Proposed Inkosi Phalane Retail Centre and Fuel Service Station in Esikhawini, uMhlatuze Local Municipality, KwaZulu-Natal

AQUATIC & WETLAND ECOSYSTEM IMPACT ASSESSMENT REPORT

7th March 2023

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Declaration of Independence

This is to certify that the following report has been prepared as per the requirements of:

- Section 32 (3) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) Environmental Impact Assessment Regulations 2017 as per Government Notice No. 40772 Government Gazette, 4 December 2014 (as amended); and

- The Department of Water & Sanitation for Water Use Licensing and wetland assessment, 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.

I, **Ryan Edwards**, hereby declare that this report has been prepared independently of any influence or prejudice as may be specified by the Department of Water and Sanitation (DWS), Department of Forestry, Fisheries and the Environment (DFFE) and/or the KZN Department of Economic Development, Tourism and Environmental Affairs (EDTEA).

Signed:

Date:
7 March 2023

Table of Contents

1. Introduction & Background 1
1.1. Location and Description of the Proposed Development Activities 1
1.2. Purpose of the Assessment 3
1.3. Scope of Work 3
1.4. Key definitions and concepts 4
1.5. Legislative Context Relevant to Freshwater Ecosystems 6
1.5.1. National Water Act (Act No. 36 of 1998) ('NWA') 6
1.5.2. National Environmental Management Act (No. 107 of 1998) ('NEMA') 7
1.5.3. Conservation of Agricultural Resources Act (No. 43 of 1983) ('CARA') 7
2. Methods 8
2.1. Desktop Review of Freshwater Ecosystem Context 8
2.2. Baseline Assessment 9
2.2.1. Determination of the Extent of the Study Area 9
2.2.2. Data Collection 11
2.2.3. Data Analysis 11
2.3. Impact Assessment 12
2.3.1. Impact Categories 12
2.3.2. Impact Scenarios 13
2.3.3. Impact Significance 13
2.4. Section 21(c) and 21(i) Water Use Risk Assessment Matrix 14
3. Desktop Assessment 16
3.1. Review of Ecosystem Context and Setting 16
3.1.1. Climate Setting 16
3.1.2. Geology and Topography 16

3.1.3. Terrestrial Vegetation Type 16
3.1.4. Drainage and River Setting 17
3.1.5. Wetland Setting 18
3.1.6. Water Resource Management Context 19
3.1.7. Conservation Context 19
3.2. Desktop Mapping within 500m and Confirmation of the Study Area 23
4. Infield Baseline Assessment 26
4.1. Delineation, Classification & Habitat Characteristics 26
4.2. Present Ecological State (PES) Assessment 30
4.2.1. Wetland PES 30
4.3. Ecosystem Services: Wetland Functional Assessment 32
4.4. Ecological Importance & Sensitivity (EIS) Assessment 34
4.4.1. Wetland EIS 34
5. Recommended Ecological Category (REC) 36
6. Recommended Mitigation Measures 38
6.1. Project Planning and Design Measures 38
6.1.1. Recommended Buffer Zones 38
6.1.2. Stormwater Management Design Measures 41
6.1.3. Road Stormwater Management Design Measures 43
6.1.4. Road Alignment and Design Measures 44
6.1.5. Sewer Pipeline Alignment and Design Measures 44
6.1.6. Onsite Waste Water Package Treatment Plant Design Measures 44
6.1.8. Water Pipeline Alignment and Design Measures 49
6.1.9. Powerline Alignment and Design Measures 49
6.2. Construction Phase 50
6.2.1. Demarcation of 'No-Go' areas and construction corridors 50
6.2.2. Runoff, erosion and sediment control 51

6.2.3. Hazardous substances / materials management 52
6.2.4. Invasive Alien Plant control 52
6.2.5. Noise, dust and light pollution minimisation 53
6.2.6. Prohibitions related to animals 53
6.2.7. General rehabilitation guidelines 53
6.2.8. Construction phase monitoring measures 54
6.3. Operational Phase 55
6.3.1. UST maintenance and management 55
6.3.2. WWTW maintenance and management 55
6.3.3. Sewerage Pump Station maintenance and management 56
6.3.4. General Maintenance and management 57
6.3.5. Spill Contingency 57
6.3.6. Monitoring 57
6.3.7. Remediation / Rehabilitation 58
7. Impact and Risk Assessment 59
7.1. Activities and Impacts Assessed 59
7.2. Key Assumptions 59
7.3. Impact Significance Assessment 65
7.4. DWS Risk Matrix Assessment 69
8. License and Permit Requirements 75
8.1. Environmental Authorisation Requirements 75
8.2. Water Use License Requirements 76
9. Additional Studies required 77
10. Assumptions, Limitations & Level of Confidence 77
11. Conclusion 79
12. References 83
Annexure A – Impact Assessment Method 85

List of Figures

Figure 1. Project locality map. 1
Figure 2. Drainage and river ecosystem setting of the study area, within catchment W12F. 17
Figure 3. Study area in relation to the wetland mapping from the National Wetland Map Version 5 (NBA, 2018). 18
Figure 4. KZN CBAs and ESAs within and near the study area. 22
Figure 5. uMhlatuze ESMP layer. 23
Figure 6. Rivers and wetlands within 500m of the project site categorised into hydro geomorphic types. 24
Figure 7. Indication of the 'likelihood of impact' related to rivers and wetlands. 25
Figure 8. Delineation map showing the location and extent of river and wetland units assessed on the project site and downstream. 27
Figure 9. The location and extent of the recommended 39m wetland buffer zone. 40

List of Tables

Table 1. Data sources and GIS information consulted to inform the freshwater ecosystem assessment. ..8
Table 2. Qualitative 'likelihood of impact' ratings and descriptions. 10
Table 3. Summary of methods used in the assessment of the affected rivers and wetlands. 11
Table 4. Overview of the key climatic characteristics of the region. 16
Table 5. Key conservation context details for the study area. 20
Table 6. Summary of the key hydro-geomorphic and biophysical characteristics of Wetland Unit W01. ...28
Table 7. PES impact categories and descriptions for wetlands. 30
Table 8. PES Summary for the wetland unit W01 assessed. 31
Table 9. Ecosystem services importance categories and descriptions. 32
Table 10. Summary of the outputs of the WET-EcoServices assessment for wetland seep W01. 33
Table 11. Wetland EIS rating categories. 34
Table 12. Summary of EIS scores and overall EIS rating for wetland unit W01. 35
Table 13. Generic matrix for the determination of REC for water resources. 36
Table 14. REC and RMO for the wetland units based on their PES and EIS ratings. 37
Table 15. Wastewater limit values applicable to discharge of wastewater into a water resource. 47

Table 16. Summary of impacts assessed for each of the project activities. 60
Table 17. Summary of the wetland impact significance assessment under 'poor' and 'good' mitigation scenarios for the proposed Retail Centre and Fuel Service Station. 67
Table 18. Summary of the wetland impact significance assessment under 'poor' and 'good' mitigation scenarios for the proposed On-Site Waste Water Treatment Works. 68
Table 19. Summary of the DWS 'Risk Assessment Matrix' results under the poor and good mitigation scenarios for the proposed retail centre and fuel service station development. 71
Table 20. Summary of the DWS 'Risk Assessment Matrix' results under the poor and good mitigation scenarios for the proposed on-site wastewater treatment works 73

1. Introduction & Background

1.1. Location and Description of the Proposed Development Activities

A new retail centre and fuel service station development is planned on Farm Ruth near Esikhawini on the P106 off the N2 in the uMhlatuze Local Municipality, KwaZulu-Natal by the Phalane Community Trust. The portion of the property that will form part of the proposed development is outlined in red in Figure 1 below and is 23.7 hectares in extent. The study area falls within the same catchment as the Mzingwenya River.

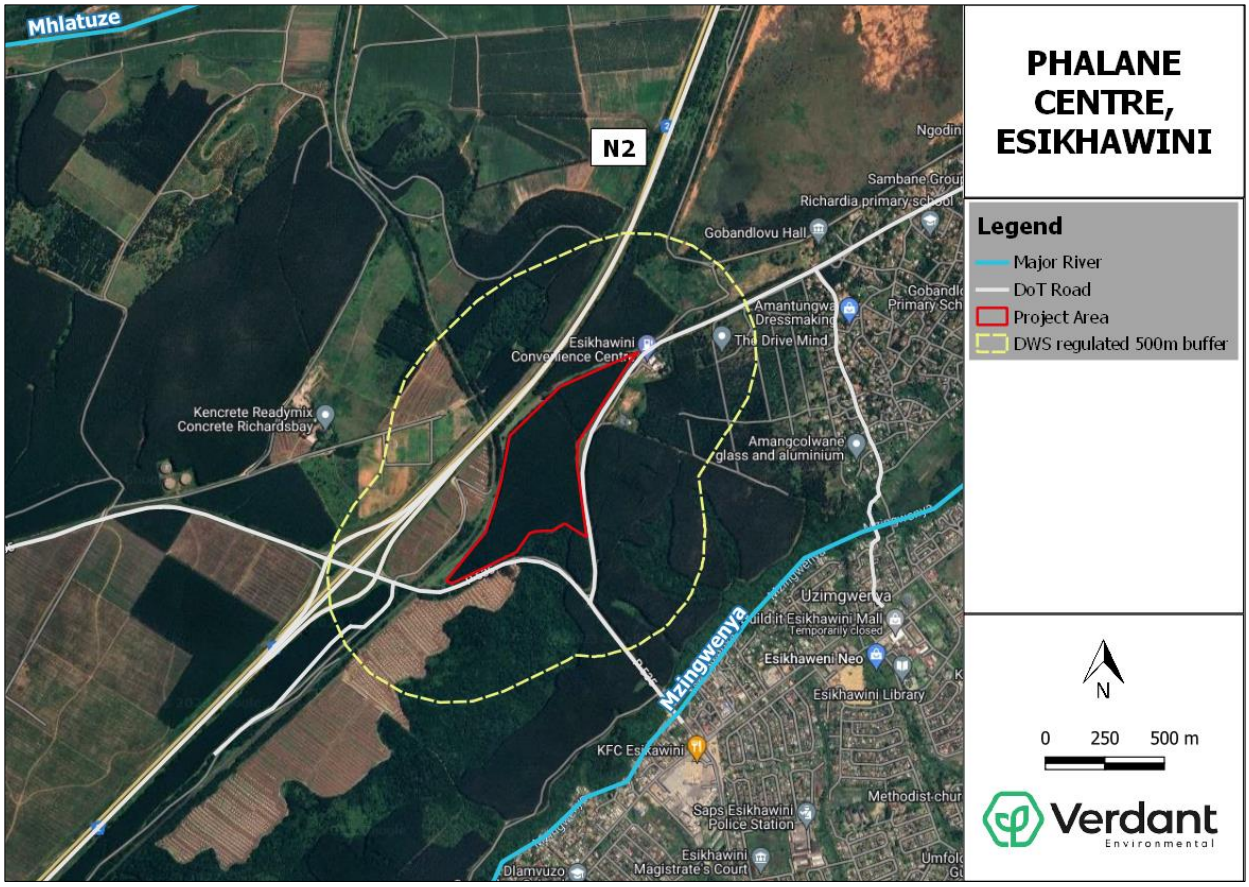

Figure 1. Project locality map.

The proposed project entails the construction of:

- A fuel service station, with a convenience store, including associated structures (all buildings planned as single-storey) and infrastructure comprising the following:
    - concrete paving & canopy at the forecourt
    - 4 x pump islands and 8 x bowsers
    - underground fuel storage tanks totalling 138 000 litres
        - 4 x 23 000 litres petrol
        - 2 x 23 000 litres diesel
    - gas which will be stored in bottles of varying sizes totalling 1270kg at any given time
        - 30 x 9kg bottles
        - 10 x 14kg bottles
        - 20 x19kg bottles
        - 10 x 48 kg bottles
    - paraffin stored on site above ground totalling 10 000 litres at any given time
    - lubricants (oil & brake fluid) totalling 200 litres at any given time
- A shopping centre with anchor shop, line shops and restaurants.

The total site is 920, 4780 hectares in extent as per the title deed with the property privately owned by the Phalane Community Trust. The proposed development footprint is anticipated to be around **23.7 hectares** with the site currently zoned as Forestry.

With regards to supporting ancillary infrastructure required for the proposed development, the following is relevant:

- Plans for bulkwater supply are still to be confirmed.
- Access to the property will be determined by the traffic impact assessment in conjunction with the relevant transport authorities.
- Tentative initial plans indicate that an onsite package treatment plant is proposed for sewage with discussions between the project engineer, applicant and uMhlatuze Municipality underway in this regard.
- Refuse will be stored on site, in a well-constructed bin area before disposal, the uMhlathuze Municipality or a private service provider will be requested to collect solid waste once a week.

- In terms of electricity there is electricity supply in the area and it will be a matter of ensuring the necessary connections to the proposed new Phalane Centre.
- A stormwater management plan still needs to be compiled.

In terms of environmental planning the listed activities under National Environmental Management Act (No. 107 of 1998) (NEMA) and water uses under National Water Act (Act 36 of 1998) (NWA) are still being confirmed.

At the time of this assessment, no site development plan or layout was provided aside from a polygon showing the estimated extent of the proposed development footprint, depicted by the red outline in Figure 1 above.

1.2. Purpose of the Assessment

The proposed development activities require a Water Use Licence (WUL) in terms of the National Water Act (Act 36 of 1998) (NWA) and Environmental Authorisation (EA) in term of the National Environmental Management Act (No. 107 of 1998) (NEMA). In this regard, Verdant Environmental were appointed by the Environmental Assessment Practitioner, Mondli Consulting Services, to undertake a combined aquatic & wetland impact assessment to inform the WUL and EA applications.

1.3. Scope of Work

The scope of work completed as part of this assessment was as follows:

- Undertake a desktop review of the biophysical setting and freshwater ecosystem conservation planning context of the project site.
- Undertake the desktop mapping of all watercourses (i.e. stream / river channels, riparian areas, wetlands, dams etc.) within a 500m radius of the project activities.
- Undertake a watercourse 'likelihood of impact' assessment to identify the rivers and wetlands to be measurably negatively affected by the proposed project activities.
- Infield delineation of all wetlands and rivers (riparian zones) that stand to be measurably negatively affected by the proposed project activities occurring within 500m of the development activities.

- Subdivision of the desktop and infield delineated wetlands and rivers into definable resource / hydrogeomorphic (HGM) units and the classification of these units according to the national aquatic and wetland ecosystem classification system (Ollis *et al*., 2013).
- Provision of a description of the key biophysical characteristics of the infield delineated rivers and wetlands (i.e. soils, vegetation and hydrology) based on the infield sampling and data collection.
- Assessment of the Present Ecological State (PES) of the infield delineated rivers and wetlands.
- Assessment of the supply, demand and importance of the direct and indirect ecosystem services provided by the infield delineated wetlands and riparian zones.
- Assessment of the Ecological Importance and Sensitivity (EIS) of the infield delineated rivers and wetlands.
- Determination of the recommended ecological category (REC) recommended management objectives for each of the river and wetland units assessed.
- Identification, description and assessment of the direct and indirect impacts of the proposed project on local rivers and wetlands.
- Assessment of the risk of potential impact to freshwater ecosystems (rivers, wetlands).
- Provision of project design, construction phase and operational phase mitigation measures to avoid, minimize and/or rehabilitate the potential impacts.

1.4. Key definitions and concepts

An ecosystem is a group of plants, animals and other organisms interacting with each other and with non-living (abiotic) components of their environment. Ecosystems can be classified broadly into terrestrial and aquatic ecosystems. Terrestrial ecosystems occur on land where water is a limiting factor, whereas aquatic ecosystems occur within landforms that are permanently or periodically inundated with flowing or standing water (Ollis *et al*., 2013). Freshwater ecosystems are a subset of the Earth's aquatic ecosystems and include all inland freshwater rivers, streams, wetlands, lakes, ponds and springs. This broad range of freshwater ecosystem types contains a multitude of habitats of varying ecological complexity and diversity (Wrona *et al*., 2016). Wetlands, streams and rivers fall under the umbrella term of "freshwater ecosystems".

Wetlands, streams and rivers fall under the umbrella term of 'watercourse' in the National Water Act (Act No. 36 of 1998) (NWA) of South Africa. Section 1(1)(xxiv) of the NWA defines a 'watercourse' as:

- 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; and
- 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 focusses on the assessment of 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, streams and rivers are defined as follows:

- **Wetlands** are 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."
- **Rivers and streams** are natural channels that are permanent, seasonal or temporary conduits of freshwater. In terms of ecological habitats, rivers and streams comprise in-stream aquatic habitat and riparian habitat. Generally, riparian zones mark the outer edge of stream and river systems. Streams and rivers are differentiated in terms of channel dimensions and generally fall within the broad category of rivers / riverine ecosystems in this report.
- **Instream habitat** is the aquatic habitat (or alluvial in the case of intermittent / ephemeral watercourses) within the active channel that includes the water column, river bed and the inundated active channel margins, and associated vegetation. In terms of Section 1 of the NWA, instream habitat is legally defined as habitat that includes "…the physical structure of a watercourse and the associated vegetation in relation to the bed of the watercourse."
- **A riparian zone** is a habitat, comprising bare soil, rock and/or vegetation that is: (i) associated with a watercourse; (ii) commonly characterised by alluvial soils; and (iii) inundated or flooded to an extent and with a frequency sufficient to support vegetation species with a composition and physical structure distinct from those of adjacent land areas (DWAF, 2005). In terms of Section 1 of the NWA, riparian habitat is legally defined

as: 'habitat that "…includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas."

1.5. Legislative Context Relevant to Freshwater Ecosystems

Rivers and wetlands are not formally protected by law but their alteration is regulated by three different pieces of legislation in South Africa, namely:

- National Water Act (No. 36 of 1998) ('NWA');
- National Environmental Management Act (No. 107 of 1998) ('NEMA'); and
- Conservation of Agricultural Resources Act (No. 43 of 1983) ('CARA').

1.5.1. National Water Act (Act No. 36 of 1998) ('NWA')

Section 21 of the National Water Act (No 36 of 1998) lists eleven (11) activities that constitute water uses that require a Water Use License (WUL) prior to the activities commencing, unless the use is excluded. The water uses included in Section 21 are:

a) taking water from a water resource;
b) storing water;
c) impeding or diverting the flow of water in a watercourse;
d) engaging in a stream flow reduction activity contemplated in section 36;
e) engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1);
f) discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;
g) disposing of waste in a manner which may detrimentally impact on a water resource;
h) disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;
i) altering the bed, banks, course or characteristics of a watercourse;

j) removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and
k) using water for recreational purposes.

Typically, development activities that directly and indirectly alter the characteristics of watercourses are considered Section 21(c) and 21(i) water uses and are the most common water uses.

1.5.2. National Environmental Management Act (No. 107 of 1998) ('NEMA')

Listed Activities that may negatively affect watercourses are included in three (3) Listing Notices in the EIA Regulations (2017) published under Section 24(5) and 44 of NEMA. Listed activities require Environmental Authorisation (EA) subject to conducting either a basic assessment or full Environmental Impact Assessment (EIA) prior to the project activities commencing.

1.5.3. Conservation of Agricultural Resources Act (No. 43 of 1983) ('CARA')

Regulated activities that may negatively affect watercourses are included in the CARA Regulations as amended (2001) published under Section 29 the CARA. Formal approval / permission from an executive officer is required before such regulated activities can take place.

2. Methods

2.1. Desktop Review of Freshwater Ecosystem Context

Freshwater ecosystems are typically linear features that are connected over regional scales in the landscape and embedded in the terrestrial matrix. Furthermore, freshwater ecosystems are typically located at topographical low points in the landscape, thereby collecting and conveying materials (water and dissolved and particulate matter) from within their entire catchment (UN Environment, 2018). It is thus important to first contextualise the onsite freshwater ecosystems in terms of local and regional setting, and conservation planning. An understanding of the biophysical and conservation context of the site will assist in the assessment of the importance and sensitivity of the onsite freshwater ecosystems, the setting of management objectives and the assessment of the significance of anticipated impacts. The following data sources and GIS spatial information listed in Table 1 was consulted to inform the specialist assessment. The data type, relevance to the project and source of the information is provided.

Table 1. Data sources and GIS information consulted to inform the freshwater ecosystem assessment.

