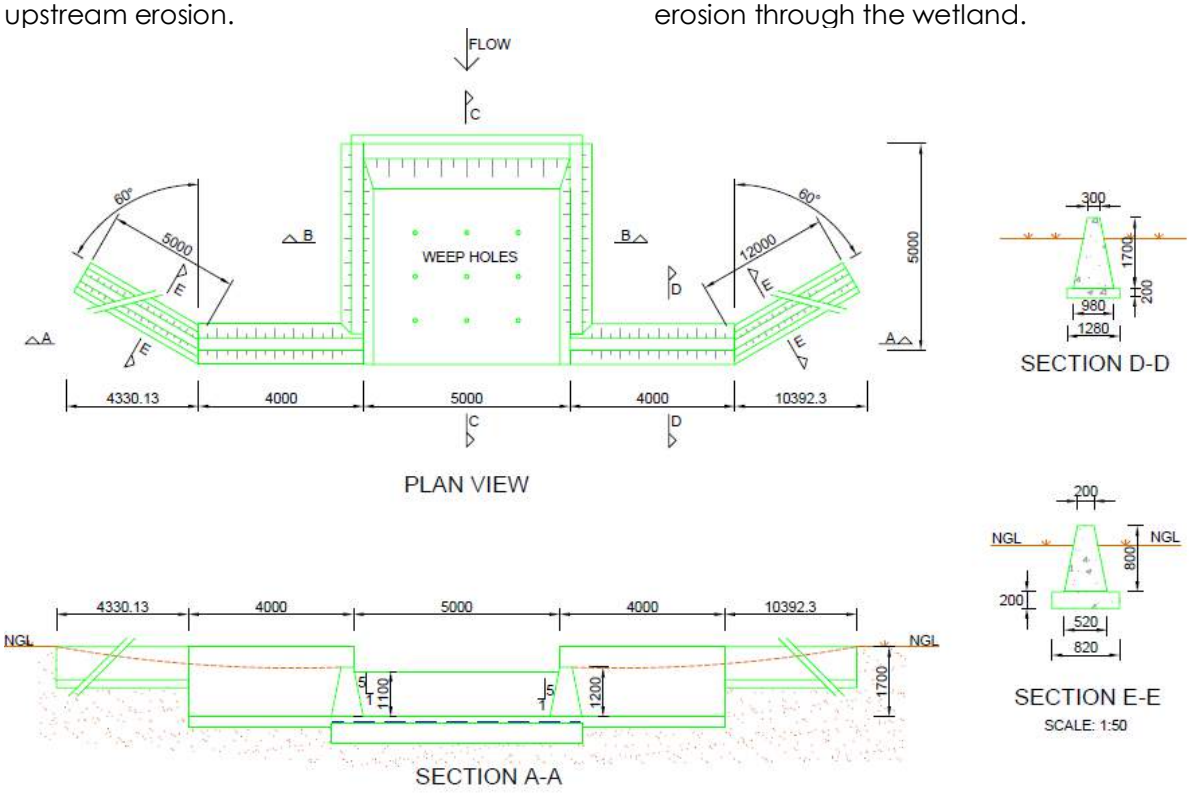


Figure A6-3. Map showing the location of planned rehabilitation interventions and their priority for implementation[4].

Photo 5. A large erosion donga at the toe of the wetland that if un-checked will result in further upstream erosion.

Photo 6. One of numerous head-cuts targeted for rehabilitation to halt the propagation of erosion through the wetland.



[4] Eco-Pulse, 2018

Figure A6-4. An example of engineering detail provided for one of the planned rehabilitation intervention. In this instance, the intervention was a concrete drop-inlet weir, designed to de-activate a head-cut (Photo 6) and so reduce the risk of further channel advancement.

Developing a local wetland inventory

The final aspect addressed in this pilot implementation project, was the development of a baseline wetland inventory for the Mnquma Local Municipality. This mapping exercise would ideally have been undertaken for the entire municipality but funding constrains meant that it needed to be focussed on a single municipality.

The ***purpose*** of the wetland inventory was to obtain a better understanding of the extent of wetland in the Municipality in order to inform wetland management interventions and strategic planning. Whilst some desktop mapping had previously been undertaken for the study area, a ***review of existing data*** suggested that mapping was patchy and somewhat inconsistent whilst no information existed on the types and condition of wetlands in the Municipality.

A ***mapping scale*** of 1: 3000 was selected for this exercise as this allows wetlands to be mapped at a high resolution. The mapping process commenced by first mapping selected areas at a desktop level using available colour photography and 5m contours available for the study area. Selected wetland sites were then visited across the local municipality in order to build a better perspective on the distribution and occurrence of wetlands in the Municipality. This included localised field sampling to refine wetland extent estimates and to confirm wetland types present. The ***mapping team*** (Junior Wetland Scientist with supervision by a Senior Wetland Scientist) then continued to map and type wetlands across the study area.

A useful ***learning point*** that emerged during this process, was that aerial photography used in the mapping process can significantly affect the mapping produced. In this instance, aerial photography provided by the Municipality had been taken in winter where wetland signatures in the vegetation were hard to detect, and meant that the mapper had to rely strongly on topographic indicators (**Photo 7**). When the initial mapping was reviewed against available Google Earth™ imagery (**Photo 8**), significant refinements in the mapping had to be made. This was particularly relevant for seep wetlands, a large number of which are only distinguishable from photos taken during wet periods.

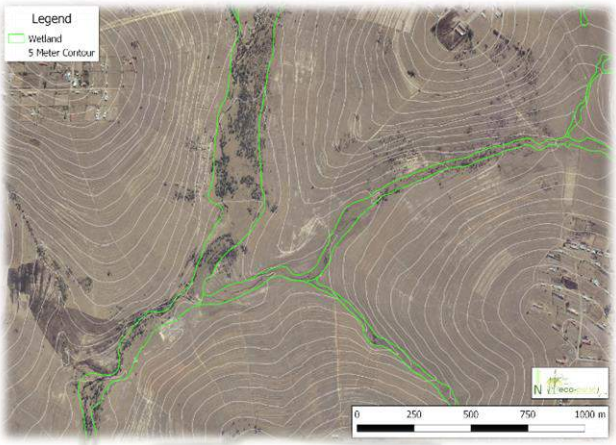


Photo 7. Imagery taken during a dry winter where vegetation provides a poor indicator to inform wetland mapping.

Photo 8. A Google Earth™ image taken during summer months was far more useful in estimating the extent of wetlands.

Once mapping had been completed, wetlands were assessed in terms of their Present Ecological State (PES). Given the sheer number of wetlands (>1000 for the study area), this assessment was undertaken at a desktop level. A new desktop-based PES assessment methodology is being developed as part of a current Water Research Commission project (WRC Project K5/2549) and was used for this assessment. The method involved the use of GIS to map wetland buffers (200m) and their associated catchments. Available national land-cover data was then re-classified into a standard suite of land-cover classes that were intersected with the wetland, buffer and catchment features. PES impact scores for each wetland feature were then determined based on algorithms that were refined for each wetland type and the default intensity scores allocated to each land-cover class. These scores were then converted to a PES category for reporting purposes (**Table A6-1**).

Table A6-1. Wetland present ecological state categories and impact descriptions.

Ecological Category	Description	Impact Score
A	Unmodified, natural.	0-0.9
B	Largely natural with few modifications / in good health. A small change in natural habitats and biota may have taken place but the ecosystem functions are still predominantly unchanged.	1-1.9
C	Moderately modified / fair condition. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	2-3.9
D	Largely modified / poor condition. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	4-5.9
E	Seriously modified / very poor condition. The loss of natural habitat, biota and basic ecosystem functions is extensive.	6-7.9
F	Critically modified / totally transformed. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota.	8-10

The results of the assessment are illustrated in **Figure A6-5**, below and show that of the wetlands mapped, close to 50% are in a moderately modified state (C PES), whilst approximately 25% remain in either a good (A/B PES) or degraded (D/E) state.

