City of Ekurhuleni Wetland and Watercourse Rehabilitation Planning within the Rietvlei Catchment

Wetlands and Watercourses Assessment and Management Report

By:

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1 INTRODUCTION

Wetland Consulting Services (WCS) was appointed by Environmental Impact Management Services (EIMS) on behalf of CoE to design a planning regime for wetland rehabilitation to be implemented within the Rietvlei catchment. This catchment was selected by CoE as a priority catchment to be focused on as part of this rehabilitation planning project.

The Rietvlei catchment is located within heavily developed areas consisting of township and urban developments and associated infrastructures, as well as subsistence agricultural areas. All these landuses can lead to typical water quality and quantity impacts. Impacts range from failing of sewer infrastructure and direct discharge of sewage into watercourses, increased stormwater flows off hardened surfaces resulting in erosion and deterioration of the natural watercourses and agricultural return flows containing a variety of pesticides and fertilisers which negatively affect water quality in the receiving watercourses. Wetland rehabilitation within this catchment provides a potential opportunity to address some of these, and other, impacts.
The Rietvlei catchment is located in the Crocodile (West) Marico Water Management Area in quaternary catchment A21A within the Hennops Catchment. The river in the study area consists of the Rietvlei River and associated smaller, first order tributaries draining into the Hennops River. Figure 2 below indicates the location of the study catchment in relation to the CoE Boundary. The Rietvlei system starts in the small-holdings area of Kempton Park and flows northwards past O.R. Tambo International Airport to Rietvlei Dam. Rietvlei Dam is an important contributor of water supply in the Tshwane Metropolitan Municipality. The primary supply of this water originates from agricultural and industrial surface run-off and is also fed by a tributary - the Grootvlei River - which originates in the Bapsfontein area. Sewage works situated at Kempton Park are responsible for serious pollution. A series of wetlands between the sewage works and the dam are anticipated to play a role in filtering some of the pollution carried by the rivers. The Tshwane Metropolitan Municipality also operates an extensive filtering plant at the dam. The landuse within the catchment is urban development around the Kempton Park area and agricultural activities towards the lower reaches of the river.

1.1 PURPOSE OF THIS REPORT

The wetlands and watercourses assessment and management report has been produced to:

1. Assess the ecological integrity and functioning of individual wetland systems targeted for rehabilitation activities;
2. Evaluate the effectiveness of the proposed interventions to improve ecological integrity and functioning of the wetlands and watercourses targeted for rehabilitation;
3. Compile management, monitoring and evaluation measures that will ensure continued functioning of the rehabilitated wetland systems.

2 APPROACH

2.1 WETLAND DELINEATION AND CLASSIFICATION

As indicated in the Situation Assessment Report, various wetland datasets of wetland coverages, including National Wetland Inventory, National Freshwater Priority Areas, Regional Conservation Plans, Environmental Management Frameworks and CoE wetland inventory datasets were used to identify any gaps that will require additional data collection. An integration of all datasets to formulate a single wetland coverage dataset was undertaken. Additional delineations on high resolution aerial imagery was undertaken where gaps were identified using the methodology as proposed by Thompson *et al*. (2002), followed by limited ground-truthing for verification, collection of ecological integrity data, verification of existence of wetlands and landuse within and around wetlands. The complete wetland layer was classified in terms of HydroGeoMorphic (HGM) setting in accordance with the South African Wetland Classification as proposed in SANBI (2009) and Ollis *et al*. (2013).

2.2 ASSESSING THE PRESENT ECOLOGICAL STATUS OF THE WETLANDS

The present ecological state (PES) of valley bottom and hillslope seepage wetland HGM units will be assessed using WET-Health Level I (Macfarlane *et al*., 2007); an assessment technique based on readily described indicators that critically examine the three components of wetland ecological integrity, namely:

- Hydrology;
- Geomorphology; and
- Vegetation.

These assessments assist in identifying the current impacts that are undermining the integrity of each wetland.

As was mentioned above, each wetland system assessed is comprised of several HGM units, such as an unchannelled valley bottom wetland with associated adjacent hillslope seepage wetlands. The WET-Health assessment will be applied individually to each wetland HGM, and then a combined PES will be calculated for each wetland system based on the individual HGM results.

The scale used to rate the various components of wetland PES is provided in Table 1 below.

Table 1. Rating scale used for the PES assessment.

Description	Combined impact score	PES Category
Unmodified, natural.	0-0.9	A
Largely natural with few modifications. A slight change in ecosystem processes is discernable and a small loss of natural habitats and biota may have taken place.	1-1.9	B
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2-3.9	C
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	D
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	E
Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8 - 10	F

2.3 FUNCTIONAL ASSESSMENT OF THE WELANDS

A functional assessment of each hydro-geomorphic wetland unit will be undertaken using the level 1 assessment as described in “Wet-EcoServices” (Kotze *et al.,* 2007). This method provides a scoring system for establishing wetland ecosystem services. It enables one to make relative comparisons of systems based on a logical framework that measures the likelihood that a wetland is able to perform certain functions.

2.4 ASSESSING THE IMPORTANCE AND SENSITIVITY (IS) OF THE WETLANDS

A wetland importance and sensitivity (IS) assessment will be conducted for each wetland system targeted for rehabilitation. This is done in order to provide an indication of the conservation value and sensitivity of the wetlands to be monitored. For the purpose of this study, the Rountree *et al*. (2013) assessment criteria will be used. The scale used to rate the various components of wetland IS is provided in Table 2 below.

Table 2: Rating scale used for the IS assessment.

Wetland Importance and Sensitivity categories	Range of EIS score
Very high: Wetlands that are considered ecologically important and sensitive on a **national or even international** level. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4
High: Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these systems may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3
Moderate: Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2
Low/marginal: Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1

2.5 DEVELOPMENT OF AN APPROPRIATE REHABILITATION STRATEGY

Objectives for wetland rehabilitation will be informed by the assessments onsite. The information recorded onsite will be used to inform the development of a rehabilitation strategy for the wetlands. The rehabilitation strategy, which serves as a precursor to a rehabilitation plan, comprises a description of the types of problems within wetlands, determination of rehabilitation objectives and deciding on appropriate measures and associated rehabilitation activities to achieve the set objectives. The Situation Assessment Report identified various rehabilitation strategies that can be employed to improve wetlands onsite. The environmental engineer for the project is responsible for designing interventions to achieve the objectives as set out in the rehabilitation strategies. The design and costing of various strategies will be outlined in the masterplans and engineering repots for the project.

2.6 ASSESSING THE LIKELY IMPACT OF WETLAND REHABILITATION ON WETLAND HEALTH AND ECOSYSTEM SERVICES DELIVERY

An assessment will be undertaken to predict the contribution that the identified rehabilitation interventions will make to improving wetland health and ecosystem service delivery by addressing the identified impacts/threats. Without these assessments, a wetland rehabilitation programme is unlikely to have a well-informed basis on which to improve the rehabilitation's "return on investment" (with return being measured in terms of wetland health and ecosystem services delivery). This process will follow the procedure as outlined in WET-Rehab Evaluate (Cowden *et al*., 2008).

The following steps will be followed to assess the contribution of rehabilitation interventions within each wetland system:

- The spatial area likely to be affected by the proposed intervention/s will be identified.

- The benefits that are likely to result from achievement of the rehabilitation objective/s, in terms of the integrity of the affected area of the wetland (using WET-Health) and the ecosystem services that the area delivers (using WET-Ecoservices - Kotze *et al.*, 2007) will be assessed.

The same approach will be used for the assessment of the different threats/impacts that would be addressed through rehabilitation. In this instance, the situation without rehabilitation (i.e. no intervention or *status quo*) would be compared with the situation with rehabilitation. For health, both situations will be scored on a scale of 0 (critically altered) to 10 (pristine), and this will be undertaken for the hydrology, geomorphology and vegetation components of health. The benefit achieved is the improvement in relation to the maximum score. For example, in areas threatened by headcut erosion which are to be rehabilitated by halting the spreading of the headcut, the benefits in terms of health would be determined based on the difference between the current health and the projected health if the headcut proceeded to erode through the threatened area. In such a case, stopping the expansion of the headcut would presumably secure the current situation. The current functioning and improvement thereof due to the proposed interventions will be represented in terms of functional hectare equivalents. A hectare equivalent (ha.eq) is a quantitative expression of the ecological integrity of a wetland hydro-geomorphic (HGM) unit under a given landuse. It represents the common currency that enables the wetland functional area restored to the landscape by rehabilitation to be compared to that of the existing functional area to reflect any potential gains associated with the proposed activities on wetlands and their functionality.