Data/Coverage Type		Relevance	Source
Biophysical / Ecological Context	**Latest Google Earth ™ imagery**	*To supplement available aerial photography where needed and to inform catchment level impacts*	Google Earth™ On-line
	National Rivers (GIS Coverage)	*Highlight potential onsite and local rivers and map local drainage network*	DWS
	South African Quaternary catchments	*Locates the project area within the principal water resource management units in South Africa*	DWS
	South African Quinary catchments	*Locates the project area within the principal water resource management units in South Africa*	DWS
	DWA Eco-regions (GIS Coverage)	*Understand the regional biophysical context in which water resources within the study area occur*	DWA (2005)
	South African Vegetation Map (GIS Coverage)	*Classify vegetation types and determination of reference vegetation*	SANBI (2006 - 2018)

Data/Coverage Type		Relevance	Source
	South African Inventory of Inland Aquatic Ecosystems (SAIIAE), 2018 – River Ecosystems	*Shows location of river within the relevant inventories*	Van Deventer *et al.* (2018a)
	South African Inventory of Inland Aquatic Ecosystems (SAIIAE), 2018 – Wetland Ecosystems	*Shows location of wetlands within the relevant inventories*	Van Deventer *et al.* (2018a)
Conservation Context	**The National Freshwater Ecosystem Priority Area (NFEPA) Assessment (2011)** – Wetland FEPAs	*Shows location of national wetland ecosystem conservation priorities*	CSIR (2011)
	The National Freshwater Ecosystem Priority Area (NFEPA) Assessment (CSIR, 2011) – River FEPAs	*Shows location of national river ecosystem conservation priorities*	CSIR (2011)
	National Biodiversity Assessment – Terrestrial Realm (GIS Coverage)	*Terrestrial ecosystem / vegetation type threat status*	Skowno et al. (2018)
	National Biodiversity Assessment – Inland Aquatic / Freshwater Realm (GIS Coverage)	*Freshwater ecosystem / vegetation type threat status*	Van Deventer *et al.* (2018b)
	KZN Biodiversity Sector Plan: Critical Biodiversity Areas Irreplaceable (GIS Coverage)	*Provincial conservation planning importance.*	EKZNW (2016)
	KZN Biodiversity Sector Plan: Critical Biodiversity Areas Optimal (GIS Coverage)	*Provincial conservation planning importance.*	EKZNW (2016)
	KZN Terrestrial KZN Aquatic Systematic Conservation Plan (GIS Coverage	*Provincial conservation planning importance.*	EKZNW (2011)
	KZN Aquatic Systematic Conservation Plan (GIS Coverage)	*Provincial conservation planning importance.*	EKZNW (2007)

2.2. Baseline Assessment

2.2.1. Determination of the Extent of the Study Area

For the purposes of this assessment, the study area for infield assessment comprised **all rivers within 100m and wetlands within 500m of the of the development footprint that stand to be measurably negatively impacted**. The wetlands and rivers likely to be impacted were identified using the 'likelihood of impact' guidelines in Table 2.

Table 2. Qualitative 'likelihood of impact' ratings and descriptions.

Likelihood of Impact Rating	Description of Rating Guidelines
Definite	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 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.
Likely / Possible	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);
Unlikely	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);

Likelihood of Impact Rating	Description of Rating Guidelines
None	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.

2.2.2. Data Collection

A field assessment to delineate and assess the rivers and wetlands within the study area was undertaken on the **28th November 2022**. Data collection involved the following:

- Systematic soil sampling across all valley lines, valley bottom areas, valley heads, hillslopes and depressions using a clay auger to confirm the presence and extent of wetland and alluvial (riparian) soils according to the guideline: '*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas'* (DWAF, 2005). Soil sample points were recorded onsite using a hand-held GPS. Soil sample points were recorded onsite using a hand-held GPS.
- The recording of the dominant plant species and general composition of the wetland and riparian vegetation in the vicinity of the soil sample points based on visual observations. Observations points were recorded onsite using a hand-held GPS.
- The recording of the landscape / terrain position at each sample point based on visual observations. Observations points were recorded onsite using a hand-held GPS.
- The recording of existing river and wetland impacts (such as extent of existing infilling) using a hand-held GPS.

2.2.3. Data Analysis

The methods and tools that were used as part of the baseline freshwater ecosystem assessment are summarised in Table 3, below.

Table 3. Summary of methods used in the assessment of the affected rivers and wetlands.

Method/ technique	Reference for methods/ tools used
Wetland and river /riparian delineation	• *'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas'* (DWAF, 2005)
Classification of Aquatic	• National Wetland Classification System for Wetlands and other

Method/ technique	Reference for methods/ tools used
Ecosystems (rivers & wetlands)	Aquatic Ecosystems in South Africa (Ollis et al., 2013)
Present Ecological State (PES)	• Level 1B WET-Health assessment (Macfarlane *et al.,* 2020)
Functional Importance	• Level 2 WET-EcoServices assessment (Kotze *et al*., 2020)
Ecological Importance & Sensitivity (EIS)	• Wetland EIS assessment (Kotze *et al*., 2020)

2.3. Impact Assessment

2.3.1. Impact Categories

Wetland and river ecosystem impacts can be grouped into the following broad impact types:

1. **Direct ecosystem modification or destruction / loss impacts** – This impact refers to the direct physical destruction and/or modification of wetland communities, habitat and associated biota. Such impacts may be attributed to a range of activities including vegetation / habitat clearing (stripping / grubbing), earthworks (i.e. excavation and infilling) and deep flooding by impoundments.
2. **Alteration of hydrological and geomorphological processes** – This impact refers to all the indirect impacts resulting from human activities within the watercourse or catchment that alter hydrological and geomorphological processes i.e. rates of erosion and sedimentation. This includes activities that: (i) modify landcover characteristics that alter the quantity and pattern of catchment runoff and sediment inputs e.g. earthworks, surface hardening, plantations, etc.; (ii) activities that regulate, reduce or increase flows e.g. impoundment / dams, abstraction, return flows and decant flows; and activities alter wetland flow hydraulics e.g. establishment of drains, flow canalisation, flow constrictions and flow diversions.
3. **Water pollution impacts** – This impact refers to the alteration of the chemical and biological characteristics of soil and water within watercourses and the associated ecological impacts. In the context of this impact assessment, water quality is assessed in relation to changes to its fitness for use (e.g. for domestic, recreational or agricultural purposes) and ability to maintain the health of aquatic ecosystems. This impact includes a full spectrum of activities ranging from direct inputs (e.g. spillages / point source

discharges) through to diffuse source inputs from land use activities that affects the quality of water entering watercourses (e.g. hazardous substances handling, storage & transport; urban stormwater management; irrigation return flows and acid mine drainage).

4. **Ecological connectivity and edge disturbance impacts** – This impact refers to the alteration of local and regional ecological processes resulting from the transformation of land and disturbance within and/or surrounding a watercourse. Key ecological processes of relevance in this regard include ecological connectivity and edge effects edge effects that are impacted by habitat fragmentation, patch size reduction, increased alien invasive plant invasion, noise pollution, vibrations, light pollution, and the occurrence of barriers to propagule and animal movement.

2.3.2. Impact Scenarios

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

1. **Realistic Poor Mitigation Scenario**: This scenario involves the implementation of the proposed development plan and designs that are currently 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 activities.
2. **Realistic Good Mitigation Scenario**: This scenario involves the implementation of the development plan and designs that incorporate all the project planning and design, construction, operational and decommissioning phase mitigation measures 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 activities.

2.3.3. Impact Significance

Impact significance is defined broadly as a measure of the desirability, importance and acceptability of an impact to society (Lawrence, 2007). A significant impact is defined in the NEMA EIA Regulations 2017 as follows:

> "*…an impact that may have a notable effect on one or more aspects of the environment or may result in non-compliance with accepted environmental quality standards, thresholds or*

targets and is determined through rating the positive and negative effects of an impact on the environment based on criteria such as duration, magnitude, intensity and probability of occurrence."

The significance of the potential construction and operational impacts was assessed using an impact assessment method developed by Verdant included in **Annexure A**.

2.4. Section 21(c) and 21(i) Water Use Risk Assessment Matrix

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(c) and 21(i) 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' 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.
- 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 associated with each of the four (4) impact groups / types considered were:

1. Direct transformation and modification of habitat – Physical disturbance
2. Indirect impacts resulting from alteration of hydrological and geomorphic processes as a result of activities within and outside of the watercourse – Erosive surface runoff, sediment and increased and/or reduced water inputs
3. Water pollution impacts – Chemical, organic and biological pollutants
4. Ecological process and disturbance impacts – Alien invasive plants, noise pollution, dust pollution

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 was used to inform WUL requirements for the proposed development.

3. Desktop Assessment

3.1. Review of Ecosystem Context and Setting

3.1.1. Climate Setting

An overview of the key climatic characteristics of the national vegetation type (i.e. **Maputaland Coastal Belt – within the Indian Ocean Coastal Belt Bioregion**) and Ecoregion (**Natal Coastal Plain)** is provided in Table 4 below.

Table 4. Overview of the key climatic characteristics of the region.

Aspect	Description
Elevation Above Mean Sea Level	0 – 300 a.m.s.l.
Mean Annual Precipitation (MAP)	933 mm/annum
Potential Evapotranspiration (PET)	1659 mm/annum
Mean Annual Simulated Runoff for Quaternary Catchment	52 - 420 mm^3
Rainfall seasonality	Summer rainfall

3.1.2. Geology and Topography

The study area is underlain predominantly by quaternary alluvium, sand and calcrete within the greater Maputaland Coastal Plan / Zululand Coastal Plain (Partridge et al., 2010). The topography of the area is characterised by coastal peneplains with low relief. The site itself is characterised by a southeast facing slope with a valley starting in the south-eastern-most corner and continuing immediately downslope of the project area.

3.1.3. Terrestrial Vegetation Type

The reference or primary terrestrial vegetation type for the area is **Maputaland Coastal Belt vegetation** within the Indian Ocean Coastal Belt Biome and Indian Ocean Coastal Belt Bioregion

(Mucina & Rutherford, 2006). The vegetation is described by Mucina & Rutherford (2006) as comprising *"Flat coastal plain originally probably densely forested in places with a wide range of interspersed non-forest plant communities including dry grasslands (which include palm veld where special conditions prevail) hygrophilous grasslands and thicket groups. Today the vegetation landscape is composed of pockets of various forest types (separated into different vegetation units) thickets, primary and secondary grasslands, extensive timber plantations and cane fields."*

3.1.4. Drainage and River Setting

The study area is located at the head of a drainage line within a low-lying linear palaeo-dune depression that comprises a seep wetland that hosts coastal forest and swamp forest. This system drains into the downstream Mzingwenya River that drains in an easterly direction into the freshwater lake, Lake Qhubu, which itself then drains into the Mhlatuze River estuary to the east, a nationally important estuary (see Figure 2). The Mzingwenya River is located on the Zululand Coastal Plain (Partridge et al., 2010) and has formed within low-lying linear palaeo-dune depressions that intercept the regional groundwater table during all or part of the year.

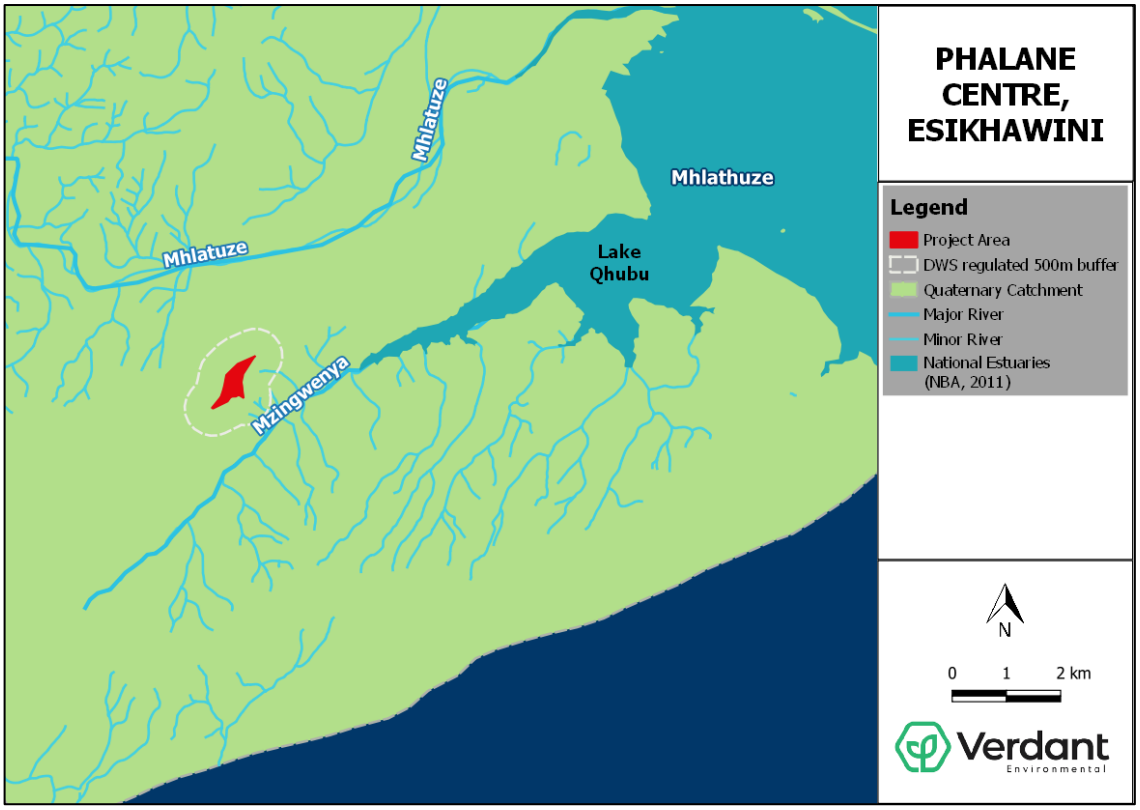

Figure 2. Drainage and river ecosystem setting of the study area, within catchment W12F.

3.1.5. Wetland Setting

The National Wetland Map (Van Deventer *et al*., 2018) does not indicate the presence of any wetlands within the development site property. However, the uMhlatuze Estuary is flagged 465m to the south-east of the site just on the edge of the DWS regulated 500m buffer zone. In addition, a number of seeps ~1km to the south-east and a large floodplain wetland along the Mhlatuze River ~ 550m to the north-east as shown in Figure 3. *Based on the National Wetland Map V5,* ***seep wetlands*** *of the type identified near the study area are considered* ***'Critically Endangered'*** *at a national level according to Van Deventer et al. (2018), as are* ***floodplain wetlands****, while the estuary is considered* ***'Endangered'*** *at a national level according to Van Deventer et al. (2018).*

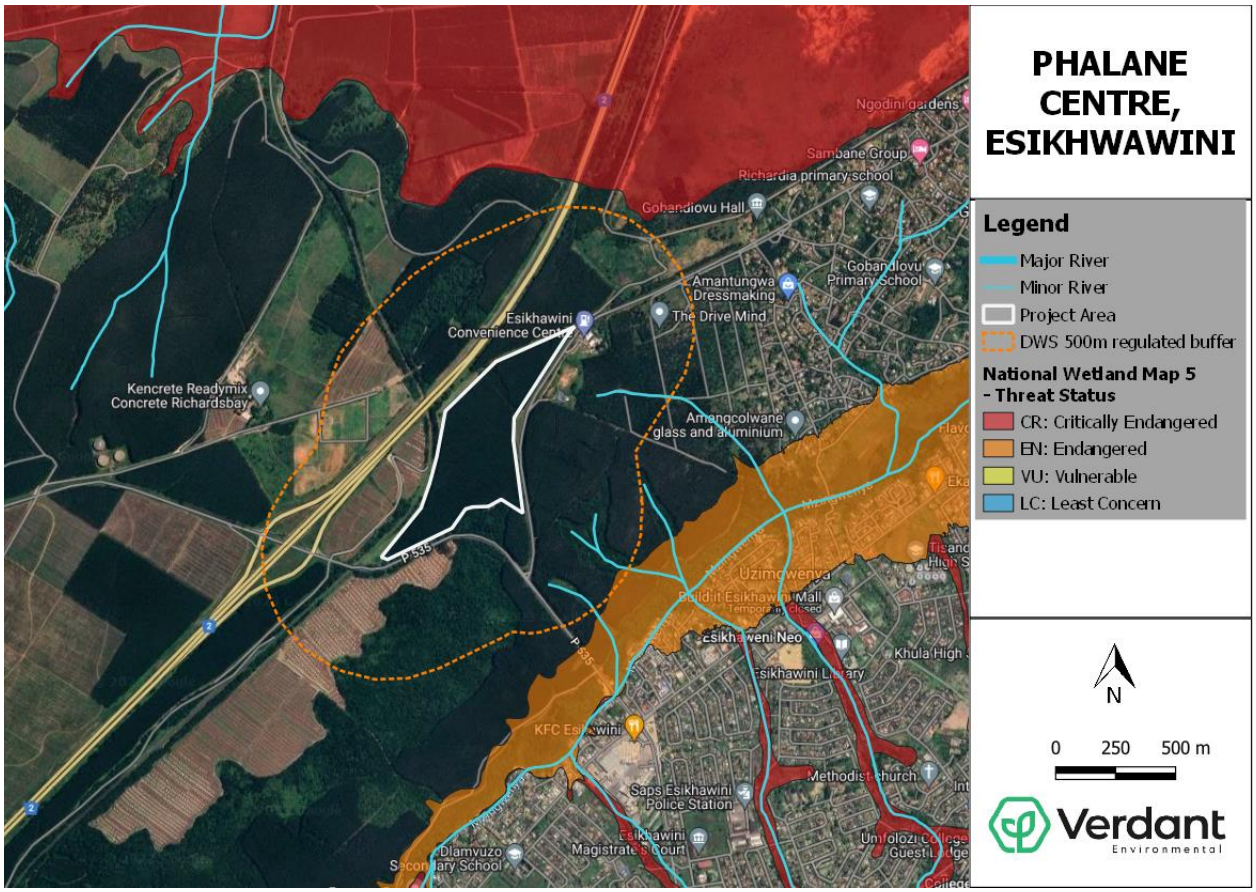

Figure 3. Study area in relation to the wetland mapping from the National Wetland Map Version 5 (NBA, 2018).

3.1.6. Water Resource Management Context

The study area is located within the Zululand Coast Strategic Water Source Area (SWSA) and the Mhlatuze Estuary is located 465 m downstream.

3.1.7. Conservation Context

A summary of the conservation planning and threat status of the ecological features in the study area is provided in Table 5. Noteworthy features include:

- The terrestrial vegetation type of the study area, Maputaland Coastal Belt, is currently listed as **Endangered** in the NBA (SANBI, 2018) at the national level, and is listed as **Endangered** at the provincial level in KZN (Jewitt, 2018),
- The **sub-quaternary catchment** within which the study area is located is **not listed as an important area** in terms of the National Freshwater Ecosystem Priority Areas (NFEPA) project. Also, none of the mapped wetland areas that stand to be potentially impacted have been identified as wetland FEPAs (Freshwater Ecosystem Priority Areas) although the Mhlatuze Estuary is located just within the DWS 500m regulated area for the project site.
- The wetland vegetation group for the study area is the 'Indian Ocean Coastal Belt Group 1' group, which is regarded as being 'Least Threatened' in terms of ecosystem threat status (CSIR, 2011). Based on the National Wetland Map V5, **seep wetlands, and floodplain wetlands** near the study area are considered **'Critically Endangered'** at a national level according to Van Deventer *et al*. (2018), while the Mhlatuze Estuary downstream is considered '**Endangered**'.
- The relevant reach of the **Mzingwenya River** is currently listed as '**Critically Endangered'** in the NBA (SANBI, 2018).
- An area **50m south of the site and downstream** of the development has been categorised as **CBA: Irreplaceable** in the KZN Terrestrial Systematic Conservation Plan (EKZNW, 2016).
- Three areas of KZN Forest occur within the site's DWS 500m regulated area, one 25m to the south (Swamp Forest: *Ficus trichopoda* Swamp Forest), one 145m to the south-east

(Swamp Forest: ***Ficus trichopoda* Swamp Forest**) and one 255m to the north-west (KwaZulu-Natal Coastal Forests: **Maputaland Moist Coastal Lowlands Forest**).

- A corridor of forest immediately downslope and downstream of the project site has been earmarked as 'Conservation Zone' in the uMhlatuze Environmental Services Management Plan (ESMP).

Table 5. Key conservation context details for the study area.

