PROPOSED WILD COAST SPECIAL ECONOMIC ZONE MTHATHA, KING SABATA DALINDYEBO LOCAL MUNICIPALITY, EASTERN CAPE

Wetland Habitat Impact Assessment Report

Version: 0.1

DRAFT REPORT FOR COMMENT

Date: 10th July 2018

Eco-Pulse Environmental Consulting Services

Report No: EP341-02

Prepared for: WSP: Environment & Energy, Africa
Building C, Knightsbridge
33 Sloane Street, Bryanston 2191, South Africa
Ms. Ashlea Strong (Principal Consultant)
T +27 11 361 1392
M +27 82 786 7819
Email: Ashlea.Strong@wsp.com

Prepared by: Eco-Pulse Environmental Consulting Services
1 Mallory Road, Hilton, 3245, South Africa
Mr. Adam Teixeira-Leite *Pr.Sci.Nat. (Senior Scientist: Wetland Ecologist)*
Tel: 031 2666 700
Mobile: 082 310 6769
E-mail: ateixeira@eco-pulse.co.za

Suggested report citation:

Eco-Pulse Consulting. 2018. Proposed Wild Coast SEZ, Eastern Cape. ***Wetland Habitat Impact Assessment Report***. Unpublished report prepared by Eco-Pulse Environmental Consulting Services for WSP. Report No. EP341-02. Version 0.1 (DRAFT). 10th July 2018

SPECIALIST ASSESSMENT REPORT DETAILS AND DECLARATION OF INDEPENDENCE

This is to certify that the following specialist vegetation assessment report has been prepared has been prepared independently of any influence or prejudice as may be specified by the Department of Environmental Affairs (DEA) and Department of Water & Sanitation (DWS).

Document Title:	***Wetland Habitat Impact Assessment Report*** for the proposed Wild Coast Special Economic Zone (SEZ)
Report Number:	EP341-02
Version Number:	0.1 (DRAFT)
Date:	10th July 2018
Report prepared by:	**Mr Adam Teixeira-Leite** (BSc. Hons. Environmental Science) Professional Natural Scientist (*Pr. Sci. Nat.*) (Ecological Science) SACNASP Registration Number: 400332/13
Client:	WSP (on behalf of Coega Development Corporation [CDC])

I, **Adam Teixeira-Leite**, hereby declare that this report has been prepared independently of any influence or prejudice as may be specified by the Department of Environmental Affairs (DEA) and Department of Water & Sanitation (DWS).

Signed: ______________________ Date: 10th July 2018

DETAILS OF PROJECT TEAM

The relevant experience of specialist team members from Eco-Pulse Consulting involved in the assessment and compilation of this report are briefly summarized below. *Curriculum Vitae's* of the specialist team are available on request.

Specialist	Role	Details
Adam Teixeira-Leite *Pr.Sci.Nat.* Senior Scientist & Wetland Ecologist	Project leader, Author	Adam is a Senior Environmental Scientist at Eco-Pulse with a BSc. Honours degree in *Environmental Science: Earth Sciences*. He is a registered Professional Natural Scientist (Pr. Sci. Nat.) in the 'Ecological Sciences' field of practice with SACNASP, with over 10 years' experience, having worked extensively on numerous specialist ecological assessment projects, both for wetland/aquatic and terrestrial (grasslands and forests) habitats and ecosystems in KZN, the Free State, Gauteng, Eastern Cape, Western Cape and Lesotho. He is also experienced in undertaking alien plant surveys and developing ecological rehabilitation and management plans and programmes.
Brian Mafela *Cand.Sci.Nat.* Environmental Scientist	Fieldwork & co-author	Brian Mafela is an Environmental Scientist at Eco-Pulse with a BSc. Honours degree in Forest Resources and Wildlife Management. Brian is a registered Candidate Natural Scientist (*Cand. Sci. Nat*.) with over 6 years' experience in undertaking EIA processes, wetland and riparian assessments, vegetation assessments, identifying and evaluating impacts of developments on the environment and providing Best Management Practice (BMP) mitigation measures.

EXECUTIVE SUMMARY

The Coega Development Corporation (CDC) intends to develop Phase 1 of the Wild Coast Special Economic Zone (ECSEZ), located immediately adjacent to the existing Mthatha Airport north-west of Mthatha town in the Eastern Cape Province of South Africa. The intended development will be for agricultural land use and a 'mixed-use' type development comprising: hotel & conferencing, commercial space, industrial land use and intensive agriculture & business process outsourcing.

In order to inform the Environmental Impact Assessment (EIA) and Water Use License Application (WULA) for the planned development, a wetland baseline and impact/risk assessment was undertaken by Eco-Pulse Consulting to satisfy the requirements of the Department of Environmental Affairs (DEA), Department of Water & Sanitation (DWS) and the National Environmental Management Act No. 107 (and NEMA EIA regulations) of 1998 as well as the National Water Act No. 36 of 1998.

This report sets out the findings of the Specialist Baseline Wetland Habitat and Impact Assessment undertaken between March and July 2018. The main findings of this report have been summarized below as follows:

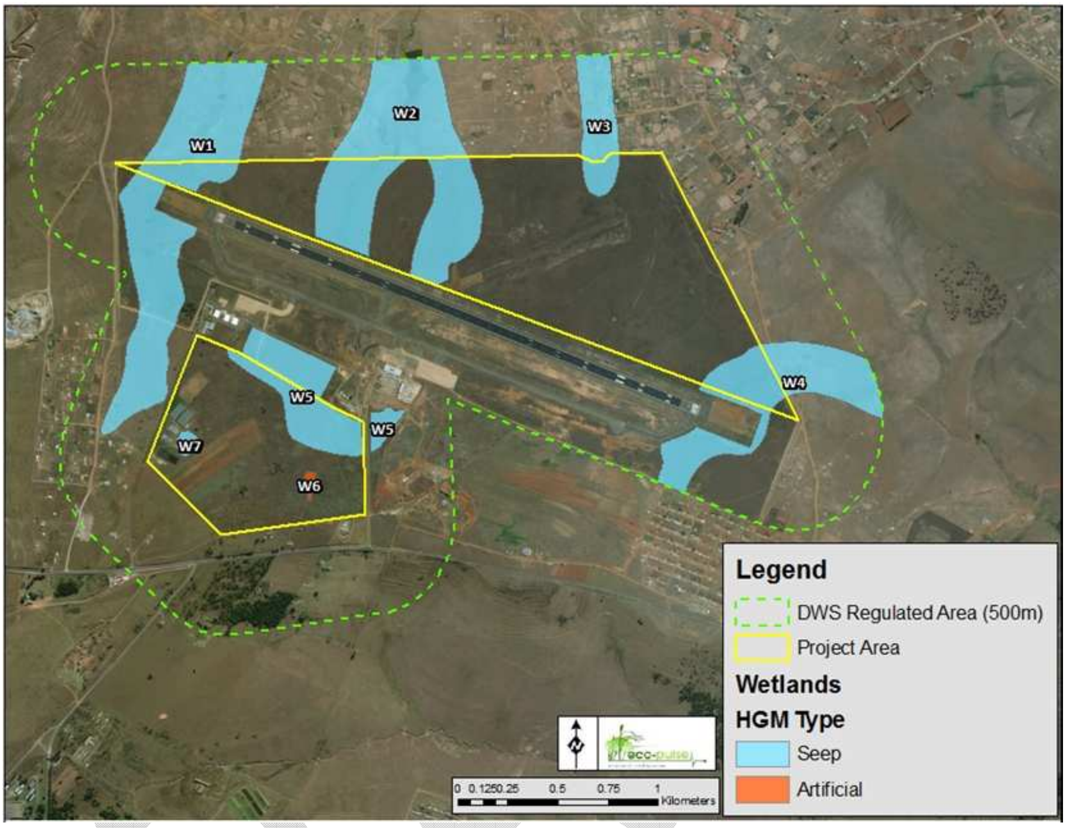
<u>**Catchment Context:**</u>

1. The area of study is located within the Mzimvubu to Keiskamma Water Management Area (WMA) (Water Management Area) and within DWS **Quaternary catchments T20B and T20C**. The proposed WCSEZ development will primarily take place upslope of the Mthatha Dam which is situated within a reach of the Mthatha River, whilst the eastern extent of the northern development is upslope of the Cicira River which terminates at the base of the Mthatha dam wall and into the Mthatha River.
2. Two wetland vegetation groups are associated with the project area: **Sub-escarpment Savanna** and **Sub-Escarpment Grassland Group 7** as defined by NFEPA (SANBI & DWS, 2014). At the wetland vegetation group (WVG) level, the Sub-escarpment Savanna wetland vegetation group has an ecosystem threat status of **Endangered** and the Sub-Escarpment Grassland Group 7 wetland vegetation type is **Critically Endangered**.

<u>**Baseline Wetland PES & EIS:**</u>

3. Seven (7) wetland units, including six (6) wetland 'seeps' and one (1) artificial wetland (wetland W6) created by a leaking bulk water pipeline infrastructure, were identified within the DWS regulated area for wetland water use (i.e. 500m radius of the development property) and are at significant risk of being potentially impacted by the proposed development. No rivers were identified as being at risk of impact, thus only wetland have been assessed in this report.
4. The findings of the baseline wetland assessment suggests that owing to a range of existing impacts within the wetlands and catchment area (linked to storm water runoff and airport development), the wetlands are generally in a '**moderately modified ('C' PES Class**) to

'largely modified' state (**'D' PES class)** state. **The larger and more intact wetlands (W1 to W4) were considered to be of 'Moderate' Ecological Importance & Sensitivity (EIS)** whilst the **smaller wetlands W6 and W7 were considered to be of 'Low' to 'Very Low' EIS.**



Resource Management Objectives & Recommendations:

5. Future management of the freshwater wetland ecosystems associated with the development should be informed by the recommended management objectives for the water resource which, in the absence of classification, is generally based on the current status of the water resource or PES and the EIS for the resources (DWAF, 2007). The recommended management objective (based on a combined PES and EIS rating) should be to ***maintain the current status quo of aquatic ecosystems without any further loss of integrity/functioning (PES/EIS).*** This is also generally aligned with the aquatic conservation priorities highlighted for the study area in terms of the Eastern Cape Biodiversity Conservation Plan (ECBCP (Hayes *et al.*, 2007; Berliner & Desmet, 2007), which recommends that the management objective for these areas should be to: "***Maintain biodiversity in as natural state as possible, Manage for no biodiversity loss***" (Hayes *et al.*, 2007).

Wetland Unit	HGM Type	PES	EIS	RMO
W1	Seep	D: Largely Modified	**Moderate**	*Maintain PES/EIS*
W2		C: Moderately modified	**Moderate**	
W3		D: Largely Modified	**Moderate**	
W4		D: Largely Modified	**Moderate**	

W5		C: Moderately modified	**Moderate**	
W6	'Artificial' Wetland	N/A	Very Low	N/A
W7	Seep	D: Largely Modified	Low	*Maintain PES/EIS*

Wetland Impacts & Mitigation:

6. The most significant ecological impacts likely to be associated with the proposed development pertains to the **potential permanent transformation and loss of a substantial amount of wetland habitat (~56 ha**), the **risk of increased sediment inputs during construction, the establishment of invasive alien plants in disturbed areas during the construction and operation phases of the development and the risk of modifying natural/pre-development flow characteristics with the development of hardened surfaces in the wetland catchment area**. There is also the risk of water quality degradation during construction and operation. These impacts are generally expected to be of **'Moderate' to "High' impact significance** under a 'poor' or 'standard' management scenario. Under a 'good' or ;best-practical' management scenario (i.e. taking into consideration the impact mitigation recommendations made by Eco-Pulse and contained in the specialist wetland assessment report), **the significance of impacts is expected to be reduced to 'moderately-low' significance levels** and therefore can be considered to be of an environmentally 'acceptable' level.

7. Most wetland ecological impacts can be effectively mitigated on-site by:

   a) **Ensuring that direct impacts to wetlands are avoided wherever possible** through ecologically sound and sustainable development layout planning that takes into account the location and sensitivity of the remaining ecological infrastructure at the site and through implementing relevant aquatic buffer zones (15m width prescribed);

   b) **Employing creative design principles and ecologically sensitive methods** in infrastructure design and layouts to minimise the risk of indirect impacts;

   c) **Ensuring that storm water management design and implementation takes into account the requirements of the environment**, including wetlands and rivers; and

   d) Taking necessary efforts aimed at **minimising/reducing potential waste streams.**

Avoiding sensitive wetland areas and applying appropriate buffer zones and restricting activities within this zone (15m buffer zone recommended), supplemented by the application of on-site practical mitigation measures and management principles to control erosion, sedimentation and water pollution impacts and risks will be necessary to reduce the significance of impacts and ensure the sustainable management of the wetland resource and ecological infrastructure on the property (and downstream).

Where storm water is appropriately managed, this impact can be potentially mitigated and a net positive effect on the downstream wetlands could be achieved. Wetland management and mitigation is dealt with in detail under Chapter 6 of the wetland report and **Appendix A: 'Conceptual Wetland Rehabilitation Plan'.**

Wetland Offset Requirements:

8. In the context of the study area and proposed development, the grassy seepage-type wetlands in the region are under considerable threat and this suggests that further losses to these wetland types is likely to constitute a 'significant' impact. This is also relevant in light of the identification of the catchment area as an *aquatic 'Critical Biodiversity Area' or CBA at level 1 (A1)*b in terms of the Eastern Cape Biodiversity Conservation Plan, which represents in this instance critically important sub-catchments in a natural state that are considered critical for conserving biodiversity and maintaining ecosystem functioning and which require high levels of protection and the recommended management objective for such areas should be to: "*Maintain biodiversity in as natural state as possible, Manage for no biodiversity loss*" (Hayes *et al.*, 2007).

9. Should the current development plan be authorised by the relevant environmental authorities based on the development motivation, this will result in the permanent loss of an estimated **56 ha** of wetland area which initially could be considered to be of **'high' impact significance and would warrant the consideration of a wetland/biodiversity offset as a means of compensating for the permanent loss of wetland habitat and functioning (i.e. residual wetland impact).**

10. The extent of the area to target for an offset (based on losses, threat status of the vegetation type and ecosystem conservation ratios/multipliers), together with the mechanisms and cost implications for doing so, will need to be investigated once confirmation for the need for an offset has been obtained from the regulating authorities. At this stage, an appropriate **Wetland Offset Plan** would need to be developed under this scenario if approved.

Water Use Licensing Requirements:

11. The proposed **development requires a Water Use License (WUL) in terms of Chapter 4 and Section 21 (c) and (i**) of the National Water Act No. 36 of 1998 and this must be secured prior to the commencement of construction. Key activities that constitute a 'non-consumptive' water use in terms of Section 21 (c) and (i) include:

- Development within a watercourse (including roads and pipelines crossing wetlands); and
- Storm water runoff management from the operational development site.

There are no anticipated consumptive water uses identified (no abstraction or storage of water).

Since wastewater will be managed by tying in to the existing regional WWTW (Waste Water Treatment Works) for treatment and disposal offsite, Section 21 (g) water use should not apply to the project.

12. The findings of the Aquatic Risk Assessment undertaken suggest initially that due to development risk being considered 'Moderate' (even once risk and impacts are fully mitigated) **the development cannot be authorised in terms of the GA (General Authorisation) for Section 21 (c) and (i) water use** under this scenario and **requires a full license application.**

CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

LIST OF TABLES

LIST OF TERMS

Catchment	The area where water from atmospheric precipitation becomes concentrated and drains downslope into a river, lake or wetland. The term includes all land surface, streams, rivers and lakes between the source and where the water enters the ocean.
Conservation	The safeguarding of biodiversity and its processes (often referred to as Biodiversity Conservation).
Delineation	Refers to the technique of establishing the boundary of a resource such as a wetland or riparian area.
Ecosystem	An ecosystem is essentially a working natural system, maintained by internal ecological processes, relationships and interactions between the biotic (plants & animals) and the non-living or abiotic environment (e.g. soil, atmosphere). Ecosystems can operate at different scales, from very small (e.g. a small wetland pan) to large landscapes (e.g. an entire water catchment area).
Ecosystem Goods and Services	The goods and benefits people obtain from natural ecosystems. Various different types of ecosystems provide a range of ecosystem goods and services. Aquatic ecosystems such as rivers and wetlands provide goods such as forage for livestock grazing or sedges for craft production and services such as pollutant trapping and flood attenuation. They also provide habitat for a range of aquatic biota.
Erosion (gully)	Erosion is the process by which soil and rock are removed from the Earth's surface by natural processes such as wind or water flow, and then transported and deposited in other locations. While erosion is a natural process, human activities have dramatically increased the rate at which erosion is occurring globally. Erosion gullies are erosive channels formed by the action of concentrated surface runoff.
Function/functioning/ functional	Used here to describe natural systems working or operating in a healthy way, opposed to dysfunctional, which means working poorly or in an unhealthy way.
Habitat	The general features of an area inhabited by animal or plant which are essential to its survival (i.e. the natural "home" of a plant or animal species).
Indigenous	Naturally occurring or "native" to a broad area, such as South Africa in this context.
Invasive alien species	Invasive alien species means any non-indigenous plant or animal species whose establishment and spread outside of its natural range threatens natural ecosystems, habitats or other species or has the potential to threaten ecosystems, habitats or other species.
Mitigate/Mitigation	Mitigating impacts refers to reactive practical actions that minimize or reduce in situ impacts. Examples of mitigation include "changes to the scale, design, location, siting, process, sequencing, phasing, and management and/or monitoring of the proposed activity, as well as restoration or rehabilitation of sites". Mitigation actions can take place anywhere, as long as their effect is to reduce the effect on the site where change in ecological character is likely, or the values of the site are affected by those changes (Ramsar Convention, 2012).

Risk	A prediction of the likelihood and impact of an outcome; usually referring to the likelihood of a variation from the intended outcome.
Soil Mottles/ Mottling	Soil mottling is a feature of hydromorphic (wet) soils and common to wetland areas. Mottles refer to secondary soil colours not associated with soil compositional properties that usually develop when soils are frequently wet for long periods of time. In water-logged soils, anaerobic (oxygen deficient) conditions generally causes redoximorphic soil features such as red mottles to develop. Lithochromic mottles on the other hand are a type of mottling associated with variations of colour due to weathering of parent materials.
Threat Status	Threat status (of a species or community type) is a simple but highly integrated indicator of vulnerability. It contains information about past loss (of numbers and / or habitat), the number and intensity of threats, and current prospects as indicated by recent population growth or decline. Any one of these metrics could be used to measure vulnerability. One much used example of a threat status classification system is the IUCN Red List of Threatened Species (BBOP, 2009).
Threatened ecosystem	In the context of this document, refers to Critically Endangered, Endangered and Vulnerable ecosystems.
Transformation (habitat loss)	Refers to the destruction and clearing an area of its indigenous vegetation, resulting in loss of natural habitat. In many instances, this can and has led to the partial or complete breakdown of natural ecological processes.
Watercourse	Means a river or spring; a natural channel in which water flows regularly or intermittently: a wetland, lake or dam into which, or from which, water flows: und any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks (National Water Act, 1998).
Wetland	Refers to 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 (NWA, 1998).
Wetland Type	This is a combination between wetland vegetation group and Level 4 of the National Wetland Classification System, which describes the Landform of the wetland.
Wetland Vegetation Group	Broad wetland vegetation groupings reflect differences in regional context such as geology, soils and climate, which in turn affect the ecological characteristics and functionality of wetlands.

LIST OF ABBREVIATIONS/ACRONYMS

CBA	Critical Biodiversity Area
CR	Critically Endangered (threat status)
DEA	Department of Environmental Affairs (formerly DEAT)
DWS	Department of Water and Sanitation (formerly DWA/F)
EA	Environmental Authorisation
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment: EIA regulations promulgated under section 24(5) of NEMA
EIS	Ecological Importance and Sensitivity
EMPr	Environmental Management Programme
FEPA	Freshwater Ecosystem Priority Area
GA	General Authorisation

GIS	Geographical Information Systems
GPS	Global Positioning System
HGM	Hydro-Geomorphic (unit)
IAPs	Invasive Alien Plants
IHI	Index of Habitat Integrity
NEMA	National Environmental Management Act No.107 of 1998
PES	Present Ecological State, referring to the current state or condition of an environmental resource in terms of its characteristics and reflecting change from its reference condition.
SANBI	South African National Biodiversity Institute
VU	Vulnerable (threat status)
WULA	Water Use Licence Application

1 INTRODUCTION

1.1 Project Locality and Description

The Coega Development Corporation (CDC) intends to develop the Wild Coast Special Economic Zone (SEZ), located immediately adjacent to the existing Mthatha Airport north-west of Mthatha town (Figure 1) in the Eastern Cape Province of South Africa. Given the economic development potential and agricultural focused advantages the region offers, and using input received during the stakeholder's consultation, developmental priorities were identified for phase 1 of the development.

Figure 1 Google Earth™ map showing the location of proposed Wild Coast SEZ at Mthatha Airport within the King Sabata Dalindyebo Local Municipality, Eastern Cape.

Based on available information received, the CDC is seeking Environmental Authorisation (EA) for Phase 1 of a broader concept, namely the industrial-commercial type development within the Mthatha Airport precinct. The two properties to be developed are shown outlined in 'yellow' in Figure 2:

- The **Phase 1: 'North'** property is 183 ha in extent and is located on the farm to the immediate north of the existing Mthatha Airport runway. *The intended development will be for agricultural land use on the majority (164ha) of this property.*
- The **Phase 1: 'South'** property is 72 ha in extent and is located on the farm to the immediate south of the existing Mthatha Airport building. *The intended development will be for a 'mixed-use' type development comprising: hotel & conferencing, commercial space, industrial land use and intensive agriculture & business process outsourcing.*

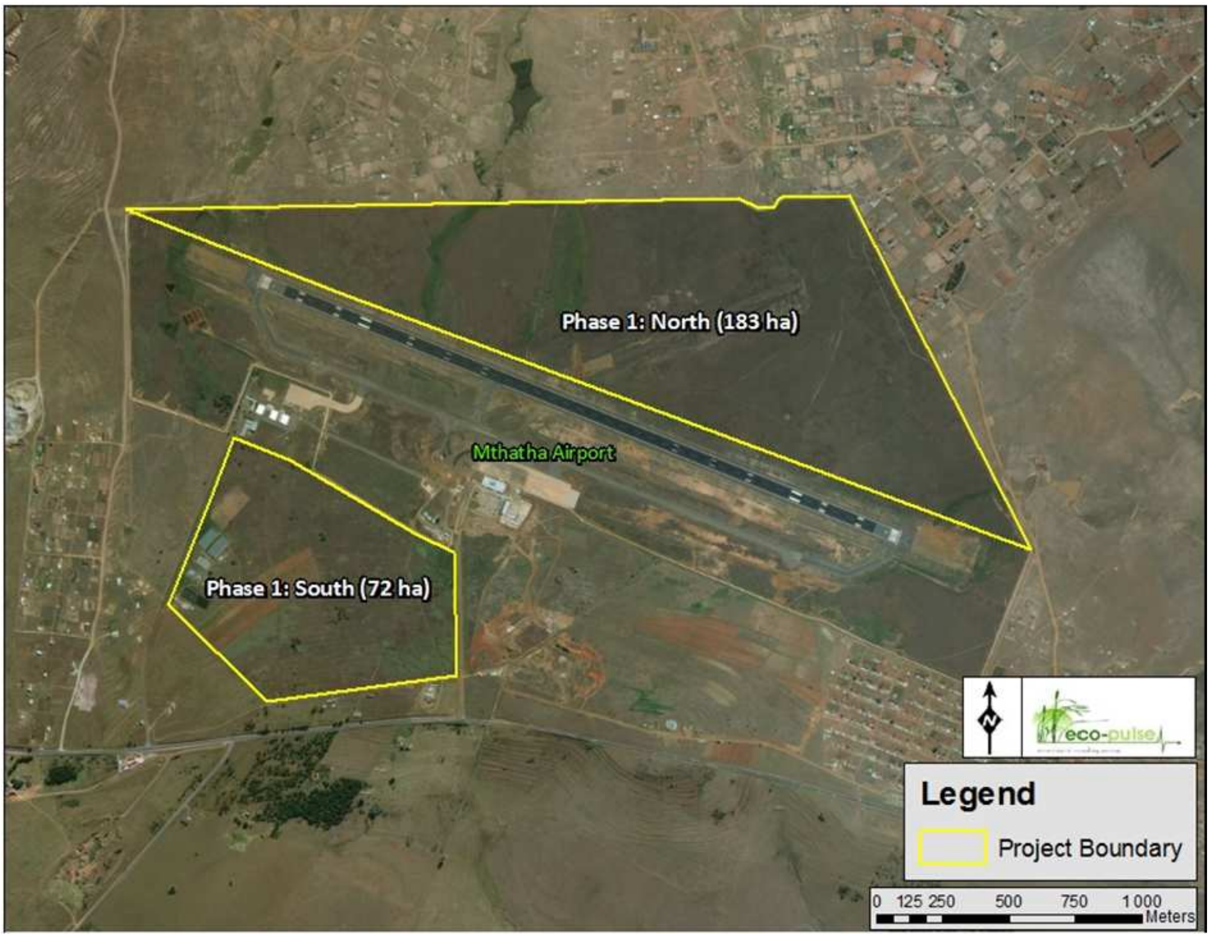


Figure 2 Map showing the northern and southern land portions associated with the Phase 1 development.

1.2 Scope of Work

The specialist wetland assessment was undertaken in accordance with the following scope of work:

1. Desktop mapping and impact likelihood screening assessment of all wetlands within a 500m radius of the proposed development project.
2. Infield delineation of the outer boundary of wetlands likely to be impacted (as defined above) according to the methods and techniques contained in '*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas*' (DWAF, 2005).
3. Classification of delineated wetlands/riparian areas using the latest National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis *et al*.,2013).
4. Undertaking a rapid wetland vegetation and habitat survey.
5. Undertaking the following baseline assessments:
   - WET-Health level 1 rapid assessment (Macfarlane *et al.*, 2008) to establish the Present Ecological State (PES) of the wetlands.
   - WET-EcoServices assessment (Kotze *et al.*, 2009) to determine the importance of the wetlands in providing ecosystem goods and services.
   - Ecological Importance and Sensitivity (EIS) of the wetlands using the WET-EIS tool (Duthie, 1999).

6. Provision of a wetland habitat sensitivity map for the site, including the location of sensitive wetland habitat and vegetation types, protected aquatic plants and any recommended development set-backs or development layout recommendations with motivation to be provided.
7. Identification and description construction and operational phase ecological impacts to freshwater habitats.
8. Provision of planning and design mitigation / recommendations to avoid and/or minimise direct and indirect impacts where possible, including suitable aquatic buffer zones in accordance with the latest National Wetland Buffer Zone Guidelines (Macfarlane and Bredin, 2016).
9. Provision of construction and operational phase controls and measures to mitigate impacts and remediate potential impacts linked with the proposed development where possible (i.e. conceptual level wetland rehabilitation strategy and relevant guidelines). *Note that detailed rehabilitation plans were not developed under this scope of work.*
10. Assessment of the need and desirability of wetland offsets as a means of mitigation/compensation for residual wetland impacts after all other forms of mitigation have been investigated.
11. Describe any assumptions made and any uncertainties or gaps in knowledge, as well as identifying the need for any future specialist inputs should these be deemed relevant to the project.
12. Compilation of a Specialist Wetland Habitat Impact Assessment Report, as well as all relevant maps and supporting information.

1.3 Key Definitions and Concepts

Under Section 1(1)(xxiv) of the National Water Act (Act No. 36 of 1998) (NWA), a 'watercourse' is defined as:

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

This assessment focuses on the assessment of all natural watercourses and their associated habitats / ecosystems likely to be measurably affected by the proposed development, focussing specifically on wetlands. For the purposes of this assessment, wetlands are defined as:

> *…areas that have water on the surface or within the root zone for extended periods throughout the year such that anaerobic soil conditions develop which favour the growth and regeneration of hydrophytic vegetation (plants which are adapted to saturated and anaerobic soil conditions). In terms of Section 1 of the NWA, wetlands are legally defined as: (1) "…land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."*

1.4 Conservation and Functional Importance of Aquatic Ecosystems

Water affects every activity and aspiration of human society and sustains all ecosystems. "Freshwater ecosystems" refer to all inland water bodies whether fresh or saline, including rivers, lakes, wetlands, sub-surface waters and estuaries (Driver *et al*., 2011). South Africa's freshwater ecosystems are diverse, ranging from sub-tropical in the north-eastern part of the country, to semi-arid and arid in the interior, to the cool and temperate rivers of the fynbos. Wetlands and rivers form a fascinating and essential part of our natural heritage, and are often referred to as the "kidneys" and "arteries" of our living landscapes and this is particularly true in semi-arid countries such as South Africa (Nel *et al*., 2013). Rivers and their associated riparian zones are vital for supplying freshwater (South Africa's most scare natural resource) and are important in providing additional biophysical, social, cultural, economic and aesthetic services (Nel *et al*., 2013). The health of our rivers and wetlands is measured by the diversity and health of the species we share these resources with. Healthy river ecosystems can increase resilience to the impacts of climate change, by allowing ecosystems and species to adapt as naturally as possible to the changes and by buffering human settlements and activities from the impacts of extreme weather events (Nel *et al*., 2013). Freshwater ecosystems are likely to be particularly hard hit by rising temperatures and shifting rainfall patterns, and yet healthy, intact freshwater ecosystems are vital for maintaining resilience to climate change and mitigating its impact on human wellbeing by helping to maintain a consistent supply of water and for reducing flood risk and mitigating the impact of flash floods. We therefore need to be mindful of the fact that without the integrity of our natural river systems, there will be no sustained long-term economic growth or life (DEA *et al*., 2013).

Freshwater ecosystems, including rivers and wetlands, are also particularly vulnerable to anthropogenic or human activities, which can often lead to irreversible damage or longer term, gradual/cumulative changes to freshwater resources and associated aquatic ecosystems. Since channelled systems such as rivers, streams and drainage lines are generally located at the lowest point in the landscape; they are often the "receivers" of wastes, sediment and pollutants transported via surface water runoff as well as subsurface water movement (Driver *et al*., 2011). This combined with the strong connectivity of freshwater ecosystems, means that they are highly susceptible to upstream, downstream and upland impacts, including changes to water quality and quantity as well as changes to aquatic habitat & biota (Driver *et al*., 2011). South Africa's freshwater ecosystems have been mapped and classified into National Freshwater Ecosystem Priority Areas (NFEPAs). This work shows that 60% of our river ecosystems are threatened and 23% are critically endangered. The situation for wetlands is even worse: 65% of our wetland types are threatened, and 48% are critically endangered (Driver *et al*., 2011). Recent studies reveal that less than one third of South Africa's main rivers are considered to be in an ecologically 'natural' state, with the principal threat to freshwater systems being human activities, including river regulation, followed by catchment transformation (Rivers-Moore & Goodman, 2009). South Africa's freshwater fauna also display high levels of threat: at least one third of freshwater fish indigenous to South Africa are reported as threatened, and a recent southern African study on the conservation status of major freshwater-dependent taxonomic groups (fishes, molluscs, dragonflies, crabs and vascular plants) reported far higher levels of threat in South Africa than in the rest of the region (Darwall *et al*., 2009). Clearly, urgent attention is required to ensure that representative natural examples of the different ecosystems that make up the natural heritage of this country for current and future generations to come. The degradation of South African rivers and wetlands s is a concern now recognized by Government as requiring urgent action and the protection of freshwater resources, including rivers and wetlands, is considered fundamental to the sustainable management of South Africa's water resources in the context of the reconstruction and development of the country.

1.5 Overview of Relevant Environmental Legislation

The link between ecological integrity of freshwater resources and their continued provision of valuable ecosystem goods and services to burgeoning populations is well-recognised, both globally and nationally (Rivers-Moore *et al.,* 2007). In response to the importance of freshwater aquatic resources, protection of wetlands and rivers has been campaigned at national and international levels. A strong legislative framework which backs up South Africa's obligations to numerous international conservation agreements creates the necessary enabling legal framework for the protection of freshwater resources in the country. Relevant environmental legislation pertaining to the protection and use of aquatic ecosystems (i.e. wetlands and rivers) in South Africa has been included in Table 1 below.

Table 1. Description of relevant environmental legislation.

South African Constitution 108 of 1996	This includes the right to have the environment protected through legislative or other means.
National Environmental Management Act 107 of 1998	This is a fundamentally important piece of legislation and effectively promotes sustainable development and entrenches principles such as the 'precautionary approach', 'polluter pays', and requires responsibility for impacts to be taken throughout the life cycle of a project.
Environmental Impact Assessment (EIA) Regulations	New regulations have been promulgated in terms of Chapter 5 of NEMA and were published on 4 December 2014 in Government Notice No. R. 32828. In addition, listing notices (GN 983-985) lists activities which are subject to an environmental assessment.
The National Water Act 36 of 1998	This Act imposes 'duty of care' on all landowners, to ensure that water resources are not polluted. The following Clause in terms of the National Water Act 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*" Chapter 4 of the National Water Act is of particular relevance to wetlands and addresses the use of water and stipulates the various types of Licenced and un-licenced entitlements to the use water. Water use is defined very broadly in the Act and effectively requires that any activities with a potential impact on wetlands (within a distance of 500m upstream or downstream of a wetland) be authorized.
General Authorisations (GAs)	These have been promulgated under the National Water Act and were published under GNR 398 of 26 March 2004. Any uses of water which do not meet the requirements of Schedule 1 or the GAs, require a Licence which should be obtained from the Department of Water and Sanitation (DWS).
National Environmental Management: Biodiversity Act No. 10 of 2004	The intention of this Act is to protect species and ecosystems and promote the sustainable use of indigenous biological resources. It addresses aspects such as protection of threatened ecosystems and imposes a duty of care relating to listed invasive alien plants.
Conservation of Agricultural	The intention of this Act is to control the over-utilization of South Africa's natural

Resources Act 43 of 1967	agricultural resources, and to promote the conservation of soil and water resources and natural vegetation. This includes wetland systems and requires authorizations to be obtained for a range of impacts associated with cultivation of wetland areas.

Other pieces of legislation that may also be of some relevance to wetlands/rivers include:

- The National Forests Act No. 84 of 1998;
- The Natural Heritage Resources Act No. 25 of 1999;
- The National Environmental Management: Protected Areas Act No. 57 of 2003;
- Minerals and Petroleum Resources Development Act No. 28 of 2002;
- The Mountain Catchments Areas Act No. 62 of 1970.

2 APPROACH & METHODS

2.1 Approach to the Assessment

The proposed WCSEZ development constitutes Listed Activities which appear in Listing Notice 2 of the NEMA EIA Regulations (2014, as amended) and therefore is subject to a Scoping and Full EIA process. Furthermore, due to the proximity of the development to watercourses the proposed development is subject to Water Use Licence Authorisation. Eco-Pulse Environmental Consulting Services (referred to hereafter as "Eco-Pulse") was appointed by WSP to undertake the required Specialist Wetland Habitat Impact Assessments to inform the Scoping and Full EIA process and Water Use Licence Application (WULA) for the project. The assessment was subdivided into two distinct phases as follows:

- **Phase1: Scoping**. The scoping phase of the assessment entailed desktop investigations and the compilation of a scoping report which was prepared in January 2018. The intention of the scoping process is to identify key ecological issues to focus on during the EIA Phase of the project as well as establish Terms of Reference (plan of study) for the EIA Phase assessments. The ecological scoping report highlighted the presence and extent of key sensitive wetland ecosystems. Furthermore it also highlighted significant impacts anticipated to key ecosystems which were used to inform the focus of the detailed EIA-phase investigation.
- **Phase 2: Detailed EIA Phase (this report)**. This phase entailed undertaking a detailed Wetland Habitat Baseline and Impact Assessment with detailed impact mitigation and management, in order to comply with the minimum requirements of Appendix 6 of the NEMA: EIA Regulations (2014). *The report has also been aligned with the requirements of the Department of Water & Sanitation (DWS) for Water Use Licensing, as outlined in the 'Regulations Regarding the Procedural Requirements for Water Use License Applications and Appeals' contained in the Government Gazette No. 40713 of 24 March 2017.*

The general approach to the freshwater (wetland/aquatic) habitat assessment was based on the proposed framework for wetland assessment proposed in the Water Research Commission's (WRC) report titled: '*Development of a decision-support framework for wetland assessment in South Africa* *and a Decision-Support Protocol for the rapid assessment of wetland ecological condition'* (Ollis *et al*., 2014) (Figure 4).

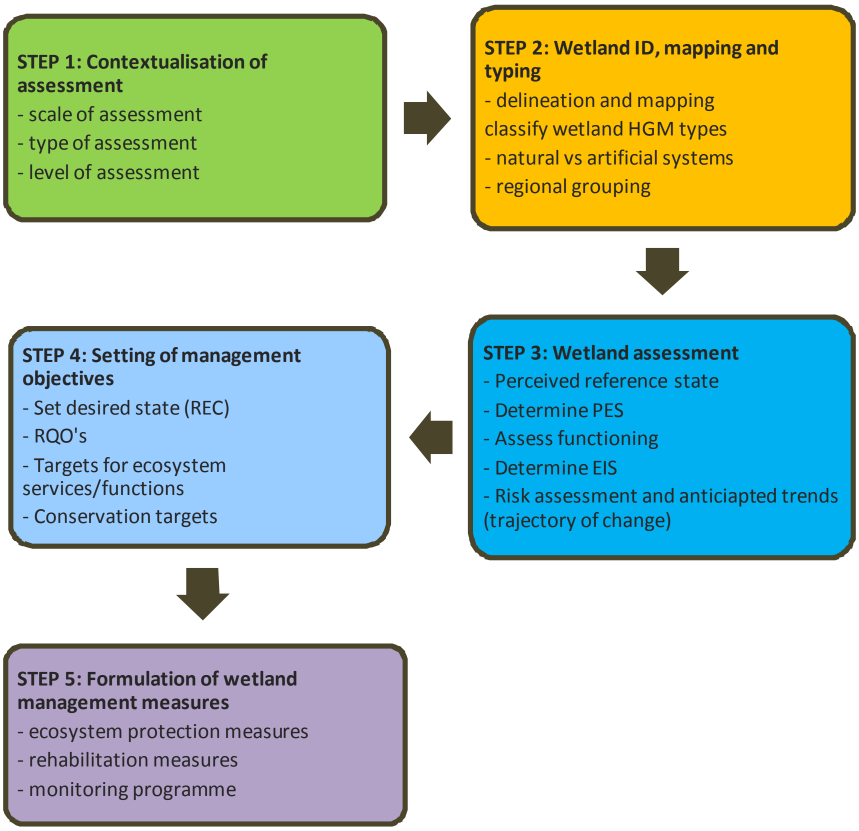


Figure 3 Proposed decision-support framework for wetland assessment in SA (after Ollis *et al*., 2014).

2.2 Methods

2.2.1 Data Sources Consulted

The following data sources and GIS spatial information listed in Table 2 was consulted to inform the specialist assessment. The data type, relevance to the project and source of the information has been provided.

Table 2. List of data sources and GIS information consulted to inform the freshwater wetland assessment.

DATA/COVERAGE TYPE	RELEVANCE	SOURCE
2009 Colour aerial photography	Desktop mapping of drainage network and vegetation/habitat	Surveyor General
Latest Google Earth ™ imagery	To supplement available aerial photography where needed	Google Earth™ On-line
1: 50 000 Relief Line (20m Elevation Contours GIS Coverage)	Desktop mapping of drainage network and wetlands	Surveyor General

DATA/COVERAGE TYPE	RELEVANCE	SOURCE
1:50 000 River Line (GIS Coverage)	Highlight potential onsite and local rivers and wetlands and map local drainage network	Surveyor General
DWA Eco-regions (GIS Coverage)	Understand the regional biophysical context in which water resources within the study area occur	DWA (2005)
RSA Geology	*Understand regional geomorphology controlling the physical environment*	Surveyor General
NFEPA: river and wetland inventories (GIS Coverage)	Highlight potential onsite and local rivers and wetlands	CSIR (2011)
National Biodiversity Assessment - Threatened Ecosystems (GIS Coverage)	Determination of national threat status of local vegetation types	SANBI (2011)
South African Vegetation Map (GIS Coverage)	*Classify vegetation types and determination of reference primary vegetation and its national threat status*	Mucina & Rutherford (2006)
Eastern Cape Biodiversity Conservation Plan (GIS Coverage)	Determination of provincial terrestrial freshwater conservation priorities and biodiversity buffers	Hayes *et al*. (2007) Berliner & Desmet (2007)

2.2.2 Desktop Mapping

The desktop delineation of all watercourses (rivers / streams and wetlands) within 500m of the proposed development / activities was undertaken by analysing available 20m contour lines and colour aerial photography supplemented by Google Earth™ imagery where more up to date imagery was needed. Digitization and mapping was undertaken using QGIS 2.18 GIS software. All of the mapped watercourses were then broadly subdivided into distinct resource units (i.e. classified as either riverine or wetland systems / habitat). This was undertaken based on aerial photographic analysis and professional experience in working in the region. *Please note that the desktop map was updated as part of the finalisation of the assessment to include the detailed delineation of the units occurring within the study area.*

2.2.3 'Impact Potential' Screening Assessment

Following the desktop identification and mapping exercise, watercourses were assigned preliminary 'likelihood of impact' ratings based on the likelihood that activities associated with the proposed development will result in measurable direct or indirect changes to the mapped watercourse units within 500m of the proposed development. The 'impact potential' ratings were refined following the completion of the field work. Each watercourse unit was ascribed a qualitative 'impact potential' rating according to the ratings and descriptions provided in Table 3, below.

Table 3. Qualitative 'likelihood of impact' ratings and descriptions.

Likelihood of Impact Rating	Description of Rating Guidelines
High	These resources are likely to require impact assessment and a Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: ➢ resources located **within the footprint** of the proposed development activity and will definitely

Likelihood of Impact Rating	Description of Rating Guidelines
	be impacted by the project; and/or ➢ resources located **within 15m upstream and/or upslope** of the proposed development activity and trigger requirements for Environmental Authorisation according to the NEMA: EIA regulations; and/or ➢ resources located **within 15m or downslope** of the development and trigger requirements for Environmental Authorisation according to the NEMA: EIA regulations; and/or ➢ resources located downstream within the following parameters: o **within 15m downstream** of a low risk development; o **within 50m downstream** of a moderate risk development; and/or o **within 100m downstream** of a high risk development e.g. mining large industrial land uses.
Moderate	These resources may require impact assessment and a Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: ➢ resources located **within 32m but greater than 15m upstream, upslope or downslope** of the proposed development; and/or ➢ resources located within a range at which they are likely to incur indirect impacts associated with the development (such as water pollution, sedimentation and erosion) based on development land use intensity and development area. This is generally resources located downstream within the following parameters: o **within 32m downstream** of a low risk development; o **within 100m downstream** of a moderate risk development; and/or o **within 500m downstream** of a high risk development (note that the extent of the affected area downstream could be greater than 500m for high risk developments or developments that have extensive water quality and flow impacts e.g. dams / abstraction and treatment plants);
Low	These resources are unlikely to require impact assessment or Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: ➢ resources located a distance upstream, upslope or downslope (>32m) of the proposed development and which are unlikely to be impacted by the development project; and/or ➢ resources located downstream but well beyond the range at which they are likely to incur impacts associated with the development (such as water pollution, sedimentation and erosion). This is generally resources located downstream within the following parameters: o **greater than 32m downstream** of a low risk development; o **greater than 100m downstream** of a moderate risk development; and/or o **greater than 500m downstream** of a high risk development (note that the extent of the affected area downstream could be greater than 500m for high risk developments or developments that have extensive water quality and flow impacts e.g. dams / abstraction and treatment plants);
Very Low	These resources will not require impact assessment or a Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: ➢ resources located within another adjacent sub-catchment and which will not be impacted by the development in any way, shape or form.

2.2.4 *Baseline Wetland/Aquatic Assessment*

The methods of data collection, analysis and assessment employed as part of the baseline freshwater habitat assessment are briefly discussed in this section. The assessments undertaken as part of this study are listed in Table 4 below along with the relevant published guidelines and assessment tools / methods / protocols utilised. A more comprehensive description of the methods listed below is included in **Annexure A**.

Table 4. Summary of methods used in the assessment of delineated wetlands.

Method/Technique	Reference for Methods/Tools Used	Annexure
Wetland delineation	➢ *A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005)*	**A1**
Classification of wetlands	➢ *National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis et al, 2013)*	**A2**
Wetland condition/PES	➢ *Level 1 WET-Health assessment tool (Macfarlane et al., 2008)*	**A3**
Wetland Functional Importance	➢ *Level 2 WET-Ecoservices assessment tool (Kotze et al., 2009)*	**A4**
Wetland Ecological Importance & Sensitivity (EIS)	➢ *Wetland EIS tool (Eco-Pulse, 2017)*	**A5**

2.2.5 Impact Assessment

While details of specific impacts will vary according to the site and development activity, aquatic / freshwater ecosystem impacts can typically be grouped into the following three (3) categories based on distinct impact-causing activities, ecosystem components and impact pathways:

1. **Direct habitat loss and modification impacts** – This impact type refers to the direct physical destruction and/or disturbance of freshwater habitat by human activities like vegetation / habitat clearing (stripping / grubbing), surface reshaping / alteration, earthworks (i.e. excavation and infilling) and flooding. This impact also includes the resultant impacts to ecosystem condition and ecosystem services but does not include the indirect hydrological, geomorphological and ecological impacts of such activities like flow modification, erosion and sedimentation and associated downstream habitat degradation.

2. **Indirect flow modification, erosion and/or sedimentation impacts** – This impact type refers to all of the indirect impacts resulting from and associated with human activities that alter wetland hydrological and geomorphological (erosion and sedimentation) processes and structures like: (i) direct physical habitat modification; (ii) catchment and buffer zone land cover modification and transformation (e.g. vegetation clearing, surface hardening, stormwater management and cultivation); and (iii) flow regulation, abstraction and controlled discharges. This impact also includes the resultant impacts to ecosystem condition and ecosystem services.

3. **Water pollution impacts** – This impact refers to the alteration or deterioration in the physical, chemical and biological characteristics of water within watercourses and the associated ecological impacts. In the context of this impact assessment, water quality refers to its fitness for maintaining the health of aquatic ecosystems and for current uses, domestic and agricultural.

Each of the above impact groups were described and qualitatively rated in terms of the following impact characteristics / aspects based on professional opinion:

- Stressor characteristics.
- Impacts to ecosystem PES (functioning).
- Impact to the supply of ecosystem services.

An impact assessment was then carried out using the above mentioned categories and then contextualised in terms of the following ultimate consequences or end-points (i.e. impacts to resources of known societal value) in line with the National Wetland Offset Guidelines (SANBI & DWS, 2014), namely:

(i) **Impacts to water resource supply and quality**: This addresses impacts to the quantity and quality of water provided by water resources. Such impacts may be the result of more direct impacts like abstraction, regulation and/or return discharges, and/or the result of freshwater ecosystem loss or degradation that affects the ability of watercourses to provide supporting regulating and supporting services.

(ii) **Impacts to ecosystem and habitat conservation:** This deals specifically with impacts to quality and condition of habitat and the ability to meet conservation targets for freshwater ecosystems. This therefore accounts for the loss or change in freshwater habitat, which is particularly important for highly threatened ecosystem types.

(iii) **Impacts to species of conservation concern**: This addresses impacts on freshwater biota, with a particular emphasis on species or populations of conservation concern and the ability to meet species conservation targets.

(iv) **Impacts to local communities**: This deals with impacts to local communities reliant on freshwater ecosystem goods and services, specifically impacts to provisioning (e.g. water supply & cultivated foods) and cultural services (e.g. cultural significance or recreational values) of direct value to local users and consequences for human health, safety and livelihood support.

The approach to impact conceptualisation is depicted by the diagram in Figure 4.

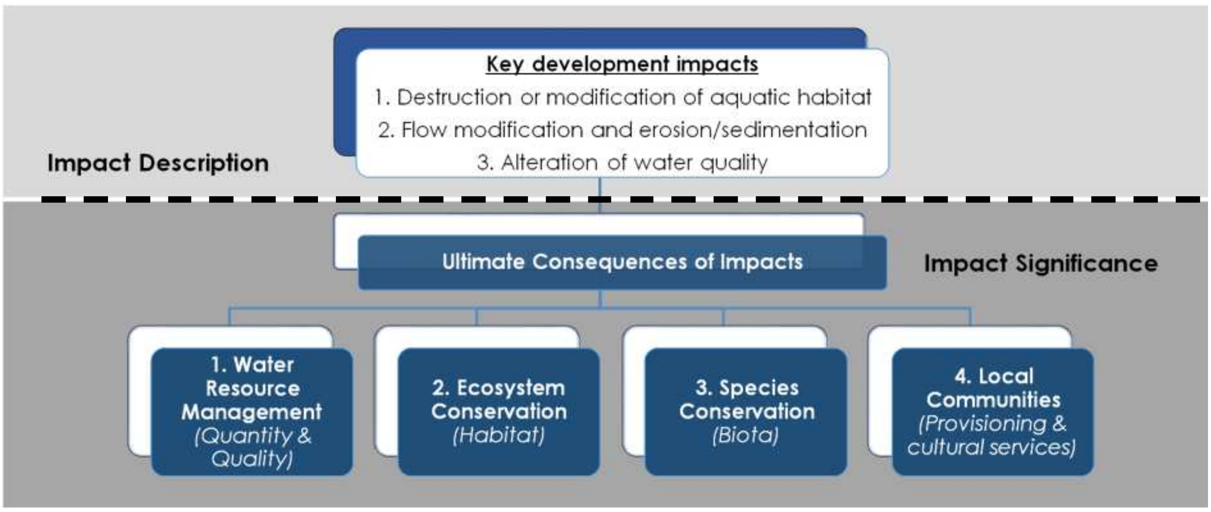


Figure 4 Diagram illustrating how the impact assessment framework is conceptualized.