2.7 COLLECTION OF MONITORING AND EVALUATION BASELINE ASSESSMENT DATA

For the purpose of monitoring of the Rietvlei project rehabilitation outcomes, it is recommended that the wetland rehabilitation monitoring tool – WET-RehabEvaluate (Cowden and Kotze, 2008) be used to guide the selection of appropriate monitoring tools and monitoring interval. Based on the WET-RehabEvaluate guideline document, a Level 2[1] assessment is proposed. The following outcomes are included in a Level 2 assessment:

1. Ecological outcomes – wetland integrity assessments (Present Ecological State (PES) both pre and post rehabilitation).
2. Aesthetic outcomes - Visual and morphological change assessment of the system. Photographic record taken and kept pre and post implementation of rehabilitation interventions.

The baseline monitoring and post rehabilitation monitoring activities are summarised in Table 3 below.

[1] Rapid assessment of rehabilitation outcomes as well as an assessment of the execution and social outputs which would encompass compliance with Working for Wetlands Best Management Practices.

Table 3: Summary of monitoring timing and frequency for the CoE project rehabilitation strategy.

LEVEL 2 – MONITORING		
MONITORING ACTIVITES	**TIMING**	**FREQUENCY**
WET-Health data (PES scores)	Not Applicable	Before and 3 years after completion
Aesthetic outcomes	Late Spring/ Summer	Annually

3 ASSESSMENT RESULTS - WETLANDS AND WATERCOURSES DETAILS

3.1 TARGETED WETLANDS FOR REHABILITATION AND THEIR ASSOCIATED CATCHMENT AREAS

As discussed in the Situation Assessment Report, the extent and distribution of wetland areas within the Rietvlei catchment area is indicated in Figure 1 below. Three types of natural wetland system, in terms of the hydro-geomorphic classification system, were recorded on site, namely:

- Depressions (Pans);
- Hillslope seepage wetlands; and
- Valley bottom wetlands (Channelled and Unchannelled).

The extent of these different HGM types across the study area is detailed in Table 4 below.

Due to the large extent of the wetland areas to be assessed on site, a simplified approach was adopted to assess the wetlands within the project area. The study catchment area was subdivided into four Rietvlei rehabilitation zones**.** Subdivision of the study area into a number of rehabilitation zones has the following benefits:

- Sharpening the focus on the environmental problems encountered in each of the seven zones;
- Reducing the scale of the problems to be addressed, to those encountered within each zone;
- Ensuring community participation in the benefits of the rehabilitation process by addressing the rivers/wetlands problems within the geographic boundaries of each community;
- Ensuring, as far as is reasonably possible, that each community passes on water of acceptable quality to its downstream neighbours.

The subdivision is merely based on the point of confluence of tributaries in order to ensure manageably small catchments upstream. Figure 1 below indicates the wetland types and the proposed rehabilitation zones within the Rietvlei study area.

Table 4: Distribution and coverage of targeted wetland types within the rehabilitation zones.

Catchment	CoE Wetland & Watercourses Types	Areas (Ha)	% Coverage
Rietvlei	Channelled Valley Bottom	841.73	40.02%
Rietvlei	Depression (Pans)	149.21	7.09%
Rietvlei	Drainage Line	5.81	0.28%
Rietvlei	Seepage	487.29	23.17%
Rietvlei	Unchannelled Valley Bottom	619.10	29.44%
TOTAL		**2103.15**	**100.00%**

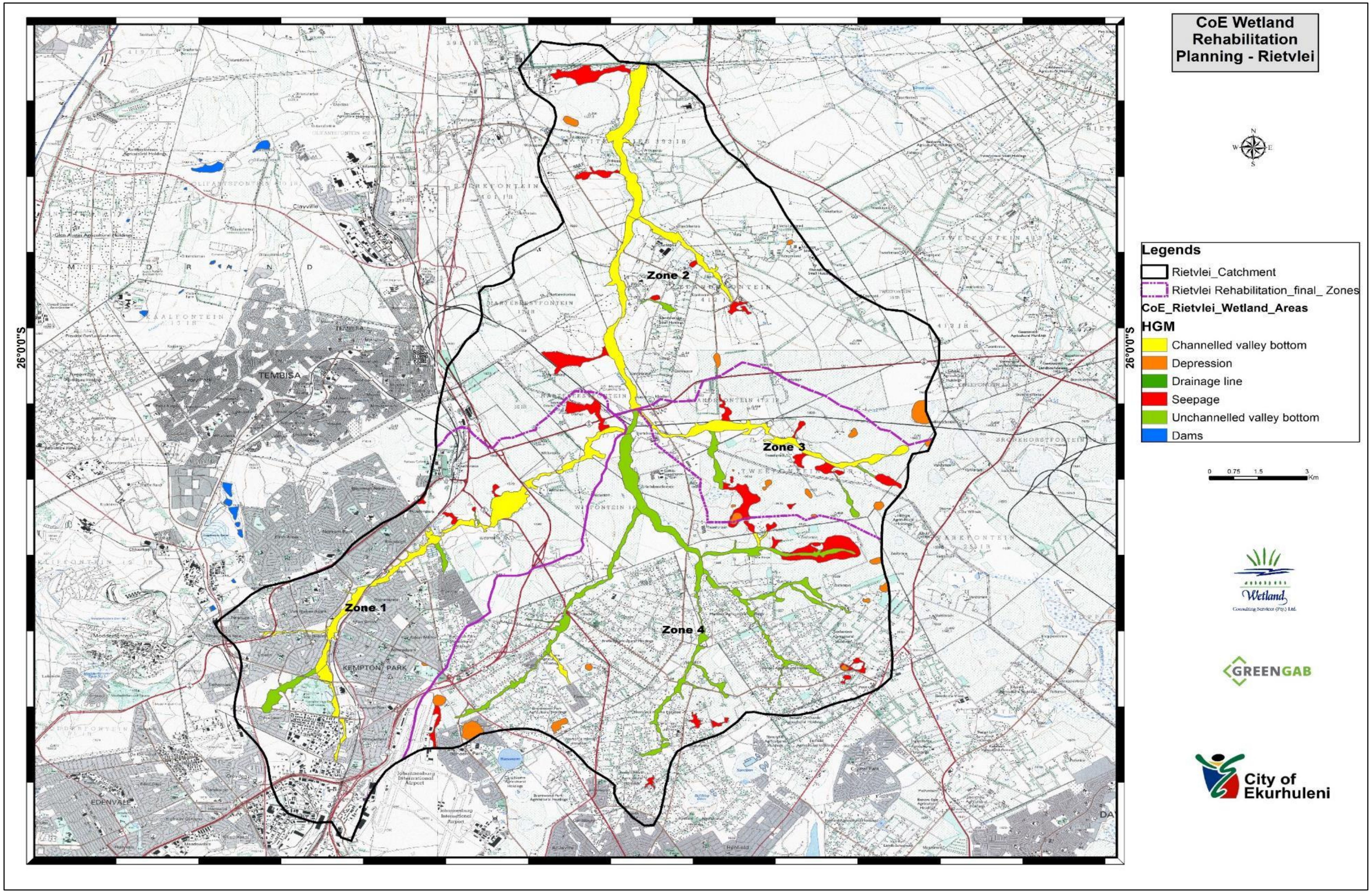

Figure 1: Map showing the wetland HGM classification of wetlands onsite and the extent of rehabilitation zones for the wetlands to be considered for rehabilitation planning onsite.