Conservation Planning Dataset		Relevant Conservation Feature	Conservation Planning / Threat Status	Location in Relation to Project Site
NATIONAL LEVEL CONSERVATION PLANNING CONTEXT				
National Freshwater Ecosystem Priority Areas (NFEPA)	SWSA	Zululand Coast Strategic Water Source Area (SWSA)	SWSA 2	Entire site and surrounding catchment
	Estuary	Mhlatuze River Estuary	Non-FEPA Estuary	2.1 km downstream
	River	Mzingwenya River	Non-FEPA River	815 m downstream
	Wetland	Channelled valley bottom wetland	Non-FEPA wetland	900 m downstream
2018 National Biodiversity Assessment	Terrestrial	Maputaland Coastal Belt	Endangered	On site
	Estuary	Mhlatuze Estuary	Endangered	465 m downstream
	River	Mzingwenya River	Critically Endangered	815 m downstream
	Wetland	Seep wetlands, floodplain wetlands	Critically Endangered	Within 2 km radius of site
PROVINCIAL AND REGIONAL LEVEL CONSERVATION PLANNING CONTEXT				

Conservation Planning Dataset	Relevant Conservation Feature	Conservation Planning / Threat Status	Location in Relation to Project Site
KZN Private Nature Reserves (EKZNW, 2015)	Richards Bay Game Reserve	Private Nature Reserve	~10 km due north-east of the site
KZN Forests	Swamp Forest: *Ficus trichopoda* Swamp Forest	Critically Endangered	50 m south and 145m south-east of the site
	Maputaland Moist Coastal Lowlands Forest)	Endangered	255 north-west of the site
KZN Biodiversity Conservation Plan Freshwater	Catchment Planning Unit 2135	Available[1]	Entire project site
KZN Biodiversity Terrestrial Systematic Conservation Plan	*Centrobolus fulgidus* (Millipede), *Doratogonus zuluensis* (Milliepede), *Orthoporoides laccatus* (Millipede), *Gulella zuluensis* (Mollusc), KwaZulu Natal Coastal Forests, *Centrobolus richardi* (Millipede), *Orthoporoides corrugatus* (Millipede), *Gulella aliciae* (Mollusc), *Parepistaurus eburlineatus* (Grasshopper),*Centrobolus rugulosus*.(Millipede).	CBA: Irreplaceable	50 m south of project site
KZN Vegetation Type Threat Assessment	Maputaland Coastal Belt	Endangered	On site
	Swamp Forest: *Ficus trichopoda* Swamp Forest	Critically Endangered	20 m south and 145 m south-east of the site
	Maputaland Moist Coastal Lowlands Forest)	Endangered	255 north-west of the site
uMhlatuze ESMP	Indigenous Forest	Conservation Zone	Immediately downslope and downstream of project site

[1] "Available" suggests that the catchment has not specifically been identified as a provincial priority area aquatic conservation priority.

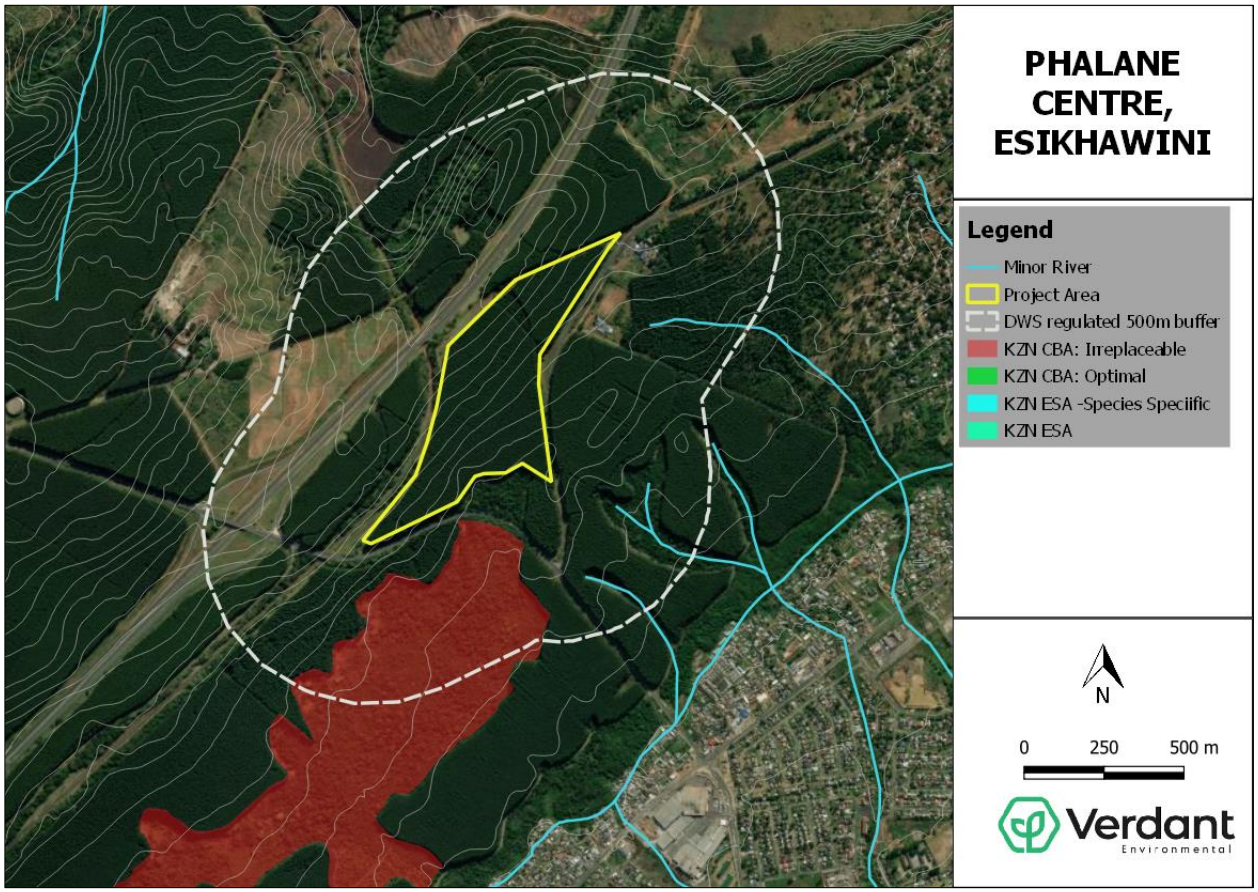

Figure 4. KZN CBAs and ESAs within and near the study area.

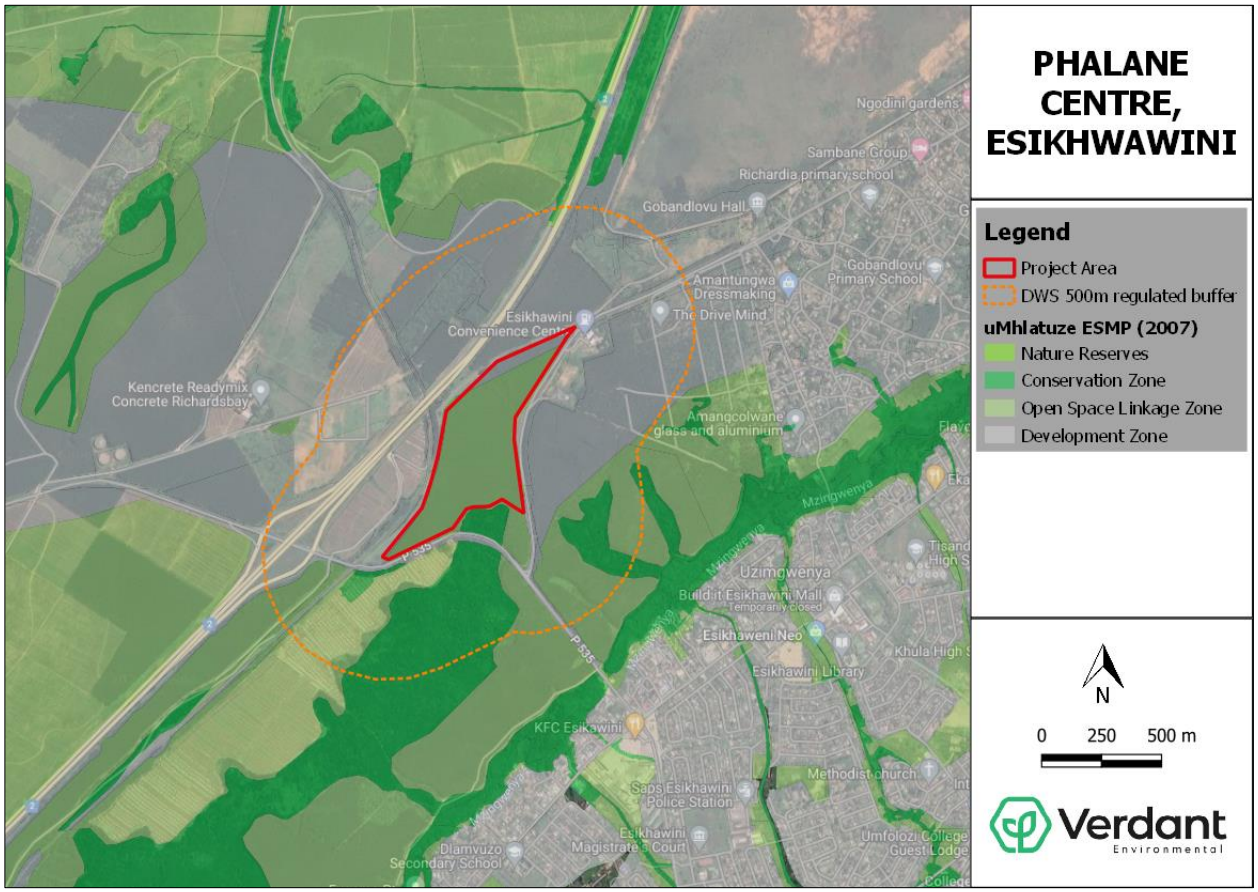

Figure 5. uMhlatuze ESMP layer.

3.2. Desktop Mapping within 500m and Confirmation of the Study Area

All the potential wetlands (natural and artificial) occurring within 500m of the proposed development site and associated activities were mapped and classified in terms of hydrogeomorphic (HGM) types as shown in Figure 6. An indication of the 'likelihood of impact' for each of the mapped rivers and wetlands is depicted visually on the map in Figure 7.

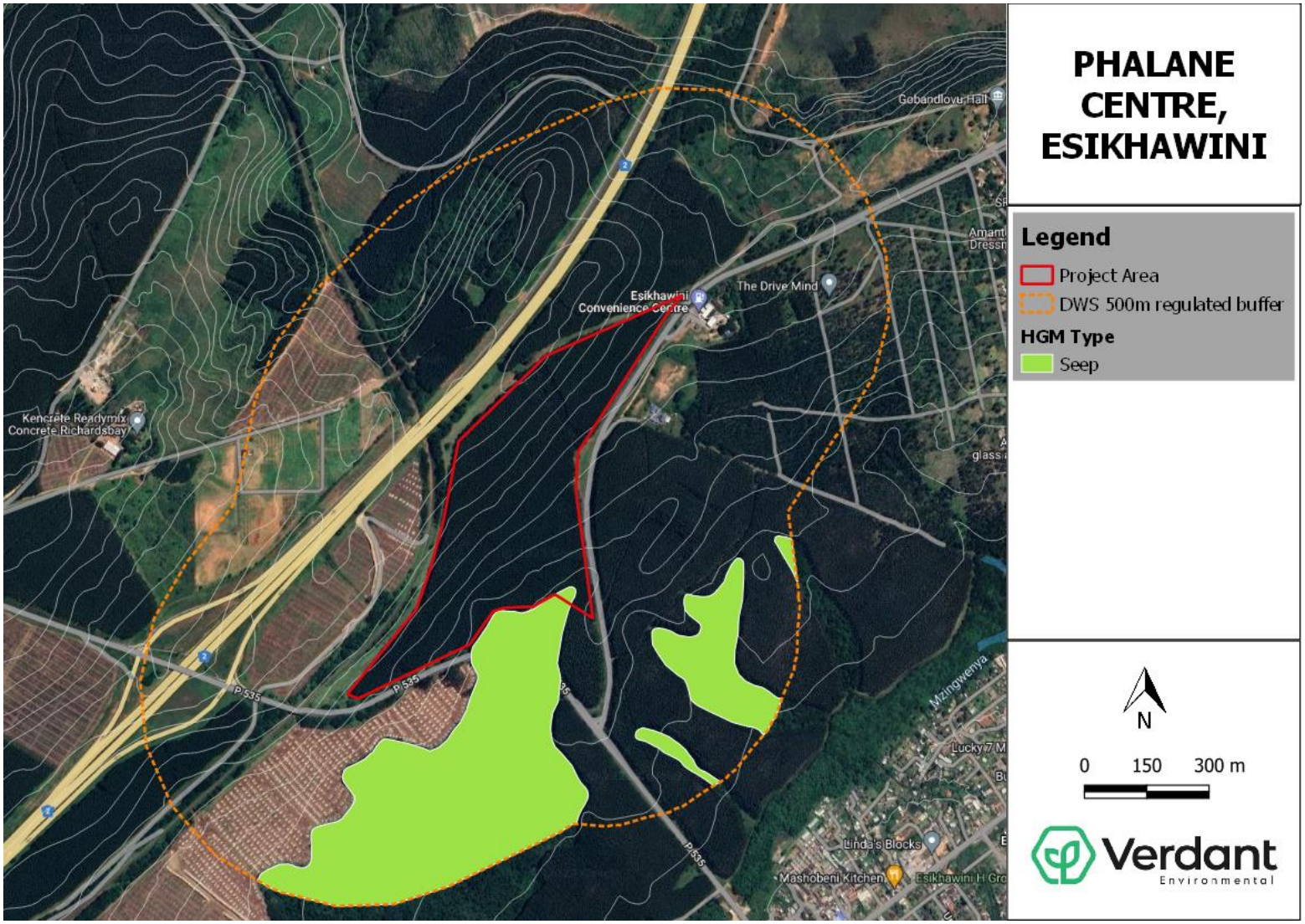

Figure 6. Rivers and wetlands within 500m of the project site categorised into hydro geomorphic types.

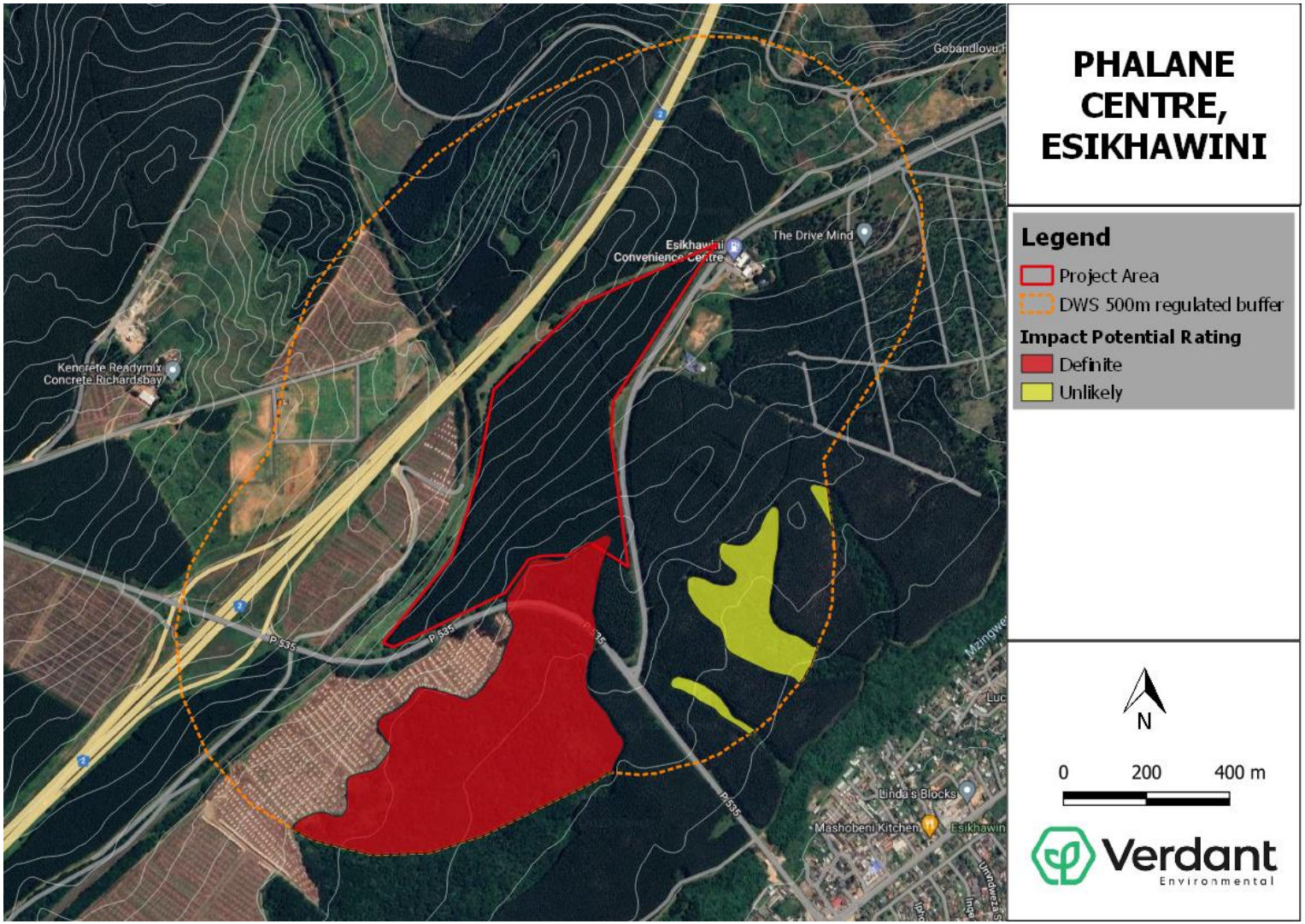

Figure 7. Indication of the 'likelihood of impact' related to rivers and wetlands.

4. Infield Baseline Assessment

The infield baseline assessment focused on the freshwater ecosystems likely to be measurably negatively impacted by the project development activities only. The extent (infield delineation), classification, habitat characteristics, present ecological state (PES) and ecological importance and sensitivity (EIS) of the rivers and wetlands are discussed in this section of the report.

4.1. Delineation, Classification & Habitat Characteristics

Soil and vegetation sampling in conjunction with the recording of terrain type enabled the delineation and classification of a **seep wetland unit (W01)** located on the south-eastern corner of the development site and extending 1.4km downstream. It is important to note however that the wetland is located within a coastal plain setting and is located within a concave-shaped valley formed within a linear paleo-dune depression. Therefore, although a seep, the wetland has features of aeolian depression wetland types (Grenfell et al., 2019).

The greater wetland unit is shown in Figure 8 (next page), with a summary of the key biophysical characteristics of the HGM unit provided in the table that follows.