The impact assessment was undertaken for the following mitigation scenarios only:

- **<u>Realistic 'Poor' Mitigation Scenario</u>**: This scenario involves the implementation of the development plan and designs that are current proposed with the associated implementation of standard construction and operational phase mitigation measures. In terms of implementation success, this scenario assumes a realistic / likely poor implementation scenario based on the author's experience with such developments. It is important to note that it is our experience in similar development settings that contractor compliance with construction Environmental Management Programmes (EMPr) is poor and that operational maintenance is poor.
- **<u>Realistic 'Good' Mitigation Scenario</u>**: This scenario involves the implementation of the development plan and designs that are current proposed with the associated implementation of the construction and operational phase mitigation measure recommended by the author. In terms of implementation success, this scenario assumes a realistic best case scenario for implementation based on the author's experience with such developments.

A comprehensive description of the impact significance assessment method employed is included in **Annexure A6.**

2.2.6 DWS Wetland Risk Assessment

Government Notice 509 of 2016 published in terms of Section 39 of the NWA sets out the terms and conditions for the General Authorisation of Section 21(c1) and 21(i2) water uses, key among which is that only developments posing a 'Low Risk' to watercourses can apply for a GA. Note that the GA does not apply to the following activities:

- Water use for the rehabilitation of a wetland as contemplated in GA 1198 contained in GG 32805 (18 December 2009).
- Use of water within the 'regulated area'[3] of a watercourse where the Risk Class is **Medium or High.**
- Where any other water use as defined in Section 21 of the NWA must be applied for.
- Where storage of water results from Section 21 (c) and/or (i) water use.

[1] 21(c): Impeding or diverting the flow of water in a watercourse

[2] 21(i): Altering the bed, banks, course or characteristics of a watercourse

[3] The 'regulated area' of a watercourse; for Section 21 (c) or (i) of the Act refers to:

i. *The outer edge of the 1:100 yr flood line and/or delineated riparian habitat, whichever is greatest, as measured from the centre of the watercourse of a river, spring, natural channel, lake or dam.*
ii. *In the absence of a determined 1:100 yr flood line or riparian area, refers to the area within 100m from the edge of a watercourse (where the edge is the first identifiable annual bank fill flood bench).*
iii. *A 500m radius from the delineated boundary of any wetland or pan.*

- Any water use associated with the construction, installation or maintenance of any sewerage pipeline, pipelines carrying hazardous materials and to raw water and wastewater treatment works.

To this end, the DWS have developed a Risk Assessment Matrix/Tool to assess water risks associated with development activities. The DWS Risk Matrix/Assessment Tool (based on the DWS 2015 publication: 'Section 21 c and I water use Risk Assessment Protocol') was applied to the proposed project. The tool uses the following approach to calculating risk:

RISK = CONSEQUENCE X LIKELIHOOD
whereby:
CONSEQUENCE = SEVERITY + SPATIAL SCALE + DURATION
and
LIKELIHOOD = FREQUENCY OF ACTIVITY + FREQUENCY OF IMPACT + LEGAL ISSUES + DETECTION

The key risk stressors[4] associated with each of the three impact groups / types considered were:

1. **Direct habitat loss and modification impacts** – Physical disturbance.
2. **Indirect flow modification, erosion and/or sedimentation impacts** – Erosive surface runoff, sediment and increased and/or reduced water inputs.
3. **Water pollution impacts** – Chemical, organic and biological pollutants.

For each of the above stressors, risk was assessed qualitatively using the DWS risk matrix tool. It is important to note that the risk matrix/assessment tool also makes provision for the downgrading of risk to low in borderline moderate/low cases subject to independent specialist motivation granted that (i) the initial risk score is within twenty five (25) risk points of the 'Low' class and that mitigation measures are provided to support the reduction of risk. The tool was applied to the project for the highest risk activities and watercourses to inform WUL requirements for the proposed development.

[4] *A stressor is any physical, chemical, or biological entity that can induce an adverse response. Stressors may adversely affect specific natural resources or entire ecosystems, including plants and animals, as well as the environment with which they interact (USA EPA - https://www.epa.gov/risk/about-risk-assessment#whatisrisk).*

2.3 Assumptions, Limitations and Information Gaps

The following limitations and assumptions apply to the specialist wetland assessment:

2.3.1 General assumptions & limitations

- This report deals exclusively with a defined area and the extent and nature of freshwater/aquatic habitat and ecosystems in that area.
- Additional information used to inform the assessment was limited to data and GIS coverage's available for the EC Province at the time of the assessment.
- All field assessments were limited to day-time assessments.

2.3.2 Sampling limitations & assumptions

- With ecology being dynamic and complex, there is the likelihood that some aspects (some of which may be important) may have been overlooked.
- While disturbance and transformation of habitats can lead to shifts in the type and extent of freshwater ecosystems, it is important to note that the current extent and classification is reported on here.
- Infield soil sampling and vegetation observations were only undertaken a strategic sampling points within the habitats likely to be negatively affected. Watercourse delineation beyond the 50m study corridor was estimated at a desktop level with limited ground-truth (low accuracy).
- The wetland boundary was identified and classified along a transitional gradient from saturated through to terrestrial soils which makes it difficult to identify the exact boundary of the wetland. The boundaries mapped in this specialist report therefore represent the approximate boundary of wetlands as evaluated by an assessor familiar and well-practiced in the delineation technique.
- The accuracy of the delineation is based solely on the recording of the onsite wetland indicators using a GPS. GPS accuracy will therefore influence the accuracy of the mapped sampling points and therefore water resource boundaries and an error of 3 – 5m can be expected. All soil/vegetation/terrain sampling points were recorded using a Garmin Monterra™ Global Positioning System (GPS) and captured using Geographical Information Systems (GIS) for further processing.
- In environments with multiple artificial water sources (e.g. leaking pipeline infrastructure, agricultural and road runoff, and water discharge from various infrastructure), interpretation of natural versus artificial hydric soils or wetland soil indicators can be difficult. In such cases, we have made an effort to substantiate all claims where applicable and necessary while acknowledging limitations.
- Infield soil sampling and vegetation observations were only undertaken at strategic sampling points within the habitats likely to be negatively affected. Sampling by its nature, means that generally not all aspects of ecosystems can be assessed and identified.
- All vegetation information recorded was based on the onsite observations of the author and no formal vegetation sampling was undertaken. Furthermore, the vegetation information provided only gives an indication of the dominant and/or indicator riparian species and only provides a general indication of the composition of the vegetation communities. Thus, the vegetation information

provided has limitations for true botanical applications i.e. accurate and detailed species lists and rare / Red Data species identification.

- Not all wetlands within the 500m DWS regulated area were assessed/delineated in the field. Focal areas at risk of being impacted or triggering Section 21 water use were flagged during the desktop risk/screening exercise to be assessed in detail in the field. Thus, finer habitat type details of the systems not formally assessed were not acquired.
- Inferences made about the ecological integrity/health of the wetlands assessed was based on selected variables sampled on selected occasions at selected geographic locations. This limits the degree to which this information can be extrapolated spatially and temporally (i.e. over seasons). Wetlands by nature can be highly variable ecosystems and can display fine and large scales changes in the structure, composition and quality of the habitat over periods of time.
- No formal aquatic faunal survey was undertaken.

2.3.3 'Seasonality' of the Assessment

The wetland delineation and baseline assessment was undertaken during the growing/wet season (summer) but does not cover the seasonal variation in conditions at the site. However, seasonality is not such an issue for the target study area surveyed which does not warrant the need for further seasonal surveys for the following reasons:

- Soil wetness indicators (i.e. soil mottles, grey soil matrix), which in practice are primary indicators of hydromorphic soils, are not seasonally dependent (wetness indicators are retained in the soil for many years) and therefore seasonality has no influence on the delineation of wetland areas.
- Seasonality can also influence the species of flora encountered at the site, with the flowering time of many species often posing a challenge in species identification. Since the wetland vegetation in the study area was found to be largely secondary/degraded with low native plant diversity, seasonality would not be as significant a limitation when compared with a vegetation community that is largely natural or high in native plant diversity. Also, since the wetland vegetation in the study area was surveyed during rainy/summer (growing season), seasonality would not be as significant a limitation.
- The location of the study area within the coastal hinterland zone (largely subtropical climate) means that climate has less of an effect on aquatic ecosystems and vegetation characteristics than typical Highveld inland systems which are exposed to more extreme variations in temperatures between seasons. Thus, vegetation response is limited and species structure and composition tend to remain the same or very similar between seasons.

2.3.4 Baseline Ecological Assessment

- It should be noted that while WET-Health (Macfarlane *et al.*, 2008) is the most appropriate technique currently available to undertake assessments of wetland condition/integrity, it is nonetheless a rapid assessment tool that relies on qualitative information and expert judgment. While the tool has been subjected to an initial peer review process, the methodology is still being tested and will be refined in subsequent versions. For the purposes of this assessment, the assessment was undertaken at a rapid level with limited field verification. It therefore provides an indication of the PES of the system rather than providing a definitive measure.

- The PES and EIS assessments undertaken are largely qualitative assessment tools and thus the results are open to professional opinion and interpretation. We have made an effort to substantiate all claims where applicable and necessary.
- The WET-Health tool's Hydrological assessment module is not particularly well suited for the assessment of wetlands with high groundwater inputs.
- The Ecological Importance and Sensitivity assessment did not specifically address the finer-scale biological aspects of the rivers such as fauna (amphibians and invertebrates) occurring.

2.3.5 Assumptions with respect to the assessment of impacts

- The assessment of impacts and recommendation of mitigation measures was informed by the site-specific ecological concerns arising from the field survey and based on the assessor's working knowledge and experience with similar projects.
- Evaluation of the significance of impacts with mitigation takes into account mitigation measures and best management practice, as provided in this report.

2.3.6 Assumptions with respect to the assessment of risk

Risks were assessed based on the DWS Risk Assessment Matrix. The following assumptions apply to the application of the DWS risk matrix tool in the context of project in question:

- All risk ratings generated by the DWS risk matrix are conditional on the effective implementation of the specialist mitigation measures provided in this report.
- For the severity ratings, impacts to wetlands were assessed on their merits rather than automatically scoring impacts to wetlands as 'disastrous' as guided in the DWS risk matrix.
- The severity assessment for changes in flow regime and physico-chemical impacts were interpreted in terms of the changes to the local freshwater ecosystem represented by the potentially affected reaches.
- For the scoring of impact duration, the predicted change in PES was also considered which could override the actual duration of the impact where applicable e.g. if the impact duration was long term (typically a score of 4 out of 5) but the predicted change in PES is negligible, the impact duration was down-rated to a score of 2 in line with the duration criteria descriptions in the risk matrix tool.

3 DESKTOP ASSESSMENT FINDINGS

3.1 Review of biophysical Context

A summary of key biophysical setting details of the study area and surrounds are presented in Table 5 below.

Table 5. Key biophysical setting details of the study area.

Biophysical Aspects	Desktop Biophysical Details	Source
Quaternary Catchment(s)	T20B & T20C	DWS
Elevation a.m.s.l.	>700m (amsl)	Google Earth™
Mean annual precipitation (MAP)	679.1mm/annum	(Shulze, 1997)
Rainfall seasonality	Late-summer	(DWAF, 2007)
Mean annual temperature	16-20°C in July to 24-28°C in February	(DWAF, 2007)
Potential Evaporation (mm) Mean Annual A-pan Equivalent	1674.7 mm/annum	(Shulze, 1997)
Geology	Sedimentary units of the Tarkastad Subgroup (Beaufort Group): comprising red and greenish-grey mudstone and fine to medium grained sandstone	National Geology dataset
DWA Ecoregion	North-Eastern Uplands (14.06)	(DWAF, 2007)

The study area occurs primarily within quaternary catchment **T20B** and partially within quaternary catchment **T20C**, both of which are drained by the Mthatha River which forms part of the Mzimvubu to Keiskamma Water Management Area (WMA). The proposed WCSEZ development activities will primarily take place upslope of the Mthatha Dam which is situated within a reach of the Mthatha River, whilst the eastern extent of the northern development is upslope of the Cicira River which terminates at the base of the Mthatha dam wall and into the Mthatha River. The Mthatha River eventually drains into the Mthatha River Estuary which is situated approximately 80km south east of the planned development which then terminates at the South Indian Ocean, approximately 85km south east of the study area (Figure 5).

Based on available climatic records maintained by the Department of Water & Sanitation (DWS), the region experienced its wettest year in 1999/00, with a total rainfall of 1470.5 mm experienced over the 12-month period. (source: DWS online climatic data for weather station at Mthatha Dam: T2E003 and DWA, 2007).

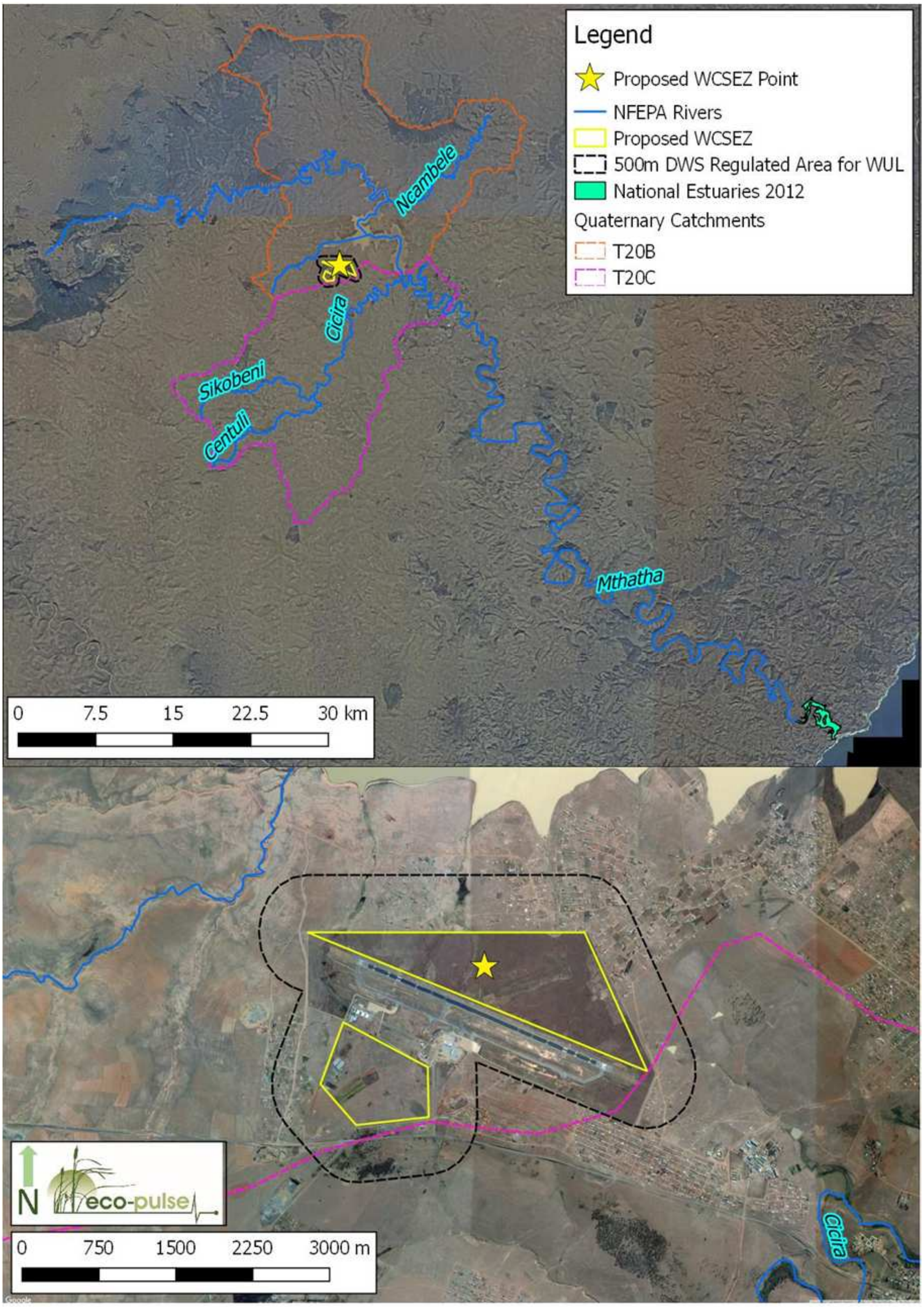


Figure 5 Regional and local (site) drainage setting associated with the proposed WC: SEZ Phase 1 development near Mthatha.

3.2 Conservation Context

Understanding the conservation context and importance of the study area and surrounds is important to inform decision-making regarding the management of aquatic ecosystems, habitats and associated biodiversity in the area. In this regard, national, provincial and regional conservation planning information available was used to obtain an overview of the study site. Key conservation context details of the project site and surrounds have been summarised in Table 6, below.

Table 6. Key conservation context summary details for the study area.

NATIONAL LEVEL CONSERVATION PLANNING CONTEXT			
Conservation Planning Dataset	**Relevant Conservation Feature**	**Location in Relation to Project Site**	**Conservation Planning Status**
The National Freshwater Ecosystem Priority Area (NFEPA) Assessment (CSIR, 2011)	Mthatha River	North of the site	Non-FEPA River
	Wetlands	Within site boundary and to the north and east	Non-FEPA Wetlands
	Wetland Vegetation: 1. Sub-Escarpment Savanna 2. Sub-Escarpment Grassland Group 7	Intact wetland areas	**1. Endangered** **2. Critically Endangered**
PROVINCIAL AND REGIONAL LEVEL CONSERVATION PLANNING CONTEXT			
Conservation Planning Dataset	**Relevant Conservation Feature**	**Location in Relation to Project Site**	**Conservation Planning Status**
EC Aquatic Conservation Plan (Berliner and Desmet, 2007)	Wetlands and catchment area	Entire site and catchment	**Aquatic Critical Biodiversity Area 1 (CBA 1) and CBA 2**

3.2.1 *National Freshwater Ecosystem Priority Areas (NFEPA)*

The National Freshwater Ecosystem Priority Area (NFEPA) project (Nel *et al*., 2011), is the first formally adopted national freshwater conservation plan that provides strategic spatial priorities for conserving the country's freshwater ecosystems and supporting the sustainable use of water resources that includes rivers, wetlands and estuaries. The importance of water resources in meeting national freshwater conservation targets is provided in the National Freshwater Ecosystems Priority Areas (NFEPA) outputs and coverage's (CSIR, 2011).

A review of the NFEPA coverage for the study area revealed the Mthatha River and its tributaries fall within a non-prioritised sub-quaternary catchments in terms of the NFEPA project, with a number of wetlands mapped on the property to the north of the Umthatha Airport however these have not been identified as wetland FEPAs (Figure 6). The Mthatha River and its sub-quaternary catchments associated with the study area are not classified as Freshwater Ecosystem Priority Areas (FEPAs).

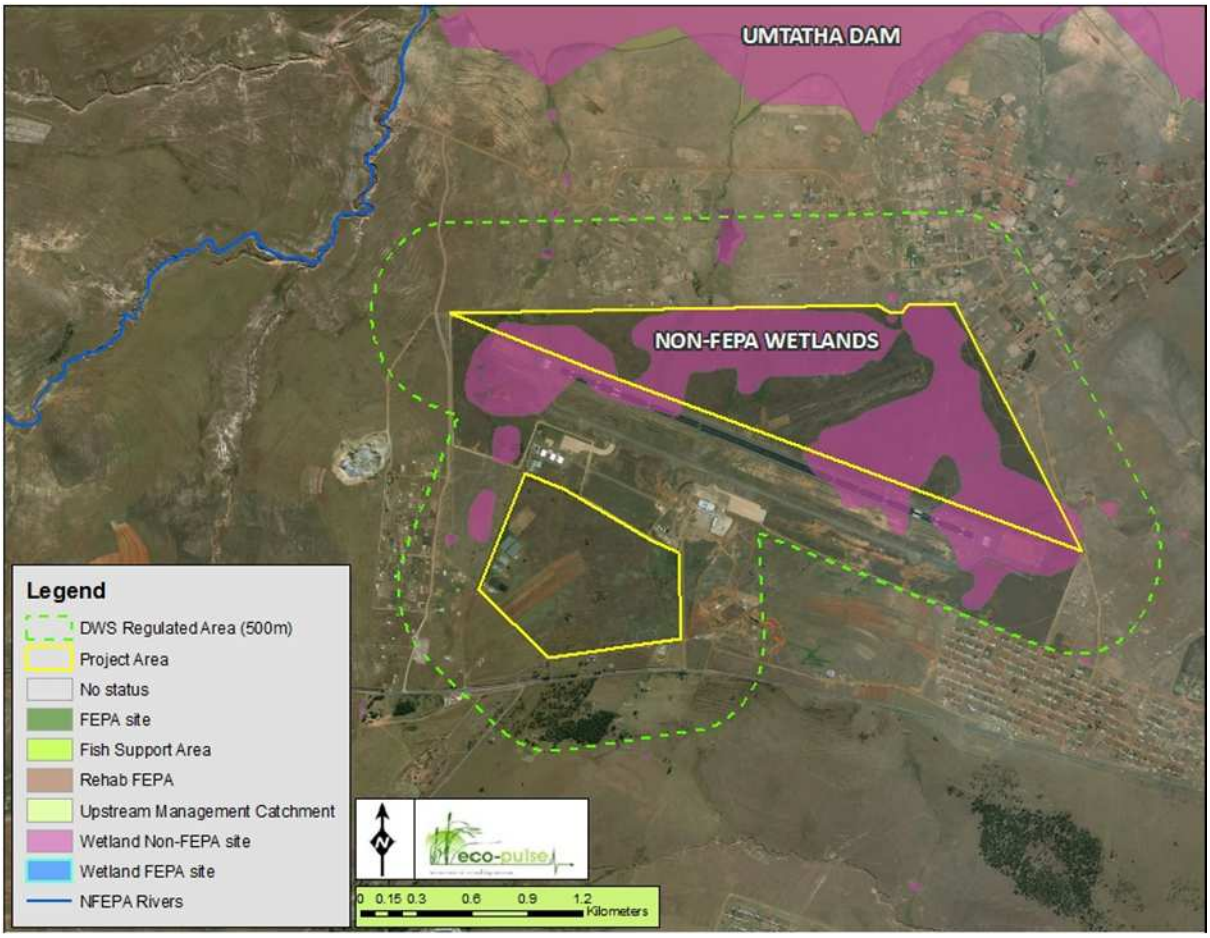


Figure 6 Map showing river and wetland Freshwater Priority Areas (FEPAs) identified for the project area (CSIR, 2011).

Two wetland vegetation groups[5] are associated with the project area: **Sub-escarpment Savanna** and **Sub-Escarpment Grassland Group 7** as defined by NFEPA (SANBI & DWS, 2014). At the wetland vegetation group (WVG) level, the Sub-escarpment Savanna wetland vegetation group has an ecosystem threat status of **Endangered** and the Sub-Escarpment Grassland Group 7 wetland vegetation type is **Critically Endangered**. In terms of protection status at the WVG level, both groups are **Not Protected**. At a 'Wetland Type' (WT), all wetlands falling within these two groups have no protection status, with wetlands relevant to the study area having the following ecosystem threat status in terms of 'wetland type' (WT):

[5] According to the *'Wetland Offset Best-Practice Guideline for South Africa'* (SANBI & DWS, 2014), ecosystem Threat Statuses and Protection Levels for Wetland Groups are taken from an assessment undertaken for the 2014 WRC project No K5/2281: '*Supporting better decision-making around coal mining in the Mpumalanga Highveld through the development of mapping tools and refinement of spatial data on wetlands*'. The methods used were identical to those applied in the National Biodiversity Assessment (SANBI, 2012).

Sub-escarpment Savanna:

- Channelled Valley Bottom wetlands: '***Endangered,*** *Not protected'*
- Unchannelled Valley Bottom wetlands: '***Endangered,*** *Not protected'*
- Seeps: '***Endangered***, *Not protected'*

Sub-escarpment Grassland Group 7:

- Channelled Valley Bottom wetlands: '***Critically Endangered,*** *Not protected'*
- Unchannelled Valley Bottom wetlands: '***Endangered,*** *Not protected'*
- Seeps: '***Critically Endangered,*** *Not protected'*

3.2.2 Eastern Cape Biodiversity Conservation Plan (ECBCP)

The Eastern Cape Biodiversity Conservation Plan (ECBCP (Hayes *et al*., 2007; Berliner & Desmet, 2007) addresses the urgent need for integrative systematic conservation planning and capacity building for land-use decision making in the Eastern Cape. The ECBCP is a systematic conservation plan that identifies and spatially maps Critical Biodiversity Areas (CBAs) required for biodiversity persistence and to inform protected area planning and rural land-use planning in the Province. For successful implementation of the ECBCP, the CBAs need to be incorporated at all levels of spatial development planning.

According to the ECBCP, aquatic conservation priorities highlighted for the project area and planned development site include the catchment draining north towards the Mthatha Dam (Figure 7) which has been identified as an ***aquatic 'Critical Biodiversity Area' or CBA at level 1 (A1)***, which represents in this instance critically important river sub-catchments in a natural state that are considered critical for conserving biodiversity and maintaining ecosystem functioning (Hayes *et al.,* 2007). Aquatic CBA 1 areas require high levels of protection and the recommended management objective for these areas should be to: "***Maintain biodiversity in as natural state as possible, Manage for no biodiversity loss***" (Hayes *et al.,* 2007).

The catchment draining south has been identified as an ***aquatic CBA at level 2 (A2b, E3b)***, which are critically important river sub-catchments in a near-natural state that are considered important catchment management areas and zones for conserving biodiversity and maintaining ecosystem functioning in order to support important downstream rivers and estuaries.

Land-use planning needs to take into account the linkages between catchments, important rivers and sensitive estuaries, with a key focus around limiting transformation in CBA catchments. When landscapes are transformed beyond certain critical thresholds, ecological processes such as fire and the water cycle show dramatic changes, with transformation of catchments also generally resulting in loss in stream flow and a decline in water quality.

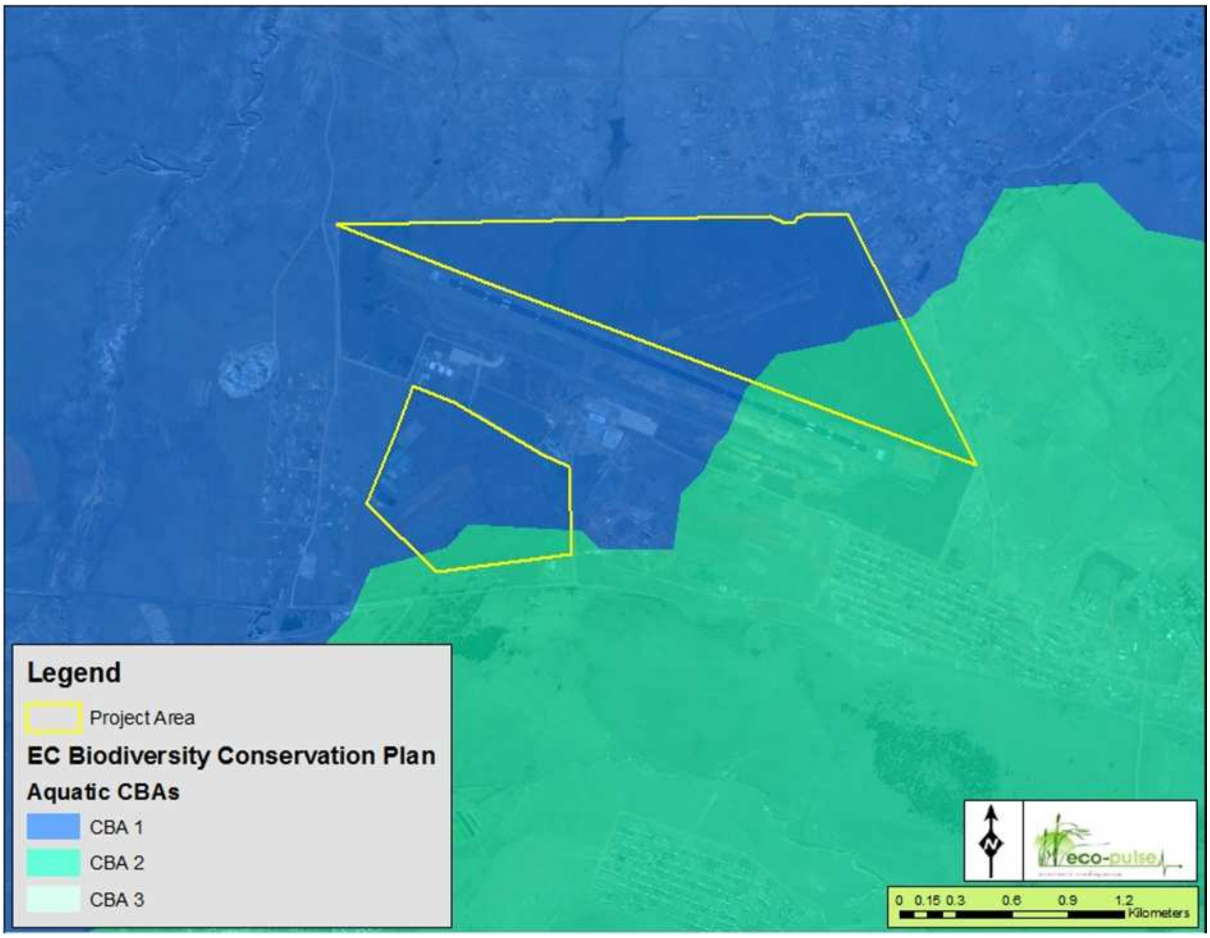


Figure 7 Map showing the location and extent of Aquatic CBAs in relation to the proposed WCSEZ: Phase 1development identified according to the Eastern Cape Biodiversity Conservation Plan (Berliner & Desmet, 2007).

3.3 Desktop Wetland and Aquatic Assessment

3.3.1 Desktop mapping of watercourses

Initially, a desktop wetland/river identification and mapping exercise was undertaken in GIS (Geographical Information Systems) based on available imagery (Google Earth™ and aerial photography), elevation contours and existing wetland coverages for the area. This allowed for the initial identification of wetlands which were later ground-truthed and delineated in the field using various indicators.

Wetlands occurring within a 500m radius of the proposed development area (i.e. within the DWS regulated area for Section 21 (c) / (i) wetland water use), were mapped at a desktop level and delineated in the field (see Figure 8). The output of the wetland identification and mapping reveals an appreciable area of wetland habitat located on the northern Phase 1 property, particularly within the northern and western sections (Figure 8 below), and this is likely to pose a potentially significant constraint to development.

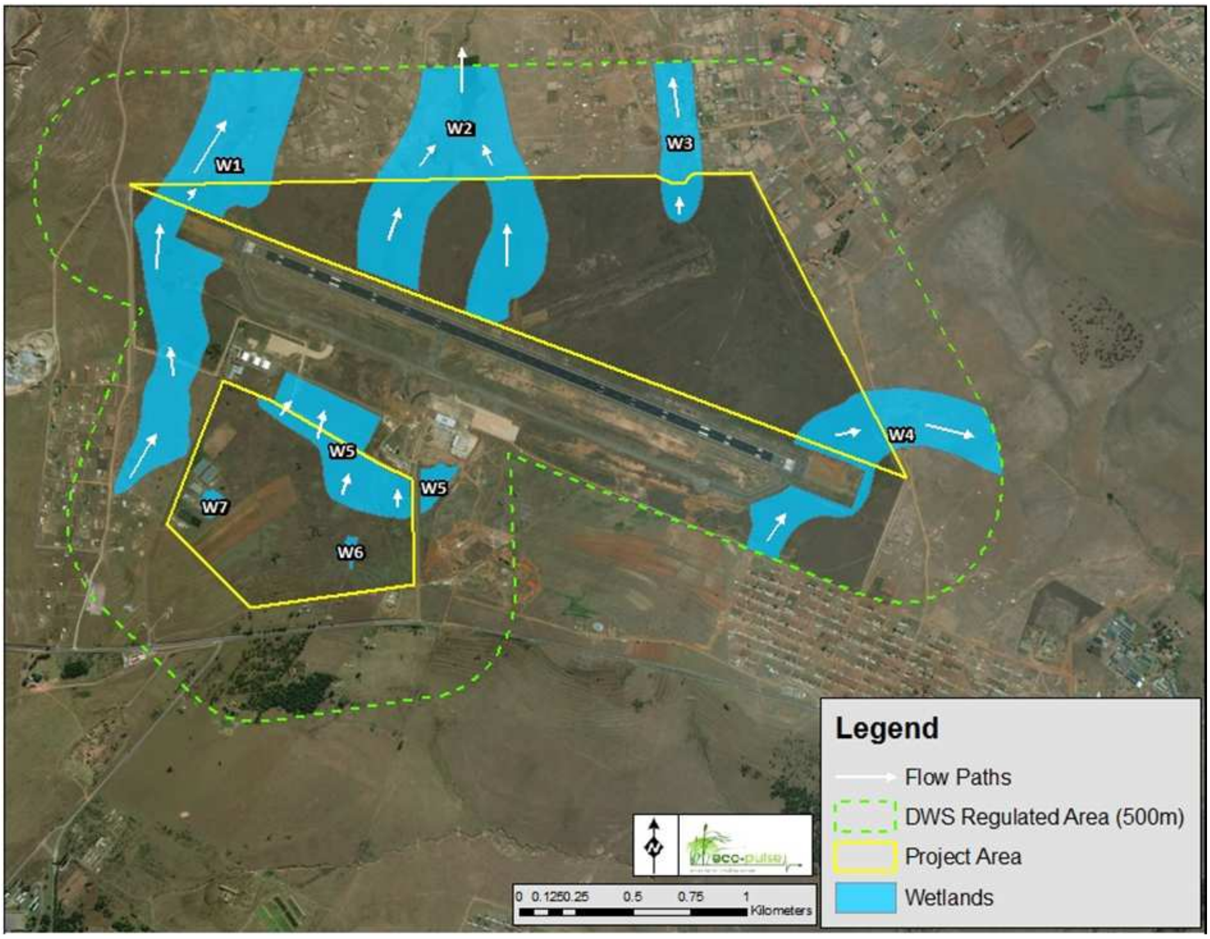


Figure 8 Map showing the location and extent of wetlands mapped within the area of study (DWS Regulated area for Section 21 c & i water use: *i.e. within a 500m radius from the development*).

3.3.2 *Screening and flagging wetlands for further focused assessment*

An initial desktop screening of 'impact potential' for identified wetland units within a 500m radius of the development (DWS regulated area for Section 21 c and i wetlands water use) was also undertaken in GIS and then verified in the field. The main risks likely to be associated with the construction and operation of the proposed development include:

1. **Direct physical loss and/or modification** of watercourses within the development site, both planned and accidental;
2. **Direct physical alteration of flow characteristics** of watercourses within the development site and associated **erosion and sedimentation impacts**;
3. **Alteration of catchment surface water processes / hydrological inputs** and associated **erosion and sedimentation impacts**; and
4. **Surface runoff contamination** and local watercourse **water quality deterioration**.

Based on the above-mentioned development construction & operation risks, all wetlands have been rated as being at risk and having a potential 'high' rating in terms of potential of being impacted (either directly or indirectly) by the proposed development in some way, shape or form based on the land use activities planned for both the northern and southern Phase 1 portions (Figure 9). As such, all wetlands required onsite delineation and assessment to inform the EIA and WULA processes.

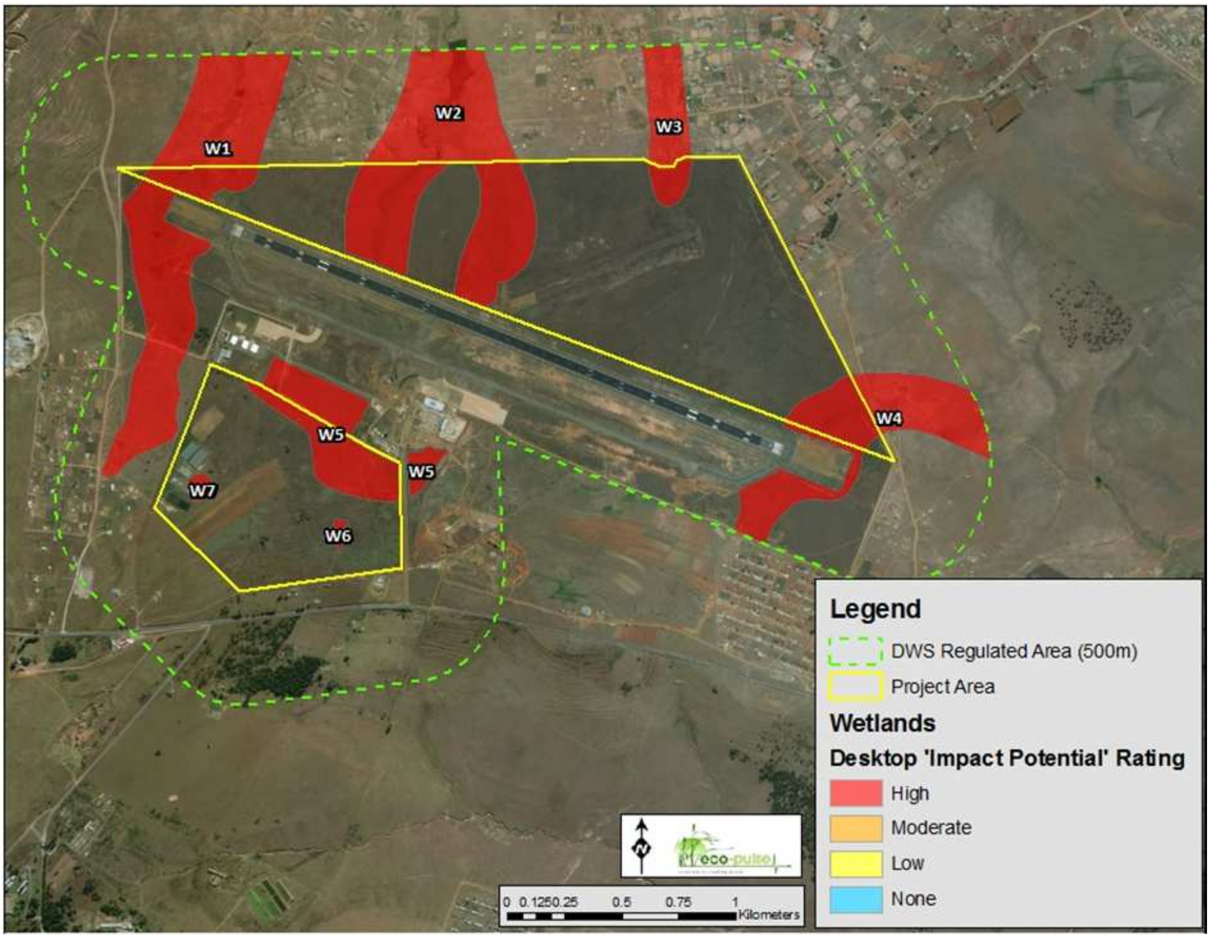


Figure 9 Map showing the results of the desktop 'wetland impact potential' screening assessment.

4 BASELINE WETLAND ASSESSMENT

4.1 Wetland Delineation, Classification & Habitat Description

4.1.1 Wetland Delineation

Wetlands targeted for detailed ground-truthing and assessment were subject to a 3-day detailed in-field sampling and delineation in March 2018 according to the methods and techniques found in the Department of Water Affairs wetland delineation manual '*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (*DWAF, 2005). The infield sampling of soil and vegetation in conjunction with the recording of diagnostic topographical / terrain indicators and features, facilitated the delineation of the outer boundary of the wetlands on the property and within adjacent areas.

Vegetation characteristics:

Vegetation was generally found to be a good indicator of the presence of wetland habitat and in some cases the level of soil wetness. A distinct transition from terrestrial/dryland grasses towards true wetland plants (hydrophytes) including *Typha capensis, Phragmites australis* and *Paspalum urvillei* was evident in many instances during fieldwork, however the temporary wetland zone was almost indistinguishable from the surrounding upland (terrestrial sites), being dominated by the grasses *Themeda triandra* and *Hyparrhenia hirta*. Most wetlands were characterised by a vast zone of temporary saturated soils with a narrow longitudinal seasonal zone. At a desktop level using digital imagery, the contrast in texture between terrestrial and wetland vegetation was used in delineating the boundary of the wetland for sections of the wetland that were not ground-truthed in the field (i.e. areas beyond the site boundary).

Soil characteristics:

The soils in the study area provided a good indication of the level of wetness of the soils and proved to be the most reliable indicator used to delineate the outer wetland boundary (i.e. boundary between temporary wetland and upland/terrestrial areas). Low soil matrix chroma and clear redoximorphic features (in the form of red/orange soil mottling) was present in nearly all instances within the wetland habitat sampled, providing evidence of generally temporary or seasonally saturated hydric soils (7.5YR: value 3 , chroma 1 - 2). The temporary saturated soils had far fewer mottles whilst seasonally saturated soil had abundant soil mottling. The soil texture was found to range between clay and clay-loam soils.

The origin of all onsite wetlands is considered strongly linked with the presence of an impermeable clay layer found to occur generally at 20-60cm depth that results in a poorly drained 'perched' water table resulting in wetland formation. This is coupled with the relatively gentle topographic gradient across much of the study area.

Example of a wetland soil extracted during the wetland delineation, with typical grey soil matrix and extensive orange mottling characteristic of a 'seasonal' zone of saturation.

4.1.2 Wetland Classification and Habitat Assessment

The infield delineation enabled the identification and mapping of seven (7) wetland systems, including six (6) wetland 'seeps' and one (1) artificial wetland (wetland W6) created by a leaking bulk water pipeline infrastructure:

Northern property:

i. Wetland Unit W1: 63.8Ha Seep Wetland
ii. Wetland Unit W2: 61.6Ha Seep Wetland
iii. Wetland Unit W3: 14.1Ha Seep Wetland
iv. Wetland Unit W4: 35.7Ha Seep Wetland

Southern property:

v. Wetland Unit W5: 24.6Ha Seep Wetland
vi. Wetland Unit W6: 0.56Ha Artificial Wetland
vii. Wetland Unit W7: 1.04Ha Seep Wetland

Detailed descriptions of each wetland unit, including type, habitat/vegetation characteristics and notable existing impacts has been provided in Table 7.

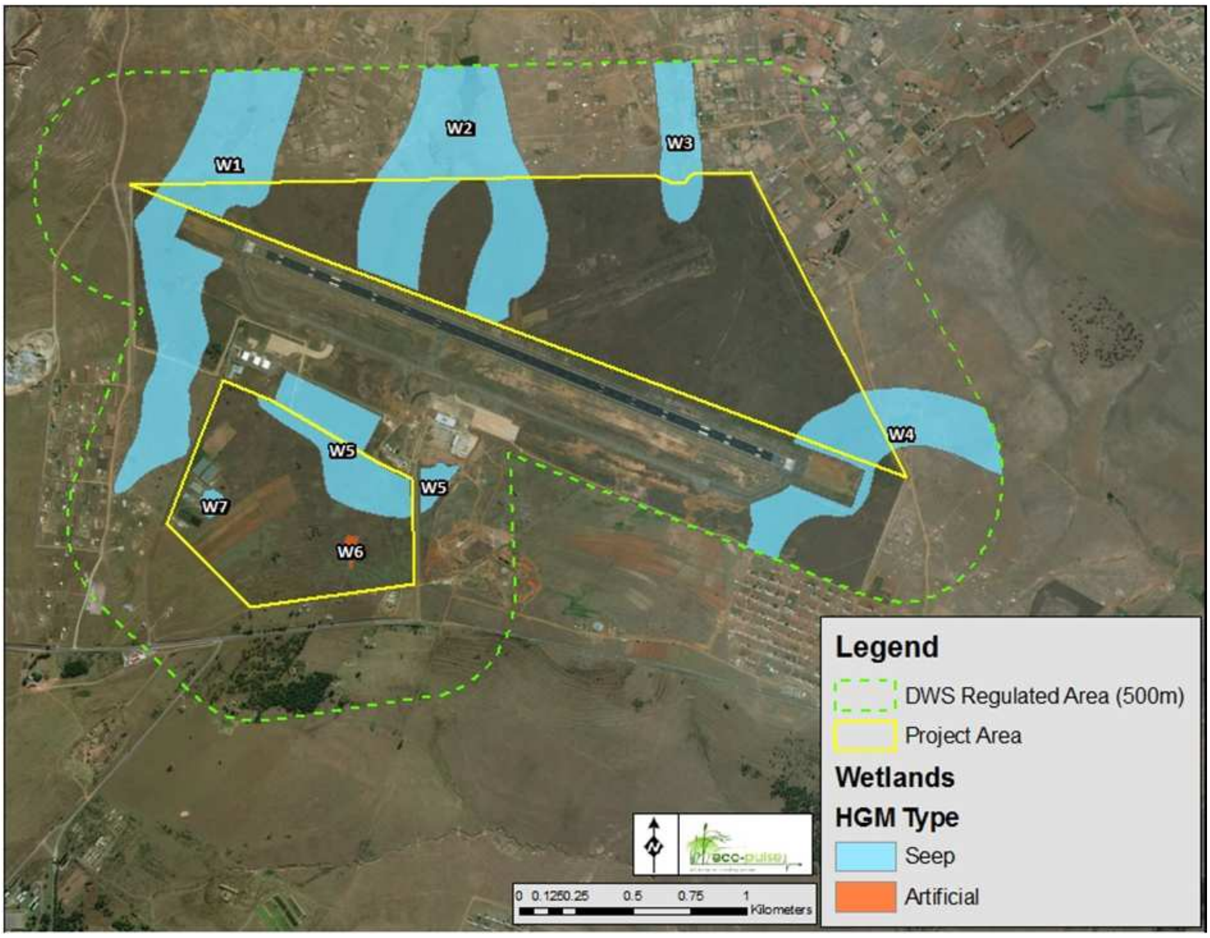


Figure 10 Wetlands in the area of study: delineated, mapped and classified according to HGM (hydro-geomorphic) type.

Table 7. Summary of wetland characteristics and description for the seven (7) wetland units assessed.

Wetland Unit	HGM Type & Extent	Dominant Wetness & Soil Characteristics	General Description	Existing Impacts
W1	Seep Wetland 63.8Ha	**Dominant wetness zone:** Temporary saturated soil. **Signs of wetness:** Grey soil matrix with distinct orange mottles.	Wetland unit W1 is a relatively extensive seepage wetland system that drains in a general northerly direction and occurs along the western perimeter of the development site, with a portion of the wetland located within the western corner of the northern property portion. The head of the wetland has a broad concave cross-sectional slope which gradually steepens as one moves towards the toe of the wetland. The unit however lacks a defined channel. A series of artificial 'dams' have been constructed within the wetland.	• Historic habitat transformation (dam, road and runway infrastructure). • Discharge of concentrated storm water and sediment into the wetland. • Intensive overgrazing of the wetland habitat outside the Airport precinct. • Limited excavation and infilling.
W2	Seep Wetland 61.6Ha	**Dominant wetness zone:** Temporary saturated soil. **Signs of wetness:** Grey soil matrix with distinct orange mottles.	Wetland unit W2 also drains to the north and is characterised by a broad concave cross-section slope towards its head, where the seepage wetland splits into two spate arms located on the northern development site that join and become steep and more defined towards the toe of the wetland. The lower section of the wetland has a gully that extends into a small dam located within the wetland habitat outside of the development property to the north. There appears to have been some historical infilling of the upper sections of the wetland as a result of the Mthatha Airfield development.	• Historic habitat transformation (dam, road and runway infrastructure). • Discharge of concentrated storm water and sediment into the wetland. • Intensive overgrazing of the wetland habitat outside the Airport precinct. • Limited excavation and infilling.
W3	Seep Wetland 14.1Ha	**Dominant wetness zone:** Temporary saturated soil. **Signs of wetness:** Grey soil matrix with distinct orange mottles.	Wetland unit W3 also drains to the north and is essentially a small wetland seep with the head of the wetland located on a small portion of the northern development site. The unit appears to be severely degraded to the north beyond the site boundary.	• Historic habitat transformation linked with the old runway. • Intensive overgrazing of the wetland habitat outside the Airport precinct.
W4	Seep Wetland	**Dominant wetness zone:** Temporary	Wetland unit W4 is a seepage type wetland that drains in an easterly direction, with a	• Historic habitat transformation.

Wetland Unit	HGM Type & Extent	Dominant Wetness & Soil Characteristics	General Description	Existing Impacts
	35.7Ha	saturated soil. **Signs of wetness:** Grey soil matrix with distinct orange mottles.	portion of the upper wetland located on the northern development site within the eastern portion of the site. The upper section of the wetland is unchannelled and relatively intact. A small dam located within the wetland habitat outside of the development property to the east. As with wetland W2, there appears to have been some historical infilling of the upper sections of the wetland as a result of the Mthatha Airfield extension development.	• Discharge of concentrated storm water and sediment into the wetland. • Intensive overgrazing of the wetland habitat outside the Airport precinct. • Limited excavation and infilling. • Limited flow impoundment resulting in pooling of water. • Limited erosion below storm water headwalls.
W5	Seep Wetland 24.6Ha	**Dominant wetness zone:** Temporary saturated soil. **Signs of wetness:** Grey soil matrix with distinct orange mottles.	Wetland unit W5 is a moderate sized hillslope seepage type wetland that drains in a general northerly direction and is located on the hillslope within the northern portion of the southern Phase 1 development property to the south of the Mthatha Airport. As with wetlands W2 & W4, there appears to have been some historical infilling of sections of the wetland as a result of the Mthatha Airfield development.	• Historic habitat transformation. • Limited excavation and infilling. • Limited flow impoundment resulting in pooling of water. • High levels of weed infestation.
W6	'Artificial' Wetland 0.56Ha	**Dominant wetness zone:** Mix of temporary and seasonally saturated soils. **Signs of wetness:** Grey soil matrix with distinct orange mottles.	Wetland unit W6 is a very small 'artificial' wetland that has formed on terraced slope within the southern development property as a result of a leaking bulk water pipeline. The wetland is artificial in terms of origin.	• Artificially created. • High levels of weed infestation.
W7	Seep Wetland 1.04Ha	**Dominant wetness zone:** Temporary saturated soil. **Signs of wetness:** Grey soil matrix with distinct orange mottles.	Wetland unit W7 is a small seepage wetland occurring on a gentle slope just below a break in slope on the southern development property. The lower section of the wetland has been extensively transformed for agriculture (green house structures).	• Historic habitat transformation. • Limited excavation and infilling. • High levels of weed infestation.