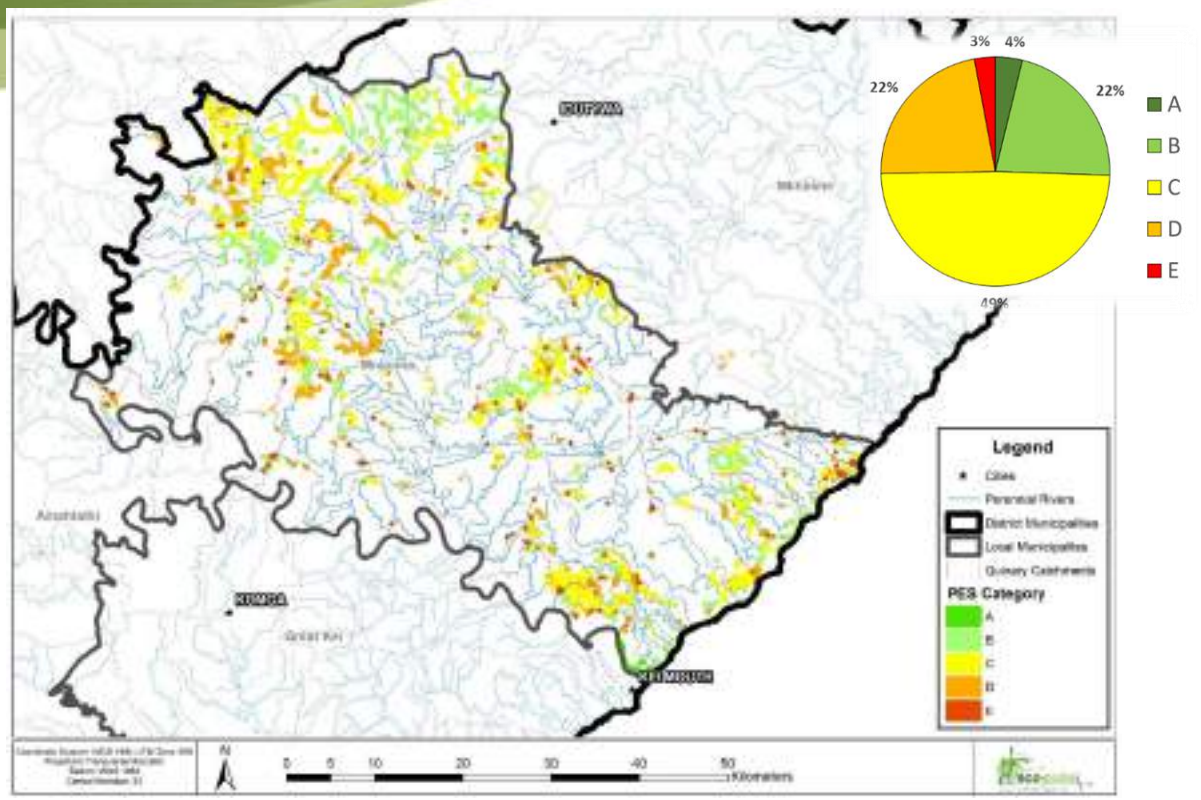


Figure A6-5. Wetland map for the Mnquma Local Municipality indicating the PES of wetlands[5].

[5] Eco-Pulse, 2018

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The public monitoring of the Liesbeek River in the City of Cape Town

The Friends of the Liesbeek (FOL) are an active citizen group which steward and maintain a 9 km stretch of the Liesbeek River which traverses some of the oldest suburbs of Cape Town. FOL have established a wide community following of over 200 members and a large following via Facebook and Twitter. FOL has also been diligently building relationships over the years with the City of Cape Town, the police service and various other authorities. Over time, the Liesbeek River has been subject to many illegal uses, including dumping, pollution, fish-netting, damming, and water extraction just to name a few. Illegal activity in and around the Liesbeek has also intensified with the escalating water scarcity in the City of Cape Town. FOL provides stewardship and maintenance along the Liesbeek River, active neighbourhood engagement through events and partnerships and an active social media presence. This has broadened its presence on the river by encouraging positive recreational activities along the Liesbeek. By having additional "eyes on the river", FOL has become increasingly aware of illegal activity impacting the river and was able in turn to refer these incidents to the authorities. Through social media, river users can easily and quickly post photos of illegal activity, disseminate information and gather support for river protection. This arms the authorities with strong evidence and facilitates the enforcement job. This crowd-sourcing approach therefore relies on community members, organisations and strong relationship building to protect a valuable water resource with relatively few policing resources.

Figure A7-1. A Facebook post showing the FOL Maintenance crew breaking up another reported illegal damming in the river. The post is asking the community to report other illegal activity had been widely shared and commented on.

The integration of the Durban Metropolitan Open Space System (D'MOSS) into the eThekwini Municipality Land Use Scheme.

Overview:

D'MOSS stands for the Durban Metropolitan Open Space System. D'MOSS is a system of open spaces, some 78 000 ha of land and water, that incorporates areas of high biodiversity value linked together in a viable network of open spaces[1]. D'MOSS is mapped by the Biodiversity Planning Branch of the Environmental Planning and Climate Protection Department (EPCPD) in consultation with relevant experts[1].

The primary objective of the D'MOSS layer is to identify open space areas which require protection and management and then to secure these through a variety of tools such as education, awareness, incentives, targeted land acquisition, supportive valuation and rating approaches, conservation servitudes and other town planning mechanisms. The proclamation of nature reserves, and establishment of public-private partnerships, are also promoted as part of efforts to protect Durban's environment.

From a natural resource perspective, D'MOSS includes approximately 2 400 ha of estuarine environment, including sand and mudbanks, mangrove and swamp forests; 14 000 ha of forests including dune, coastal and scarp forests; 7 500 ha of wetlands including floodplains, swamp forest and reedbeds; 13 000 ha of grassland including the threatened KZN Sandstone Sourveld Grasslands; and 40 000 ha of dry valley thicket[1].

A Work Bank report completed in 2017 shows that natural and semi-natural systems within the eThekwini Municipal Area give rise to flows of ecosystem services worth at least R4.2 billion per year[2]. The total asset value of these areas are estimated to be at least R48 — 62 billion[2]. Without these free services, the municipality would require an unaffordable increase to its budget to provide these services, especially in the rural areas, where communities rely heavily on the natural environment for daily needs[2].

The D'MOSS plan was recently updated based on a Systematic Conservation Assessment (SCA)[3] approved by eThekwini Council in 2016. The purpose of the SCA was to identify and prioritize areas for the conservation of biodiversity and the ecosystem services biodiversity provides to the citizens of Durban[3].

A map showing the location and extent of D'MOSS and the priorities identified as part of the SCA are shown in Figure A8-1.

[1] EPCPD, 2011a
[2] EPCPD, 2011b
[3] McLean et al., 2016

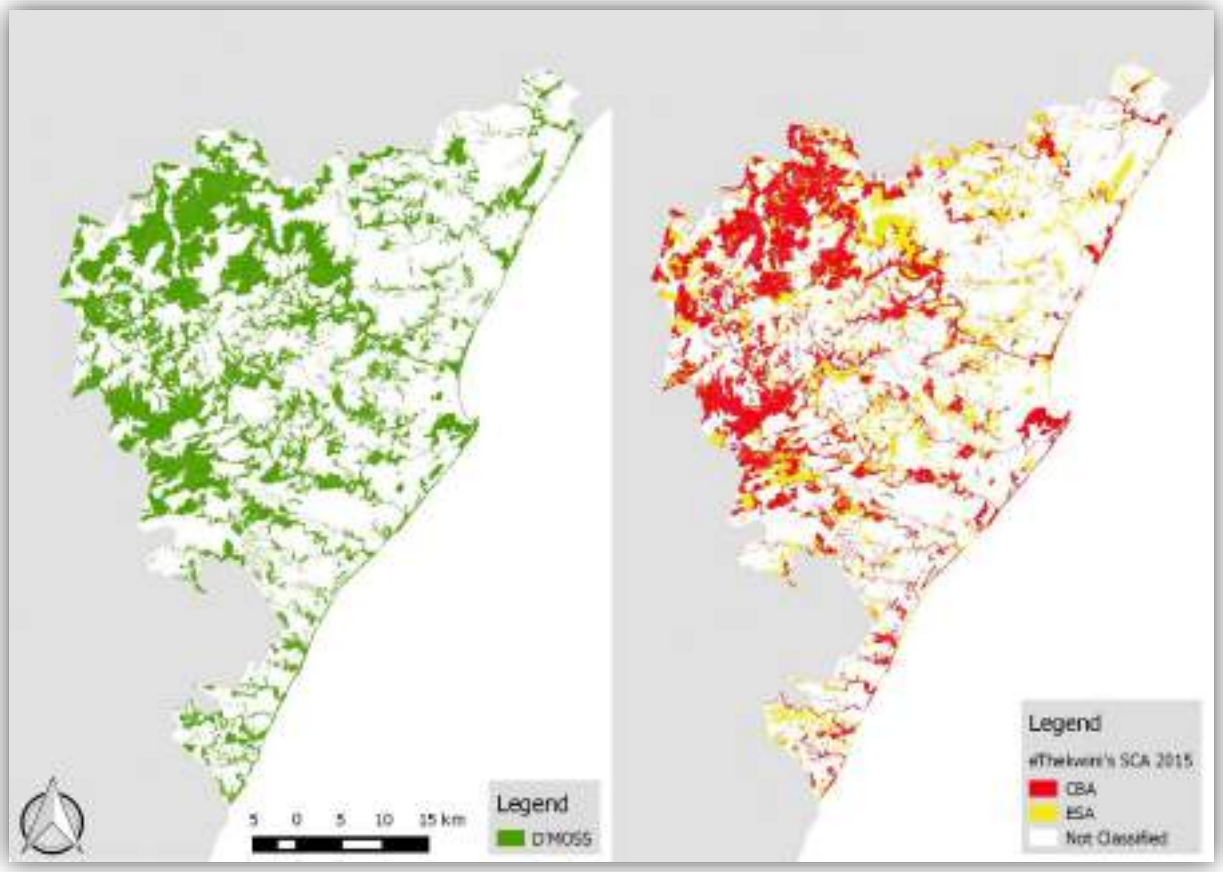

Figure A8-1. Maps illustrating the D'MOSS and biodiversity priorities of the SCA.