3.2 ASSESSMENT OF THE ECOLOGICAL STATE (WET-HEALTH) OF WETLANDS AND WATERCOURSES TARGETED FOR REHABILITATION

Wetland areas have been subjected to numerous impacts associated with modification of the systems' hydrology, vegetation integrity and morphology. Increases in flow peaks caused by stormwater discharges and urbanization have resulted in channel incision, bank collapsing, erosion and sediment loss, as well as water quality deterioration. These changes have resulted in the desiccation of the adjacent wetland habitat, loss of riparian vegetation, loss of aquatic habitats and subsequently loss of biodiversity. Dumping, infilling, sand and brick materials mining (excavation), the surcharging of outfall sewers and manholes, not to mention an influx of pollutants originating from the upslope residential areas, have also impacted on the quality of water, morphological structure and aesthetic appeal of the wetland areas within the catchment. Developmental activities on site as well as several road crossings, tracks and bridges have all compromised hydrology, geomorphology and the overall integrity of the wetland systems due to the extensive incision and subsequent erosion created by these features. The incision of the channels has resulted in further impacts to the systems. The vegetation within the wetland areas has been significantly altered with the desiccation of the systems and the consequent encroachment of alien invasive plant species such as Kikuyu grass and other terrestrial plant species. Without the implementation of rehabilitation interventions, it is likely that the integrity of the systems will deteriorate even further.

The main impacts within the catchment are:

- Cultivation and agricultural activities within and around wetlands;
- Sediment loss due to erosion associated with channel switching and incision caused by un-attenuated stormwater flows, resulting in loss of aquatic habitat, biodiversity and both riparian and wetland vegetation;
- Dumping of litter, building rubble and debris that has affected the morphological structure and aesthetic appeal of the wetland areas on site;
- Water quality deterioration associated with return flows from Kempton Park developed areas surrounding wetland areas on site; and
- The level of transformation within the wetland areas has created a niche for invasive alien vegetation and weeds within the wetlands.

Based on the recorded impacts in and around wetlands within the catchment, a PES assessment was undertaken for wetlands targeted for rehabilitation onsite using the WET-Health method (MacFarlane *et al*., 2008). The impacts recorded were area weighted to determine the health of the systems. Figure 2 below indicates the results of the PES assessment and Tables 5 – 7 indicate associated PES scores for each of the rehabilitation zones.

Table 5: Table indicating PES assessment results of the targeted wetlands within Zone 1

Catchment	HGM	Area	PES	EIS	HGM_ID	Current Hectare Equivalent
Rietvlei	Unchannelled valley bottom	45.25	D	Moderate	UCVB1	22.85
Rietvlei	Channelled valley bottom	126.12	E	Moderate	CVB1	38.47
Rietvlei	Channelled valley bottom	136.36	D	Moderate	CVB2	68.86
TOTAL		**307.73**				**130.18**

Table 6: Table indicating PES assessment results of the targeted wetlands within Zone 2

Catchment	HGM	Area	PES	EIS	HGM_ID	Current Hectare Equivalent
Rietvlei	Channelled valley bottom	307.69	C	Moderate	CVB1	216.92
TOTAL		**307.69**				**216.92**

Table 7: Table indicating PES assessment results of the targeted wetlands within Zone 4

Catchment	HGM	Area	PES	EIS	HGM_ID	Current Hectare Equivalent
Rietvlei	Channelled valley bottom	142.62	C	Moderate	CVB1	70.50
Rietvlei	Depression	26.43	E	Moderate	P1	30.50
Rietvlei	Depression	3.45	D	Moderate	P2	50.50
Rietvlei	Channelled valley bottom	11.01	D	Moderate	CVB3	50.50
Rietvlei	Channelled valley bottom	67.51	E	Moderate	CVB2	30.50
TOTAL		**251.03**				**232.50**

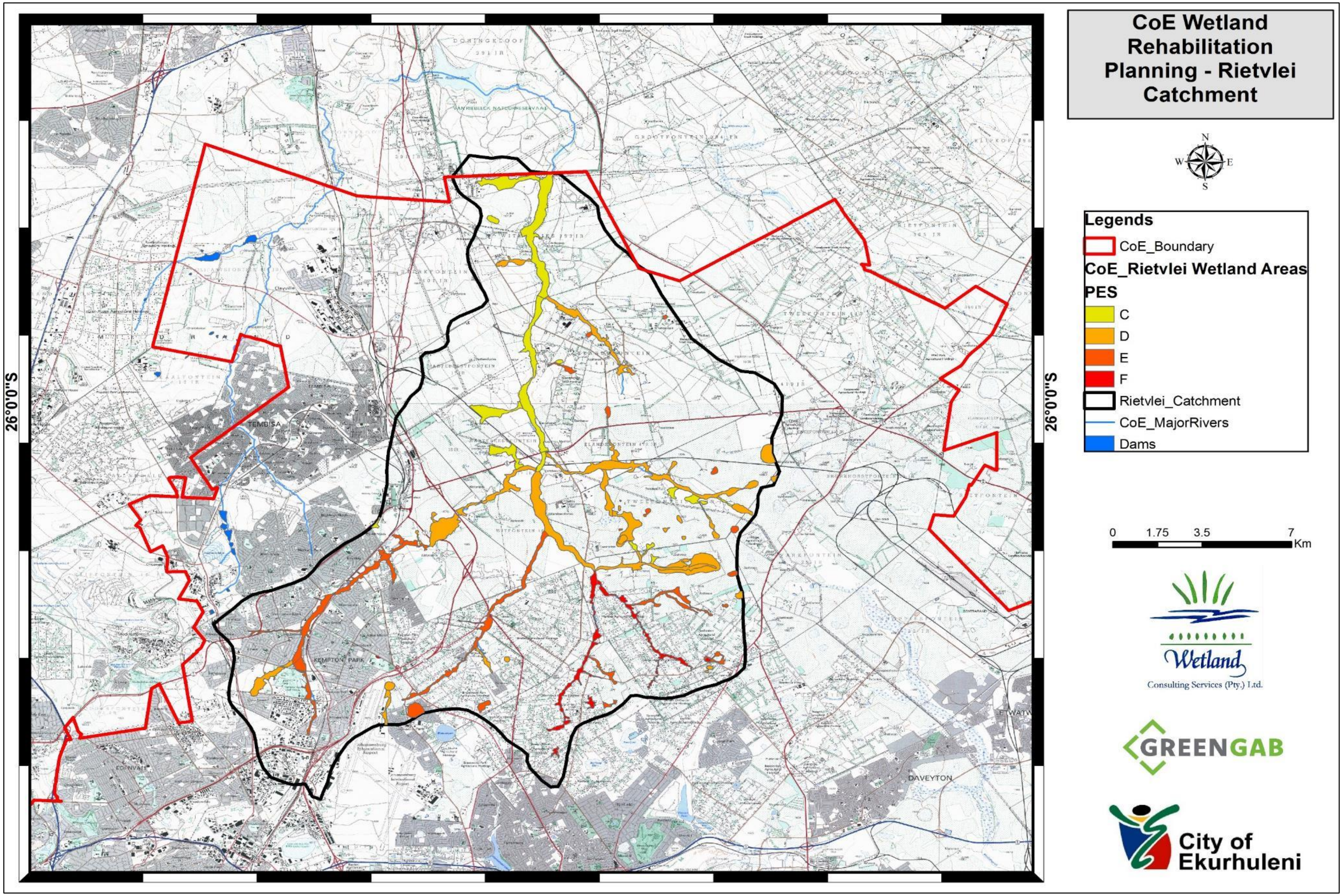

Figure 2: Map showing PES assessment results for the targeted wetlands within the Rietvlei Catchment.

3.3 FUNCTIONAL ASSESSMENT OF TARGETED WETLANDS FOR REHABILITATION

Wetlands support a number of functions that include biodiversity support, nutrient removal (and more specifically nitrate removal), sediment trapping, and associated with this, trapping of phosphates bound to iron as a component of the sediment, and flow regulation. Many of these functions linked to wetlands are wetland type specific and can be linked to the position of wetlands in the landscape as well as to the way in which water enters and flows through the wetlands.

3.3.1 CHANNELLED VALLEY BOTTOM WETLANDS

Channelled valley bottom wetlands represent 40% of the wetland areas targeted for rehabilitation in the study area. These wetlands onsite indicate that sediment loss and export is a dominant process. Erosion is both vertical and lateral and reflects the attempts of the streams to reach equilibrium with the imposed hydrology due to developmental activities associated with Kempton Park. Given the above, from a functional perspective, the broader channelled valley bottom wetlands onsite may, under intermediate flow conditions contribute sediment to downstream reaches (siltation of the Rietvlei Dam). The smaller channelled valley bottom wetlands located higher up within the catchment are expected to play a less significant role in flood attenuation, except in those areas where impoundments have been constructed across the valley bottoms. The channelled valley bottom wetlands also play a role in biodiversity support. The short contact time between flows within the channelled valley bottom wetlands and the wetland soil and vegetation limits the ability of these wetlands to play a significant role in water quality improvement and therefore the ability of the wetlands and watercourses to improve water quality is low. There are several religious and praying activities taking place within the wetlands and watercourses onsite, which represents a human benefit provided by the wetlands.