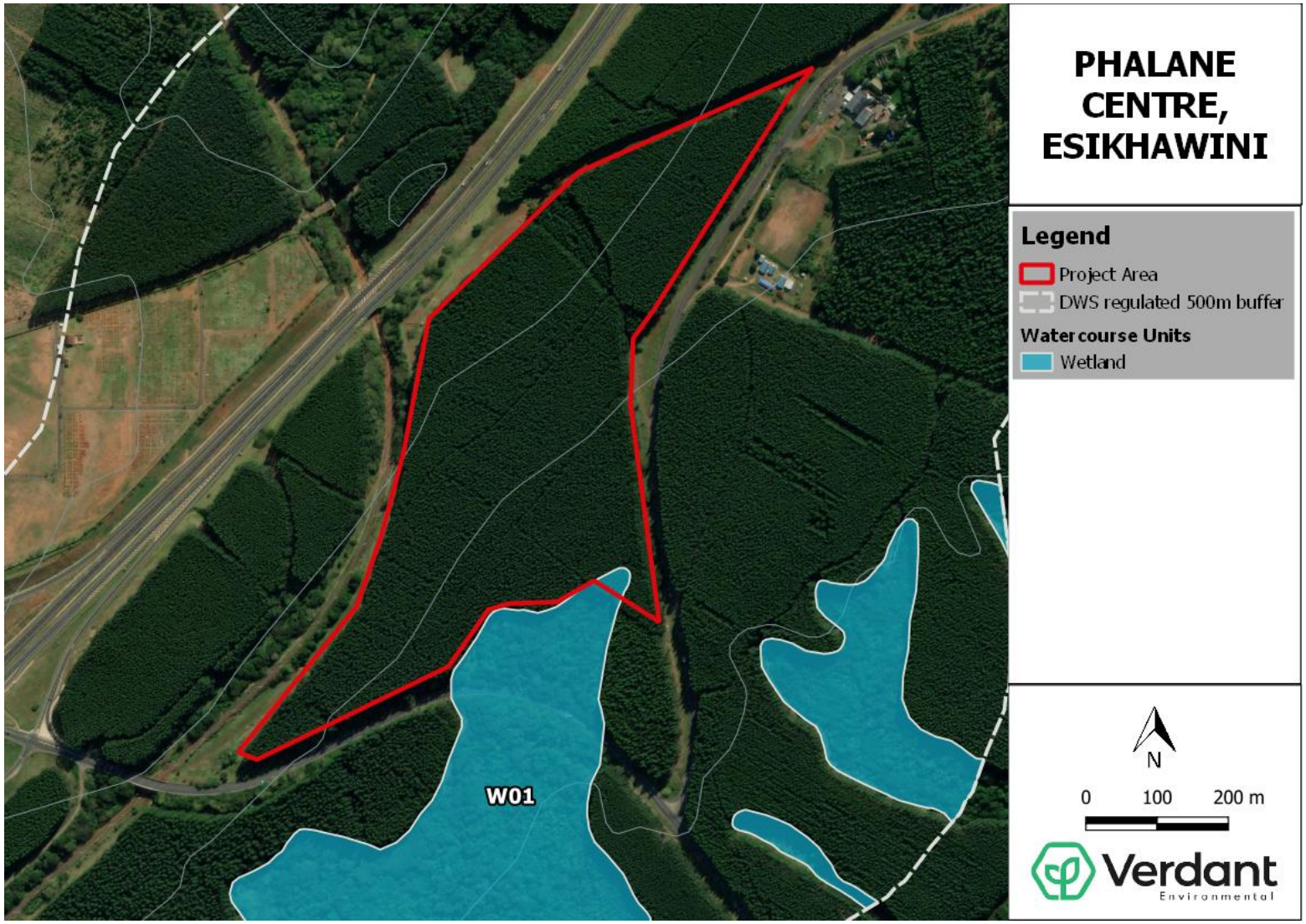

Figure 8. Delineation map showing the location and extent of river and wetland units assessed on the project site and downstream.

Table 6. Summary of the key hydro-geomorphic and biophysical characteristics of Wetland Unit W01.

Unit W01: Seep wetland	
HGM classification	Seep wetland
Size	~26.4 hectares
Dominant wetness zone(s)	Seasonal saturation. Permanent saturation would have likely been prominent under natural conditions prior to the establishment of the surrounding plantations.
Dominant water input	Intercepts fluctuating perched water table and lateral subsurface seepage.
Low flow pattern	Subsurface diffuse flow.
Sampled soil characteristics	**Wetland soils:** Soils were typically loam and sand textured, with wetland soils being dark brown almost black where organics were evident or grey to very dark grey. <u>Sample 1: seasonal wetland:</u> • 0 – 30cm depth: dark brown/black loamy sand high in organics (10YR 2/1), no mottles. • 30-40cm depth: very dark grey fine sand (7.5YR 3/1), no mottles. • 40 – 50cm depth: dark grey/grey fine sand (7.5YR 4/1 or 5/1) no mottles. <u>Sample 2: seasonal wetland:</u> • 0 – 30cm depth: dark brown/black loamy sand high in organics (10YR 2/1), no mottles. • 30 – 40cm depth: fine dark grey sand (7.5YR 4/1), no mottles. • 40 – 50cm depth: fine very dark grey sand with some organics (7.5YR 3/1) • At 50cm depth: fine grey sand (7.5YR 5/1), no mottles. <u>Sample 3: temporary/seasonal wetland:</u> • 0 – 30cm depth: very dark brown grey sand (no munsell taken) • At 30 cm depth: slightly lighter coloured very dark grey fine sand (7.5YR 3/1) • At 30 – 40cm depth: fine dark grey sand (7.5YR 4/1), no mottles. • 40 – 50cm depth: fine very dark grey sand with some organics (7.5YR 3/1) • At 50cm depth: fine grey sand (7.5YR 5/1), no mottles. <u>Sample 4: temporary wetland/wetland edge:</u> • 0 – 40cm depth: very dark brown grey sand (7.5YR 3/2), no mottles. 40 – 50cm depth: fine very dark grey sand (7.5YR 3/1), no mottles. <u>Sample 5: non wetland:</u> • 0 – 30cm depth: dark reddish brown clay loam (5YR 3/3)

Unit W01: Seep wetland	
	• 30 – 40cm depth: dark brown fine sand (7.5YR 3/2) • 40 – 80cm depth: brown fine sand (7.5 YR 4/2) • At 80cm depth: brown/light brown fine sand (7.5 YR 5/2)
Vegetation characteristics	The vegetation communities comprise the following: • **Swamp forest in temporary/seasonal wetness zone**: comprising a relatively intact and diverse indigenous canopy of trees such as *Syzigium cordatum, Bridelia micrantha, Rauvolfia caffra, Schefflera sp., Ficus trichopoda, Barringtonia racemosa,* as well as *Monanthotaxis caffra*, *Rhoicissus rhomboidea*, *Peddiea africana*, *Tabernaemontana ventricosa*, *Psychotria capensis*, *Dalbergia armata* and *Phoenix reclinata* in the sub-canopy with the understorey characterised primarily by the fern *Stenochlaena tenuifolia*, some scattered cover of *Asystasia gangetica*, *Gloriosa superba*, *Scadoxus puniceus*, *Ledebouria sp* and *Cyperus albostriatus* amongst large patches of leaf litter and juvenile tree species were also noted. Very low and localised occurrences of the alien invasive *Rivina humilis* were observed in the understorey. On the edge of the swamp forest a narrow ecotone of more dryland tree species were noted with *Albizia adianthifolia*, *Trema orientalis* and *Canthium inerme* more frequently encountered, along with the fern *Pellaea viridis*. • **Temporarily wet *Eucalyptus* plantation:** a portion of the wetland extended into the adjacent *Eucalyptus* plantation with the groundcover in these areas dominated by leaf litter and *Pennisetum clandestinum* with occasional scattered cover of *Commelina purpureum*, *Ledebouria sp* and *Asystasia gangetica*.
Other comments	• A portion of the wetland has been planted with *Eucalyptus* along with sections of its upstream catchment, not only resulting in a loss in extent of intact wetland vegetation but also likely resulting in a lowering of the local groundwater table, which may have altered the hydrological regime of the wetland to be drier in comparison to its reference state. • One dirt road and a formalised tar road (the P535 –which is the main access road off the N2 into Esikhawini) cut across the wetland unit resulting in dis-connectivity in terms of hydrology and geomorphology, with some loss in extent also associated with their development. Back-flooding behind the P535 was evident during the site visit with 2 blocked culverts noted and stagnant water sitting upstream of these blocked culverts.

Selected Photos of Wetland W01:

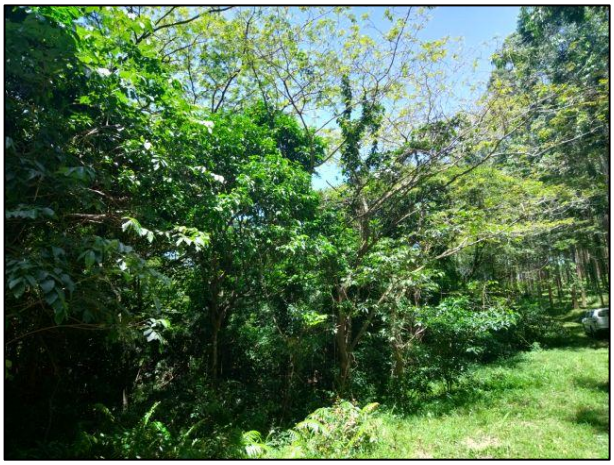

Photo 01: View of wetland W01 looking downstream to the south showing the forest ecotone.

Photo 02: View of wetland W01 immediately above the P535 road looking across the wetland to the west, with the fern *Stenochlaena tenuifolia* forming an almost monotypic stand in the foreground and stagnant open water and indigenous trees visible in the background.

4.2. Present Ecological State (PES) Assessment

This section presents and discusses the results of the river and wetland PES assessments. PES is defined as a measure of the similarity or deviation from a natural or reference state (Macfarlane *et al*., 2020).

4.2.1. Wetland PES

The impact scores were interpreted using the PES categories and descriptions provided in Table 7 below.

Table 7. PES impact categories and descriptions for wetlands.

IMPACT CATEGORY	DESCRIPTION	IMPACT SCORE RANGE
None	No discernible modification or the modification is such that it has no impact on wetland integrity.	0-0.9

IMPACT CATEGORY	DESCRIPTION	IMPACT SCORE RANGE
Small	Although identifiable, the impact of this modification on wetland integrity is small.	1-1.9
Moderate	The impact of this modification on wetland integrity is clearly identifiable but limited.	2-3.9
Large	The modification has a clearly detrimental impact on wetland integrity. Approximately 50% of wetland integrity has been lost.	4-5.9
Serious	The modification has a clearly adverse effect on this component of habitat integrity. Well in excess of 50% of the wetland integrity has been lost.	6-7.9
Critical	The modification is present in such a way that the ecosystem processes of this component of wetland health are totally / almost totally destroyed.	8-10

The results of the wetland PES assessment are summarised in Table 8. Overall, the PES of Wetland W01 (seep) was rated as a **'C' Category or 'Fair'**: '*There has been some modification that has had a moderately detrimental impact on wetland integrity and approximately 30% of wetland integrity has been lost*'.

The wetland remains in a fair condition due to (1) limited within-wetland impacts, and (2) its largely intact vegetation composition. Within-wetland impacts are very localised and confined to areas impacted by the existing road crossing, both infilling and upstream flow impoundment, as well as some of the wetland margins that have been cleared for *Eucalyptus* plantations.

The most prominent and intense impacts are the indirect impacts of the surrounding *Eucalyptus* plantations on catchment and wetland hydrology, which is predicted to have resulted in a measurable draw-down of perched water tables and reduced subsurface water inputs to the wetland system. This is reflected in the hydrology impact score that falls within PES Class D, largely modified.

Table 8. PES Summary for the wetland unit W01 assessed.

Wetland Unit	Hydrology	Geomorphology	Water Quality	Vegetation	Overall PES
W01: seep	5.5 Class D	2.3 Class C	1.8 Class B	2.0 Class C	**3.2** **Class C**

4.3. Ecosystem Services: Wetland Functional Assessment

This section discusses the results of the wetland ecosystem services assessment. Ecosystem services are broadly defined as the benefits people obtain from ecosystems (Kotze *et al*., 2020). A broader definition is that they are all the aspects of ecosystems utilized (actively or passively) to produce human well-being (Kotze *et al*., 2020). The ecosystem services scores were interpreted using the categories and descriptions provided in Table 9, below.

Table 9. Ecosystem services importance categories and descriptions.

Importance Category		Description
Very Low	0-0.79	The importance of services supplied is very low relative to that supplied by other wetlands.
Low	0.8 – 1.29	The importance of services supplied is low relative to that supplied by other wetlands.
Moderately-Low	1.3 – 1.69	The importance of services supplied is moderately-low relative to that supplied by other wetlands.
Moderate	1.7 – 2.29	The importance of services supplied is moderate relative to that supplied by other wetlands.
Moderately-High	2.3 – 2.69	The importance of services supplied is moderately-high relative to that supplied by other wetlands.
High	2.7 – 3.19	The importance of services supplied is high relative to that supplied by other wetlands.
Very High	3.2 – 4.0	The importance of services supplied is very high relative to that supplied by other wetlands.

The results of the WET-EcoServices assessment are summarised in Table 10 below.

In terms of the regulating services assessed, carbon storage was rated as being of moderately-high importance due to the presence of dense forest vegetation and measurable organic matter in the top 30cm of the soil profiles samples. The importance of carbon storage is reduced by the seasonal saturation regime where the soils dry out seasonally and thus organic matter decomposition occurs.

Toxicant assimilation was assessed as being of moderate importance due to the dominant diffuse subsurface flows and temporarily and seasonally saturated soils that facilitate adsorption of pollutants to sediments.

The rest of the regulating services were assessed as being of low to moderately-low importance. This was largely due to the low catchment risks for additional sediment and pollutant inputs that down weighted the demand score for regulating services. The reduced soil saturation regime has also had an influence on reducing the supply scores. It must be noted however, that the wetland is assessed as having high supply scores for sediment trapping and toxicant removal services, with contributing factors including diffuse patterns of low flows observed, seasonal saturation and high levels of vegetation cover, which all lead to increased residence time, maximising opportunity for the wetland to assimilate toxicants received from upstream.

The wetland unit is assessed as being of moderate importance in terms of the provision of biodiversity maintenance services. This is because the wetland vegetation / ecosystem type represents an intact version of a critically endangered HGM type with swamp forest elements. The presence of threatened flora and fauna could not be confirmed for this assessment but if any such biota are confirmed to occur, the importance score will likely be increased to high.

The wetland provides very limited cultural and provisioning services due to lack of use for food, craft making, recreation, tourism, research and religious / spiritual ceremonies.

Table 10. Summary of the outputs of the WET-EcoServices assessment for wetland seep W01.

ECOSYSTEM SERVICE		Importance Score	Importance
REGULATING AND SUPPORTING SERVICES	Flood attenuation	1.2	Low
	Stream flow regulation	1.3	Moderately Low
	Sediment trapping	1.6	Moderately Low
	Erosion control	1.0	Low
	Phosphate assimilation	0.9	Low
	Nitrate assimilation	1.5	Moderately Low
	Toxicant assimilation	1.8	Moderate
	Carbon storage	2.4	Moderately High
	Biodiversity maintenance	2.2	Moderate

ECOSYSTEM SERVICE		Importance Score	Importance
PROVISIONING SERVICES	Water for human use	0.0	Very Low
	Harvestable resources	1.7	Moderately Low
	Food for livestock	0.0	Very Low
	Cultivated foods	0.6	Very Low
CULTURAL SERVICES	Tourism and Recreation	0.0	Very Low
	Education and Research	0.0	Very Low
	Cultural and Spiritual	0.5	Very Low

4.4. Ecological Importance & Sensitivity (EIS) Assessment

This section discusses the results of the Ecological Importance and Sensitivity (EIS) assessment. Ecological Importance (EI) is the expression of the importance of rivers and wetlands in terms of the maintenance of biological diversity and ecological functioning at a local and landscape level (Kotze et al., 2020). Ecological Sensitivity (S) refers to ecosystem fragility or the ability to resist or recover from disturbance (Kotze et al., 2020).

4.4.1. Wetland EIS

The wetland EIS scores were interpreted using the categories and descriptions provided in Table 11 below.

Table 11. Wetland EIS rating categories.

EIS Score	EIS Rating	General Description
0-0.79	Very Low	Wetlands that are not ecologically important and sensitive at any scale and provide negligible biodiversity maintenance, regulating, provisioning and cultural services.
0.8 – 1.29	Low	Wetlands that are not ecologically important and sensitive at any scale and provide low levels of biodiversity maintenance, regulating, provisioning and cultural services.

EIS Score	EIS Rating	General Description
1.3 – 1.69	Moderately-Low	Wetlands that are not ecologically important and sensitive at any scale and provide moderately-low levels of biodiversity maintenance, regulating, provisioning and cultural services.
1.7 – 2.29	Moderate	Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale and provide biodiversity maintenance, regulating, provisioning and/or cultural services of moderate importance. They play a small but measurable role in moderating the quantity and quality of water in major rivers.
2.3 – 2.69	Moderately-High	Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale and provide biodiversity maintenance, regulating, provisioning and/or cultural services of moderately-high importance. They play a measurable role in moderating the quantity and quality of water of major rivers.
2.7 – 3.19	High	Wetlands that are ecologically important and sensitive on a provincial or national scale and provide biodiversity maintenance, regulating, provisioning and/or cultural services of high importance. They play an important role in moderating the quantity and quality of water of major rivers.
3.2 - 4.0	Very High	Wetlands that are considered ecologically important and sensitive on a national or even international level and provide biodiversity maintenance, regulating, provisioning and/or cultural services of very high importance The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water in major rivers.

A summary of the wetland EIS scores and ratings is provided in Table 12.

Wetland Unit W01 was assessed as being of **'Moderately High' EIS** driven by its Ecological Importance rating which can be attributed to its potential to supply carbon storage and biodiversity maintenance services of moderate importance.

Table 12. Summary of EIS scores and overall EIS rating for wetland unit W01.

Determinants	Wetland W01
Biodiversity Maintenance	2.2
Regulating Services	2.4
Provisioning Services	1.0
Cultural Services	0.5
Ecological Importance	2.4 Moderate
Ecological Sensitivity	1.7 Moderately Low
Final EIS Score	**2.4**

Determinants	Wetland W01
EIS Category & Rating	Moderately-High

5. Recommended Ecological Category (REC)

The recommended ecological category (REC) is the target or desired state of freshwater ecosystems 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 watercourse (Kleynhans & Louw, 2007). However, the causes related to a 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 for water resources is shown in Table 13, below.

Table 13. Generic matrix for the determination of REC 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 the above matrix (Table 13), the regional management objective for W01 would be to 'maintain PES and functioning' (see Table 14 for the REC and RMO). Any indirect negative impacts as a result of the proposed development activities would be undesirable from a water resource management perspective and therefore the management objective must be to ensure that the project impacts are mitigated such that the current supply of ecosystem services and present ecological state is maintained.

Table 14. REC and RMO for the wetland units based on their PES and EIS ratings.

Watercourse Units	PES	EIS	REC	RMO
W01: seep wetland	C	Moderately High	C	Maintain

6. Recommended Mitigation Measures

This section outlines the mitigation measures recommended to avoid, reduce / minimise, and rehabilitate the freshwater ecosystem impacts discussed in **Section 7** that follows this section. This is in accordance with the 'mitigation hierarchy' approach to wetland ecological impact mitigation.

6.1. Project Planning and Design Measures

6.1.1. Recommended 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 developments. 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 (1998), which is to provide for the sustaining of water quality and preserving natural aquatic habitats and ecosystem functions.

According to the draft Guidelines for Biodiversity Impact Assessment in KZN (EKZNW, 2011), a standard buffer width of 30m from the outer edge of the delineated wetland areas in the Province of KZN, often irrespective of site conditions and development/land use type. The guideline document goes on to recommend that the determination of ecological buffers should rather be based on a number of site-specific factors. A national protocol for buffer determination around rivers, wetlands and estuaries has recently been developed (Macfarlane & Bredin, 2016) and represents emerging best-practice in aquatic buffer zone determination.

The national buffer zone determination tool for wetlands and rivers (Macfarlane & Bredin, 2016) was applied for the seep wetland (W01) and used to allocate suitable buffers based on the generic risk levels associated with the proposed development type (refined at a site level). The "Multi-Purpose Retail and Office" and the "Petrol Station/Fuel Depot" land use/development types were used to inform operational risks/threats in the buffer model.

Based on the buffer model outputs, the following buffer zone width has been recommended (see map in Figure 9 below):

- **Wetland buffer width = 39m**

It is important that the recommended buffer/no-go area is incorporated into the design and planning of the proposed development so that all planned development is located outside this no-go area. In addition, the following activities will need to take cognisance of the buffer zones indicated on the map in Figure 9 and must be located outside of the recommended buffers:

- Construction site camps;
- Materials storage and laydown areas;
- Construction vehicle parking and temporary access roads;
- Soil, vegetation and materials stockpiles;
- Any ancillary services such as telecommunications, sewer and water pipelines, etc.

