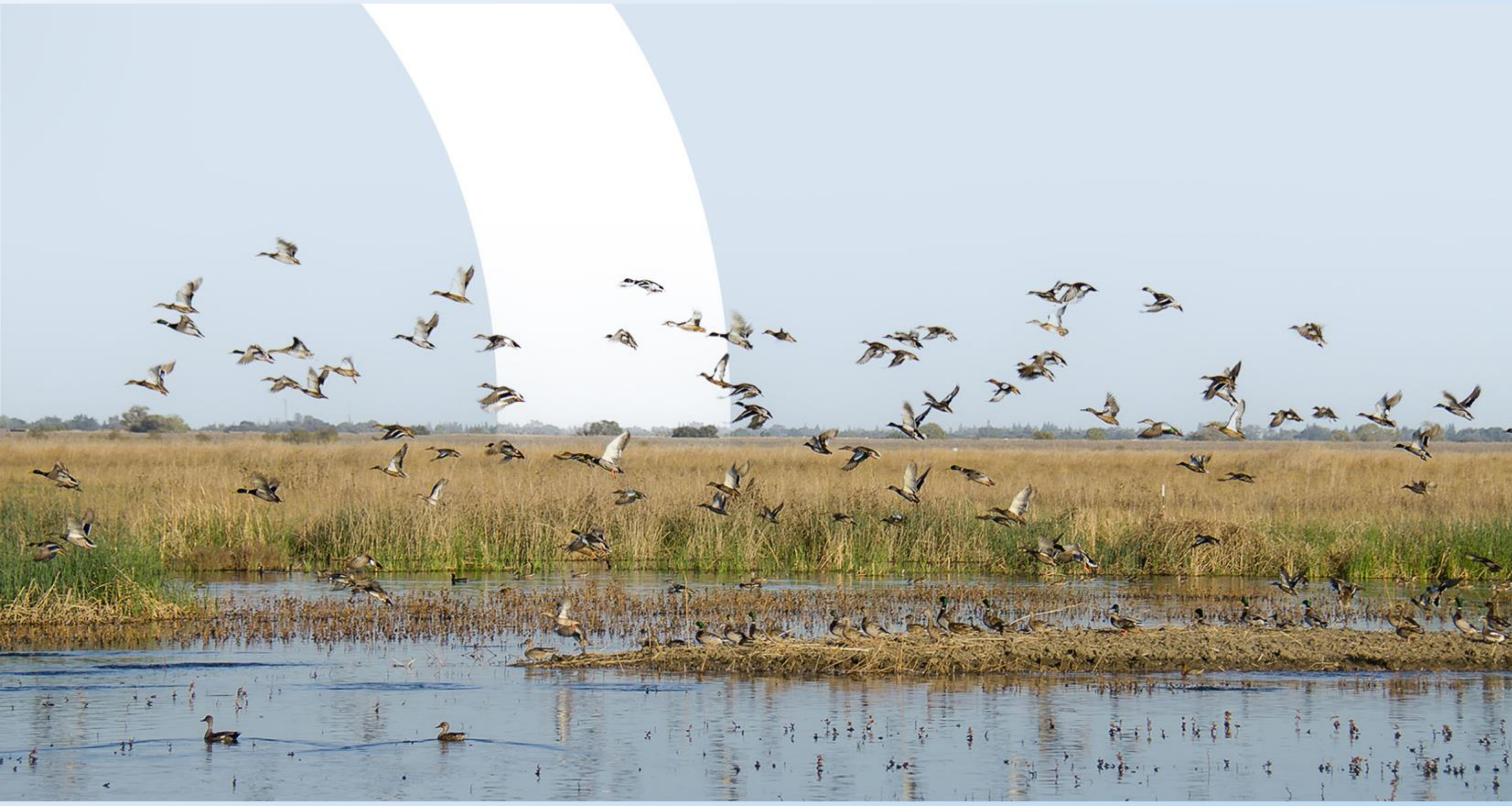
Appendix G.4

AQUATIC BIODIVERSITY ASSESSMENT

Kromhof Wind Power (Pty) Ltd.

AQUATIC BIODIVERSITY AND IMPACT ASSESSMENT REPORT

Kromhof Wind Energy Farm



JUNE 2025

CONFIDENTIAL

Kromhof Wind Power (Pty) Ltd.

AQUATIC BIODIVERSITY AND IMPACT ASSESSMENT REPORT

Kromhof Wind Energy Farm

REPORT (DRAFT) CONFIDENTIAL

PROJECT NO. 41106427

REPORT NO. 41106427-REP00010

DATE: JUNE 2025

Kromhof Wind Power (Pty) Ltd.

AQUATIC BIODIVERSITY AND IMPACT ASSESSMENT REPORT

Kromhof Wind Energy Farm

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CONFIDENTIAL

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APPENDIX C

SITE PHOTOS

1 REPORT REQUIREMENTS

Legal Requirement		Section in Report
-1	A specialist report prepared in terms of these Regulations must contain-	
(a)	details of-	Page 1
	(i) the specialist who prepared the report; and	
	(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	
(b)	a declaration that the specialist is independent in a form as may be specified by the competent authority;	Page 2
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	Section 3.5
c (i)	And indication of the quality and age of the base data used for the specialist report;	Section 4.2.1
c (ii)	A description of existing impacts on site, cumulative impacts of the proposed development and levels of acceptable change;	Section 8.4**Error! Reference source not found.**
(d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 6
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of the equipment and modelling used;	Section 4.2
(f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure inclusive of a site plan identifying site alternatives;	Section 6 **Error! Reference source not found.**, Section 7 (Site alternatives not assessed)
(g)	an identification of any areas to be avoided, including buffers;	Section 8.1.2
(h)	a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Figure 8-2 & Figure 8-3
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 3.6
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Section 8
(k)	any mitigation measures for inclusion in the EMPr;	Section 8
(l)	any conditions/aspects for inclusion in the environmental authorisation;	Sections 8.5 and 9
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 8.5
(n)	a reasoned opinion (Environmental Impact Statement) -	Section **Error! Reference source not found.** 9.1
	whether the proposed activity, activities or portions thereof should be authorised; and	
	if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	
(o)	a description of any consultation process that was undertaken during the course of preparing the specialist report;	N/A

(p)	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	
(q)	any other information requested by the competent authority.	N/A

2 SPECIALIST DETAILS AND DECLARATION

Wetland Specialist

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Qualification:	M.Sc. Zoology
Professional Affiliations:	**South African Council for Natural Scientific Professions (SACNASP)** *Pr.Sci.Nat*. – 115025 (Zoological Science, Ecological Science)

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Qualification:	M.Sc. Biodiversity and Conservation
Professional Affiliations:	**South African Council for Natural Scientific Professions (SACNASP)** *Pr.Sci.Nat*. – 119651 (Aquatic Science)
	DWS accreditation - South African Scoring System (SASS5) **Southern African Society of Aquatic Scientists -** SASAQS0450

Declarations of Independence

I, Tebogo Khoza, a duly authorised representative of WSP (Pty) Ltd, declare that I –

- Act as an independent specialist in this application.
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed.
- Do not have nor will have a vested interest in the proposed activity proceeding.
- Have no, and will not engage in, conflicting interests in the undertaking of the activity.
- Undertake to disclose, to the competent authority, any information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document.

I, Bhavna Ramdhani, a duly authorised representative of WSP (Pty) Ltd, declare that I –

- Act as an independent specialist in this application.
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed.
- Do not have nor will have a vested interest in the proposed activity proceeding.
- Have no, and will not engage in, conflicting interests in the undertaking of the activity.
- Undertake to disclose, to the competent authority, any information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document.

I, Shavaughn Davis, a duly authorised representative of WSP (Pty) Ltd, declare that I –

- Act as an independent specialist in this application.
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed.
- Do not have nor will have a vested interest in the proposed activity proceeding.
- Have no, and will not engage in, conflicting interests in the undertaking of the activity.
- Undertake to disclose, to the competent authority, any information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document.

I, Alpheus Moalosi, a duly authorised representative of WSP (Pty) Ltd, declare that I –

- Act as an independent specialist in this application.
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed.
- Do not have nor will have a vested interest in the proposed activity proceeding.
- Have no, and will not engage in, conflicting interests in the undertaking of the activity.
- Undertake to disclose, to the competent authority, any information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document.

3 INTRODUCTION

WSP Group Africa (Pty) Ltd (WSP) has been appointed by Kromhof Wind Power (Pty) Ltd. to undertake an Environmental Impact Assessment (EIA) to meet the requirements under the National Environmental Management Act (Act 107 of 1998) (NEMA), for the various applications associated with the proposed Verkykerskop Wind Energy Facility (WEF) Cluster located in the Free State Province.