3.3.2 HILLSLOPE SEEPAGE WETLANDS

Hillslope seepage wetlands account for almost 23% of the wetland area in the study area. They are predominantly associated with the granite derived soils in the catchment and typically reflect the presence of seasonal shallow interflow. In some cases they may be associated with the emergence of shallow groundwater, where these occur in areas dominated by vertic soils. As is the case of the other wetland types, hillslope seepage wetlands support plants in particular, and associated insects, birds and small mammals adapted to the seasonal moisture regime. In addition, hillslope seeps support conditions that facilitate both sulphate and nitrate reduction as interflow emerges through the organically rich wetland soil profile. They typically represent low energy environments where soil moisture conditions remain high throughout the year and can thus accumulate carbon. As hillslope seepage wetlands, for the most part, are dependent on the presence of an aquitard, either a hard or soft plinthic horizon, they are not generally regarded as significant sites for groundwater recharge (Parsons, 2004). The interflow component of these systems undoubtedly contributes to the base flow component in the streams and in dams where these flows have been intercepted.

3.3.3 PANS

Pans make up less than 7% of the study area, consisting of sizeable pans scattered across the headwaters of the site (upper reaches of the catchment) the soils on these areas are characterised by sandy soils and that have been extensively impacted by urbanisation, such as urban developments and associated activities, dumping and subsistence agricultural activities. Given the position of most pans within the landscape, which is usually isolated from any stream channels, the opportunity for pans to attenuate floods is fairly limited, though some run-off is stored in pans. Pans are also not considered important for sediment trapping, as many pans are formed through the removal of sediment by wind when the pan basins are dry. Some precipitation of minerals and de-nitrification is expected to take place within pans, which contributes to improving water quality, though this water is usually isolated from the surrounding stream channels. Within the study area pans are expected to play an important role in biodiversity support, especially with regards to water birds. An important function performed by pans is the support of faunal and floral biodiversity, which is enhanced by the diversity in habitat types offered by different pans. The ability of the pans to support this bird life is, however, in threat given the poor water quality within the pans, which is believed to be derived from urban stormwater and sewerage discharge, dumping and littering, agricultural return flows as well as houses encroaching into the pans and their catchments.

3.3.4 UNCHANNELLED VALLEY BOTTOM WETLANDS.

The fact that unchannelled valley bottom wetlands remain unchannelled indicates that under the current hydrological conditions flows within these wetlands do not attain sufficient energy to erode a channel through the wetland. In the study area these wetlands account for approximately 29% of the wetland area and are located primarily in the upper reaches of the streams. Many of the unchannelled valley bottom wetlands are supported by subsurface interflow rather than surface flow, with the exception of some of the unchannelled valley bottom wetlands located on vertic soils. In addition to the biodiversity associated with these systems, it is expected that they play an important role in retaining water in the landscape as well as in contributing to influencing water quality through, for example, mineralization of rain water. Where these wetlands occur on sandy soils, they could be seen to play an important role in nutrient removal, including ammonia through adsorption onto clay particles. However, in areas of vertic soils the actual removal capacity is likely to be limited by the low permeability of these soils. The water quality enhancement function of these wetlands is especially important in those areas where these wetlands adjoin cultivated areas that are regularly fertilised. They are likely to play a role in nitrogen removal through the process of denitrification, a process that occurs in areas characterized by organicly rich, saturated substrates typically associated with wetlands. The interflow component of these systems undoubtedly contributes to the base flow component in the streams and in farm dams where these flows have been intercepted.

3.4 ASSESSMENT OF IMPORTANCE AND SENSITIVITY OF TARGETED WETLANDS FOR REHABILITATION

"Importance" of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. "Sensitivity" refers to the system's ability to resist disturbances and its capability to recover from disturbance once it has occurred.

The wetlands within the study area form part of the Crocodile (West) Marico Water Management Area, which is a heavily utilised and economically important catchment. Wetlands and rivers within the Rietvlei and Hennops Rivers have been greatly impacted upon by various activities, which include urbanisation and informal settlements and associated infrastructural activities, water abstraction and supply and agriculture, etc. As a result of these impacts, serious water quality and quantity concerns have been raised within the sub-catchment. Given this situation, and the fact that wetlands can support functions such as water purification and stream flow regulation, a high importance and conservation value is placed on all wetlands and rivers within the catchment that have as yet not been seriously modified. Within this context, a wetland IS assessment was conducted for every hydro-geomorphic wetland unit identified within the study area. Further considerations that informed the IS assessment include the following:

- The wetland vegetation types extending across the catchment include Dry Highveld Grassland Group 5 and Mesic Highveld Grassland Group 3, which are both considered Least Threatened, but which are poorly protected or not protected at all;
- According to the Gauteng Conservation Plan (C-Plan), the majority of the wetlands within the catchment form part of a network of Ecological Support Areas and areas that are Important for biodiversity conservation;
- The wetlands connect to the larger system/water resource that drains the entire area; and
- Several FEPA wetlands are present within the catchment.
- Varying wetland functionality associated with different wetland HGM types.

It is these considerations that have, in part, informed the scoring of the systems in terms of their importance and sensitivity. Figure 3 below indicates the results of the targeted wetlands IS assessments and Tables 8 – 10 indicate the associated IS scores.

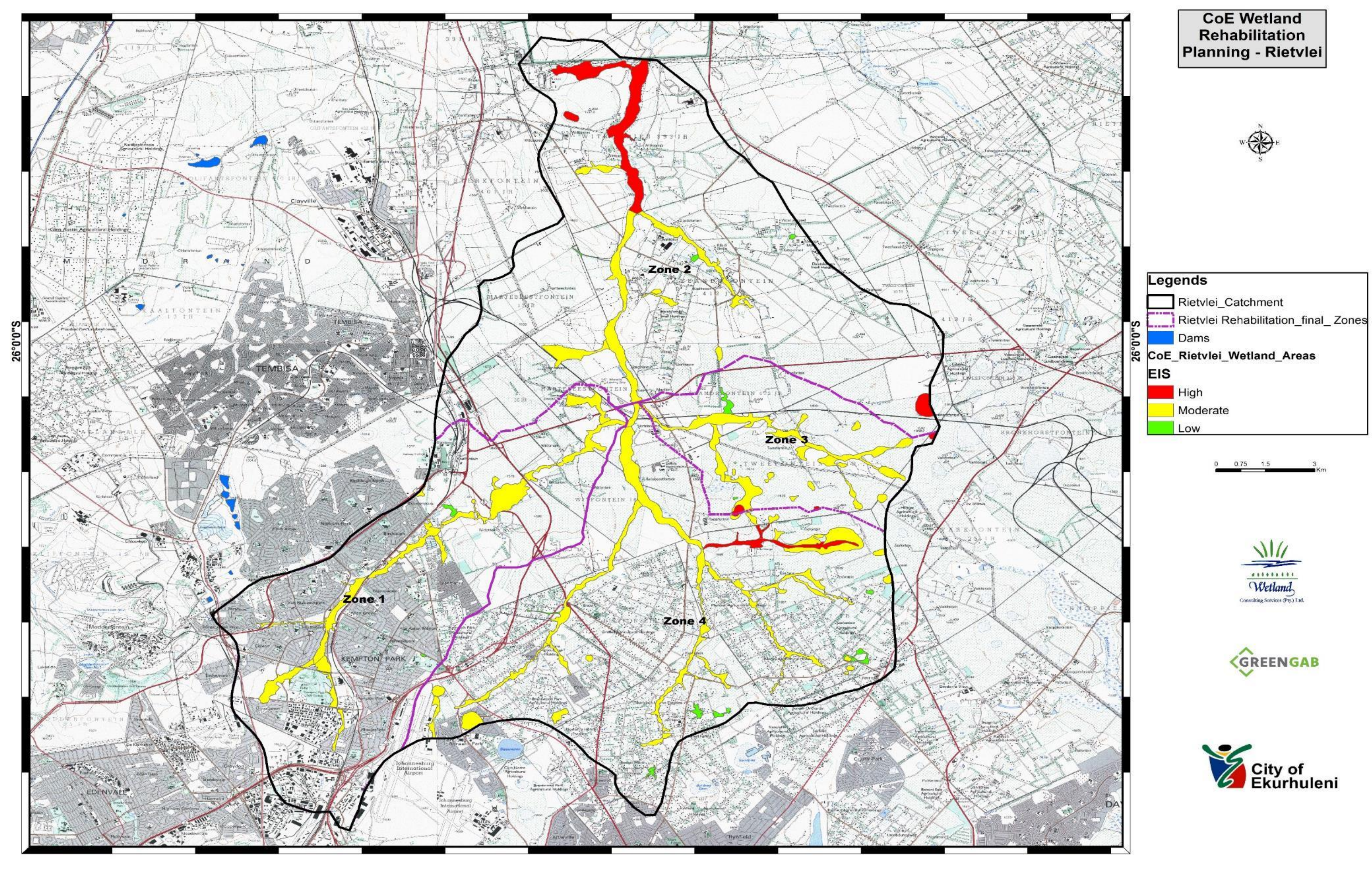
CoE Wetland Rehabilitation Planning - Rietvlei
Legends
Rietvlei_Catchment
Rietvlei Rehabilitation_final_ Zones
Dams
CoE_Rietvlei_Wetland_Areas
EIS
High
Moderate
Low
0 0.75 1.5 3 Km
Zone 1
Zone 2
Zone 3
Zone 4
TEMBISA
KEMPTON PARK
EDENVALE
26°0'0"S
City of Ekurhuleni
GREENGAB
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Figure 3: Map showing the IS assessment results of the targeted wetlands for rehabilitation onsite.