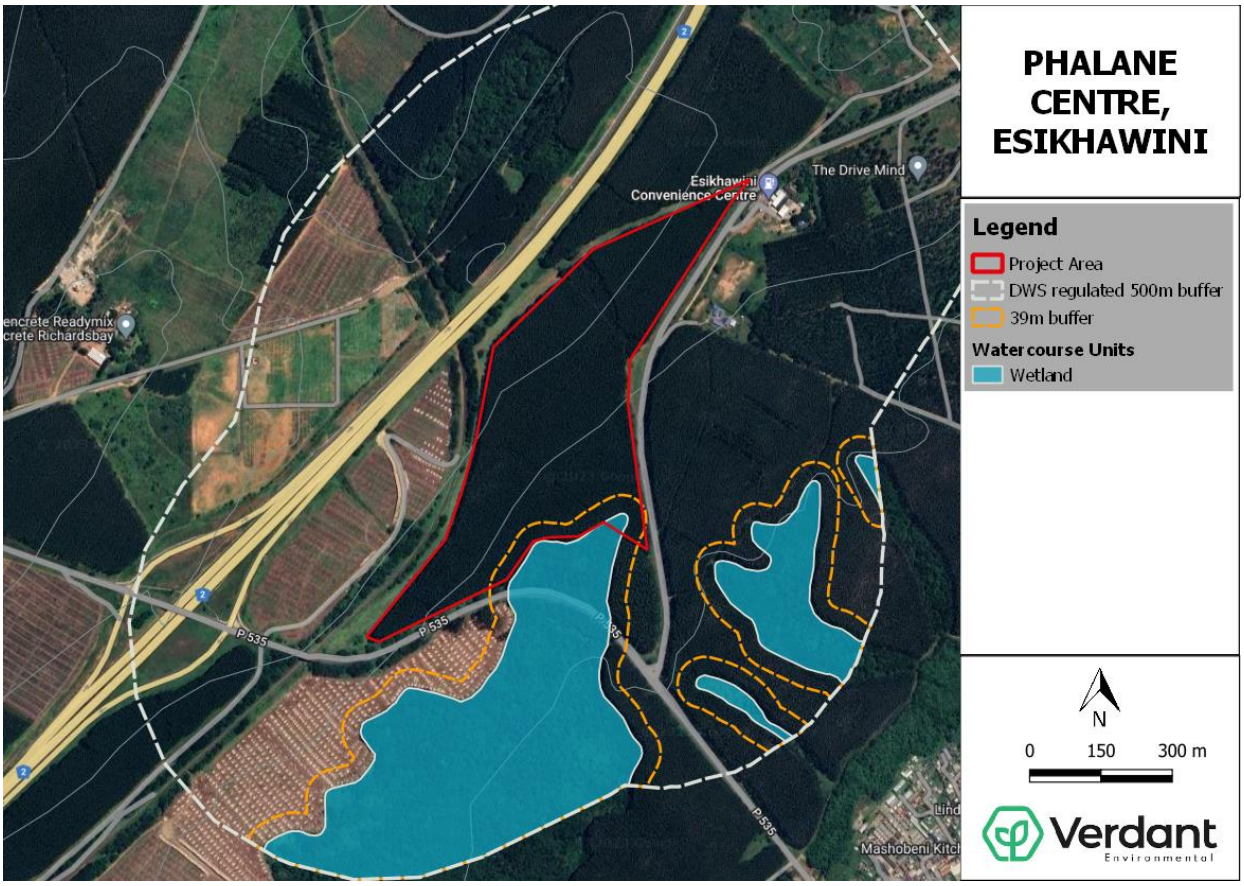

Figure 9. The location and extent of the recommended 39m wetland buffer zone.

It is also important to note that the buffer tool is based on the stressors arising from diffuse runoff and interflow and very localised concentrated surface flow conditions. Buffers do not apply to and cannot mitigate the stressors of point source stormwater discharges. Additional specific mitigation will need to be applied to minimise the intensity of the stressors and mitigate the risks of point source stormwater discharges. This might include end-of-pipe detention and bioretention or expanding the width of the buffer zone below stormwater outlets where relevant.

A measurable proportion of the seep wetland's catchment (W01) is proposed to be hardened as part of the development. As the hydrology of the onsite wetland is predominantly driven by subsurface interflows, catchment hardening is likely to substantially reduce soil infiltration rates, increase surface runoff inputs and decrease subsurface water inputs to the wetland unless stormwater generated by the development is allowed to infiltrate back into the soil profile evenly across the wetland's catchment. In this regard, it is recommended that in addition to the minimum 39m buffer zone required as part of the no-go area a hydro-pedological assessment is undertaken

to determine whether expansion of the buffer zone is required to maintain groundwater recharge to the seep. In addition to potential expansion of the buffer zone (pending the outcomes of a hydro-pedological assessment) please refer to the recommended stormwater infiltration measures included in the stormwater management recommendations in Section 6.1.2 below.

6.1.2. Stormwater Management Design Measures

When developing a stormwater management plan for the site, it will be critical that due consideration is given to the collection and treatment of stormwater prior to discharge into the natural environment. It is therefore recommended that the stormwater management plan be developed with appropriate ecological input and be developed based on Sustainable Drainage Systems (SUDS). The following best practice stormwater management design measures are recommended based on our understanding of the soils, geology and sensitivity of the site:

- Rainwater harvesting and storage should take place onsite and runoff from roofs should be collected in closed-top tanks or landscaped features for irrigation and non-potable purposes.
- Ideally, all stormwater runoff generated by the proposed development during all design storm events (1:1yr – 1:100yr) should be attenuated within the development footprint to pre-development levels prior to discharge to the freshwater environment.
- All stormwater infrastructure must be located outside of the onsite wetland and the 39m buffer zone.
- As the wetland is a subsurface fed system, it will be critically important to maximise runoff infiltration within or along the edges of the development footprint but ideally outside of the 39m buffer zone.
- Infiltration should ideally be built into the development land uses using permeable paving, into the internal stormwater conveyance system, into the attenuation / detention systems and into the outlet / discharge system. Recommended infiltration structures include underground storage tanks, bioretention areas and unlined detention basins, infiltration basins, and grassed swales. Contour infiltration swales will be important.
- If runoff infiltration cannot be accommodated within the development footprint then an adequate area of hillslope between the development and the wetland will need to be maintained to allow for the infiltration of stormwater runoff and maintain the hillslope hydrological processes.
- Considering the erodibility of the soil, all stormwater discharges should be via infiltration into the subsurface / interflow zone.

- Stormwater discharge must be evenly spread out across the length of the wetland rather than focussed at a few points.
- If surface discharges are required for well substantiated reasons, infiltration areas must be established below these points. For example, if surface outlets are proposed from attenuation structures at the lowermost / downslope parts of the site, such surface runoff should be conveyed into infiltration trenches or swales established along the toe of the development footprint to ensure surface flow discharges are minimised. If overtopping of surface flows from these trenches / swales is planned to occur, this must be in a diffuse manner.
- In terms of general stormwater conveyance, stormwater runoff generated by developed and hardened surfaces should be directed into, and conveyed by, open, impermeable swales rather than into underground piped systems or concrete V-channels wherever feasible and practical. These features should be well vegetated with appropriate species and stabilised by means of gabion or concrete check walls to prevent erosion and vertical incision. This will provide for some filtration and removal of urban pollutants (e.g. oils and hydrocarbons), provide some attenuation by increasing the time runoff takes to reach low points, and reduce the energy of storm water flows within the stormwater system through increased roughness when compared with pipes and concrete V-drains.
- Many smaller stormwater outlets must be favoured over a few large outlets. This also applies to roads.
- All outlets must be designed to dissipate the energy of outgoing flows to levels that present a low erosion risk. In this regard:
    - Suitably designed energy dissipation (e.g. stilling basins) and erosion protection structures (Reno-mattresses) will need to be installed at appropriate locations.
    - Pre- and post-discharge velocities at each outlet should be calculated to inform the appropriate design of the energy dissipation and erosion protection measures.
    - All outlet erosion protection measures (e.g. Reno-mattresses) must be established to reflect the natural slope of the surface and located at the natural ground-level.
- If subsoil drains are required, the following outlet design recommendations should be adhered to:
    - Level spreaders must be installed at all subsoil drain outlets.
    - The level spreaders must be designed to accommodate the predicted flow velocities and, in this regard, the predicted flow velocities at each outlet must be calculated / estimated.
    - Alternatively, the outlets could feed into the infiltration channels.

  - Measures to capture solid waste and debris entrained in stormwater runoff must be incorporated into the design of the system and should include the use of either curb inlet/inlet drain grates and/or debris baskets/bags.
- All stormwater generated by any medium to high-risk contamination urban surfaces (internal roads, parking areas, washing areas, etc.) must receive basic filtering and treatment onsite prior to discharge into the freshwater environment. The higher the watercourse pollution risk, the more stringent the basic treatment methods. Furthermore, all treatment should occur within the development footprint. Recommended filtering interventions include: grit / oil separators and/or sand filter traps. These structures will require regular maintenance by the site owners / operators. In this regard, a 'first-flush' system should also be investigated.
- In order to function adequately, it is critically important that the onsite stormwater system be regularly maintained over time. Key maintenance will include litter and sediment clearing and the servicing and maintenance of key collection points like catch pits, filtering devices (e.g. grit / oil separators), detention tanks etc. Such maintenance should be the responsibility of the mall operator and budgeted for accordingly.

6.1.3. Road Stormwater Management Design Measures

Key design considerations for the management of stormwater and erosion linked with road development have been included below:

- Measures must be implemented to distribute storm water as evenly as possible across the site to avoid point sources of discharge which could lead to preferential flow paths and erosion affecting the 39m buffer zone and wetland downstream.
- The location and design of road drainage and discharge points for the development site shall be done in a manner that minimises peak discharge to downstream aquatic resources by considering the following:
  - Decreasing the volume of water reaching wetlands as surface flow by encouraging infiltration; and
  - Decreasing the velocity of flows entering aquatic resources (either through structural or vegetative means).
- In order to reduce the volume and velocity of stormwater runoff received by watercourses, road runoff should be removed from roads via road drainage infrastructure constructed at regular intervals to avoid point source scouring at the outlets, particularly if these outlets are located close to the no-go area for the development.

- When designing stormwater outlets, many small outlet discharges must be favoured over a few large outlets to reduce outlet flow volumes and velocities.
- All outlets must have adequately designed erosion protection and energy dissipation measures (e.g. Reno-mattresses, stone-pitching) suitable to reduce anticipated discharge velocities to levels that do not pose an erosion risk.
- Armouring (e.g. reno-mattresses with vetiver bands) must be installed below all storm water outlets prior to flows entering the downstream 39m buffer zone and watercourses.
- Wherever possible, vegetated swales/side drains should be specified rather than concrete lined drainage channels (e.g. concrete V-drains). Vegetated swales/side drains should be well-vegetated with appropriate species and stabilized by means of gabion or concrete cut-off walls to prevent erosion and vertical incision. Similarly, outlets should not be piped outlets but open vegetated channels or vegetated mitre drains.
- Water should be discharged at regular intervals along road segments on the approach to no-go areas so that the volume and velocity of flows reaching final discharge points are reduced as far as possible.
- Appropriate outlet structures and energy dissipator blocks are to be specified at all discharge points to break the energy of the storm water.

6.1.4. Road Alignment and Design Measures

- No new roads should be located within 39m of the delineated wetlands.

6.1.5. Sewer Pipeline Alignment and Design Measures

- No sewer pipelines, manholes or pump stations should be located within 39m of the delineated wetlands.

6.1.6. Onsite Waste Water Package Treatment Plant Design Measures

An onsite package sewage treatment plant is proposed as an option to treat and dispose of sewage generated by the proposed development. No details on the type of technology, design capacity sewage loads, discharge volumes and discharge location has been provided at this stage. Considering this, the following best practice planning and design measures should be considered:

Sewage Treatment Options to Consider:

- Wherever possible, waste water should be discharged into the municipal waterborne system linked to an established WWTW.
- Privately operated WWTWs should only be considered in areas where there is no capacity for existing municipal WWTWs to receive and treat additional sewage.
- Onsite Package treatment plants (PTPs) should only be considered for small / low volume developments where occupation is permanent such that the bacterial populations in the system are maintained throughout the year. PTPs are not suitable for seasonal occupation like holiday home and recreational estates where collapses in bacterial populations may occur due to the periodic lack of sewage generation.

Siting & design of waste water treatment plants:

- Due to the relatively high treated effluent volumes and relatively high pollutant loads of WWTWs relative to wetland water input volumes and pollutant loads, WWTW discharges directly into or upstream of Unit W01 will have marked negative impacts on wetland PES and functionality. The siting of the treatment plants and discharge points must take into account the ability, capacity and sensitivity of the downstream freshwater ecosystem to assimilate the additional flows and physico-chemical constituents.
- Due to the sensitivity of Unit W01 to receiving additional surface water flows, it is recommended that direct discharges to the wetland unit be avoided. Alternative options to consider include:
    - Option 1A - Discharge to a series of containment / storage dams upstream / upslope of Unit W01 and use of treated effluent for irrigation purposes. Irrigation must only take place on dryland / terrestrial areas and not within 39m of a watercourse.
    - Option 1B - Discharge to a series of containment / storage dams upstream / upslope of Unit W01 that release flows in a diffuse and low energy manner. If required, treated effluent discharge should encourage the spreading out and infiltration of flows. To achieve this, effluent should be diverted into a network of swales that allow for infiltration into the soil profile.
    - Option 2 - Discharge into the buffer zone to the Mzingwenya River downstream of Unit W01. Wherever possible, discharge to channelled systems (streams and rivers) are favoured over unchanneled wetlands unless the purpose of the wetland

is to act as a constructed or enhanced treatment wetland system. If this option is favoured, then the following outlet design options should be considered:

  - Treated effluent discharge should ideally be via an open engineered channel with in-built erosion and energy dissipation measures rather than an underground pipe with a single outlet headwall.
  - Suitable engineered erosion protection measures must be installed at the PWWTP effluent outlet location e.g. stilling basin and gabion Reno-mattresses.
  - The discharge outlet and erosion protection structures should not be established within the Mzingwenya River and should be setback from the top of the bank of river bank. Furthermore, flow entering the channel must be at the elevation of the channel bed so that there is no erosion at or below the outlet point.

- All treatment plants require downstream / end-of-pipe emergency containment in the event of process malfunction or failure. The level of containment should vary depending on the risk and practicality. In the case of small PTPs, emergency containment should be for 100% of the design waste volumes over a 48hr period.
- Where feasible, treated effluent discharges must be polished by passive treatment structures/artificial wetlands prior to entering the closest watercourse.
- Utilisation/reuse of treated effluent generated should be investigated wherever possible to reduce discharge volumes to the environment, especially when downstream watercourses do not have the capacity to assimilate flows and pollutant loads.

Package Wastewater Treatment Plant Design: Process design:

The main water quality risk associated with the operation of the proposed PWWTW is the malfunction and/or failure of the treatment process. The success of the treatment process is mostly influenced by appropriate process design that adequately takes both the biological load (based on contributing population) and hydraulic load (based on water consumption) into account, as well as takes the local and site-specific conditions. For these reasons, the following design measures are recommended:

- A detailed design, particularly process design, of the proposed PWWTW must be completed. In the design it is important to note that the most important factor is the correct sizing of the plant from both a hydraulic and a biological load point of view as well as a clear statement of the effluent quality required.
- A detailed plant operational management plan must be completed.

- The detailed designs must be reviewed and approved by the relevant Municipality's Water and Sanitation Department. It is also important that a local and well-respected process engineer experienced in the design and operation of wastewater treatment plants in KwaZulu-Natal provide professional independent comment and review on the detailed plant design and operational management plan, in addition to that provided by eThekwini Municipality Water and Sanitation Department.
- The plant must be able to effectively and consistently achieve General Wastewater Limit Values (GLVs)[2] (Table 15) at a minimum as defined in Section 3.9 of Government Notice No. 339 (2004) published under the NWA that sets the terms of General Authorisation for Section 21(f) water uses.
- Suspended solids must be removed from any wastewater, and the resulting sludge disposed of according to the requirements of any relevant law or regulation, including the document Guidelines for the Utilisation and Disposal of Wastewater Sludge, Volumes 1-5, Water Research Commission Reports TT 261/06, 262/06, 349/09, 350/09, 351/09, as amended from time to time.
- All stop-valves and taps on the pipelines conveying water containing waste must be of a type that can be opened and closed by means of a loose wrench. This wrench must be in the safekeeping of a responsible member of the staff to prevent unauthorised use thereof.
- A berm must be constructed around the perimeter of the wetland in order to contain seepage of domestic waste from the wastewater pipeline and the waste water treatment plant.

Table 15. Wastewater limit values applicable to discharge of wastewater into a water resource.

SUBSTANCE/PARAMETER	GENERAL LIMIT	SPECIAL LIMIT
Faecal Coliforms (per 100 ml)	1 000	0
Chemical Oxygen Demand (mg/l)	75 (i)	30(i)
pH	5,5-9,5	5,5-7,5
Ammonia (ionised and un-ionised) as Nitrogen (mg/l)	6	2
Nitrate/Nitrite as Nitrogen (mg/l)	15	1,5
Chlorine as Free Chlorine (mg/l)	0,25	0

[2] As defined in Section 3.6 of Government Notice No. 339 (2004) published under the NWA, a wastewater limit value means the mass expressed in terms of the concentration and/or level of a substance which may not be exceeded at any time. Wastewater Limit Values shall apply at the last point where the discharge of wastewater enters into a water resource, dilution being disregarded when determining compliance with the wastewater limit values. Where discharge of wastewater does not directly enter a water resource, the wastewater limit values shall apply at the last point where the wastewater leaves the premises of collection and treatment.

SUBSTANCE/PARAMETER	GENERAL LIMIT	SPECIAL LIMIT
Suspended Solids (mg/l)	25	10
Electrical Conductivity (mS/m)	70 mS/m above intake to a maximum of 150 mS/m	50 mS/m above background receiving water, to a maximum of 100 mS/m
Ortho-Phosphate as phosphorous (mg/l)	10	1 (median) and 2,5 (maximum)
Fluoride (mg/l)	1	1
Soap, oil or grease (mg/l)	2,5	0
Dissolved Arsenic (mg/l)	0,02	0,01
Dissolved Cadmium (mg/l)	0,005	0,001
Dissolved Chromium (VI) (mg/l)	0,05	0,02
Dissolved Copper (mg/l)	0,01	0,002
Dissolved Cyanide (mg/l)	0,02	0,01
Dissolved Iron (mg/l)	0,3	0,3
Dissolved Lead (mg/l)	0,01	0,006
Dissolved Manganese (mg/l)	0,1	0,1
Mercury and its compounds (mg/l)	0,005	0,001
Dissolved Selenium (mg/l)	0,02	0,02
Dissolved Zinc (mg/l)	0,1	0,04
Boron (mg/l)	1	0,5

6.1.7. Sewer Pump Station Design Measures

The following design recommendations for sewer pump stations have been taken into account in the event these are planned as part of the proposed development:

- Pump stations must be fenced off to prevent unauthorized access by humans/wildlife which could cause damage to infrastructure and cause accidental malfunction and/or spillage of untreated wastewater.
- 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 pump station can be functional within 24 hours.
- The pump station must be placed within a lined, impermeable concrete bunded area with the capacity to hold untreated wastewater in an emergency and provide for sufficient time

for maintenance staff to address any faults/ problems. This is to limit the risk of untreated wastewater overflowing in the event of any leakage or accidental spillage at the pump station(s).

- Signage should be provided at a visible location at pump stations to inform local residents in the area of the purpose of the pump station. 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.

6.1.8. Water Pipeline Alignment and Design Measures

- No water pipelines or manholes should be located within 39m of the delineated wetlands.

6.1.9. Powerline Alignment and Design Measures

- No powerlines or pylons should be located within 39m of the delineated wetlands.

6.1.10. Underground Fuel Storage Tanks (USTs)

During the design phase, it will be critical that due consideration is given to the safe storage of the underground fuel tanks to avoid/reduce the likelihood of leaks and spills occurring along with their associated negative environmental impacts. Therefore the following best practice environmental design guidelines are recommended for Underground (fuel) Storage Tanks (USTs) and pipework required for a service station:

- The USTs must be installed according to:
    - The selected petrol station Engineering Guidelines and specifications.
    - Relevant National Building Regulations.
    - Relevant SANS and SABS codes.
- A geo-hydrologist must be commissioned to provide detailed mitigation measures to mitigate against UST and underground pipework leakages specific to coastal plain soils. Such measures must include details on the following:
    - The lining of the tank pit(s).
    - Underground leakage detection and collection facilities e.g. sumps and monitoring piezometers.
    - Pipework grading.