A selection of digital photographs has been provided below, showing key wetland habitat and vegetation characteristics:

Photo 1: View over the mid-section of Wetland Unit W1 and its upstream catchment.

Photo 2: View over Wetland Unit W2 showing dense growth of typical obligate wetland plants (*Typha capensis* & *Phragmites australis)* which tend to grow in wetlands >90% of the time. The Mthatha Dam can be seen in the background. The yellow line marks the toe of the existing Mthatha airfield runway embankment.

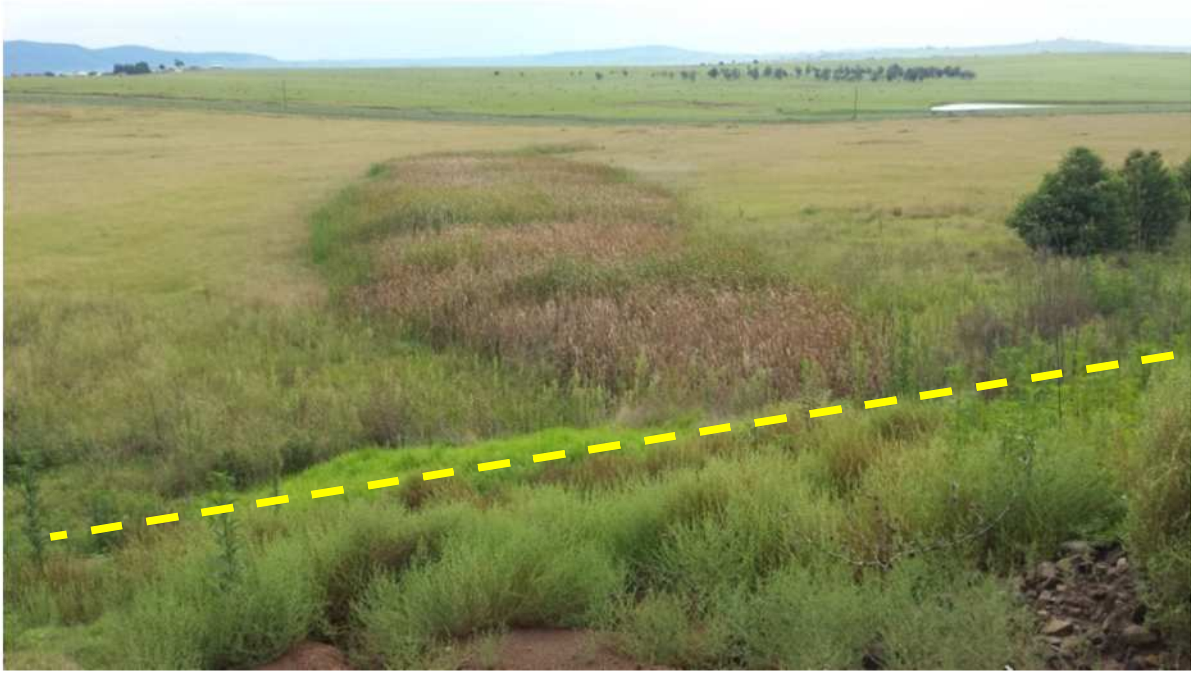


Photo 3: View over Wetland Unit W4 showing the showing dense growth of *Typha capensis* & *Phragmites australis* along the low-lying area of the wetland. The yellow line marks the toe of the runway embankment.

Photo 4: View across Wetland Unit W5.

Photo 5: View over Wetland Unit W6 an 'artificial' wetland created by leaking bulk water infrastructure. The inset shows the valve chamber which is the source of water sustaining the artificial wetland.

Photo 5: View across Wetland Unit W7. Note extensive development (green houses) along the toe of the wetland in the background of the image.

4.2 Wetland Present Ecological State (PES) Assessment

Wetlands form at the interface between terrestrial and aquatic environments, and between groundwater and surface-water systems. The complex interaction of inflows and outflows of water, sediment, nutrients and energy over time is what shapes the physical template of the wetland and understanding theses fluxes and interactions considered is fundamentally important in developing an understanding the occurrence, morphology and dynamics of different wetland systems (Ellery et al., 2009).

The current health or Present Ecological State (PES) of wetlands was assessed using the WET-Health tool (Macfarlane et al. 2008) which was applied at a rapid level 1 assessment level. WET-Health assesses wetland condition or PES based on an understanding of both catchment and on-site impacts. The approach to assessing wetland PES essentially works by comparing a wetland in its current state with the estimated baseline/reference state of the wetland.

4.2.1 Hypothetical Reference State

When assessing the Present Ecological State (PES) of wetlands, it is important to first establish their hypothetical 'reference state' (prior to any anthropogenic impacts) which essentially provides a 'benchmark' against which deviations or changes in condition can be evaluated. This is typically achieved by reviewing and interpreting available historical aerial photography, a knowledge of local reference wetland sites (where available) and professional experience working in the area.

There is currently a lack of comprehensive guidelines relating specifically to the determination of hypothetical natural reference state for wetlands in the South African context and in cases where there are no relatively pristine reference wetlands in a similar setting to compare with (i.e. transformed landscapes) or where the characteristic features of some wetlands are naturally highly variable, determining natural reference state can be particularly challenging (Ollis *et al.*, 2014). The assessor's knowledge of the vegetation and habitat characteristics of some of the more intact/natural wetlands in similar settings was used in this instance. The anticipated reference state has been defined for each wetland HGM type encountered onsite and is summarised in Table 8, below.

It is important to note upfront that only wetlands perceived to be 'natural' in terms of their origin (i.e. W1 – W5 and W7) were assessed in terms of PES using the WET-Health method, which relies on there being a 'reference state' from which to compare deviation. Since 'artificial wetlands' (Unit W6) associated with a leaking bulk water pipeline do not have a natural reference state, PES could not be determined for unit W6.

Table 8. Hypothetical reference state of the seepage wetland types assessed.

Unit No.	Reference HGM	Reference Flow / Wetness Regime	Reference Vegetation Communities
W1 – W5 & W7	Seep Wetland	Water inputs to these seep wetland would naturally have occurred as a result of a combination of surface and subsurface flow from adjoining slopes, with water moving through the wetland as interflow with diffuse overland flow after rainfall events. Natural channels would have been absent and permanent open water would also not have been present. The wetland would have been largely dominated by a broad temporary zone of wetness with limited seasonal to permanent saturation along the central core zone and lowest point of the wetland.	The seepage wetland would likely have been naturally characterised by short to medium height hygrophilous grassland, sedgeland and rushland vegetation communities, with a species composition dominated by typical obligate wetland plants including sedges, rushes and bulrushes. The temporary zone of saturation would most likely have been characterised by a mix of natural grasses and small sedges/forbs, transitioning to terrestrial grassland. Alien plants and weeds would have been naturally absent from wetlands.

4.2.2 Wetland PES Assessment

The results of the wetland PES assessment are presented in Table 9. Two of the wetlands (Units W2 & W5) were assessed as being 'Moderately Modified' ('C' PES) which implies that *a moderate change in ecosystem process and loss of natural habitat and biota has taken place but the natural wetland habitat remains predominately intact*. The remaining four (4) wetlands were assessed as being 'Largely Modified' ('D' PES) which implies that *a large change in ecosystem processes and loss of natural habitat and biota has occurred.*

Key existing impacts affecting the condition of the various wetland units include:

i. Permanent vegetation and habitat transformation by the Airport runway, artificial instream dams, access roads and storm water infrastructure;
ii. Inundation of the wetland habitat caused by the impeding of flows behind structures such as access roads, fill embankments, etc.
iii. Direct discharge of storm water into wetlands, creating 'artificially wetter' conditions;
iv. Historic drainage of wetlands;
v. Limited erosion of the wetland habitat;
vi. Limited sediment deposition within low lying areas; and
vii. Overgrazing of wetland vegetation outside the Mthatha Airport precinct by livestock (cattle).

Table 9. Summary of the wetland PES assessment.

Unit	PES Rating & Category	Key Existing Wetland Impacts
W1	D: Largely Modified	• Habitat transformation by the airport runway & dams. • Overgrazing of wetland vegetation outside the Mthatha Airport precinct. • Discharge of storm water into the wetland. • Limited alteration of water distribution patterns by historic dams.
W2	C: Moderately	• Habitat transformation by the airport runway, dam, houses and storm water infrastructure.

Unit	PES Rating & Category	Key Existing Wetland Impacts
	modified	• Overgrazing of wetland vegetation outside the Mthatha Airport precinct. • Discharge of storm water into the wetland.
W3	D: Largely Modified	• Habitat transformation by the airport runway & dams. • Overgrazing of wetland vegetation outside the Mthatha Airport precinct. • Discharge of storm water into the wetland. • Limited alteration of water distribution patterns by historic dams.
W4	D: Largely Modified	• Habitat transformation by the airport runway & dams. • Overgrazing of wetland vegetation outside the Mthatha Airport precinct. • Discharge of storm water into the wetland. • Limited alteration of water distribution patterns by the airport runway.
W5	C: Moderately modified	• Historic degradation of wetland vegetation. • Limited habitat transformation by historic homesteads and the access road. • Limited alteration of water distribution patterns by dams and berms.
W6	N/A	Note assessed: artificial origin.
W7	D: Largely Modified	• Transformation of wetland habitat by greenhouse infrastructure. • Historic degradation of wetland vegetation. • Limited habitat transformation by historic homesteads and the access road.

Note that individual WET-Health assessment Excel TM spreadsheets can be made available by Eco-Pulse upon request

4.3 Wetland Functional (WET-Ecoservices) Assessment

Wetlands are known to provide a range of ecosystem goods and services to society, and it is largely on this basis that policies aimed at protecting wetlands have been founded. This section of the report provides a summary of the predicted level of importance of the various wetland ecosystems in terms of their effectiveness in providing aquatic ecosystem goods and benefits. A modified version of the WET-Ecoservices assessment method by Kotze et al. (2009) *was used for this purpose.*

A summary of the wetland functional assessment undertaken using the WET-Ecoservices assessment method for all wetland units, is presented in Table 10:

- As a general consequence of the moderate to large level of wetland degradation caused by the range of existing impacts to wetlands (discussed under section 4.2, above), wetland functioning has been reduced at varying levels.
- The results clearly highlight units W1 – W4 to be the most important at providing ecosystem services particularly water quality enhancing services, water supply and food for livestock due to the gentle gradient, extent of wetland habitat, relatively intact vegetation and presence of dams.
- Wetland W1-W4 also provide potentially important habitat for supporting local biodiversity. Indeed, the wetland were assessed in 2012 by Eco-Pulse as part of the expansion of the Mthatha Airport Runway and found to be potentially important in providing foraging habitat for Grey Crowned Crane and other biota. Noteworthy was a pair of Grey Crowned Crane (*Balearica regulorum)* observed in the wetland/grassland areas back in 2012 (these are red-

data listed (vulnerable) and probably exploit the airport site as the area is fenced and less vulnerable to predators).

- In comparison to Units W1 – W4, Units W5 – W7 where found to be the least important at providing ecosystem services with most services ranging between **moderately-low** and **moderate**. The most notable services were identified as water quality enhancing services which were rated as being of moderate importance. All other services were assessed as being of very-low to low importance.
- All wetlands were assessed as being of least importance in terms of providing cultural services due to poor provision of direct benefits to humans (wetlands are generally located on privately owned land, inaccessible to the general public, and generally has a low level of appeal for this sort of activity, falling outside of major tourism areas).

Table 10. Summary outputs the WET-Ecoservices assessment for all wetland units.

Ecosystem Service		Importance Scores (0-4) & Ratings						
		W1	W2	W3	W4	W5	W6	W7
REGULATING AND SUPPORTING SERVICES	Flood attenuation	1.4 ML	1.1 ML	1.3 ML	1.4 ML	1.1 ML	0.0 VL	1.1 ML
	Stream flow regulation	1.3 ML	1.0 L	1.0 L	0.8 L	0.0 VL	0.0 VL	0.0 VL
	Sediment trapping	1.6 M	1.6 M	1.8 M	2.1 M	2.0 M	1.0 L	2.0 M
	Erosion control	1.4 ML	1.9 M	1.6 M	1.5 ML	1.6 M	1.0 L	1.5 ML
	Phosphate removal	2.5 MH	2.7 MH	2.5 MH	2.4 M	2.1 M	1.0 L	2.1 M
	Nitrate removal	3.0 H	2.6 MH	2.5 MH	2.3 M	2.3 M	1.0 L	2.2 M
	Toxicant removal	2.6 MH	2.2M	2.1 M	2.1 M	2.0 M	1.0 L	1.7 M
	Carbon storage	1.2 ML	1.2 ML	1.1 ML	1.2 ML	1.3 ML	0.5 VL	1.3 ML
	Biodiversity maintenance	2.7 MH	2.8 MH	2.8 MH	2.6 MH	1.1 ML	0.5 VL	1.1 ML
PROVISIONING SERVICES	Water supply	2.5 MH	3.2H	3.2H	2.7MH	0.0 VL	0.0 VL	0.0 VL
	Harvestable natural resources	1.0 L	1.4 ML	1.4 ML	1.4 ML	0.8 L	0.8 L	0.8 L
	Food for livestock	3.0H	1.8 M	1.8 M	2.0 M	0.8 L	0.5 VL	0.8 L
	Cultivated foods	0.4VL	0.4 VL	0.4 VL	0.4 VL	0.5 VL	0.0 VL	0.5 VL
CULTURAL SERVICES	Cultural significance	0.0 VL	0.0 VL	0.0 VL	0.0 VL	0.0 VL	0.0 VL	0.0 VL
	Tourism & recreation	0.3 VL	0.8 L	0.8 L	0.8 L	0.3 VL	0.0 VL	0.2 VL
	Education and research	0.6 L	0.6 L	0.6 L	0.6 L	0.2 VL	0.0 VL	0.2 VL

Note that individual WET-Ecoservices assessment Excel ™ spreadsheets can be made available by Eco-Pulse upon request.

4.4 Ecological Importance & Sensitivity (EIS) Assessment

The Ecological Importance and Sensitivity (EIS) of a wetland is an expression of the importance of the aquatic resource for the maintenance of biological diversity and ecological functioning on local and wider scales; whilst Ecological Sensitivity (or fragility) refers to a system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Kleynhans & Louw, 2007).

A summary of the EIS and socio-cultural importance assessment scores and ratings for wetlands is provided in Table 11 below and show that:

- Wetland units **W1-W5** are considered to be of '**Moderate' EIS**, linked with their moderately-low to moderate importance in providing biodiversity maintenance and water quality enhancement services primarily as well as their moderately-low sensitivity to external impacts.
- The much smaller less arguably important wetland **W7** was found to be of '**Low' EIS**, which can be attributed to the wetland's low functionality and low sensitivity to external impacts.
- The '**artificial' wetland W6** was considered to be of '**Very Low' EIS** and this is linked to the very poor and limited wetland functionality and low biodiversity value and sensitivity of the limited wetland habitat associated with W6.

Table 11. Summary of wetland EIS scores and ratings.

	W1	W2	W3	W4	W5	W6	W7
Ecological Importance	**2.72**	**2.83**	**2.83**	**2.56**	**2.16**	**1.00**	**2.00**
Biodiversity maintenance	2.72	2.83	2.83	2.56	1.13	0.50	1.07
Flow regime regulation	1.38	1.09	1.31	1.39	1.10	0.00	1.05
Water quality enhancement	2.67	2.47	2.36	2.25	2.16	1.00	2.00
Sediment & erosion regulation	1.56	1.89	1.83	2.14	2.00	1.00	2.00
Climate regulation	1.19	1.19	1.15	1.22	1.26	0.50	1.26
Ecological Sensitivity	**1.50**	**1.80**	**1.60**	**1.25**	**1.25**	**0.05**	**0.45**
EIS (out of 4)	**2.11**	**2.32**	**2.22**	**1.90**	**1.71**	**0.53**	**1.23**
EIS Rating	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Very Low**	**Low**

Note that individual EIS assessment Excel ™ spreadsheets can be made available by Eco-Pulse upon request.

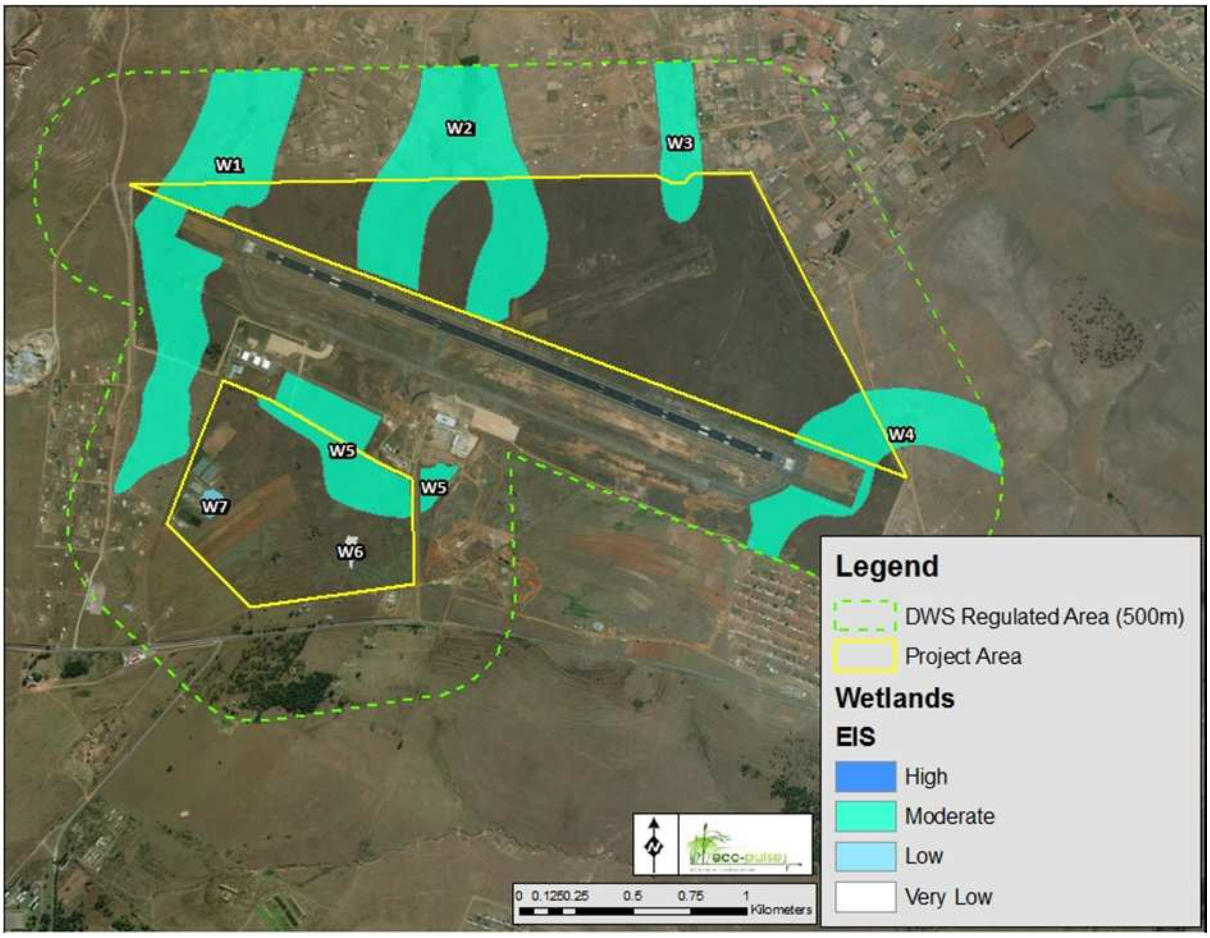


Figure 11 Wetland units classified according to ecological importance and sensitivity (EIS) rating.

4.5 Resource Management Principles and Objectives

The recommended ecological category (REC) is the target or desired state of resource units required to meet water resource management objectives and quality targets. It is determined through the consideration of the PES, EIS and realistic opportunities to improve the PES that is driven by the context / setting. The modus operandi followed by DWAF's Directorate: Resource Directed Measures (RDM) is that if the EIS is high or very high, the ecological management objective should be to improve the condition of the aquatic resource (Kleynhans & Louw, 2007). However, the causes related to a particular PES should also be considered to determine if improvement is realistic and attainable (Kleynhans & Louw, 2007). This relates to whether the problems in the catchment can be addressed and mitigated (Kleynhans & Louw, 2007). If the EIS is evaluated as moderate or low, the ecological aim should be to maintain the river in its PES (Kleynhans & Louw, 2007). Within the Ecological Reserve context, Ecological Categories A to D can be recommended as future states depending on the EIS and PES (Kleynhans & Louw, 2007). Ecological Categories E and F PES are regarded as ecologically unacceptable, and remediation is needed if possible (Kleynhans & Louw, 2007). A generic matrix for the determination of RECs and RMOs for water resources is shown in Table 12 below.

Table 12. Generic matrix for the determination of REC and RMO for water resources.

			EIS			
			Very high	**High**	**Moderate**	**Low**
PES	**A**	**Pristine/Natural**	A Maintain	A Maintain	A Maintain	A Maintain
	B	**Largely Natural**	A Improve	A/B Improve	B Maintain	B Maintain
	C	**Good - Fair**	B Improve	B/C Improve	C Maintain	C Maintain
	D	**Poor**	C Improve	C/D Improve	D Maintain	D Maintain
	E/F	**Very Poor**	D Improve	E/F Improve	E/F Maintain	E/F Maintain

Based on this matrix (Table 12) and the catchment context of each wetland unit, the recommended management objective for all water resource units (with the exception of artificial wetland W6) was assessed as being to **'*maintain the current status quo of aquatic ecosystems without any further loss of integrity (PES) or functioning*'** (Table 13, below). This management objective is driven by the generally fair to poor PES and low to moderate EIS for most wetland.

This is also generally aligned with the aquatic conservation priorities highlighted for the study area in terms of the Eastern Cape Biodiversity Conservation Plan (ECBCP (Hayes *et al*., 2007; Berliner & Desmet, 2007), which recommends that the management objective for these areas should be to: "***Maintain biodiversity in as natural state as possible, Manage for no biodiversity loss***" (Hayes *et al*., 2007).

Table 13. Summary of the assessment of the RMO based on PES and EIS ratings.

Unit	HGM Type	PES	EIS	RMO
W1	Seep	D: Largely Modified	**Moderate**	*Maintain PES/EIS*
W2		C: Moderately modified	**Moderate**	
W3		D: Largely Modified	**Moderate**	
W4		D: Largely Modified	**Moderate**	
W5		C: Moderately modified	**Moderate**	
W6	'Artificial' Wetland	N/A	Very Low	N/A
W7	Seep	D: Largely Modified	Low	*Maintain PES/EIS*

5 WETLAND IMPACT ASSESSMENT

This Chapter of the report deals with the identification, description and significance assessment of the potential construction and operational impacts and risks posed to wetlands by the WC: SEZ Phase 1 development.

5.1 Proposed Development Context

The planned development (according to the latest development layout plan: see Figure 12) includes the following aspects:

➢ The development proposed for the **Phase 1: 'North'** property (183 ha) will include:

- Agriculture on 164ha of the property
- Access road infrastructure
- Storm water conveyance and attenuation infrastructure

➢ The development proposed for the **Phase 1: 'South'** property (72 ha) will include:

- Hotel & conferencing development (5.5 ha)
- Commercial development (6.6 ha)
- Industrial development (22 ha)
- Intensive agriculture and business process outsourcing (23 ha)
- Internal road infrastructure
- Storm water conveyance and attenuation infrastructure
- Water pipeline reticulation
- Wastewater pipeline infrastructure

Based on this information, impacts were identified and described and then assessed in terms of significance.

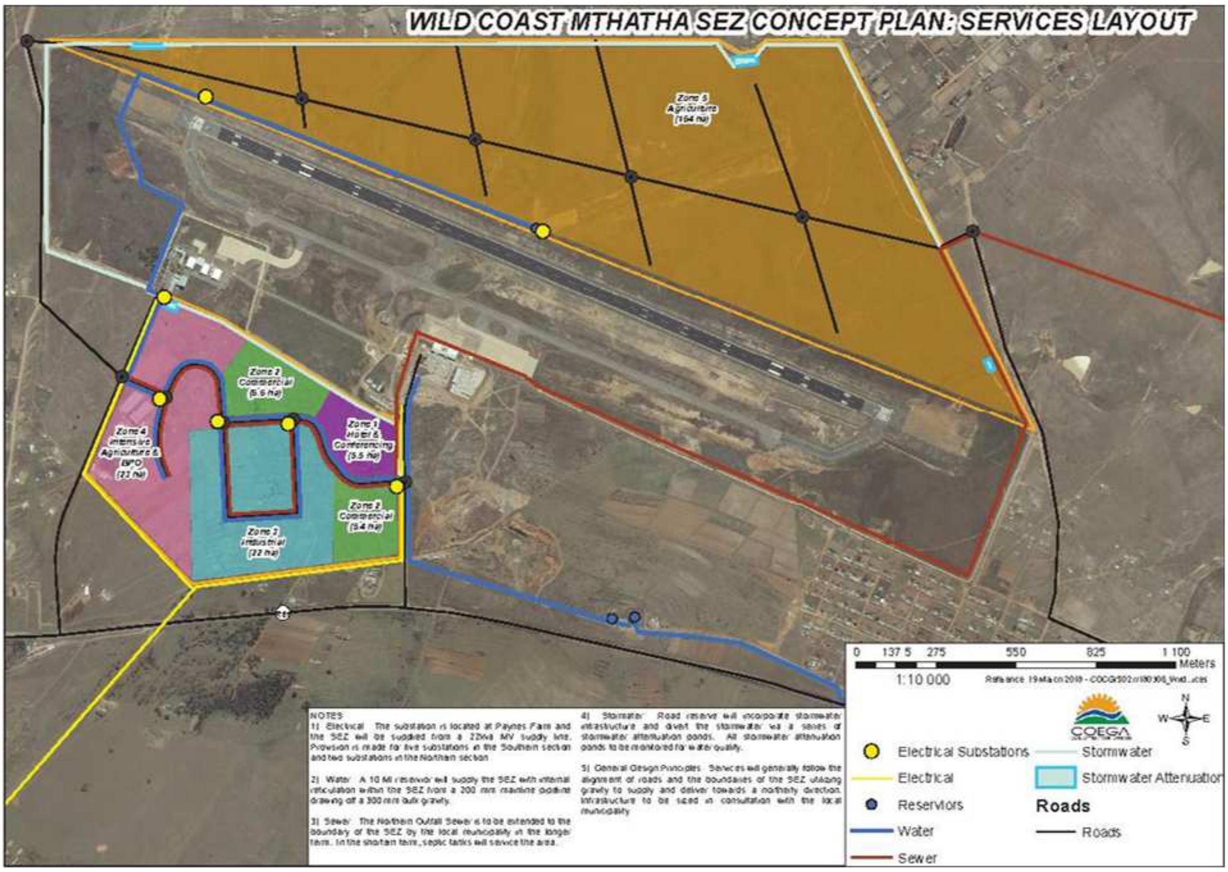


Figure 12 Proposed land uses and services infrastructure development layout plan for Phase 1 of the WC: SEZ (Source: Coega Development Corporation).

5.2 Impact Identification and Description

Freshwater ecosystems, including wetlands and rivers, are particularly vulnerable to human activities and these activities can often lead to irreversible damage or longer term, gradual/cumulative changes to these ecosystems. Threats to freshwater biodiversity include processes and activities which reduce system persistence, and alter community diversity and patterns, including reduced genetic diversity (Rivers-Moore *et al.*, 2007).

When making inferences on the potential impacts or risks that development activities place on ecosystems, it is important to understand that these impacts speak specifically to their effect on the ecological condition and/or functional importance/value of these ecosystems. Generally, impacts can be grouped into the following broad categories:

A. **Direct impacts**: are those impacts directly linked to the project (e.g. clearing of land, destruction of vegetation and habitat).

B. **Indirect impacts**: are those impacts resulting from the project that may occur beyond or downslope/downstream of the boundaries of the project site and/or after the project activity has ceased (e.g. migration of pollutants from construction sites).

Impacts to watercourses were identified and described based on an understanding of the receiving aquatic environment, associated sensitivities and the location and extent of the proposed infrastructure (as per the layout map presented in Figure 12). *Note that while an attempt has been made to separate impacts into categories, there is inevitably some degree of overlap due to the inherent interrelatedness of many ecological impacts.*

Impact 1: Physical Destruction and/or Modification Impacts

This impact refers to the physical destruction or disturbance of wetland habitat caused by vegetation clearing, excavation and/or infilling during construction of the proposed infrastructure associated with the development as well as associated unintended indirect / secondary disturbances that are likely to persist during the operational phase of the project.

A. Construction Phase Impacts:

Wetland vegetation and habitat can be impacted directly through the complete removal or partial disturbance of existing indigenous wetland vegetation (plants) during construction (i.e. stripping of vegetation and infilling), leading to the deterioration in the wetland vegetation & ecological condition. Based on the proposed development footprint (shown in Figure 12) which intends to maximise the available space for development infrastructure and agricultural land use, a total loss of wetland habitat is expected under the current proposed development scenario which does not seek to avoid permanent loss of wetlands. Such a loss of wetland habitat (estimated to be in the region of ~56 ha) is considered to be of **'high' impact significance** and would warrant the consideration of a wetland/biodiversity offset as a means of compensating for the permanent (residual) impact on wetland habitat and functioning. *The reader is referred to* ***Chapter 8 'Wetland Offset Requirements'*** *for further information on offset requirements.*

Should development consider the avoidance of the delineated wetland areas and recommended 15m buffer zones (see impact mitigation and management recommendations in Chapter 6), **direct loss of wetland can potentially be avoided and impact significance reduced to an appreciably low level.** The only direct impact for the project is then likely to be associated with the crossing of wetlands by services infrastructure (water and wastewater pipelines) and access roads. The necessary establishment of service infrastructure such as sewer/bulk water reticulation through wetlands will result mainly in the temporary destruction of wetland vegetation and habitat which should recover post-construction. Other associated impacts of working within freshwater habitats may include faunal fatalities, increased poaching, harvesting of indigenous vegetation, and dust and noise pollution. Sedentary (slow moving) fauna such as millipedes, molluscs, crustaceans and amphibians will likely be killed or forced to migrate into adjoining habitat during the clearing, excavation, re-shaping and infilling of wetlands for the purpose of road construction and sewer/water pipeline installation across these systems. Accidental or negligent infringements outside of the active construction zone may cause minor direct impacts to habitats adjacent to active construction areas, however this impact together with temporary modification/disturbance of watercourses by construction machinery and workers, is likely to be of moderately-low impact significance.

Impact Description	Mitigation Level	Impact Significance
		Construction Phase
1 Destruction and modification of freshwater habitat	'Poor' Mitigation	High (-)
	'Good' Mitigation	Moderately-Low (-)

B. Operational Phase Impacts:

During operation, there is unlikely to be any further direct or indirect impacts to wetlands located outside of the development footprint. However, the presence of a number of Invasive Alien Plant (IAP) species and undesirable weeds identified on the property creates a risk of alien plant and weed communities expanding and further colonising wetland areas if left unmanaged or poorly managed. This can have a significant impact on local biodiversity by displacing indigenous plants and creating undesirable alien plant-dominated wetland habitat, as well as potentially increasing soil erosion and fire risks. The anticipated significance of this impact is likely to be 'Moderate' for a poorly managed scenario, and of 'Low' significance where good mitigation is involved (i.e. alien plant eradication and control implemented appropriately as per the recommendations in Chapter 6 of this report).

Impact Description	Mitigation Level	Impact Significance
		Operational Phase
1 Destruction and modification of freshwater habitat	'Poor' Mitigation	Moderate (-)
	'Good' Mitigation	Low (-)

Impact 2: Flow Modification and Erosion/Sedimentation Impacts

This impact relates to the potential for modification of hydrological drivers (volumes, velocities pattern and timing of flow received and distributed though wetlands), including the resultant change in fluvio-geomorphological processes (i.e. such as rates of erosion and deposition of sediment).

A. Construction Phase Impacts:

During construction there is a risk that vegetation stripping and bulk earthworks occurring adjacent and upstream of wetlands could result in increased surface runoff volumes and velocities, which can lead to soil erosion and entrain sediment, transporting and discharging this into sensitive downstream wetland areas. Furthermore, roads and pipeline trenches across wetlands for services infrastructure installation may intercept runoff and act as a preferential flow path, channelling runoff containing high concentrations of suspended sediment into wetlands. The effect of enhanced/unnatural sediment deposition on wetlands and instream habitats is well-documented, and can lead to habitat destruction, blanketing of vegetation and temporary disturbance of aquatic breeding and foraging sites as well as refugia. Intolerant species of aquatic biota (fauna and flora) will be most at risk. A temporary change in local hydrological regimes will also likely be as a result from construction activities associated with road and pipeline crossings of wetland, including the use of coffer dams, diversions and dewatering activities to create a 'dry' working area during construction. Coffer dams typically result in the temporary inundation of wetland habitat which often excludes vegetation not adapted to permanently saturated areas.

Disturbance of soil profiles within wetlands (at road/pipeline crossings) will also render soils susceptible to suspension and transport via surface runoff and result in the sedimentation and increased turbidity of downstream water resources. This may occur as surface runoff transports fine soil particles (e.g. sand, clay and silt) while draining and dewatering of active work areas may result in the discharge of sediment rich water from trenches in order to ensure a dry work area.

Under a poor mitigation scenario, the significance of this impact is likely to be 'Moderately-High'. Under a good/best practical mitigation scenario (*in accordance with best practice impact mitigation and management measures recommended in Chapter 6 of this wetland report*), sediment and erosion control and the presence of a well-vegetated 15m buffer zone between the development and wetlands should reduce the intensity and probability of some of the above mentioned sediment and erosion impacts. Impact significance under a 'good' or best practical mitigation scenario is likely to be reduced to a 'Moderately-Low' level.

Impact Description	Mitigation Level	Impact Significance
		Construction Phase
2 Flow modification and erosion / sedimentation	'Poor' Mitigation	Moderately-High (-)
	'Good' Mitigation	Moderately-Low (-)

B. Operational Phase Impacts:

During operational phase of the Phase 1 SEZ development, it is expected that there will be increased water inputs to the downstream wetlands from irrigation associated with agricultural land use on the northern property and an increase in hardened surfaces associated with built infrastructure development on the southern property (not to forget asphalt access roads) leading to the reduced infiltration capacity of the ground and increased runoff volumes and rates. The development of hardened surfaces within a wetland's catchment is recognized as having the potential to either increase or decrease the flows that reach downstream aquatic systems such as wetlands, rivers and streams. Greater volumes of water are generated more quickly while smaller and longer-duration flows that would occur under less developed conditions are reduced or perhaps eliminated. Research has shown that collecting storm water through modern storm drains, culverts, and catchments results in the rapid transport of large volumes of storm water runoff into rivers, lakes, and wetlands at much faster rates and higher volumes than under predevelopment conditions (Sheldon *et al.*, 2003). The amount of impervious surface within a contributing basin is a key influence on hydrologic patterns, and even small changes in watershed conditions have measurable influences on the flows and volumes of water in the system. Increased imperviousness (more hardened or impermeable surfaces) will experience an increase in the magnitude of runoff volume from a given storm event. The "typical" event occurs far more frequently. For example, the peak flows created from a two-year storm event, after urbanization, will occur far more frequently than every two years. Small storm events that did not create measurable peak discharges in natural vegetation conditions create measurable peak runoff flows in urbanized conditions, because the removal of the vegetation makes the same size storm event result in far greater volumes of water reaching aquatic resources such as wetlands and streams. Larger flows with more erosive force may occur in urbanized basins with much greater frequency, for example increasing from once or twice per decade to several times per year. Catchment hardening can also cause a decrease in interflow (shallow subsurface flow) and base flow from the developed catchment, with changes in the volume of interflow typically influencing the hydroperiod of downstream wetlands fed by shallow subsurface flow. Instead of water infiltrating the ground and recharging groundwater which feeds the wetland throughout the dry season, it will flow straight into the wetland and likely be lost to evapotranspiration (during early vegetation succession especially), surface and sub-surface outflow. Ultimately, the consequences of the interplay between rates, volumes, and durations of flows are complex and research on the impacts of urbanization on stormwater and watershed processes indicates that catchment hardening results in several disturbances that can impact wetlands and rivers, including:

- Increased erosion;
- Sediment movement and deposition;
- Burying of vegetation;
- Increased depths of inundation;
- Water level fluctuations;
- Down-cutting or incising of natural channels (which can remove riparian vegetation from the floodplain);
- Changes in the seasonal extent and duration of saturation and inundation; and
- Unstable substrates.

Also, poorly designed and implemented instream infrastructure (roads, bridges, culverts, pipelines) could alter the flow regime within affected watercourses. Road bridges and culverts narrower than the width of the watercourse often concentrate flows resulting in erosion of the downstream areas. Infrastructures with a base located above the natural level of the watercourse will result in impounding of flows and inundation of wetland or riparian habitat thus altering the natural saturation regime of the affected watercourse. Overtime the upstream area under inundation will experience increased sediment deposition and destruction of aquatic habitat.

Furthermore, in the event of a damaged/broken or malfunctioning water/effluent pipelines, additional water inputs to wetlands/rivers will likely result in increased saturation and may reduce hydrological variability in wetland ecosystems, resulting in a probable shrift in the structure and composition of vegetation communities to favour species suited to higher soil saturation and could result in a possible reduction in natural species diversity. Discharges from broken/leaking pipeline infrastructure and uncontrolled releases can also lead to point scouring of wetland and riverine instream habitats and channel incision at the point of discharge, with the associated sedimentation of downstream ecosystems.

While the impacts discussed above are all possible and can be considered of 'High' impact significance under a 'poor' or 'standard' mitigation scenario, the likelihood of flow and flow-related erosion and sedimentation risks can be reduced through careful planning, environmental design considerations and the implementation of site-specific construction phase mitigation measures, *as per the recommendations made in Chapter 6 of this wetland report*, reducing impact significance to a potentially 'Moderately-Low' level.

Impact Description	**Mitigation Level**	**Impact Significance**
		Operational Phase
2 Flow modification and erosion / sedimentation	'Poor' Mitigation	High (-)
	'Good' Mitigation	Moderately-Low (-)

Impact 3: Water Quality Impacts

This impact refers to the modification of the microbiological, physical and chemical properties of water that determine its fitness for a specific use, determined by substances which are either dissolved or suspended in the water. Pollution of water resources is a human-induced impact and defined by the National Water Act No. 36 of 1998 as the direct or indirect alteration of the physical, chemical or biological properties of a water resource so as to make it:

a) Less fit for any beneficial purpose for which it may reasonably be expected to be used;
b) Harmful or potentially harmful –

- *to the welfare, health or safety of human beings;*
- *to any aquatic or non-aquatic organisms;*
- *to the resource quality; or*
- *to property.*

A. Construction Phase Impacts:

In the context of the planned development and receiving wetland environment, water quality refers to its fitness for maintaining the health of aquatic ecosystems (namely wetlands). Key sources of contaminants during the construction phase of the development project that could alter water quality include:

- **Hydrocarbons** – leakages from petrol/diesel stores and machinery/vehicles, spillages from poor dispensing practices.

- **Oils and grease** - leakages from oil/grease stores and machinery/vehicles, spillages from poor handling and disposal practices.
- **Cement** - spillages from poor mixing and disposal practices.
- **Sewage** – leakages from and/or poor servicing of chemical toilets and/or informal use of surrounding bush by workers.
- **Suspended solids** – suspension of fine soil particles as a result of soil disturbance and altered flow patterns.

Mismanagement of the above contaminants and any soil/material stockpiles could potentially result in the pollution of the adjacent and downstream wetlands. Although water pollution impacts can potentially be experienced during the construction phase of the project, the quantity of pollutants is likely to be quite limited. This is however relevant given the close proximity of development to the wetlands. Impact significance is likely to be relatively 'Low' during the construction phase where well-managed ('good' mitigation).

Impact Description	Mitigation Level	Impact Significance
		Construction Phase
3 Water quality impacts	'Poor' Mitigation	Moderate (-)
	'Good' Mitigation	Low (-)

B. Operational Phase Impacts:

Pollution sources from developments in their operational-phase can vary greatly. Mixed-use development that incorporates a range of land-uses including industry, commercial/retail space and agriculture can typically be associated with the following potential operational phase contaminants:

- **Suspended solids –** associated with runoff from hardened surfaces and bare soils leading to soil erosion and sedimentation.
- **Nutrients** – associated with agricultural runoff and fertilise application.
- **Sewage –** associated with leaks, infrastructure failure and/or storm water ingress into sewer manholes leading to the surcharge of contaminated water.
- **Hydrocarbons, oils and grease** – run-off from parking lots and roads.
- **Toxicants** – run-off containing detergents and other toxic substances used by residents.

These contaminants which may enter downstream and adjacent wetlands have the capacity to negatively affect the in-stream aquatic habitat and species. Where significant changes in water quality occur, this will ultimately result in a shift in aquatic species composition, favouring more tolerant species and potentially resulting in the localised reduction of sensitive species. Sudden drastic changes in water quality can also have chronic effects on aquatic biota in general, leading to localised extinctions. Accidental and intentional release of the above mentioned contaminants into the environment will alter surface and ground water quality which will eventually flow into downstream wetlands, altering the water quality of the resource in the short-term during construction. Potential consequences of degraded water quality may include:

- **Nutrient enrichment**: Increase in denitrification rate and biological uptake and processing.
- **Organic loading:** Reduces biological uptake and processing, especially at high loadings or if associated with acidification.
- **Acidification**: Usually depresses denitrification, biological uptake and processing and usually results in increased mobility of heavy metals.
- **Turbidity:** Reduces photo-oxidation of some contaminants and usually depresses denitrification rate and biological uptake and processing.
- **Contaminatio**n: Can depress denitrification rate and biological uptake and processing and photosynthesis.
- **Salinization**: Can depress denitrification rate and biological uptake and processing and photosynthesis.

Given the close proximity of the development to wetlands on the property and downstream, impact significance is likely to be of 'Moderately-High' significance under a 'poor mitigation' scenario but can be mitigated and reduced to a relatively 'Low' significance level with proper mitigation and activity controls in place (*as per the mitigation options recommended under Chapter* 6).

Impact Description	Mitigation Level	Impact Significance
		Operational Phase
3 Water quality impacts	'Poor' Mitigation	Moderately-High (-)
	'Good' Mitigation	Moderately-Low (-)

5.3 Impact Significance Statement

Impact significance is defined broadly as a measure of the 'desirability, importance and acceptability of an impact to society' (Lawrence, 2007). The degree of significance depends upon two dimensions: the measurable characteristics of the impact (e.g. intensity, extent, duration) and the importance societies/communities place on the impact. Put another way, impact significance is the product of the value or importance of the resources, systems and/or components that will be impacted and the intensity or magnitude (degree and extent of change) of the impact on those resources, systems and/or components.

An attempt has been made to qualitatively quantify the relative significance of the ultimate negative consequences associated with the range of negative impacts potentially associated with the planned development. The significance of identified impacts on freshwater ecosystems was assessed for the following realistically possible scenarios:

i. **Realistic "standard / poor mitigation" scenario** – this is a realistic worst case scenario involving the poor implementation of construction mitigation, bare minimum incorporation of recommended design mitigation, poor operational maintenance, and poor onsite rehabilitation.

ii. **Realistic "good / best practical mitigation" scenario** – this is a realistic best case scenario involving the effective implementation of construction mitigation, incorporation of the majority of design mitigation, good operational maintenance and successful rehabilitation. Please note that this realistic scenario does not assume that unrealistic mitigation measures will be implemented and/or measures known to have poor implementation success (>90% of the time) will be effectively implemented.

Table 14 below provides an overview of the impact ratings presented per impact category.

Table 14. Summary of construction and operation phase wetland impact significance ratings.

Impact Description	Mitigation Level	Impact Significance	
		Construction Phase	Operational Phase
1 Destruction and modification of freshwater habitat	'Poor' Mitigation	High (-)	Moderate (-)
	'Good' Mitigation	Moderately-Low (-)	Low(-)
2 Flow modification and erosion / sedimentation	'Poor' Mitigation	Moderately-High (-)	High (-)
	'Good' Mitigation	Moderately-Low (-)	Moderately-Low (-)
3 Water quality impacts	'Poor' Mitigation	Moderate (-)	Moderately-High (-)
	'Good' Mitigation	Low (-)	Moderately-Low (-)

6 IMPACT MITIGATION

6.1 Introduction

A strong legislative framework which backs up South Africa's obligations to numerous international conservation agreements creates the necessary enabling legal framework for the protection and management of freshwater resources in the country. Given the value of wetlands and other aquatic ecosystems (such as rivers and estuaries) and the fact that humans depend on aquatic resources, it is against the law to deliberately damage wetlands and rivers. The law therefore places, directly and indirectly, the responsibility on landowners and other responsible parties, to manage and restore wetlands where relevant.

According to the National Environmental Management Act No. 107 of 1998 (NEMA), sensitive, vulnerable, highly dynamic or stressed ecosystems, such as wetlands, rivers and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure. NEMA also requires "a risk-averse and cautious approach which takes into account the limits of current knowledge about the consequences of decisions and actions". The 'precautionary principle' therefore applies and cost-effective measures must be implemented to pro-actively prevent degradation of the region's water resources and the social systems that depend on it. ***Ultimately, the risk of water resource degradation and biodiversity reduction/loss must drive sustainability in development design.***

Of particular importance is the requirement of 'duty of care' with regards to environmental remediation stipulated in Section 28 of NEMA (National Environmental Management Act No.107 of 1998):

> **Duty of care and remediation of environmental damage**: "(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 be reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment*."

6.2 Approach to Impact Mitigation: *'The Mitigation Hierarchy'*

The protection of water resources (wetlands & rivers/streams) begins with the avoidance of adverse impacts and where such avoidance is not feasible; to apply appropriate mitigation in the form of reactive practical actions that minimizes or reduces in situ impacts. Driver *et al.* (2011) recommend that the management of freshwater ecosystems should aim to prevent the occurrence of large-scale damaging events as well as repeated, chronic, persistent, subtle events which can in the long-term be far more damaging (e.g. as a result of sedimentation and pollution). 'Impact Mitigation' is a broad term that covers all components involved in selecting and implementing measures to conserve biodiversity and prevent significant adverse impacts as a result of potentially harmful activities to natural ecosystems. The mitigation of negative impacts on aquatic resources is a legal requirement for authorisation purposes and must take on different forms depending on the significance of impacts and the particulars of the target area being affected. This generally follows some form of 'mitigation hierarchy' (see Figure 13, below) which aims firstly at avoiding disturbance of ecosystems and loss of biodiversity, and where this cannot be avoided, to minimise, rehabilitate, and then finally offset any remaining significant residual impacts.

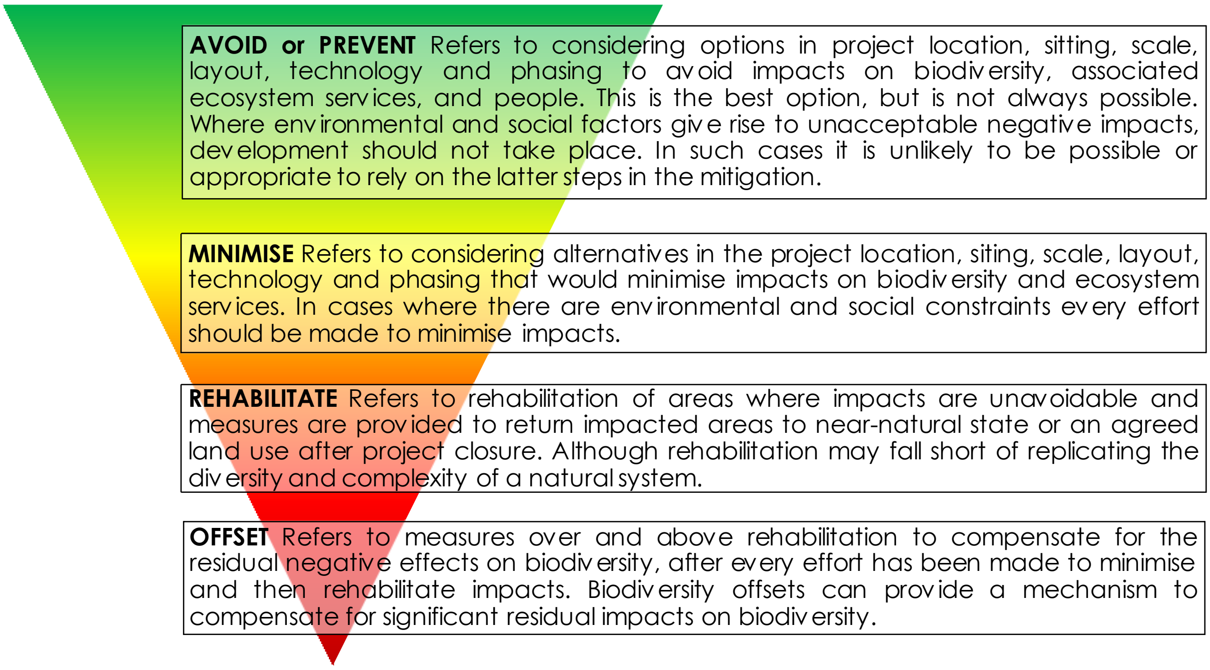


Figure 13 Diagram illustrating the 'mitigation hierarchy' (after DEA *et al*., 2013).