Table 8: Table indicating IS assessment results of the targeted wetlands within Zone 1.

Catchment	HGM	Area	PES	NFEPA	Wetland Type	GAUTENG C-PLAN	VEGETATION THREAT STATUS	OVERALL IS	IS Category
Rietvlei	Channelled valley bottom	136.36	D	Yes	CVB	Important	DHG5	**2.00**	**Moderate**
Rietvlei	Channelled valley bottom	126.12	E	No	CVB	Irreplaceable	DHG5	**2.00**	**Moderate**
Rietvlei	Unchannelled valley bottom	45.25	D	No	UCVB	Important	DHG5	**2.00**	**Moderate**

Table 9: Table indicating IS assessment results of the targeted wetlands within Zone 2.

Catchment	HGM	Area	PES	NFEPA	Wetland Type	GAUTENG C-PLAN	VEGETATION THREAT STATUS	OVERALL IS	IS Category
Rietvlei	Channelled valley bottom	307.69	C	Yes	CVB	Important	DHG5	**2.00**	**Moderate**

Table 10: Table indicating IS assessment results of the targeted wetlands within Zone 4.

Catchment	HGM	Area	PES	NFEPA	Wetland Type	GAUTENG C-PLAN	VEGETATION THREAT STATUS	OVERALL IS	IS Category
Rietvlei	Channelled valley bottom	11.01	D	No	CVB	Important	MHG3	**2.00**	**Moderate**
Rietvlei	Depression	26.43	E	No	DEP	Important	MHG4	**1.50**	**Moderate**
Rietvlei	Depression	3.45	D	Yes	DEP	Important	MHG3	**2.00**	**Moderate**
Rietvlei	Unchannelled valley bottom	67.51	E	Yes	UCVB	Important	MHG3	**2.00**	**Moderate**
Rietvlei	Unchannelled valley bottom	142.62	C	Yes	UCVB	Important	DHG5	**2.00**	**Moderate**

3.5 WETLANDS AND WATERCOURSES REHABILITATION STRATEGY

Planning a wetland rehabilitation strategy is a three-phase process involving:

1. The identification of the problems compromising wetland ecological integrity;
2. Setting rehabilitation objectives based on an analysis of the problems and the feasible extent of addressing them in order to make ecological improvements; and
3. Formulating solutions aimed at achieving the set objectives.

Only those processes that are realistically achievable were therefore considered and used to form the basis of the rehabilitation objectives. Under the current scenario, the goal of rehabilitating the wetlands to functional systems is, in some places, considered to be realistic. This rehabilitation strategy provides an indication of rehabilitation interventions that can be considered during the design phase of the project. The feasibility of some of the proposed activities will further be assessed with an environmental engineer in terms of implementability and costing. As detailed in the situation assessment report, below are generic problems recorded affecting wetlands onsite, proposed rehabilitation objectives and associated rehabilitation activities in all wetlands onsite. Table 11 provides a summary of the impacts recorded affecting wetlands onsite and the proposed rehabilitation strategy to improve the ecological state of the wetlands.

Table 11: Summary of the rehabilitation objectives, their rational and the proposed interventions for the targeted wetlands for rehabilitation onsite.

Watercourses Impacts	• Dumping of building rubble and litter;
	• Ground clearing/scraping;
	• Excavation for brick materials and sand mining;
	• Collapsing rehabilitation interventions in some wetland systems;
	• Tracks and informal roads;
	• Preferential flow paths;
	• Damming and impoundment of flows;
	• Channel incision and gully erosion;
	• Cultivation and agricultural activities;
	• Storm-water drainage from the road;
	• Surcharging manholes and discharging of sewage into watercourses – water quality deterioration;
	• Abandoned concrete pipes and structures; and
	• Alien invasive vegetation, including but not limited to:
	  • *Bidens formosa*
	  • *Bidens pilosa*
	  • *Populus alba*
	  • *Arundo donax*
	  • *Salix babylonica*

Rehabilitation Objectives	• Improve aesthetic appeal of the wetlands and surrounding areas; • Improve habitat and attract local avifauna species; • Improve natural vegetation species composition; • Improve geomorphology and morphological characteristics of the wetland systems by stabilising the channels; and • Improve hydrology and distribution of water in the wetlands by construction of instream weirs and other instream infrastructure that will limit impediment of flows within the wetland systems.
Rehabilitation Goal	• To encourage diffuse flows, reinstate natural flow patterns and improve the morphological characteristics and aesthetic appeal of the wetlands and their surrounding landscape.
Rehabilitation Strategy	• Palisade fencing of the wetland area, particularly where recreation facilities are proposed, to control access at specific points and thus limit multiple human tracks that may lead to preferential flow paths; • Provision of access to the areas around wetlands using turn style gate access or similar to control access; • Removal of litter and rubbles within and around wetland areas; • Make plans to designate alternative dumping sites outside wetland areas (e.g. recycling zone for litter such as plastics); • Repair and redesign, where required, of existing failing rehabilitation interventions; • Ploughing of disturbed areas around the wetlands and revegetation of these areas with indigenous vegetation to encourage vegetation re-establishment; • Practice regular mowing before weeds start flowering to encourage indigenous grass species to spread; • Revegetate areas around the wetlands that remain eroded after ploughing if indigenous vegetation does not re-establish; • Create walkways around wetlands and vegetate open spaces; • Planting of trees in selected areas to provide shade for bird viewing and picnics; and • Ground clearing and landscape flattening for areas around the wetlands that have formed mounds (and consequently become vegetated with mostly alien plants).
Type of intervention likely to be required	• Earth works, backfilling, sloping and levelling; • Physical removal of alien invasive vegetation;

	• Installation of waste management facilities at certain places i.e. bins, etc. • Installation of outdoor gyms and other recreational equipment e.g. soccer fields, etc. in specific areas; • Disc plough or ripping of disturbed areas prior to revegetation with local species; • Revegetation of generally disturbed areas with indigenous vegetation; • Construction of weirs (concrete/gabion) within trenches and incised channels; • Construction of spanning rail crossings for human use where walkways traverse wetlands; • Replace certain wetland crossings with gabion packed rock crossings or concrete structures; and • Construction of multiple culverts at crossings to allow for even distribution of water across the wetlands.

3.6 ANTICIPATED REHABILITATION OUTCOMES

3.6.1 EFFECT ON WETLAND INTEGRITY

The effects of implementation of the rehabilitation strategy, and associated proposed interventions, on the targeted wetlands have been assessed by predicting the anticipated future state of the wetlands with and without rehabilitation. This was undertaken to estimate the functional hectare equivalent gains achieved through the wetland rehabilitation activities.