The current aquatic biodiversity specialist assessment report forms part of the required specialist studies for environmental authorisation. The study was conducted in line with the '*Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in Terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998, When Applying for Environmental Authorisation*', and the '*Protocol for the specialist assessment and minimum report content requirements for environmental impacts on aquatic biodiversity'*

3.1 PROJECT DESCRIPTION

The Verkykerskop WEF Cluster is divided into 3 projects based on location and as listed below;

- Groothoek WEF (up to 300MW)
- Kromhof WEF (up to 300MW)
- Normandien WEF (up to 300MW)

The focus of this report is the Kromhof WEF only. The other projects are addressed in separate aquatic specialist reports.

The project infrastructure associated with the Kromhof WEF is detailed in Table 3-1 below. The connection of the powerlines (132kV) will be a separate process and therefore does not form part of the current project scope.

Table 3-1 – Project infrastructure details

Applicant Name	Kromhof Wind Power (Pty) Ltd
Municipalities	Thabo Mofutsanyana District Municipality
	Phumelela Local Municipality
Extent	7 269 ha
Buildable area	150 ha
Export Capacity	Up to 300MW
Power system technology	Wind
Number of Turbines	Up to 55
Rotor Diameter	up to 200m
Hub Height	up to 150m
Hard Standing Dimensions	up to 0,8 ha per turbine
	— Excavation up to 4.5 m deep, constructed of reinforced concrete to support the mounting ring.
	— Once tower established, footprint of foundation is covered with soil.

Substation	— 1 x 33kV/132kV onsite collector substation (IPP Portion) being up to 2ha.
Powerlines	— 33kV cabling to connect the wind turbines to the onsite collector substations, to be laid underground where practical.
Construction camp and laydown area	— Construction compounds including site office inclusive of
	— Concrete Batching plant of up to 1ha
	— Site office of 4 ha
	— laydown area of 8ha
Internal Roads	Up to 8m in width (operational road surface width excluding V drains and cabling). During construction the disturbed road footprint will be up to 14m wide including v-drains and trenching for cabling)
O&M Building	O&M office of up to 1ha.
BESS	— Battery Energy Storage System (BESS) (200MW/800MWh).
	— Pre-assembled solid state batteries
	— Export Capacity of up to 800MWh
	— Total storage capacity 200MW
	— Storage capacity of up to 6-8 hours
	— The BESS will be housed in containers covering a total approximate footprint of up to 7ha
O&M Building = Operations and Management Buildings **BESS = Battery Energy Storage System**	

3.2 STUDY AREA

The Kromhof WEF is located near the town of Harrismith in Ward 5 of the Phumelela Local Municipality (PLM) and in the Thabo Mofutsanyana District Municipality (TMDM) in the Free State Province (Figure 3-1).

The study area for the assessment was defined as follows:

- Project Area – the areas of the proposed Project footprint within which access permission had been secured.
- Project Area Of Influence (PAOI) - the geographical area where the proposed Project's direct and indirect impacts occur. A 500m area has been demarcated around the proposed infrastructure (Turbines and substations) for the project to facilitate the identification of water resources within the regulatory zone (Figure 3-2).