  - Pipeline materials / types.
  - Emergency overfill protection.
- USTs must be properly founded and be leak-proof.
- Once in place, and before backfilling, all USTs must be inspected for damage / cracks. Any damage to be repaired, or the tanks to be replaced before any further action is taken.
- The tank farm must be lined with a HDPE liner or a suitable clay layer to prevent infiltration of product to the ground water should a spill\leak occur.
- The void around the UST must be back filled with a non-cohesive granular material to ensure that any product loss through the UST or ancillary pipe work will flow towards the low point, where a monitoring well should be located.
- The USTs are to be overlain with a reinforced concrete slab, its thickness and strength is to be determined by a qualified Engineer.
- The filler point and tank must be fitted with overfill protection. The critical level should be such that a space remains in the tank to accommodate the delivery hose volume.
- All pipeline connections are to be housed within impermeable containment chambers.
- All pipework to consist of internationally approved non-corrosive material and all pipes to be housed in secondary containment sleeving.
- Tanks should ideally be double walled / Jacketed (i.e., possessing secondary containment and must have an interstitial leak detection monitoring system between the two walls to monitor for product leakage).

6.2. Construction Phase

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

6.2.1. Demarcation of 'No-Go' areas and construction corridors

- Prior to the commencement of any construction activities, the outer edge of the 39m buffer zone of the wetlands must be staked out by a surveyor and demarcated using brightly coloured shade cloth.
- All areas within / inside the 39m buffer zone must be considered no-go areas for the entire construction phase. Any contractor found working within No-Go areas must be fined as per fining schedule/system setup for the project.

- The demarcation work must be signed off by the Environmental Control Officer (ECO) before any work commences.
- The demarcations are to remain until construction and rehabilitation is complete.

6.2.2. Runoff, erosion and sediment control

- 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.
- Clearing 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.
- Sediment barriers (e.g.: silt fences/sandbags/hay bales) must be installed immediately downstream of active work areas (including soil stockpiles) as necessary to trap any excessive sediments generated during construction.
- All bare slopes and surfaces to be exposed to the elements during clearing and earthworks must be protected against erosion using rows of hay-bales, sandbags and/or silt fences aligned along the contours and spaced at regular intervals (e.g. every 2m) to break the energy of surface flows.
- Once shaped, all exposed/bare surfaces and embankments must be re-vegetated immediately.
- If re-vegetation of exposed surfaces cannot be established immediately due to phasing issues, temporary erosion and sediment control measures must be maintained until such a time that re-vegetation can commence.
- 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.
- Regular maintenance of any sediment control dams must be undertaken during the construction / establishment period to ensure that these structures continue to function appropriately.

6.2.3. Hazardous substances / materials management

- The proper storage and handling of hazardous substances (e.g. fuel, oil, cement, etc.) needs to be administered.
- 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 stormwater.
- Drip trays should be utilised at all dispensing areas.
- No refuelling, servicing or chemical storage should occur within 39m of any watercourse.
- No vehicles transporting concrete, asphalt or any other bituminous product may be washed on site.
- Vehicle maintenance should not take place on site unless a specific bunded area is constructed for such a purpose.
- Hazardous storage and refuelling areas must be bunded prior to their use on site during the construction period following the appropriate SANS codes. The bund wall should be high enough to contain at least 110% of any stored volume. The surface of the bunded surface should be graded to the centre so that spillage may be collected and satisfactorily disposed of.
- All necessary equipment for dealing with spills of fuels/chemicals must be available at the site. Spills must be cleaned up immediately and contaminated soil/material disposed of appropriately at a registered site.
- 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.
- Spills must be cleaned up immediately and contaminated soil/material disposed of appropriately at a registered site.

6.2.4. Invasive Alien Plant control

- All alien invasive vegetation that colonise the construction site must be removed, preferably by uprooting. The contactor should consult the ECO regarding the method of removal.
- All bare surfaces across the construction site must be checked for IAPs every two weeks and IAPs removed by hand pulling/uprooting and adequately disposed.

- Herbicides should be utilised where hand pulling/uprooting is not possible. ONLY herbicides which have been certified safe for use in wetlands by independent testing authority are to be used. The ECO must be consulted in this regard. The herbicide contractor must be certified to apply/utilise the herbicide in question.

6.2.5. Noise, dust and light pollution minimisation

- Temporary noise pollution due to construction works should be minimized by ensuring the proper maintenance of equipment and vehicles and tuning of engines and mufflers as well as employing low noise equipment where possible.
- Water trucks will be required to suppress dust by spraying water on affected areas producing dust. This will likely be required daily in the drier months or during dry periods.
- No lights must be established within the construction area near the watercourses and buffer zones.

6.2.6. Prohibitions related to animals

- The handling and/or killing of any animal species present is strictly prohibited and all staff/personnel must be notified of such incidents.
- Wetland fauna (e.g. snakes, frogs, small mammals) that are encountered during the construction phase must be relocated to other parts of the wetland under the guidance of the EO or ECO.
- Poaching/snaring is strictly prohibited.

6.2.7. General rehabilitation guidelines

- 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 land impacted by the proposed development must be rehabilitated by undertaking the following general tasks:
    - All foreign material must be removed from site.
    - Land must be regraded / re-shaped and topsoils must be reinstated.

- Compacted soils must be adequately ripped/loosened where compacted, as informed by the ECO.
- Re-vegetation should take place as follows:
  - For any permanently, seasonally and temporarily saturated areas - via translocation / transplanting of resecured sods or shrubs and tree saplings and, where there are not enough rescued sods/shrubs and trees, via the translocation / transplanting of plants from the surrounding wetland as advised by a wetland ecologist.
  - For dryland areas - via hydroseeding using an appropriate indigenous seed mix as advised by a qualified ecologist.

6.2.8. Construction phase monitoring measures

- 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.
- A photographic record of the state of the onsite wetlands prior to the commencement of clearing/construction must be kept for reference and rehabilitation monitoring purposes.
- The ECO must undertake bi-monthly compliance monitoring audits. Freshwater ecosystem aspects that must be monitored related to monitoring freshwater ecosystem impacts include:
  - The condition of the demarcation fence.
  - Evidence of any no-go area incursions.
  - The condition of the temporary runoff, erosion and sediment control measures and evidence of any failures.
  - Evidence of sedimentary deposits / plumes and elevated rates of sedimentation (i.e. vegetation smothering / burial).
  - Evidence of elevated river / stream turbidity levels.
  - Evidence of gully or bed/bank erosion.
  - Visual assessment of stormwater quality and instream water quality.
  - The condition of waste bins and the presence of litter within the working area.
  - Evidence of solid waste within the no-go areas.
  - Evidence of hazardous materials spills and soil contamination.
  - Presence of alien invasive and weedy vegetation within the working area.

- Rehabilitation and re-vegetation methods and success.

- Once the construction and rehabilitation has been completed, the ECO should conduct a close out site audit 1 month after the completion of rehabilitation.

6.3. Operational Phase

6.3.1. UST maintenance and management

- The integrity of UST and pipelines must be tested at least once a year.

6.3.2. WWTW maintenance and management

- Flow metering, recording and integrating devices shall be maintained in a sound state of repair and calibrated by a competent person at intervals of not more than two years. Calibration certificates shall be available for inspection.
- The quality of wastewater shall be monitored by taking grab samples every week. Each sample shall be analysed accordingly for the variables tabulated above and/or any other variable as may be required from time to time.
- Shallow monitoring wells must be drilled around the waste facilities to ensure any potential leakage are detected in time. An early warning detection leak system should be placed within the monitoring wells and beneath the facility liner. In the event of an elevated concentration observed for any element the source should be determined and remediated.
- The treatment works must be regularly and periodically inspected for possible leaks of waste and/or wastewater from the system that could enter the groundwater system.
- The wastewater treatment works shall be supervised and controlled by a suitably qualified and experienced employee of the Licensee in terms of Regulation 2834 in terms of Section 26 of the National Water Act, 1998 (Act 36 of 1998), or any update thereto to ensure proper functioning of the works and processes at all times.
- A water balance for the WWTW shall be developed and the water balance updated annually.
- Accurate and up-to-date records shall be kept of all system malfunctions resulting in non-compliance. The records shall be available for inspection. Such malfunctions shall be tabulated under the following headings with a full explanation of all the contributory

circumstances: operating errors, mechanical failures, environmental factors, loss of supply services, and other causes.

6.3.3. Sewerage Pump Station maintenance and management

- Maintenance of pipelines and pump stations must be undertaken as sensitively as possible to prevent adverse impacts to the environment during access and repairs.
- Ensure the area around the pump station is mown on a regular basis to prevent fire damage.
    - Blockages and manhole overflows must be fixed immediately.
    - Ensure that an incident response and contingency plan is prepared to deal with any potential unforeseen impacts that could arise at the pump station during operation. These may include:
        - Failure of sewer pipeline design/poor construction;
        - Failure of materials leading to rupture of the sewer pipe and leakage;
        - Exposure of sewer pipelines and damage through erosion;
        - Unintentional damage by machinery operating near pipelines; and
        - The pump station also has the potential to malfunction, overflow or leak raw sewerage into the environment due to electrical failure, poor maintenance, environmental damage (e.g. storms) or systems operating above capacity.
- A monitoring and maintenance programme should be prepared for the pump station(s) to ensure the on-going performance of infrastructure and prevention of foreseeable faults/problems that could result in leakage/failure. Pump station monitoring to include:
    - Assessing motor/gearbox problems – replace gearbox oil;
    - Checking for wear and tear;
    - Checking electrical components are working correctly (e.g. electrical board in good operating condition);
    - Looking for any surcharging (blockages);
    - Checking that access to the facility is controlled (no gaps in fencing, etc.); and
    - Checking that any emergency alarms are in working-order.

6.3.4. General Maintenance and management

- It is the applicant's responsibility to ensure the proper functioning of infrastructure that is likely to require regular on-going maintenance. This includes the stormwater management infrastructure, road infrastructure, water infrastructure and sewerage infrastructure.
- Onsite sewers must be serviced appropriately. All sewage blockages must be dealt with immediately to ensure that the proposed development does not cause manhole surcharge events. It is the responsibility of the landowners/site operators to ensure that all sewage infrastructure is operating effectively for the lifetime of the proposed development.
- It is important that the location and extent of the wetlands in the vicinity of project activities be incorporated into all formal maintenance and repair plans for the project.
- In terms of management, alien invasive plant control must be practiced on an on-going basis 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 their property.

6.3.5. Spill Contingency

- All accidental surface spills of oil or fuel must be contained on-site and diverted to the oil/water separator.
- All minor spills must be cleaned and a spill management procedure must be prepared to include procedures for spill clean-up, waste and waste water collection and disposal.
- Spill kits must be kept on site and staff must be trained to execute a spill management procedure.

6.3.6. Monitoring

It will be important that long-term monitoring of the potential freshwater ecosystem impacts be undertaken to proactively identity any environmental issues and impacts that may arise as a result of the operational phase of the project. The following key aspects should be monitored:

- Erosion and/or sedimentation in the onsite and downstream wetlands;
- Presence of alien invasive plants; and
- Daily, monthly, and annual treated effluent discharge volumes.

- Water quality and evidence of pollution.
- Monthly treated effluent discharge quality.
- A geo-hydrologist must inform the required type, location and number of monitoring wells for the USTs.
- A geo-hydrologist must compile a groundwater monitoring programme for the operation of the proposed development. This includes the aspects to be monitored / measured and the frequency of monitoring. Furthermore, the wet stock reconciliation records must be scrutinised to ensure that the records are maintained and any discrepancies in product volume must be flagged for further investigation immediately. In the event of a suspected product loss, the UST and subsurface pipe work must be tested to identify problem areas. Problem areas should be isolated and shut down immediately and appropriate remedial action be implemented as soon as possible.

6.3.7. Remediation / Rehabilitation

Where appreciable direct vegetation/habitat impacts, water quality impacts (i.e. due to spills) or erosion/sedimentation impacts resulting from storm water releases to wetlands result, these must be reported immediately to the relevant environmental authorities, and an independent wetland specialist appointed to conduct a site inspection to assess the residual impacts and determine the need for any onsite remediation or rehabilitation requirements. Following this assessment, an implementable remediation and/or wetland rehabilitation plan may need to be compiled and implemented to the satisfaction of KZN EDTEA and DWS.

7. Impact and Risk Assessment

This section deals with the assessment of the construction and operational and phase impacts of the project on local freshwater ecosystems.

7.1. Activities and Impacts Assessed

The activities requiring assessment for this study and the associated potential impacts are summarised in Table 16, on the next page.

7.2. Key Assumptions

The following assumptions apply to the impact assessment:

- The realistic poor mitigation scenario assumes the following:
    - That the wetland and the 39m buffer zone will be excluded from all development.
    - Standard / typical bare minimum stormwater management plan.
    - The WWTW discharge will be into Unit W01, the outlet points to be established upslope and outside of the buffer zone.
- The realistic good mitigation scenario assumes the following:
    - All the planning and design measures recommended in Section 6.1 will be adhered to. If any of the recommended mitigation measures provided in Section 6.1 cannot be adhered to, the impact and risk assessments will need to be revised.
    - The (Site Development Plan) will avoid wetlands and buffer zones will be implemented to specification. Should there be any deviations from this plan, the impact significance assessment ratings could change appreciably.

Table 16. Summary of impacts assessed for each of the project activities.

Project Phasing & Activities	Impact Group	Impact Description
C1. Retail Centre and Fuel Service Station Construction activities: Establishment (construction) of all onsite infrastructure, including buildings, roads, parking, storm water and sewer infrastructure, including soil and vegetation stripping, earthworks	**C1-1: Direct ecosystem destruction and modification impacts**	• Accidental direct impacts to wetland habitat and vegetation by heavy machinery during construction.
	C1-2: Indirect hydrological and geomorphological impacts	• Erosion and/or sedimentation of wetland ecosystems due to catchment and/or wetland soil and vegetation clearing and landcover disturbance during construction. • Fine, sandy soils at the site will be relatively erodible if not properly managed, however and given the moderate gradient of the site, the risk of sediment mobilisation is moderately high and can only be reduced to a certain degree with proper onsite management.
	C1-3: Water quality impacts	• Pollution of rivers and wetland ecosystems on the site and possibly also downstream, due to the mishandling of hazardous substances and/or improper maintenance of machinery during construction (e.g. oil and diesel leaks and spills). • Any erosion leading to sedimentation of rivers and wetlands onsite/downstream could also lead to raised water turbidity and suspended solids concentrations, also affecting water quality.
	C1-4: Fragmentation and ecological disturbance impacts	• Expanded / more intense edge impacts could occur as a result of buffer zone encroachment, deterioration in vegetation quality and cover and the potential for increased alien invasive plant invasion due to disturbance causing activities near to rivers and wetlands. • Noise pollution and vibrations associated with earthworks and the use of heavy machinery could affect local wildlife (birds, amphibians and small mammals especially). • Light pollution associated with construction crews and the use of heavy machinery use at night which could affect locally occurring nocturnal wetland species, such as amphibians, however this would only be significant during certain times of the year (i.e. the typical frog breeding season, for example). • Given that there is already a busy road cutting across the wetland, existing noise and light impacts are already present and will therefore reduce the intensity of any further impacts which will be cumulative.

Project Phasing & Activities	Impact Group	Impact Description
C2. On-Site Waste Water Package Treatment Plant Construction activities: Establishment (construction) of all onsite sewerage infrastructure, including soil and vegetation stripping, earthworks	**C2-1: Direct ecosystem destruction and modification impacts**	• Accidental direct impacts to wetland habitat and vegetation by heavy machinery during construction.
	C2-2: Indirect hydrological and geomorphological impacts	• Erosion and/or sedimentation of wetland ecosystems due to catchment and/or wetland soil and vegetation clearing and landcover disturbance during construction. • Fine, sandy soils at the site will be relatively erodible if not properly managed, however and given the moderate gradient of the site, the risk of sediment mobilisation is moderately high and can only be reduced to a certain degree with proper onsite management.
	C2-3: Water quality impacts	• Pollution of rivers and wetland ecosystems on the site and possibly also downstream, due to the mishandling of hazardous substances and/or improper maintenance of machinery during construction (e.g. oil and diesel leaks and spills). • Any erosion leading to sedimentation of rivers and wetlands onsite/downstream could also lead to raised water turbidity and suspended solids concentrations, also affecting water quality.
	C2-4: Fragmentation and ecological disturbance impacts	• Expanded / more intense edge impacts could occur as a result of buffer zone encroachment, deterioration in vegetation quality and cover and the potential for increased alien invasive plant invasion due to disturbance causing activities near to rivers and wetlands. • Noise pollution and vibrations associated with earthworks and the use of heavy machinery could affect local wildlife (birds, amphibians and small mammals especially). • Light pollution associated with construction crews and the use of heavy machinery use at night which could affect locally occurring nocturnal wetland species, such as amphibians, however this would only be significant during certain times of the year (i.e. the typical frog breeding season, for example). • Given that there is already a busy road cutting across the wetland, existing noise and light impacts are already present and will therefore reduce the intensity of any further impacts which will be cumulative.

Project Phasing & Activities	Impact Group	Impact Description
O1: Retail Centre and Fuel Service Station Operational activities: Operation of all established retail and fuel service station facilities, including associated stormwater management and access road infrastructure	**O1-1: Direct ecosystem destruction and modification impacts**	• Accidental direct impacts to wetland habitat and wetland/buffer vegetation by heavy machinery during infrastructure repair and maintenance activities (particularly water and sewer pipelines and manholes for example).
	O1-2: Indirect hydrological and geomorphological impacts	• Erosion and/or sedimentation of onsite wetlands and downstream rivers as a result of the discharge of stormwater from the development. • The fine sandy soils at the site will be relatively erodible if not properly managed, however, given the moderately sloped nature of the site, the risk of sediment mobilisation is moderately high and can only be reduced to a certain degree with proper onsite management.
	O1-3: Water quality impacts	• Potential accidental releases/spills from wastewater (sewer) pipelines and manholes through inadequate design, improper use of flush toilets (leading to blockages for example) or other unforeseen events (such as release of stormwater into sewer system, leading to potential overflow from manholes). • Any erosion leading to sedimentation of rivers and wetlands onsite/downstream could also lead to raised water turbidity and suspended solids concentrations, also affecting water quality. • Pollution of onsite and downstream rivers and onsite wetlands due to the mishandling of hazardous substances and/or improper maintenance of machinery during repair and maintenance activities (e.g. oil and diesel leaks) or leaks associated with underground fuel storage tanks and lack of early detection resulting in pollution of groundwater and surface water feeding into the wetland and other watercourses downstream.
	O1-4: Fragmentation and ecological disturbance impacts	• Expanded / more intense edge impacts could occur as a result of buffer zone encroachment, deterioration in vegetation quality and cover and the potential for increased alien invasive plant invasion due to disturbance causing activities taking place near to rivers and wetlands. • Noise and light pollution associated with the operational site could affect local wildlife and especially nocturnal wetland species, such as amphibians, however this would only be significant during certain times of the year (i.e. the typical frog breeding season, for example).

Project Phasing & Activities	Impact Group	Impact Description
		• Given that there already an existing busy road in the vicinity of the property, existing noise and light impacts are already present and will therefore reduce the intensity of any further impacts which will be cumulative.
O2: On-Site Waste Water Package Treatment Plant Operational activities: Operation of the onsite wastewater treatment plant including maintenance and monitoring	**O2-1: Direct ecosystem destruction and modification impacts**	• Accidental direct impacts to wetland habitat and wetland/buffer vegetation by heavy machinery during repair and maintenance activities at the onsite waste water treatment plant.
	O2-2: Indirect hydrological and geomorphological impacts	• Erosion and/or sedimentation of onsite wetlands and downstream rivers as a result of the discharge of wastewater from the onsite waste water treatment plant. • The fine sandy soils at the site will be relatively erodible if not properly managed, however, given the moderately sloped nature of the site, the risk of sediment mobilisation is moderately high and can only be reduced to a certain degree with proper onsite management.
	O2-3: Water quality impacts	• Potential accidental releases/spills from proposed on-site package treatment plant, through inadequate design, improper or lack of maintenance, equipment malfunction or other unforeseen events (leading to point source discharge). • Any erosion leading to sedimentation of rivers and wetlands onsite/downstream could also lead to raised water turbidity and suspended solids concentrations, also affecting water quality. • Pollution of onsite and downstream rivers and onsite wetlands due to the mishandling of hazardous substances and/or improper maintenance of machinery during repair and maintenance activities (e.g. oil and diesel leaks) or leaks and lack of early detection resulting in pollution of water resources.
	O2-4: Fragmentation and ecological disturbance impacts	• Expanded / more intense edge impacts could occur as a result of buffer zone encroachment, deterioration in vegetation quality and cover and the potential for increased alien invasive plant invasion due to disturbance causing activities taking place near to rivers and wetlands. • Noise and light pollution associated with the operational site could affect local wildlife and especially nocturnal wetland species, such as amphibians, however this would only be significant during certain times of the year (i.e. the typical frog breeding season, for example).