The projected gains were calculated according to the procedure as indicated in the Wet-Rehab Evaluate guidelines (Cowden and Kotze, 2008). The aim of the rehabilitation strategy is to improve the PES scores of the wetlands considered suitable by at least one category. In some cases improvements resulting from rehabilitation are not expected to result in a full category increase, but remain within the same category. In these cases, it was assumed that this would be within the highest range of the category. Based on the PES assessments undertaken, it is predicted that 78.23 functional hectare equivalents will be gained through the proposed rehabilitation and interventions identified. Tables 12 - 14 below detail project gains anticipated per each targeted wetland due to the proposed rehabilitation of wetlands onsite.

Table 12: Summary of the anticipated functional hectare equivalent gains through implementation of rehabilitation measures proposed for the wetland areas onsite – Zone 1

HGM	PES	Catchment	Area	EIS	HGM_ID	Average PES Score	Current Hectare Equivalent	Average Projected PES Score	Projected PES	Projected Hectare Equivalent	Hectare Equivalent Gains
Channelled valley bottom	E	Rietvlei	126.12	Moderate	CVB1	6.95	38.47	4.95	D	63.69	25.22
Channelled valley bottom	D	Rietvlei	136.36	Moderate	CVB2	4.95	68.86	4.00	D	81.82	12.95
Unchannelled valley bottom	D	Rietvlei	45.25	Moderate	UCVB1	4.95	22.85	3.95	C	27.38	4.53
TOTAL			**307.73**				**130.18**			**172.88**	**42.70**

Table 13: Summary of the anticipated functional hectare equivalent gains through implementation of rehabilitation measures proposed for the wetland areas onsite – Zone 2

HGM	PES	Catchment	Area	EIS	HGM_ID	Average PES Score	Current Hectare Equivalent	Average Projected PES Score	Projected PES	Projected Hectare Equivalent	Hectare Equivalent Gains
Channelled valley bottom	C	Rietvlei	307.69	Moderate	CVB1	2.95	216.92	2.50	C	230.77	13.85
TOTAL			**307.69**				**216.92**			**230.77**	**13.85**

Table 14: Summary of the anticipated functional hectare equivalent gains through implementation of rehabilitation measures proposed for the wetland areas onsite – Zone 4

HGM	PES	Catchment	Area	EIS	HGM_ID	Average PES Score	Current Hectare Equivalent	Average Projected PES Score	Projected PES	Projected Hectare Equivalent	Hectare Equivalent Gains
Channelled valley bottom	C	Rietvlei	142.62	Moderate	CVB1	2.95	100.55	2.95	C	100.55	0.00
Channelled valley bottom	D	Rietvlei	11.01	Moderate	CVB3	4.95	5.56	2.95	C	7.77	2.20
Channelled valley bottom	E	Rietvlei	67.51	Moderate	CVB2	6.95	20.59	4.95	D	34.09	13.50
Depression	E	Rietvlei	26.43	Moderate	P1	6.95	8.06	4.95	D	13.35	5.29
Depression	D	Rietvlei	3.45	Moderate	P2	4.95	1.74	2.95	C	2.43	0.69
TOTAL			**251.03**				**136.51**			**158.19**	**21.68**

3.6.2 EFFECT ON SUPPLY OF GOODS AND SERVICES

Increased functionality of the wetlands will be reflected in improved provision of the following specific goods and services, which contribute towards the overall functionality of the wetlands. Details of anticipated changes in the delivery of wetland services are summarized in Table 15 below. Guidelines for interpreting these scores are detailed in Table 16. The results shown suggest that improvements to a range of regulating and supporting services can be anticipated.

Table 15. Anticipated change scores for ecosystem services post-rehabilitation based on the rehabilitation strategy proposed (Wet-Rehab Evaluate - Cowden and Kotze, 2008).

Ecosystem Service		Score	Comments
REGULATING AND SUPORTING SERVICES	Flood Attenuation	2	Rehabilitation activities will help to increase residence times of floodwaters and stormwater within the watercourses onsite.
	Stream Flow Regulation	0	The impact on streamflow regulation is uncertain. On the one hand, rehabilitation will result in increased recharge of previously drained areas, providing greater storage. On the other hand, diffuse flows will encourage greater evaporative and transpirational losses that may negatively affect water availability.
	Sediment Trapping	1	Rehabilitation activities will increase diffuse flows and encourage plant growth which will improve the effectiveness of the wetland at trapping sediments.
	Phosphate Assimilation	1	Due to extensive agricultural activities in the surrounding area, there is high demand for this service. The potential of the wetlands to provide this service will be improved.
	Nitrate Assimilation	1	As above
	Toxicant Assimilation	1	Wetland rehabilitation activities are being designed to improve the water purification functions of the wetlands.
	Erosion Control	1	While rehabilitation activities will address stabilisation of incision and gully erosion within some sections of the wetlands, the risk of erosion in these systems is still high with ever increasing urbanisation and associated infrastructures. It is, however anticipated that with continuous monitoring and improvement within and around the wetlands, this function is likely to increase.

Ecosystem Service		Score	Comments
	Carbon Storage	1	Rehabilitation will encourage greater plant growth and organic matter accumulation which will improve climate regulation and carbon storage functions.
	Biodiversity Maintenance	1	Rehabilitation of degraded areas will improve vegetation characteristics and should provide improved habitat for wetland-dependant species. This is most anticipated in the depressions and some of the areas where interventions will result in the creation of open water bodies in terms of providing habitat for avifauna.
PROVISIONING SERVICES	Water Supply for Human Use	0	No impact anticipated.
	Natural Resources	0	Rehabilitation will increase the availability of harvestable natural resources. There is, however, no real demand for this service.
	Cultivated Foods	1	Rehabilitation is likely to reduce the extent of cultivated fields and there will therefore be a slightly negative impact on current cultivation activities. However, with the proposed formalisation of the subsistence agricultural plots outside wetlands and watercourses, this function is likely to improve, but not within the watercourses themselves.
CULTURAL SERVICES	Cultural Significance	0	No impact anticipated.
	Tourism and Recreation	2	This function is likely to increase with the proposed creation of parks around and through wetland areas as part of wetland integration and open green spaces. A large improvement is therefore expected.
	Education and Research	0	No impact anticipated.

Table 16. Description of change scores used to rate the potential impact of rehabilitation on ecosystem services delivery (Wet-Rehab Evaluate – Cowden and Kotze, 2008).

Score	Description of impact or rehabilitation on Ecosystem Services
-2	Substantial loss anticipated
-1	Slight loss anticipated
0	No significant loss anticipated
1	Slight improvement anticipated
2	Substantial improvement anticipated

3.7 BASELINE MONITORING AND EVALUATION DATA

It is essential to know, and to be able to demonstrate to others, that the rehabilitation process has been successfully managed and that rehabilitation objectives are being achieved. Given the special context and objectives for the project, a range of baseline information has been collected in order to assess the long-term effectiveness of rehabilitation activities. The results of the baseline data collection for the wetlands are provided here (excluding water quality data that is being collated by Ecotone as part of the River Health Assessment). This data will be used by CoE to inform a longer-term monitoring programme for the site in line with project objectives and environmental authorization requirements.

3.7.1 BASELINE WET-HEALTH INFORMATION

A summary of the wetland assessments are provided in Section 3.2 and Tables 5 – 10, above. This shows that the state of the wetlands prior to rehabilitation ranges from *Moderately* to *Critically* modified. Any future monitoring, including an indication of the upward or downward trajectory of change of the wetland systems within various rehabilitation zones will be assessed in relation to the baseline results as indicated in Section 3.2 above.

3.7.2 FIXED POINT PHOTOGRAPHY

Fixed point photos were used to document the appearance of wetland habitat and vegetation prior to wetland rehabilitation activities being implemented. Photos were taken at points where significant changes are anticipated (linked to the Wet-Health assessments) and should be taken at the same time of the year for consecutive monitoring periods. Photographs taken are included below (Figure 4) while the locations of fixed photo points are indicated in Table 17 and Figure 5.


Point A


Point B


Point C


Point D


Point E

Figure 4: Fixed point photographs for monitoring.