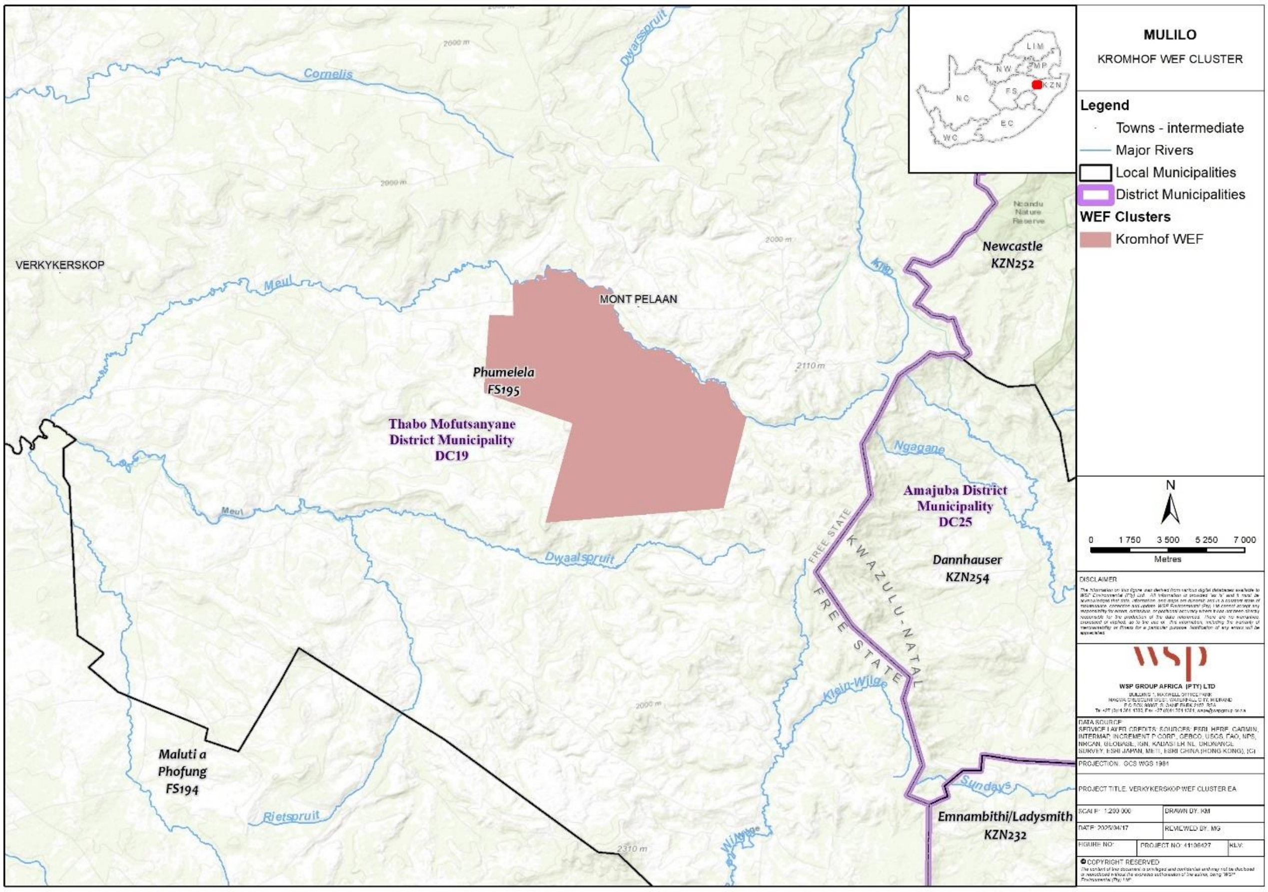


Figure 3-1 - Locality map of the Kromhof WEF

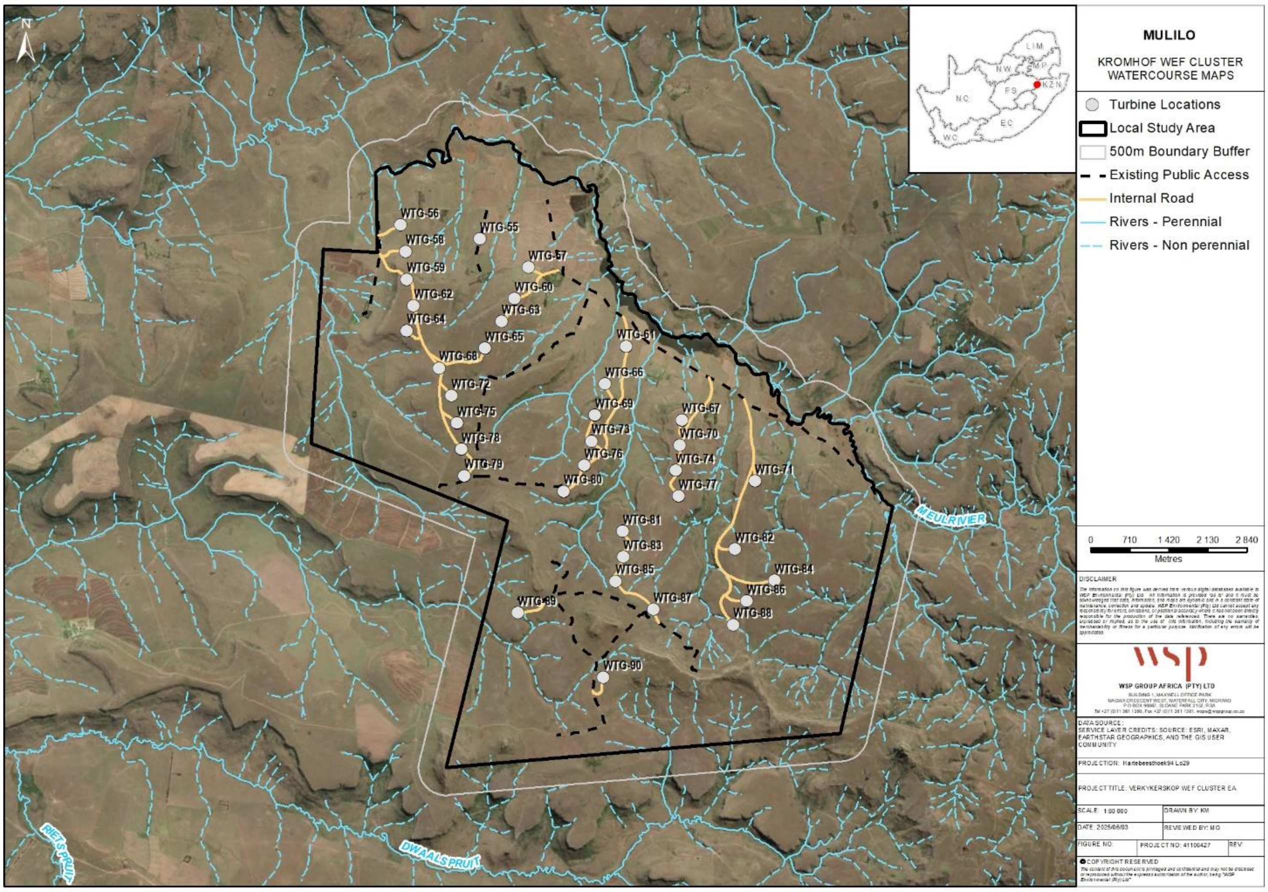


Figure 3-2 - Kromhof WEF project area of influence

3.3 APPLICABLE SOUTH AFRICAN LEGISLATION, POLICY AND STANDARDS

Applicable national and provincial legislation, associated regulations and policies that are pertinent to the aquatic biodiversity study, which were used to guide the EIA, include:

- **National Environmental Management Act (NEMA) (Act No. 107 of 1998):** Section 24 (1)(a) and (b) states that "the potential impact on the environment and socio-economic conditions of activities that require authorisation or permission by law and which may significantly affect the environment must be considered, investigated and assessed before their implementation and reported to the organ of state charged by law with authorizing, permitting, or otherwise allowing the implementation of an activity. Section 24 also highlights the procedures for the assessment and minimum criteria for reporting on identified themes in terms of Sections 24(5)(a) and (h) and 44 of the NEMA, when applying for environmental authorisation.
  - Protocol for the specialist assessment and minimum report content requirements for environmental impacts on aquatic biodiversity

- **National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (NEM:BA) –** The NEM:BA regulates the management and conservation of the biodiversity of South Africa within the framework provided under NEMA. This Act regulates the protection of species and ecosystems that require national protection and considers the management of alien and invasive species.
  - ToPS – National lists of critically endangered, endangered, vulnerable and protected species (2007).
  - National list of alien and invasive species (2016).
- **National Water Act (Act No. 27 of 2014) (NWA) –** The NWA aims to protect, use, develop, conserve, manage and control water resources including rivers, dams, wetlands, the surrounding land, groundwater, as well as human activities that influence them. The NWA intends to protect these water resources against over exploitation and to ensure that there is water for social and economic development and water for the future.
- Free State Nature Conservation Ordinance (Act No. 8 of 1969).
- Free State Biodiversity Sector Plan (2013).
- National Protected Area Expansion Strategy (2016).

3.4 ENVIRONMENTAL SCREENING TOOL

The Department of Forestry, Fisheries and Environment (DFFE) web-based Environmental Screening Tool was applied to screen for aquatic biodiversity sensitivity pertaining to the proposed study area. The resulting screening report (Figure 3-3) indicated that the project boundary predominantly lies within an area of *Low Sensitivity* for the aquatic biodiversity theme, with sections of *Very High Sensitivity* within the north and south portions, due to the presence of the following features:

- FEPA sub-catchments;
- Rivers with largely natural Present Ecological Status (PES of A/B);
- Surface Water - Strategic Water Source Area (SWSA-SW) i.e. Northern Drakensberg.
- Wetlands _Mesic Highveld Grassland Bioregion (Depression)
- Wetlands _Mesic Highveld Grassland Bioregion (Floodplain)
- Wetlands _Mesic Highveld Grassland Bioregion (Seep)

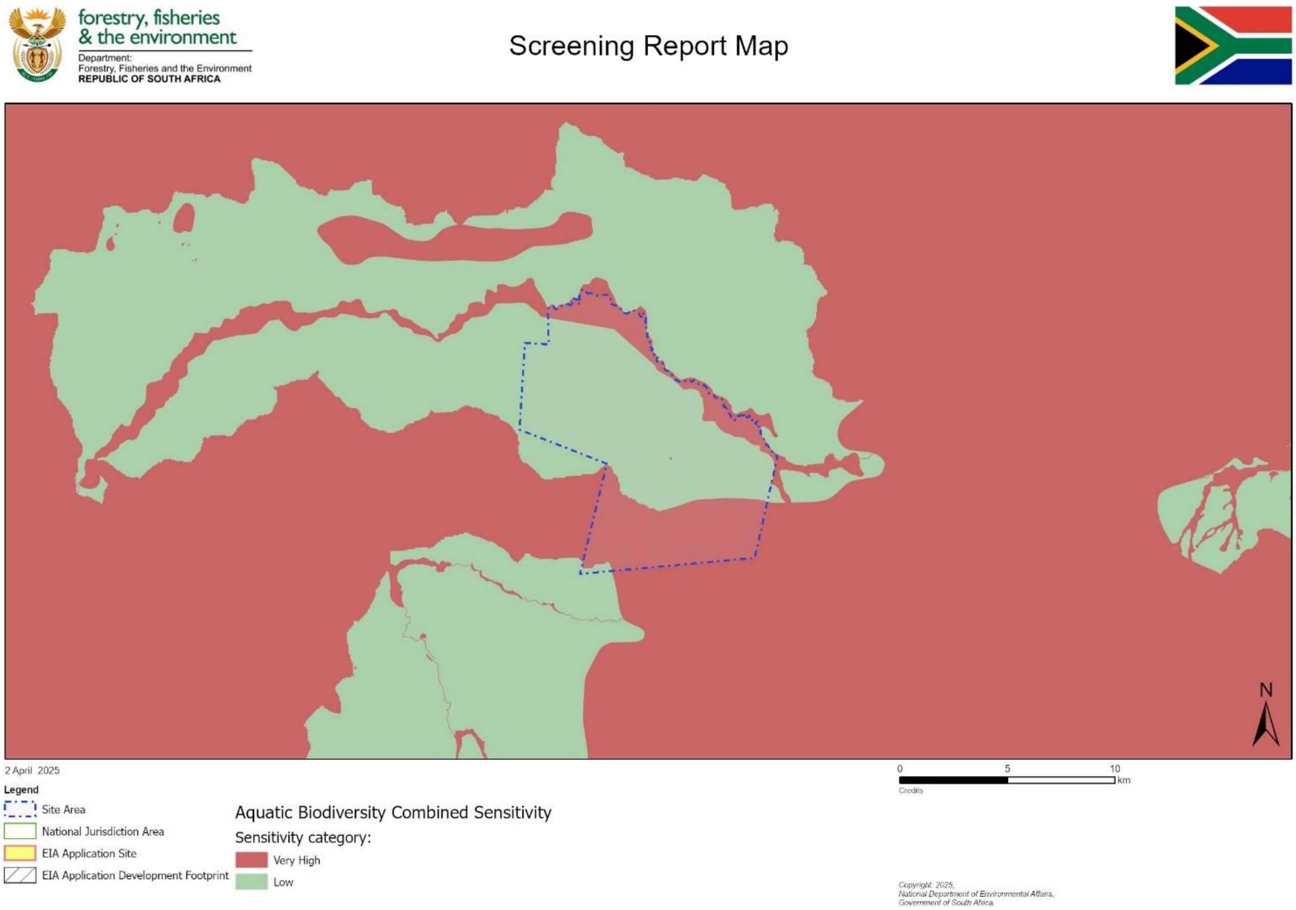


Figure 3-3 – Study area in relation to the DFFE web-based Environmental Screening Tool

3.5 SCOPE OF WORK

The outcomes of the DFFE screening tool highlighted areas of the project area as being of Very High sensitivity. According to the gazetted protocols, this site sensitivity must be verified, and if confirmed, a specialist assessment undertaken. In addition to the outcomes of the screening tool, at a desktop level, numerous first order streams and rivers, as well as associated wetland systems, are evident in the proposed Kromhof development footprint. In light of this, the following terms of reference guided the execution of this study:

- A consolidation of all pre-existing baseline data was reviewed (e.g. National Freshwater Priority Areas (FEPA), National Wetland Map 5 (NWM5) and provincial conservation planning datasets).
- Detailed desktop delineation of wetland and watercourse habitat within the Kromhof study area was conducted. This was followed by targeted field investigations of wetlands during the wet season (Feb-March 2025) in order to verify the preliminary desktop mapping, with a focus placed on ground truthing wetland habitats within a 500m buffer of proposed surface infrastructures (turbines and substations). During the site survey, data was collected to inform classification of wetland habitats on site and establish a current baseline condition.
- Two surveys (low flow and high flow) of riparian systems at points upstream and downstream of development areas, which included characterisation of aquatic macroinvertebrate and fish assemblage within potentially affected riparian systems

- The field verification data was used to determine the Present Ecological Status (PES), Ecological Importance and Sensitivity (EIS) and Recommended Ecological Categories (REC) for wetlands potentially affected by the proposed project. In addition, appropriate buffers were determined which can be incorporated in Project design so that potential impacts can be avoided.
- A detailed assessment of the potential impacts of the project infrastructure on wetland and riparian systems, in accordance with the NEMA aquatic biodiversity protocol requirements, were conducted

3.6 STUDY LIMITATIONS, ASSUMPTIONS AND KNOWLEDGE GAPS

The following limitations, assumptions and knowledge gaps are relevant to the current study:

- This study is considered as a once off assessment, which can only take into consideration the current condition with some speculation of historical events based on evidence observed in field and with the aid of satellite imagery. Since vegetation and habitats often vary temporally and spatially, there must be recognition that certain aspects or features may not have been present on the day of site visit.
- Due to the large extent of the study area, the wetlands and watercourses were mapped at a desktop level, with limited on-site verification focused on ground truthing accessible wetland habitats within the footprints of the infrastructure layout available at the time of the site surveys and assessed infrastructures and a 500m buffer thereof.
- The hydrogeomorphic units on site were assessed in their entirety, however regions that were deemed a health & safety hazard (excess flows) or inaccessible during the site survey; were assessed from aerial imagery with limited infield verification.
- All wetland delineation verification was done using a GPS system. The precision of such systems is generally limited to 5m and therefore this error must be taken into account when utilising the GPS coordinates.
- Whilst the assessment techniques applied in this report are used to standardise and 'objectify' the assessment of the systems' function, potential impacts and services, it must be noted that much of the information is subjectively collected based on the assessor's experience and training. The assessor will, if additional information or counter arguments are provided and verified, hold the right to amend the report if need be.
- The road network connecting the wind turbines was not made available at the time of the field surveys or at the time of compiling this report and therefore, although shown in several of the maps, is excluded from this specialist assessment at this time.
- The powerline connections (132kV) will be assessed as part of a separate process and therefore are not addressed as part of this study scope of work.
- Resource Quality Objectives (RQOs) for the catchment within which the watercourses of focus occur were not available at the time of writing, therefore the RQOs referred to in this report are those for the adjacent Integrated Unit of Analysis (IUA): UC2 (Wilge River and tributaries) within the resource unit II.

4 STUDY APPROACH

4.1 OBJECTIVES

The objectives of the current study were as follows:

- To determine, describe and delineate the aquatic systems (wetlands and rivers) that occur within the PAOI.
- To establish the current state of the aquatic systems within areas that may be impacted by the proposed project.
- To identify and quantify potential impacts to sensitive aquatic features that may arise due to the proposed project.
- To provide practical mitigation/management measures for inclusion in the Environmental Management Plan (EMPr).

4.2 METHODOLOGY

This aquatic biodiversity and impact assessment took cognisance of Government Notice No. 320, published in 2020 under the National Environmental Management Act (1998) concerning '*Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Theme in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act (1998), when applying for Environmental Authorisation*'.

In line with the assessment and reporting requirements set out in the protocol, this report includes two main study components: a desktop literature review of available local and regional data, and field surveys within the proposed development footprint and extended areas of influence to verify data reviewed at a desktop level. The tasks associated with these components are described below.

4.2.1 LITERATURE REVIEW AND GAP ANALYSIS

The aim of the desktop literature review component was to collate and review the extensive available ecological information related to important biodiversity and conservation features in the PAOI, key ecological processes and function, and the likely composition and structure of local aquatic fauna communities.

The following sources were consulted for the desktop literature review:

- The desktop assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa. Compiled by RQIS-RDM (DWS, 2014);
- National spatial planning datasets were consulted to provide a regional/national context for assessing the biodiversity significance of the site, namely
  - The Free State Biodiversity Sector Plan (FBSP)
  - National Freshwater Ecosystem Priority Areas (NFEPA)
  - National Wetland Map 5 (NWM5)
  - Strategic Water Sources (SWS)

4.2.2 WETLAND ECOLOGY

4.2.2.1 Wetland Delineation

The National Water Act, Act 36 of 1998, defines wetlands, watercourses and riparian habitat as follows:

Wetlands:

"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."

Riparian Habitat:

"*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."*

Watercourse:

"(a) a river or spring;

(b) a natural channel in which water flows regularly or intermittently;

(c) a wetland, lake or dam into which, or from which, water flows; and

(d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks;"

Use was made of 1:50 000 topographical maps, 1:10 000 orthophotos and Google Earth Imagery to create digital base maps of the study area onto which the wetland boundaries could be delineated using ArcMap 10.5. A desktop delineation of suspected wetland areas was undertaken by identifying rivers and wetness signatures on the digital base maps.

Identified areas suspected to be wetlands were then further investigated in the field as part of a comprehensive field survey. The site survey to ground truth the desktop delineated wetlands was undertaken in March 2025 and focused on visiting and verifying accessible wetlands within the footprint of proposed infrastructures and a 500m buffer thereof. The field survey included identifying wetland habitat, delineating the outer boundaries, and collecting data relevant to the classification of the wetlands and determination of their current condition and importance and sensitivity.

It should be noted that areas not accessible were delineated at a desktop level using the best available spatial data.

Wetlands were identified and delineated according to the delineation procedure as set out by the "A Practical Field Procedure for the Identification and Delineation of Wetlands and Riparian Areas" document, as described by (DWAF, 2005) and (Kotze & Marneweck, Guidelines for delineating the boundaries of a wetland and the zones within a wetland in terms of the South African Water Act, 1999). Using this procedure, wetlands were identified and delineated using the Terrain Unit Indicator, the Soil Form Indicator, the Soil Wetness Indicator and the Vegetation Indicator.

The wetland delineation procedure identifies the outer edge of the temporary wetland zone, marking the boundary between the aquatic and adjacent terrestrial areas. The wetland delineation field verification began at the lowest lying point of the wetland and proceeded outwards into the permanent, seasonal and ultimately the outermost temporary zone. For the purposes of delineating the actual wetland boundaries use was made of indirect indicators of prolonged saturation, namely wetland plants (hydrophytes) and wetland soils (hydromorphic soils), with particular emphasis on hydromorphic soils. It is important to note that under normal conditions hydromorphic soils must display signs of wetness (mottling and gleying) within the first 50cm of the soil surface for an area to be classified as a wetland (DWAF, 2005).

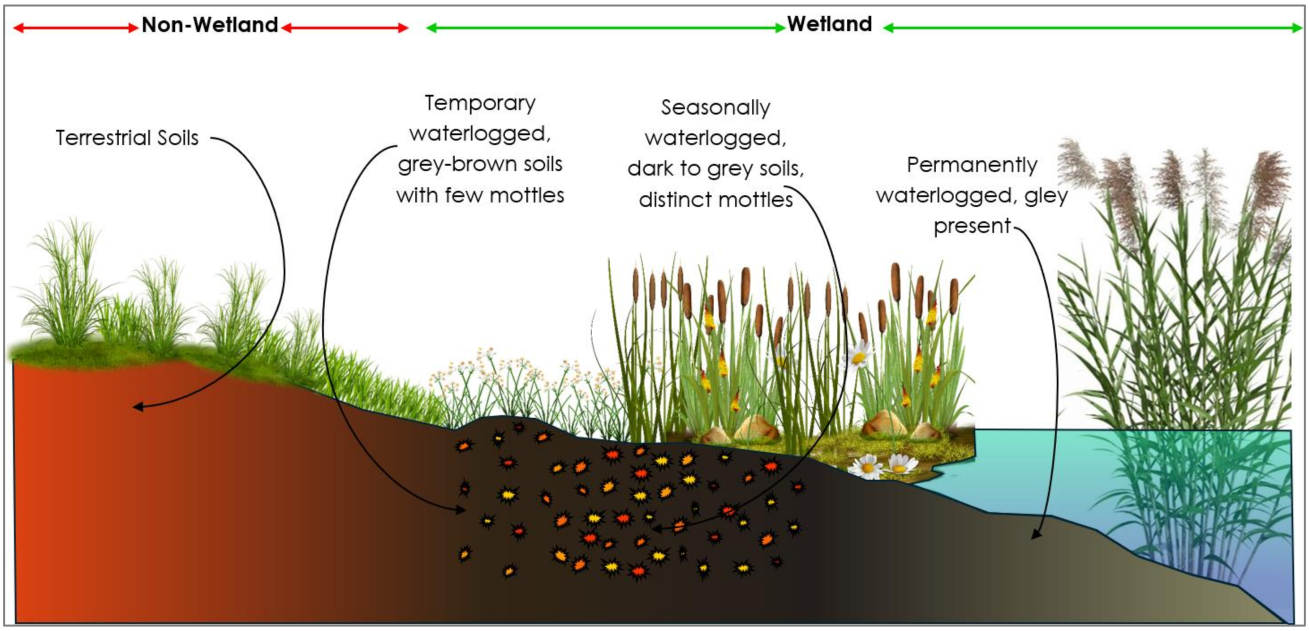


Figure 4-1 - Cross sectional diagram of a wetland, indicating how the soil moisture and vegetation indicators change along a gradient of decreasing wetness, from the middle to the edge of the wetland (DWAF, 2005)