The mitigation hierarchy is inherently proactive, requiring the on-going and iterative consideration of alternatives in terms of project location, siting, scale, layout, technology and phasing until the proposed development can best be accommodated without incurring significant negative impacts to the receiving environment. In cases where the receiving environment cannot support the development or where the project will destroy the natural resources on which local communities are wholly dependent for their livelihoods or eradicate unique biodiversity; the development may not be feasible and the developer knows of these risks, and can plan to avoid them, the better. In the case of particularly sensitive ecosystems, where ecological impacts can be severe, the guiding principle should generally be "*anticipate and prevent*" rather than "*assess and repair*". This principle is also in line with the recommended management objective for the project and receiving aquatic environment, that being to '*maintain the current status quo of aquatic ecosystems without any further loss of integrity (PES) or functioning*'.

A stepped approach has therefore been followed in trying to minimize impacts, which includes:

i. **Firstly, attempting to avoid/prevent impacts through appropriate project design and location:** *Development set-backs / buffer zones recommended*

ii. **Secondly, employing mitigation measures aimed at minimizing the likelihood and intensity of potential risks/impacts**: *Provision of construction and operation phase management and mitigation measures to avoid any unnecessary direct or indirect impacts to watercourses.*

iii. **Thirdly, addressing residual impacts to areas adjacent to the development site which may be impacts:** *Provision of a watercourse rehabilitation and management plan.*

iv. **Lastly, compensating for any remaining/residual impacts associated with permanent habitat transformation:** *The reader is referred to **Chapter 8**: 'Assessment of the need and desirability of wetland offsets' for further information).*

6.3 Implementation of Mitigation Measures

In terms of Section 2 and Section 28 of NEMA (National Environmental Management Act, 1998), the land owner is responsible for any environmental damage, pollution or ecological degradation caused by their activities "inside and outside the boundaries of the area to which such right, permit or permission relates". In dealing with the range of potential ecological impacts to natural ecosystems and biodiversity highlighted in this report, this would be best achieved through the incorporation of the management & mitigation measures (recommended in this report) into the Construction **Environmental Management Programme (EMPr**) for the development project. The EMPr should be separated into construction & operational phase.

The EMPr should define the responsibilities, budgets and necessary training required for implementing the recommendations made in this report. This will need to include appropriate monitoring as well as impact management and the provision for regular auditing to verify environmental compliance. The EMPr should be enforced and monitored for compliance by a suitably qualified/trained ECO (Environmental Control Officer) with any additional supporting EO's (Environmental Officers) having the required competency skills and experience to ensure that environmental mitigation measures are being implemented and appropriate action is taken where potentially adverse environmental impacts are highlighted through monitoring and surveillance. The ECO will need to be responsible for conducting regular site-inspections of the construction process and activities and reporting back to the relevant environmental authorities with findings of these investigations. The ECO will also need to be responsible for preparing a monitoring programme to evaluate construction compliance with the conditions of the EMPr.

6.4 Development Planning: Environmental Guidelines and Principles

At the forefront of mitigating impacts to the wetlands on the property and downstream should be the incorporation of ecological and environmental sustainability concepts into the design of the development project, with a central focus on the following:

1. Ensuring that direct impacts to wetlands are avoided wherever possible through ecologically sound and sustainable development layout planning that takes into account the location and sensitivity of the remaining ecological infrastructure at the site;
2. Employing creative design principles and ecologically sensitive methods in infrastructure design and layouts to minimise the risk of indirect impacts;
3. Ensuring that storm water management design and implementation takes into account the requirements of the environment, including wetlands; and
4. Taking necessary efforts aimed at minimising/reducing potential waste streams.

6.4.1 Wetland Buffer Zones

'Buffer Zones' (also termed "development set-backs") are essentially strips of vegetated undeveloped land typically designed to act as a protective barrier between human activities and sensitive habitats such as wetlands, rivers and forests. Research shows that buffer zones are useful at performing a wide range of functions such as sediment trapping and nutrient retention, and in doing so, play an important role in protecting water resources from the adverse impacts that are typically associated with various land-uses and development. Although there are no legislative requirements regarding the establishment of buffers around water resources in the South African legislation, the application of buffers is aligned with the principles of the National Water Act No. 36 of 1998, which is to provide for the sustaining of water quality and preserving natural aquatic habitats and ecosystem functions.

Based on the nature of the proposed development and the receiving wetland environment's susceptibility to water quality and storm water run-off impacts, buffer zones (or 'development setbacks') are proposed as an initial means of minimizing potential environmental impacts and reducing the risk of wetland degradation in the long term.

A national protocol for buffer determination around rivers, wetlands and estuaries (Macfarlane & Bredin, 2016) has recently been developed and represents emerging best-practice in aquatic buffer zone determination. The methodology and accompanying wetland buffer zone determination model were used to confirm whether the 15m buffer zone width prescribed during the project EIA phase are still appropriate for the development project. The wetland buffer model by Macfarlane & Bredin (2016) produces an output based on potential risk associated with the proposed development type ('mixed-use development' and 'agricultural use') in conjunction with the sensitivity of aquatic resources (i.e.

wetlands of generally moderate EIS). Potential risk to wetlands in terms of a range of criteria (see Table 15, below) are estimated by the model and used to allocate suitable buffers based on the generic risk levels associated the proposed development project.

Table 15. Preliminary desktop-level threats used in the aquatic buffer assessment for the development type scenario (after Macfarlane & Bredin, 2016).

Threat Type	Preliminary Threat Ratings		Recommended Approach for Addressing Threats
	Construction Phase	Operation Phase	
1. Alteration to flow volumes	Very Low	Moderate	• Source directed controls
2. Alteration of patterns of flows (increased flood peaks)	Low	Moderately-High	• Control of water inputs
3. Increase in sediment inputs & turbidity	High	Moderately-High	• **Buffer zones** • Other suitable on-site BMPs[6]
4. Increased nutrient inputs	Very Low	Moderately-High	
5. Inputs of toxic organic contaminants	Very Low	Moderate	
6. Inputs of toxic heavy metal contaminants	Low	Low	
7. Alteration of acidity (pH)	Very Low	Low	• On-site BMPs and other measures
8. Increased inputs of salts (salinization)	N/A	Moderate	
9. Change (elevation) of water temperature	Very Low	Low	
10. Pathogen inputs (i.e. disease-causing organisms)	Very Low	Low	• Buffer zones • Other suitable on-site BMPs

Based on the threats posed by the development and additional mitigation measures provided in this report, particularity storm water management recommendations, a **15m aquatic buffer** width is deemed to be adequate and appropriate for the development type and receiving wetland environment's sensitivity to external impacts (see Figure 14).

Note that buffers have not been assigned to the 'artificial wetland' unit W6 in light of this wetland area being considered artificial in nature and of very low ecological importance/functioning (not warranting conservation/protection).

[6] BMPs = 'Best Management Practices'

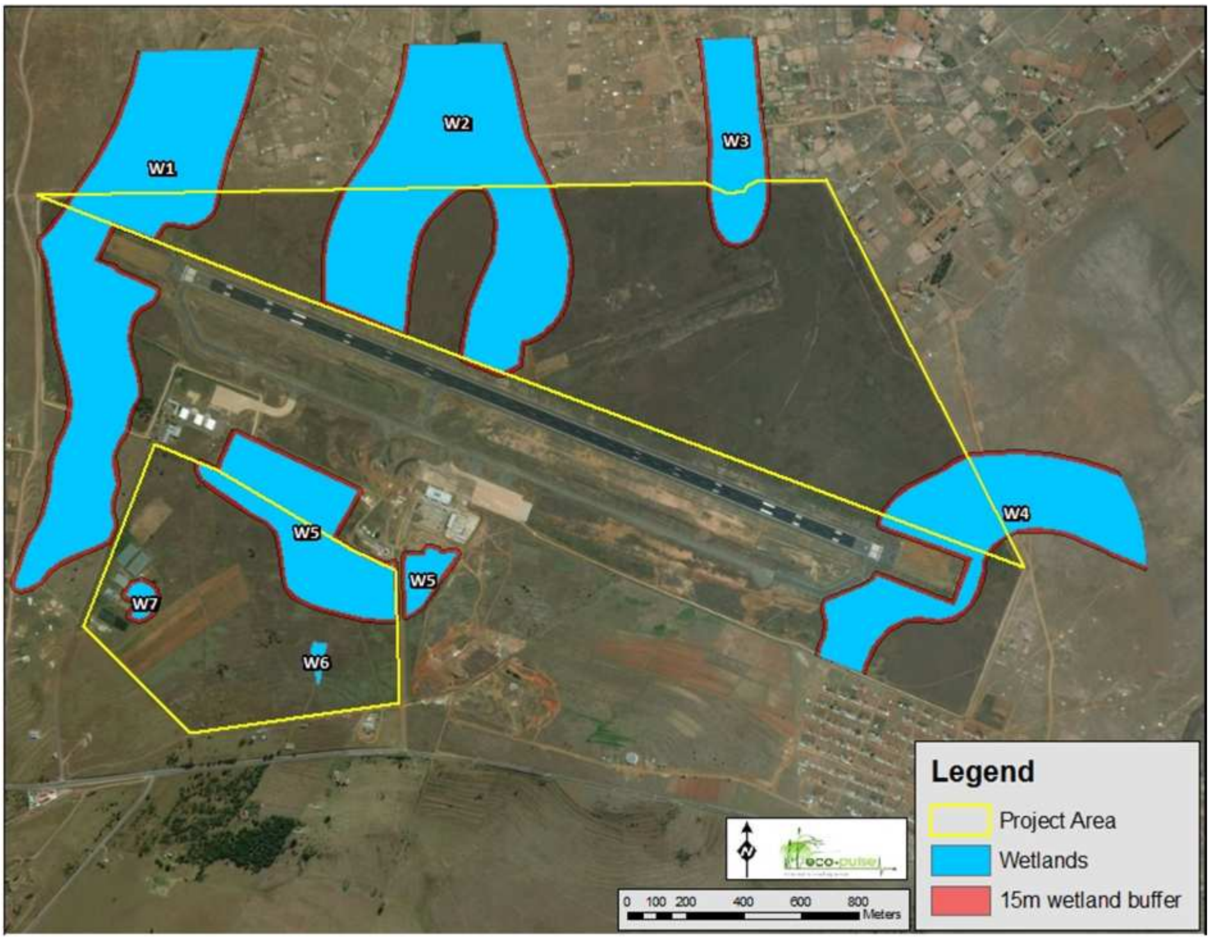


Figure 14 Map showing the extent of the 15m wetland buffer zone (shown shaded in "red"), aimed at mitigating (to an extent) non-point source above-ground impacts to wetlands.

The proposed wetland buffers at the site will probably work best at limiting direct disturbance/edge effects to wetland habitats, reducing sediment/erosion impacts through sediment trapping ability and soil-binding capacity of the vegetated buffer strips and dealing with water quality impacts such as nutrient enrichment of surface runoff. This will be of particular importance in protecting the wetland at the site from sediment impacts and water quality risks. Also, maintaining terrestrial habitat in the form of aquatic buffer zones is also likely to assist in facilitating aquatic fauna to move into terrestrial areas to complete their life-cycles as many species such as frogs/amphibians may rely on the adjacent terrestrial grassland areas for breeding purposes in particular. *It is important to note, however, that buffers have their limitations in terms of protecting wetlands from adjacent/upstream land-use impacts and that other mitigation measures may be necessary in most cases, which is emphasised in Macfarlane & Bredin (2016) and discussed in more detail below:*

- Buffers may be most effective at reducing pollutants in diffuse surface flow but are far less effective at addressing point-source pollution or concentrated flows and their role in mitigating pollution impacts associated with ground-water (subsurface flow) is not well documented.

- According to the Preliminary Guideline for the Determination of Buffer Zones (Macfarlane & Bredin, 2016), buffer zone requirements are only advocated where scientific studies have shown that they can be an effective mitigation measure. Table 16 (below) highlights situations where the implementation of suitable aquatic buffer zones can have a potentially positive mitigating effect and should be considered in impact mitigation (e.g. water quality and sediment impacts) and those situations where buffers are not particularly suited at mitigating impacts/risks and where other forms of mitigation should be identified (e.g. water quantity impacts, including stream flow reduction activities).
- Furthermore, the proposed aquatic buffer zone widths do not specifically take into account biodiversity concerns related to fauna/flora, etc.

Table 16. Summary of common threats posed by land use/activities on water resources and typical approaches to addressing them, including where buffers can play a particularly important role (after Macfarlane & Bredin, 2016).

<table>
<tr><th colspan="2">THREAT TYPE</th><th>SOURCE OF IMPACT</th><th>APPROACH FOR ADDRESSING THREATS</th></tr>
<tr><td rowspan="2">Water Quantity</td><td>Altered volumes of flow</td><td>Reduction in water inputs</td><td>• Source directed controls
• Restricting surface flow requirement (SFR) activities</td></tr>
<tr><td>Altered patterns of flow (flood peaks)</td><td>Increased water inputs</td><td>• Control of water inputs</td></tr>
<tr><td rowspan="7">Water Quality</td><td>Increased inputs of nutrients</td><td rowspan="8">Concentrated flows / Diffuse runoff</td><td rowspan="4">• Buffer zones
• Other suitable on-site BMPs</td></tr>
<tr><td>Increased inputs of organic contaminants</td></tr>
<tr><td>Increased inputs of toxic contaminants (heavy metals)</td></tr>
<tr><td>Pathogens</td></tr>
<tr><td>Changes in acidity (pH)</td><td rowspan="3">• On-site BMPs and other measures</td></tr>
<tr><td>Salinization</td></tr>
<tr><td>Temperature changes</td></tr>
<tr><td colspan="2">Sedimentation & turbidity</td><td>• Buffer zones
• Other suitable on-site BMPs</td></tr>
</table>

The limitations of buffer zones need to be borne in mind with respect to their role in mitigating against changes in catchment hydrology (such as altered flow volumes and runoff characteristics as well as water abstraction), which they are not suited for. This needs to be emphasized in light of the potential impact of the development on runoff reaching wetlands. Hydrological modifications to wetlands can have far reaching negative consequences on both the integrity and functioning of these sensitive resources, typically having knock-on effects on aquatic vegetation structure and composition, aquatic habitat integrity and suitability for wetland-dependent biota (especially sensitive species/taxa) as well as increasing the risk of reducing wetland functioning and the supply of important wetland goods & services.

The primary assumptions regarding the effectiveness of buffer zones therefore include:

- While buffer zones are known to work well at trapping sediments and nutrients, the potential to reduce impacts such as point source pollution and sedimentation is strongly dependent on the site-specific characteristics of the buffer (such as vegetation cover, slope of the buffer, etc.);
- In order to maximise their effectiveness, buffer zones will need to be established and maintained with indigenous vegetation cover (without erosion features/concentrated flow paths) as open space natural grassland areas with appropriate alien plant control and/or slashing to maintain grass cover; and
- For impacts involving the concentration of surface flow (e.g. storm water discharge, etc.), buffers have a limited capacity to function at attenuating flows and trapping sediment/nutrients/pollutants.

In light of the limitations of buffer zones and the need to maximise their effectiveness through proper maintenance and management, buffer zone management recommendations and guidelines have been developed for the proposed aquatic buffer zones and are included under the operational mitigation in Section 6.6 of this report.

6.4.2 Storm water Management

The management of storm water prior to discharge and the manner in which water is released into the natural environment will be critical in managing and protecting downstream aquatic resources from degradation and to allow for the continued capacity of these natural areas to receive and absorb/transmit storm water from the site. This is in light of the risk of altered flow volumes and velocities in the post-development (operational phase) context of the site and the risk of further erosion and sedimentation of adjacent / downstream wetlands as a result.

An appropriate storm water management plan must be designed for the development project in line with best practice. Storm water management at the site is likely to be handled by some form of generic storm water management system that allows for the satisfactory drainage of accumulated surface water from roofed and hardened surfaces to approved points of disposal and that adequately attenuates flows before discharging into the natural drainage network. A range of recommendations and guidelines for managing storm water runoff from the perspective of protecting wetlands on the property (and downstream) have been compiled by the specialists from Eco-Pulse Consulting involved in undertaking the wetland assessment and are based on recommendations made for similar development projects. It is recommended that these guidelines/recommendations for managing storm water be considered by the developer/project engineers and used to inform the development of the storm water management plan and system for the project.

The guidelines and recommendations for storm water management (Table 17) apply to the development project and need to be considered when designing and developing a storm water management plan and system for the property.

Table 17. Storm water management recommendations.

Item	Recommendations
Grading of the site	• To avoid the formation of preferential storm water flow paths and associated point source erosion/ scouring the entire site must be graded/ sloped to encourage shallow diffuse sheet flow towards storm water collection and conveyance systems. •
Source controls & Rainwater harvesting	• Storm water should be harvested onsite from roofed surfaces thus reducing the quantity (volume) of water received by downstream water resources as surface flow. This water is to be used onsite for non-potable applications or made available for irrigation of agricultural fields or other non-potable uses. • As the majority of the wetlands are subsurface fed systems, it will be critically important to maximise runoff infiltration within footprint and within the wetland buffer zones. Recommended infiltration structures include underground storage tanks, bioretention areas and unlined detention basins, infiltration basins, and grassed swales. • The use of hardened surfaces on the property should be kept to a minimum as far as possible to encourage infiltration and reduce runoff capacity. Car parks for example could be gravel or another semi-permeable material (permeable paving, porous bricks/blocks) rather than impermeable asphalt or concrete.
Attenuation	• Ideally, all stormwater runoff generated by the proposed development during all design storm events should be attenuated within the development footprint to pre-development levels prior to discharge to the freshwater environment. • All storm water management infrastructure/ systems including collection, detention, attenuation, conveyance and outlet structures must be located outside of delineated watercourses and their respective buffer zones with some allowance for outlet protection/ armouring within buffers where this is not practically feasible.
Local controls and storm water conveyance	• The location and design of road drainage and discharge points shall be done in a manner that minimises peak discharge to downstream aquatic resources by considering the following: - Decreasing volume of water reaching wetlands as surface flow by encouraging infiltration; and - Decreasing velocity of flows entering aquatic resources (either through structural or vegetative means). • Use a combination of open, grass-lined channels/swales and stone-filled infiltration ditches rather than simply relying on underground piped systems or concrete V-drains. This will encourage infiltration across the site, provide for the filtration and removal of pollutants and provide for some degree of flow attenuation by reducing the energy and velocity of storm water flows through increased roughness when compared with pipes and concrete V-drains • For parking lots and driveways - garden beds (landscaped areas) and storm water conveyance channels, the use of concave open-lined swales or bio-retention areas should be used to receive and convey storm water. For these areas no curbs or spaced curbs are recommended so water can move freely from hardened surfaces into the swales or bio-retention areas. • Equally, if flower/plant beds are to be established adjacent to paved surfaces, then these should be designed to receive storm water from hardened surfaces and should be planted with robust indigenous species that to contribute to storm water management objectives. • Road runoff will need to be managed through use of grassed swales or grassed drainage trenches running parallel along the road on the downslope side of the access road. Grassed swales/drainage ditches/trenches will intercept runoff and promote storm water infiltration thus reducing surface runoff volumes and velocities downslope. Alternatively, numerous metre drains can be constructed to dissipate water in small quantities and low velocities. • Bio-retention methods do not only address flow volume and velocity issues but are an effective means of removing suspended solids, heavy metals, hydrocarbons, organic

Item	Recommendations
	compounds, and dissolved nutrients from storm water. Images 1 and 2, below, provide a visual example of the type of bio-retention swales being recommended[7].  Source: https://za.pinterest.com/pin/419186677789410327/  Source: http://www.dec.ny.gov/lands/
Storm water outlets	Storm water discharge outlets are to be used to ensure that the erosive energy of surface run-off is dissipated and sediment suspended in the run-off is trapped before entering aquatic ecosystems. With regards to these outlets, the following environmentally responsible storm water discharge/outlet design considerations should be considered: • A series of smaller storm water outlets is recommended over a few large outlets. The storm water outlets must be constructed at regular intervals to spread out surface flow and avoid flow concentration. • All outlets must be designed to dissipate the energy of outgoing flows to reduce point source scouring and erosion risks. In this regard, adequately sized concrete stilling basins/sumps must be installed at all outlets and flow from these stilling basins must fall onto suitably designed gabion reno-mattresses with wing walls. The reno-mattresses must extend an appropriate distance downslope to ensure that erosion risks are minimised. • Appropriate amouring (e.g. reno-mattresses or rock packs) downstream/downslope of discharge points is essential to avoid scouring and sedimentation. This applies to discharge points in terrestrial and aquatic ecosystems and is of particular importance due to the sandy erodible nature of the soils in the study area. • The outlet reno-mattresses must be established to reflect the natural slope of the surface it is constructed on and are to be located at the natural ground-level. • The outlets and associated outlet protection structures should be aligned parallel to contours wherever possible to reduce the gradient of outflows and remain outside of wetlands and their buffer zones where possible.
Inlet protection	• Measures to capture solid waste and debris entrained in storm water entering the storm water management system (inlet protection devices) will be incorporated into the design of the system and could include the use of either curb inlet/inlet drain grates and/or debris baskets/bags.
Management of 'dirty water'	• The recycling/reuse of dirty water is promoted; alternatively this water will need to be directed into the sewer system.

It will be important for all storm water management (including conveying of storm water and attenuation structures/facilities) be undertaken on the site of the development and that this be **located outside of the delineated wetlands and buffer zones.** This is in line with best practice and is also aligned

[7] Note that Images 1 to 4 are for visual aid and descriptive purposes only. They should be considered conceptual in nature and do not promote any particular product, company or brand.

with the requirements of the Department of Water & Sanitation.

It is also important to note that storm water infrastructure will likely require regular on-going **maintenance** in the form of silt, debris/litter clearing in order to ensure their optimal functioning. They will therefore be designed to cater for regular maintenance.

6.4.3 Road design

When designing new roads or road upgrades, proper sizing and installation of stream crossing culverts is critical to ensure long-term sustainability and project success, with culvert failure often leading to access problems and can cause extensive environmental degradation, especially if flows get diverted to unstable slopes. Ultimately, the responsibility lies with engineers to go beyond traditional methodologies and apply a holistic approach to wetland crossing design to reduce negative environmental impacts. The following best-practice environmental design considerations are to be considered in culvert design and construction:

- Use existing roads or upgrade existing tracks to cross wetlands rather than constructing entirely new roads wherever possible.
- Road design must ensure that flows through the wetlands to be traversed by roads remain unhindered and mimic the natural situation as far as possible.
- Roads crossing wetlands must be perpendicular to the general water flow direction and cross in a straight line as far as possible.
- The invert level of piped culverts needs to match the ground level of the wetland/river bed and should not be elevated above the wetland/river at the downstream end so as to cause erosion where water flows incorrectly onto the wetland surface/river bed from height.
- Crossings that are installed below the natural ground level are to be constructed with an appropriate drop inlet structure on the upstream side to ensure that 'headcut' erosion does not develop as a result of the gradient change from the natural ground level to the invert level of the culvert.
- Best management practices for road engineering includes designing stream crossing culverts to convey a minimum discharge equal to the 100-year flow.
- Culverts should ideally be sized to transport not only water, but the other materials that might be mobilized, as well as provide passage of aquatic species such as fish.
- When sizing culverts, the minimum size pipe that should be used when evidence of a defined channel exists is 18-inches or 7-8cm (Crowley, 2003). Road-watercourse crossings with undersized culverts can cause large inputs of sediment to streams if the culvert inlet is plugged and stream-flow overtops the road fill (Furniss *et al*., 1998).
- To prevent culvert plugging, one large culvert is more effective than several smaller ones (Furniss *et al*., 1998).

- When using multiple pipes, they should be separated by at least one culvert diameter apart to allow for the proper compaction of the soil material placed as backfill around the pipes, which is critical in preventing "piping" of water around the culverts which will eventually lead to crossing failure (Crowley, 2003).
- A headwall should be installed at the inlet of the culvert to protect crossing fill from saturation and scour and direct flow into the culvert. The stream should flow straight into the culvert inlet at all stream discharges without any ponding, eddying or abrupt changes in flow path which could result in increased potential for culvert blockage by woody material (Cafferata *et al.*, 2004).
- In situations where the new culvert discharges onto an unstable wetland bed or stream channel, an energy dissipater should be installed to prevent scour at the outlet. This can be constructed of appropriately sized rock armour and should have a concave cross-section to prevent the scouring of adjacent stream banks.
- Coarse bedding material or geotextile wrapped dump rock must be used wherever the roads crosses wetland characterised by diffuse subsurface flows. Based on the nature of wetlands in the study area, this is likely to include headwaters of valley bottoms and valley-bottoms fed by lateral subsurface water inputs.
- Reducing the road width and contouring farther up into the stream valley significantly reduces the size and fill volume in the crossing, and in the event of a crossing failure, less fill is then available for erosion and delivery directly into the drainage network.
- Where existing roads are utilised, an assessment of whether sufficient numbers of existing culverts are located across the extent of the wetland as crossed by the road must be made. If insufficient numbers of existing culverts are located within the existing road structure to allow flows across the width of the watercourse to be maintained, additional culverts must be included in the design of the upgraded road.
- It is suggested that semi-pervious materials be used to construct roads that allow for some infiltration rather than using totally impermeable tarred road surfaces, as this will assist with reducing storm water runoff.
- Where flows are encountered, water should be diverted away from excavation areas to reduce turbidity and eliminate saturation of the crossing fill as it is excavated. A small diversion dam should be built upstream and stream flow piped around the worksite and discharged into the wetland below the worksite or to a site where sediment can be captured.
- Under no circumstance should a wetland be impounded / dammed in such a manner as to totally restrict the flow and cause flooding/inundation upstream of the road embankment.
- Adequate storm water and erosion control will need to be included in the road design (see also Section 6.4.2, above).

6.4.4 Wastewater Management

The management and disposal of domestic wastewater (sewage) will be an important consideration and the necessary environmental design criteria and operational management guidelines will need to be implemented at the site in order to manage the risk of affecting surface and ground water quality.

At this stage, it is understood that a municipal wastewater pipeline will be constructed to service the area, with wastewater to be reticulated to the municipal WWTW (Waste Water Treatment Works) servicing Umthatha.

There is therefore no need to consider an onsite package type treatment plant or septic tanks. However, if and where septic tanks are to be considered, the option of installing conservancy tanks as a feasible alternative option should first be considered.

6.4.5 Water/Sewer Pipeline Design

The following design/planning recommendations were used as a guide to inform design and location of pipeline infrastructure in order to be pro-active in minimizing potential wetland ecological impacts where practically possible

- Align pipeline crossings of watercourses with planned road crossings where possible.
- Avoid crossing delineated wetlands where possible. Avoid placing pipeline infrastructure within the 15m wetland buffer zones recommended unless a clear motivation is provided for why this must occur.
- Avoid multiple wetland crossings where possible by crossing the wetland at one location.
- Wetland crossings must be constructed perpendicular to the natural direction of flow. Pipeline trenches and sandy bedding material can produce preferential flow paths for water across wetlands that can potentially drain wetland areas. Crossing wetlands perpendicular to the general direction of flow instead of at an angle will reduce this risk.
- Pipelines across wetlands should be buried at a sufficient depth below ground level such that the pipelines do not interfere with surface water movement or create obstructions where flows can cause erosion to initiate.

6.4.6 Sewer Pump Station Design (where applicable)

For wastewater/sewer pump stations (where required to reticulate wastewater to the regional WWTW), the following design guidelines apply:

- Pump stations will need to be fenced/secured to prevent unauthorized access by humans/wildlife which could cause damage to infrastructure and cause accidental malfunction and/or spillage of untreated waste water.

- Reasonable measures must be taken to provide back-up for mechanical, electrical, operational or process failure and malfunction at pump stations. At a minimum there should be an alarm system to warn of an electrical failure and sufficient standby equipment to provide for reasonable assurance that the infrastructure can be fully functional within 24 hours.
- Pump stations will need to be placed within a suitably lined, impermeable concrete bunded area with the capacity to hold untreated waste water in an emergency and provide for sufficient time for maintenance staff to address any faults/ problems. This is to limit the risk of untreated sewage overflowing in the event of any leakage or accidental spillage at the pump station.
- Signage should be provided at a visible location at the pump stations to inform local residents in the area of the purpose of the pump station and treatment works. Emergency telephone contact details should also be provided on the signs so that pump station failure, leakage or electrical power outages affecting the system can be easily reported to the Local Municipality.

6.5 Construction-Phase Impact Mitigation & Management

A number of practical measures and onsite controls are also recommended to prevent or limit the impact of the proposed development project during the **construction phase**. These should be included in the Environmental Management Programme (EMPr) for the development project where not already covered by the EMPr.

Impact mitigation measures and recommendations have been compiled based on specialist knowledge and experience in similar waste water pipeline projects as well as a range of literature including:

- FERC (US Federal Energy Regulatory Commission), 2002. Wetland and Waterbody construction and mitigation procedures.
- DWAF (Department of Water Affairs and Forestry) 2005b. Environmental Best Practice Specifications: Operation. Integrated Environmental Management Sub-Series No. IEMS 1.6. Third Edition. DWAF, Pretoria.
- DWAF (Department of Water Affairs and Forestry) 2005c. Environmental Best Practice Specifications: Operation. Integrated Environmental Management Sub-Series No. IEMS 1.6. Third Edition. DWAF, Pretoria.
- CSIR, 2003. Guidelines for human settlement planning and design. Chapter 10: Sanitation. Revised August 2003.

The following mitigation measures must be implemented in conjunction with any generic measures provided in the Environmental Management Programme (EMPr):

A. Defining and Management of No-Go Areas

- The edges of the construction servitude / development zone within the vicinity of the wetlands and 15m buffer zone must be clearly staked-out by a surveyor and demarcated using highly visible material (e.g. danger tape) prior to construction commencing.
- The demarcation work must be signed off by the Environmental Control Officer (ECO) before any work commences.
- Demarcations are to remain until construction and rehabilitation is complete.
- All areas outside of this demarcated working servitude must be considered no-go areas for the entire construction phase.
- No equipment laydown or storage areas must be located within delineated wetland areas or the recommended 15m wetland buffer zone.
- Access to and from the development area should be either via existing roads or within the construction servitude.
- Any contractor found working within No-Go areas must be fined as per fining schedule/system setup for the project.
- All disturbed areas beyond the construction site that are intentionally or accidentally disturbed during the construction phase must be rehabilitated immediately to the satisfaction of the ECO. All disturbed areas must be prepared and then re-vegetated to the satisfaction of the ECO as per the relevant wetland rehabilitation plan.

B. Specific Measures for Working within or Directly Upslope of Wetlands: *roads and pipelines crossing wetlands*

Suitable engineering **Method Statements** for pipelines/roads crossing wetland and for general activities taking place within wetland must be developed and according to the following environmental guidelines:

- Where possible, vegetation should be cut to ground level rather than removing completely so as to assist with binding/stabilising the soil during land-clearing operations.
- No clearing of indigenous vegetation outside of the defined working servitudes is permitted for any reason (i.e. for fire wood or medicinal use). No persons may remove, damage, deface, paint or disturb of any flora (plants) outside of the demarcated construction areas, unless specifically authorised by the ECO in consultation with the resident engineer.
- Any indigenous vegetation suitable for rehabilitation should be stored appropriately for later use. Indigenous wetland vegetation removed from the road/pipeline crossing footprint and suitable for rehabilitation activities must be carefully removed and stored in an appropriate facility for rehabilitation purposes.

- Any direct modification of wetland and river habitat for the installation of culverts and road drainage must be limited to the construction servitude. For roads this should be limited to the road footprint.
- Before any work commences, sediment control/silt capture measures (e.g. bidim/silt curtains) must be installed downstream/downslope of the active working areas. Quantities of silt fences/curtains shall be decided on site with the engineer, contractor and ECO. The ECO should be present during the location and installation of the silt curtains.
- Silt fences/curtains must be regularly checked and maintained (de-silted to ensure continued capacity to trap silt), and repaired where necessary. When de-silting takes place silt must not be returned to the wetland / watercourse.
- Any topsoil removed watercourses must be stockpiled separately from subsoil material and be stored appropriately for use in rehabilitation activities.
- Movement of construction vehicles across wetlands must be minimised as much as possible.
- Excavated rock and sediments from the construction zone, and including any foreign materials, should not be placed within the delineated rivers and riparian areas in order to reduce the possibility of material being washed downstream.
- No physical damage should be done to any aspects of the wetland other than those necessary to complete the works as specified. Channel bed and bank materials are not to be removed from the watercourse or used for construction purposes. Bed material disturbed during construction should be stockpiled for use in rehabilitation.
- Any topsoil and vegetation from areas to be excavated should be stripped and stored at the designated soil stockpile area outside of the aquatic zone for use later in rehabilitation.
- Disturbed channel bed material should be stockpiled for use in rehabilitation.
- Soil and other material required for construction purposes must not be derived from any river or wetland.
- All cleared and trimmed vegetation shall be removed from the watercourse upon completion of clearing in order to prevent the risk of flooding/snagging.
- Rehabilitate disturbed wetland habitat immediately after construction as per the recommendations contained in the relevant wetland rehabilitation plan.
- To reduce the need to divert water away from the construction area when crossing watercourses, all construction activities within wet areas should ideally take place in the dry season/winter (May to September).
- Construction within/across watercourses should progress as quickly as practically possible to reduce the risk of exceeding the temporary diversion capacity.
- Diversions must be temporary in nature and no permanent walls, berms or dams may be installed within a watercourse.
- Not more than one diversion is to be undertaken within any given watercourse any given time.
- Sandbags used in any diversion or for any other activity within a watercourse must be in a good condition, so that they do not burst and empty sediment into the watercourse.

- Upon completion of the construction at the site, the diversions shall be removed to restore natural flow patterns.
- Options for temporary flow diversion when working within channels may include:
    - diversion of the entire watercourse through use of a bypass large diameter pipe;
    - the installation of removable coffer dams; and
    - use of removal sandbags.
    - Figure 15 serves as a guide to support decisions around the use of coffer dams versus temporary barriers, etc.
- Once the correct approach has been adopted for the type of construction, it will be important to undertake the desired approach according to the best practise methods, as described in Table 18.

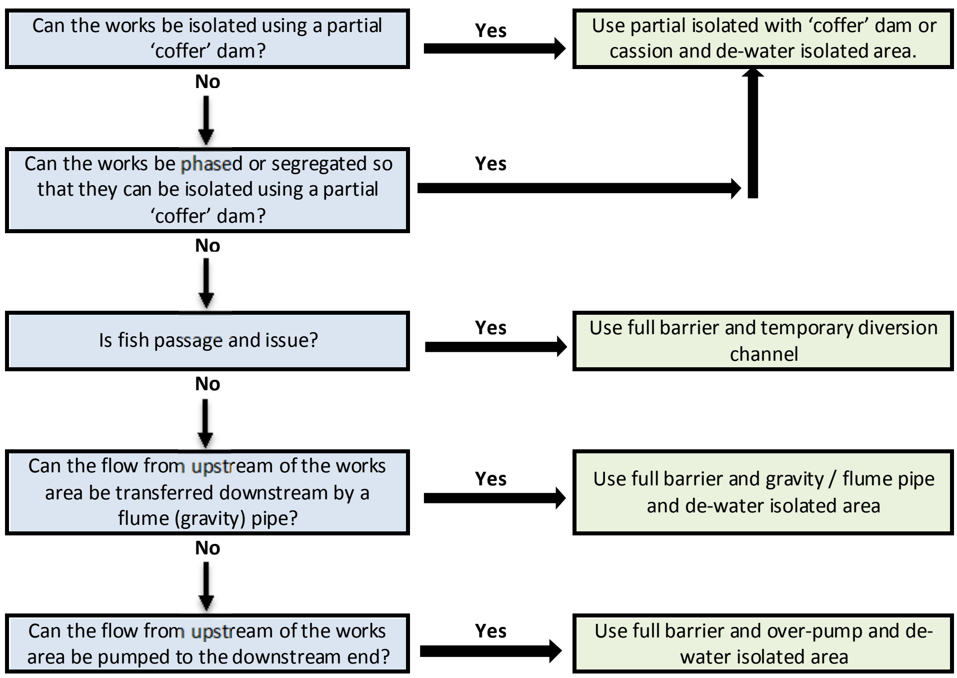
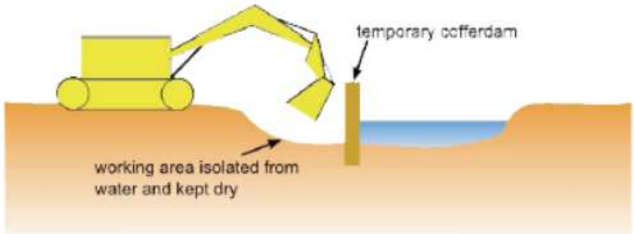
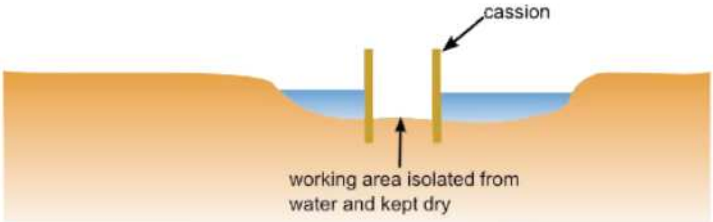
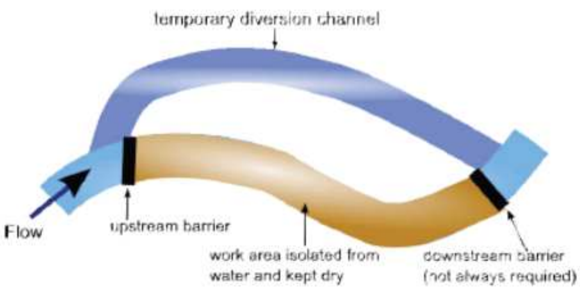
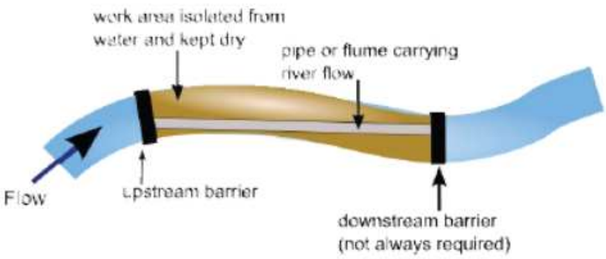
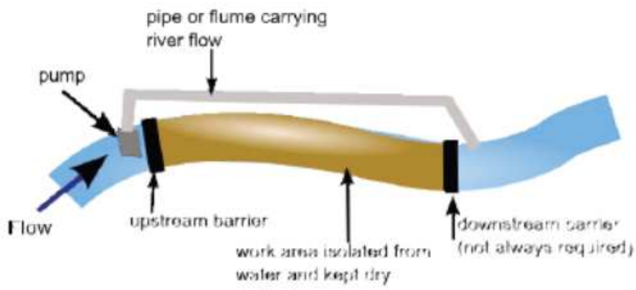
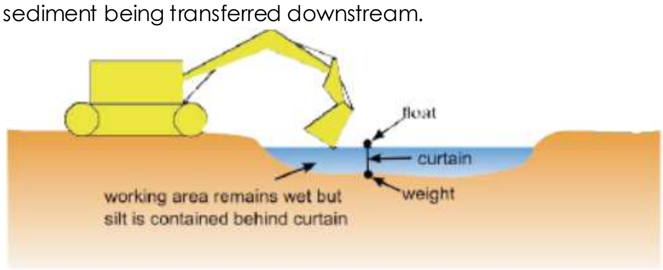


Figure 15 Decision support system for using cofferdams (after SEPA, 2009).

Table 18. Best practise methods for partial and full isolation (after SEPA, 2009).

Method/Approach	Description
Partial isolation	Partial area of the channel is isolated and kept dry with the use of barriers (often referred to as a cofferdam) and flow is allowed to continue in the remainder of the channel. Barriers used to isolate part of the channel can be made of a number of different materials. 
Partial isolation using a Caisson	Provides isolation of the channel similar to cofferdams. They are essentially large boxes or cylinders (usually pre-cast concrete and steel) which are open at the top and bottom and are lowered into the water to isolate an area of bed. 
Full isolation Temporary diversion channel	A whole section of the channel is isolated and kept dry, and the water is transferred downstream of the works area by excavating a temporary open channel. 
Full isolation gravity/flume pipe	A whole section of the channel is isolated using barriers that span the full width of the river. This keeps a stretch of the river dry and the water is transferred downstream of the works area through gravity fed flumes/pipes. The flume(s) is normally placed on the bed of the watercourse through the works area and outfalls at the downstream barrier, if present, or far enough downstream to prevent the water backing up into the work area. 
Full isolation over pumping / siphon	A whole section of the channel is isolated using barriers that span the full width of the river. This keeps a stretch of the river dry and the water is transferred downstream of the works area by mechanical assistance (pumping or siphon). The pump and associated pipe work

Method/Approach	Description
	need not be located in the isolated area. 
Isolation with silt curtain	In this case the works area still remains wet and a silt curtain is placed around the works area to minimise sediment being transferred downstream. 

C. Soil Management (Stockpile Areas)

- The topsoil layer must be stripped from the construction footprint and stockpiled separately from overburden (subsoil and rocky material). The thickness of the topsoil for harvesting must be obtaining from the geotechnical report and if not defined in the report, the top 30cm must be harvested.
- Topsoil is to be handled twice only – once during stripping and stockpiling, and once during replacement and levelling.
- All stockpile areas must ideally be established on disturbed flat ground or within the proposed development area.
- Stripped topsoil should be reinstated in areas from which they are stripped. A stockpile register may help in this regard.
- Where the risk of erosion of the soil stockpiles is high, erosion/sediment control measures such as silt fences, concrete blocks and/or sand bags must be placed around soil/material stockpiles to limit sediment runoff from stockpiles.
- Stockpiled soil is to be kept free of weeds and not to be compacted.
- The slope and height of stockpiles must be limited to 2m to avoid soil compaction and destruction of soil microbes.
- Spoil material must be hauled to a designated spoil site. No spoil material must be discarded on site.

D. Erosion Control Measures

Storm water and erosion control measures must be implemented during the construction phase to ensure that erosion is avoided or minimised. In this regard, the following measures should be implemented:

- Wherever possible, existing vegetation cover on the development site should be maintained during the construction phase. The unnecessary removal of groundcover from slopes must be prevented, especially on steep slopes which will not be developed.
- Vegetation clearing and soil stripping activities must only be undertaken during agreed working times and permitted weather conditions. If heavy rains are expected, clearing activities should be put on hold. In this regard, the contractor must be aware of weather forecasts.
- Any vegetation clearing should be done immediately before construction activities to avoid prolonged exposure of the soil to weather elements.
- All bare slopes and surfaces to be exposed to the elements during clearing and earthworks must be protected against erosion using rows of silt fences, sandbags, hay bales and/or earthen berms spaced along contours at regular intervals. The spacing interval must be smaller for steeper slopes and if required the ECO should advise in this regard.
- All temporary erosion and sediment control measures must be monitored for the duration of the construction phase and repaired immediately when damaged. All temporary erosion and sediment control structures must only be removed once vegetation cover has successfully recolonised the affected areas.
- After every rainfall event, the contractor must check the site for erosion damage and rehabilitate this damage immediately. Erosion rills and gullies must be filled-in with appropriate material and silt fences or fascine work must be established along the gulley for additional protection until vegetation has re-colonised the rehabilitated area.

E. Pollution Prevention Measures

The following pollution prevention measures must be implemented at the site:

- The proper storage, handling and disposal of hazardous substances (e.g. fuel, oil, cement, etc.) must be undertaken.
- All hazardous substances must be stored in appropriate containment structures free from the ingress and egress of storm water runoff.
- Hazardous storage and re-fuelling areas must be bunded prior to their use on site during the construction period. The bund wall should be high enough to contain at least 110% of any stored volume.

- Mixing and/or decanting of all chemicals and hazardous substances must take place on a tray, shutter boards or on an impermeable surface and must be protected from the ingress and egress of storm water.
- Cement/concrete batching is to be located in an area to be hardened and must first be approved by the ECO. No batching activities shall occur directly on the ground.
- Provide drip-trays beneath standing machinery/plant that are prone to leaks.
- No refuelling, servicing nor chemical storage should occur outside the established construction camp.
- Vehicle maintenance should not take place on site unless a specific bunded area is constructed for such a purpose.
- Spillages of fuels, oils and other potentially harmful chemicals should be cleaned up immediately and contaminants properly disposed of using appropriate spill kits. Any contaminated soil from the construction site must be removed and rehabilitated accordingly or disposed appropriately.
- Contaminated water containing fuel, oil or other hazardous substances must never be released into the environment. It must be disposed of at a registered hazardous landfill site.
- Sanitation - portable toilets (1 toilet per 10 users) to be provided where construction is occurring. Workers need to be encouraged to use these facilities and not the natural environment. Toilets must not be located within the 1:100yr flood line of a watercourse or within the buffer of any natural watercourses. Waste from chemical toilets must be disposed of regularly (at least once a week) and in a responsible manner by a registered waste contractor. Toilet facilities must be serviced weekly and in a responsible manner by a registered waste contractor to prevent pollution and improper hygiene conditions.

F. Management of Solid Waste

- Provide adequate rubbish bins and waste disposal facilities on-site and at the campsite.
- Litter bins must be equipped with a closing mechanism to prevent their contents from blowing out or wild animals from accessing the contents.
- Clear and completely remove from site all general waste, constructional plant, equipment, surplus rock and other foreign materials once construction has been completed.
- The construction site must be kept clean and tidy and free from rubbish.
- Recycling/re-use of waste is to be encouraged.
- No solid waste may be burned on site.

G. Invasive Alien Plant (IAP) Control

- Equipment used on site must be seed free and vehicles must be properly washed before moving onto site.

- All invasive alien plants that colonise the construction site must be removed immediately on detection, preferably by uprooting. The contactor should consult the ECO regarding the method of removal if uprooting is unfeasible (e.g. mechanical and/or herbicide methods).
- All bare surfaces across the construction site must be checked for IAPs every two weeks and if recorded, IAPs must be removed by hand pulling/uprooting and burned in a controlled environment.
- Herbicides should be utilised where hand pulling/uprooting is not possible.

H. Water Abstraction and Use

- No water is to be abstracted from the wetland or any river on the site or downstream for use in construction activities without prior approval by the Department of Water and Sanitation (DWS), subject to acquiring a relevant Water Use License in terms of Section 21 (a) of the National Water Act for taking water from a water resource.
- Employees are not to make use of any natural water sources (e.g. wetlands or rivers) for the purposes of swimming, bathing or washing of equipment, machinery or clothes.
- Drinking water is to be provided to all employees and labourers are to be discouraged from drinking directly from wetlands or rivers on site.

I. Wetland Rehabilitation

Guidelines in the form of a 'Conceptual-level wetland rehabilitation plan' for addressing post-construction impacts of road and pipeline crossings of wetlands has been compiled and is included as **Appendix A** to this wetland report.

6.6 Operational-Phase Impact Mitigation & Management

A number of wetland management and mitigation measures are recommended to address the operational impacts of the project and it is recommended that these be included in an operational EMPr and/or Wetland Management Plan for the operational development project and related activities:

A. Access Control

Access to wetlands should be controlled / restricted to promote the preservation of these sensitive environments.

B. Maintenance of Storm Water Infrastructure

Importantly, the storm water management system and related infrastructure is likely to require regular on-going maintenance in the form of silt, debris/litter clearing in order to ensure the optimal functioning of such systems.

Storm water management systems will therefore be designed with longevity in mind and in order to require little maintenance by catering for silting, etc.

C. Landscaping Recommendations

It is recommended that landscaping promote the use of indigenous species common to the region and that as much natural ground cover is established (naturally) on the site to help with binding soils and encouraging water infiltration, thus reducing overland flows and the pressure on storm water management infrastructure.

D. Waste Minimisation, Reuse and Recycling

A culture of "conserve, reduce, reuse & recycle" should be promoted with regards to the use and disposal of products to minimise resource consumption and reduce the amount of potential waste. Project design can also promote the conservation and efficient utilisation of water, implement rainwater harvesting measures, the recycling / re-use through grey water systems and using water efficient fittings.

E. Rules and Regulations for Future Land Owners

It is recommended that all future home owners/tenants should be provided with a set of rules and obligations regarding the correct use of any toilets, drains, sinks, etc. Biodegradable detergents and cleaning materials should be promoted where the storm water runoff from the development site could be contaminated by such products, for example.

F. Contingency Plan for Aquatic Ecosystems

A suitable **Environmental Contingency Plan for Aquatic Ecosystems** should be developed to assist in the identification of potential abnormal/unforeseen environmental incidents and provide guidance on communication including notification and activation in the event of an environmental emergency. It provides a framework of organisational responsibility and actions to be taken in the event of an incident on, or in the immediate vicinity of the development site. The plan will need to identify key personnel and their responsibilities in terms of identifying incidents, reporting on emergencies, preparing for abnormal incidents/events and implementing measures to contain and remediate aquatic environmental hazards. This plan should be referred to for all aspects of the management of operational emergencies relating to the planned development.

G. IAP (Invasive Alien Plant) Control

In line with the requirements of Section 2(2) and Section 3 (2) the National Environmental Management: Biodiversity Act (NEM:BA), which obligates the landowner/developer to control IAPs on his property, all IAPs within the property must be controlled on an on-going basis. The need for this exercise will need to be reviewed based on the presence of IAPs during the operational phase and the ECO will advise accordingly.

7 WETLAND MONITORING RECOMMENDATIONS

7.1.1 Introduction

Monitoring is required in order to ensure that wetlands associated with the proposed development are maintained in their current ecological state or improved but incurring no net loss to habitat condition and functionality as a result of the project.