Table 17. Description of the fixed point photographs and their location

Fixed Point	Description	Location
Point A	Alien invasive vegetation - Poplar trees	26° 4'41.55"S 28°13'26.79"E
Point B	Erosion and side cutting of existing gabion intervention	26° 4'39.87"S 28°13'33.42"E
Point C	Breached dam wall	26° 4'50.45"S 28°17'7.65"E
Point D	Informal road crossing and channelling downstream	26° 3'43.68"S 28°17'58.97"E
Point E	Informal road crossing and driving ruts	26° 3'19.20"S 28°18'49.84"E
Point F	Alien invasive vegetation	26° 1'28.17"S 28°18'12.83"E
Point G	Erosion and channel incision	26° 1'12.41"S 28°18'15.75"E
Point H	Road crossing scouring and channel incision downstream	25°58'8.29"S 28°18'3.51"E

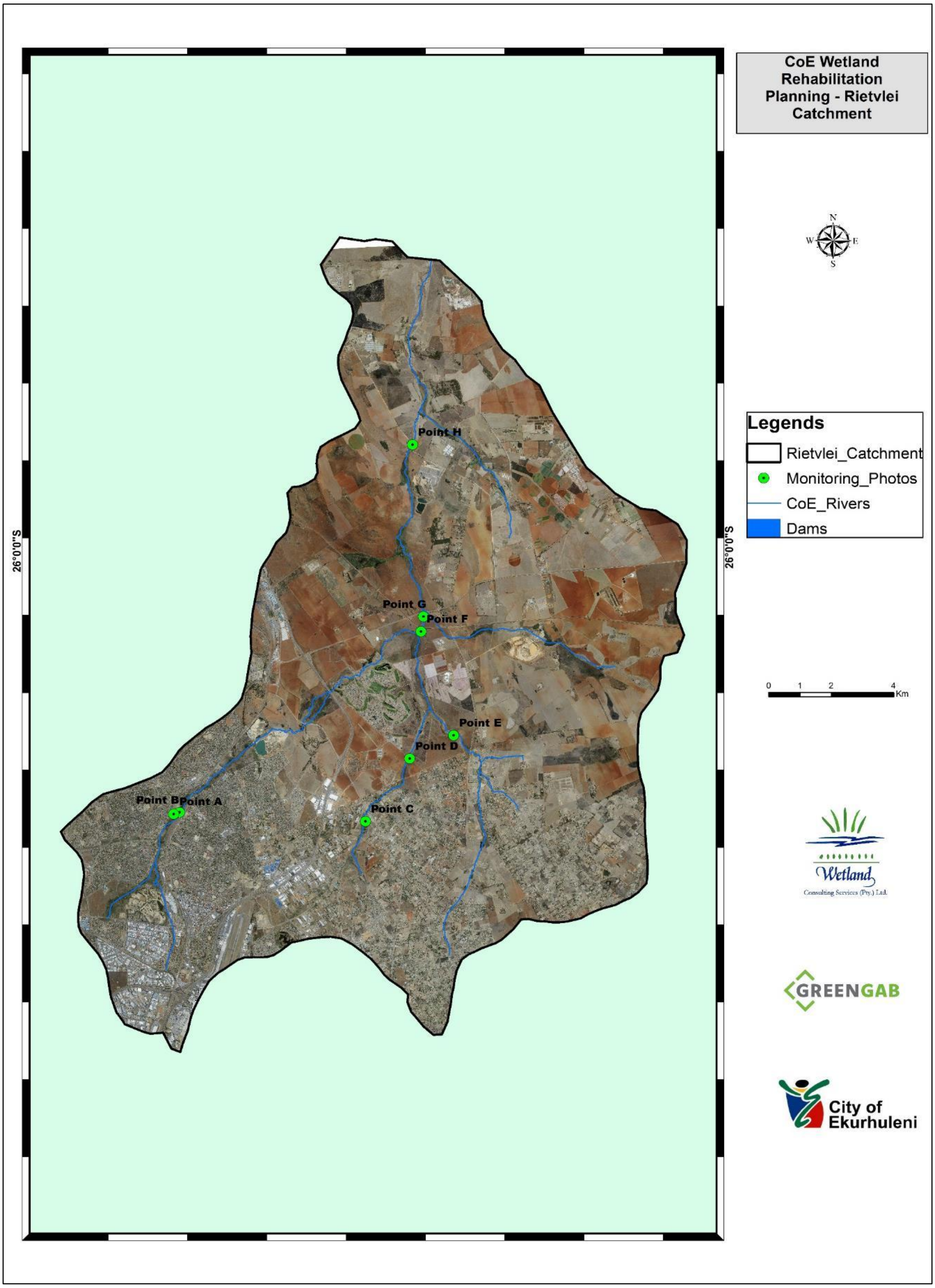

Figure 5: Location of the fixed point photographs.

3.7.3 WATER QUALITY MONITORING

Water quality monitoring is being undertaken by Ecotone as part of the State of Rivers Assessment within the Rietvlei Catchment. This monitoring is designed to provide useful baseline water quality monitoring data and other constituencies which can be compared against the post-rehabilitation scenario.

4 MANAGEMENT MEASURES

The wetlands within the study area have been considerably impacted by the existing urban developments and associated infrastructural activities and agricultural activities. As such, considerable opportunity exists for improving the remaining wetlands' condition and functioning through rehabilitation activities. Directly addressing the existing impacts, such as erosion, flow impoundment and flow concentration, through the placement of structures and/or the redesign of existing infrastructures is a key component in successful wetland rehabilitation. However, another important factor in successful wetland rehabilitation, which is often overlooked, is implementation of a holistic wetland management plan that addresses, amongst other things, the factors that contribute to wetland deterioration, such as livestock utilisation, alien vegetation encroachment and other agricultural activities that extend into wetlands.

The aim of the wetland management plan is therefore to support the rehabilitation of wetland habitat through effective management of the rehabilitation implementation process and landuse management. In order to realise this aim, a number of management measures are recommended, which should be implemented in conjunction with the rehabilitation measures and structural interventions discussed above.

4.1 MANAGEMENT MEASURES

4.1.1 CONSTRUCTION AND ENVIRONMENTAL MANAGEMENT PLAN (CEMP)

The implementation of the proposed rehabilitation interventions must take into account all relevant provisions of Best Management Practices and Construction Environmental Management Plans.

4.1.2 WETLAND MANAGEMENT RECOMMENDATIONS

While construction-related impacts will be addressed through best management practices and the CEMP, there are a range of longer-term aspects that need to be addressed to ensure that anticipated improvements in wetland functionality are achieved and maintained over the long-term. A range of management recommendations are therefore detailed here, which will need to be taken into account when managing the wetland systems. CoE must appoint an independent consultant (both a wetland specialist and an environmental engineer) to undertake monitoring of wetlands and wetland interventions on site. The consultants or specialists must be a wetland specialist registered with South African Council for Natural Scientific Profession (SACNASP) and a Professional Registered Engineer and both should have as a minimum, wetland rehabilitation and monitoring experience of 5 years. The measures included here plus additional measures required for managing and protecting the wetlands should be incorporated into a Wetland Management Plan for the area.

4.1.3 DEVELOPMENT OF WETLAND SERVITUDES

Access to the wetlands, particularly during construction of rehabilitation interventions, should be restricted through the installation of fences:

- The required surface infrastructure footprints should be fenced off and no activities should be allowed to take place outside the fenced off area. The fence should be designed according to the safety requirements as specified by the resident Engineer of the project.

Access to the wetland areas by personnel other than authorised individuals should be prevented. Specifically, the dumping of litter, building rubble and garden refuse within the wetland areas should be prevented.

4.1.4 MANAGEMENT OF REHABILITATION INTERVENTIONS

Regular monitoring of all interventions and areas of revegetation is critical to ensure that any unforeseen problems with rehabilitation interventions are picked up in a timeous manner. In this regard, the following potential concerns should be taken into consideration when inspecting interventions and other rehabilitated areas:

- Signs of erosion around the sides of structures (particularly constructed weirs);
- Signs of scouring below concrete weirs and other structures which could undermine the structures;
- Signs of water not being retained behind weirs which would suggest that water may be finding its way around or under the structures;
- Cracks in concrete structures or damage caused by debris washed down during storms;
- Head-cuts that may develop downstream of structures where water re-enters the main drainage channel;
- Wash / disturbance that has caused failure of earth berms / distribution berms;
- Poor vegetation cover of areas where earthworks have been undertaken;
- Encroachment or re-establishment of alien invasive vegetation; and
- Lack of recovery of wetland vegetation in sections of the wetland that have been rehabilitated.