Mainstreaming D'MOSS into spatial / land use planning:

The 2014–2015 IDP includes D'MOSS as part of a programme that aims to ensure the long-term sustainability of the natural resource base. Refer to Plan 1: 'Develop and Sustain our Social, Natural and Built Environment' of 'The Eight Point Plan' of the IDP. The goal of this particular plan is as follows: "Citizens will be able to access and use resources to meet their needs without compromising the amenity for others and the resource base of the Municipality in the present and in the future". To achieve this goal, an inventory of the natural resource base, the opportunities and limitations on its use, and the threats to its sustainability, have to be clearly documented and translated into spatially explicit implementation tools, such as the D'MOSS[4]. This layer is a crucial cog in the regulatory machine of development assessment as well as a focal point for proactive initiatives such as the promotion of 'green job' projects, a component of Plan 2: Developing a Prosperous, Diverse Economy and Employment Creation[3].

Until recently, D'MOSS has been a policy directive that poses no formal restrictions on development and land rights and no legal weight in planning applications[5]. This proved to be problematic as in some cases, the potential land uses are incompatible with the environmental qualities of the site leading to uncertainty about the future development potential of the land[5]. Although D'MOSS has appeared in the

[4] McLean et al., 2016
[5] Boon et al., 2016

city's strategic plans since 1998, many of the local level schemes were developed many years ago (some as early as the 1950s), with little environmental input and as a result the perceived development 'rights' they confer often conflict with more recent environmental plans, policy and law[5]. If the development notionally permitted by the schemes was fully realised, it would be impossible to conserve Durban's biodiversity adequately[5]. This has led to conflict during development application processes, when development has been refused or limited in environmentally sensitive areas, apparently contradicting what is permitted by the schemes[5].

In order to proactively address this disjuncture, D'MOSS was included in all municipal schemes on 9 December 2010 as a 'controlled development layer'[5]. This is the first for a South African city[5]. The scheme regulations require that all planning applications in or adjacent to D'MOSS are assessed for potential biodiversity impacts[5]. The amendment to the schemes was approved after extensive public consultation involving owners of approximately 18 000 properties[5]. The successful inclusion of D'MOSS in all spatial plans stems in part from the location of the EPCPD in a planning unit, an institutional opportunity that has been effectively utilised[5]. As a consequence, eThekwini Municipality's Treasury and Real Estate Departments can now consider potential environmental restrictions when property values and taxes are calculated and developers are prompted to consider the environment earlier in their development plans[5].

The inclusion of D'MOSS in the schemes has been viewed by some as illegally curtailing existing property rights[5]. As a result, an application was made by a landowner to the High Court of South Africa to have the resolution of the city council set aside[5]. The applicant argued that the introduction of D'MOSS into the Municipality's schemes was unconstitutional and that local government's actions exceeded its powers as it lacked the authority to legislate on biodiversity related matters, which it was contended are the exclusive sphere of national and provincial government[5]. The court agreed with local governments' argument that legislating for the environment through municipal planning (a local government competence) was permissible and that the D'MOSS amendments were in no way a transgression of national and provincial government competencies (Le Seuer vs eThekwini Municipality & Others 2013)[5].

In recent years, eThekwini Municipality has also introduced a Conservation Zone and Environmental Conservation Reserve into all of its schemes[6]. The Conservation Zone is used for environmental protection on private land, whereas the Environmental Conservation Reserve is used for state land including conservation land owned by local government[6]. The reservation was introduced to differentiate land with a conservation purpose from Public Open Space, which permits various uses, some incompatible with environmental protection[6]. The Conservation Zone regulations allow possible relaxation of the minimum property size and the required 25m buffer from D'MOSS areas, and the transfer of potential rights from the Conservation Zone portion of split zoned sites to the developable portion[6]. These provisions minimize the impact on development potential and protect environmentally sensitive land[6].

[6] Boon et al., 2016

Since D'MOSS has been included in the Municipality's scheme provisions, any planning application for a site included in or immediately adjacent to D'MOSS must be assessed by the EPCPD[6]. This is additional to any requirements for environmental authorisation, which may be 'triggered' in terms of the National Environmental Management Act (Act 107 of 1998) Environmental Impact Assessment Regulations. The eThekwini Municipality is the decision-maker in planning applications and a commenting authority in environmental applications. Including environmental considerations in planning applications ensures that local government's interests are covered and that small-scale developments, which do not require assessment in terms of national legislation, do not have a significant local or cumulative environmental impact[6]. Development of critical biodiversity areas is not supported unless circumstances are exceptional (e.g. for strategic infrastructure) and options to avoid and mitigate impacts have been thoroughly investigated[6]. Portions of development sites, which are excluded from development, may be protected through conditions of approval including conservation servitudes or appropriate zoning[6]. EPCPD also has a small, but growing, compliance and enforcement function, which is tasked with working with various regulatory authorities to take action on priority biodiversity compliance issues[6].

Incentivizing D'MOSS conservation – Environmental Rates Certificates[7]:

eThekwini Municipality has made incentives available to reduce the financial burden on D'MOSS landowners who are managing their land for conservation purposes. Currently, the main incentive is a rates reduction through the eThekwini Rates Policy, which first came into effect in 2008. Sections 7.15.4 to 7.15.7 of the Policy states:

7.15.4 Upon application to the Environment Planning and Climate Protection Department, by no later than 30 April preceding the start of the new Municipal year for which the certificate is sought, an Environmental Certificate may be granted to owners of any piece of land or part thereof, where:

a) The Municipality considers the land to be environmentally sensitive, e.g. it forms part of the Durban Metropolitan Open Space System (DMOSS);
b) The land is zoned for conservation purposes or an environmental servitude has been registered in favour of the Municipality over the environmentally sensitive area; and
c) The landowner, with the assistance of the Municipality, prepares and implements an approved management plan aimed at protecting and improving the local environment.

7.15.5 Where the land is not zoned for conservation purposes and an environmental servitude has not been registered in favour of the Municipality, an owner may be granted a reduction or rebate, provided the owner has agreed to the Municipality rezoning the affected land to protect the environment.

7.15.6 The owner of a Nature Reserve / Conservation area cannot receive a reduction or rebate on the Nature Reserve/Conservation area component of the property in addition to the rate benefits in terms of 7.15.4 above.

7.15.7 The Environmental Certificate will lapse if the property is no longer used for bona fide environmental conservation purposes, in which event, the property will be rated on its new use from date of such use.

[7] This section has been extracted from EPCPD, 2011c

Should a property satisfy all three requirements as listed in a. to c. above, a landowner may apply to the EPCPD) for an Environmental Rates Certificate. Should the application be successful, the property value will be reduced so that no rates will be charged on the portion that is being managed for conservation, assuming that the portion could be developed and had value in the first place.

The EPCPD will assist applicants to prepare an Environmental Management Plan, which will be audited on an annual basis to verify that it was implemented. Based on the outcome of the audit, the arrangement for no rates to be paid on the portion being managed for conservation will either continue or be discontinued.

D'MOSS management[8]:

The management of D'MOSS in Durban is undertaken by various departments and agencies. Overall 7.96% of D'MOSS is formally managed. Durban's Parks Leisure and Cemeteries Department manages a number of municipal nature reserves and other municipal-owned areas included in D'MOSS. The Department does not, however, have sufficient resources to increase the areas under its management (e.g. those newly acquired for conservation) or to implement best practice programmes focused on the management of fire-dependent ecosystems. As a result in 2009, EPCPD initiated local Working on Fire (WoF) and Working for Ecosystems (WfE) programmes to manage and rehabilitate important areas outside of the Parks, Leisure and Cemeteries Department's jurisdiction. WoF and WfE have social co-benefits through alleviating poverty and developing skills in the previously disadvantaged people employed in the programmes. In the 2012/2013 financial year, the eThekwini Municipality spent nearly R11 million on these programmes. Work is focused on the control of invasive alien plants and the use of fire to maintain grassland condition.

Conclusion:

The case of D'MOSS indicates that a well substantiated and scientifically backed open space system can become an important and powerful tool for mainstreaming environmental concerns, including wetland biodiversity and ecosystem management concerns, into municipal spatial planning as well as assisting in the regulation of all future land development. Such a formal open space system can also become a focal point of IDP programmes and projects. In terms of wetland management, it will be important for the development of open space systems like D'MOSS to also include direct and indirect ecosystem services and integrate these aspects with biodiversity priorities.

[8] This section has been extracted from Boon et al., 2016

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Annexure B

Annexure B1: Description and summary of Legislation regulating activities that impact Wetlands

National Water Act, No. 36 of 1998 ('NWA')

The alteration of the condition and characteristics of a wetland is considered a water use in Sections 21(c) and 21(i) of the NWA. The relevant excerpts in the act as listed as follows:

- 21(c): impeding or diverting the flow of water in a watercourse.
- 21(i): altering the bed, banks, course or characteristics of a watercourse.

Note: Wetlands fall under the umbrella term 'watercourses' in the NWA.