4.2.2.2 Wetland Classification

The aquatic ecosystems delineated were classified using the classification system detailed in Ollis, Snaddon, Job and Mbona (2013). This classification system has a six-tiered structure, with the first four levels distinguishing between different types of aquatic ecosystems on the basis of 'primary discriminators', which are criteria that consistently differentiate between the specified categories at a particular level (Figure 4-2). The tiered structure progresses from 'Systems' (Marine vs. Estuarine vs. Inland) at the broadest spatial scale (Level 1), through to HGM Units (Level 4) as the core units of classification (Ollis e al., 2015). 'Secondary discriminators' are applied at Level 5 to classify the tidal/hydrological regime of an HGM Unit, and 'Descriptors' at Level 6 to categorise a range of biophysical attributes. Certain categories within the classification system can be split on the basis of additional criteria; in these cases, the relevant tier is divided into sub-levels that are labelled with sequential letters of the alphabet (e.g. Level 3A and 3B; Level 4A to 4C, etc.). The aquatic ecosystems within the study area were classified to Level 4a (See Table 4-1).

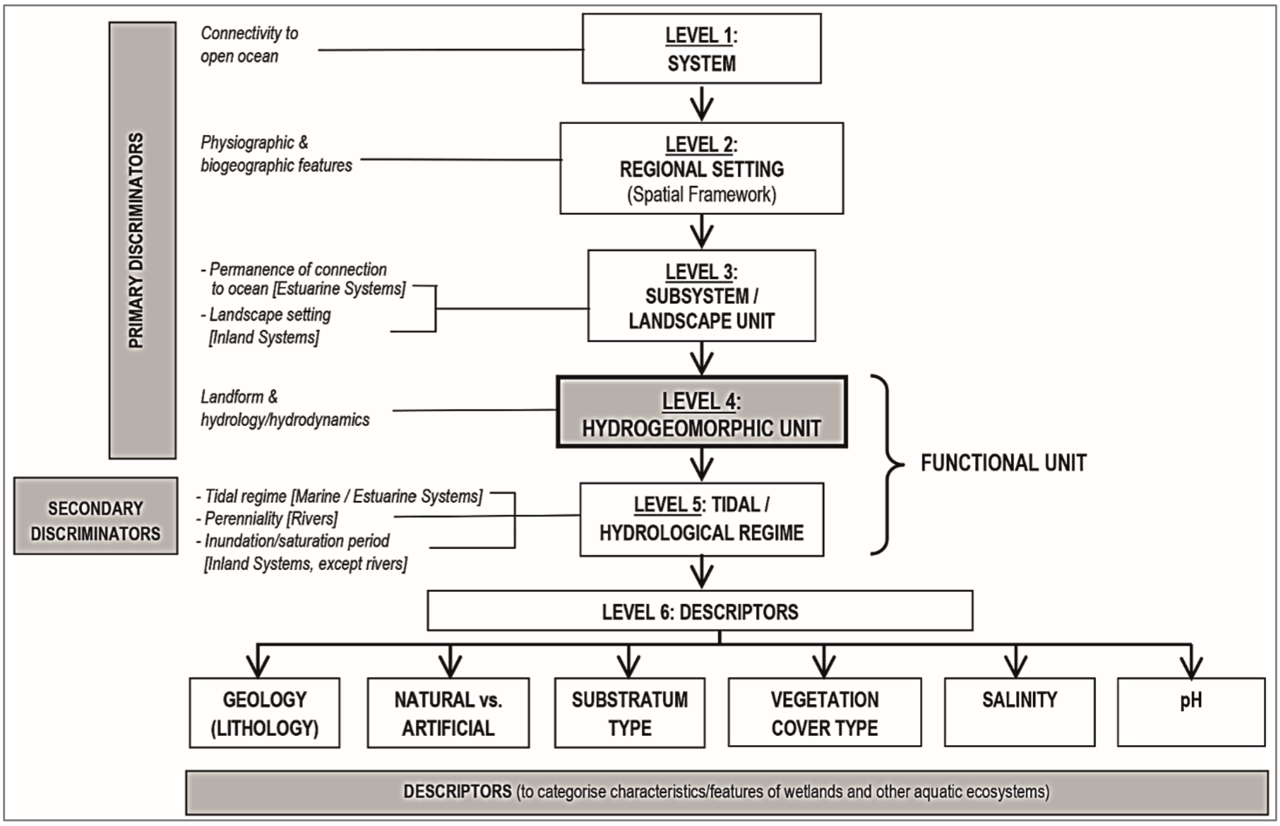


Figure 4-2 - Conceptual overview of the classification system for wetlands and other aquatic ecosystems, taken from Ollis et al. (2015).

Table 4-1 - Hydrogeomorphic (HGM) Units for Inland Systems, showing the primary HGM Types at Level 4A and the subcategories at Levels 4B to 4C (Taken from Ollis et al. (2013)).

LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM Type	**Longitudinal zonation/landform/outflow drainage**	**Landform/inflow drainage**
A	**B**	**C**
River	Mountain Headwater Stream	Active Channel
		Riparian Zone
	Mountain Stream	Active Channel
		Riparian Zone
	Transitional	Active Channel
		Riparian Zone
	Upper Foothills	Active Channel
		Riparian Zone

	Lower Foothills	Active Channel
		Riparian Zone
	Lowland River	Active Channel
		Riparian Zone
	Rejuvenated Bedrock Fall	Active Channel
		Riparian Zone
	Rejuvenated Foothills	Active Channel
		Riparian Zone
	Upland Floodplain	Active Channel
		Riparian Zone
Floodplain Wetland	Floodplain Depression	n/a
	Floodplain Flat	n/a
Channelled Valley-Bottom Wetland	n/a	n/a
Unchannelled Valley-Bottom Wetland	n/a	n/a
Depression	Exorheic	With Channelled Inflow
		Without Channelled Inflow
	Endorheic	With Channelled Inflow
		Without Channelled Inflow
	Dammed	With Channelled Inflow
		Without Channelled Inflow
Seep	With Channelled Outflow	n/a
	Without Channelled Outflow	n/a
Wetland Flat	n/a	n/a

4.2.2.3 Wetland Present Ecological State Assessment

Present Ecological State (PES) assessments were undertaken for every HGM unit identified and delineated within the study area. This was done in order to establish a baseline of the current state of the wetlands in the study area.

For the purpose of this study the updated WET-Health tool (Macfarlane, Ollis and Kotze, 2020), was applied for the determination of the PES. WET-Health uses indicators based on geomorphology, hydrology and vegetation for assessing the PES of wetland systems. It was primarily developed to assess wetland condition in linear systems where the wetland is linked to a drainage line. It has since been applied extensively in wetland assessments including for rehabilitation studies where the intention is to help understand the condition of the wetland in order to determine whether it is beyond repair, whether it requires rehabilitation intervention, or whether, despite damage, it is perhaps healthy enough not to require intervention. A WET-Health level 1A assessment was applied to each wetland HGM unit identified and delineated. The Excel based assessment tool WET-Health (V2.0) Level-1A (corrected_Oct2022.xls) (Macfarlane, Ollis and Kotze, 2020) was used for this study.

The results of the PES assessments are reflected in the placement of each wetland unit into a category based on the assessment scores. A description of the PES categories is provided in Table 4-2 below.

Table 4-2 - Rating scale used for the PES assessment (modified from Macfarlane et al., 2020).