Where such concerns are noted, input from the wetland specialist and environmental engineer should be sought to assess the need for maintenance or additional interventions to address issues of concern. Monitoring of the above issues will form part of the monitoring plan for the wetland rehabilitation plan.

4.1.5 COMPLIANCE OF REHABILITATION ACTIVITIES WITH AUTHORISATION CONDITIONS

CoE as well as the relevant authorities, including DWS and DEA, should audit compliance and ensure enforcement of all the conditions of the authorisations to be provided for the proposed operations to ensure minimisation of future and projected impacts to remaining wetlands on site or receiving watercourses. Should there be any transgressions; appropriate mitigation measures must be enforced as part of on-going monitoring by all the relevant authorities to minimize impacts on the wetlands and downstream water resources.

4.1.6 STORMWATER AND SEWERAGE INFRASTRUCTURE MAINTENANCE

All stormwater and sewerage management infrastructures on site should be inspected, ideally just before the start of the wet season and then again during the middle of the wet season, for any damage or obstructions. Obstructions should be cleared and damage repaired immediately to ensure optimal operation of the infrastructure. All discharge points should also be inspected for signs of erosion. Any erosion damage identified should be repaired immediately and corrective measures implemented as required. Surcharging manholes must be monitored on a weekly basis and it is proposed that all manholes be erected at least a metre above ground to make it easier to see if there are any problems requiring attention to prevent prolonged discharge of sewage to the wetlands. Continuous upgrading of sewerage infrastructure is required to ensure it can deliver for the community within the area and limit opportunities of failure resulting in sewage discharging into the watercourses.

4.1.7 MANAGEMENT OF AGRICULTURAL LANDS

As part of the rehabilitation strategy, all cultivated lands that currently extend into wetland habitat should be pulled back outside of the wetland boundaries. In addition, agricultural use of herbicides, pesticides and fertilizers in the vicinity of the wetlands should be carefully controlled to avoid toxic effects on the flora and fauna occurring within the wetlands. Appropriate contour berms should be maintained between any agricultural lands and wetland areas so as to limit impacts associated with sedimentation and pollutant runoff. Cultivation techniques must also employ measures to limit erosion and sediment loss from the cultivated fields, i.e. contour ploughing, etc. It will be the responsibility of the CoE to engage with land users of the wetlands and immediately adjacent areas to ensure best management practices are adhered to as detailed above.

4.1.8 FIRE MANAGEMENT

With the exception of special treatment areas, as a general rule, for low rainfall regions (<900 mm per annum), an area of wetland should be burnt every 4 to 5 years. Where possible, burning should be undertaken on a rotational basis. Cool and patchy burns should be promoted where possible by burning when relative humidity is high and air temperatures are low, preferably after rain. Preference should be given to burning of areas with abundant dead (moribund) stem and leaf material that limits new growth. Autumn/early winter breeding species such as the grass owl and marsh harrier may be negatively impacted by early winter burning. Where these species occur, burning should be done rotationally through block burning and checked before burning by having 'beaters' 10 m apart walking through the area and then closely examining all localities where these birds are flushed. Areas should be left un-burnt where chicks have still not fledged, or, if possible, delay burning for that year. Further reference to this must be according to the recent published SANBI Grazing & Burning Guidelines (SANBI, 2014). A burning management strategy should be included in the Wetland Management Plan for this purpose.

4.1.9 CONTROL OF ALIEN INVASIVE VEGETATION

Alien invasive plants (patches of Black wattle and Eucalyptus), as well as any other plant species listed as alien invasive species according to the National Environmental Management: Biodiversity Act (10/2004): Alien and Invasive Species Regulations, 2014, occurring within the wetlands and sub-catchments pose a threat to wetland functioning and should ideally be removed as part of rehabilitation activities. This should be considered for future rehabilitation planning cycles.

4.1.10 LIVESTOCK MANAGEMENT

Should the wetlands and surrounding areas be utilised for agricultural activities, then livestock numbers should be maintained within acceptable carrying capacities to ensure that species composition is not compromised and trampling does not lead to further erosion of wetland areas or compromise the integrity of structural rehabilitation interventions. If necessary, the Department of Agriculture should be called upon to determine the grazing capacity for the bioclimatic region in which the wetlands are located. As a general rule, grazing capacity in temporary wetland areas can be estimated as 1.5 times that of dryland areas, while grazing within seasonal and permanently wet areas should be restricted to 0.5AU/ha during the spring months. Where important biota occurs, further advice should be sought by an Agricultural Extension Officer. Where cattle trampling is causing significant disturbance near drinking points, alternative water sources should be provided or the area hardened to reduce the potential for erosion. It is also recommended that wetland areas be fenced off to allow effective control of livestock numbers within the wetland habitat. A livestock management and grazing plan should be included in the Wetland Management Plan for this purpose.

4.1.11 RE-VEGETATION OF DISTURBED AREAS

Bare soil areas within the wetlands resulting from construction or rehabilitation activities should be re-vegetated as soon as possible following the disturbance. A wetland specialist or botanist must assist during re-vegetation and must prescribe the suitable approach and species for re-vegetation of disturbed wetland areas. Typical species that could be considered include a mix of pioneer and climax species such as the following:

- *Digitaria eriantha*
- *Chloris gayana*
- *Eragrostis curvula*
- *Eragrostis tef*
- *Cynodon dactylon*
- *Setaria spp.*
- *Panicum maximum*
- *Melinis repens*

Soil compaction should be alleviated through ploughing/ripping and scarifying, followed by landscaping to the natural/surrounding landscape profile. Where ploughing/ripping takes place on slopes leading towards wetland areas or water courses, sediment barriers should be installed along the lower edge of the ploughed area. Once soil preparation is complete, seed beds should be prepared as per the guidelines supplied by the seed supplier, or as follows: Furrows should be made in the soil by hand using hoes. Furrows must be made horizontally in the soil (perpendicular to slope) and should be spaced 0.4 meters (maximum) apart and at least 10 cm deep. Work should commence from the top of the slope and be conducted downwards and any loose soil and rocks from the process should be removed to prevent siltation of the wetlands downwards. The beds should follow the contours of the land and not in any way allow water to collect or flow in high volumes, thus creating erosion gullies. Larger clumps of soil and stones should be removed to prevent impeded flow of water. On steep slopes and high erosion risk areas the use of hessian blankets is recommended to increase erosion protection. Seeding should commence as soon as the hessian is in place and seed bed preparation has been completed. Either hand or hydro-seeding can be considered, depending on the area required to be planted. Both hand and hydro-seeding must be done by professionals only. If any fertilizers are recommended these should be applied to the side slopes only and not within the wetland. If hydro seeding is selected for the seeding process the hydro-seeders used must run for 10 minutes at least before the commencement of the seeding project. This is to ensure adequate mixing of the seed and water. Water extraction for the hydro-seeding from the wetlands and pans is not allowed unless authorization is received from the DWS.

4.1.12 MANAGEMENT AND MONITORING OF IMPORTANT BIOTA

- No threatened flora should be collected or harvested;
- No threatened fauna should be hunted;
- Where endangered animal species occur in the wetlands, records should be kept of sightings in order to help establish whether or not wetland management practices and rehabilitation efforts are having a positive impact on these species; and
- The local district conservation officer should be contacted to obtain further information on monitoring of important species.

4.1.13 ROAD CROSSINGS

Further roads through the wetlands should be avoided as far as possible. Should these be necessary, then measures must be implemented to address potential future impacts, such as flow impoundment and concentration. As such, if roads are constructed through wetlands, they should be designed in such a manner that they have minimal impact on natural flow patterns through the wetlands.

4.1.14 REMOVAL OF REDUNDANT INFRASTRUCTURE

It is recommended that a survey of all infrastructures located within the wetland areas earmarked for rehabilitation must be undertaken and that, in consultation with the land users, all redundant infrastructures and roads be removed and the footprints rehabilitated. Any such rehabilitation activities should be undertaken under supervision of a qualified engineer and a wetland specialist.

5 CONCLUSION

This report sets out the detailed wetland assessments and baseline data collected for the targeted wetlands for rehabilitation within the Rietvlei Catchment area and will be the primary working document for the implementation of the project via construction/undertaking of interventions required for wetland rehabilitation. Details of the rehabilitation plan, including individual intervention designs are presented in the engineering report that will accompany this report.

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