The definitions of the particular terms within Section 21(c) and (i) of the NWA are included in Section 1 of the NWA and Section 2 of Government Notice 509 of 2016 dealing with provisions for general authorisations published under Section 39 of the NWA. The relevant definitions are as follows:

Section 1 of NWA (1998):

- 'Resource quality' means the quality of all the aspects of a water resource including -
  - (a) the quantity, pattern, timing, water level and assurance of instream flow;
  - (b) the water quality, including the physical, chemical and biological characteristics of the water;
  - (c) the character and condition of the instream and riparian habitat; and
  - (d) the characteristics, condition and distribution of the aquatic biota.

Section 2 of GN No. 509 (2016):

- 'Characteristics of a watercourse' means the resource quality of a watercourses within the extent of a watercourse.
- 'Diverting' means to, in any manner, cause the instream flow of water to be rerouted temporarily or permanently.
- 'Extent of a watercourses' means:
  - The outer edge of the 1 in 100 year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam; and
  - Wetlands and pans: the delineated boundary (outer temporary zone) of any wetland or pan.
- 'Flow altering' means to, in any manner, alter in the instream flow route, speed or quantity of water temporarily or permanently.
- 'Impeding' means to, in any manner, hinder or obstruct the instream flow of water temporarily or permanently, but excludes the damming of flow so as to cause storage of water.

The important implications of these definitions are:

- A section 21(i) water use is applicable if the characteristics of a watercourse are altered irrespective of whether the alteration is direct or indirect. This means that a development can be located some distance away from watercourses but could still negatively impact a watercourse e.g. alteration of catchment hydrology, pollution of runoff etc.
- If the 1:100 year floodline of a river / stream is larger than the delineated riparian zone, the 1:100 year floodline constitutes the outer extent of the watercourse that could be negatively affected.

If an activity is considered a Section 21(c) and/or 21(i) water use, a water use license to commence with the construction and operation of the activity is required from the DWS subject to a formal water use license application (WULA). However, Section 39 of the NWA makes provision for the general authorisation of a water use without a formal water use license. General authorisations are applicable in the following situations as stipulated in GN No. 509 (2016):

- Where the proposed use has a low risk class as determined using the risk matrix published with GN No. 509 (2016).
- The activity constitutes maintenance work associated with an existing lawful water use in terms Section 21(c) or (i) of the Act that has a low risk class as determined using the risk matrix.
- The activity constitutes river and stormwater management activities as contained in a river management plan.
- Rehabilitation of wetlands or rivers where such rehabilitation activities has a low risk class as determined using the risk matrix.

- Emergency work arising from an emergency situation or incident associated with the persons' existing lawful water use, provided that all work is executed and reported in the manner prescribed in the Emergency Protocol.

It is important to note that Sections 9 – 17 of GN No. 209 (2016) provide a generic / standard set of conditions for GA's, some of which are particularly onerous.

If the Department of Water & Sanitation (DWS) confirm that a water use licence is not required, the NWA still imposes 'duty of care' on all landowners / developers, to ensure that water resources are not negatively impacted, particularly pollution. The following Clause in terms of the NWA is applicable in this case:

> *19 (1) "An owner of land, a person in control of land or a person who occupies or uses the land on which (a) any activity or process is or was performed or undertaken; which causes, has caused or likely to cause pollution of a water resource, must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring"*

A person who is responsible for an incident; or who owns a substance involved in an incident or who was in control of a substance involved in an incident, must take all reasonable measures to contain and minimise the effects of an incident and any other such measures that a Catchment Management Agency (CMA) may require.

National Environmental Management Act, No. 107 of 1998 ('NEMA')

Listed Activities that may negatively affect watercourses including wetlands have been published in Listing Notices of the EIA Regulations (2017) published under Section 24(5) and 44 the NEMA. The relevant listed activities are described in Table 1 below. The environmental authorisation of activities included in Listing Notices 1 and 3 must be subject to a basic assessment and those under Listing Notice 2 must be subject to a full Environmental Impact Assessment (EIA).

Table 1. Relevant listed activities related to wetlands.

Government Notice No.	Activity No.	Activity Description
R. 327 (Listing Notice 1)	12	The development of- (i) canals exceeding 100 square metres in size; (ii) channels exceeding 100 square metres in size; (iii) bridges exceeding 100 square metres in size; (iv) dams, where the dam, including infrastructure and water surface area, exceeds 100 square metres in size; (v) weirs, where the weir, including infrastructure and water surface area, exceeds 100 square metres in size; (vi) bulk storm water outlet structures exceeding 100 square metres in size; (vii) marinas exceeding 100 square metres in size; (viii) jetties exceeding 100 square metres in size; (ix) slipways exceeding 100 square metres in size; (x) buildings exceeding 100 square metres in size; xi) boardwalks exceeding 100 square metres in size; or (xii) infrastructure or structures with a physical footprint of 100 square metres or more, (xiii)dams or weirs, where the dam or weir, including infrastructure and water surface area, exceeds 100 square metres; or (xiv) infrastructure or structures with a physical footprint of 100 square metres or more; where such development occurs- (a) within a watercourse; (b) in front of a development setback; or (c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse; -

Government Notice No.	Activity No.	Activity Description
		excluding- (aa) the development of infrastructure or structures within existing ports or harbours that will not increase the development footprint of the port or harbour; (bb) where such development activities are related to the development of a port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies; (cc) activities listed in activity 14 in Listing Notice 2 of 2014 or activity 14 in Listing Notice 3 of 2014, in which case that activity applies; (dd) where such development occurs within an urban area; or (ee) where such development occurs within existing roads or road reserves. (ff) the development of temporary infrastructure or structures where such infrastructure or structures will be removed within 6 weeks of the commencement of development and where indigenous vegetation will not be cleared.
R. 327 (Listing Notice 1)	13	The development of facilities or infrastructure for the off-stream storage of water, including dams and reservoirs, with a combined capacity of 50000 cubic metres or more, unless such storage falls within the ambit of activity 16 in Listing Notice 2 of 2014.
R. 327 (Listing Notice 1)	19	The infilling or depositing of any material of more than 10 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 10 cubic metres from- (i) a watercourse; (ii) the seashore; or (iii) the littoral active zone, an estuary or a distance of 100 metres inland of the high-water mark of the sea or an estuary, whichever distance is the greater but excluding where such infilling, depositing , dredging, excavation, removal or moving- (a) will occur behind a development setback; (b) is for maintenance purposes undertaken in accordance with a maintenance management plan; or (c) falls within the ambit of activity 21 in this Notice, in which case that activity applies. (d) occurs within existing ports or harbours that will not increase the development footprint of the port or harbour; or (e) where such development is related to the development of a port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies.
R. 327 (Listing Notice 1)	48	The expansion of- . (i) canals where the canal is expanded by 100 square metres or more in size ; (ii) channels where the channel is expanded by 100 square metres or more in size ; (iii) bridges where the bridge is expanded by 100 square metres or more in size; (iv) dams, where the dam, including infrastructure and water surface area, is expanded by 100 square metres or more in size; (v) weirs, where the weir, including infrastructure and water surface area, is expanded by 100 square metres or more in size; (vi) bulk storm water outlet structures where the bulk storm water outlet structure is expanded by 100 square metres or more in size; or (vii) marinas where the marina is expanded by 100 square metres or more in size; (viii) infrastructure or structures where the physical footprint is expanded by 100 square metres or more; or (viv) dams or weirs, where the dam or weir, including infrastructure and water surface area, is expanded by 100 square metres or more;

Government Notice No.	Activity No.	Activity Description
		where such expansion or expansion and related operation occurs- (a) within a watercourse; (b) in front of a development setback; or (c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse; excluding- (aa) the expansion of infrastructure or structures within existing ports or harbours that will not increase the development footprint of the port or harbour; (bb) where such expansion activities are related to the development of a port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies; (cc) activities listed in activity 14 in Listing Notice 2 of 2014 or activity 14 in Listing Notice 3 of 2014, in which case that activity applies; (dd) where such expansion occurs within an urban area; or (ee) where such expansion occurs within existing roads or road reserves and railway reserves.
R. 327 (Listing Notice 1)	49	The expansion of - (i) jetties by more than 100 square metres; (ii) slipways by more than 100 square metres; (iii) buildings by more than 100 square metres; (iv) boardwalks by more than 100 square metres; or (v) infrastructure or structures where the physical footprint is expanded by 100 square metres or more; where such expansion or expansion and related operation occurs- (a) within a watercourse; (b) in front of a development setback; or (c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse; excluding- (aa) the expansion of infrastructure or structures within existing ports or harbours that will not increase the development footprint of the port or harbour; (bb) where such expansion activities are related to the development of a port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies; (cc) activities listed in activity 14 in Listing Notice 2 of 2014 or activity 14 in Listing Notice 3 of 2014, in which case that activity applies; (dd) where such expansion occurs within an urban area; or (ee) where such expansion occurs within existing roads or road reserves.
R. 325 (Listing Notice 2)	15	The clearance of an area of 20 hectares or more of indigenous vegetation, excluding where such clearance of indigenous vegetation is required for— (i) the undertaking of a linear activity; or (ii) maintenance purposes undertaken in accordance with a maintenance management plan.
R. 325 (Listing Notice 2)	24	The extraction or removal of peat or peat soils, including the disturbance of vegetation or soils in anticipation of the extraction or removal of peat or peat soils, but excluding where such extraction or removal is for the rehabilitation of wetlands in accordance with a maintenance management plan.
R. 324 (Listing Notice 3)	5	The development of resorts, lodges, hotels, [and] tourism or hospitality facilities that sleep less than 15 people: For all areas outside of urban areas in the Eastern Cape, Free State, KwaZulu-Natal, Limpopo, Mpumalanga, Northern Cape:

Government Notice No.	Activity No.	Activity Description
		- Areas within a watercourse or wetland, or within 100 metres of a watercourse or wetland. For all areas of the North West Province: - Areas within a watercourse or wetland, or within 100 metres of a watercourse or wetland.
R. 324 (Listing Notice 3)	6	The development of resorts, lodges, hotels, [and] tourism or hospitality facilities that sleep 15 people or more: For all areas outside of urban areas in Eastern Cape: - Areas on the watercourse side of the development setback line or within 100 metres from the edge of a watercourse where no such setback line has been determined; or - A watercourse, For all areas outside of urban areas in Free State, KwaZulu-Natal, Limpopo, Mpumalanga, Northern Cape: Areas within a watercourse or wetland, or within 100 metres of the edge of a watercourse or wetland; or For all areas of the North West Province: (vi) Areas within a watercourse or wetland, or within 100 metres of a watercourse or wetland.
R. 324 (Listing Notice 3)	7	The development of aircraft landing strips and runways 1,4 kilometres and shorter. For all areas outside of urban areas in Eastern Cape: - Areas on the watercourse side of the development setback line or within 100 metres from the edge of a watercourse where no such setback line has been determined; - A watercourse. For all areas outside of urban areas in Free State, KwaZulu-Natal, Limpopo, Mpumalanga, Northern Cape: - Areas within a watercourse or wetland, or within 100 metres of the edge of a watercourse or wetland.
R. 324 (Listing Notice 3)	8	The development and related operation of above ground cableways and funiculars. For all areas inside urban areas in Free State, Mpumalanga, Northern Cape and North West: - Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland. For all areas inside urban areas in KZN: - Areas within a watercourse or wetland.
R. 324 (Listing Notice 3)	9	The development and related operation of ziplines or foefieslides Exceeding 100 metres in length. All areas within the Free State and North West: - Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland. For all areas inside urban areas in KZN: - Areas within a watercourse or wetland. For all areas inside urban areas in Mpumalanga and Northern Cape:

Government Notice No.	Activity No.	Activity Description
		- Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland.
R. 324 (Listing Notice 3)	10	The development and related operation of facilities or infrastructure for the storage, or storage and handling of a dangerous good, where such storage occurs in containers with a combined capacity of 30 but not exceeding 80 cubic metres. For all areas outside of urban areas in Free state, KZN, Mpumalanga: - Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland; or All areas within Northern Cape, North West: - Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland;
R. 324 (Listing Notice 3)	11	The development of tracks or routes for the testing, recreational use or outdoor racing of motor powered vehicles excluding conversion of existing tracks or routes for the testing, recreational use or outdoor racing of motor powered vehicles. For all areas inside urban areas in KZN: - Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland; All areas within North West: - Areas within a watercourse or wetland, or within 100 metres from the edge of a watercourse or wetland.
R. 324 (Listing Notice 3)	12	The clearance of an area of 300 square metres or more of indigenous vegetation except where such clearance of indigenous vegetation is required for maintenance purposes undertaken in accordance with a maintenance management plan. All areas within Free State, North West: - Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland.
R. 324 (Listing Notice 3)	13	The development and related operation of facilities of any size for any form of aquaculture. All areas within Free State, Northern Cape, North West: - Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland. All areas within KZN: - Areas within a watercourse or wetland;
R. 324 (Listing Notice 3)	16	The expansion of reservoirs, [for bulk water supply] excluding dams, where the capacity will be increased by more than 250 cubic metres. Inside urban areas within KZN: - Areas within a watercourse or wetland;
R. 324 (Listing Notice 3)	17	The expansion of a resort, lodge, hotel, [and] tourism or hospitality facilities where the development footprint will be expanded and the expanded facility can accommodate an additional 15 people or more. Outside urban areas within KZN: - Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland; All areas within North West:

Government Notice No.	Activity No.	Activity Description
		- Areas within a watercourse or wetland, or within 100 metres from the edge of a watercourse or wetland.
R. 324 (Listing Notice 3)	18	The widening of a road by more than 4 metres, or the lengthening of a road by more than 1 kilometre. Outside urban areas within Free State, Northern Cape: - Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland; All areas within North West: - Areas within a watercourse or wetland, or within 100 metres from the edge of a watercourse or wetland.
R. 324 (Listing Notice 3)	19	The expansion of runways or aircraft landing strips where the expanded runways or aircraft landing strips will be longer than 1,4 kilometres in length. Outside urban areas within Free State, KZN, Northern Cape: - Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland;
R. 324 (Listing Notice 3)	20	The expansion and related operation of above ground cableways and funiculars where the development footprint will be increased. Inside urban areas within Free State, Mpumalanga, Northern Cape: Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland. Inside urban areas within KZN: - Areas within a watercourse or wetland; All areas within North West: - Areas within a watercourse or wetland, or within 100 metres from the edge a watercourse or wetland.
R. 324 (Listing Notice 3)	21	The expansion of tracks or routes for the testing, recreational use or outdoor racing of motor powered vehicles excluding conversion of existing tracks or routes for the testing, recreational use or outdoor racing of motor powered vehicles, where the development footprint will be expanded. Inside urban areas within KZN: - Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland; All areas within North West: - Areas within a watercourse or wetland, or within 100 metres from the edge of a watercourse or wetland.
R. 324 (Listing Notice 3)	22	The expansion and related operation of facilities or infrastructure for the storage, or storage and handling of a dangerous good, where such storage facilities or infrastructure will be expanded by 30 cubic metres or more but no more than 80 cubic metres. Outside urban areas within Free State, KZN, Mpumalanga: - Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland; Inside urban areas within Mpumalanga: - Areas within 100 metres of a watercourse or wetland. All areas within Northern Cape, North West:

Government Notice No.	Activity No.	Activity Description
		- Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland;
R. 324 (Listing Notice 3)	24	The expansion and related operation of facilities of any size for any form of aquaculture. All areas within Free State, Northern Cape, North West: - Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland. All areas within KZN: - Areas within a watercourse or wetland;
	25	The expansion and related operation of zip- lines or foefie-slides, where the zip- line or foefie-slide is expanded by 100 metres in length or more. All areas within Free State, North West: - Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland. Inside urban areas within KZN: Areas within a watercourse or wetland; Inside urban areas within Mpumalanga, Northern Cape: - Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland.

Where environmental authorisation is not required, Section 28 of NEMA still imposes 'duty of care' on all landowners / developers. According to Section 28:

(1) Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment.

(3) The measures required in terms of subsection (1) may include measures to—

a. investigate, assess and evaluate the impact on the environment;

b. inform and educate employees about the environmental risks of their work and the manner in which their tasks must be performed in order to avoid causing significant pollution or degradation of the environment;

c. cease, modify or control any act, activity or process causing the pollution or degradation;

d. contain or prevent the movement of pollutants or the causant of degradation;

e. eliminate any source of the pollution or degradation; or

f. remedy the effects of the pollution or degradation.

Conservation of Agricultural Resources Act, 1983

Regulated activities that may negatively affect watercourses including wetlands are included in the CARA Regulations as amended (2001) published under Section 29 the CARA. The relevant regulated activities are described in Table 2 below. Formal approval / permission from an executive officer is required before such regulated activities can take place.

Table 2. Relevant regulations related to watercourses.

Government Notice No.	Regulation No.	Regulation Description
R280 (March 2001)	2	- Cultivation of virgin soil Except on the authority of a written permission by the executive officer, no land user shall cultivate* any virgin soil**.

Government Notice No.	Regulation No.	Regulation Description
		* Cultivation: In relation to land, means any act by means of which the topsoil is disturbed mechanically. ** Virgin soil: land, which in the opinion of the executive officer, has at no time during the preceding ten (10) years been cultivated.
R280 (March 2001)	7	Utilisation and protection of vleis, marshes, water sponges and water courses. 7(1) no land user shall utilise the vegetation in a vlei, marsh or water sponge or within the flood area of a water course or within 10 metres horizontally outside such flood area in a manner that causes or may cause the deterioration of or damage to the natural agricultural resources 7(3) Except on authority of a written permission by the exec. officer, no land user shall – – 7(3)(a) drain or cultivate any vlei, marsh or water sponge or a portion thereof on his farm unit; or – 7(3)(b) cultivate any land on his farm unit within the flood area of a water course or within 10 metres horizontally outside the flood area of a water course. *** *Watercourse*:** a natural flow path in which water is concentrated and along which it is carried away.
R280 (March 2001)	8	Regulation of the flow pattern of run-off water 8(1) no land user shall in any manner whatsoever divert any run-off water from a water course on his farm unit to any other water course, except on authority of a written permission by the executive officer. 8(4) no land user shall effect an obstruction that will disturb the natural flow pattern of run-off water on his farm unit or permit the creation of such an obstruction unless the provision for the collection, passing through and flowing away of run-off water through, around or along that obstruction is sufficient to ensure that it will not be a cause for excessive soil loss due to erosion through the action of water or the deterioration of the natural agricultural resources.