7.1.2 Approach to Monitoring

It is recommended that a suitable and appropriate **Wetland Monitoring Plan** be developed and implemented in accordance with the following guidelines:

A. Responsibilities for Monitoring:

Compliance monitoring will be the responsibility of a suitably qualified/trained ECO (Environmental Control Officer) with any additional supporting EO's (Environmental Officers) having the required competency skills and experience to ensure that monitoring is undertaken effectively and appropriately.

B. Construction Monitoring Objectives:

Key monitoring objectives during the construction-phase should include:

- Ensuring that management and mitigation measure are adequately implemented to limit the potential impact on wetlands; and
- Ensuring that disturbed wetland areas have been adequately to stabilise and rehabilitated to minimise residual impacts to affected resources.

C. Record keeping:

The ECO shall keep a record of activities occurring on site, including but not limited to:

- Meetings attended;
- Method Statements received, accepted and approved;
- Issues arising on site and cases of non-compliance with the EMPr;
- Corrective actions taken to solve problems that arise;

- Penalties/fines issued; and
- Complaints from interested and affected parties.

D. Construction Phase Monitoring Requirements:

During construction:

This involves the monitoring of construction related impacts as identified in this report. Regular monitoring of the construction activities is critical to ensure that any problems with are picked up in a timeous manner. In this regard, the following potential concerns should be taken into consideration:

- Destruction of habitat outside the construction zone including 'No Go' areas;
- Destruction of conservation important/protected plants and trees;
- Erosion of wetland;
- Signs of intense or excessive erosion (gullies, rills, scouring and 'headcuts') and/or sedimentation within, along the edge and/or immediately downstream of the construction zone;
- Erosion of disturbed soils, road batters and soil stockpiles by surface wash processes;
- Sedimentation of wetland habitat downstream of work areas;
- Altering the hydrology and through flows to downstream wetlands during construction;
- Pollution of wetlands (with a particular focus on hazardous substances such as fuels, oils and cement products);
- Poorly maintained and damaged erosion control measures (e.g. sand bags, silt fences and silt curtains).

These risks can be monitored visually on-site by the ECO (together with construction staff) with relative ease and should be reported on regularly during the construction process. Any concerns noted should be prioritised for immediate corrective action and implemented as soon as possible.

Directly after construction (rehabilitation effectiveness):

This involves monitoring the effectiveness of rehabilitation activities, as per the Conceptual Wetland Rehabilitation Plan (see **Appendix A**).

E. Operation phase monitoring requirements:

This involves annual monitoring of water resource units (rivers/streams) affected by the development in order to ensure that operational impacts are being effectively managed. This can also be achieved through basic visual inspections by the ECO and support staff, documenting issues such as:

- Invasive Alien Plant infestation;
- Scouring and deposition associated with storm water runoff;

- Development of erosion ‘headcuts’;
- Channel incision downstream of development;
- Blockage/siltation of culverts/pipes/side drains;
- Scouring around infrastructure at river/stream crossings; and
- Erosion or instability of road embankments.

Surface water quality will be monitored at strategic points in the landscape and the results will be used to inform further management actions, remedial measures and/or the revision of mitigation strategies aimed at protecting the wetlands on the property and downstream from water quality impacts associated with the development. This monitoring plan should be referred to for all aspects of surface water quality monitoring and biomonitoring at the site. Note that due to the absence of suitable instream/channelled riverine habitat, river health indicators and techniques (such as the SASS 5 macro-inveterate sampling method) are not recommended for aquatic biomonitoring. Instead simple surface water quality sampling and analysis and basic wetland habitat integrity monitoring should be used to monitor any changes to wetland condition.

Note that operational monitoring of storm water and wastewater management infrastructure is to occur as per best-practice and in line with the engineers specifications. It will be critical that any leakages or failures leading to the release of untreated effluent be identified and rectified through regular site inspections by trained individuals.

8 WETLAND OFFSET REQUIREMENTS

8.1 National and Regional Guidance on Biodiversity Offsetting

According to the Draft National Policy on Biodiversity Offsetting in South Africa (DEA, 2017), biodiversity offsetting is simply defined as:

> “*The process of establishing and **quantifying** the residual negative effects on biodiversity and ecological infrastructure resulting from an activity after every effort has been made to avoid, prevent, reduce, moderate, minimise and rehabilitate impacts and then **counter-balancing** these residual effects through interventions that avoid, prevent, reduce, moderate, minimise and rehabilitate impacts or impacted areas elsewhere in order to achieve a net biodiversity and ecological infrastructure gain*.”

This policy aims to provide a set of “minimum requirements” for biodiversity offsets and makes specific provision for offset authorities to compile and publish best-practise guidelines that are aligned with this policy. As such guidelines are lacking for the Eastern Cape, the National Guidelines would therefore be applicable only.

The Draft National Policy also sets out the principal objective of biodiversity offsetting as being "*to slow and progressively reverse the erosion and degradation of our biodiversity and ecological infrastructure resulting from the residual negative impacts of development by counterbalancing these residual negative effects, after every effort has been made to avoid, prevent, reduce, moderate, minimise and then rehabilitate impacts, through avoiding, preventing, reducing, moderating, minimising and rehabilitating current or potential impacts or impacted areas elsewhere*".

Biodiversity offsets are therefore regarded as an important step in the 'mitigation hierarchy' and are recognised for their potential to contribute towards priority actions proposed by the 2011 National Biodiversity Assessment (NBA), namely:

i. ***Reducing loss and degradation of natural habitat in priority areas***. These actions focus on preventing loss and degradation of natural habitat in those biodiversity priority areas that are still in good ecological condition.

ii. ***Protecting critical ecosystems***. These actions focus on consolidating and expanding the protected area network as well as strengthening the effectiveness of existing protected areas.

iii. ***Restoring and enhancing ecological infrastructure***. These actions focus on active interventions required to restore those biodiversity priority areas that are currently not in good ecological condition, in order to enhance ecological infrastructure and support delivery of ecosystem services.

The need for a biodiversity offset is typically evaluated based on the significance of residual impacts to biodiversity, including direct, indirect and cumulative impacts. Simply stated, the significance of an impact relates to the amount of change to the environment that would be acceptable to affected communities and society as a whole. Guidance on defining impact significance is still somewhat lacking in the draft National Biodiversity Offsetting Policy. More clarity is however provided in the National Wetland Offset Guidelines: '***Wetland Offsets: A best practice guideline for South Africa***' (SANBI &DWS, 2016).

8.2 Impact significance contextualised

The significance assessment methodology developed by Eco-Pulse Consulting and applied in this wetland impact assessment (see Chapter 5 of this report) is largely aligned with the guideline and has been developed to specifically cater for wetland/biodiversity impacts by customizing impact descriptions such that they integrate threat status into the assessment of extent and intensity as part of the impact significance process. The method also specifically addresses different components of wetland biodiversity by considering impacts to (i) ecosystems (different wetland vegetation types), (ii) species of conservation concern and (iii) ecosystem services provided by wetlands. As part of this assessment, consideration is also given to direct, indirect and cumulative impacts on biodiversity pattern and process (specifically impacts that affect species movement). This methodology is therefore regarded as being appropriate for assessing the significance of impacts associated with planned developments and the need for biodiversity offsets for this development application.

Whilst impact significance is strongly influenced by the extent of impact, significance is also strongly influenced by the broader context of transformation and the extent to which existing sustainability thresholds (typically defined as conservation targets) have been compromised. The link between transformation and threat status is illustrated graphically in Figure 16, below. This shows two hypothetical scenarios depicting different rates of transformation and associated habitat / biodiversity loss. Under Scenario 1, transformation is relatively slow, but if unchecked, results in critical levels of biodiversity loss in the long term. Scenario 2 illustrates a process of more rapid decline. As loss continues, the importance of safeguarding remaining habitat remnants increases. If steps are not taken to counter on-going impacts, sustainability thresholds for biodiversity are exceeded as reflected by a critically endangered (CR) threat status.

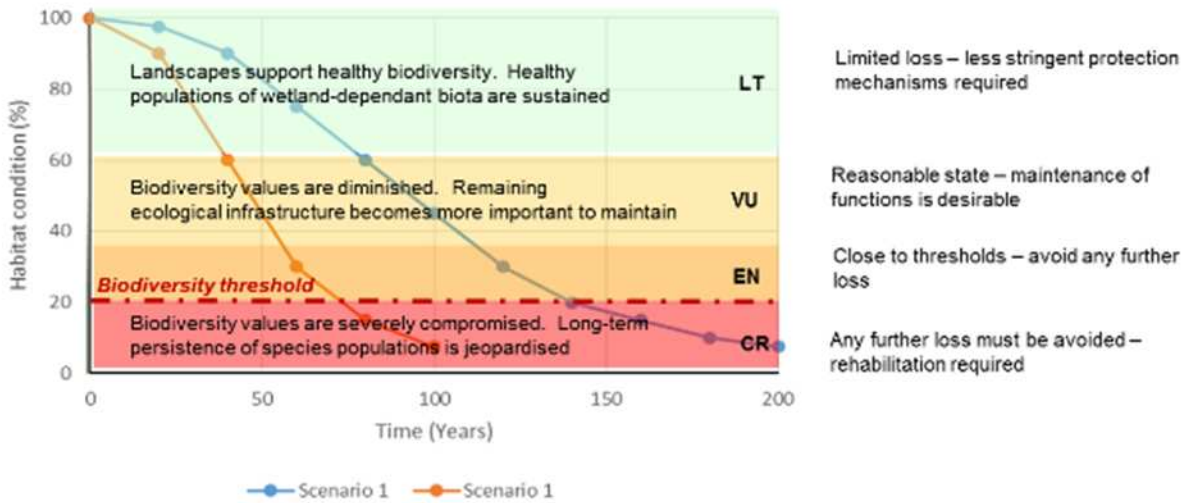


Figure 16 Biodiversity thresholds in relation to different levels of habitat loss.

The contextual overview of the study area provided in Section 3.2 of this wetland report illustrates that seep-type wetlands in the study area belonging to the Sub-Escarpment Grassland Group 7 and Sub-escarpment Savanna wetland vegetation groups are considered 'not protected' and with a conservation/threat status of 'Critically Endangered' and 'Endangered', respectively. This context clearly shows that the herbaceous seepage-type wetlands in the region are under considerable threat and suggests that further losses to these wetland types is likely to constitute a 'significant' impact. This is also relevant in light of the identification of the catchment area as an *aquatic 'Critical Biodiversity Area' or CBA at level 1 (A1)*b in terms of the Eastern Cape Biodiversity Conservation Plan, which represents in this instance critically important sub-catchments in a natural state that are considered critical for conserving biodiversity and maintaining ecosystem functioning and which require high levels of protection and the recommended management objective for such areas should be to: "*Maintain biodiversity in as natural state as possible, Manage for no biodiversity loss*" (Hayes *et al.*, 2007).

Context is also critical when assessing the significance of impacts in relation to regulating and supporting services provided by wetlands in particular. As with biodiversity, a reduction in functional values provided by wetlands typically accompanies development as illustrated in the two development scenarios depicted in Figure 17. As long as water resources continue to deliver functions in line with social demands and ecological limits, some loss if wetland functions may be acceptable (above the sustainability threshold). Where wetlands can no longer deliver these functions, the sustainability threshold has been exceeded and further degradation will result in unacceptable impacts to water resources and downstream users.

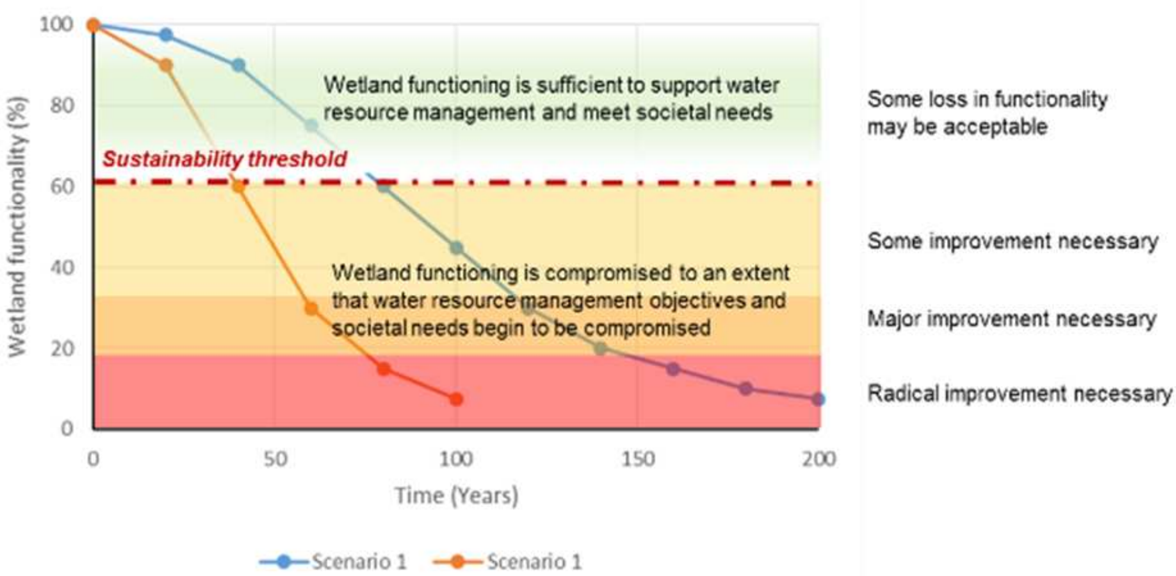


Figure 17 Sustainability thresholds for maintaining functional values provided by wetlands.

In the above example, the sustainability threshold for wetland functioning is set at 60%. This threshold is likely to be highly context-specific however and is responsive to the demand for the functions provided by wetlands in the landscape. This is demonstrated in Figure 18 which shows how the sustainability threshold (indicated by way of dashed line) could vary under different scenarios:

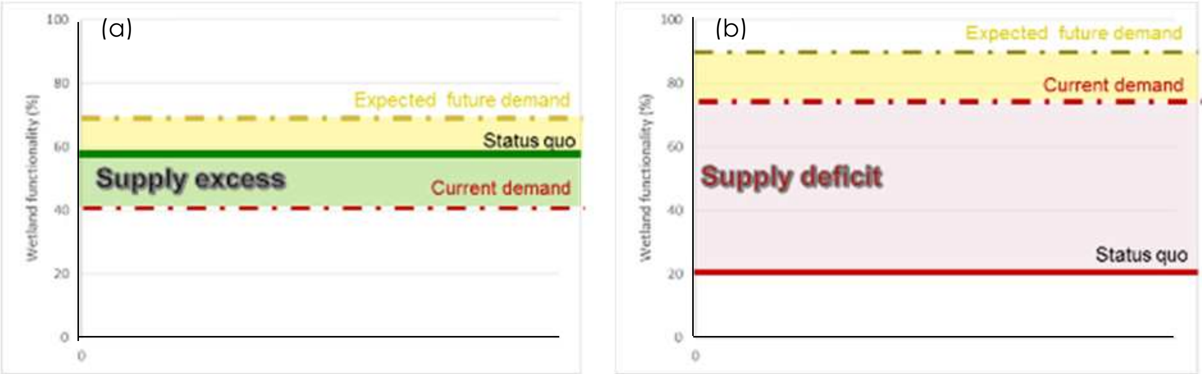


Figure 18 Supply and demand for wetland functions in (a) a typical rural agricultural landscape and (b) in a rapidly developing urban landscape.

In Figure 18 (a), the landscape is characterised by moderate levels of transformation; low pollution loads; low flood risk; and limited erosion. Despite some wetland loss, the demand for wetland functions may therefore be low such that the supply of benefits such as sediment trapping and water quality enhancement may exceed demand. In Figure 18 (b) however, the demand for wetland functions is high and is linked to high pollution loads; increasing flood risk and widespread erosion and sediment loss that affects downstream users. Under such a scenario, there is a clear supply deficit which may worsen in response to future development plans. Under such a scenario, there is a clear need to rehabilitate wetlands in order to improve their functioning and to implement additional interventions to address anthropogenic impacts.

8.3 Preliminary assessment of the need for wetland offsets

While the impact mitigation and risk management measures and guidelines proposed in Chapter 6 of this wetland report aim to reduce residual impacts to aquatic ecosystems, based on the proposed development layout (see Figure 12), large-scale transformation of wetland habitat is being pursued to maximise the developable area at the site of the WC:SEZ Phase 1 development. Should the current development plan be authorised by the relevant environmental authorities based on the development motivation, this will result in the permanent loss of an estimated **56 ha** of wetland area which initially would be considered to be of **'high' impact significance** and should warrant the consideration of a wetland/biodiversity offset as a means of compensating for the permanent loss of wetland habitat and functioning (i.e. residual wetland impact).

Residual impacts have been quantified as far as possible to inform the need for additional mitigation by calculating **hectare equivalents** of wetland lost and through applying the principles contained in the National Wetland Offset Guidelines: '***Wetland Offsets: A best practice guideline for South Africa'*** (SANBI &DWS, 2016). These guidelines suggest that four key components be evaluated when assessing residual impacts to wetland systems. These components include (i) **Indirect** (regulating and supporting)

Services, (ii) **Direct** (cultural and provisioning) Services, (iii) **Ecosystem Conservation**, and (iv) **Species of Conservation Concern**, as described in Figure 19.

The draft offset guidelines provide guidance on establishing offset requirements for significant impacts to wetlands and associated biota. In order to evaluate potential impacts, the anticipated residual impacts associated with each of these components needs to be assessed and evaluated. Given that detailed offset calculations were beyond the scope of this assessment, a number of broad assumptions were made in determining the significance of the impact to the wetland and whether this would warrant an offset. In the case of indirect services, wetland area and condition are typically used to provide a surrogate measure for the level of impact through the calculation of "hectare equivalents" lost (the "hectare equivalent" is the primary currency for wetland offset negotiations and an expression of wetland functional area based on joint consideration of wetland area and condition). The loss of 56 ha (hectares) of wetland in a generally 'fair to poor' condition ("C/D" PES) equates to roughly ***36 hectare equivalents of intact habitat to be potentially (permanently) lost due to infilling and habitat transformation associated with the planned development.*** Based on this, the residual wetland habitat loss based on the preferred development layout plan can be ***considered to be a significant impact and one can motivate that this would warrant the need for an offset*** (i.e. moderate to large size of impact, significant functional losses anticipated but no anticipated loss of sensitive species).

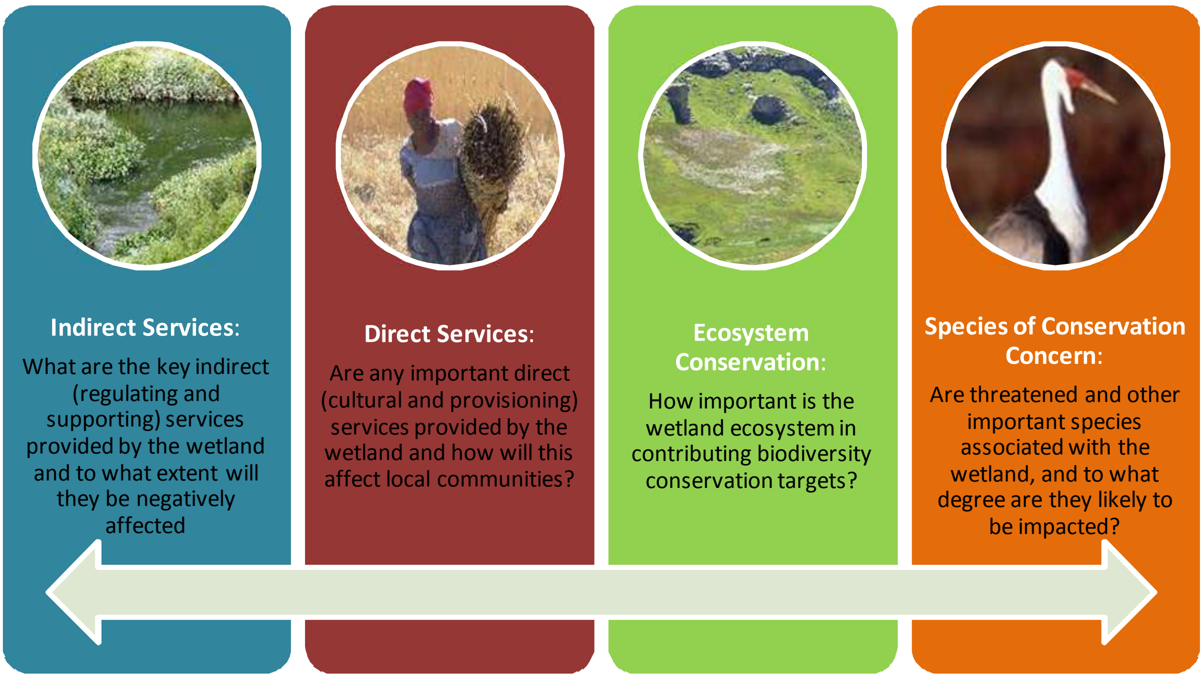


Figure 19 Key components to be taken into account when determining wetland offset requirements (after SANBI & DWS, 2016.

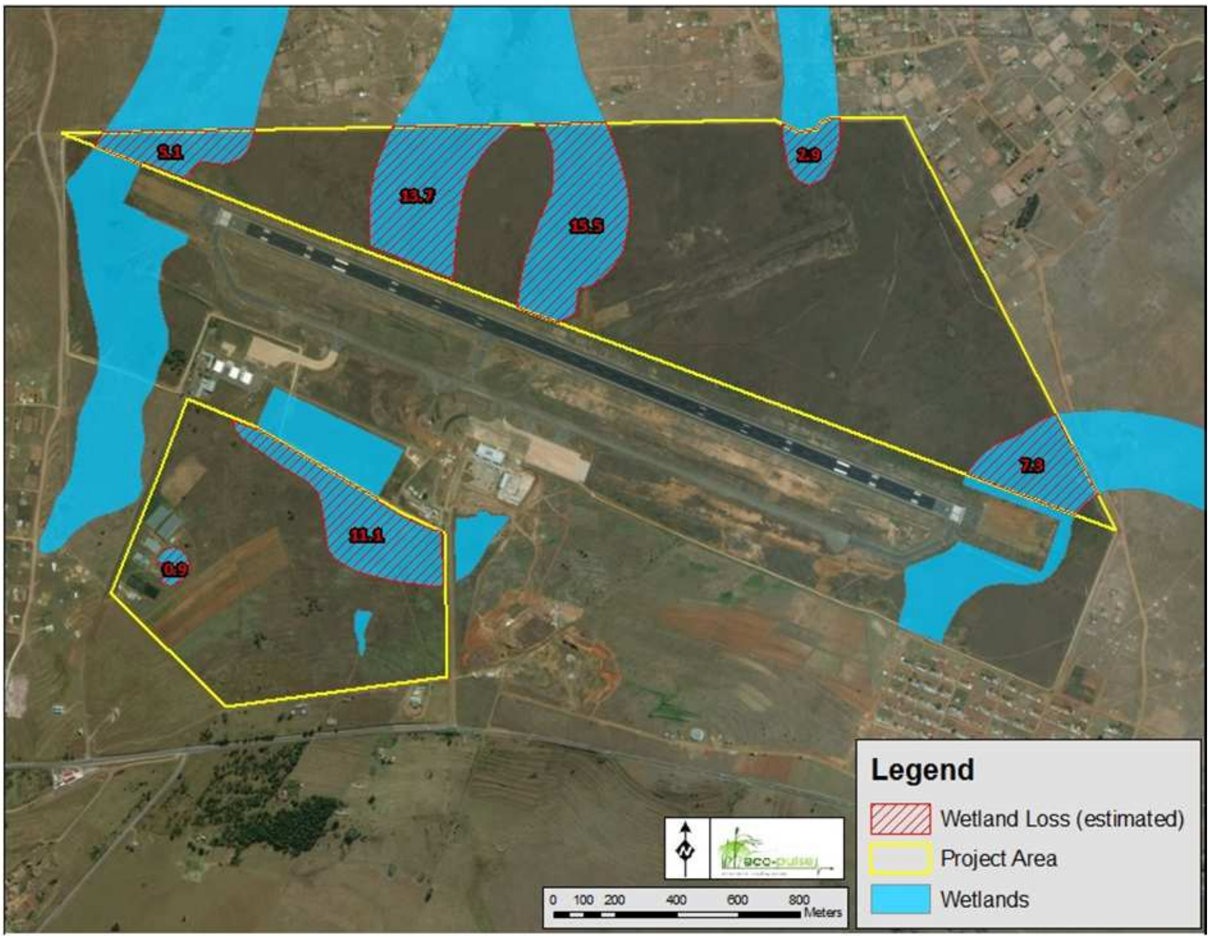


Figure 20 Map showing anticipated 'wetland loss' and residual impacts to wetlands.

8.4 Preliminary offset recommendations

Whilst the need and desirability of biodiversity offsets will still need to be confirmed by the regulating authority, an initial estimation of potential offset requirements was undertaken through the rapid application of available wetland offset guidelines. This suggests that the loss of 56 ha (hectares) of wetland in a generally fair to poor condition ("C/D" PES) equates to roughly ***36 hectare equivalents of intact habitat to be permanently lost due to drainage/infilling (transformation).***

The extent of the area to target for an offset (based on losses, threat status of the vegetation type and ecosystem conservation ratios/multipliers), together with the mechanisms and cost implications for doing so, will need to be investigated once confirmation for the need for an offset has been obtained from the regulating authorities.

An appropriate **Wetland Offset Plan** would need to be developed under this scenario if approved by the relevant environmental authorities (the development of such a plan is beyond the scope of work of this appointment). The offset plan would need to confirm offset targets for residual wetland habitat and functional losses, identify suitable offset receiving areas and outline the process for the establishment, governance and management of the offset in collaboration with the assessing environmental and conservation authorities at the national and provincial levels of Government.

9 LICENSING & PERMIT REQUIREMENTS

9.1 Water Use Licensing Requirements

Section 21 of the National Water Act (No 36 of 1998) lists certain activities for which water use must be licensed, unless its use is excluded. There are several reasons why water users are required to register and license their water use with the Department of Water & Sanitation (DWS), the most important being: (i) to manage and control water resources for planning and development; (ii) to protect water resources against over-use, damage and impacts and (iii) to ensure fair allocation of water among users.

Depending on the nature of the development and water use, Section 21 (a), (c), (g) and (i) water uses described in Table 19 (below) could potentially be triggered by the development (and associated activities) and would then require a Water Use License (WUL) from the DWS. Based on site specific attributes and the nature of the proposed development following Section 21 water use activities (Table 19) may be to be triggered by the proposed development and associated activities and would require a water use license from the DWS.

Table 19. Water Uses applicable to the proposed development.

NWA Section 21 Water Use	Description (DWAF, 2009)	Relevance to the site / Development activity constituting the water use
21 (a) : *Taking water from a watercourse*	*Abstraction of water from a water resource.*	• *Abstraction for construction/re-vegetation purposes. May fall under General Authorisation depending on quantity abstracted. No details on potential abstraction were provided and it thus assumed no abstraction will occur.*
21(c) : *Impeding or diverting the flow of water in a watercourse*	*This water use includes the temporary or permanent obstruction or hindrance to the flow of water into watercourse by structures built either fully or partially in or across a watercourse; or a temporary or permanent structure causing the flow of water to be re-routed in a watercourse for any purpose.*	• This water use is generally a standard requirement for any development within 500m of any wetland/river or within the 1:100 year floodline of a watercourse. • **Any work within a wetland/river (including for rehabilitation purposes) will trigger this water use**. • Management of domestic waste water.
21(i): *Altering the bed, banks, course or characteristics of a watercourse*	*This water use relates to any change affecting the resource quality of the watercourse (the area within the riparian habitat or 1:100 year floodline, whichever is the greatest).*	
21 (g): *Disposing of waste in a manner that may detrimentally impact on a water resource*	*This water use relates to any change affecting the resource quality of the watercourse as a result of the disposal of waste or water containing waste into a watercourse*	• Unlikely to be relevant if piped to regional WWTW.

9.2 Aquatic Risk Assessment

Water resource screening and risk rating is largely a requirement for all potential water uses as contemplated in the National Water Act No. 36 of 1998 (NWA). Risk can be defined broadly as *'a prediction of the likelihood or probability and impact of an outcome as a result of external or internal vulnerabilities operating on a system and which may be possible to avoid through pre-emptive action'*.

The recent General Authorisation (GA) in terms of Section 39 of the National Water Act No. 36 of 1998 for Water Uses as defined in Section 21 (c) and/or Section 21 (i), (as contained in Government Gazette No. 40229, 26 August 2016) replaces the need for a water user to apply for a license in terms of the National Water Act No. 36 of 1998, *'provided that the water use is within the limits and conditions of the GA'*. Note that the GA does not apply to:

1. Water use for the rehabilitation of a wetland as contemplated in GA 1198 contained in GG 32805 (18 December 2009).
2. Use of water within the 'regulated area'[8] of a watercourse where the Risk Class is **Medium or High.**
3. Where any other water use as defined in Section 21 of the NWA must be applied for.
4. Where storage of water results from Section 21 (c) and/or (i) water use.
5. Any water use associated with the construction, installation or maintenance of any sewerage pipeline, pipelines carrying hazardous materials and to raw water (wastewater) and wastewater treatment works.

9.2.1 Identification and description of typical risks

The DWS has developed a Risk Assessment Matrix/Tool to assess the risk to watercourses associated with typical development activities. The DWS Risk Matrix/Assessment Tool was applied to the proposed development project with an emphasis on Section 21 (c) and (i) water uses. The Risk Assessment Matrix/Tool considers the risks posed to watercourses posed by various activities and for different phases of a development (i.e. Construction and Operation in this case). Activities typically give rise to different environmental stressors (or aspects) which manifest in impacts to the receiving aquatic environment and ecosystems. The tool rates the anticipated severity of impacts on the four key drivers of aquatic ecosystem persistence, health and functioning, that being:

---

[8] The 'regulated area' of a watercourse; for Section 21 (c) or (i) of the Act refers to:

- iv. The outer edge of the 1:100 year flood line and/or delineated riparian habitat, whichever is greatest, as measured from the centre of the watercourse of a river, spring, natural channel, lake or dam.
- v. In the absence of a determined 1:100 year flood line or riparian area, refers to the area within 100m from the edge of a watercourse (where the edge is the first identifiable annual bank fill flood bench).
- vi. A 500m radius from the delineated boundary of any wetland or pan.

1. **Flow Regime**
2. **Water Quality**
3. **Habitat & Vegetation**
4. **Aquatic Biota**

Possible activities, aspects (or stressors) and potential ecological risks associated with the planned residential estate development, that could potentially manifest in impacts to the four drivers of river condition/functioning as defined by the DWS, are likely to include the following:

Construction Phase Activities, Aspects (stressors) and Risks:

Activities, stressors and ecological risks likely to be associated with the construction phase of the development are likely to include:

1. Site clearing (vegetation stripping).
2. Earth works, land preparation (site grading and plat-forming) and construction of infrastructure (roads, buildings, pipelines, storm water infrastructure etc.).
3. Alteration of soil profiles and associated flow patterns with a resultant increase in sediment delivered to downstream wetlands (sedimentation and increased turbidity).
4. Use of machinery and other sources of hazardous pollutants within and adjacent to wetlands (i.e. in order to undertake Activity 1 & 2 above).
5. Potential water pollution and associated biotic impacts from hazardous substances such as oils, grease, hydrocarbons and volatile organic compounds.
6. Temporary flow diversion during pipeline and road construction/upgrading across wetlands.

Operational Phase Activities, Aspects (stressors) and Risks:

Operationally, the main activities and stressors would probably relate to:

1. Increased storm water run-off volumes and velocities from storm water management systems. Increased floodpeaks received by wetlands and associated erosion and sedimentation impacts.
2. Contaminated runoff containing elevated nutrient and salt levels from agricultural areas.
3. Contaminated urban run-off containing heavy metal, hydrocarbons, solids and organic compounds (from roads, parking lots and other hardened surfaces). Low intensity water pollution and associated water resource management and biotic impacts.
4. Possible leakages/ spills from broken sewage pipelines located outside watercourses. Possible water pollution and associated water resource management and biotic impacts.
5. The potential for Invasive Alien Plants, weeds and other undesirable plant species to colonise wetlands.

9.2.2 Quantifying ecological risks

For the purposes of this aquatic risk assessment, the DWS "Risk Assessment Matrix" approach, as detailed in the latest General Authorisation in terms of Section 39 of the National Water Act, was applied at a project level in order to identify whether the project will fall within the realm of the GA or whether a full WULA will likely be required and also to dictate what level of risk/impact mitigation will be required for the construction and operational phases of the project to reduce risk to manageable and environmentally acceptable levels.

The spatial scale, duration, frequency of activity and impact, applicable legal issues and ease of detection of impacts were all rated qualitatively using a scale of 1 – 5 (5 being the highest/most significant) and used to automatically calculate significance and provide a risk rating of Low, Moderate or High based on the outcomes of rating the various criteria. In instances where low/moderate risk scores were obtained, risk scores were manually adjusted downwards up to a maximum of 25 points based on the implementation of practical mitigation measures identified.

A broad overview of ratings applied for the development scenario is provided in Table 20, below. This reflects the range of scores associated with both construction and operational aspects and impacts with a brief rationale for the scores allocated. Further details of the specific scores allocated can be viewed in **Annexure D** of this report whilst the outcomes of the risk assessment are reported in the text that follows.

Table 20. Risk criteria rating and rationale.

DWS Risk Rating Criteria	Rating / Score (1-5)	Rationale/Motivation
1 Severity of impact[9]		
a. Flow regime	Insignificant (1) to Slightly Harmful (3)	Increased storm water runoff from hardened surfaces may modify the flow regime of the receiving wetlands, enhancing flows and increasing the regularity of stream flows.
b. Water quality	Small/potentially harmful (2) to Significant/great (4)	Some sedimentation is likely during construction but is unlikely to be extensive or particularly detrimental to the receiving aquatic environment if mitigated and managed effectively through onsite erosion and sediment controls. The main risk posed by the development will likely be during the operational phase and linked with the potential for erosion and sedimentation due to enhanced storm water runoff from hardened surfaces as well as contaminated agricultural runoff to watercourses.

[9] Note that ratings here have been assessed on a scale from 1 (Insignificant / non-harmful) to 5 (Disastrous / extremely harmful. Whilst the DWS guidelines suggest that any impacts to a wetland should be rated as a "5", this generates risk scores that are artificially elevated. Following discussions with Dr Wietsche Roots (DWS National), it was agreed that specialists should apply their minds and that the severity rating should rather be assessed on a case by case basis. This approach has therefore been followed for this risk assessment.

DWS Risk Rating Criteria	Rating / Score (1-5)	Rationale/Motivation
c. ***Habitat & vegetation***	Small/potentially harmful (2) to Significant/great (4)	With the buffer zone recommendations implemented adequately, direct impacts to aquatic habitat and vegetation are unlikely apart from where roads and pipeline need to cross wetlands. During operation, increased runoff/storm flows and potential water quality risks (dealt with above) could affect habitat more indirectly.
d. ***Aquatic biota***	Insignificant (1) to Small/potentially harmful (2)	No nesting/breeding aquatic biota of conservation concern were identified in conservation planning datasets or field investigations. Hence, indirect risks of impacts to biota are likely to be largely insignificant.
2 Spatial scale	Area specific / local (1) to Neighbouring/downstream areas (3)	The extent of impact is likely to be largely restricted to the site of the planned development (1). Contaminated runoff discharged to the environment can potentially affect downstream areas in the catchment.
3 Duration	From <1month (1) to the life of the activity (4)	Impacts range from temporary (1) during construction through to permanent impacts during the operation of the development (4).
4 Frequency of activity	Annually or less (1) to Daily (5)	Construction-related activities will occur over a short period (1) but may persist through the operational phase (5).
5 Frequency (probability) of impact	Seldom/unlikely (2) to Infrequent (3)	The probability of incurring direct impacts is likely to be seldom/unlikely (2), with the probability of indirect impacts being potentially infrequent (3) with adequate mitigation.
6 Legal issues	Full (5)	Impacts to natural watercourses (wetlands) are regulated under a range of South African legislation (i.e. the National Water Act and National Environmental Management Act).
7 Detection	Immediate (1) to Requiring some effort (3)	Direct impacts are easily detectable (1), whilst indirect impacts are likely to be more difficult to observe and may require some effort (3).

The results in Table 21 (below) and **Annexure D** indicate that the risks posed by the construction and operation of the proposed mixed-use development on water resources (i.e. wetland), based on the latest development layouts and proposed development activities, range from being considered 'low' to 'moderate' overall under a 'standard mitigation' scenario, with the moderate risk ratings driven largely by potential for contaminated storm water run-off and related erosion impacts and possible indirect water resource quality impacts to wetlands. With the addition of the site-specific mitigation measures recommended in Chapter 6 of this specialist wetland assessment report, some of the border-line 'low-moderate' risk ratings can be reduced to 'low' risk levels, however most risks remain at a 'moderate' level. This suggests that **the development is considered to be exempted from authorisation in terms of the GA (General Authorisation) for Section 21 (c) and (i) water use and a full WULA is required.** In any case, the GA for Section 21 c and i water use does not apply for "*Any water use associated with the construction, installation or maintenance of any sewerage pipeline, pipelines carrying hazardous materials and to raw water (wastewater) and wastewater treatment works.*"

Table 21. Summary of the DWS Risk Matrix/Tool assessment results applied to the proposed Wildcoast SEZ (Special Economic Zone) 'Phase 1' development project.

Phase(s)	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Mitigation / Control measures	Revised Risk Rating Borderline LOW / MODERATE	
Construction	Construction phase of the mixed-use development: including vegetation clearing, bulk earthworks (site grading/plat-forming), land preparations and construction of all infrastructure including buildings, roads and associated service infrastructure.	1. Site clearing (vegetation stripping).	Potential physical destruction or disturbance of wetland habitat where roads and water / sewage pipelines intend to cross wetlands.	2	6	12	72	Moderate	Onsite best-management practice (BMP) controls. Avoid wetland habitat destruction by reducing road and pipeline construction servitude width across rivers/streams. Rehabilitate areas crossed by roads and pipelines where necessary.	47	Low
		2. Earth works, land preparation (site grading and plat-forming) and construction of infrastructure (parking lots, buildings, wastewater pipelines across wetlands, storm water infrastructure, etc.).	Disturbance of soil profiles with a resultant risk of increased levels of sediment potentially delivered to the downstream watercourses (leading to sedimentation and increased water turbidity within wetlands).	2.75	7.75	12	93	Moderate	Onsite best-management practice (BMP) controls. Avoid wetland habitat destruction by reducing road and pipeline construction servitude width across rivers/streams. Rehabilitate areas crossed by roads and pipelines where necessary.	68	Moderate
		3. Use of machinery and other sources of hazardous pollutants within and adjacent to wetlands (i.e. in order to undertake Activity 1 & 2 above).	Potential water pollution and associated biotic impacts from hazardous substances such as oils, grease, fuels / hydrocarbons and volatile organic compounds used during construction of the infrastructure.	2	5	11	55	Low	Onsite best-management practice (BMP) controls around fuel/chemical storage, dispensing and general management.	30	Low

Phase(s)	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Mitigation / Control measures	Revised Risk Rating Borderline LOW / MODERATE	
Operation	Operational phase of the mixed-use development: including management of storm water and grey water and wastewater reticulation.	1. Increased storm water run-off volumes and velocities from storm water management systems.	Increased flood peaks (volume and velocity of storm water runoff) leading to possible soil erosion and potential sedimentation impacts to downstream wetlands.	2	7	13	91	Moderate	Storm water management plan to be implemented.	66	Moderate
		2. Contaminated urban run-off containing hydrocarbons (fuel/oil), suspended solids and organic compounds (from roads, parking lots and other hardened surfaces).	Potential water pollution and associated water resource management and biotic impacts.	2	7	13	91	Moderate	Storm water management plan to be implemented. Waste management plan to be implemented.	66	Moderate
		3. Contaminated agricultural runoff containing elevated nutrients, organics and salts.	Potential water pollution and associated water resource management and biotic impacts.	2	7	13	91	Moderate	Storm water management plan to be implemented. Waste management plan to be implemented.	66	Moderate
		4. Risk of accidental leakages/ spills from wastewater pipeline infrastructure crossing wetlands.	Possible water pollution and associated water resource management and biotic impacts.	2.75	8.75	13	113.75	Moderate	Pipeline 'environmental' design recommendations to be implemented + ecological monitoring.	88.75	Moderate

*Refer to **Annexure D** for further details on the Risk Assessment.*

10 CONCLUSION

The Coega Development Corporation (CDC) intends to develop Phase 1 of the Wild Coast Special Economic Zone (ECSEZ), located immediately adjacent to the existing Mthatha Airport north-west of Mthatha town in the Eastern Cape Province of South Africa. Eco-Pulse Environmental Consulting Services assessed the freshwater wetland ecosystems associated with the project in early summer 2018) to inform the environmental requirements for the project in terms of the NEMA and the NWA.

The Specialist Wetland Assessment undertaken by Eco-Pulse identified seven (7) wetland units, including six (6) wetland 'seeps' and one (1) artificial wetland that stand to be measurably affected by the development project and triggering water use in terms of Section 21 of the NWA and the need for impact assessment. The wetlands were found to be in a 'moderately modified ('C' PES Class) to 'largely modified' state ('D' PES class) state, with the larger and more intact wetlands considered to be of 'Moderate' Ecological Importance & Sensitivity (EIS) and smaller wetlands of 'Low' to 'Very Low' EIS. Wetlands belonged to one of two wetland vegetation groups associated with the project area: Sub-escarpment Savanna ('endangered' type) and Sub-Escarpment Grassland Group 7 ('critically endangered' type) as defined by NFEPA (SANBI & DWS, 2014).

With good environmental management and adequate mitigation of potential ecological impacts at the site, the overall impact of the proposed development on the ecological condition and functioning of the various wetland habitats is unlikely to be of such an intensity and extent that the Present Ecological State (PES) will be significantly altered and it is therefore unlikely that the proposed development activities will compromise the ability to meet the water resource management objectives as defined by the Recommended Ecological Category (REC).

Managing impacts such as the direct disturbance of vegetation/habitat and erosion/sedimentation risks will be necessary to maintain the current level of integrity and functioning of aquatic ecosystems (i.e. the management objective set for watercourses assessed) and to this end, a number of recommendations have been made regarding the design of the project and infrastructure as well as the provision of practical mitigation measures and impact management considerations to deal with anticipated construction phase and operational impacts and risks, a number of post-construction rehabilitation guidelines and an ecological monitoring protocol. With adequate mitigation and management measures in place for the construction and operational phases, continued wetland habitat functioning is likely to remain largely unchanged for this project. It therefore comes recommended that Chapters 6 and 7 of this report which deals with 'Impact Mitigation/Management' be referenced in the Environmental Authorisation (EA) for this project as a specific condition of the EA and WULA. With the adequate implementation of the mitigation and management measures prescribed in this report, the overall impact of the project on aquatic ecosystems is considered to be low and there are no fatal flaws or conditions that would make this project unacceptable from an aquatic environment perspective.

However, should the current development plan proposed be authorised by the relevant environmental authorities based on the development motivation and without mitigation aimed at avoiding wetland losses, this will result in the permanent loss of an estimated **56 ha** of wetland area which initially could be considered to be of **'high' impact significance and would warrant the consideration of a wetland/biodiversity offset as a means of compensating for the permanent loss of wetland habitat and functioning (i.e. residual wetland impact).**

Other requirements include the need for a Water Use License according to Section 21 (c), (g) and (i) of the National Water Act No. 36 of 1998. Due to the operational management and treatment/discharge of wastewater considered to be a 'moderate' level risk, the development is considered to be exempted from authorisation in terms of the GA (General Authorisation) for Section 21 (c) and (i) water use and a full WULA is required (the GA for Section 21 c and i water use also does not apply for "*…pipelines carrying hazardous materials and to raw water (wastewater) and wastewater treatment works.")*.

Should you have any queries regarding the findings and recommendations in this Specialist Freshwater Wetland Assessment report, please contact Eco-Pulse Environmental Consulting Services directly.

Yours faithfully

Adam Teixeira-Leite *Pr.Sci.Nat.(Ecological Science)*

Senior Scientist & Wetland Specialist: Eco-Pulse Environmental Consulting Services

Email: ateixeira@eco-pulse.co.za | Mobile: 082 310 6769

11 REFERENCES

Berliner, D. and Desmet, P. 2007. Eastern Cape Biodiversity Conservation Plan: Technical Report. Department of Water Affairs and Forestry Project No 2005-012, Pretoria. 1 August 2007.

Cafferata, P., Spittler, T., Wopat, M., Bundros, G. and Flanagan, S. (2004). Designing Watercourse Crossings for Passage of 100 Year Flood Flows, Wood, and Sediment. California Department of Forestry and Fire Protection. Sacramento, CA.

Cowan (ed) 1995. Wetlands of South Africa. Department of Environmental Affairs and Tourism, Pretoria.

Crowley, C. (2003). Ten Rules of Thumb for Culvert Crossings. Erosion Control Magazine, September/October.

Chittenden, H., 2009. Robert's Bird Guide: A comprehensive field guide to over 950 bird species in southern Africa

CSIR (Council for Scientific and Industrial Research). 2010. National Freshwater Ecosystem Priority Areas (NFEPA). Council for Scientific and Industrial Research, Pretoria, South Africa.

CSIR, 2003. Guidelines for human settlement planning and design. Chapter 10: Sanitation. Revised August 2003.

Darwall, W.R.T., Smith, K.G., Tweddle, D. and Skelton, P. (eds) 2009. The Status and Distribution of Freshwater Biodiversity in Southern Africa. International Union for Conservation of Nature (IUCN): Gland, Switzerland and South African Institute for Aquatic Biodiversity (SAIAB), Grahamstown, South Africa. 120 pages.

DEAT (Department of Environmental Affairs and Tourism). 1998. Guideline Document on EIA Regulations of Environmental Affairs and Tourism.

Driver, A., Nel, J.L., Snaddon, K., Murray, K., Roux, D.J., Hill, L., Swartz, E.R., Manuel, J. and Funke, N. 2011. Implementation Manual for Freshwater Ecosystem Priority Areas. Report to the Water Research Commission. WRC Report No. XXXX. June 2011.

Driver, A., Sink, K.J., Nel, J.L., Holness, S., Van Niekerk, L., Daniels, F., Jonaz, Z., Majiedt, P.A., Harris, L. & Maze, K. 2012. National Biodiversity Assessment 2011: *An assessment of South Africa's biodiversity and ecosystems. A synthesis Report*. South African National Biodiversity institute (SANBI) and Department of Environmental Affairs, DWAF (Department of Water affairs and Forestry). 2009. DWAF Training Manual: National Water Act Section 21(c) and (i) Water Uses. Version: November 2009.

Didham, R. K., Tylianakis, J. M., Hutchison, M. A., Ewers, R. M. and Gemmell, N, J. 2005: Are invasive species the drivers of ecological change, *Trends in Ecology and Evolution,* 20 (9), p470-474.

DWAF (Department of Water affairs and Forestry). 2005. A practical field procedure for identification and delineation of wetland and riparian areas. Edition 1, September 2005. DWAF, Pretoria.

DWAF (Department of Water Affairs and Forestry) 2005b. Environmental Best Practice Specifications: Operation. Integrated Environmental Management Sub-Series No. IEMS 1.6. Third Edition. DWAF, Pretoria.

DWS Risk Matrix Tool. 2016.

Eco-Pulse Consulting, 2015. Wetland EIS Assessment Tool. Unpublished assessment tool.

Eco-Pulse Consulting, 2015. Impact Assessment method for EIAs. Unpublished assessment tool.

Ellery, W.N., Grenfell, M., Grenfell, S., Kotze, D.C., McCarthy, T.S., Tooth, S., Grundling, P.L., Beckedahl, H., Le Maitre, D. and Ramsay, L., 2009. WET-Origins: Controls on the distribution and dynamics of wetlands in South Africa. WRC Report No. TT 334/09, Water Research Commission, Pretoria.

Erwin, K.L. 2009. Wetlands and global climate change: the role of wetland restoration in a changing world. Wetlands Ecological Management,**17**:71–84.

FERC (US Federal Energy Regulatory Commission), 2002. Wetland and Waterbody construction and mitigation procedures.

Furniss, M.J., Ledwith, T.S., Love, M.A, McFadin, B.A. and Flanagan, S.A.(1998). Response of Roadstream Crossings to Large Flood Events in Washington, Oregon, and Northern California. USDA Forest Service. Technology and Development Program. 9877–1806—SDTDC. 14 p.

Gaydon, P., McNab, N., Mulder, G., Pillay, I., Sahibdeen, M. and Thompson, P. 2007. Evaluation of Sewage Treatment Package Plants for Rural, Peri-Urban and Community Use. Report to the Water Research Commission (WRC) Report No. 1539/1/06. Wastewater Treatment and Trade Effluent Section, Engineering and Scientific Services, Umgeni Water.

General Authorisation in terms of Section 39 of the National Water Act, 1998 (Act No. 36 of 1998) for Water Uses as defined in Section 21 (c) and (i).

Hayes, Y., Berliner, D. and Desmet, P. 2007. Eastern Cape Biodiversity Conservation Plan Handbook. Department of Water Affairs and Forestry Project No 2005-012, King William's Town. August 2007.

Kotze, D.C., Marneweck, G.C., Batchelor, A.L., Lindley, D.S. and Collins, N.B. 2009. WET-Ecoservices: A technique for rapidly assessing ecosystem services supplied by wetlands.

Lawrence, D.P., 2007. Impact significance determination - Designing an approach. Environmental Impact Assessment Review 27 (2007) 730 - 754.

Macfarlane, D.M., Kotze, D.C., Ellery, W.N., Walters, D., Koopman, V., Goodman, P. & Goge, C. 2008. WET-Health: A technique for rapidly assessing wetland health, Version 2.