Impact Category	Ecological Category	Description	Impact Score Range
None	**A**	Unmodified/natural	0 – 0.9
Small	**B**	Mostly Natural with a few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1 – 1.9
Moderate	**C**	Moderately modified. A moderate change in the ecosystem processes and the loss of natural habitats has taken place but the natural habitat remains predominantly intact	2 – 3.9
Large	**D**	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4 – 5.9
Serious	**E**	A very large change in ecosystem processes and loss of natural habitat and biota but some of the remaining natural habitat features are still recognizable.	6 – 7.9
Critical	**F**	The modification has reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota	8 – 10

4.2.2.4 Wetland Importance and Sensitivity (IS) Assessment

The scoring system as described in the document “Manual for the Rapid Ecological Reserve Determination of Inland Wetlands (Version 2.0)” (Rountree et al., 2013) was applied for the determination of the IS of the wetlands. The results of the IS assessments are reflected in the placement of each wetland unit into a category based on the assessment scores. A description of the IS categories is provided in Table 4-3 below. Due to the large number of wetland units within the Kromhof study area, IS assessments were only completed for wetland habitat identified within a 500m buffer of project infrastructures.

“**Ecological importance**” of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. “**Ecological sensitivity**” refers to the system’s ability to resist disturbances and its capability to recover from disturbance once it has occurred (resilience). In determining the EIS of a wetland, the following factors are considered:

- **Biodiversity maintenance**– i.e. the presence of rare and endangered species, species richness, diversity of habitat types, populations of unique species and migration/breeding and feeding sites for wetland species

- **Hydrological functionality** – i.e. sensitivity to changes in the supporting hydrological regime and/or changes in water quality, nitrate and/or toxicant assimilation and sediment trapping

- **Functionality** – i.e. flood attenuation, energy dissipation and particulate/element removal

- **Direct human benefit** – i.e. human water uses as a harvestable resource, cultivation and cultural heritage

Table 4-3 - Scoring System Used for the IS Assessment (modified from DWAF, 1999 and used in Rountree et al., 2013).

EIS Category	Ecological Management Class[1]	Description	Range of Median
Very High	**A**	Ecologically important and sensitive on a national or even international level. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4
High	**B**	Ecologically important and sensitive. The biodiversity of these systems may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3
Moderate	**C**	Ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2
Low/marginal	**D**	Ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>0 and <=1

4.2.2.5 Wetland Buffers

The “Buffer Zone Guidelines for Wetlands, Rivers and Estuaries. Part 1: Technical Manual” (Macfarlane & Bredin, 2017a) was used to determine the appropriate buffer zone for the proposed activity.

Buffer zones are natural areas around the watercourse boundaries, which are requested to protect the watercourse from developmental or land use changes. Protection may also extend to peak runoff/flood flows and the buffer zone may also provide feeding/breeding areas for wetland or river fauna and accordingly enhance the corridor function of drainage lines.

4.2.3 AQUATIC ECOLOGY

4.2.3.1 Field Survey

This section provides a brief description of the aquatic biodiversity study approach and methodologies utilised during the field surveys and the locations wherein the assessments were undertaken.

To enable an adequate description of the aquatic environment and the determination of the PES, the following stressor, habitat and response indicators were evaluated:

Water Quality

- *In situ* water quality assessment including temperature, pH, electrical conductivity, dissolved oxygen and comparison to applicable guideline values and identification of variables of potential concern.

Habitat Indicators

- General habitat assessment including site location (GPS coordinates), site photographs (for future identification of major changes and documentation of habitat conditions); and surrounding features such as land uses, potential sources of pollution, erosion etc;
- Index for Habitat Integrity (IHI): a rapid, visual assessment of modifications to a number of pre-selected biophysical drivers and used to determine the PES or Ecological Category of associated instream and riparian habitats; and
- Integrated Habitat Assessment System (IHAS, Version 2.2): This index evaluates habitat suitability specifically for aquatic macroinvertebrates and is used in conjunction with the South African Scoring System Version 5 (SASS5) index.

Response Indicators

- Aquatic macroinvertebrate assessment, including the determination of ecological condition through the South African Scoring System (SASS Version 5) and the Macro-Invertebrate Response Assessment Index (MIRAI);
- Ichthyological assessment, including the evaluation of reference conditions and determination ecological condition through the Fish Response Assessment Index (FRAI); and
- Determination of the integrated EcoStatus (EcoStatus 4, Version 1.02).

A detailed description of the aquatic biomonitoring methodologies used for the survey is provided in Appendix A.

4.2.3.2 Monitoring sites

The selection of monitoring sites was based on the proposed location of infrastructure relative to the aquatic ecosystems likely to be impacted. The sites were strategically selected based on ease of accessibility and availability of suitable habitat (Figure 4-3).

A total of nine sampling sites were selected within the Project's AOI. Site names, GPS coordinates and brief descriptions are provided in Table 4-4. Photographs showing the upstream and downstream views at each monitoring location are provided in Appendix C

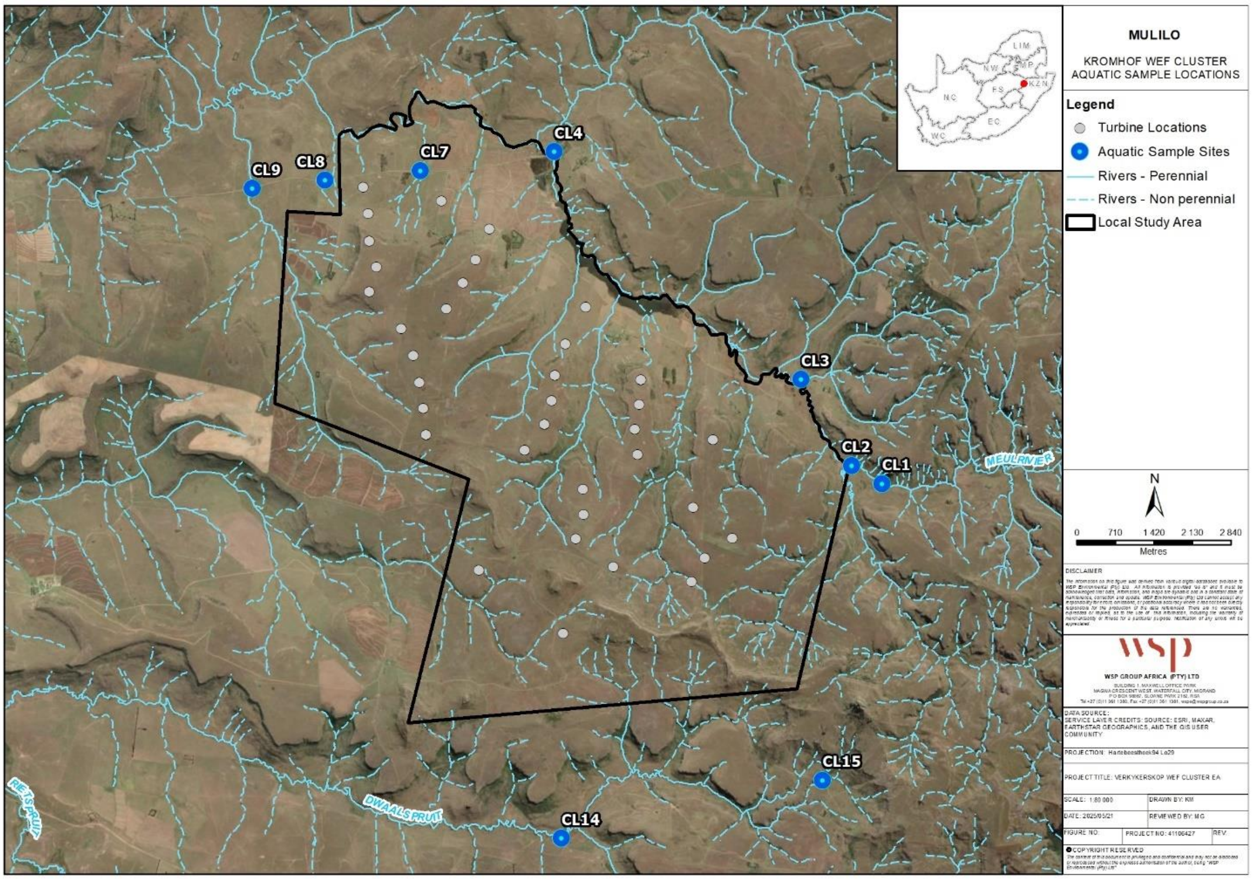


Figure 4-3 - Locations of the aquatic ecology sampling points

Table 4-4 – Locations of the sampling points and brief descriptions

River	Site	GPS	Site Description
Meul River	CL1	27°59'15.72"S 29°35'59.57"E	Located along the Meul River catchment. Sites serve as reference points to determine any impacts resulting from the turbines located within the proposed project area.
	CL2	27°59'0.29"S 29°35'20.82"E	
	CL3	27°58'8.65"S 29°34'46.31"E	Located within the Meul River catchment. Sites serve as sampling points to determine any impacts from the adjacent turbines within the proposed project area.
	CL4	27°55'52.70"S 29°31'59.13"E	
Meul River tributari	CL7	27°56'4.44"S 29°30'28.94"E	
	CL8	27°56'10.55"S 29°29'24.57"E	
	CL9	27°55'38.25"S 29°32'11.62"E	
Dwaalspruit	CL14	28° 2'27.18"S 29°29'55.43"E	Located within the Dwaalspruit catchment. Site serves as a sampling point to determine any impacts resulting from the turbines located in the southern portion of the project area.
	CL15	28° 2'9.02"S 29°35'2.35"E	Located within the Dwaalspruit catchment. Site serves as reference point to determine any impacts resulting from the turbines located in the southern portion of the project area.