Project Phasing & Activities	Impact Group	Impact Description
		• Given that there already an existing busy road in the vicinity of the property, existing noise and light impacts are already present and will therefore reduce the intensity of any further impacts which will be cumulative.

7.3. Impact Significance Assessment

The results of the wetland impact significance assessment for impacts to wetland W01 in the study area are summarised in Tables 17 and Table 18, below.

Construction phase impacts:

Under a poor mitigation scenario for the proposed retail centre and fuel service station development direct ecosystem destruction and modification impacts (C1-1) were rated as moderately low, indirect hydrological and geomorphological impacts (C1-2) as moderate, water quality impacts (C1-3) as moderately low and fragmentation and ecological disturbance impacts (C1-4) as low. The moderate rating assigned to C1-2 was due to the large extent of bare areas that are anticipated to be exposed given the large 23.7 ha site footprint and the potential erosion and sedimentation impacts that could affect the wetland on-site and downstream. Erosion and sedimentation impacts could alter the PES of the wetland and reduce its PES by one class, resulting in a reduction in its functioning which has negative implications at the local scale. All impacts for the construction phase can be reduced to 'Low' significance levels under a good mitigation scenario where all the mitigation measures recommended in this report are effectively implemented and strictly adhered to, including avoidance of the wetland and its recommended buffer zone.

Under a poor mitigation scenario for the proposed on-site waste water treatment works, indirect hydrological and geomorphological impacts (C2-2) were rated as moderately low, due to possible erosion and sedimentation impacts associated with site clearing activities and associated earthworks. The remainder of impacts were rated as 'Low'. Indirect hydrological and geomorphological impacts (C2-2) can be reduced to low under a good mitigation scenario where all mitigation measures recommended in this report are effectively implemented and strictly adhered to, including avoidance of the wetland and its recommended buffer zone.

Operational phase impacts:

Under a poor mitigation scenario for the proposed retail centre and fuel service station development, the indirect erosion and sedimentation impacts (Impact O1-2) and water quality impacts (Impact O1-3) were assessed as being of moderate significance. Although the wetland's catchment is already highly impacted by forestry, the shift to hardened surfaces over 14 hectares in the upstream catchment would result in increased flood-peaks within the study area which

could lead to erosion impacts within the seep wetland downstream. In addition, given that a large proportion of the water inputs received by the seep are diffuse sub-surface inputs, hardening a large portion of the upstream catchment will result in a large change in its hydrology. The moderate significance of Impact O1-3 (operational water quality impacts) is driven by the discharge of polluted stormwater into the wetland as well as the possibility of sewage leakages and discharges and/or fuel spills or leakages into the wetland. The moderately low significance of Impact O1-1 is driven by the same rationale as C1-1 during the construction phase, in the event further accidental incursion into the wetland takes place during maintenance activities etc. Under a good mitigation scenario where all the mitigation measures recommended in this report are effectively implemented, the significance of all impacts can be reduced to 'Low' or 'Moderately-Low'.

Under a poor mitigation scenario for the proposed on-site waste water treatment plant, the indirect erosion and sedimentation impacts (Impact O2-2) and water quality impacts (Impact O2-3) were assessed as being of 'Moderately-High' significance and unacceptable. In terms of Impact O2-2 the higher concentrated flows associated with point source discharge impacts is likely to lead to erosion and preferential flow paths forming and affecting the wetland's hydrology and geomorphology thus also altering the PES of the system and its ability to provide various ecosystem services. In terms of Impact O2-3, this is linked to the anticipated impacts of point source discharge which would include increased levels of nutrients and toxicants feeding into the wetland causing die-back of vegetation, altering the PES of the system and affecting its ability to assimilate and provide water quality enhancement services. Under a good mitigation scenario where all the mitigation measures recommended in this report are effectively implemented, the significance of Impacts O2-2 and O2-3 can be reduced to moderate and still potentially unacceptable with the remaining impacts reduced to 'Low'. It is important to note that the aforementioned significance ratings are conservative / precautionary considering the lack of information provided on the proposed WWTW.

Table 17. Summary of the wetland impact significance assessment under 'poor' and 'good' mitigation scenarios for the proposed Retail Centre and Fuel Service Station.

Phase	Impacts	Intensity	Extent	Duration	Probability	Significance
'Poor' Mitigation Scenario						
Construction	C1-1: Direct ecosystem destruction and modification impacts	Moderate	Local	Medium-term	Probable	Moderately-Low
	C1-2: Indirect hydrological and geomorphological impacts	Moderately-High	Local	Medium-term	Highly Probable	Moderate
	C1-3: Water quality impacts	Moderate	Local	Medium-term	Probable	Moderately-Low
	C1-4: Fragmentation and ecological disturbance impacts	Moderately-Low	Surrounding Area	Medium-term	Probable	Low
Operation	O1-1: Direct ecosystem destruction and modification impacts	Moderate	Surrounding Area	Long-term	Probable	Moderately-Low
	O1-2: Indirect hydrological and geomorphological impacts	Moderately-High	Local	Long-term	Highly Probable	Moderate
	O1-3: Water quality impacts	Moderately-High	Local	Long-term	Highly Probable	Moderate
	O1-4: Fragmentation and ecological disturbance impacts	Moderately-Low	Surrounding Area	Long-term	Highly Probable	Low
'Good' Mitigation Scenario						
Construction	C1-1: Direct ecosystem destruction and modification impacts	Low	Surrounding Area	Short-term	Possible	Low
	C1-2: Indirect hydrological and geomorphological impacts	Moderate	Surrounding Area	Medium-term	Probable	Low
	C1-3: Water quality impacts	Low	Surrounding Area	Short-term	Possible	Low
	C1-4: Fragmentation and ecological disturbance impacts	Moderately-Low	Surrounding Area	Short-term	Probable	Low
Operation	O1-1: Direct ecosystem destruction and modification impacts	Low	Surrounding Area	Long-term	Possible	Low
	O1-2: Indirect hydrological and geomorphological impacts	Moderate	Surrounding Area	Long-term	Highly Probable	Moderately-Low
	O1-3: Water quality impacts	Moderate	Local	Long-term	Highly Probable	Moderately-Low
	O1-4: Fragmentation and ecological disturbance impacts	Moderately-Low	Surrounding Area	Long-term	Probable	Low

Table 18. Summary of the wetland impact significance assessment under 'poor' and 'good' mitigation scenarios for the proposed On-Site Waste Water Treatment Works.

Phase	Impacts	Intensity	Extent	Duration	Probability	Significance
'Poor' Mitigation Scenario						
Construction	C2-1: Direct ecosystem destruction and modification impacts	Moderate	Surrounding Area	Medium-term	Probable	Low
	C2-2: Indirect hydrological and geomorphological impacts	Moderate	Surrounding Area	Medium-term	Highly Probable	Moderately-Low
	C2-3: Water quality impacts	Moderate	Surrounding Area	Medium-term	Probable	Low
	C2-4: Fragmentation and ecological disturbance impacts	Moderately-Low	Surrounding Area	Medium-term	Probable	Low
Operation	O2-1: Direct ecosystem destruction and modification impacts	Moderate	Surrounding Area	Long-term	Probable	Moderately-Low
	O2-2: Indirect hydrological and geomorphological impacts	High	Local	Long-term	Highly Probable	Moderately-High
	O2-3: Water quality impacts	High	Local	Long-term	Highly Probable	Moderately-High
	O2-4: Fragmentation and ecological disturbance impacts	Moderately-Low	Surrounding Area	Long-term	Highly Probable	Low
'Good' Mitigation Scenario						
Construction	C2-1: Direct ecosystem destruction and modification impacts	Low	Surrounding Area	Short-term	Possible	Low
	C2-2: Indirect hydrological and geomorphological impacts	Moderately-Low	Surrounding Area	Medium-term	Probable	Low
	C2-3: Water quality impacts	Low	Surrounding Area	Short-term	Possible	Low
	C2-4: Fragmentation and ecological disturbance impacts	Moderately-Low	Surrounding Area	Short-term	Probable	Low
Operation	O2-1: Direct ecosystem destruction and modification impacts	Low	Surrounding Area	Long-term	Possible	Low
	O2-2: Indirect hydrological and geomorphological impacts	Moderately-High	Local	Long-term	Probable	Moderate
	O2-3: Water quality impacts	Moderately-High	Local	Long-term	Probable	Moderate
	O2-4: Fragmentation and ecological disturbance impacts	Moderately-Low	Surrounding Area	Long-term	Probable	Low

7.4. DWS Risk Matrix Assessment

It is our understanding that the purpose of the risk matrix tool developed by the DWS is to give a preliminary indication of the likely impact / degree of change (consequence) of activities (water uses) to local and regional water resource quality. For the purposes of this study, the degree of change is reflected in PES change and/or the change in the supply of regulating ecosystem services associated with wetlands onsite and/or downstream of activities.

The results of the wetland risk assessment for impacts to wetland W01 in the study area are summarised in Tables 19 and Table 20, below.

Under a poor mitigation scenario for the proposed retail centre and service station development, several measurable risks with a moderate rating were assessed, namely:

- C1-2: Indirect hydrological and geomorphological impacts
- C1-3: Water quality impacts
- O1-2: Indirect hydrological and geomorphological impacts
- O1-3: Water quality impacts

This indicates that some marked ecosystem change could occur if construction and operational impacts are poorly managed. The rest of the impacts were assessed as being of low risk.

With the effective implementation of the recommended mitigation measures provided in this report, some risks can be reduced to low, however, Impacts O1-2 O1-3 remain moderate risk. This is largely due to erosion and sedimentation impacts remaining a concern even with effective mitigation as a large proportion of the wetland's upstream catchment will be hardened and this will result in increased runoff and increase the likelihood that the wetland will experience erosion impacts. In addition, long-term operational water quality risks will be small but measurable.

Under a poor mitigation scenario for the proposed on-site waste water treatment works, two impacts were assessed as being of high risk, namely Impact O2-2: Indirect hydrological and geomorphological impacts; and Impact O2-3: Water quality impacts, with three impacts being of moderate risk, namely: Impact C2-2: Indirect hydrological and geomorphological impacts, Impact C2-3: Water quality impacts and Impact O2-1: direct impacts during operation. The high risks are the result of the impacts on additional flow volumes and pollutant loads entering Unit W01 as well as the downstream important ecosystems that will likely lead to a long-term reduction in

ecosystem PES and functionality. In addition, if construction and operational impacts are poorly managed, there are some moderate risks. With the effective implementation of the recommended mitigation measures provided in this report, most risks can be reduced to low, with the exception of Impacts O2-2 and O2-3 that can be reduced to moderate, indicating that a measurable change is predicted even under a good mitigation scenario.

Table 19. Summary of the DWS 'Risk Assessment Matrix' results under the poor and good mitigation scenarios for the proposed retail centre and fuel service station development.

No.	Phase(s)	Activity	Impact	Flow Regime	Physico & chemical (water Quality)	Habitat (Geomogh & Vegetation)	Biota	Severity	Spatial Scale	Duration	Consequence	Frequency of Activity	Frequency of Impact	Legal Issues	Detection	Likelihood	Pre-mitigation Significance	Pre-mitigation Risk Rating	Post-mitigation Significance	Post-mitigation Risk Rating
1	Construction	CONSTRUCTION PHASE (C):	C1-1: Direct ecosystem destruction and modification impacts	1	1	1	1	**1**	1	2	**4**	5	2	5	1	**13**	**52**	**Low**	**52**	**Low**
			C1-2: Indirect hydrological and geomorphological impacts	1	1	3	2	**1.75**	3	3	**7.75**	3	3	5	2	**13**	**100.75**	**Moderate**	**55**	**Low**
			C1-3: Water quality impacts	1	1	1	1	**1**	2	2	**5**	3	2	5	2	**12**	**60**	**Moderate**	**55**	**Low**

No.	Phase(s)	Activity	Impact	Flow Regime	Physico & chemical (water Quality)	Habitat (Geomogh & Vegetation)	Biota	Severity	Spatial Scale	Duration	Consequence	Frequency of Activity	Frequency of Impact	Legal Issues	Detection	Likelihood	Pre-mitigation Significance	Pre-mitigation Risk Rating	Post-mitigation Significance	Post-mitigation Risk Rating
			C1-4: Fragmentation and ecological disturbance impacts	1	1	1	1	**1**	1	2	**4**	3	2	5	2	**12**	**48**	**Low**	**48**	**Low**
2	**Operation**	OPERATIONAL PHASE (O)	O1-1: Direct ecosystem destruction and modification impacts	1	1	2	1	**1.25**	1	2	**4.25**	3	3	5	1	**12**	**51**	**Low**	**51**	**Low**
			O1-2: Indirect hydrological and geomorphological impacts	2	2	3	2	**2.25**	3	3	**8.25**	3	3	5	2	**13**	**107.25**	**Moderate**	**82.25**	**Moderate**
			O1-3: Water quality impacts	1	2	1	2	**1.5**	3	2	**6.5**	3	3	5	2	**13**	**84.5**	**Moderate**	**59.5**	**Moderate**
			O1-4: Impacts to ecological connectivity and/or ecological disturbance impacts	1	1	1	1	**1**	1	2	**4**	3	2	5	1	**11**	**44**	**Low**	**44**	**Low**

Table 20. Summary of the DWS 'Risk Assessment Matrix' results under the poor and good mitigation scenarios for the proposed on-site wastewater treatment works.

No.	Phase(s)	Activity	Impact	Flow Regime	Physico & chemical (water Quality)	Habitat (Geomogh & Vegetation)	Biota	Severity	Spatial Scale	Duration	Consequence	Frequency of Activity	Frequency of Impact	Legal Issues	Detection	Likelihood	Pre-mitigation Significance	Pre-mitigation Risk Rating	Post-mitigation Significance	Post-mitigation Risk Rating
3	**Construction**	CONSTRUCTION PHASE (C):	C2-1: Direct ecosystem destruction and modification impacts	1	1	1	1	**1**	1	2	**4**	5	2	5	1	**13**	**52**	**Low**	**52**	**Low**
			C2-2: Indirect hydrological and geomorphological impacts	1	1	2	2	**1.5**	2	2	**5.5**	3	3	5	2	**13**	**71.5**	**Moderate**	**55**	**Low**
			C2-3: Water quality impacts	1	1	1	1	**1**	2	2	**5**	3	2	5	2	**12**	**60**	**Moderate**	**55**	**Low**

No.	Phase(s)	Activity	Impact	Flow Regime	Physico & chemical (water Quality)	Habitat (Geomogh & Vegetation)	Biota	Severity	Spatial Scale	Duration	Consequence	Frequency of Activity	Frequency of Impact	Legal Issues	Detection	Likelihood	Pre-mitigation Significance	Pre-mitigation Risk Rating	Post-mitigation Significance	Post-mitigation Risk Rating
			C2-4: Fragmentation and ecological disturbance impacts	1	1	1	1	**1**	1	2	**4**	3	2	5	2	**12**	**48**	**Low**	**48**	**Low**
4	**Operation**	OPERATIONAL PHASE (O)	O2-1: Direct ecosystem destruction and modification impacts	1	1	2	1	**1.25**	2	2	**5.25**	3	3	5	1	**12**	**63**	**Moderate**	**55**	**Low**
			O2-2: Indirect hydrological and geomorphological impacts	4	1	4	4	**3.25**	3	4	**10.25**	5	5	5	2	**17**	**174.25**	**High**	**169**	**Moderate**
			O2-3: Water quality impacts	1	4	4	4	**3.25**	3	4	**10.25**	5	5	5	2	**17**	**174.25**	**High**	**169**	**Moderate**
			O2-4: Impacts to ecological connectivity and/or ecological disturbance impacts	1	1	1	1	**1**	1	2	**4**	3	2	5	1	**11**	**44**	**Low**	**44**	**Low**

8. License and Permit Requirements

8.1. Environmental Authorisation Requirements

From a purely water resources (wetlands and rivers) perspective:

- Activity 12 in Listing Notice 1 in terms of the NEMA: Environmental Impact Assessment (EIA) Regulations (of 2014, as amended) may be triggered in the event that the proposed development encroaches into the watercourse on site or is within 32m of the watercourse on site "*The development of— (1) dams or weirs, where the dam or weir, including infrastructure and water surface area, exceeds 100 square metres; or (ii) infrastructure or structures with a physical footprint of 100 square metres or more; where such development occurs (a) within a watercourse; (b) in front of a development setback; or (c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse*;"
- Activity 19 in Listing Notice 1 in terms of the NEMA: Environmental Impact Assessment (EIA) Regulations (of 2014, as amended) may be triggered in the event that the proposed development encroaches into watercourses on site "*The infilling or depositing of any material of more than [5] 10 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than [5] 10 cubic metres from [—(i)] a watercourse*".
- Activity 10 in Listing Notice 3 in terms of the NEMA: Environmental Impact Assessment (EIA) Regulations (of 2014, as amended) may be triggered in the event that the proposed development encroaches into the watercourse on site or is within 100m of the watercourse on site "*The development and related operation of facilities or infrastructure for the storage, or storage and handling of a dangerous good, where such storage occurs in containers with a combined capacity of 30 but not exceeding 80 cubic metres. d. KwaZulu-Natal xiii. Outside urban areas: (cc) Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland*;"
- Activity 14 in Listing Notice 3 in terms of the NEMA: Environmental Impact Assessment (EIA) Regulations (of 2014, as amended) may be triggered in the event that the proposed development encroaches into the watercourse on site or is within 32m of the watercourse

on site "*The development of— (xii) infrastructure or structures with a physical footprint of 10 square metres or more; where such development occurs—(a) within a watercourse; (b) in front of a development setback; or (c) if no development setback has been adopted, within 32 metres of a watercourse, measured from the edge of a watercourse*;"

There may however be other listed activities from a terrestrial vegetation and biodiversity perspective that could be associated with the development, including the clearance of natural indigenous vegetation for example, that need to be investigated. These have not been identified at this stage as further investigations into the terrestrial habitat and vegetation found on the development site will be required to inform the identification of listed activities and EIA requirements from a terrestrial vegetation and biodiversity perspective.

8.2. Water Use License Requirements

The proposed development constitutes the following water uses:

- Section 21 (c): impeding or diverting the flow of water in a watercourse; and
- Section 21 (i): altering the bed, banks, course or characteristics of a watercourse.
- Section 21(e): engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1):
    - Section 37(1)(a) irrigation of any land with waste or water containing waste generated through any industrial activity or by a waterwork.
- Section 21(f): discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit.
- Section 21(g): disposing of waste in a manner which may detrimentally impact on a water resource.

An integrated Water Use License will be required subject to the submission of a full water use license application (WULA).

9. Additional Studies required

The following additional studies are recommended:

- Update this wetland report to include systematic sampling of the downstream wetland system that wasn't sampled as part of the original appointment, as well as the Mzingwenya wetland system.
- Estuarine impact assessment for the treated effluent discharges.
- Hydrological assessment of water quantity (flow) and water quality impacts to Mzingwenya River (and wetland), Lake Qhubu and estuary as a result of the treated effluent discharges. The hydrological studies will inform both the updated wetland study and the estuarine impact assessment.
- A hydropedological assessment to inform impacts to water budget and patterns of water inputs to Unit W01.

10. Assumptions, Limitations & Level of Confidence

The following limitations and assumptions apply to this assessment:

- Although all watercourses occurring within 500m of the proposed activities were mapped at a desktop level, field investigations were confined to only those rivers and wetlands where an appreciable 'risk of potential impact' was determined.
- The mapping and classification of the watercourse units outside of the study area but occurring within a 500m radius of activities should be considered preliminary and coarse in resolution. These units were not verified in the field.
- Sampling by its nature means that not all parts of the study area were visited. The assessment findings are thus only applicable to those areas sampled, which were extrapolated to the rest of the study area.
- A Soil Munsell Colour Chart was used to determine the soil matrix colour of the soil sampled. However, it is important to note that the recording of the colours using the soil

chart is highly subjective and varies significantly depending on soil moisture and the prevailing light conditions. In this case, all the soils sampled were dry and sampling was undertaken in sunny conditions.