Macfarlane, D.M. and Bredin, I.P., 2016. Buffer Zone Guidelines for Rivers, Wetlands and Estuaries. Part 2: Practical Guide. WRC Report No. xx/xx. Water Research Commission, Pretoria. November 2016.

Macfarlane, D.M., von Hase, A. and Brownlie, S., 2014. Towards a best-practice guideline for wetland offsets in South Africa. Report prepared for: The SANBI Grasslands Programme. 141pp.

Mitch, W. J. and Gosselink, J. G., 2007. Wetlands. Fourth Edition. John Wiley & Sons, New York.

Mucina, L., & Rutherford, M. 2006. The Vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. Pretoria: South African National Biodiversity Institute.

Mooney, H.A., 2005. Invasive alien species: the nature of the problem. In: Mooney, H.A., Mack, R.N., McNeely, J.A., Neville, L.E., Schei, P.J., Waage, J.K. (Eds.), Invasive Alien Species: A New Synthesis. Island Press, Washington, DC, pp. 1–15.

Nel, J. L., Murray, K. M., AM Maherry, A. M., Petersen, C. P., DJ Roux, D. J., Driver, A., Hill, L., van Deventer, H., Funke, N., Swartz, E. R., Smith-Adao, L. B., Mbona, N., Downsborough, L. and Nienaber, S. 2011. Technical Report for the National Freshwater Ecosystem Priority Areas project. Report to the Water Research Commission. WRC Report No. 1801/2/11.

Nel, J., Colvin, C., Le Maitre, D., Smith, J. and Haines, I. 2013. South Africa's Strategic Water Source Areas (SWSA's). Report for WWF-South Africa. March 2013. Report No: CSIR/NRE/ECOS/ER/2013/0031/A. CSIR, Stellenbosch, South Africa.

Ollis, D.J., Day, J.A, Malan, H.L, Ewart-Smith, J.L. and Job, N.M. 2014. Development of a decision-support framework for wetland assessment in South Africa and a Decision-Support Protocol for the rapid assessment of wetland ecological condition. Report to the WRC (Water Research Commission). Report No. TT 609/14. August 2014.

Ollis, D., Snaddon, K., Job, N., & Mbona, N. 2013. Classification Systems for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems. SANBI Biodiversity Series 22. Pretoria: South African National Biodiversity Institute.

Palmer CG, Berold RS and Muller WJ (2004) Environmental water quality in water resources management. WRC Report No TT 217/04, Water Research Commission, Pretoria, South Africa.

Ramsar Convention on Wetlands, 2012. Resolution XI.9: An Integrated Framework and guidelines for avoiding, mitigating and compensating for wetland losses. 11th Meeting of the Conference of the Parties to the Convention on Wetlands, Bucharest, Romania, 6-13 July 2012.

Ramsar Convention Secretariat, 2010. Wise use of wetlands: Concepts and approaches for the wise use of wetlands. Ramsar handbooks for the wise use of wetlands, 4th edition, vol. 1. Ramsar Convention Secretariat, Gland, Switzerland.

SANBI (South African Biodiversity Institute), 2010. Threatened Species: A guide to Red Lists and their use in conservation. Threatened Species Programme, Pretoria, South Africa. 28 pp.

SANBI and DWS, 2016. Wetland Offsets: A best practice guideline for South Africa. Report to the Water Research Commission compiled by Macfarlane, D.M., Holness, S.D., von Hase, A., Brownlie, S., Dini, J.A., and Killian, V. as part of the series "Wetlands in Working Landscapes". Series editors: de Klerk, A.R., Dini, J., Holness, S and Oberholster, P. WRC Report No. TT 660/16. April 2016.

SE Solutions. 2014. Sharpening the Tool: New techniques and methods in environmental impact assessment. Course presented by SE Solutions.

SEPA (Scottish Environment Protection Agency). Engineering in the Water Environment Good Practice Guide: Temporary Construction Methods, First edition, March 2009, Document reference: WAT-SG-29.

Sheldon et al., 2003. Freshwater Wetlands in the Washington State. Volume 1: A synthesis of the science. August 2003.

Shulze, R. 1997. South African altas of agrohydrology and climatology. Report TT82/96. Pretoria: Water Research Commission.

Trombulak, S., & Frissell, C. (2000). Review of ecological effects of roads on terrestrial and aquatic communities. Conservation Biology, 14(1):18-30.

US EPA, 1992. A synoptic approach to cumulative impact assessment: A proposed methodology. United States Environmental Protection Agency: Office of Research and Development, Washington. October 1992.

Van Ginkel, C.E., Glen, R.P., Gordan-Gray, K.D., Cilliers, C.J., Muasya and van Deventer, P.P., 2011. Easy identification of some South African Wetland Plants (Grasses, Restios, Sedges, Rushes, Bulrushes, Eriocaulons and Yellow-eyed grasses). WRC Report No. TT 459/10.

Van Oudtshoorn, F., 2006. Guide to grasses of Southern Africa. Pretoria, South Africa.

Van Wilgen, B.W., Forsyth, G., Le Maitre, D.C., Wannenburgh, A., Kotze, J.D.F., Van den Berg, E. and Henderson, L. 2012. An assessment of the effectiveness of a large, national-scale invasive alien plant control strategy in South Africa. Biological Conservation **148**: 28–38.

12 ANNEXURES

ANNEXURE A: Detailed Assessment Methods.

A1 Wetland Delineation

The outer boundary of wetlands was identified and delineated according to the Department of Water Affairs wetland delineation manual '*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas*' (DWAF, 2005). Three specific wetland indicators were used in the detailed field delineation of wetlands, which include:

i. **Terrain unit indicator**

A practical index used for identifying those parts of the landscape where wetlands are likely to occur based on the general topography of the area.

ii. **Wetland vegetation indicator**

Vegetation in an untransformed state is a useful guide in finding the boundary of a wetland as plant communities generally undergo distinct changes in species composition as one proceeds along the wetness gradient from the centre of a wetland towards adjacent terrestrial areas. An example of criteria used to classify wetland vegetation and inform the delineation of wetland zones is provided in Table 22.

Table 22. Criteria used to inform the delineation of wetland habitat based on wetland vegetation (adapted from Macfarlane *et al.*, 2008 and DWAF, 2005).

Vegetation	Temporary wetness zone	Seasonal wetness zone	Permanent wetness zone
Herbaceous	Mixture of non-wetland species and hydrophilic plant species restricted to wetland areas	Hydrophilic sedges and grasses restricted to wetland areas	Emergent plants including reeds and bulrushes; floating or submerged aquatic plants
Woody	Mixture of non-wetland and hydrophilic species restricted to wetland areas	Hydrophilic woody species restricted to wetland areas	Hydrophilic woody species restricted to wetland areas with morphological adaptations to prolonged wetness (e.g.: prop roots)
SYMBOL	**HYDRIC STATUS**	**DESCRIPTION/OCCURRENCE**	
Ow	Obligate wetland species	Almost always grow in wetlands (>90% occurrence)	
Fw/F+	Facultative wetland species	Usually grow in wetlands (67-99% occurrence) but occasionally found in non-wetland areas	
F	Facultative species	Equally likely to grow in wetlands (34-66% occurrence) and non-wetland areas	
Fd/F-	Facultative dryland species	Usually grow in non-wetland areas but sometimes grow in wetlands (1-34% occurrence)	
D	Dryland species	Almost always grow in drylands	

iii. Soil wetness indicator

According to the wetland definition used in the National Water Act (NWA, 1998), vegetation is the primary indicator which must be present under normal circumstances. However, in practice the soil wetness indicator (informed by investigating the top 50cm of wetland topsoil) tends to be the most important, and the other three indicators are used to refine the assessment. The reason for this is that vegetation responds relatively quickly to changes in soil moisture and may be transformed by local impacts; whereas the soil morphological indicators are far more permanent and will retain the signs of frequent saturation (wetland conditions) long after a wetland has been transformed/drained (DWAF, 2005). Thus the on-site assessment of wetland indicators focused largely on using soil wetness indicators, determined through soil sampling with a soil auger, with vegetation and topography being a secondary indicator. Soil sampling points were recorded using a GPS (Global Positioning System) and captured using Geographical Information Systems (GIS) for further processing. An example of soil criteria used to assess the presence of wetland soils is provided below in Table 23 while Figure 20 provides a conceptual overview of soil and vegetation characteristics across the different wetness zones.

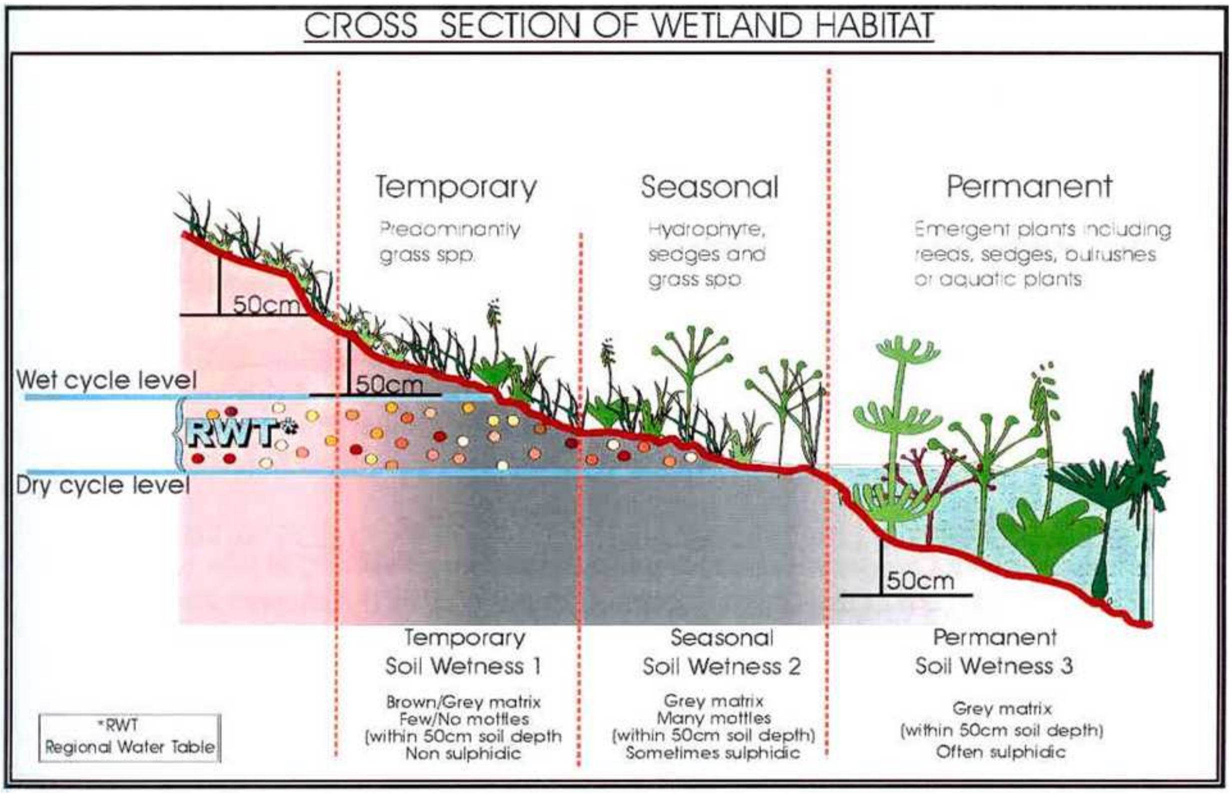


Figure 21 Diagram representing the different zones of wetness found within a wetland (DWAF, 2005).

Table 23. Soil criteria used to inform wetland delineation using soil wetness as an indicator (after DWAF, 2005).

Soil depth	Temporary wetness zone	Seasonal wetness zone	Permanent wetness zone
0 – 10cm	**Matrix chroma**: 1- 3 (Grey matrix <10%) **Mottles**: Few/None high chroma mottles **Organic Matter**: Low **Sulphidic**: No	**Matrix chroma**: 0- 2 (Grey matrix >10%) **Mottles**: Many low chroma mottles **Organic Matter**: Medium **Sulphidic**: Seldom	**Matrix chroma**: 0- 1 (Prominent grey matrix) **Mottles**: Few/None high chroma mottles **Organic Matter**: High **Sulphidic**: Often
30 – 50cm	**Matrix chroma**: 0 – 2 **Mottles**: Few/Many	As Above	As Above

A2 Classification of wetlands

For the purposes of this study, wetlands were classified according to HGM (hydro geomorphic) type (Level 4A classification level) using the National Wetland Classification System which was developed for the South African National Biodiversity Institute (Ollis *et al.*, 2013) as outlined in Table 24 below.

Table 24. Wetland classification (based on Ollis *et al.*, 2013).

LEVEL 3	LEVEL 4A	
Landscape Setting	**HGM Type**	**Description**
SLOPE	Channel (river)	*Areas of channelled flow including rivers and streams where water is largely confined to a main channel during low flows. Flood waters may over top the banks of the channel and spread onto an adjacent floodplain*
	Hillslope seep	*Wetlands on slopes formed mainly by the discharge of sub-surface water.*
VALLEY FLOOR	Channel (river)	*River channels in a valley floor setting.*
	Channelled valley-bottom wetland	*Valley floors with one or more well-defined stream channels, but lacking characteristic floodplain features.*
	Unchannelled valley-bottom wetland	*Valley floors with no clearly defined stream channel.*
	Floodplain wetland	*Valley floors with a well-defined stream channel, gently sloped and characterised by floodplain features such as oxbows and natural levees.*
	Depression	*Basin-shaped areas that allow for the accumulation of surface water, an outlet may be absent (e.g. pans).*

LEVEL 3	LEVEL 4A	
Landscape Setting	HGM Type	Description
	Valleyhead seep	*Seeps located at the head of a valley, often the source of streams.*
PLAIN	Channel (river)	*River channels in a plain landscape setting.*
	Floodplain wetland	*Floodplain wetlands as above but in a plain landscape setting.*
	Unchannelled valley-bottom wetland	*Unchannelled valley bottom type wetlands as above but in a plain landscape setting.*
	Depression	*Depression type wetlands as above but in a plain landscape setting.*
	Flat	*Extensive areas characterised by level, gently undulating or uniformly sloping land with a very gentle gradient.*
BENCH (HILLTOP / SADDLE / SHELF)	Depression	*Depression wetlands located on a bench.*
	Flat	*Flat wetlands located on a bench.*

A3 Wetland PES Assessment

The qualitative/rapid wetland health assessment tool used in this assessment was adapted from the Level 1 WET-Health tool (Macfarlane *et al.*, 2008) which provides an appropriate framework for undertaking an assessment to indicate the functional importance of the wetland system that could be impacted by the proposed development. The assessment also helps to identify specific impacts thereby highlighting issues that should be addressed through mitigation and rehabilitation activities. While this is a rapid assessment, we regard it as adequate to inform an assessment of existing impacts on wetland condition. This approach relies on a combination of desktop and on-site indicators to assess various aspects of wetland condition, including:

- ***Hydrology*****:** defined as the distribution and movement of water through a wetland and its soils.
- ***Geomorphology*****:** defined as the distribution and retention patterns of sediment within the wetland.
- ***Vegetation*****:** defined as the vegetation structural and compositional state.

Each of these modules follows a broadly similar approach and is used to evaluate the extent to which anthropogenic changes have impacted upon wetland functioning or condition. While the impacts considered vary considerably across each module, a standardized scoring system is applied to facilitate the interpretation of results (Table 25). Scores range from 0 indicating no impact to a maximum of 10 which would imply that impacts had totally destroyed the functioning of a particular component. The reader is encouraged to refer back to the tables below to help interpret the results presented in the site assessment.

Table 25. Guideline for interpreting the magnitude of impacts on wetland integrity (after Macfarlane et al., 2008).

IMPACT CATEGORY	DESCRIPTION	Score
None	No discernible modification or the modification is such that it has no impact on this component of wetland integrity.	0 – 0.9
Small	Although identifiable, the impact of this modification on this component of wetland integrity is small.	1 – 1.9
Moderate	The impact of this modification on this component of wetland integrity is clearly identifiable, but limited.	2 – 3.9
Large	The modification has a clearly detrimental impact on this component of wetland integrity. Approximately 50% of wetland integrity has been lost.	4 – 5.9
Serious	The modification has a highly detrimental effect on this component of wetland integrity. Much of the wetland integrity has been lost but remaining integrity is still clearly identifiable.	6 – 7.9
Critical	The modification is so great that the ecosystem processes of this component of wetland integrity are almost totally destroyed, and 80% or more of the integrity has been lost.	8 – 10

Impact scores obtained for each of the modules reflect the degree of change from natural reference conditions. Resultant health scores fall into one of six health categories (A-F) on a gradient from "unmodified/natural" (Category A) to "severe/complete deviation from natural" (Category F) as depicted in Table 26. This classification is consistent with DWAF categories used to evaluate the present ecological state of aquatic systems.

Table 26. Health categories used by WET-Health for describing the integrity of wetlands (after Macfarlane *et al.*, 2008).

PES CATEGORY	DESCRIPTION	RANGE
A	Unmodified, natural.	0 – 0.9
B	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1 – 1.9
C	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
D	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4 – 5.9
E	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
F	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

An overall wetland health score was calculated by weighting the scores obtained for each module and combining them to give an overall combined score using the following formula:

Overall health rating = [(Hydrology*3) + (Geomorphology*2) + (Vegetation*2)] / 7

This overall score assists in providing an overall indication of wetland health/functionality which can in turn be used for recommending appropriate management measures.

A4 Wetland Ecosystem Services (Functional) Importance Assessment

The relative importance of ecosystem goods and services provided by the wetland(s) was assessed using an approach based on the WET-EcoServices assessment tool Kotze *et al.* (2009). This approach relies on a combination of desktop and on-site indicators to assess the importance of a range of common wetland ecosystem services as described in Table 27, below.

Table 27. Descriptions of common wetland ecosystem goods and services (after Kotze *et al.*, 2009).

ECOSYSTEM SERVICE	Description
Flood Attenuation	*Refers to the effectiveness of wetlands at spreading out and slowing down storm flows and thereby reducing the severity of floods and associated impacts.*
Stream Flow Regulation	*Refers to the effectiveness of wetlands in sustaining flows in downstream areas during low-flow periods.*
Sediment Trapping	*Refers to the effectiveness of wetlands in trapping and retaining sediments from sources in the catchment.*
Nutrient & Toxicant Retention and Removal	*Refers to the effectiveness of wetlands in retaining, removing or destroying nutrients and toxicants such as nitrates, phosphates, salts, biocides and bacteria from inflowing sources, essentially providing a water purification benefit.*
Erosion Control	*Refers to the effectiveness of wetlands in controlling the loss of soil through erosion.*
Carbon Storage	*Refers to the ability of wetlands to act as carbon sinks by actively trapping and retaining carbon as soil organic matter.*
Biodiversity Maintenance	*Refers to the contribution of wetlands to maintaining biodiversity through providing natural habitat and maintaining natural ecological processes.*
Water Supply	*Refers to the ability of wetlands to provide a relatively clean supply of water for local people as well as animals.*
Harvestable Natural Resources	*Refers to the effectiveness of wetlands in providing a range of harvestable natural resources including firewood, material for construction, medicinal plants and grazing material for livestock.*
Cultivated Foods	*Refers to the ability of wetlands to provide suitable areas for cultivating crops and plants for use as food, fuel or building materials.*
Food for Livestock	*Refers to the ability of wetlands to provide suitable vegetation as food for livestock.*
Cultural significance	*Refers to the special cultural significance of wetlands for local communities.*
Tourism & Recreation	*Refers to the value placed on wetlands in terms of the tourism-related and recreational benefits provided.*
Education & Research	*Refers to the value of wetlands in terms of education and research opportunities, particularly concerning their strategic location in terms of catchment hydrology.*

A level 2 (detailed) assessment was conducted that assessed a suite of services/benefits by assigning a score to each service based on a rating system that rates a range of pre-defined variables affecting the importance of services provided by the wetland system. The results are captured in tabular form as a list of services/goods with the level of supply and demand rated on a scale of 0 - 4. The following rating shown in Table 28 was used to describe the level of supply, demand and importance (integration of supply and demand).

Table 28. Classes for determining the likely level to which a service is being supplied or demanded.

Score	Supply/Demand/Importance Scores	Importance Description
0.0 – 0.5	Very Low	Not important
0.6 – 1.0	Low	Low importance
1.1 – 1.5	Moderately-Low	Moderately-low importance
1.6 – 2.4	Moderate	Moderately important
2.5 – 2.9	Moderately-High	Important
3.0 – 3.4	High	Very/highly important
3.5 – 4.0	Very High	Critically important

Since the importance of wetland goods and services is dictated not only by the supply (service availability) of a particular good/benefit but also on the need or demand (user requirement) for such a benefit, the overall importance of the ecosystem service is ultimately derived from a combination of supply and demand scores. For example, a wetland may supply a particular service at a high level; however this service may not be in great demand, limiting the importance of the benefit to society. The results of the assessment were therefore interpreted to reflect the perceived importance of each of the ecosystem goods and services assessed.

A5 Wetland Ecological Importance and Sensitivity (EIS) Assessment

The outcomes of the WET-Health and WET-EcoServices functional assessment were used to inform an assessment of the importance and sensitivity of wetland and river ecosystems using a Wetland EIS (Ecological Importance and Sensitivity) assessment tool developed by Eco-Pulse Consulting (2015). The Eco-Pulse Wetland EIS tool includes an assessment of the following components:

- Biodiversity maintenance supply (informed by biodiversity noteworthiness, PES and ecological viability of the habitat);
- Biodiversity maintenance demand (at a regional/national scale); and
- Sensitivity of the water resource (i.e. Biota, floods, low flows, sediment, water quality, erosion risk and edge disturbances)

The maximum score for these components was taken as the importance rating for the wetland which is rated using Table 29, below.

Table 29. Rating table used to rate EIS (Eco-Pulse, 2015).

EIS Score	EIS Rating
>3.4	Very High
3.0 - 3.4	High
2.5 - 2.9	Moderately-High

EIS Score	EIS Rating
1.6 - 2.4	Moderate
1.1 - 1.5	Moderately-Low
0.6 - 1.0	Low
<0.6	Very Low

A6 Impact Significance Assessment

Impact significance is defined broadly as a measure of the 'desirability, importance and acceptability of an impact to society' (Lawrence, 2007). The degree of significance depends upon two dimensions: the measurable characteristics of the impact (e.g. intensity, extent, duration) and the importance societies/communities place on the impact. Put another way, impact significance is the product of the value or importance of the resources, systems and/or components that will be impacted and the intensity or magnitude (degree and extent of change) of the impact on those resources, systems and/or components.

The significance of the potential impacts of the proposed development on terrestrial habitat was assessed for the following scenarios:

i. **Realistic "poor mitigation" scenario** – this is a realistic worst case scenario involving the poor implementation of construction mitigation, bare minimum incorporation of recommended design mitigation, poor operational maintenance, and poor onsite rehabilitation.

ii. **Realistic "good" scenario** – this is a realistic best case scenario involving the effective implementation of construction mitigation, incorporation of the majority of design mitigation, good operational maintenance and successful rehabilitation. Please note that this realistic scenario does not assume that unrealistic mitigation measures will be implemented and/or measures known to have poor implementation success (>90% of the time) will be effectively implemented.

For the purposes of this assessment, the assessment of potential impacts was undertaken using an "Impact Assessment Methodology for EIAs" adopted by Eco-Pulse (2015). This assessment was informed by baseline information contained in this report relating to the sensitivity of habitats and potential occurrence of protected species as well as information on the proposed development provided by the client and experience in similar projects in South Africa. The approach adopted is to identify and predict all potential primary and secondary/indirect impacts resulting from an activity from origin (e.g. catchment land hardening) to end point (e.g. loss of ecosystem services as a result of erosion). Thereafter, the approach is to rate intensity as the realistic worst case consequence (end-point / ultimate) of an activity (according to Table 30) and then assess the likelihood of this consequence occurring as well as the extent and duration of the impact.

Impact significance = (impact intensity + impact extent + impact duration) x impact likelihood.

This formula is based on the basic risk formula: **Risk = consequence x probability**

Table 30. Criteria and numerical values for rating environmental impacts.

Score	Rating	Description
Intensity (I) – defines the magnitude and importance of the impact		
16	**High**	Loss of human life. Deterioration in human health. High impacts to resources: · Critical / severe local scale (or larger) ecosystem modification/degradation and/or collapse. · Critical / severe local scale (or larger) modification (reduction in level) of ecosystem services and/or loss of ecosystem services. <u>Critical / severe ecosystem impact description:</u> Impact affects the continued viability of the systems/components and the quality, use, integrity and functionality of the systems/components permanently ceases and are irreversibly impaired (system collapse). Rehabilitation and remediation often impossible. If possible, rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation. · Extinction of habitat type or serious impact to future viability of a critically endangered habitat type. · Extinction of species or serious impact to survival of critically endangered species.
8	**Moderately-High**	· Loss of livelihoods. · Individual economic loss. Moderately-high impacts to resources: · Large local scale (or larger) ecosystem modification/degradation and/or collapse. · Large local scale (or larger) modification (reduction in level) of ecosystem services and/or loss of ecosystem services. <u>Large ecosystem impact description:</u> Impact affects the continued viability of the systems/components and the quality, use, integrity and functionality of the systems/components are severely impaired and may temporarily cease. High costs of rehabilitation and remediation, but possible. · Measurable reduction in extent of endangered and critically endangered habitat types. · Measurable reduction in endangered and critically endangered floral and faunal populations.
4	**Moderate**	Moderate impacts to resources: · Moderate local scale (or larger) ecosystem modification/degradation and/or collapse. · Moderate local scale (or larger) modification (reduction in level) of ecosystem services and/or loss of ecosystem services. <u>Moderate ecosystem impact description:</u> Impact alters the quality, use and integrity of the systems/components but the systems/ components still continue to function but in a moderately modified way (integrity and functionality impaired but major key processes/drivers somewhat intact / maintained). · Measurable reduction in vulnerable habitat types. · Measurable reduction in non-threatened habitat types resulting in an up-listing to threatened status. · Measurable reduction in near-threatened and vulnerable floral and faunal populations. · Measurable reduction in non-threatened floral and faunal populations resulting in an up-listing to threatened status.

Score	Rating	Description
2	**Moderately-Low**	Moderately-low impacts to resources: · Small but measurable local scale (or larger) ecosystem modification / degradation. · Small but measurable local scale (or larger) modification (reduction in level) of ecosystem services and/or loss of ecosystem services. <u>Small ecosystem impact description:</u> Impact alters the quality, use and integrity of the systems/components but the systems/ components still continue to function, although in a slightly modified way. Integrity, function and major key processes/drivers are slightly altered but are still intact / maintained. · Reduction in non-threatened endangered habitat types with no up-listing to threatened status. · Reduction in non-threatened floral and faunal populations with no up-listing to threatened status.
1	**Low**	Negative change to onsite characteristics but with no impact on: · Human life · Human health · Local resources, local ecosystem services and/or key ecosystem controlling variables · Threatened habitat conservation/representation · Threatened species survival
Extent (E) – relates to the extent of the Impact Intensity		
5	**Global**	The scale/extent of the impact is global/worldwide.
4	**National**	The scale/extent of the impact is applicable to the Republic of South Africa
3	**Regional**	Impact footprint includes the greater surrounding area within which the site is located (e.g. between 20-200km radius of the site).
2	**Local**	Impact footprint extends beyond the cadastral boundary of the site to include the areas adjacent and immediately surrounding the site (e.g. between a 0-20km radius of the site).
1	**Site**	Impact footprint remains within the cadastral boundary of the site.
Duration (D) – relates to the duration of the Impact Intensity		
5	**Permanent**	The impact will continue indefinitely and is irreversible.
4	**Long-term**	The impact and its effects will continue for a period in excess of 30 years. However, the impact is reversible with relevant and applicable mitigation and management actions.
3	**Medium-term**	The impact and its effects will last for 10-30 years. The impact is reversible with relevant and applicable mitigation and management actions.
2	**Medium-short**	The impact and its effects will continue or last for the period of a relatively long construction period and/or a limited recovery time after this construction period, thereafter it will be entirely negated (3 – 10 years). The impact is fully reversible.
1	**Short-term**	The impact and its effects will only last for as long as the construction period and will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (0 – 3 years). The impact is fully reversible.
Probability (P) – relates to the likelihood of the Impact Intensity		
1	**Definite**	More than 75% chance of occurrence. The impact is known to occur regularly under similar conditions and settings.
0.75	**Highly Probable**	The impact has a 41-75% chance of occurring and thus is likely to occur. The impact is known to occur sporadically in similar conditions and settings.
0.5	**Possible**	The impact has a 10-40% chance of occurring. This impact may/could occur and is known to occur in low frequencies under the similar conditions and settings.
0.2	**Unlikely**	The possibility of the impact occurring is low with less than 10% chance of occurring. The impact has not been known to occur under similar conditions and settings.
0.1	**Improbable**	The possibility of the impact occurring is negligible and only under exceptional circumstances.

Table 31. Impact significance categories and definitions.

Impact Significance	Impact Significance Score Range	Definition
High	18 - 26	Unacceptable and fatally flawed. Impact should be avoided and limited opportunity for offset/compensatory mitigation. The proposed activity should only be approved under special circumstances.
Moderately High	13 – 17.9	Generally unacceptable unless offset/compensated for by positive gains in other aspects of the environment that are of critically high importance (i.e. national or international importance only). Strict conditions and high levels of compliance and enforcement are required. The potential impact will affect a decision regarding the proposed activity require that the need and desirability for the project be clearly substantiated to justify the associated ecological risks.
Moderate	8 – 12.9	Impact has potential to be significant but is acceptable provided that there are strict conditions and high levels of compliance and enforcement. If there is reasonable doubt as to the successful implementation of the strict mitigation measures, the impact should be considered unacceptable. The potential impact should influence the decision regarding the proposed activity and requires a clear and substantiated need and desirability for the project to justify the risks.
Moderately Low	5 – 7.9	Acceptable with moderately-low to moderate risks provided that specific/generic mitigation applied and routine inspections undertaken. The potential impact may not have any meaningful influence on the decision regarding the proposed activity.
Low	0 – 4.9	The potential impact is very small or insignificant and should not have any meaningful influence on the decision regarding the proposed activity. Basic duty of care must be ensured.

A confidence rating was also given to the impacts rated in accordance with the table below:

Table 32. Confidence ratings used when assigning impact significance ratings.

Level of confidence	Contributing factors affecting confidence
Low	A low confidence level is attributed to a low-moderate level of available project information and somewhat limited data and/or understanding of the receiving environment.
Medium	The confidence level is medium, being based on specialist understanding and previous experience of the likelihood of impacts in the context of the development project with a relatively large amount of available project information and data related to the receiving environment.
High	The confidence level is high, being based on quantifiable information gathered in the field.

ANNEXURE B: Plant Species List

NB: exotic species shown in "Red" text & conservation important plants shaded in "green").

No	Species Name	Common Name	Type	Species Status	Conservation Status	Mthatha Moist Grassland	Secondary Degraded Grassland
1.	*Acacia mearnsii*	Black wattle	Tree	Alien (invasive)	N/A	x	x
2.	*Acacia natalitia*		Tree	Indigenous	LC		x
3.	*Ajuga ophrydis*	Bugle Plant	Herb	Indigenous	LC	x	
4.	*Alectra sessiliflora*		Herb (upright)	Indigenous	LC	x	
5.	*Andropogon eucomus*	Snowflake grass	Grass	Indigenous	LC	x	x
6.	*Anthospermum rigidum*		Herb	Indigenous	LC		x
7.	*Argyrolobium tuberosum*	Little Russet Pea	Herb	Indigenous	LC	x	
8.	*Bidens pilosa*	Blackjack	Herb (upright)	Alien (weed)	N/A	x	x
9.	*Bulbine abyssinica*		Herb	Indigenous	LC	x	
10.	*Bulbine asphodeloides*		Herb	Indigenous	LC	x	x
11.	*Bulbine narcissifolia*		Herb	Indigenous	LC	x	
12.	*Centella asiatica*	Marsh pennywort	Herb (flat growing)	Indigenous (weed)	LC	x	x
13.	*Cephalaria sp.*		Herb	Indigenous	LC	x	
14.	*Chaetacanthus burchellii*		Herb	Indigenous	LC	x	
15.	*Chamaecrista capensis*		Herb	Indigenous	LC	x	
16.	*Chamaecrista mimosoides*	Dwarf Senna	Herb (upright)	Indigenous	LC	x	x
17.	*Cirsium vulgare*	Scotch thistle	Herb (upright)	Alien (weed)	N/A	x	?
18.	*Commelina africana*	Yellow commelina	Herb (flat growing)	Indigenous		x	x
19.	*Convolvulus saggitatus*		Herb	Indigenous	LC	x	
20.	*Conyza canadensis*	Horseweed fleabane	Herb (upright)	Alien (weed)	N/A	x	x
21.	*Conyza chilensis*	Fleabane	Herb (upright)	Alien (weed)	N/A	x	x
22.	*Crabbea hirsuta*		Herb	Indigenous	LC	x	
23.	*Cucumis zeyheri*		Herb	Indigenous (weed)	LC	x	
24.	*Cyanotis speciosa*	Wondering Jew	Herb	Indigenous	LC	x	
25.	*Diclis reptans*	Dwarf Snapdragon	Herb	Indigenous	LC	x	x
26.	*Dicoma anomala*		Herb	Indigenous	LC	x	?
27.	*Digitaria eriantha*	Common finger grass	Grass/reed	Indigenous	LC	x	x

No	Species Name	Common Name	Type	Species Status	Conservation Status	Mthatha Moist Grassland	Secondary Degraded Grassland
28.	*Eriospermum sp.*		Herb	Indigenous	LC	x	
29.	*Falkia repens*		Herb	Indigenous	LC	x	
30.	*Gazania krebsiana*		Herb (upright)	Indigenous (weed)	LC	x	
31.	*Gladiolus sp.*		Herb	Indigenous	Protected	x	x
32.	*Gomphocarpus physocarpus*	Milkweed	Herb (upright)	Indigenous	LC	x	x
33.	*Helichrysum nudifolium* var. *nudifolium*	Hottentot's tea	Herb (upright)	Indigenous	LC	x	x
34.	*Helichrysum odoratissimum*		Herb	Indigenous	LC	x	x
35.	*Helichrysum rugulosum*		Herb (upright)	Indigenous	LC	x	x
36.	*Hermannia parviflora*		Herb	Indigenous	LC	x	
37.	*Hermannia* sp.		Herb	Indigenous	LC	x	
38.	*Hibiscus aethiopicus*		Herb	Indigenous	LC	x	
39.	*Hyparrhenia dregeana*		Grass	Indigenous	LC	x	x
40.	*Hyparrhenia hirta*	Common thatching grass	Grass	Indigenous	LC	x	x
41.	*Hypoxis acuminata*		Herb (upright)	Indigenous	LC	x	
42.	*Hypoxis argentea*		Herb (upright)	Indigenous	LC	x	
43.	*Hypoxis hemerocallidea*	Star-flower	Herb (upright)	Indigenous	LC	x	
44.	*Imperata cylindrica*	Cottonwool grass	Grass	Indigenous	LC	x	
45.	*Indigofera hilaris*		Herb	Indigenous	LC	x	
46.	*Indigofera zeyheri*		Herb	Indigenous	LC		x
47.	*Ipomoea crassipes*		Climber	Indigenous	LC	x	?
48.	*Ledebouria marginata*		Herb (flat growing)	Indigenous	LC	x	
49.	*Ledebouria ovatifolia*		Herb	Indigenous	LC	x	
50.	*Ledebouria revoluta*		Herb	Indigenous	LC	x	
51.	*Linum thunbergii*		Herb	Indigenous	LC	x	
52.	*Lobelia flaccida*		Herb (upright)	Indigenous	LC	x	x
53.	*Melilotus albus*	White sweet clover	Herb/shrub	Alien (weed)	N/A	x	
54.	*Melinis repens*	Natal red-top	Grass/reed	Indigenous	LC	x	
55.	*Monopsis uniflora*		Herb (upright)	Indigenous	LC		x
56.	*Oenothera rosea*			Alien (weed)	N/A	x	
57.	*Oenothera sp.*			Alien (weed)	N/A	x	x
58.	*Oxalis sp.*		Herb (flat growing)	Indigenous	LC	x	x

No	Species Name	Common Name	Type	Species Status	Conservation Status	Mthatha Moist Grassland	Secondary Degraded Grassland
59.	*Paspalum dilatatum*	Dallis grass	Grass	Indigenous (weed)	LC	x	x
60.	*Pelargonium alchemelloides*		Herb (upright)	Indigenous	LC	x	
61.	*Pelargonium luridum*	Wild geranium	Herb	Indigenous	LC	x	
62.	*Polygala* sp.		Herb	Indigenous	LC	x	
63.	*Rhynchosia adenodes*		Herb	Indigenous	LC	x	
64.	*Richardia brasiliensis*	Mexican Richardia	Herb (upright)	Alien (weed)	N/A	x	x
65.	*Schizocarpus nervosus*		Herb	Indigenous	LC	x	
66.	*Schkuhria pinnata*	Dwarf Marigold	herb	Alien (invasive)	N/A	x	
67.	*Searsia pyrioides* var. *integrifolia*	Mountain Firethorn Currant	Shrub	Indigenous	LC	x	
68.	*Senecio bupleurioides*		Herb (upright)	Indigenous	LC	x	
69.	*Senecio glaberrimus*		Herb (upright)	Indigenous	LC	x	
70.	*Senecio madagascarensis*		Herb (upright)	Indigenous	LC	x	
71.	*Senecio pterophorus*		Herb (upright)	Indigenous	LC	x	
72.	*Senecio sp. (not in flower)*		Herb (upright)	Indigenous	LC	x	x
73.	*Solanum alaeagnifolium*		Tree	Alien (invasive)	N/A	x	x
74.	*Sporobolus africanus*	Rat's tail dropseed	Grass	Indigenous	LC	x	x
75.	*Stachys sp.*		Herb	Indigenous	LC	x	?
76.	*Striga asiatica*	Witchweed		Indigenous	LC	x	
77.	*Sutera sp.*			Indigenous	LC	x	x
78.	*Tagetes minuta*	Khaki weed	Herb (upright)	Alien (weed)	N/A	x	x
79.	*Tephrosia capensis*		Herb	Indigenous	LC	x	
80.	*Teucrium trifidum*		Herb (upright)	Indigenous	LC	x	
81.	*Themeda triandra*	Red grass	Grass	Indigenous	LC	x	x
82.	*Thunbergia capensis*		Herb	Indigenous	LC	x	
83.	*Tolpis capensis*		Herb	Indigenous	LC	x	
84.	*Verbena bonariensis*	Purple-top	Herb (upright)	Alien (invasive)	N/A		x
85.	*Verbena officialis*	Purple top	herb	Alien (weed)	N/A		x
86.	*Vernonia natalensis*		Herb	Indigenous	LC	x	
87.	*Vigna vexillata*			Indigenous	LC	x	
88.	*Wahlenbergia stellariodes*		Herb (upright)	Indigenous	LC	x	

No	Species Name	Common Name	Type	Species Status	Conservation Status	Mthatha Moist Grassland	Secondary Degraded Grassland
89.	*Xysmalobium undulatum*	Milkwort	Herb (upright)	Indigenous	LC	x	
90.	*Zornia capensis*	Caterpillar bean	Herb	Indigenous	LC	x	x

ANNEXURE C: Impact Significance Assessment Tables.

C1. Construction-Phase Impact Significance Assessment.

CONSTRUCTION PHASE IMPACT SIGNFICANCE: *'Poor' or 'Standard' Impact Mitigation Scenario*								
No.	**Nature of Impact**	**Status**	**Extent**	**Intensity**	**Duration**	**Probability**	**Water resource management**	**Confidence**
C1	Destruction and modification of aquatic habitat	Negative	Site	High	Short-term	Definite	Moderately-Low	High
C2	Flow modification and erosion / sedimentation:	Negative	Site	High	Short-term	Definite	Moderately-Low	Medium
C3	Water pollution	Negative	Site	High	Short-term	Unlikely	Low	Medium

CONSTRUCTION PHASE IMPACT SIGNFICANCE: *'Good' or 'Best Practical' Impact Mitigation Scenario*								
No.	**Nature of Impact**	**Status**	**Extent**	**Intensity**	**Duration**	**Probability**	**Water resource management**	**Confidence**
C1	Destruction and modification of aquatic habitat	Negative	Local	High	Permanent	Definite	High	High
C2	Flow modification and erosion / sedimentation:	Negative	Local	High	Long-term	Highly Probable	Moderately-High	Medium
C3	Water pollution	Negative	Local	High	Long-term	Probable	Moderate	Medium

C2. Operational-Phase Impact Significance Assessment.

OPERATION PHASE IMPACT SIGNFICANCE: *'Poor' or 'Standard' Impact Mitigation Scenario*								
No.	**Nature of Impact**	**Status**	**Extent**	**Intensity**	**Duration**	**Probability**	**Water resource management**	**Confidence**
O1	Modification of aquatic habitat	Negative	Surrounding Area	High	Permanent	Highly Probable	Moderate	High
O2	Flow modification and erosion / sedimentation:	Negative	Local	High	Permanent	Definite	High	Medium
O3	Water pollution	Negative	Local	High	Long-term	Highly Probable	Moderately-High	Medium

OPERATION PHASE IMPACT SIGNFICANCE: *'Good' or 'Best Practical' Impact Mitigation Scenario*								
No.	**Nature of Impact**	**Status**	**Extent**	**Intensity**	**Duration**	**Probability**	**Water resource management**	**Confidence**
O1	Modification of aquatic habitat	Negative	Site	High	Long-term	Unlikely	Low	High
O2	Flow modification and erosion / sedimentation:	Negative	Surrounding Area	High	Long-term	Possible	Moderately-Low	Medium
O3	Water pollution	Negative	Surrounding Area	High	Long-term	Possible	Moderately-Low	Medium

ANNEXURE D: DWS Risk Assessment Table.

RISK MATRIX (Based on DWS 2015 publication: Section 21 c and I Water Use Risk Assessment Protocol)

Project Name: 'Wildcoast Special Economic Zone (SEZ) Phase 1' Development Project

Date: 9th July 2018

Name of Assessor(s): Mr. Adam Teixeira-Leite *Pr.Sci.Nat.* (Ecological Science) **SACNASP Registration No.** 400332/13

Risk to be scored for construction and operational phases of the project. MUST BE COMPLETED BY SACNASP PROFESSIONAL MEMBER REGISTERED IN AN APPROPRIATE FIELD OF EXPERTISE.

Phase(s)	Activity	Aspect	Impact	SEVERITY: Flow Regime	SEVERITY: Physico & chemical (water Quality)	SEVERITY: Habitat (Geomogh & Vegetation)	SEVERITY: Biota	Severity	Spatial Scale	Duration	Consequence	Frequency of Activity	Frequency of Impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence Level	Mitigation / Control measures	Revised Risk Rating	LOW / MODERATE
Construction	Construction phase of the mixed-use development: including vegetation clearing, bulk earthworks (site grading/plat-forming), land preparations and construction of all infrastructure including buildings, roads and associated service infrastructure.	1. Site clearing (vegetation stripping).	Potential physical destruction or disturbance of wetland habitat where roads and water / sewage pipelines intend to cross wetlands.	2	1	4	1	**2**	1	3	**6**	1	4	5	2	**12**	**72**	**Moderate**	80%	Onsite best-management practice (BMP) controls. Avoid wetland habitat destruction by reducing road and pipeline construction servitude width across rivers/streams. Rehabilitate areas crossed by roads and pipelines where necessary.	47	Low

Phase(s)	Activity	Aspect	Impact	SEVERITY Flow Regime	Physico & chemical (water Quality)	Habitat (Geomorph & Vegetation)	Biota	Severity	Spatial Scale	Duration	Consequence	Frequency of Activity	Frequency of Impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence Level	Mitigation / Control measures	Revised Risk Rating	LOW / MODERATE
		2. Earth works, land preparation (site grading and plat-forming) and construction of infrastructure (parking lots, buildings, wastewater pipelines across wetlands, storm water infrastructure, etc.).	Disturbance of soil profiles with a resultant risk of increased levels of sediment potentially delivered to the downstream watercourses (leading to sedimentation and increased water turbidity within wetlands).	2	3	4	2	**2.75**	2	3	**7.75**	1	4	5	2	**12**	**93**	Moderate	80%	Onsite best-management practice (BMP) controls. Avoid wetland habitat destruction by reducing road and pipeline construction servitude width across rivers/streams. Rehabilitate areas crossed by roads and pipelines where necessary.	68	Moderate
		3. Use of machinery and other sources of hazardous pollutants within and adjacent to wetlands (i.e. in order to undertake Activity 1 & 2 above).	Potential water pollution and associated biotic impacts from hazardous substances such as oils, grease, fuels / hydrocarbons and volatile organic compounds used during construction of the infrastructure.	1	3	2	2	**2**	1	2	**5**	1	2	5	3	**11**	**55**	Low	60%	Onsite best-management practice (BMP) controls around fuel/chemical storage, dispensing and general management.	30	Low

Phase(s)	Activity	Aspect	Impact	SEVERITY: Flow Regime	SEVERITY: Physico & chemical (water Quality)	SEVERITY: Habitat (Geomorph & Vegetation)	SEVERITY: Biota	Severity	Spatial Scale	Duration	Consequence	Frequency of Activity	Frequency of Impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence Level	Mitigation / Control measures	Revised Risk Rating	LOW / MODERATE
Operation	Operational phase of the mixed-use development: including management of storm water and grey water and wastewater reticulation.	1. Increased storm water run-off volumes and velocities from storm water management systems.	Increased flood peaks (volume and velocity of storm water runoff) leading to possible soil erosion and potential sedimentation impacts to downstream wetlands.	3	1	3	1	**2**	3	2	**7**	2	3	5	3	**13**	**91**	**Moderate**	80%	Storm water management plan to be implemented.	66	**Moderate**
		2. Contaminated urban run-off containing hydrocarbons (fuel/oil), suspended solids and organic compounds (from roads, parking lots and other hardened surfaces).	Potential water pollution and associated water resource management and biotic impacts.	2	3	1	2	**2**	3	2	**7**	2	3	5	3	**13**	**91**	**Moderate**	60%	Storm water management plan to be implemented. Waste management plan to be implemented.	66	**Moderate**
		3. Contaminated agricultural runoff containing elevated nutrients, organics and salts.	Potential water pollution and associated water resource management and biotic impacts.	2	3	1	2	**2**	3	2	**7**	2	3	5	3	**13**	**91**	**Moderate**	60%	Storm water management plan to be implemented. Waste management plan to be implemented.	66	**Moderate**

Phase(s)	Activity	Aspect	Impact	SEVERITY: Flow Regime	SEVERITY: Physico & chemical (water Quality)	SEVERITY: Habitat (Geomogh & Vegetation)	SEVERITY: Biota	Severity	Spatial Scale	Duration	Consequence	Frequency of Activity	Frequency of Impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence Level	Mitigation / Control measures	Revised Risk Rating	LOW / MODERATE
		4. Risk of accidental leakages/ spills from wastewater pipeline infrastructure crossing wetlands.	Possible water pollution and associated water resource management and biotic impacts.	2	4	2	3	**2.75**	3	3	**8.75**	4	1	5	3	**13**	**113.75**	**Moderate**	60%	Pipeline 'environmental' design recommendations to be implemented + ecological monitoring.	88.75	**Moderate**

PROPOSED WILD COAST SPECIAL ECONOMIC ZONE MTHATHA, KING SABATA DALINDYEBO LOCAL MUNICIPALITY, EASTERN CAPE

APPENDIX A:

Conceptual Wetland Rehabilitation Plan

Version: 0.1

DRAFT REPORT FOR COMMENT

Date: 10th July 2018

Eco-Pulse Environmental Consulting Services

Report No: EP341-02 (Appendix A)

REPORT DETAILS

Document Title:	**Conceptual Wetland Rehabilitation Plan**
Report No.:	EP341-02A
Version:	0.1 (DRAFT FOR COMMENT)
Revision No.:	Rev 0
Date:	10th July 2018
Author:	**Mr. Adam Teixeira-Leite** *Pr.Sci.Nat.* (Ecological Science) Wetland Ecologist & Senior Scientist *Eco-Pulse Environmental Consulting Services cc*
Project/Site Name :	Wilcoast SEZ (Special Economic Zone) Phase 1
Region (Province) :	Eastern Cape
Coordinates:	-31° 32' 34.62" S | 28° 40' 43.57" E
Nearest Town:	Mthatha
Combined property size:	~255 ha
Land Owner/Applicant:	Coega Development Corporation (CDC)

SPECIALIST CONTACT DETAILS

Mr. Adam Teixeira-Leite *Pr.Sci.Nat. (Ecological Science)*

Senior Scientist & Wetland Specialist

Eco-Pulse Environmental Consulting Services

26 Mallory Road, Hilton, 3245, South Africa

Email: ateixeira@eco-pulse.co.za

Tel: 031 2666 700

Mobile: 082 310 6769

Recommended report citation:

Eco-Pulse Consulting. 2018. ***'Wildcoast SEZ Phase 1: Conceptual Wetland Rehabilitation Plan.*** *Unpublished report for Coega Development Corporation. Report No. EP341-02A. Version 1.0 _10th July 2018.*

CONTENTS

LIST OF FIGURES

LIST OF TABLES

DISCLAIMER

- This Conceptual Wetland Rehabilitation Plan has been drawn up for sole use at the property of the planned 'Wildcoast Special Economic Zone (SEZ) Phase 1, Umthatha, Eastern Cape. Neither its guidelines/recommendations nor background information may be used in any form without prior permission from the Coega Development Corporation (CDC).
- This Rehabilitation Plan must not be amended without prior consultation and approval from the Client.
- All changes must be formally motivated and supplemented with additional information as necessary.