4.2.4 IMPACT ASSESSMENT AND MITIGATION

The assessment of impacts evaluates the likely extent and significance of the potential impacts on identified receptors and resources against defined assessment criteria, to develop and describe measures that will be taken to avoid, minimise or compensate for any adverse environmental impacts, to enhance positive impacts, and to report the significance of residual impacts that occur following mitigation.

The key objectives of the risk assessment methodology are to identify any additional potential environmental issues and associated impacts likely to arise from the proposed project, and to propose a significance ranking. Issues / aspects will be reviewed and ranked against a series of significance criteria to identify and record interactions between activities and aspects, and resources and receptors to provide a detailed discussion of impacts. The assessment considers direct1, indirect2, secondary3 as well as cumulative4 impacts.

A standard risk assessment methodology is used for the ranking of the identified environmental impacts pre-and post-mitigation (i.e. residual impact). The significance of environmental aspects is determined and ranked by considering the criteria5 presented in Table 4-5.

Table 4-5 - Impact Assessment Criteria and Scoring System

CRITERIA	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Impact Magnitude (M) The degree of alteration of the affected environmental receptor	**Very Low**: No impact on processes	**Low:** Slight impact on processes	**Medium:** Processes continue but in a modified way	**High:** Processes temporarily cease	**Very High:** Permanent cessation of processes
Impact Extent (E) The geographical extent of the impact on a given environmental receptor	**Site:** Site only	**Local:** Inside activity area	**Regional:** Outside activity area	**National:** National scope or level	**International:** Across borders or boundaries
Impact Reversibility (R) The ability of the environmental receptor to rehabilitate or restore after the activity has caused environmental change	**Reversible:** Recovery without rehabilitation		**Recoverable:** Recovery with rehabilitation		**Irreversible:** Not possible despite action

[1] Impacts that arise directly from activities that form an integral part of the Project.
[2] Impacts that arise indirectly from activities not explicitly forming part of the Project.
[3] Secondary or induced impacts caused by a change in the Project environment.
[4] Impacts are those impacts arising from the combination of multiple impacts from existing projects, the Project and/or future projects.
[5] The definitions given are for guidance only, and not all the definitions will apply to all the environmental receptors and resources being assessed. Impact significance was assessed with and without mitigation measures in place.

Impact Duration (D) The length of permanence of the impact on the environmental receptor	**Immediate:** On impact	**Short term:** 0-5 years	**Medium term:** 5-15 years	**Long term:** Project life	**Permanent:** Indefinite
Probability of Occurrence (P) The likelihood of an impact occurring in the absence of pertinent environmental management measures or mitigation	**Improbable**	**Low Probability**	**Probable**	**Highly Probability**	**Definite**
Significance (S) is determined by combining the above criteria in the following formula	$[S = (E + D + R + M) \times P]$ $Significance = (Extent + Duration + Reversibility + Magnitude) \times Probability$				
IMPACT SIGNIFICANCE RATING					
Total Score	**4 to 15**	**16 to 30**	**31 to 60**	**61 to 80**	**81 to 100**
Environmental Significance Rating (Negative (-))	**Very Low**	**Low**	**Moderate**	**High**	**Very High**
Environmental Significance Rating (Positive (+))	**Very Low**	**Low**	**Moderate**	**High**	**Very High**

The impact significance without mitigation measures will be assessed with the design controls in place. Impacts without mitigation measures in place are not representative of the proposed development's actual extent of impact and are included to facilitate understanding of how and why mitigation measures were identified. The residual impact is what remains following the application of mitigation and management measures and is thus the final level of impact associated with the development. Residual impacts also serve as the focus of management and monitoring activities during Project implementation to verify that actual impacts are the same as those predicted in this report.

The mitigation measures chosen are based on the mitigation sequence/hierarchy which allows for consideration of five (5) different levels, which include avoid/prevent, minimise, rehabilitate/restore, offset and no-go, in that order. The idea is that when project impacts are considered, the first option should be to avoid or prevent the impacts from occurring in the first place if possible. However, this is not always feasible. If this is not attainable, the impacts can be allowed, however they must be minimised as far as possible by considering reducing the footprint of the development for example so that little damage is encountered. If impacts are unavoidable, the next goal is to rehabilitate or restore the areas impacted back to their original form after project completion. Offsets are then considered if all the other measures described above fail to remedy high/significant residual negative impacts. If no offsets can be achieved on a potential impact, which results in full destruction of any ecosystem for example, the no-go option is considered so that another activity or location is considered in place of the original plan. The mitigation sequence/hierarchy is shown in Figure 4-4 below.

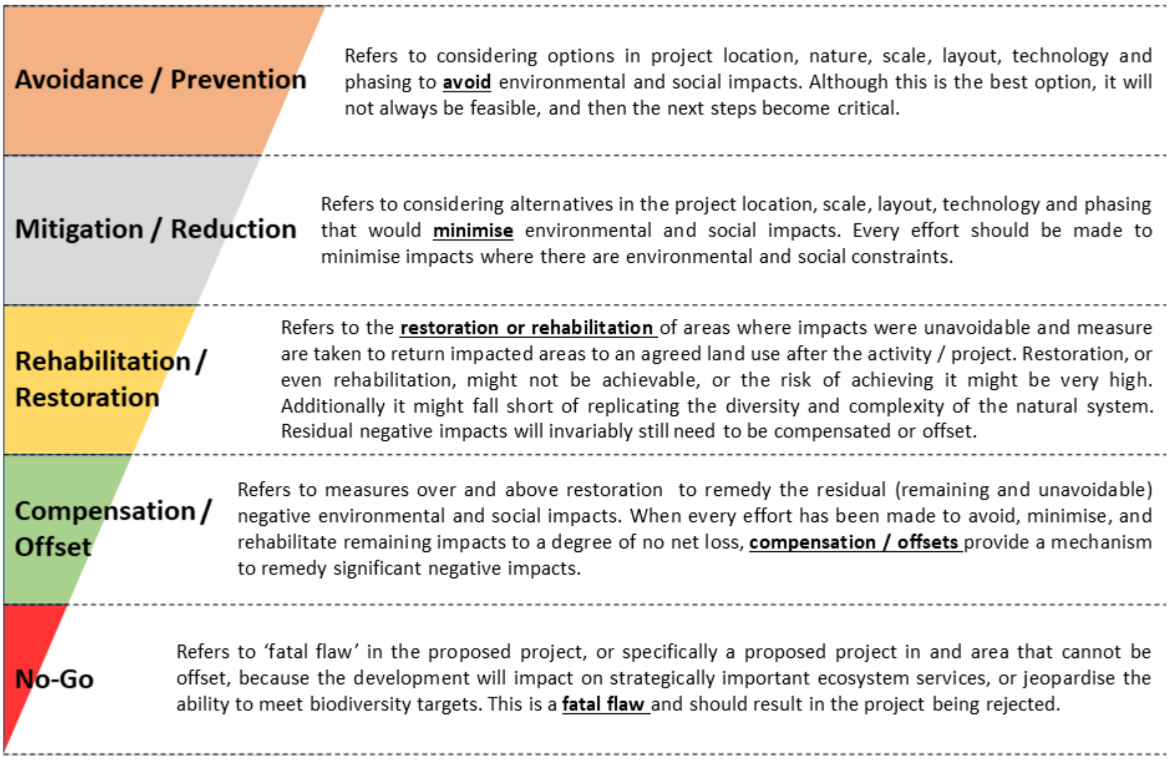


Figure 4-4 - Mitigation Sequence/Hierarchy

5 REGIONAL SETTING

5.1 CATCHMENTS

The proposed Project falls within the quaternary catchment C81L of the Vaal Water Management Area (WMA). The two main rivers draining this quaternary catchment are Meul River and Dwaalspruit. These rivers drain the northern and southern portions of the project area respectively.