- 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.
- All vegetation information recorded was based on the onsite visual observations of the author and no formal vegetation sampling was undertaken. Furthermore, only dominant and noteworthy plant species were recorded. Thus, the vegetation information provided has limitations for true botanical applications.
- Although every effort was made to correctly identify the plant species encountered onsite, wetland plants, particularly the Cyperaceae (sedge) family, are notoriously difficult to identify to species level. Every effort was made to accurately identify plants species but where identification to species level could not be determined, such species were only identified to genus level.
- 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.
- The assessment of impacts is predictive and was based on the information and site development provided by the client[3]. The 'realistic good mitigation scenario' impact significance ratings and assessment outcomes assumes that all the mitigation measures recommended in Section 6 will be adhered to.

[3] **Note:** at the time of this assessment no site development layout for the proposed development or confirmation regarding the location and specific designs for the proposed on-site waste water treatment plant – including the location of a proposed discharge point and anticipated discharge volumes, were provided.

11. Conclusion

The combined wetland and aquatic ecological assessment identified a seep wetland unit (W01) in the south-eastern edge of the development site and extending further downstream. The baseline assessment revealed that the wetland was found to be in fair condition ('C' PES) and is considered of Moderately High Ecological Importance and Sensitivity (EIS).

In terms of impact significance, the key findings are:

- Construction phase impacts of the proposed retail centre and fuel service station development:
    - Under a poor mitigation scenario for the proposed retail centre and fuel service station development direct ecosystem destruction and modification impacts (C1-1) were rated as moderately low, indirect hydrological and geomorphological impacts (C1-2) as moderate, water quality impacts (C1-3) as moderately low and fragmentation and ecological disturbance impacts (C1-4) as low.
    - The moderate rating assigned to C1-2 was due to the large extent of bare areas that are anticipated to be exposed given the large 23.7 ha site footprint and the potential erosion and sedimentation impacts that could affect the wetland on-site and downstream. Erosion and sedimentation impacts could alter the PES of the wetland and reduce its PES by one class, resulting in a reduction in its functioning which has negative implications at the local scale.
    - All impacts for the construction phase can be reduced to 'Low' significance levels under a good mitigation scenario where all the mitigation measures recommended in this report are effectively implemented and strictly adhered to, including avoidance of the wetland and its recommended buffer zone.
- Operational phase impacts of the proposed retail centre and fuel service station development:
    - Under a poor mitigation scenario for the proposed retail centre and fuel service station development, the indirect erosion and sedimentation impacts (Impact O1-2) and water quality impacts (Impact O1-3) were assessed as being of moderate significance. Although the wetland's catchment is already highly impacted by forestry, the shift to hardened surfaces over 14 hectares in the upstream

catchment would result in increased flood-peaks within the study area which could lead to erosion impacts within the seep wetland downstream. In addition, given that a large proportion of the water inputs received by the seep are diffuse sub-surface inputs, hardening a large portion of the upstream catchment will result in a large change in its hydrology. The moderate significance of Impact O1-3 (operational water quality impacts) is driven by the discharge of polluted stormwater into the wetland as well as the possibility of sewage leakages and discharges and/or fuel spills or leakages into the wetland. The moderately low significance of Impact O1-1 is driven by the same rationale as C1-1 during the construction phase, in the event further accidental incursion into the wetland takes place during maintenance activities etc. Under a good mitigation scenario where all the mitigation measures recommended in this report are effectively implemented, the significance of all impacts can be reduced to 'Low' or 'Moderately-Low'.

- Construction phase impacts for the on-site waste water treatment works:
    - Under a poor mitigation scenario for the proposed on-site waste water treatment works, indirect hydrological and geomorphological impacts (C2-2) were rated as moderately low, due to possible erosion and sedimentation impacts associated with site clearing activities and associated earthworks. The remainder of impacts were rated as 'Low'. Indirect hydrological and geomorphological impacts (C2-2) can be reduced to low under a good mitigation scenario where all mitigation measures recommended in this report are effectively implemented and strictly adhered to, including avoidance of the wetland and its recommended buffer zone.
- Operational phase impacts for the on-site waste water treatment works:
    - Under a poor mitigation scenario for the proposed on-site waste water treatment plant, the indirect erosion and sedimentation impacts (Impact O2-2) and water quality impacts (Impact O2-3) were assessed as being of 'Moderately-High' significance and unacceptable. In terms of Impact O2-2 the higher concentrated flows associated with point source discharge impacts is likely to lead to erosion and preferential flow paths forming and affecting the wetland's hydrology and geomorphology thus also altering the PES of the system and its ability to provide various ecosystem services. In terms of Impact O2-3, this is linked to the anticipated impacts of point source discharge which would include increased levels of nutrients and toxicants feeding into the wetland causing die-back of vegetation, altering the PES of the system and affecting its ability to assimilate

and provide water quality enhancement services. Under a good mitigation scenario where all the mitigation measures recommended in this report are effectively implemented, the significance of Impacts O2-2 and O2-3 can be reduced to moderate and still potentially unacceptable with the remaining impacts reduced to 'Low'. It is important to note that the aforementioned significance ratings are conservative / precautionary considering the lack of information provided on the proposed WWTW.

In terms of risk assessment, the key findings are:

- For the proposed retail centre and service station development:
    - Under a poor mitigation scenario for the proposed retail centre and service station development, several measurable risks with a moderate rating were assessed, namely:
        - C1-2: Indirect hydrological and geomorphological impacts
        - C1-3: Water quality impacts
        - O1-2: Indirect hydrological and geomorphological impacts
        - O1-3: Water quality impacts

      This indicates that some marked ecosystem change could occur if construction and operational impacts are poorly managed. The rest of the impacts were assessed as being of low risk.
    - With the effective implementation of the recommended mitigation measures provided in this report, some risks can be reduced to low, however, Impacts O1-2 O1-3 remain moderate risk. This is largely due to erosion and sedimentation impacts remaining a concern even with effective mitigation as a large proportion of the wetland's upstream catchment will be hardened and this will result in increased runoff and increase the likelihood that the wetland will experience erosion impacts. In addition, long-term operational water quality risks will be small but measurable.
- For the proposed on-site waste water treatment works:
    - Under a poor mitigation scenario for the proposed on-site waste water treatment works, two impacts were assessed as being of high risk, namely Impact O2-2: Indirect hydrological and geomorphological impacts; and Impact O2-3: Water quality impacts, with three impacts being of moderate risk, namely: Impact C2-2: Indirect hydrological and geomorphological impacts, Impact C2-3: Water quality impacts and Impact O2-1: direct impacts during operation. The high risks are the

result of the impacts on additional flow volumes and pollutant loads entering Unit W01 as well as the downstream important ecosystems that will likely lead to a long-term reduction in ecosystem PES and functionality. In addition, if construction and operational impacts are poorly managed, there are some moderate risks. With the effective implementation of the recommended mitigation measures provided in this report, most risks can be reduced to low, with the exception of Impacts O2-2 and O2-3 that can be reduced to moderate, indicating that a measurable change is predicted even under a good mitigation scenario.

In conclusion, there are no fatal flaws with the proposed retail centre and service station development (excluding the onsite WWTW) as long as the mitigation measures provided are strictly upheld. However, even under a good mitigation scenario, the water quantity and quality impacts of the proposed WWTW were assessed as being of moderate significance and potentially unacceptable. This signals that an onsite WWTW may not be the most appropriate option with potential residual impacts to the downstream ecosystems that may need to be offset.

It is also important to note that the impacts of the proposed WWTW will need to be updated and finalised following the undertaking of the following additional work and assessments:

- Update this wetland report to include systematic sampling of the downstream wetland system that wasn't sampled as part of the original appointment, as well as the Mzingwenya wetland system.
- Estuarine impact assessment for the treated effluent discharges.
- Hydrological assessment of water quantity (flow) and water quality impacts to Mzingwenya River (and wetland), Lake Qhubu and estuary as a result of the treated effluent discharges. The hydrological studies will inform both the updated wetland study and the estuarine impact assessment.
- A hydropedological assessment to inform impacts to water budget and patterns of water inputs to Unit W01.

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Annexure A – Impact Assessment Method

For the purposes of this assessment, the assessment of potential impacts was undertaken using the "Impact Assessment Methodology for EIAs" designed by Eco-Pulse Consulting (2020).

The assessment of impact significance is based on the basic risk formula: **Risk = consequence x probability**. However, the calculation of consequence has been modified to assess significance rather than risk. The basic significance formula utilised is:

Impact significance = impact consequence x impact probability, where
Impact consequence = (impact intensity + impact extent) x impact duration

In order to improve the repeatability of the system, concise descriptions have been developed to assist the user in rating extent and intensity criteria (Table A1). These have been specifically tailored for each of the four ultimate consequences considered as part of the significance assessment. An overall statement of impact significance is then obtained by qualitatively assessing the cumulative effect of all impacts on each aspect of the water resource being assessed.

Table A1. Criteria and numerical values for rating environmental impacts to freshwater ecosystems.

Score	Rating	Description
Extent (E) – relates to the expected extent of the impact in spatial and population terms		
10	**National**	***The effects of an impact are experienced over a very large geographic area. Given the extent of impacts, they are likely to be relevant at a national scale.*** ***Water resource management:*** • Water resources are affected across a very extensive geographic area (e.g. spanning a number of water management areas / crossing international boundaries); and / or • Indirect impacts continue to affect water resources far from the development site (e.g. impacts continue to be experienced > 100km downstream). ***Ecosystem conservation:***

Score	Rating	Description
		• The extent of direct impacts results in extensive impacts to water resources relative to the remaining extent (e.g. affecting >100ha wetlands / >10km watercourses); and / or • The extent of direct impacts is high relative to the extent of affected habitat types (e.g. affecting >10% of a remaining ecosystem type); and / or • The proposed development affects large areas (e.g. > 1000 ha) across a broad geographic area and affecting a range of terrestrial habitat types. ***Species conservation:*** • Impacts affect a large proportion of the population of an important species at a national level (e.g. >10% of species population affected); and / or • The proposed development will affect a wide range of important species populations across a very large geographic area. ***Direct use values***: • Impacts will affect a society at a national scale (e.g. large number of stakeholders across multiple district municipalities / provinces).
8	**Regional**	***The effects of an impact are experienced over a large geographic area. Given the extent of impacts, they are likely to be relevant at a regional scale.*** ***Water resource management:*** • Water resources are affected across a broad geographic area (e.g. extending across a large number of quaternary catchments); and / or • Indirect impacts continue to affect water resources a considerable distance from the development site (e.g. 10 - 100km downstream). ***Ecosystem conservation:*** • The extent of direct impacts results in large-scale impacts to water resources relative to the remaining extent, (10-100ha wetlands / 2-10km watercourses); and / or • The extent of direct impacts is notable relative to the extent of affected habitat types (e.g. affecting 1 - 10% of a remaining ecosystem type); and / or • The proposed development affects *a large area (100 – 1000ha) and typically extends across a range of terrestrial habitat types.* ***Species conservation:*** • Impacts affect a large proportion of the population of an important species at a regional level (e.g. 1 - 10% of species population affected); and / or • The proposed development will affect a wide range of important species populations across a large geographic area. ***Direct use values:*** • Impacts will affect a society at a regional scale (e.g. large number of communities and stakeholders across a number of local municipalities).
5	**Local**	***The effects of an impact are experienced over a limited geographic area. Given the extent of impacts, they are likely to be relevant at a local scale.*** ***Water resource management:*** • Water resources are affected within a localised geographic area (e.g. single quaternary catchment); and / or

Score	Rating	Description
		• Indirect impacts continue to affect water resources some distance from the development site (e.g. 1 - 10km downstream). ***Ecosystem conservation:*** • The extent of direct impacts results in localised impacts to water resources relative to the remaining extent, (1 - <10ha wetlands / 200m - <2km watercourses); and / or • The extent of direct impacts is limited relative to the extent of affected habitat types (e.g. affecting <1% of a remaining ecosystem type); and / or • The proposed development affects *a moderately large area (10 – 100ha) but may extend across a wide range of terrestrial habitat types.* ***Species conservation:*** • Impacts affect species populations that are important at a local scale (e.g. < 1% of population affected); and / or • The proposed development will affect a number of important species across a local geographic area. ***Societal impacts***: • Impacts will affect society at a local scale (e.g. a number of communities across a single local municipality).
2	**Surrounding Area**	***The effects of an impact are experienced over a very small area. Given the extent of impacts, they are likely to be relevant at a very localised scale.*** ***Water resource management:*** • Water resources are affected within a small geographic area (e.g. single quinery catchment); and / or • Indirect impacts affect water resources a limited distance downstream of the development site (e.g. <1km downstream). ***Ecosystem conservation:*** • Direct impacts affects a small area proportion of water resources (e.g. 0.1-1ha wetlands / 20 – <200m watercourses); and / or • The proposed development affects a small localised area (1 – 10ha) and is often confined to a very few terrestrial habitat types. ***Species conservation:*** • Impacts affect populations of important species beyond the site level; ***Direct use values:*** • Impacts will affect society at a very local scale (e.g. a number of households within a single community).
0.5	**Site**	***The effects of an impact are confined to a very small footprint. Given the extent of impacts, they are likely to be relevant at a site scale.*** ***Water resource management:***

Score	Rating	Description
		• Impacts are largely confined to the development footprint with limited downstream impact (<100m downstream effect). ***Ecosystem conservation:*** • Direct impacts are typically confined to a single water resource or few water resources within a small focal area (typically <0.1ha wetlands / 20m watercourses); and / or • The proposed development affects a small area (<1ha) and is typically confined to very few terrestrial habitat types. ***Species conservation:*** • Impacts are very localised and are unlikely to affect important species beyond the site level; ***Direct use values:*** • Impacts will affect society at a very local scale (single or few households within a single local community)
Intensity (I) – defines the severity and importance of the impact to water resources / habitats / species or human populations within defined impact extent		
10	**High**	***Water resource management:*** • Loss of regulating and supporting services critical to support effective water resource management (as defined by management objectives / sustainability thresholds / RQOs); and / or • Loss will compromise the ability to meet water resource management objectives. ***Ecosystem conservation:*** • Loss of largely intact critically endangered habitat; and / or • Loss of habitat associated with validated FEPA Rivers & wetlands; and / or • Loss of particularly unique / especially important special habitat features. ***Species conservation:*** • Loss of or seriously compromises persistence of viable populations of critically endangered species; and / or • Loss of or seriously compromises viable landscape-level corridors and longitudinal connectivity (e.g. dams on free-flowing rivers) ***Direct use values:*** • Loss of human life; and / or • Marked deterioration in human health; and / or • Loss of ecosystem services that are critical to support / protect livelihoods of dependant vulnerable communities; and / or

Score	Rating	Description
7	**Moderately-High**	***Water resource management:*** • Loss of regulating and supporting services important to support effective water resource management (as defined by management objectives / sustainability thresholds / RQOs) ; and / or • Loss is very likely to compromise the ability to meet water resource management objectives. ***Ecosystem conservation:*** • Serious modification (2 or more classes) of critically endangered habitat; and / or • Loss of largely intact endangered habitat types; and / or • Loss of moderately modified critically endangered habitat types (and with reasonable rehabilitation potential) ; and / or • Loss of habitat that has special habitat attributes (e.g. high habitat diversity / species richness). ***Species conservation:*** • Loss of or seriously compromises persistence of viable populations of endangered species; and / or • Loss of regionally important species populations (e.g. at municipal scale). ***Direct use values:*** • Loss of human livelihoods; and / or • Some deterioration in human health; and / or • Loss of ecosystem services that are important (highly valued but not critical to) supporting / protecting vulnerable communities. Alternative options / resources are not available to meet community needs without incurring significant costs.
4	**Moderate**	***Water resource management:*** • Loss of regulating and supporting services important to support effective water resource management (as defined by management objectives / sustainability thresholds / RQOs); and / or • Loss could compromise the ability to meet water resource management objectives. ***Ecosystem conservation:*** • Moderate modification (1 classes) of critically endangered habitat / serious modification (2 classes) of endangered habitat; and / or • Loss of largely intact vulnerable habitat types; and / or • Loss of moderately modified endangered habitat types (and with reasonable rehabilitation potential). ***Species conservation:*** • Loss of or seriously compromises persistence of viable populations of vulnerable / endemic / specially protected species; and / or • Loss of or seriously compromises viable corridors that are locally important for species movement. ***Direct use values:*** • Notable impact on human livelihoods; and / or • Moderate reduction in the availability of ecosystem services that are important for supporting / protecting vulnerable communities; and / or

Score	Rating	Description
		• Loss of ecosystem services that are moderately valued by local communities. Alternative options / resources are available but limited.
2	**Moderately-Low**	***Water resource management:*** • Loss of regulating and supporting services which are not particularly important for water resource management (as defined by management objectives / sustainability thresholds / RQOs); and / or • Loss is unlikely to compromise the ability to meet water resource management objectives. ***Ecosystem conservation:*** • Moderate modification (1 classes) of endangered habitat / serious modification (2 classes) of vulnerable habitat; and / or • Loss of largely intact least-threatened habitat types; and / or • Loss of moderately modified vulnerable habitat types (and with reasonable rehabilitation potential). ***Species conservation:*** • Reduction in populations of vulnerable / endemic / specially protected species (without compromising viability of locally occurring populations); and / or • Loss of populations of locally important species. ***Direct use values:*** • Limited but identifiable impact on human livelihoods; and / or • Moderate reduction in the availability of ecosystem services with a noticeable but limited impact to livelihoods.
0	**Low**	***Water resource management:*** • Loss of regulating and supporting services which are not particularly important for water resource management (as defined by management objectives / sustainability thresholds / RQOs); and / or • Loss will not compromise the ability to meet water resource management objectives. ***Ecosystem conservation:*** • Loss of highly degraded threatened vegetation types (and with low rehabilitation potential) ; and / or • Moderate modification (1 classes) of vulnerable habitat; and / or • Loss of moderately modified least threatened habitat types. ***Species conservation:*** • Limited impact to any locally important species populations. ***Direct use values:*** • None / very limited impact on human livelihoods; and / or • None / limited reduction in the availability of ecosystem services with very limited impact to livelihoods.
Duration (D) – relates to the duration of the impact in time (consideration should be given to reversibility which may reduce the duration of impact)		

Score	Rating	Description
1	**Permanent**	The impact will continue indefinitely (>30 years) and is essentially regarded as irreversible.
0.95	**Long-term**	The impact and its effects will continue over the long-term (10 - 30 years).
0.85	**Medium-term**	The impact and its effects will persist for a number of years (1 – 10).
0.75	**Short-term**	The impact and its effects will persist for a number of months after the impact has occurred (2 -12 months) but is unlikely to persist for more than a year.
0.5	**Immediate**	The impact and its effects will cease within days or weeks after the impact has occurred (0 – 2 months).
Probability (P) – relates to the expected likelihood and frequency of the impact causing event occurring		
1	**Definite**	More than 80% likelihood of occurrence. The impact is typically recorded under similar conditions and settings.
0.95	**Highly Probable**	The impact has a 50-80% chance of occurring and thus expected to occur. The impact is known to occur regularly in similar conditions and settings.
0.8	**Probable**	The impact has a 20-50% chance of occurring and thus is quite likely to occur. The impact is known to occur quite frequently in similar conditions and settings (less than once in 10 years).
0.6	**Possible**	The impact has a 5-20% chance of occurring. This impact could occur and is known to occur irregularly under the similar conditions and settings (less than once in 20 years).
0.4	**Unlikely**	The possibility of the impact occurring is low with less than 5% chance of occurring. The impact has little chance of materialising (less than once in 50 years).

Table A2. Impact significance categories and definitions.

Impact Significance	Impact Significance Score Range	Definition
High	**14.5 - 20**	**Totally unacceptable** and fatally flawed from an environmental perspective. The proposed activity should only be approved under very special circumstances (i.e. national priorities with large societal benefit). If authorised, residual impacts must be adequately compensated through appropriate offset mechanisms.
Moderately High	**12 – 14.4**	**Generally unacceptable** and should ideally be avoided. The potential impact will affect a decision regarding the proposed activity and require that the need and desirability for the project be clearly substantiated to justify the associated ecological risks. If authorised, residual impacts must be adequately compensated through appropriate offset mechanisms
Moderate	**8.5 – 11.9**	**Potentially unacceptable** and should ideally be reduced to lower significance levels. 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. If authorised, offsets should be considered to compensate for residual impacts.
Moderately Low	**4.5 - 8.4**	**Acceptable** with low to moderate risks. The potential impact may not have any meaningful influence on the decision regarding the proposed activity.

Impact Significance	Impact Significance Score Range	Definition
Low	**0 – 4.4**	**Acceptable**. The potential impact is very small or insignificant and should not have any meaningful influence on the decision regarding the proposed activity.

Thank you. If you have any questions, please contact us via the contact details below.

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