ASSUMPTIONS AND LIMITATIONS

In compiling this document, the following has been assumed:

- The information provided in this report is based on site visits that have been undertaken by the project team (Wetland Ecologist from Eco-Pulse Consulting) and their subsequent input into the Reporting, which includes baseline wetland assessments. It is understood that this information is sufficient for the relevant environmental authorisation processes.
- This Conceptual Wetland Rehabilitation Plan should be read in conjunction with the specialist baseline wetland assessment report:
    - *Eco-Pulse Consulting. 2018. Proposed Wild Coast SEZ, Eastern Cape. Wetland Habitat Impact Assessment Report. Unpublished report prepared by Eco-Pulse Environmental Consulting Services for WSP. Report No. EP341-02.*
- Information contained in this Report/Plan will be used to inform, where necessary, the rehabilitation of wetlands on the target property and to guide the development of a detailed wetland rehabilitation plan, together with relevant mitigation actions and remediation activities where needed.
- The implementation of this Plan must take into account all relevant recommendations of the Environmental Authorisation (EA) and Water Use License (WUL) processes for the development project.

Other relevant limitations include:

- The information in this Report is based on existing available information and input from the wetland ecologists from Eco-Pulse Consulting. Until this Conceptual Wetland Rehabilitation Plan has been finalised and signed off by the Client/Developer, the content of the document should be considered as preliminary (draft form).
- Rehabilitation and management activities and interventions have been developed for site conditions as at the time of the planning site visits. Should site conditions change before the rehabilitation plan is implemented, changes to the plan may be necessary. In this case, project implementers may require the assistance of a wetland ecologist and/or professional engineer to revise the relevant section(s) of the plan.

ACKNOWLEDGMENT

The report template is based on previous Wetland & River Management and Rehabilitation Plans developed for other projects by Eco-Pulse Consulting. Eco-Pulse therefore controls the intellectual rights of this document and acknowledges that these will become the property of the Client/Developer (Coega Development Corporation).

KEY REFERENCES AND SOURCES OF INFORMATION

A number of key documents were referred to in compiling this Conceptual Wetland Rehabilitation Plan. The principle ones included:

- Construction Environmental Management Plan (CEMP) for Working for Wetlands Projects (SANBI/DEA Working for Wetlands Programme, 2010).
- Guidelines for the in situ Management of Ecosystems in KwaZulu-Natal, according to Biodiversity Conservation Principles: Wetlands (Kotze and Cowden, 2009).
- WETRehabEvaluate: Guidelines for the monitoring and evaluation of wetland rehabilitation projects (Cowden and Kotze, 2008).
- WET-RehabPlan: Guidelines for planning wetland rehabilitation in South Africa (Kotze *et al.*, 2009).
- Siyathuthuka Housing Development Phase 2 – Environmental Management Plan for Wetlands (Teixeira-Leite and Macfarlane, 2012).
- Wetland and Waterbody construction and mitigation procedures (US Federal Energy Regulatory Commission, 2002).
- Wetland Restoration: A handbook for New Zealand Freshwater Systems (Clarkson and Peters, 2012).
- WET-Rehab Methods: National guidelines and methods for wetland rehabilitation (Russell, 2009).

1 INTRODUCTION

Wetlands and rivers are dynamic ecosystems that are highly sensitive to influences from both natural and anthropogenic factors. In order to maintain the biological diversity and productivity of aquatic ecosystems such as rivers and wetlands, and to permit the wise use of aquatic resources by people whilst ensuring that the requirements of the natural environment are met, an overall agreement is essential between the various managers, land owners, occupiers and other stakeholders.

1.1 Purpose

This '<u>Conceptual</u> Wetland Rehabilitation Plan' provides the relevant guidelines, initial methods and tasks required for the effective rehabilitation of the various wetlands on the properties of the proposed Wildcoast SEZ Phase 1 development. The Plan is intended to address any post-construction impacts to wetlands associated with the development of infrastructure including but not necessarily limited to:

- Vegetation clearing
- Bulk earthworks
- Stockpiling of soils
- Storm water discharge management
- Road construction across wetlands
- Water/sewer pipeline trenching and installation through wetlands

A Wetland Rehabilitation Plan is required for the wetland habitat on the development property in accordance with the requirements of the relevant environmental authorities and the principles and requirements stipulated in terms of the National Environmental Management Act No. 107 of 1998 and the National Water Act No. 36 of 1998 with regards to wetland protection and remediation (*refer also to the summary of applicable legislature contained in Section 2 of this document*). Rehabilitation will aid the recovery of wetland ecosystems potentially impacted by the development project and can be seen as critical in preventing further impacts to these sensitive ecosystems including those associated with alien plant infestations, soil erosion and sedimentation for example.

This document forms **Appendix A** of the specialist baseline wetland assessment report by Eco-Pulse Consulting (2018, Report No. EP341-02) and presents the **'Conceptual Wetland Rehabilitation Plan'** for the wetland ecosystems located on the properties of the planned Wildcoast SEZ Phase 1 development. **Note that this document/plan is not intended to be a detailed plan for implementation purposes but rather provides a 'conceptual level plan' to inform the EIA/WULA processes and to guide and inform the development of a detailed rehabilitation plan for the wetlands at the site.**

This Plan is intended to be both educational and provide a practical tool to inform wetland rehabilitation at the site. The Rehabilitation Plan is a structured document that:

- Defines the purpose and objectives of the rehabilitation plan;
- Outlines the existing problems and impacts to wetlands;
- Describes key benefits that are likely to be derived from rehabilitation;

- Defines the key roles and responsibilities of stakeholders involved;
- Describes the need for intervention;
- Sets out the steps to be taken to rehabilitate wetlands on the target property;
- Provides guidance on the proposed timing of rehabilitation activities;
- Describes key negative environmental impacts that the rehabilitation interventions may have on the environment and recommends means for managing these impacts; and
- Outlines requirements for follow-up/maintenance work and ecological monitoring.

1.2 Project Locality

The Coega Development Corporation (CDC) intends to develop the Wild Coast Special Economic Zone (SEZ), located immediately adjacent to the existing Mthatha Airport north-west of Mthatha town (Figure 1) in the Eastern Cape Province of South Africa. Given the economic development potential and agricultural focused advantages the region offers, and using input received during the stakeholder's consultation, developmental priorities were identified for phase 1 of the development.

Figure 1 Google Earth™ map showing the location of proposed Wild Coast SEZ at Mthatha Airport within the King Sabata Dalindyebo Local Municipality, Eastern Cape.

1.3 Project Background and Aquatic Environment at the Site

1.3.1 Development Project Details

Based on available information received, the CDC is seeking Environmental Authorisation (EA) for Phase 1 of a broader concept, namely the industrial-commercial type development within the Mthatha Airport precinct. The two properties to be developed are shown outlined in 'yellow' in Figure 2:

- The **Phase 1: 'North'** property is 183 ha in extent and is located on the farm to the immediate north of the existing Mthatha Airport runway. *The intended development will be for agricultural land use on the majority (164ha) of this property.*
- The **Phase 1: 'South'** property is 72 ha in extent and is located on the farm to the immediate south of the existing Mthatha Airport building. *The intended development will be for a 'mixed-use' type development comprising: hotel & conferencing, commercial space, industrial land use and intensive agriculture & business process outsourcing.*

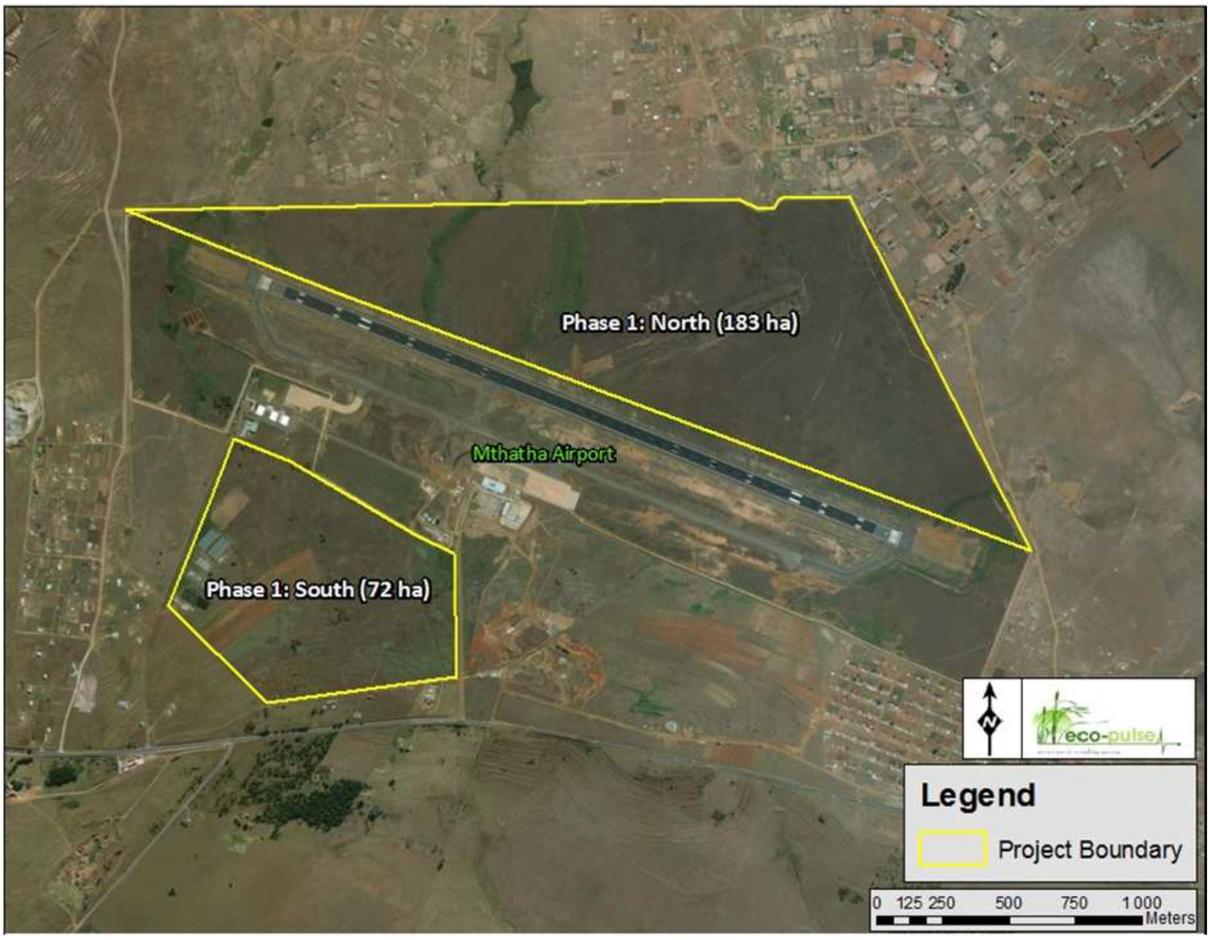


Figure 2 Map showing the northern and southern land portions associated with the Phase 1 development.

Table 1. Project details.

Project/Site Name	'Wildcoast SEZ: Phase 1'
Region (Province)	Eastern Cape
Coordinates	-31° 32' 34.62" S | 28° 40' 43.57" E
Nearest Town	Umthatha
Combined property size	~ 255 ha
Land Owner	Coega Development Corporation (CDC)

1.3.2 Aquatic Environment: *wetlands*

Wetlands occurring within a 500m radius of the proposed development area (i.e. within the DWS regulated area for Section 21 (c) / (i) wetland water use), were mapped at a desktop level and delineated in the field (see Figure 3). The output of the wetland identification and mapping reveals an appreciable area of wetland habitat located on the northern Phase 1 property, particularly within the northern and western section, and this is likely to pose a potentially significant constraint to development. The infield delineation enabled the identification and mapping of seven (7) wetland systems, including six (6) wetland 'seeps' and one (1) artificial wetland (wetland W6) created by a leaking bulk water pipeline infrastructure:

Northern property:

i. Wetland Unit W1: 63.8Ha Seep Wetland
ii. Wetland Unit W2: 61.6Ha Seep Wetland
iii. Wetland Unit W3: 14.1Ha Seep Wetland
iv. Wetland Unit W4: 35.7Ha Seep Wetland

Southern property:

v. Wetland Unit W5: 24.6Ha Seep Wetland
vi. Wetland Unit W6: 0.56Ha Artificial Wetland
vii. Wetland Unit W7: 1.04Ha Seep Wetland

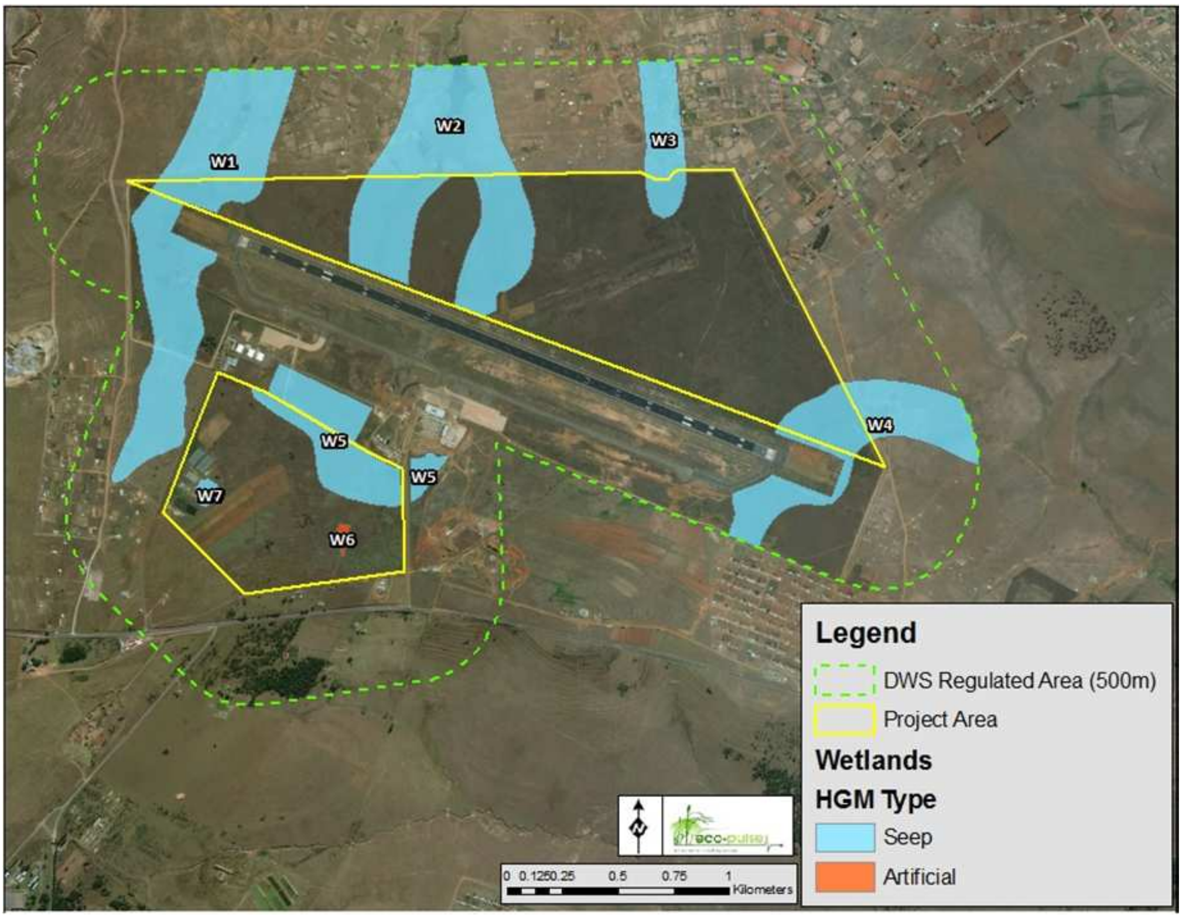


Figure 3 Wetlands in the area of study: delineated, mapped and classified according to HGM (hydro-geomorphic) type.

The findings of the baseline wetland assessment suggests that owing to a range of existing impacts within the wetlands and catchment area (linked to storm water runoff and airport development), the wetlands are generally in a 'moderately modified ('C' PES Class) to 'largely modified' state ('D' PES class) state. The larger and more intact wetlands (W1 to W4) were considered to be of 'Moderate' Ecological Importance & Sensitivity (EIS) whilst the smaller wetlands W6 and W7 were considered to be of 'Low' to 'Very Low' EIS.

Based on the joint consideration of present condition ('fair to poor') and ecological importance & sensitivity of the wetland located on the property ('moderate to low'), the recommended management objective for the wetland should be at a minimum to '*maintain the current state and functioning with no further loss permitted*'. This Wetland Rehabilitation Plan therefore serves to inform and guide rehabilitation of the wetlands (where relevant) in order to maintain the present state and functioning of wetlands in the catchment area. This is also generally aligned with the aquatic conservation priorities highlighted for the study area in terms of the Eastern Cape Biodiversity Conservation Plan (ECBCP (Hayes et al., 2007; Berliner & Desmet, 2007), which recommends that the management objective for these areas should be to: *"Maintain biodiversity in as natural state as possible, Manage for no biodiversity loss"*.

Table 2. Summary of the assessment of the wetland RMO based on PES and EIS ratings.

Wetland Unit	HGM Type	PES	EIS	RMO
W1	Seep	D: Largely Modified	**Moderate**	*Maintain PES/EIS*
W2		C: Moderately modified	**Moderate**	
W3		D: Largely Modified	**Moderate**	
W4		D: Largely Modified	**Moderate**	
W5		C: Moderately modified	**Moderate**	
W6	'Artificial' Wetland	N/A	Very Low	N/A
W7	Seep	D: Largely Modified	Low	*Maintain PES/EIS*

For further details regarding the wetlands and their present ecological state and functioning, the reader is referred specifically to the relevant section(s) of the ***Specialist Wetland Assessment Report*** (Eco-Pulse, 2018, Report No. EP341-02).

1.4 Key concepts & guiding principles in wetland rehabilitation

Wetland rehabilitation is rather broadly defined and generally refers to the process of assisting in (i) the recovery of a degraded wetland ecosystem by reinstating the natural ecological driving forces, or alternatively, (ii) halting the decline in health of an ecosystem that is in the process of degrading (Russell, 2009).

Wetland rehabilitation and the development of relevant plans to guide the rehabilitation of these sensitive aquatic ecosystems and habitat should be underpinned by a number of general guiding principles. The following key principles relating to wetland rehabilitation (after Russell, 2009) were used to guide and inform the development of the wetland rehabilitation plan:

1. ***Rehabilitation is a process, not an endpoint.*** Rehabilitation is not the static endpoint of a 'recipe-like process' but rather it is a process in its own right, whereby the wetland system is given an opportunity for a new beginning. The goal of rehabilitation should not be to return and maintain a wetland in a static state, but rather to achieve a persistent resilient system that is largely self-sustaining and able to respond to change with little human intervention.
2. ***Rehabilitation should work with natural processes.*** Rehabilitation requires that one attempts to imitate natural processes and reinstate natural ecological driving forces in such a way that rehabilitation aids the recovery (or maintenance) of dynamic systems so that, although they are unlikely to be identical to their natural counterparts, they will be comparable in critical ways so as to function similarly. Rehabilitation essentially involves the reinstatement of these driving ecological forces to a level close to the original system, but seldom fully attaining it.
3. ***Rehabilitation interventions are likely to have different starting and ending points***. Rehabilitation interventions may have different ecological starting points (ranging from totally degraded to slightly degraded) and different goal endpoints (ranging from a state that is close to the pristine to one which is still far from pristine, but nonetheless an improvement on the state of the system without any rehabilitation intervention). This ultimately depends on what is achievable, given the site conditions, and those ecosystem attributes and services that are considered most important. Any rehabilitation project should therefore be based on an understanding of both the ecological starting point and on a defined goal endpoint, and should accept that it is not possible to predict exactly how the wetland is likely to respond to the rehabilitation interventions.
4. ***Rehabilitation is a complex process and often it is more appropriate to focus on reinstating functional values than on reinstating natural processes.*** Wetlands are complex and dynamic systems and some attributes of these systems may have changed irreversibly such that it is impractical to reverse all modifications contributing to degradation and/or loss of wetlands Given these factors there may be an emphasis in rehabilitation – not so much on restoring natural processes – but accepting the irreversible nature of irreversible change and focusing on reinstating functional values instead.
5. ***Wetlands are an integral part of catchments and broader landscapes.*** Rehabilitation must be integrated with the surrounding landscape if it is to fully address the causes of degradation and not just focus on the symptoms.

2 LEGAL CONTEXT

2.1 Wetland Rehabilitation and the Law: *the South African Context*

Wetlands are defined in the National Water Act as '*land which is transitional between terrestrial and aquatic systems*'. In view of the fact that they are transitional, they are subject to a wide range of legislation that reflects their location as well as their importance in the landscape and to society. The link between the ecological integrity of freshwater resources and their continued provision of valuable ecosystem goods and services to burgeoning populations is well-recognised, both globally and nationally (Rivers-Moore *et al.,* 2007) and in response to the importance of freshwater aquatic resources, protection of wetlands and rivers has been campaigned at national and international levels.

A strong legislative framework which backs up South Africa's obligations to numerous international conservation agreements creates the necessary enabling legal framework for the protection and management of freshwater resources in the country. Given the value of wetlands and other aquatic ecosystems (such as rivers and estuaries) and the fact that humans depend on aquatic resources, it is against the law to deliberately damage wetlands and rivers. The law therefore places, directly and indirectly, the responsibility on landowners and other responsible parties, to manage and restore wetlands where relevant. Relevant environmental legislation pertaining to the protection, management and use of aquatic ecosystems (i.e. wetlands and rivers) in South Africa has been summarised in Table 3, below. Of particular importance is the requirement of 'duty of care' with regards to environmental remediation stipulated in Section 28 of NEMA (National Environmental Management Act No.107 of 1998):

> **Duty of care and remediation of environmental damage**: "(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 be reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment.*"

The requirements for rehabilitation of disturbed wetland/riparian areas stipulated in the National Water Act (No. 36 of 1998) are also noteworthy:

> *'A person who lawfully impedes or diverts the flow of water in a wetland, or who alters the beds, banks or characteristics of a wetland must take necessary measures to stabilise the diversion structure and surrounding area through:*
>
> - *rehabilitation of the riparian habitat using only indigenous shrubs and grasses;*
> - *rehabilitation of disturbed and degraded riparian areas;*
> - *restoring and upgrading the riparian habitat integrity to sustain a biodiverse riparian ecosystem;*
> - *removal of alien vegetation, and*
> - *conducting an annual habitat assessment.'*

Table 3. Relevant environmental legislation that compels the protection, management and use of aquatic ecosystems (i.e. wetlands and rivers) in South Africa (after Armstrong, 2008).

Legislation/Act	Key Principles/Requirements
National Environmental Management Act 107 of 1998 (NEMA)	• The loss or disturbance of ecosystem and loss of biological diversity must be avoided. • The pollution and degradation of the environment must be avoided. • The disturbance of landscapes and sites that constitute the Nations' cultural heritage must be avoided. • The use and exploitation of non-renewable and renewable natural resources must be avoided. • The development and exploitation of renewable resources and ecosystem of which they are part, must not exceed the level beyond which the integrity is jeopardised. • Sensitive, vulnerable, highly dynamic or stressed ecosystems such as wetlands require specific attention. A duty of care rests in all persons to avoid environmental degradation and pollution.
National Environmental Management: Biodiversity Act 10 of 2004 (NEM:BA)	• The South African National Biodiversity Institute (SANBI) may co-ordinate and finance programmes for the rehabilitation of ecosystems. • The Minister may publish national lists of ecosystems that are threatened and in need of protection, as may a provincial MEC.
National Water Act 36 of 1998 (NWA)	• The Minister must determine the class of water-resource and resource-quality objectives, and must give effect to the determination of the reserve. • A duty of care rests on the owner of the land, a person in control of the land or a person who occupies or uses the land, to take all reasonable measures to prevent pollution of a water resource. • 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. • Water-resource management is delegated to Catchment Management Agencies. • A Catchment Management Agency must advise interested persons on: the protection, use for development, conservation, management and control of water resources the development of a catchment management strategy the co-ordinated activities related to water uses the co-ordination of any relevant development plan, and the promotion of community participation in the control of water resources. • The Minister may establish bodies to implement international agreements in respect of the management of water resources with neighbouring countries. • The Minister may establish and operate government waterworks and fund such works. • A holder of a servitude must maintain the servitude area, and repair and maintain infrastructure relating to the servitude and access roads. • A person who lawfully impedes or diverts the flow of water in a wetland, or who alters the beds, banks or characteristics of a wetland must take necessary measures to stabilise the diversion structure and surrounding area through: - rehabilitation of the riparian habitat using only indigenous shrubs and grasses; - rehabilitation of disturbed and degraded riparian areas; - restoring and upgrading the riparian habitat integrity to sustain a biodiverse riparian ecosystem; - removal of alien vegetation, and - conducting an annual habitat assessment.
Conservation of Agricultural Resources Act 43 of 1983 (CARA)	• This Act does not apply to land in urban areas, except with respect to the provisions relating to alien invader plants.
National Forests Act 84 of 1998 (NFA)	• Natural forests may not be destroyed save for "exceptional circumstances". • In terms of the National Forest Act, all forests are protected and no trees (dead or alive) may be cut, damaged or removed without a license from DAFF (or a delegated authority). • Forests must be managed to conserve biological diversity, ecosystems and habitats. • Maintaining natural forests in a good state and the rehabilitation of degraded forests must be promoted. • Any decisions on land use or development that will affect natural forests must be taken with the utmost care (the precautionary principle) and with due

Legislation/Act	Key Principles/Requirements
	consideration for: - Keeping the dynamic forest processes intact; - Preventing disturbance to forest ecosystems, fauna and flora; - The most sensitive parts of forests have to be avoided; - Keeping forest margins and surrounding mosaics of habitats in place as far as possible (inter alia through sufficient buffer zones, corridors and protected areas); - Natural corridors linking forests and other habitats must be retained as far as possible; and - Not allowing disturbance caused by poor land management to be used as a motivating factor for land use change that transforms natural forest

Other pieces of legislation that may also be of some relevance include:

- The National Forests Act No. 84 of 1998;
- The Natural Heritage Resources Act No. 25 of 1999;
- The National Environmental Management: Protected Areas Act No. 57 of 2003;
- Minerals and Petroleum Resources Development Act No. 28 of 2002;
- The Mountain Catchments Areas Act No. 62 of 1970.

Context of the information contained in this Plan in terms of the National Water Act requirements:

The National Water Act (No. 36 of 1998) imposes 'duty of care' on all landowners, to ensure that water resources are not polluted. Chapter 4 of the NWA is of particular relevance to wetlands and addresses the use of water and stipulates the various types of licensed and unlicensed entitlements to the use water. Water use is defined very broadly in the Act and effectively requires that any activities with a potential impact on wetlands (within a distance of 500m upstream or downstream of a wetland) be authorized. Relevant to wetland rehabilitation, certain water-use activities require registration and/or licensing by the Department of Water & Sanitation (DWS, formerly DWAF) where activities trigger Section 21 of the National Water Act. According to the Act, water use must be licensed unless its use is excluded. Application for a water use license, permit or authorisation must therefore be made for the following listed activities under Section 21 of the NWA applicable to wetland rehabilitation:

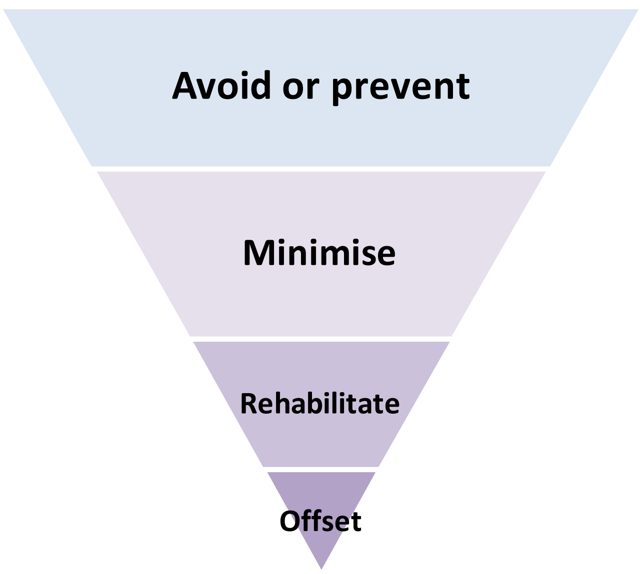
- Section 21 (a) water use: Taking water from a water resource (*where water is required for construction of interventions*);
- Section 21 (c) water use: Impeding or diverting the flow of water in a watercourse; and
- Section 21 (i) water use: Altering the bed, banks, course or characteristics of a watercourse.

2.2 Wetland Rehabilitation and the 'Mitigation Hierarchy'

The protection of aquatic ecosystems (rivers and wetlands) begins with the avoidance of adverse impacts and where such avoidance is not feasible; to apply appropriate mitigation in the form of reactive practical actions that minimizes or reduces in situ impacts and aims to prevent the occurrence of large-scale damaging events as well as repeated, chronic, persistent, subtle events which can in the long-term be far more damaging (e.g. as a result of sedimentation and pollution).

'Impact Mitigation' is a broad term that covers all components involved in selecting and implementing measures to conserve biodiversity and prevent significant adverse impacts as a result of potentially harmful activities to natural ecosystems. The mitigation of negative impacts on aquatic resources is a legal requirement for authorisation purposes and must take on different forms depending on the significance of impacts and the particulars of the target area being affected. This generally follows some form of 'mitigation hierarchy' (see Figure 4) which aims firstly at avoiding disturbance of ecosystems and loss of biodiversity, and where this cannot be avoided, to minimise, rehabilitate, and then finally offset any remaining significant residual impacts. In the case of particularly sensitive ecosystems such as wetlands and rivers, where ecological impacts can be severe, the guiding principle should generally be "*anticipate and prevent*" rather than "*assess and repair*". The 'Management Plan' component of this plan/document aims to satisfy the need to manage potential impacts and thus aligns with the principle of "*anticipate and prevent*" rather than "*assess and repair*".

However, where the need to rehabilitate degraded wetlands/rivers does arise, the onus shall therefore rest upon the developer and landowner to '**rehabilitate**' any disturbed/degraded watercourses (wetlands/rivers) on the property in order to ensure 'no net loss' of water resource integrity and functioning through appropriate rehabilitation actions and interventions. Rehabilitation will aid the recovery of the disturbed wetland habitat and can be seen as critical in preventing further impacts to these sensitive aquatic ecosystems.



Refers to considering options in project location, sitting, scale, layout, technology and phasing ***to avoid impacts*** *on biodiversity, associated ecosystem services, and people. This is the best option, but is not always possible. Where environmental and social factors give rise to unacceptable negative impacts, development should not take place. In such cases it is unlikely to be possible or appropriate to rely on the latter steps in the mitigation.*

Refers to considering alternatives in the project location, siting, scale, layout, technology and phasing that would ***minimise impacts*** *on biodiversity and ecosystem services. In cases where there are environmental and social constraints every effort should be made to minimise impacts.*

Refers to ***rehabilitation*** *of areas where impacts are unavoidable and measures are provided to return impacted areas to near-natural state or an agreed land use. Although rehabilitation may fall short of replicating the diversity and complexity of a natural system.*

Refers to measures over and above rehabilitation to compensate for the residual negative effects on biodiversity, after every effort has been made to minimise and then rehabilitate impacts. ***Biodiversity offsets*** *can provide a mechanism to compensate for significant residual impacts on biodiversity.*

Figure 4 Diagram illustrating the 'mitigation hierarchy' (after DEA *et al*., 2013).

3 INSTITUTIONAL CONTEXT

For the Wetland Rehabilitation Plan to be successfully implemented, it is critical that the plan has an allocated lead agent to drive implementation of the rehabilitation plan and that clear mandates and responsibilities of key role-players be established. If this is not in place, there is little chance of effective implementation of the plan. A brief outline of the proposed strategic-level mandates and responsibilities of the lead agent and other key stakeholders has been defined in this section of the plan.

3.1 Roles and Responsibilities for Implementation

The ultimate responsibility for the implementation of the Wetland Rehabilitation Plan lies with the landowner/developer as well as contractors/parties responsible for any direct or indirect disturbance of wetlands that have been identified in the baseline specialist wetland assessment report (Eco-Pulse, 2018) and this Plan. They will be tasked with overseeing the management and rehabilitation of the wetland during the construction and operational phases of the development, and/or appointing an appropriately qualified/experienced wetland rehabilitation implementer to undertake the required rehabilitation should they not have the required expertise needed to complete the recommended tasks. The ECO appointed to the project will be responsible for undertaking general ecological monitoring of the wetland areas to inform the management of these areas and to identify problems requiring remediation. The Contractors and all relevant parties involved in the development must be familiar with the relevant Management/Rehabilitation Plan and Methods contained therein and implement appropriate wetland management and mitigation of potential impacts in accordance with the guidelines and requirements contained therein. The roles and responsibilities of Key Stakeholders has been summarised as per Table 4, below.

Table 4. Roles and key responsibilities for Key Stakeholders involved in the implementation of the Wetland Rehabilitation Plan.

Role Players	Key Roles and responsibilities
Developer/ Landowner/ Project Manager	i. Shall be responsible for the overall implementation of the Plan and relevant management/mitigation measures as set out in this document; ii. Shall be responsible for ensuring that the monitoring wetland habitat is undertaken as per the recommendations of the Plan, for the life-span of the project; iii. Tasked with appointing relevant environmental staff (ECO and EO's) for the relevant phases of the project; and iv. Shall be responsible for the actions of all sub-contractors as well as disseminating information pertaining to the management of wetlands on the site;
Environmental Control Officer (ECO)	i. An ECO (Environmental Control Officer) with appropriate training/experience in terms of the implementation of environmental management specifications will need to be appointed for the duration of the project; ii. The ECO will be tasked with providing feedback to the Project Manager regarding all environmental matters; iii. Shall be responsible for providing basic training and environmental awareness to labourers undertaking impact mitigation and management activities; iv. Shall be responsible for monitoring and reporting on impact mitigation and management processes; v. Shall be responsible for making amendments and exceptions to the mitigation and management measures/guidelines provided in the Plan; vi. Liaison between Project Manager and Contractors on environmental matters;

Role Players	Key Roles and responsibilities
	vii. Undertaking regular site inspections and monitoring the performance of contractors and ensuring compliance with the Plan; viii. Reviewing and approving method statements from the Contractors prior to the commencement of construction activities; ix. Preparing regular audit reports that summarize the findings of the site inspections; x. Ensuring that the Contractors have received the appropriate environmental awareness training prior to commencing construction; xi. Maintaining an Environmental Incident Log of all major incidents including spills, injuries, and legal transgressions and other documentation related to the Plan; xii. Issuing of site instructions to the contractor for corrective actions required as recorded in the Environmental Incident Log; xiii. The ECO may order the Contractors to suspend part or all the works if the Contractors repeatedly cause damage to the environment by not adhering to the Plan (i.e. more than 3 significant cases of infringement depending on severity). The suspension shall be enforced until such time as the offending actions, procedure or equipment is corrected and the environmental damage repaired. xiv. Maintaining a Complaints Register of all local environment-related complaints; xv. Assisting in the resolution of conflict; xvi. Communication of any modifications to the Plan to all stakeholders; and xvii. Signing off on all mitigation work and wetland rehabilitation related activities.
Contractors/ Sub-Contractors	i. All contractors/sub-contractors operating on the property shall be responsible for implementing the construction-phase management measures and mitigation provided in this plan for the duration of the contract period; ii. Shall be responsible (contracted by the developer) to implement the wetland rehabilitation measures as set out in this document, to the satisfaction of the developer and/or competent authority; iii. Contractors are answerable to the ECO for non-compliance with the requirements of the Plan.
Wetland Ecologist	i. Where appointed by the landowner/developer, shall be responsible for providing remote and/or on-site ecological support pertaining to various aspects of the Plan.

3.2 Funding for wetland rehabilitation

This Plan has not attempted to address financial requirements associated with the implementation of the wetland rehabilitation plan. The lead agent (developer/landowner) is however responsible for securing adequate funding to implement the Plan (*as well as sourcing funding to implement the proposed wetland rehabilitation activities*). An annual budget for the implementation of key activities will therefore need to be developed to support key activities. The responsibility for allocating appropriate funds to ensure that appropriate wetland management / mitigation measures are implemented will need to secured and allocated as part of the development budget. A budget including costing of all wetland management activities and equipment costs will need to be compiled.

3.3 Timing of rehabilitation

Wetland rehabilitation should be initiated as soon as possible with regards to the stabilisation of eroded areas and repair/upgrading of any damaged roads/culverts for example and ideally, should take concurrently as development progresses. Rehabilitation of any eroded wetlands will be necessary prior to storm water being released into the wetlands during site operation.

PLEASE NOTE HOWEVER THAT NO REHABILITATION WITHIN A WATERCOURSE (WETLAND OR RIVER) MAY COMMENCE PRIOR TO A WATER USE LICENSE BEING OBTAINED FOR THE DEVELOPMENT AND WETLAND

REHABILITATION PLANNED. THIS WOULD OTHERWISE CONSTITUTE AN UNLAWFUL ACTIVITY/WATER USE ACCORDING TO THE NATIONAL WATER ACT AND THE DEVELOPER COULD BE LIABLE TO FINANCIAL PENALTIES AND/OR CRIMINAL PROSECUTION IF FOUND GUILTY OF UNLAWFUL ACTIVITY.

In terms of the timing of the implementation of re-vegetation, it is best that any planting take place as early in the growing season when the chances of frequent rainfall are high and temperatures are high to warm (i.e. between November and March). Planting outside of this period may necessitate regular irrigation until establishment is successful. Soil moisture is not the only factor which will slow the rate of plant growth. Low night temperatures and shorter day-lengths – both of which are characteristic of autumn and winter – can also retard plant growth rates to a significant degree. An undesirable consequence of this fact is that if spring (August – October) rains start early and occur as high-intensity events, the ground cover may not have developed sufficiently to reduce soil erosion risks. Careful planning is required to maximise the success of re-vegetation and avoid peak flow events where relevant.

3.4 Term of the Plan

The implementation of this Plan shall be an on-going process and the Plan is likely to continue to be relevant in perpetuity or until such time as the Plan has been revised or replaced by an alternative wetland rehabilitation and/or management plan.

4 SITUATIONAL ASSESSMENT

Understanding key impacts, threats and challenges facing wetlands at the site is the first step in developing a Wetland Rehabilitation Plan. The situational assessment therefore sets a backdrop for management planning for the wetlands and riparian areas on the property by identifying and describing key issues that need to be addressed in the Plan.

4.1 Opportunities and Constraints

A number of potential environmental opportunities and constraints are likely to influence the management of the wetlands on the property and provide a unique challenge to aquatic ecosystems management. These are highlighted in Table 5 and were considered in the development of this Wetland Rehabilitation & Management Plan.

Table 5. Key environmental opportunities and constraints identified for the target property.

KEY OPPORTUNITIES	KEY CONSTRAINTS
• The wetlands are in a degraded/drained state with numerous opportunities to enhance these areas both functionally and in terms of ecological integrity/habitat value.	• The management of wetland on private and communal land to the north is beyond the scope of this plan which deals with the wetland on the property of the development proposed ONLY.
• The northern property is fully fenced and secure, preventing unauthorised access to the site.	• New access roads and pipeline infrastructure will need to cross wetland areas, posing a risk of degradation and impact. *Potential risks and*
• Current levels of alien plants and weeds are	

KEY OPPORTUNITIES	KEY CONSTRAINTS
relatively low and quite isolated.	*predicted impacts will need to be managed and any disturbance created will need to be remediated.*
• No high levels local demand for wetland resources such as wetland plants, timber, soil, etc. have been identified, which will facilitate the sustainable management of the wetland habitats in the long-term.	• Alien plants and seed sources from adjacent agricultural properties are considered significant. *On-going alien plant and weed control will need to be undertaken at the site regularly and as necessary.*
• Long-term wetland management could be easily secured at the site based on the intention to manage "conservation areas" (i.e. wetlands and buffers) in perpetuity potentially.	

4.2 Key environmental issues and impacts addressed by the Plan

This rehabilitation plan does not intend to address the range of existing onsite and catchment impacts currently affecting the wetlands on the development property, but rather aims to identify and remediate any impacts caused to wetlands as a result of the development proposed and in particular, post-construction residual impacts that needs to be addressed through active wetland rehabilitation.

These may include the following:

- Disturbance of wetland vegetation caused by construction or access taking place within wetland areas (e.g. during pipeline / road construction across wetland areas);
- Indirect disturbance caused by storm water runoff from the construction/development site that may result in soil erosion and/or sedimentation within wetland areas; and
- Impacts caused by accidental incursions by vehicles / labour into wetlands.

For further information on key ecological impacts and issues highlighted for the project, the reader is referred to 'Section 6: Aquatic Ecological Impact Assessment' of the Specialist Baseline Wetland Assessment Report (Eco-Pulse, 2018).

5 CONCEPTUAL WETLAND REHABILITATION PLAN

5.1 Outline of the Rehabilitation Process

The following steps must be followed during the implementation of wetland rehabilitation for the project in terms of the key tasks and methods outlined in this wetland rehabilitation plan:

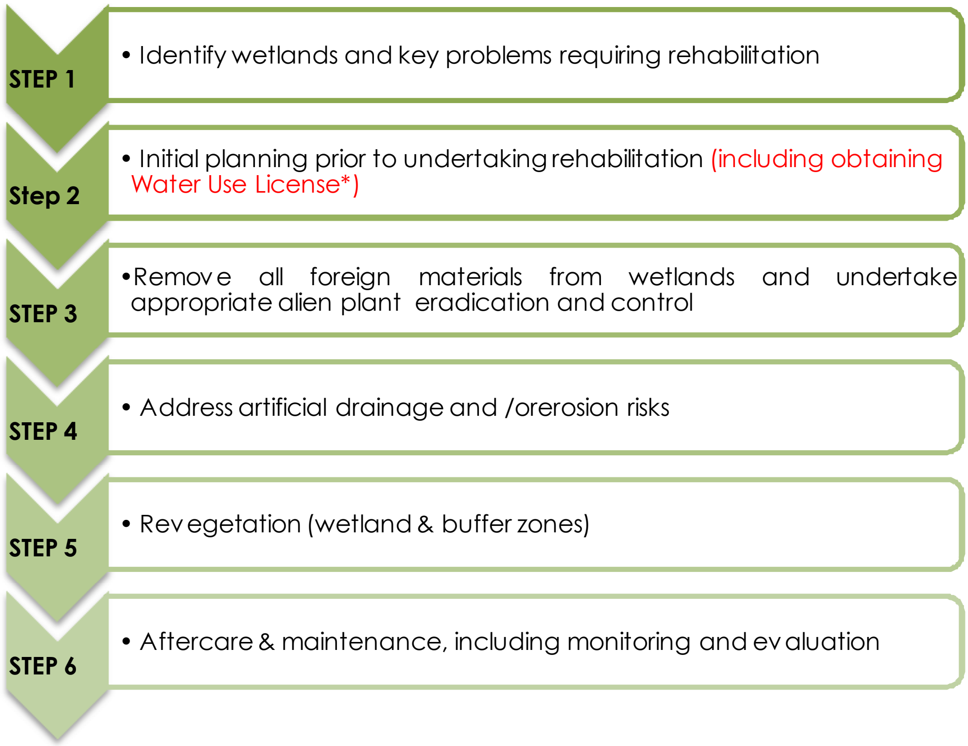


Figure 5 Diagram depicting the rehabilitation process to be followed when implementing the wetland rehabilitation plan.

5.2 Rehabilitation Tasks, Methods and Interventions

The relevant steps and tasks (as per the rehabilitation process outlined in Figure 5 are detailed in this section of the Plan. This includes Steps 1 through 6, including initial tasks for each step of the rehabilitation process from planning through to completion and post-rehabilitation maintenance and monitoring.

STEP 1: Identify wetland areas and impacts requiring rehabilitation and appropriate rehabilitation measures and interventions

Where impacts (direct or indirect) during construction of roads, pipeline, etc. have been sustained by wetland habitat, rehabilitation will be required to address any impacts caused and to return impacted areas (that have not been completely transformed) as close as possible to their former state and functioning. An assessment will need to be undertaken post-construction to determine which areas require rehabilitation, guided by Table 6 below.

All construction phase impacts to freshwater habitats, both planned and unplanned, need to be rehabilitated successfully before the contractor's scope of work and responsibilities can be considered completed. The desired state for the areas to be rehabilitated is to rehabilitate all physical disturbances and establish an indigenous grass cover that effectively stabilises the soil, minimises long-term erosion, and minimises long-term alien pant invasion.

Table 6. Summary of key wetland impact likely to result from development construction with the potential causes of wetland degradation and recommended rehabilitation interventions in each case.

Wetland Problem	Indicator(s)	Causes of the degradation	Recommended rehabilitation interventions
Artificial drainage of wetland	Trenches or artificial drains dug in wetlands that act to lower local water tables.	• Artificial channels dug in wetlands that act to drain these systems.	• Deactivate trenches/drains by back-filling and compacting with re-vegetation or using concrete weirs where necessary.
Invasive Alien Plants (IAPs) and weeds	Signs of exotic plants species and weeds that colonise disturbed areas and compete with/replace native wetland plant species.	• Disturbance of wetlands leaves areas vulnerable to IAPs and weeds.	• Clear and control alien plants/weeds. • Re-vegetate with suitable indigenous wetland plants.
Erosion and bank instability within wetland	Erosion gullies and erosion headcuts.	• Altered flow volumes and velocities. • Impact of roads and culverts.	• Stabilise eroded gullies and deactivate headcuts using a combination of soft and hard engineered options such as concrete weirs/retaining walls
Vegetation clearing	Removal of native wetland vegetation.	• Clearing of native wetland plants to enable construction of road/pipeline infrastructure crossing wetland areas.	• Re-vegetate with suitable indigenous wetland plants

STEP 2: Initial Rehabilitation Planning

Proper planning for rehabilitation is considered critical for ensuring that rehabilitation is successful. Table 7 below highlights key aspects that need to be considered as part of the initial rehabilitation planning process to be undertaken by the rehabilitation implementer. This process will need to be undertaken specifically prior to any wetland rehabilitation activities taking place onsite to avoid unnecessary delays and complications.

Table 7. Aspects to consider during pre-rehabilitation planning.

Planning Aspect	Description
Budget	A budget including costing of all rehabilitation and re-vegetation activities detailed in this report and equipment costs will need to be compiled prior to commencement of construction. Ideally the cost should be included in the contractual agreement for the project.
Appointment of landscapers / contractors	Whilst appointment of external landscapers is a feasible and acceptable option, a lot of preparation will need to be undertaken exclusively by the main contractor at the inception of the project. Preparation activities include correct stockpiling of topsoil needed for rehabilitation, harvesting of indigenous plants for use later on in rehab, managing a nursery

Planning Aspect	Description
	for rescued plants, etc.
Appointment of wetland specialist	It is recommended that a suitably qualified wetland ecologist with experience in wetland rehabilitation be appointed to provide practical input and oversight into the rehabilitation during implementation of the aquatic rehabilitation plan.
Timing	Implementation as soon as practically possible, bearing in mind planting season limitations.
Temporary equipment storage/laydown areas	Location of any temporary equipment storage/laydown areas to be planned outside of wetlands and natural fringing grassland vegetation.
Methods of re-vegetation	Methods of re-vegetation to be finalised and sources of plant material to be identified (see planting methods and sources as per STEP 5).

➢ *General guidelines and restrictions*

Before the implementation of any of the proposed mitigation measures/rehabilitation activities outlined in this plan, it is important to understand the following general site guidelines and restrictions:

i. **INDIGENOUS VEGETATION MAY NOT BE REMOVED DURING REHABILITATION** unless this has been specifically specified for use in vegetation by means of transplanting.

ii. The site is characterised by **ERODIBLE SOILS THAT ARE SENSITIVE TO DISTURBANCE**. Site clearing and movement of workers/equipment within the site must therefore be aware of any steep, sandy and unstable slopes and restrict movement & activities where necessary.

iii. The use of chemicals/herbicides in alien plant control must be **STRICTLY RESTRICTED TO A CERTIFIED HERBICIDE CONTROL APPLICATOR ONLY.** The application of herbicides will need to take into account the presence of aquatic systems (stream and riparian zone) on site.

iv. Where possible, **WATER AND HERBICIDE SOLUTIONS MUST BE USED** instead of diesel and herbicide solutions. Water and herbicide solutions have lower pollution risks when compared to diesel and herbicide solutions.

v. **THE EDUCATION OF FIELD WORKERS IS VERY IMPORTANT** as they will be primarily responsible for undertaking the rehabilitation work.

vi. **WORKERS MUST BE STRICTLY MONITORED** by a suitable trained site supervisor as they undertake rehabilitation.

vii. All **VEHICLES USED TO ACCESS THE SITE AND TRANSPORT EQUIPMENTN MUST BE RESTRICTED TO EXISTING DISTURBED AREAS ONLY** and should not be permitted to move into undisturbed vegetation or habitat.

viii. **GOOD TIMING AND FOLLOW-UPS ARE VERY IMPORTANT** for a successful rehabilitation process which often generally capital expense in the long-term.

ix. **BASIC EQUIPMENT REQUIREMENTS:** alien plant control teams must wear the necessary personal protective clothing (PPE) and use appropriate equipment to do the work. This should include the following where relevant:

a. Long overalls
b. Eye protection (safety goggles/glasses)
c. Protective gloves
d. Safety boots/gum boots
e. Sun protection hats/caps
f. Bush knives, machetes, saws, axes, chainsaws, etc.
g. Registered herbicides and diesel carrier
h. Paintbrushes, spray jets to apply herbicide
i. Drinking water

➢ *Obtaining relevant licenses prior to undertaking rehabilitation**

Note that wetland rehabilitation in line with this rehabilitation plan **MAY NOT COMMENCE PRIOR TO PERMISSION IN THE FORM OF A WATER USE LICENSE BEING GRANTED FOR THE DEVELOPMENT AND AQUATIC REHABILITATION PLANNED. THIS WOULD OTHERWISE CONSTITUTE AN UNLAWFUL ACTIVITY/WATER USE ACCORDING TO THE NATIONAL WATER ACT AND THE DEVELOPER COULD BE LIABLE TO FINANCIAL PENALTIES AND/OR CRIMINAL PROSECUTION IF FOUND GUILTY OF UNLAWFUL ACTIVITY.**

STEP 3: (Invasive) Alien Plant Eradication and Control

Exotic/Alien plants, particularly those considered invasive in terms of the National Environmental Management: Biodiversity Act (NEMBA), will need to be removed/eradicated from wetlands and the proposed 15m wetland buffer zone. During this phase of the rehabilitation, it will also be necessary to address any dry-land erosion within terrestrial areas outside of wetlands and to deal with any wetland erosion and instability concurrently, as per STEP 4 (see below).