Annexure B2: Constitutionally mandated functions that may impact wetlands and water resources:

Schedule 4: Part B

- Child care facilities
- Electricity and gas reticulation
- Local tourism
- Municipal airports
- Municipal planning
- Municipal health services
- Municipal public transport
- Municipal public works only in respect of the needs of municipalities in the discharge of their responsibilities to administer functions specifically assigned to them under this Constitution or any other law
- Pontoons, ferries, jetties, piers and harbours, excluding the regulation of international and national shipping and matters related thereto
- Stormwater management systems in built-up areas
- Water and sanitation services limited to potable water supply systems and domestic wastewater and sewage disposal systems

Schedule 5: Part B

- Beaches and amusement facilities
- Cemeteries, funeral parlours and crematoria
- Facilities for the accommodation, care and burial of animals
- Local amenities
- Local sport facilities
- Markets
- Municipal abattoirs
- Municipal parks and recreation
- Municipal roads
- Public places Refuse removal, refuse dumps and solid waste disposal
- Traffic and parking

Annexure C

Annexure C1: Waste Water Management Wetland BMPs

Selection of preferred waste water treatment option:

- Wherever possible, for urban, suburban, and densely settled peri-urban areas, domestic waste water should be discharged into a municipal waterborne system.
- Privately operated WWTWs should only be considered in areas where there is no capacity for existing municipal WWTWs to receive and treat additional sewage. Such development should ideally be put on hold until, or timed to occur with, the establishment of a new municipal WWTW for that area or an existing WWTW is upgraded.
- Package treatment plants (PTPs) should only be considered for low density or small developments where occupation is permanent such that the bacterial populations in system are maintained throughout the year. PTPs are not suitable for seasonal occupation like holiday home and recreational estates where collapses in bacterial populations may occur due to the periodic lack of sewage generation.
- Conservancy tanks should be considered in settings where the receiving watercourses have a low ability and capacity to assimilate the treated effluent flows and physico-chemical constituents and/or the receiving watercourses are of high ecological value and/or are highly sensitive.

Siting & design of waste water treatment plants:

- Due to the high treated effluent volumes and relatively high pollutant loads of WWTWs relative to wetland water input volumes and pollutant loads, moderate to large WWTWs should not discharge directly into upstream feeder watercourse of natural, intact wetlands.
- Treated effluent from any treatment process should not be discharged into a wetland FEPA or other wetland conservation priority.
- Wherever possible, discharge to wetlands must be avoided and the discharge to channelled systems (streams and rivers) favoured unless the purpose of the wetland is to act as a constructed or enhanced treatment wetland system.
- All treatment plants require downstream / end-op-pipe emergency containment in the event of process malfunction or failure. The level of containment should vary depending on the risk and practicality. In the case of small PTPs, emergency containment should be for 100% of the design waste volumes over a 48hr period.
- The siting of the treatment plants and discharge points must take into account the ability, capacity and sensitivity of the downstream freshwater ecosystem to assimilate the additional flows and physico-chemical constituents.
- Where feasible, treated effluent discharges must be polished by passive treatment structures/artificial wetlands prior to entering the closest watercourse.
- Utilisation/reuse of treated effluent generated should be investigated wherever possible to reduce discharge volumes to the environment, especially when downstream watercourses do not have the capacity to assimilate flows and pollutant loads.

Alignment and design of sewer reticulation systems and sewer pipeline wetland crossings:

- The number of wetland sewer pipeline crossings must be minimised as far as practically possible and crossings of important systems should be avoided.
- All pipeline crossings must be aligned and designed to minimise the extent of wetland habitat directly impacted by construction activities. In this regard the pipeline crossings should be aligned at right angles to flow and along existing or planned areas / corridors of disturbance.
- For wetland crossings, pipelines should be installed below the natural surface and encased with concrete to limit operational risks.
- No sewer manholes or pump stations must be established within wetlands, rivers and riparian zones.
- Pump stations should be located outside of the 1:100 year floodline.
- A minimum 30m buffer zone should be established between wetlands and manholes. If this cannot be adhered to for substantiated technical reasons, a minimum 15m buffer zone must be established between wetlands and manholes and the following additional mitigation measures applied:
    - All sewer manholes occurring within 15m of any watercourses must be sufficiently sealed to ensure that surcharge events do not occur if there is a blockage.
    - For all sewer manholes within 30m but outside of 15m of any watercourse, permanent surcharge containment / emergency storage measures must be installed e.g. earthen bund, concrete box. In addition, these manholes should be raised by 1 metre to improve backup storage capacity if required.
- Ideally manholes should be located outside of the 1:100 year floodline. If this is unavoidable for substituted reasons the manholes must be sufficiently sealed.
- To reduce the risk of surcharging sewer manholes onsite and downstream, a form of gully trap should be installed at or before the connection of the various components of the development with the main line. This gully trap will block foreign objects from entering the main internal line of the site and isolate blockage problems at the source.
- All pump stations should have at least 24 hours emergency storage capacity (freeboard) to ensure that surcharge and overflow events are avoided. This should ensure that the municipal workers have sufficient time to address the issues before the emergency storage facility is full.

Septic tank systems:

- Septic tanks should only be considered in low density situations where there is adequate evapotranspiration area and appropriate subsoil conditions.
- The suitability of the soils for a septic tank and soakaway system must be confirmed by a professionally registered geotechnical engineer.
- Septic tanks must not be located within 50m of a watercourse and where this is not possible a minimum 30m buffer should be established.
- To reduce the risk of septic tank blockages and decreased tank capacity, a form of gully trap should be installed before the connection of the house line with the septic tank. This gully trap will block foreign objects from entering the septic tank.

- Effluent from kitchens must pass through a grease trap prior to discharge to septic tanks.
- The financial ability of the septic tank owner / operator to service and maintain the system needs to be considered. The use of septic tanks in rural or poor / low income communities is likely impractical and unacceptable if the municipality do not service and maintain these systems.
- The septic tanks should be designed to cope with the realistic loads expected from each household based on the residential type. The size of the tank and soakaway should be increased if it is clear that more than one family is going to use the toilet system within the plot. This is typical of lower income urban settings where there is generally a lack of acceptable housing to meet the housing demand.

Conservancy tanks:

- Conservancy tanks should not be established within wetlands, rivers and riparian zones.
- Conservancy tanks should be located outside of the 1:100 year floodline.
- A minimum 30m buffer zone should be established between wetlands and conservancy tanks.
- The conservancy tanks will need to be suitably designed and constructed according to relevant standards and must be designed to accommodate anticipated loads.
- Leak detection systems must be installed on all conservancy tanks.

Rural sanitation:

- For each circumstance and setting, the socially acceptable sanitation option, as agreed to by the relevant community, must be located a minimum of 30m from the edge of any freshwater resource including wetlands.
- Unless waste water can be effectively treated by a municipal WWTW, mini-WWTW or package treatment plant, a dry sanitation option should be favoured over flush / waterborne options.
- The emptying of single pit VIPs can be difficult and hazardous. For this reason planners should rather favour more easily maintained options such as movable VIP toilets (with lightweight top structures), twin pit VIPs (with relatively shallow and therefore more emptyable pits) or single or double pit UD toilets (Still et al., 2009).
- If socially acceptable, Urine Diversion Latrines (UDLs) should be favoured over Ventilated Improved Latrines (VIPs) when considering non-flush systems for the following reasons provided by Still et al., 2009:
    - UDLs can be relatively easily managed and maintained by the users themselves.
    - UDLs allow the users to capture a waste product (urine) which has UDLs perform poorly in communal settings, and in settings where there has not been acceptance by the users of their role in the maintenance of the system.
- If soil depth is very shallow (a metre or less) then single pit VIP latrines are not suitable (Still et al., 2009). Double pit VIPs or UD toilets can be used, or waterborne sanitation.
- Septic tanks are generally impractical and unacceptable in rural settings due to the cost and practicality of maintenance and replacement.