Alien plants will need to be removed/controlled as per the requirements of the NEM:BA guidelines for alien species management and control. There are various means of controlling invasive alien plants in South Africa. The primary methods are discussed below in Box 1. The suitability of control methods depends on a number of factors, including practical constraints, economic constraints and applicability of methods for particular species of alien plants.

It is generally advised that a form of integrated control be implemented; however the final selection of the appropriate methods of control should be based on the following criteria:

- **Species to be controlled:** herbicides are registered for specific species. Selection should be based on "*A Guide to the use of Herbicides*" issued by the Directorate: Agricultural Production Inputs and labels and information brochures provides by herbicide suppliers.
- **Size/age of target plants:**
    - For **seedlings:** hand-pulling or hoeing and foliar applications of herbicides for dense stands.
    - For **saplings:** hand-pulling or hoeing, foliar applications of herbicides for dense stands, basal stem treatments and cut stump treatments recommended.
    - For **mature trees**: ring barking, frilling, basal stem treatments and cut stump treatments recommended.

- **Density of stands:** Overall applications of herbicide can be made to dense stands of seedlings or saplings. Where dense stands of large trees are present, treatment of standing trees may be appropriate to obviate the problem of disposing felled trees.
- **Accessibility of terrain:** In inaccessible areas, methods that rely on the minimum amount of transportation of equipment and chemicals should be given preference.
- **Environmental considerations:** Riparian/wetland areas require a careful approach to treatment/control. Only herbicides approved for use in wetland/riparian areas are to be considered. Washing of equipment or disposal of any chemical substances is prohibited in or near areas where there is a potential risk of contamination of wetlands/riparian areas.
- **Desirable vegetation:** Control methods that will cause the least damage to desirable indigenous vegetation must be considered. Selective herbicides or mixes that will not damage other desirable vegetation should be applied where relevant.
- **Disposal of dead vegetation:** Where possible, utilizable wood should be removed after tree felling. This is also the case for trees that could cause the blockage of water courses. Brushwood should be spread rather than stacked to limit soil damage in instances where burning is planned.
- **Cost of application:** the cost of application and re-treatment should be taken into consideration when selecting methods/herbicides, etc.

Box 1. Alien Plant Control Methods

The control methods detailed below have been adapted from the ARC-PPRI (Agricultural Research Commission: Plant Protection Research Institute) Weed Research Programme (online at www.arc.agric.za/arc-ppri/), the DWA Working for Water Programme ((http://www.dwaf.gov.za/wfw/Control/) and eThekwini Municipality's *Practical tips on the management and eradication of invasive alien plants* (EcoFiles Sheet 4. Local Action for Biodiversity).

1 Mechanical control

Mechanical control entails physically damaging or removing the target alien plant. Mechanical control is generally labour intensive and therefore expensive, and can also result in severe soil disturbance and erosion. Different techniques can be applied and include uprooting/hand-pulling, felling, slashing, mowing, ring-barking or bark stripping. This control option is only really feasible in sparse infestations or on a small scale, and for controlling species that do not coppice after cutting. Species that tend to coppice (e.g. *Melia azedarach)* need to have the cut stumps or coppice growth treated with herbicides following mechanical treatment.

- **Hand pulling/uprooting:** The hand-pulling should be reserved for small plants and shrubs with shallow root systems (not recommended for trees with a stem diameter of more than 10cm). Grip the young plant low down and pull out by hand (using gloves). Uprooting is similar but is undertaken on slightly older individuals with the major drawback being that a relatively large area can be disturbed with the soils being altered and opening the area up to re-infestation.
- **Chopping/ cutting/ slashing:** This method is most effective for plants in the immature stage, or for plants that have relatively woody stems/trunks. An effective method for non re-sprouters or in the case of re-sprouts (coppicing), it must be done in conjunction with chemical treatment of the cut stumps. Cut/slash the stem of the plant as near as possible to ground level. Paint re-sprouting plants with an appropriate herbicide immediately after they have been cut.
- **Strip bark:** Using a bush knife, strip bark away from tree from waist height down to soil. Cambium is stripped with the bark. No herbicide used.
- **Felling:** Large trees can be cut-down in their entirety, however, this is often not recommended unless absolutely necessary as large trees can play a pivot role in soil protection and biodiversity maintenance.
- **Girdling:** Girdling involves cutting a groove or notch into the trunk of a tree to interrupt the flow of sap between the roots and crown of the tree. The groove must completely encircle the trunk and should penetrate into the wood to a depth of at least 1.5 centimetres on small trees, and 2.5 to 4 centimetres on larger trees. The effectiveness of girdling can be increased by using herbicides.

2 Chemical control

Chemical control involves the use of registered herbicides to kill the target weed. The use of herbicide is often essential to the success of an eradication/control programme as it greatly reduces the re-growth potential of alien plants. Unfortunately, if the wrong herbicide is chosen, one can potentially cause more harm than good to the environment. When choosing the most appropriate herbicide, one needs to consider the following:

- **Relative toxicity to humans/animals**
- **Selective vs non-selective herbicides**: There are advantages and disadvantages to using each type. When dealing with light to moderate infestations in grass-dominated veld types, a broad-leaf selective herbicide is recommended so as to reduce the danger that spray drift could kill natural grass. In areas of heavy infestation, a non-selective herbicide is recommended.
- **Residual effect**: Some active ingredients in herbicides will remain in the environment for months, even years, before denaturing. Others start to denature as soon as they enter the soil. If a persistent herbicide is used, ensure that it is not used near any watercourse or area with a high water table (such as wetlands & riparian areas).
- **Is the herbicide registered for the target species:** A list of registered herbicides can be obtained from the Department of Water Affairs: Working for Water Programme – Policy on the Use of Herbicides for the Control of Alien Vegetation (January 2002). Also see http://www.arc.agric.za/arc-ppri/Pages/Weeds%20Research/Specific-IAP-Species-and-their-control-according-to-botanical-names.aspx

Some additional recommendations regarding herbicide use include:

- Herbicides should be applied during the active growing season.
- Always observe all safety precautions printed on the labels and manufacturer's instructions when mixing and applying herbicide.
- Herbicides can be applied in various ways. They can be sprayed onto dense infestations or painted onto the main stem of the plant or cut stump.
- Spraying herbicide on small infestations is not recommended, rather cut and apply herbicide to the stumps either with a brush.
- Spraying should be restricted to windless days when there is less risk of droplets drifting onto non-target species.
- Pressure or flow regulators should be fitted to sprayers for overall application. Spraying should be restricted to plants waist height or lower, but also ensuring there is sufficient foliage to carry the applied herbicide to the root system of the target plant.
- For water-based applications, Actipron Super Wetter should be added where recommended on the herbicide label, at a rate of 1.75/ha for dense-closed stands of alien vegetation.
- For all water-based treatments, a suitable brightly coloured dye should be added to the mix to ensure that all target plants are treated. For diesel-based applications, Sudan Red Dye should be added.
- Chemical control of IAPs is not recommended in aquatic systems due to the risk of water pollution, but may be used in conjunction with cutting or slashing of plants.
- Chemicals should only be applied by qualified personnel.
- Only herbicide registered for use on target species may be used.
- Follow the manufacturer's instructions carefully.
- Appropriate protective clothing must be worn.
- Only designated spray bottles to be used for applying chemicals.
- The number of herbicides for safe use under wet conditions is very limited.

3 Biological control
Biological weed control involves the releasing of natural biological enemies to reduce the vigor or reproductive potential of an invasive alien plant. Research into the biological control of invasive alien plants is the main activity of the Weeds Research Programme of ARC-PPRI and a list of biocontrol agents released against invasive alien plants in South Africa can be downloaded from their website. To obtain biocontrol agents, provincial representatives of the Working for Water Programme or the Directorate: Land Use and Soil Management (LUSM), Department of Agriculture, Forestry and Fisheries (DAFF).

4 Mycoherbicides
A mycoherbicide is a formulation of fungal spores in a carrier, which can be applied to weeds in a similar way as a conventional chemical herbicide (using herbicide application equipment). The spores germinate on the plant, penetrating plant tissues and causing a disease which can eventually kill the plant. Mycoherbicides are indigenous to the country of use and therefore are already naturally present in the environment and do not pose a risk to non-target plants. Under natural conditions they do not cause enough damage to the weed to have a damaging impact and are therefore mass produced and applied in an inundative inoculation, which leads to an epidemic of the disease knocking the weed population down. Mycoherbicides need to be re-applied at regular intervals.

5 Integrated control
It is frequently advisable to use a combination of two or more of the control method mentioned above, which is referred to as *integrated control*. Killing plants without cutting down causes the least disturbance to the soil and is the ideal.

The following integrated control options are available:

- **Basal bark and stem application**: apply recommended herbicide mixed in diesel carrier to the base of the stem of trees (<25cm stem height) and saplings. This method is appropriate for plants with thin bark or stems up to 25cm in diameter. Do not cut the bark. Apply herbicide mix with paintbrushes or using a coarse droplet spray from a narrow angle solid cone nozzle at low pressure. For multi-stemmed plants, each stem must be treated separately.

- **Ring barking**: Invasive trees growing away from any structures or roads can be ring-barked, poisoned and left standing rather than felled. They will slowly collapse over time and can establish habitat for birds, etc. Strip all bark and cambium from a height of 75cm to 100cm down to just below soil level. Cut a ring at the top and pull strips. All bark must be removed to below ground level for good results. Where clean de-barking is not possible due to crevices in the stem or where exposed roots are present, a combination of bark removal and basal stem treatments should be carried out. Bush knives or hatchets should be used for debarking.
- **Frilling:** Using an axe or bush knife, make angled cuts downward into the cambium layer through the bark in a ring. Ensure to effect the cuts around the entire stem and apply herbicide into the cuts.
- **Cut stump treatment**: This is a highly effective and appropriate control method for larger woody vegetation that has already been cut off close to the ground. The appropriate herbicide should be applied to the stump using a paintbrush within 30 min of being cut. Apply recommended herbicide mixture to the cut surface with hand sprayers, a paintbrush or knapsack sprayer at low pressure. Apply only to the cambium or outer layer of large stumps and the entire cut surface of small stumps. Ensure the stumps are cut as low to the ground as practically possible (about 10 – 15 cm or as stipulated on specific herbicide label). Herbicides are applied in diesel or water as recommended for the herbicide. Applications in diesel should be to the whole stump and exposed roots and in water to the cut area as recommended on the label.
- **Scrape and paint**: This method is suitable for large vines and scrambling plants i.e. creepers. Starting from the base of the stem, scrape 20-100cm of the stem to expose the sapwood just below the bark. Within 20 seconds apply the herbicide to the scraped section. Do not scrape around the stem. Stems over 1cm in diameter can be scraped in 2 sides. Leave the vines to die in place to prevent damaging any indigenous plants they may be growing over.
- **Foliar spray:** This is not an advocated method of application by unqualified applicators due to the danger of spraying indigenous species. Should be restricted to droplet application made directly on the leaves on plants that are no higher than knee height. Use a solid cone nozzle that ensures an even coverage on all leaves and stems to the point of runoff. Do not spray just before rain (a rainfall-free period of 6 hours is recommended) or before dew falls. Avoid spraying in windy weather as the spray may come into contact with non-target plants. Spraying dormant or drought stressed plants is not effective as they do not absorb enough of the herbicide.
- **Burning**: Spindly invasive alien plant species, such as Triffid Weed (*Chromolaena odorata*), growing on sandy soils, where there is between 30-40% grass still present, can be eradicated using annual controlled burns. Moderate to low infestations in wetland areas can be treated by controlled burning at the beginning of autumn, followed by mechanical removal or herbicide application in mid spring. ***Note that burning would generally not be acceptable in a developed area due to fire hazard/risk and nuisance.***
- *Note that no heavy machinery should be used to remove invasive alien plants, no matter how high the infestation, without prior authorization from relevant government departments when operating in wetlands and riverine areas.*

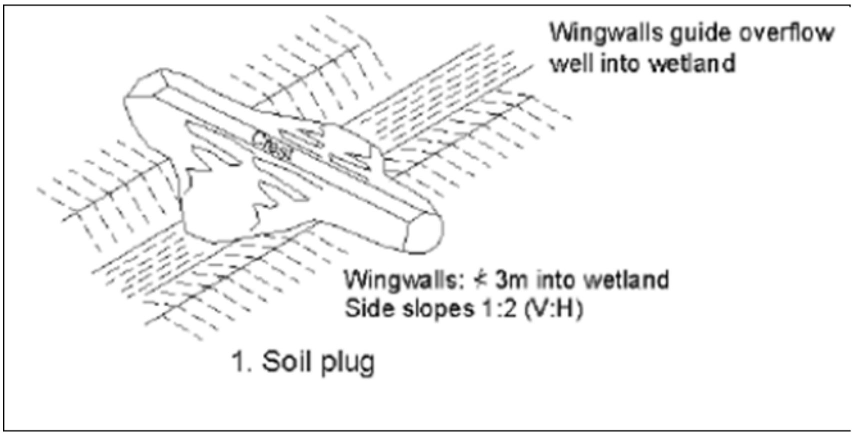
6 Disposal of alien plant material

Treated/removed alien plant material will need to be removed from the site and disposed of at a proper/registered receiving area such as a local registered land fill site.

STEP 4: Address erosion risks and artificial drainage

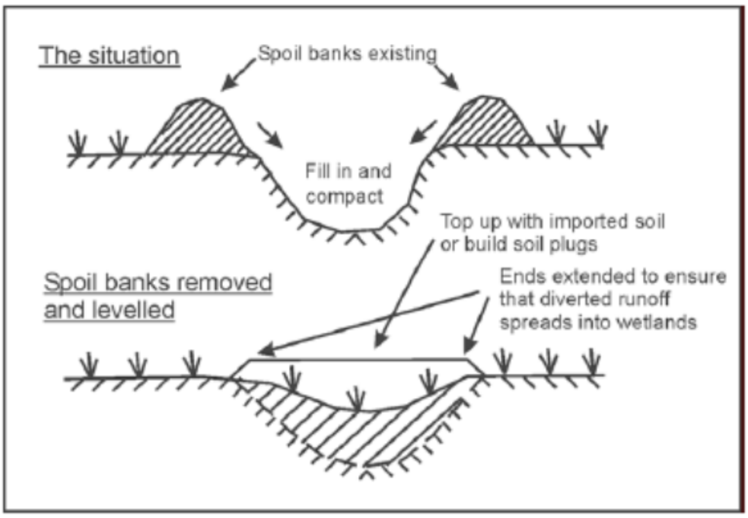
Any artificial drainage impacts need to be addressed to reinstate wetland hydrological functioning before the vegetation can recover naturally or be reinstated.

For small (minor), shallow drains the quickest and simplest method to deactivate the network of small/shallow artificial drainage channels within the wetland is either to backfill with soil and compact or alternatively to use earth plugs at intervals along the drain to "plug" the drains which will naturally silt-up, stabilise and become vegetated. It is recommended that earthen plugs be used to deactivate the drains as this will require less material and be less labour intensive and will ultimately still be able to achieve the desired effect. A maximum spacing of 20m between plugs is recommended along the length of each drain. Back-filling of small shallow drains can only take place where there is adequate material at the site, which is a major limitation for this property.



Example 1: Conceptual drawing and example of a soil or earth 'plug' designed to typically deactivate small artificial drains (Source: Russell, 2009).

Example 2: Example of 'Soil Plugs designed to deactivate small/shallow artificial drains at a wetland in the Ballito area (Source: Eco-Pulse).



Example 3: Conceptual drawing and example of back-filling of small artificial drains and eroded gullies with soil & other natural material such a rock (Source: Russell, 2009).

For larger drains / erosion gullies and where higher volumes and flow velocities are experienced, more robust structures such as concrete buttress weirs or concrete-capped gabion weirs should be used to deactivate the drainage effect by back-flooding the artificial drains / gullies and promoting over-topping of the drains to re-wet adjacent wetland areas and spread flows more broadly over the wetland surface. The spillway for each weir will need to be as close to natural wetland level as possible to promote back-flooding and full drain deactivation as well as over-topping of the drains during the wet season to re-activate the adjacent desiccated wetland areas. An earthen spreader berm may also be included in weir design to promote the spreading of flows towards distal wetland areas and to prevent flows from bypassing the weir and re-entering the drains/gulley.

Example 4: Example of a concrete buttress weir placed within an incised drain to raise the water level and effectively 'deactivate' an incised drain within a wetland system in the Free State Province as part of the SANBI/DEA Working for Wetland Programme (Source; Eco-Pulse).

Erosion 'headcuts' (often linked with road and culvert impacts) may need to be rehabilitated as where active these erosion features can pose a significant threat of 'advancing' further up the wetland (especially during large flows when erosive potential is high) and this could result in extensive gulley erosion to the detriment of the wetland habitat and functioning. Where relevant, this risk therefore needs to be addressed to avoid further wetland erosion and subsequent habitat degradation.

One proven method of 'deactivating' the headcuts is to construct concrete-filled geocell or gabion 'chutes' at the site of the headcut. An example of a concrete/geocell chute employed to deactivate an erosion headcut is shown below.

Example 5: Example of a concrete filled geocell chute designed to 'deactivate' an erosion headcut from advancing and forming a gulley/donga within a wetland system in the Free State Province as part of the SANBI/DEA Working for Wetland Programme (Source; Eco-Pulse). (Source: Eco-Pulse Consulting).

An alternative would be to construct a small 'drop-inlet' type weir to deactivate at the point of the headcut, an example of which is shown below.

Example 6: Example of a drop-inlet type concrete weir designed to 'deactivate' an erosion headcut from advancing and forming a gulley/donga in the Free State Province as part of the SANBI/DEA Working for Wetland Programme (Source; Eco-Pulse). (Source: Eco-Pulse Consulting). (Source: Eco-Pulse Consulting).

STEP 5: Re-vegetation

Vegetation plays an important role in natural wetland ecosystems. Wetland/aquatic vegetation has compositional and structural characteristics that provide specialized habitats for a range of wetland dependent organisms and is well known for providing a range of wetland ecosystem goods and services (Macfarlane et al., 2008). Aquatic plants assist in binding the soil together and slow down the flow of water, reducing the risk of erosion and promoting sediment deposition. They are also a major source of organic material in wetland/river soils and can affect the quality of surface and subsurface water by providing soil organic matter required by microbes to assimilate nutrients and toxicants and plants contribute through direct uptake of nutrients and toxicants (Russell, 2009). Owing to the vital role *of aquatic vegetation in wetland ecosystem health and functioning, the re-establishment of natural or semi-natural vegetation is widely recognized as an important component of any wetland rehabilitation programme. The establishment of plants can be a rehabilitation intervention in its own right or can be used to complement other interventions (Russell, 2009).*

Generally, the broad aim of re-vegetation should be to introduce desirable plants in order to develop a wetland/aquatic plant community that will eventually become naturally self-sustaining over time (Brock & Casanova, 2000).

Note that prior to commencing with any revegetation activity (e.g. planting/seeding), it is important that disturbed areas are adequately prepared in advance. The following guidelines apply during this phase of wetland rehabilitation:

- During site preparation, all waste products (spoil, construction materials, hazardous substances and general litter) need to be removed from the site and disposed of at an appropriate landfill site.
- Minimise additional disturbance by limiting the use of heavy vehicles and personnel during clean-up operations.
- Any large plumes of sediment collected in temporary storm water infrastructure must be removed, taking care not to remove or disturb the natural soil profile.
- Exposed slopes are to be stabilized either through use of a retaining wall or cut the slope to 1:3 and re-vegetated as soon as practically possible.
- Erosion control and soil protection measures such as geofabric, eco-logs and biodegradable silt fences must generally be installed prior to revegetation.
- Rip and / or scarify all disturbed and compacted areas of the construction site. The ECO with the assistance of the engineer will specify whether ripping and / or scarifying is necessary, based on the site conditions.
- Do not rip and / or scarify areas that are saturated with water, as the soil will not break up.
- If required, topsoil must be imported. Imported or stored topsoil must be re-spread across the reshaped surfaces prior to revegetation.
- For the hydroseeding the soil will need to be prepared to optimise germination. Such preparation may be undertaken by racking. The soil in the seedbed should be loosened to facilitate good contact between the seeds and the soil.

Once construction is completed and alien vegetation and waste products have been removed and soils are prepared for planting, vegetation is to be reinstated as soon as weather conditions allow for good plant growth according to the following guidelines:

- The soil which is to be planted should be watered to within 10% of field capacity the day before planting ('Field Capacity' is the amount of soil moisture or water content held in soil after excess water has drained away and the rate of downward movement has decreased, which usually takes place within 2–3 days after a rain or irrigation in pervious soils of uniform structure and texture.

- Revegetation should focus primarily on all bare exposed/ unstable soils within and in close proximity to wetlands.
- For central/permanent or seasonal wetland areas: wetland sedges, rushes and grasses occurring within the areas to be disturbed should be rescued, temporarily stored onsite and transplanted later on. Wetland plants occurring in these areas that can be rescued/harvested and used in transplanting may include: *Phragmites australis, Typha capensis, Juncus* spp. and various smaller sedges (*Cyperus* spp.)
- For the temporary wetland areas: re-vegetation should be undertaken by seeding or planting the following species: *Aristida junciformis, Digitaria eriantha, Andropogon eucomus, Imperata cylindrical.*

Note that the final species selection will depend on which species are commercially available at the time of wetland rehabilitation taking place and which species propagules are present within local 'donor' wetlands for harvesting and transplanting.

It is recommended that methods of re-vegetation that have proven successful, efficient and cost effective in the past be used. The general method of riparian areas re-vegetation recommended for the site is detailed below:

- ***No exotic/alien plants are to be used in re-vegetation.***
- The following planting procedures are recommended for herbaceous wetland plants:
    - Transplanting or planting of live wetland plants or plant parts (also termed propagules) should be undertaken within disturbed wetland areas that are permanently to seasonally saturated/inundated to establish emergent aquatic vegetation in shallow open water, deep marsh and shallow marsh zones where seed can often be difficult to establish in these "wet" zones.
    - It is recommended that wetland plants be established in specific 'zones' according to the natural wetness regime present at the site, with permanent wetland within standing water areas fringed by seasonally saturated wetland as one retreats from the central 'core' area of the wetland and the habitat grades from tall reeds and sedges towards grasses and ferns and transitions to drier terrestrial grasses.
    - It is recommended that one transplants sods or sprigs from existing wetland plants at the site or harvest seed and other suitable vegetative parts (propagules) from plants in existing wetland plant populations nearby.
    - Mono-specific planting should be avoided as diversity is the key to robustness, which will assist in retaining sediment and preventing erosion. For this purpose, a mixture of naturally occurring grasses and sedges be sourced and used in the re-vegetation of wetland areas subject to disturbance.
    - The timing of planting is best done shortly before or at the beginning of the growing season (i.e. spring, or at the onset/early summer), however given the typical need to rehabilitate disturbed wetlands as a priority, planting should occur as soon as practically possible.

- A recommended approximate average planting density of 2–3 plants per m^2 generally applies to wetlands (Clarkson and Peters, 2012) (depending of course on the size of the individual plant material of course). Some of the larger sedges/rushes may be planted at even lower densities of only 1 plant per m^2 for example, whilst the smaller sedges will likely require a higher planting density of up to 8 plants per m^2.
- When using vegetation plugs, the spacing of plugs should not be too wide and planting should be done in patches rather than wider spacing. Hoag (2005) recommends a spacing of 46-50cm centers in patches that are about $3m^2$ in terms of extent/area and spaced about 3m apart. Over time the plants will then spread via natural recruitment from the planted areas into adjoining unplanted parts of the wetland, particularly along water flow paths.
- Vegetation that has very recently been planted is generally susceptible to being washed away until it has become well established, particularly in areas of permanent water flow or high-energy environments. It may be necessary to 'stake' plants into the ground where substrate is unstable or where there is standing water so that they don't wash away or use a vegetative blanket or similar material such as coarse mesh (steel wire or plastic) and/or a fine biodegradable mat placed over the vegetation to secure the plants while they become established to secure the vegetation. The plants must be able to grow unhindered through the mesh or mat. Biodegradable fibre mats may be placed on the soil surface to protect the soil from erosion and will generally decompose by the time the vegetation has become well established. Mats can be staked down or held down with timber batons tied down using duckbill anchors. Planting can also be done into holes punched in sisal bags filled with soil and buried, or into ecologs.
- Note that if the soil into which the plugs are to be planted is dry (unlikely for most wetlands), it will be necessary to add a suitable hydroscopic gel to the receiving cavity at the time the plug is planted (Granger, 2014).
- It is essential that when a plug is planted that the receiving cavity is slightly deeper than the length of the root ball so that when the cavity is pinched closed a slight depression remains around the base of the leaves. This is especially important if the plugs are small and planted into dry soil even though hydroscopic gel has been added to the cavity.
- Transplanted plants should be planted with their roots in as much of the original soil medium as possible from which they were removed and in a water depth similar to that where they were collected. The bottom of the root ball should be in contact with the saturation zone (Hoag, 2005).
- Plants in general must be planted with their tops out of the water or they will die.
- The soil around the plant should be firmly compacted.
- Leaves of large plants should be trimmed back to about 10 to 15cm in length so as to reduce water losses through transpiration.
- No form of fertilizer, or soil ameliorant such as lime, should be used in the planting of any wetland and neither should any fertilizer or soil ameliorant be allowed to enter any

wetland from any adjacent area which is being prepared for or is in the process of being re-vegetated.

- The site should be monitored through visual inspections at regular intervals to determine whether planting has been successful and whether further intervention may be required (see STEP6: Aftercare/Maintenance and Monitoring requirements). It is essential that survival of all plants be monitored closely for at least the first eight weeks from the day following their planting and any dead plants be replaced as soon as possible.

Recommendations for Sourcing Seed / Plant Material for Planting:

When sourcing seed and live plant plugs for broadcasting and plug planting it is important to consider the recommendation outlined below:

- When looking at transplanting* live plants, select nearby 'donor 'wetland vegetation at the site that is dense and indigenous that can be selectively harvested.
- Tubers and rhizomes of wetland species can be collected and replanted where required.
- If seed is to be used it should be harvested from plants which are growing as close as possible to the site where the seedlings are to be planted (to minimise the risk of contaminating local gene pools).
- Note that collection/harvesting of indigenous plants (whole plants, plant material or seed) may generally only take place with the appropriate permits and with permission from the land owner on which donor wetlands occur.
- Harvesting of plants must be done with caution so as not to unduly disturb the donor wetland. Material from within stream channels, flow concentration zones or in any other areas susceptible to erosion should not be targeted for plant harvesting.
- Collection should limit habitat destruction by implementing a "mosaic collection" method to ensure limited disturbance and adequate recovery of the donor site.
- Use individuals of local species taken from surrounding areas, in order to avoid or reduce genetic pollution. Collection of plant material should be well-documented (locality specifically) such that plant origins are known.
- Plant/seed collection should be undertaken under the strict supervision of a qualified botanist who is able to recognize the various wetland plant species in the field.
- Wetland plant harvesting should be sustainable by ensuring that plants can still recover where cuttings are taken and that at least 50% of seeding material is retained to allow plants to complete their life-cycles (Kerry Seppings, 2011).
- For whole/growing plants, ensure that plants are dug up with as much of their roots intact and such that the soil around the roots is not disturbed (i.e. intact root ball). Care also needs to be taken that weeds/alien plants are not transplanted with the donor plants.
- Collected plants should be replanted as quickly as possible following removal (i.e. within a day or two of harvesting).
- Large clumps of plants can be carefully separated into smaller clumps or into several individual stems with attached roots, known as slips.

- Whenever sourcing plants from nurseries, it is important to consider the genetic origin of the plants. It is considered best to use small regional nurseries that breed plants from the region, instead of large commercial nurseries that are likely to obtain stock from large regional suppliers. It is also important to note that few nurseries maintain the quantities of plugs that are needed for the proposed re-vegetation. Therefore, it is essential that the following recommendations be implemented (after Granger, 2014):
  - A nursery that has the experienced staff and facilities capable of producing large quantities of the recommended species in the format required is identified and notified prior to construction commencing.
  - The proposed species are perennial and therefore produce seed once a year. Therefore, it is essential that the nursery which is to supply the plugs be appointed as soon as possible so that they have sufficient time to harvest seed and other propagation material.
  - Because plants grown as plugs in plastic or polystyrene trays have a limited lifespan in these trays (about 3 months depending on time of year and some other factors), it is essential that there is close and frequent communication between the nursery who is to supply the plants and the contractor who is to undertake the planting. It is extremely important that the rate of supply of the required quantities of the specified species coincides with the rate at which they can be planted. Failure to achieve this coordination may result in rehabilitation being set back by a year or more.

Buffer zone re-vegetation:

A 15m conservation bufferzone has been recommended, measured from the outer edge of the delineated wetland on the property. The bufferzone is to be maintained as indigenous terrestrial coastal grassland. The terrestrial grassland habitat at the site is in relatively good condition and should recover post-construction with some intervention required. Re-vegetation of the terrestrial grassland within the 15m buffer zone will need to consider establishing an initial grass cover to prevent erosion of any bare soils using indigenous grasses common to the site such as *Aristida junciformis* (Ngongoni grass), predominantly.

STEP 6: Aftercare/Maintenance, Monitoring & Evaluation

Aftercare, maintenance, monitoring and evaluation of rehabilitation and re-vegetation efforts must be undertaken during and after rehabilitation has been completed. The monitoring and evaluation of rehabilitation activities and outcomes is critical in assessing the extent to which the rehabilitation plan has achieved what it set out to accomplish. Monitoring the condition of the re-established vegetation cover will be necessary to assess particular aftercare or plant maintenance requirements. Visual monitoring of the site must be carried out in accordance with the rehabilitation plan at regular intervals during the rehabilitation process. The benefit of regular monitoring will be that problems can be quickly identified and easily addressed during the process whilst rehabilitation teams are busy at the site.

The monitoring process must be conducted in the presence of the main contractor by a suitably qualified external/independent party, such as an Environmental Control Officer (ECO) but can also be undertaken by the Environmental Site Officer (ESO), Competent Authority and Interested and Affected Parties (I&APs). Should any defects or failures be identified during each monitoring exercise, the main contractor must take all necessary and relevant actions address these immediately and accordingly. The recovery of disturbed areas that have been rehabilitated should be assessed for at least the first 3 months following rehabilitation completion to assess the success of rehabilitation actions. Any areas that are not progressing satisfactorily must be identified (e.g. on a map) and action must be taken to actively re-vegetate these areas. If natural recovery is progressing well, no further intervention may be required. The ECO should assess the need / desirability for further monitoring and control after the first 6 months and include any recommendations for further action to the relevant environmental authority. Table 8 (below) provides a basic monitoring framework and checklist of the rehabilitation aspects to be monitored.

Table 8. Description of basic visual monitoring requirements to assess the success of wetland/riparian areas rehabilitation.

Aspect	Description	Frequency of monitoring
Solid waste and construction rubble	Has all solid waste, litter and construction rubble been adequately cleared from the site and disposed of at a registered site?	Weekly
Salvaged indigenous species	Are salvaged indigenous species being watered twice a week? Are there any mortalities?	Bi-weekly
Watering/maintenance requirements of planted grass, trees and shrubs	What is the plant survival rate? Are there areas of bare soil/poor growth? Is there a need for follow-up re-vegetation?	Weekly
Response of planted grass, trees and shrubs	What is the progress of re-vegetation planting? Are there areas of bare soil/poor growth?	Bi-weekly
Alien plant control and eradication (including follow-up control	Are there dense infestations of alien plants within and around the rehabilitated site? (Seedlings, shoots, coppice growth, etc.) Is there a need for further follow-up control?	Weekly during and immediately after rehab, thereafter on a monthly basis
Sediment barriers/traps and erosion control measures	Are sediment/erosion controls functioning adequately? Have these been properly maintained? Are there signs of erosion/sedimentation?	Daily during rehabilitation

Upon completion of the planned wetland rehabilitation, an evaluation of the success of the rehabilitation project will need to be undertaken in order to facilitate the dissemination of lessons learnt and provide a means of reporting on the success of specific rehabilitation initiatives. In order to evaluate project success, the following attributes/rehabilitation indicators need to be clearly defined and understood:

i. Aspects/values of interest referred to herewith as 'concerns';
ii. Level of achievement required to consider the rehabilitation exercise successful; and
iii. Quantitative performance level used as a desirable target.

Table 9, below, provides for basic rehabilitation evaluation guidelines useful for evaluating the success of the wetland rehabilitation project. The evaluation process can be conducted by the developer, Competent Authority, I&APs or an independent ECO after a period of 3-6 months post-completion of the rehabilitation process. An external audit report on performance should ideally be provided as part of the rehabilitation project success evaluation process.

Table 9. Summary guideline for evaluating the success of rehabilitation.

Item	Aspect to Evaluate	Performance indicator	Desired Target
1	**There should be low levels of Invasive Alien Plants**	IAP species cover/abundance	<10% IAP cover
2	**Indigenous vegetation should be re-instated**	Indigenous species cover/abundance	>90% indigenous cover
3	**Erosion and slope instability should be managed appropriately**	Signs of soil erosion and slope/bank instability	No signs of erosion
4	**Wetlands and Riparian areas should be adequately re-planted**	Indigenous tree/shrub cover/abundance	No large gaps in the vegetation structure or bare soils
5	**Sedimentation of water resources must be limited**	Signs of sedimentation in downstream channel	No signs of major sedimentation/turbidity in water column
6	**There should be no foreign solid waste materials or waste within rehabilitated areas**	Solid waste/litter levels	No solid waste remaining

5.3 Potential negative impacts of rehabilitation

While the intention of wetland/river rehabilitation should always be to benefit the environment and society through the protection or improvement of wetland ecosystems and the goods and services that they provide, poorly planned rehabilitation interventions can often cause more harm than good (Armstrong, 2008). Rehabilitation interventions vary considerably in terms of their potential to cause environmental impacts both in terms of the type of impact caused as well as the magnitude of the impact. Thus it is appropriate that all wetland rehabilitation projects are scrutinized for their potential to cause unintended, negative environmental impacts (Armstrong, 2008) Potential negative impacts associated with wetland rehabilitation projects are highlighted in Armstrong (2008), and those most relevant to this aquatic rehabilitation plan have been summarised in Table 10, below.

It is recommended that these and other potential negative impacts be noted by the Implementing Agent for the rehabilitation and managed on-site according to the various 'means of avoidance/mitigation' detailed in Table 10 (below) in conjunction with the impact management and mitigation measures included in ***Chapter 6 of the Specialist Wetland Assessment Report (Eco-Pulse, 2018, Report No. EP341-02).***

Table 10. Key potential negative environmental impacts associated with wetland/riparian rehabilitation activities and interventions and means of avoiding or mitigating these impacts (after Armstrong, 2008).

Item	Rehabilitation Interventions/Actions	Potential negative environmental consequences	Means of avoidance or mitigation
1	**A weir, earthen plug or sediment fence across a stream channel, artificial Drainage channel or erosion gully**	Trapping of bedload and spreading of high flows.	Little that can be done to mitigate this impact.
2	**Sloping of steep slopes and erosion gully head/sides**	Exposure of soils to risk of erosion, which may impact negatively on the wetland and downstream aquatic habitats.	Assess whether bioengineering will be adequate. Ensure re-vegetation takes place as rapidly as possible. Provide supplementary support (e.g., biomats, ecologs, etc.) to the vegetation, where required.

Item	Rehabilitation Interventions/Actions	Potential negative environmental consequences	Means of avoidance or mitigation
3	**Infilling of erosion gullies or artificial drainage channels**	Fill material may become washed away, which may impact negatively on the wetland and downstream aquatic habitats. Obtaining fill will also have associated impacts	Re-vegetate the fill as quickly as possible. Temporarily divert flow, if required, until the fill has become adequately re-vegetated.
4	**Planting of vegetation**	Introduction of alien species that spread beyond the site. Use of plant material of indigenous species that is genetically different to that occurring locally, resulting in 'genetic contamination'.	Do not use species with invasive potential. Use local material only.
5	**Any structures, particularly those of concrete, that do not become re-vegetated**	Aesthetic impact, which is of particular importance where a sense of the natural environment is maintained in the general area.	Keep structures as low as possible. Where possible. Encourage tall vegetation to grow in front of structures. Add natural pigment to concrete.
6	**Any structure with a high risk of failure**	Failure of a structure may act to focus gully erosion, which may impact negatively on the wetland and downstream aquatic habitats.	The designs of all structures must match the anticipated flood discharge levels at a site.
7	**Any intervention resulting in an increased level of wetness or flooding across the wetland surface**	Increased risk to road-crossings or other infrastructure in the area of increased flooding. Check the area to be flooded for any infrastructure.	All landholders to be consulted to determine their use of the wetland, and whether increased wetness would interfere with this. Alternative crossing points may exist.
8	**Any intervention resulting in the increased growth of tall vegetation in response to increased level of wetness**	In an urban context, in particular, this may provide increased opportunities for criminals to hide.	Promote the growth of shorter vegetation. Promote more open water habitat.
9	**Access to the site during rehabilitation by workers and equipment**	Soil compaction and disturbance and vegetation disturbance.	As far as possible, use existing roads and tracks. In very wet areas obtain foot access using boards. Rehabilitate access paths when work is complete (e.g. loosen compacted areas).
10	**Temporary storage of materials**	Disturbance of vegetation. Visual impact.	Remove all material on completion of the work. Rehabilitate site when work is complete.
11	**Mixing of concrete**	Local contamination of the soil.	Confine mixing of concrete to designated area/s not susceptible to flooding.
12	**Human waste associated with toilets**	Contamination of soil and water.	Locate toilets outside of the wetland.
13	**Disturbance associated with the noise and presence of workers**	Disturbance of fauna, particularly breeding Red Data species.	Consider timing of activities. Screening with shade-cloth, if required.
14	**Fuel spills or leaks**	Contamination of soil and water.	Maintain any machines (e.g., pumps) being used at the site in good working order, and any stored fuel should be located well outside of the wetland.
15	**Temporary diversion channels**	Temporary drying out (usually not great, and of a short duration). If not properly rehabilitated, the diversion could become the focus of long-term erosion.	Ensure that the diversion channel is fully blocked, in-filled and re-vegetated once work is complete.
16	**Removal of plugs of vegetation from donor wetland sites**	Potential exposure of donor sites to erosion. Disturbance of sensitive habitat.	Remove plugs where the threat of erosion is low and the site is not considered sensitive.

Item	Rehabilitation Interventions/Actions	Potential negative environmental consequences	Means of avoidance or mitigation
17	**Cutting and filling (e.g. in order to slope a gully head or sides)**	Disturbance of soil and vegetation. Erosion and washing of sediment into downstream habitats.	Where the site is located in water flow paths, particularly where discharges are high, confine activity to the dry season. Divert flow until the intervention is well stabilised. Encourage rapid re-vegetation.
18	**Collection of rocks and material from the local environment**	Loss of habitat from rock removal.	Do not collect rocks or sediments from a stream channel bed.
19	**Collection of local sand**	Disturbance of vegetation, possible increase in risk of erosion.	Collect sand where risk of erosion is low and in areas where pioneer vegetation dominates.
20	**In all cases of disturbance of soil or vegetation, the opportunities for invasive alien species to invade are increased,**	Competition and displacement of native vegetation, loss of biodiversity, increased soil erosion/fire risk, increased water consumption (depending on species of IAPs).	Control alien plants and weeds.

6 CONCLUSION

This 'Conceptual Wetland Rehabilitation Plan' has provided a conceptual-level plan to inform the EIA/WULA processes and to guide and inform the development of a detailed rehabilitation plan for the wetlands at the site of the proposed Wildcoast SEZ Phase 1 development. **Note that this document/plan is not intended to be a detailed plan for implementation purposes. A detailed wetland rehabilitation plan will still need to be developed for the wetlands on the property.**

The following are outstanding tasks that still need to be completed as part of the finalisation of rehabilitation planning:

a) Defining key roles and responsibilities and budgets for implementation.
b) Identification and estimation of the final extent of areas requiring wetland rehabilitation.
c) Development of an implementation plan based on the phasing of construction activities and expected completion dates.
d) Comprehensive list of plant species required for rehabilitation based on availability of plants.
e) Development of a detailed planting strategy and planting method that is specific to target areas.
f) Compilation of a detailed method statement that addresses the following issues:
    - Stabilisation measures and resources based on slope and soil types.
    - Methods and equipment for IAP clearing.
    - Planting methods, preferred species, plant spacing and densities.
    - Bill of quantities and costs for all interventions (including re-vegetation).

7 REFERENCES

ARC-PPRI (Agricultural Research Commission: Plant Protection Research Institute) Weed Research Programme (online at www.arc.agric.za/arc-ppri/)

Armstrong A, 2008. WET-Legal: Wetland rehabilitation and the law in South Africa. WRC Report No. TT 338/08. Water Research Commission, Pretoria.

Brock, M.A. and Casanova, M.T., 2000. Are there plants in your wetland: Revegetating wetlands. LWRRDC, UNE, DLWC and EA.

Bromilow, C., 2010. Problem Plants and Alien Weeds of South Africa. Third Edition. Briza Publications, Pretoria, South Africa.

Cafferata, P., Spittler, T., Wopat, M., Bundros, G. and Flanagan, S. (2004). Designing Watercourse Crossings for Passage of 100 Year Flood Flows, Wood, and Sediment. California Department of Forestry and Fire Protection. Sacramento, CA.

Clarkson, B. and Peters, M., 2012. Wetland Restoration: A handbook for New Zealand Freshwater Systems. Chapter 10: Revegetation. NSW Murray Wetlands Working Group Inc., Albury NSW.

Cowden, C., Kotze, D. and Pike, T. 2013. Assessment of the long-term response of two wetlands to working for wetland rehabilitation. Report to the WRC (Water Research Commission). Report No. 2035/1/13. ISBN 978-1-3412-0396-3. April 2013.

Cowden, C. and Kotze, D.C., 2008. WETRehabEvaluate: Guidelines for the monitoring and evaluation of wetland rehabilitation projects. WRC Report No TT 342/08, Water Research Commission, Pretoria.

DEFRA (Department for Environment, Food and Rural Affairs). 2005. Controlling soil erosion: A manual for the assessment and management of agricultural land at risk of water erosion in lowland England. Crown copyright, 2005. United Kingdom.

Department of Environmental Affairs. 2008. Okavango Delta Management Plan: January 2008. Report developed as part of the Okavango Delta Management Plan Project.

Department of Environmental Affairs, Department of Mineral Resources, Chamber of Mines, South African Mining and Biodiversity Forum and South African Biodiversity Institute. 2013. Mining and Biodiversity Guideline: Mainstreaming biodiversity into the mining sector. Pretoria.

Didham, R. K., Tylianakis, J. M., Hutchison, M. A., Ewers, R. M. and Gemmell, N, J. 2005: Are invasive species the drivers of ecological change, Trends in Ecology and Evolution, 20 (9), p470-474.

DRAINAGE CRITERIA MANUAL (V. 2) REVEGETATION 06/2001 1993. Design Workbook for Establishment of Natural Vegetation. Denver, CO: Urban Drainage and Flood Control District.

Driver, A., Maze, K., Rouget, M., Lombard, A.T., Nel, J., Turpie, J.K., Cowling, R.M., Desmet, P., Goodman, P., Harris, J., Jonas, Z., Reyers, B., Sink, K., Strauss, T., 2005. National Spatial Biodiversity Assessment 2004: Priorities for biodiversity conservation in South Africa. Strelitzia 17. South African National Biodiversity Institute, Pretoria.

ERO Resources Corporation, 1997. City of boulder: Wetland Protection Program Best Practices: Revegetation Rules. Wetland publication series No. 6. First Edition.

eThekwini Municipality, 2002. Revegetation specification for engineering construction projects. Unpublished literature.

FERC (US Federal Energy Regulatory Commission), 2002. Wetland and Waterbody construction and mitigation procedures.

Furniss, M.J., Ledwith, T.S., Love, M.A, McFadin, B.A. and Flanagan, S.A.(1998). Response of Roadstream Crossings to Large Flood Events in Washington, Oregon, and Northern California. USDA Forest Service. Technology and Development Program. 9877–1806—SDTDC. 14 p.

Hoag, J.C., 2005. Wetland Revegetation Planning. *Technical Notes: Plant Material.* U.S. Department of Agriculture: Natural Resources Conservation Service. Spokane, Washington. February 2005.

Jacobson, R.L., 2006. Restoring & Managing Native Wetland & Upland Vegetation. Minnesota Board of Soil & Water Resources Minnesota Department of Transportation. January 2006.

Kentula, M.E., Magee, T.K. and Nahlik, A.M., 2011. Potential Frameworks for Reporting on Ecological Condition and Ecosystem Services for the 2011 National Wetland Condition Assessment. EPA/600/R11/104. U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC.

Kotze, D.C., Breen C.M., Nxele, I.Z. and Kareko, J., 2007. WET-ManagementReview: The impact of natural resource management programmes on wetlands in South Africa. WRC Report No TT 335/08, Water Research Commission, Pretoria.

Mitch, W. J. and Gosselink, J. G., 2007. Wetlands. Fourth Edition. John Wiley & Sons, New York.

Mooney, H.A., 2005. Invasive alien species: the nature of the problem. In: Mooney, H.A., Mack, R.N., McNeely, J.A., Neville, L.E., Schei, P.J., Waage, J.K. (Eds.), Invasive Alien Species: A New Synthesis. Island Press, Washington, DC, pp. 1–15.

Mucina, L. and Rutherford, M. C. (eds) 2006. The Vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

Mulibana, N.E. 2001. Analysis and synthesis of data on relationships between soil factors and soil erosion in South Africa. Dissertation submiited in partial fulfilment of the requirement fo a Magister Instititionis Agrariae in Land Use Planning. Faculty of Natural & Agricultural Science, University of Pretoria, South Africa. December 2001.

O'Connor, T.G., 2005. Influence of land use on plant community composition and diversity in Highland Sourveld grassland in the southern Drakensberg, South Africa. J. Appl. Ecol. 42: 975–988.

Olsen, D.M., Dinerstein, E., 1998. The global 200: a representation approach to conserving the earth's most biologically valuable ecoregions. Cons. Biol. 12, 502-515.

Palmer CG, Berold RS and Muller WJ (2004) Environmental water quality in water resources management. WRC Report No TT 217/04, Water Research Commission, Pretoria, South Africa

Ramsar Convention on Wetlands, 2012. Resolution XI.9: An Integrated Framework and guidelines for avoiding, mitigating and compensating for wetland losses. 11th Meeting of the Conference of the Parties to the Convention on Wetlands, Bucharest, Romania, 6-13 July 2012.

Ramsar Convention Secretariat, 2010. Wise use of wetlands: Concepts and approaches for the wise use of wetlands. Ramsar handbooks for the wise use of wetlands, 4th edition, vol. 1. Ramsar Convention Secretariat, Gland, Switzerland.

Ramsar Convention Secretariat, 2010. Managing wetlands: Frameworks for managing Wetlands of International Importance and other wetland sites. Ramsar handbooks for the wise use of wetlands, 4th edition, vol. 18. Ramsar Convention Secretariat, Gland, Switzerland

Russell, W.B., 2009. WET-Rehab Methods: National guidelines and methods for wetland rehabilitation. WRC Report No. TT 341/09. Water Research Commission, Pretoria.

SANBI Working for Wetlands Programme, 2010. Construction Environmental Management Plan (CEMP) for Working for Wetlands Projects. Working for Wetlands Programme Planning, Monitoring and Evaluation Section. September 2010, Version 1.

Sieben, E.J.J., Mtshali, H. and Janks, M. 2014. National Wetland Vegetation Database: Classification and analysis of wetland vegetation types for conservation planning and monitoring. Water Research Commission (WRC) Report No. 1980/1/14. ISBN 978-1-4312-0569-1. July 2014.

South African National Biodiversity Institute (SANBI), 2011. Compilation of Ecosystem Guidelines for the Land-Use Mainstreaming Component of the Grasslands Programme: Draft 3. Compiled by Wetland Consulting Services (Pty) Ltd. 75pp.

Van Wilgen, B.W., Forsyth, G., Le Maitre, D.C., Wannenburgh, A., Kotze, J.D.F., Van den Berg, E. and Henderson, L. 2012. An assessment of the effectiveness of a large, national-scale invasive alien plant control strategy in South Africa. Biological Conservation 148: 28–38.

Van Ginkel, C.E., Glen, R.P., Gordan-Gray, K.D., Cilliers, C.J., Muasya and van Deventer, P.P., 2011. Easy identification of some South African Wetland Plants (Grasses, Resticios, Sedges, Rushes, Bulrushes, Eriocaulons and Yellow-eyed grasses). WRC Report No. TT 459/10.

Van Oudtshoorn, F., 2006. Guide to grasses of Southern Africa. Pretoria, South Africa.

Wetland Care Australia, 2008. Wetland Rehabilitation Guidelines for the Great Barrier Reef catchment. Compiled for Department of the Environment, Water, Heritage and the Arts.