- The lifespan of the sanitation option needs to be considered and a plan with funding put into place for replacements and upgrades i.e. VIPs have a 5-15 year lifespan depending on use.
- The financial ability of residents to service and maintain the system needs to be considered in both design and option selection.
- All rural communities must be educated on the correct use and management of the selected sanitation option and buy in from the local residents is of utmost importance.

a. Industrial, landfill and mining waste water management systems

- Wherever possible, waste water generated by industrial and mining processes must be disposed of at a licensed hazardous waste disposal facility. If offsite disposal at a licensed facility is not feasible, then such hazardous waste water will need to either be treated to a very high level before disposal to the freshwater environment or be stored (temporarily or permanently) onsite in a manner that does not pose a serious risk to local water resources until such a time that municipal waste disposal facilities can receive such waste or a treatment system is established.
- Similarly, waste water treatment at solid waste and industrial hazardous waste landfills will also need to treat leachate waste and industrial waste to a very high level before disposal to the freshwater environment.
- The selected treatment process and system should be able to effectively treat and remove all potentially hazardous substances prior to discharge to the freshwater environment. If no single system or process is able to achieve this, multiple treatment systems will be required.
- All storage and containment structures in treatment processes should be completely impermeable and isolated from the surrounding environment.
- Under no circumstances should un-treated hazardous waste be allowed to be discharged into the freshwater environment.
- The risk of hazardous waste leaking or spilling into the freshwater environment must be reduced to negligible levels through the appropriate design of all storage dams. Key design principles include:
    - Dam capacity must include adequate free-board and maximum design capacity to ensure that overtopping is impossible.
    - All pollution control dam walls and basins must be lined with a totally impermeable material or suitable depth to ensure that plant roots cannot penetrate through the liner.
- Leak detection systems must be installed at all pollution control dams.
- Refer to the design measures for the 'Siting & design of waste water treatment plants' above.

b. Agricultural waste water management systems

- Contaminated wash water generated by the washing of animal facilities for hygiene reasons and agricultural process waste water must be contained onsite, stored in pollution control dams and treated using an appropriate technology before being discharged to the freshwater environment.
- Refer to the design measures for the 'Siting & design of waste water treatment plants' above.

- The risk of waste water leaking or spilling into the freshwater environment must be reduced to negligible levels through the appropriate design of all storage dams. Key design principles include:
    - Dam capacity must include adequate free-board and maximum design capacity to ensure that overtopping is impossible.
    - All pollution control dam walls and basins must be lined with a totally impermeable material or suitable depth to ensure that plant roots cannot penetrate through the liner.
- Leak detection systems must be installed at all pollution control dams.

2. Hazardous products storage & reticulation systems

The storage, handling and transport of hazardous products poses a serious risk to watercourses crossed by or within close proximity to such facilities and features.

Hazardous substance handling and storage:

- All surfaces on which hazardous substances are to be handled, dispensed, stored, mixed, processed etc. must be impermeable (underlain by concrete) and bunded (self-contained), and totally separated from the formal onsite stormwater management system that discharges into the municipal system. The bunded areas must have enough capacity to store and retain a minimum of 110% of all stored hazardous substances. This will reduce the risk of the infiltration of hazardous contaminants into the soil profile (and groundwater) and reduce the level of stormwater runoff contamination.
- Leak detection systems should be established for all hazardous material / substance storage structures and areas.

Hazardous products pipeline wetland crossings:

- The number of wetland pipeline crossings must be minimised as far as practically possible and crossings of importance systems must be avoided.
- All pipeline crossings must be aligned and designed to minimise the extent of wetland habitat directly impacted by construction activities. In this regard the pipeline crossings should be aligned at right angles to flow and along existing or planned areas / corridors of disturbance.
- For wetland crossings, pipelines should be installed below the natural surface and encased with concrete to limit operational risks.
- A leak detection systems should be established for the pipeline.

Annexure C2: Linear Project Crossing BMPs

Roads:

Road alignment measures:

- Watercourse road crossings should be minimised as far as practically possible and crossings of important systems should be avoided to avoid or minimize direct habitat impacts, hydrological impacts and ecological fragmentation impacts.
- All road crossings should be aligned and designed to minimise the extent of wetland habitat directly impacted by construction activities and permanent structures. In this regard the crossings should be aligned at right angles to flow and along existing or planned areas / corridors of disturbance wherever possible.

Crossing type and design:

- For all crossing types and designs, flow through road crossings should not be unnecessarily concentrated and flow velocity should not be increased. In this regard, wetland crossings should be either spanned with a bridge or crossed using box / portal culverts established across the entire width of the wetland to avoid flow narrowing and concentration. Pipe culverts should be avoided.
- The selection decision between bridges and box culvert crossings should be a trade-off between the cost, importance and sensitivity of the wetland and predicted impact to hydrology.
- Erosion protection and energy dissipation measures should be established at all road crossing outlets e.g. stilling basins and reno-mattresses.

Bridge design:

- The bridge platform should ideally be established above the major storm event flood levels e.g. 1:100 year flood level.
- If possible every effort should be made to span the entire wetland. If this is not possible, the number, width and footprint (extent) of the piers and their bases / footers should be minimised.
- If piers are required to be placed in wetlands, these should be intentionally located within the least sensitive areas of the wetland where flow impacts are minimised. In this regard, wetland channels and preferential flow routes should be avoided.
- All piers (and bases / footers) should be aligned parallel to the direction of flow.
- The surface of the pier bases / footers should be established at the existing bed level so that flow and sediment patterns are not altered. Under no circumstances should the pier bases / footers be established above or below the bed surface level / elevation.

Box culvert crossing design:

- The key impact minimisation measure for watercourse crossings (both existing and new) is the establishment of an adequate number of box culverts to ensure that the culverts span the entire

width of the channel being crossed to minimise flow concentration / constriction as far as practically possible.

- Culverts should ideally be sized to transport not only water, but the other materials that might be mobilized (i.e. debris).
- The potential overtopping of the road surface by flood flows should be accommodated in the crossing design.
- The base (invert) of the new portal/box culvert should be at the exact same elevation as the existing culvert to be replaced so that there are no significant upstream and downstream adjustments in the rates of channel erosion and deposition. In this regard, the levels should be accurately pegged out by an engineer and the engineer should be onsite to guide the settling of the foundation.
- The inlet of the culvert base should match the elevation of the stream bed so that there is no culvert base perching (if culvert inlet higher than river bed) or a drop into the culvert (if culvert inlet lower than bed).
- Erosion protection structures should be established at all culvert outlets to reduce bed erosion / scour. Such structures include Reno-mattresses and/or stilling basins established at the current stream bed surface.

Note: Inadequate design and installation of culverts may result in culvert failure. Box 1 (below) summarises some key causes of culvert failure for consideration.

Box 1: Possible causes of culvert failure

Culvert failure can have far reaching impact on aquatic resources, particularly those related to system hydrology, erosion/ sedimentation and aquatic biota. Attention should therefore be given to the following to mitigate against possible failure of installed culverts:

- Inadequate culvert capacity for the calculated stream flow.
- Structural failure due to excessive soil loading.
- Wash-out due to water overtopping the road.
- End scouring from poor end treatment and lack of erosion protection.
- Improper jointing resulting in water piping along the outside of the culvert.
- Erosion due to excessive water transport of sand and gravel, arising from the acceleration of flow through the culvert.
- Corrosion from acid or salt laden soils and water.
- Improper inlet and outlet structures, resulting in embankment failures.
- Improper alignment of the culvert relevant to the natural channel, resulting in scour of the embankment at the inlet.
- Poor installation and/or bedding condition resulting in settlement, joint separation, or structural failure of the culvert.

Pipelines:

Alignment and design of sewer reticulation systems and sewer pipeline wetland crossings:

- The number of wetland sewer pipeline crossings should be minimised as far as practically possible and crossings of important systems should be avoided.
- All pipeline crossings should be aligned and designed to minimise the extent of wetland habitat directly impacted by construction activities. In this regard the pipeline crossings should be aligned at right angles to flow and along existing or planned areas / corridors of disturbance.
- For wetland crossings pipelines should be installed below the natural surface and encased with concrete to limit operational risks.
- No sewer manholes or pump stations should be established within wetlands, rivers and riparian zones.
- Pump stations should be located outside of the 1:100 year floodline.
- A minimum 30m buffer zone should be established between wetlands and manholes. If this cannot be adhered to for substantiated technical reasons, a minimum 15m buffer zone should be established between wetlands and manholes and the following additional mitigation measures applied:
    - All sewer manholes occurring within 15m of any watercourses should be sufficiently sealed to ensure that surcharge events do not occur if there is a blockage.
    - For all sewer manholes within 30m but outside of 15m of any watercourse, permanent surcharge containment / emergency storage measures should be installed e.g. earthen bund, concrete box. In addition, these manholes should be raised by 1 metre to improve backup storage capacity if required.
- Ideally manholes should be located outside of the 1:100 year floodline. If this is unavoidable for substituted reasons the manholes should be sufficiently sealed.
- To reduce the risk of surcharging sewer manholes onsite and downstream, a form of gully trap should be installed at or before the connection of the various components of the development with the main line. This gully trap will block foreign objects from entering the main internal line of the site and isolate blockage problems at the source.
- All pump stations should have at least 24 hours emergency storage capacity (freeboard) to ensure that surcharge and overflow events are avoided. This should ensure that the municipal workers have sufficient time to address the issues before the emergency storage facility is full.

Hazardous products pipeline wetland crossings:

- The number of wetland pipeline crossings should be minimised as far as practically possible and crossings of importance systems should be avoided.
- All pipeline crossings should be aligned and designed to minimise the extent of wetland habitat directly impacted by construction activities. In this regard the pipeline crossings should be aligned at right angles to flow and along existing or planned areas / corridors of disturbance.
- For wetland crossings, pipelines should be installed below the natural surface and encased with concrete to limit operational risks.

- A leak detection systems should be established for the pipeline.

Water pipeline wetland crossings:

- The number of wetland pipeline crossings should be minimised as far as practically possible and crossings of importance systems should be avoided.
- All pipeline crossings should be aligned and designed to minimise the extent of wetland habitat directly impacted by construction activities. In this regard the pipeline crossings should be aligned at right angles to flow and along existing or planned areas / corridors of disturbance.
- For wetland crossings, pipelines should be installed below the natural surface and encased with concrete to limit operational risks.

Powerlines:

Best practice road alignment and design measures to consider are as follows:

- The number of wetland poweline crossings should be minimised as far as practically possible and crossings of importance systems or systems that provide habitat for threatened bird or bat species should be avoided.
- Crossing of woody wetlands (e.g. swamp fotrests) should be avoided in favour of herbaceous wetlands so that there is no need to clear vegetation under the servitude.
- The width of the powerline servitude at wetland crossings should be minimised as far as possible.
- Under no circumstances should herbaceous wetland vegetation occurring within the powerline servitude be cleared.
- As far as practically possible, powerline crossings should be aligned at right angles to flow and along existing or planned areas / corridors of disturbance.
- Under no circumstances should powerline pylons, towers or poles be located within a wetland.
- Under no circumstances should service roads be established across wetlands. Service roads should be re-touted around wetlands via the existing road network.
- Ideally a minimum 30m buffer zone should be established between wetlands and pylons, towers and poles.
- For all powerlines within (crossing) and in close proximity to wetlands that provide habitat for bird species at risk from powerlines, the following design measures should be implemented:
    - Flight deviators or bird anti-collision devices.
    - Sufficient insulation should also be fitted to the tower structures and the proposed substation to prevent electrocution.
    - Finally, bird friendly tower structures as per Eskom's designs can be considered to further mitigate collision and electrocution impacts.

Annexure D

Reference & Guidance Documents	Author	Date	Download Link
A practical field procedure for identification and delineation of wetland and riparian areas	Department of Water Affairs & Forestry (DWAF)	2005	https://www.dwaf.gov.za/Documents/Other/EnvironRecreation/wetlands/WetlandZoneDelineationSep05Part1.pdf
Alternative Technology for Stormwater Management Sustainable Drainage Systems – Report and South African Case Studies	Armitage et al.	2013	
ATLAS of FRESHWATER ECOSYSTEM PRIORITY AREAS in South Africa	Nel et al.	2011	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20500-11.pdf
Classification system for wetland and other aquatic ecosystems in South Africa. User manual: inland systems	Ollis et al.	2013	https://www.sanbi.org/wp-content/uploads/2018/04/sanbi-biodiversity-series-wetlands-classification-no-22.pdf
DWAF Best Practice Guidelines for Water Resource Protection in the South Africa Mining Industry Series	Department of Water Affairs & Forestry (DWAF)		http://www.dwa.gov.za/Documents/Default.aspx
DWAF Best Practice Guidelines for Water Resource Protection in the South Africa Mining Industry Series	Department of Water Affairs & Forestry (DWAF)	2006 - 2008	http://www.dwa.gov.za/Documents/Default.aspx
DWAF Training Manual: National Water Act Section 21(c) and (i) Water Uses	Department of Water Affairs & Forestry (DWAF)	2009	https://www.dwaf.gov.za/documents/section21/egs21ci.pdf
Framework and Manual for the evaluation of aquatic ecosystems services for the Resource Directed Measures	Ginsburg et al.	2010	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20462%20Conservation%20of%20Water%20Ecosystems.pdf
Guidelines for Integrating the Protection, Conservation and Management of Wetlands into Catchment Management Planning	Dickens et al.	2003	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT-220-03.pdf
HIGH RISK WETLANDS ATLAS: Reference Guide to the Mpumalanga Mining Decision Support Tool	Holness et al.	2016	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20659%20-16.pdf
Implementation Manual for Freshwater Ecosystem Priority Areas	Driver et al.	2011	
Integrated Water Resource Management Plan Guidelines for Local Authorities	Department of Water Affairs & Forestry (DWAF)	2007	http://www.pacificwater.org/userfiles/file/IWRM%20Planning%20Guidelines%20for%20Local%20Authorities.pdf
Local Action for Biodiversity: Wetlands SA: Strategy and Action Plan Guidelines	ICLEI	2017	http://cbc.iclei.org/wp-content/uploads/2017/02/WSAP-Guidelines.docx
Local Action for Biodiversity: Wetlands Strategy and Action Plan Guidelines	ICLEI	2017	http://cbc.iclei.org/project/lab-wetlands-sa/
Manual for the Rapid Ecological Reserve Determination of Inland Wetlands (Version 2.0)	Rountree	2013	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/1788-1-13.pdf
Mining and Biodiversity Guideline: Mainstreaming biodiversity into the mining sector	DEA et al.	2013	https://www.environment.gov.za/sites/default/files/legislations/miningbiodiversity_guidelines2013.pdf
Preliminary guideline for the determination of buffer zones for rivers, wetlands and estuaries	Macfarlane & Bredin	2016	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20610-1-14.pdf
Supporting better decision-making around coal mining in the Mpumalanga Highveld through the development of mapping tools and refinement of spatial data on wetlands	Mbona et al.	2015	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20%20614-14.pdf
Technical Report for the National Freshwater Ecosystem Priority Areas project	Nel et al.	2011	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/1801-2-11.pdf
The Design of a National Wetland Monitoring Programme Implementation Manual, Volume 2	Sustento Development Services	2016	http://www.dwa.gov.za/iwqs/rhp/wetlands/documents/Wilkinson_2016_The_Design_of_a_National_Wetland_Monitoring_Programme_Implementation_Manual_Volume_2.pdf.
The Design of a National Wetland Monitoring Programme Implementation Manual, Volume 2	Sustento Development Services	2016	http://www.dwa.gov.za/iwqs/rhp/wetlands/documents/Wilkinson_2016_The_Design_of_a_National_Wetland_Monitoring_Programme_Implementation_Manual_Volume_2.pdf.
The Development of a Comprehensive Manual for River Rehabilitation in South Africa	Day et al.	2016	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20646-16.pdf
The Economics of Ecosystems and Biodiversity (TEEB) for Water and Wetlands	Russi et al.	2013	https://www.ramsar.org/sites/default/files/documents/library/teeb_waterwetlands_report_2013.pdf
The South African Guidelines for Sustainable Drainage Systems	Armitage et al.	2013	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20558-13.pdf
Water Sensitive Urban Design (WSUD) for South Africa: Framework and guidelines	Armitage et al.	2014	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20588-13.pdf

WET Management Series: WELL-WET	Hay et al.	2014	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20605-14.pdf
WET Management Series: WET-EcoServices	Kotze et al.	2009	
WET Management Series: WET-Health	Macfarlane et al.	2009	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20340-09.pdf
WET Management Series: WET-Legal	Armstrong	2009	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20338-09.pdf
WET Management Series: WET-ManagementReview	Kotze et al.	2009	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20335%20(2).pdf
WET Management Series: WET-Origins	Ellery et al.	2009	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20334%20web.pdf
WET Management Series: WET-OutcomeEvaluate	Kotze & Ellery	2009	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20343-09.pdf
WET Management Series: WET-Prioritise	Rountree et al.	2009	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20337-09.pdf
WET Management Series: WET-RehabEvaluate	Cowden & Kotze	2009	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20342-11.pdf
WET Management Series: WET-RehabMethods	Russell	2009	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20341%20web%20NEW.pdf
WET Management Series: WET-RehabPlan	Kotze et al.	2009	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20336-09.pdf
WET Management Series: WET-RoadMap	Dada et al.	2007	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20321-07.pdf
Wetland Health and Importance Research Programme: WET-Sustainable Use	Kotze	2010	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20438%20-09%20Conservation%20of%20Water%20Ecosystems.pdf
Wetland inventory: A Ramsar framework for wetland inventory and ecological character description	Ramsar Convention Secretariat	2010	https://www.ramsar.org/sites/default/files/documents/pdf/lib/hbk4-15.pdf
Wetland Offset Calculator	SANBI & DWS	2014	http://biodiversityadvisor.sanbi.org/industry-and-conservation/conservation-and-mining/action-2/wetland-offset-guidelines/
Wetland offsets: a best-practice guideline for South Africa	SANBI & DWS	2014	http://biodiversityadvisor.sanbi.org/wp-content/uploads/2014/09/Wetland-Offset-Guidelines-Version-7-For-stakeholder-comment.pdf
Wetland Rehabilitation in Mining Landscapes: An Introductory Guide – WRC Report No. TT 658/16	Macfarlane et al.	2016	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT%20658-16.pdf
Wetlands and Wellbeing: A Decision Support System	Kotze	2014	http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Documents/TT%20591-14.pdf
Wetlands: The basics and some more	Collins	2005	http://www.dwa.gov.za/IWQS/rhp/provinces/freestate/wetlands_basics&more.pdf