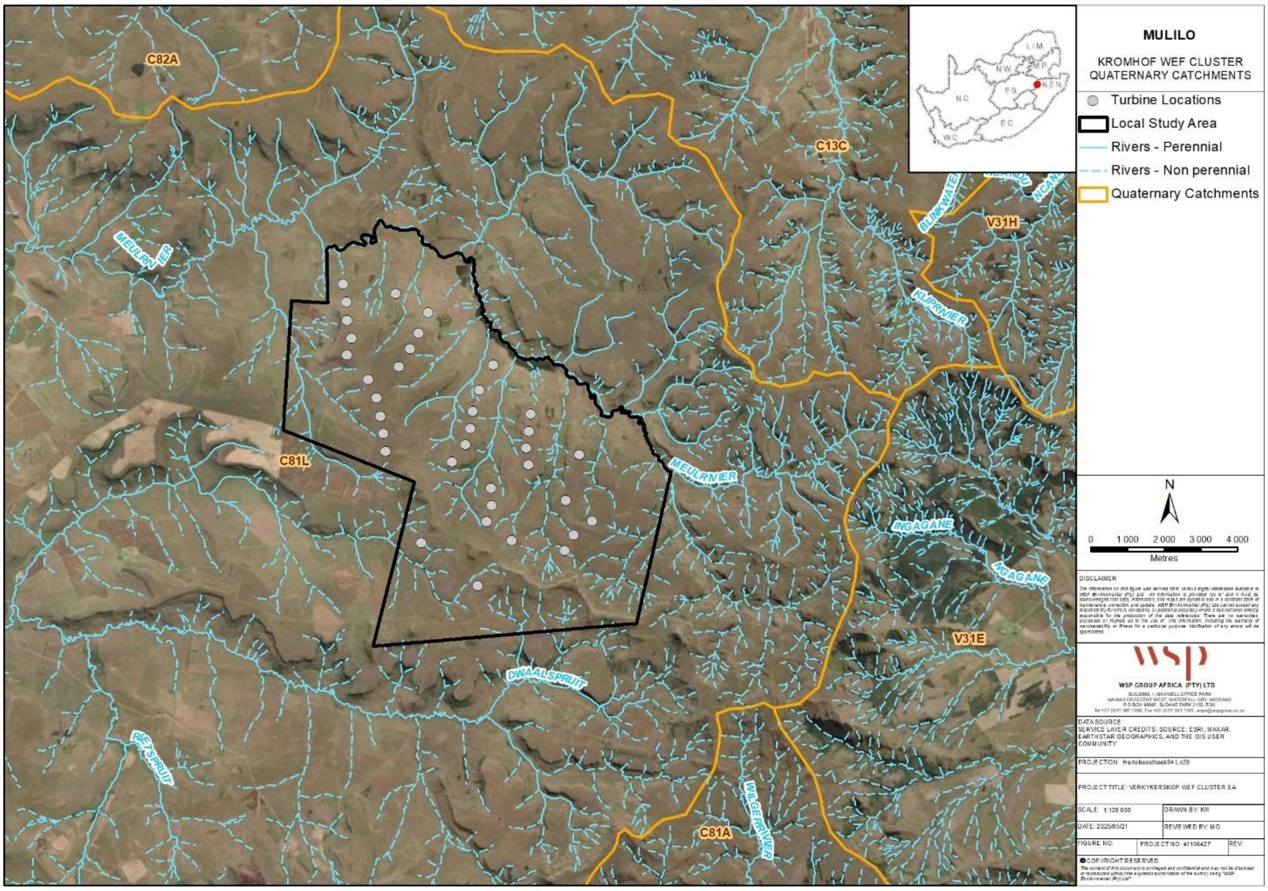


Figure 5-1 - Quaternary Catchments and drainage lines associated with the proposed Project

5.2 NATIONAL FRESHWATER ECOSYSTEM PRIORITY AREAS (NFEPA)

The Atlas of Freshwater Ecosystem Priority Areas in South Africa (Nel et al, 2011a) (The Atlas) which represents the culmination of the National Freshwater Ecosystem Priority Areas project (NFEPA), a partnership between SANBI, CSIR, WRC, DEA, DWA, WWF, SAIAB and SANParks, provides a series of maps detailing strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources.

Freshwater Ecosystem Priority Areas (FEPA's) were identified through a systematic biodiversity planning approach that incorporated a range of biodiversity aspects such as ecoregion, current condition of habitat, presence of threatened vegetation, fish, frogs and birds, and importance in terms of maintaining downstream habitat. The Atlas incorporates the National Wetland Inventory (NWI Wetlands) (SANBI, 2011) to provide information on the distribution and extent of wetland areas. River, wetland and estuarine FEPAs should be regarded as significant water resources, and should be regarded as ecologically important and as generally sensitive to changes in water quality and quantity, owing to their role in protecting freshwater ecosystems and supporting sustainable use of water resources.

5.2.1 WETLAND FEPAS

Both wetland FEPA's and FEPA wetland clusters overlap with the project area. The aim of identifying wetland clusters is to determine wetlands that exist within a relatively natural landscape in which dispersal between wetlands can occur (e.g. frogs and invertebrates) due to close proximity between systems.

As such, only non-riverine wetlands were used to identify wetland clusters (channelled valley-bottom wetlands, floodplain wetlands and valley head seeps were excluded in the cluster identification process). Unchanneled valley bottom wetlands were treated as non-riverine wetlands. In many areas of the country, wetland clusters no longer exist because the surrounding land has become too fragmented by human impacts. However, the northern boundary of the project area is located within an identified wetland cluster (Figure 5-2). This indicates that the wetland clusters in the project area are considered to exist within a relatively natural landscape, allowing for connectivity between the systems (ecological corridors). The wetland clusters coincide with the Meul River floodplain and therefore is listed as an important system

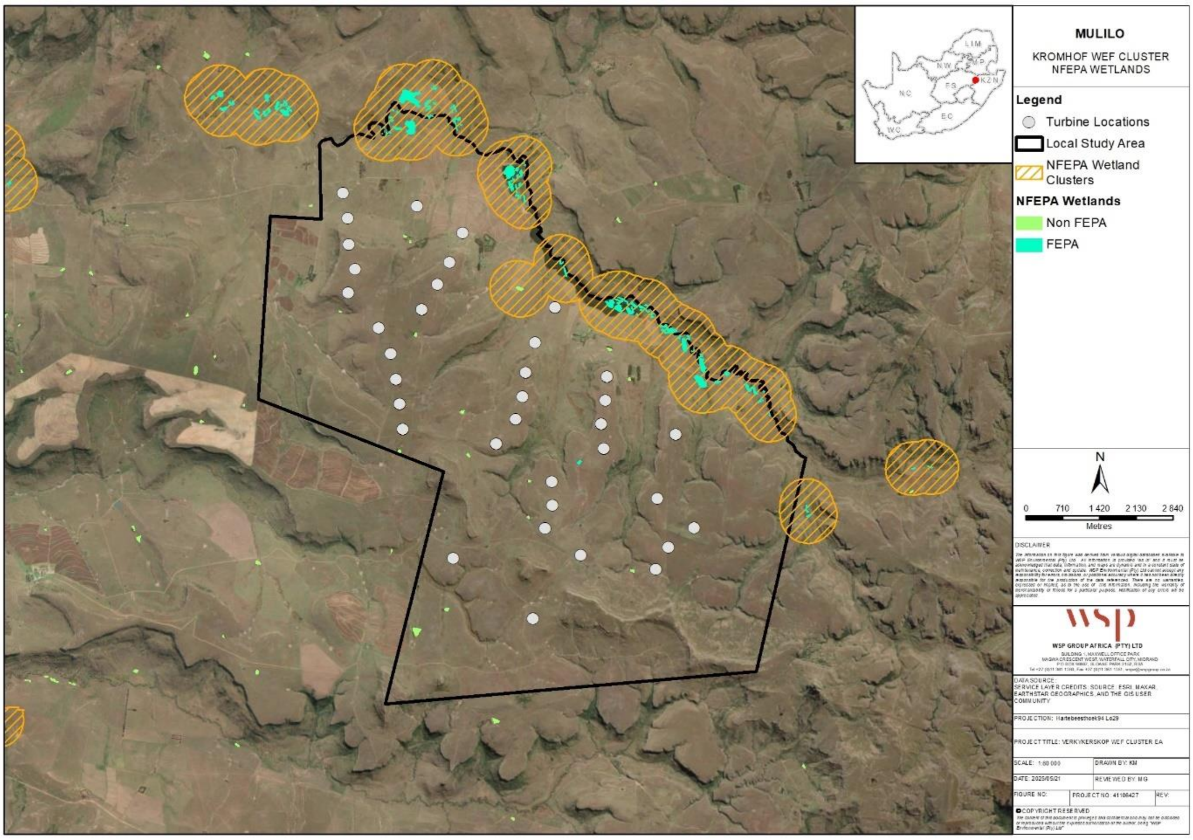


Figure 5-2 - FEPA wetland systems intersecting the Project study area

5.2.2 RIVER FEPAS

Riverine Freshwater Ecosystem Priority Area (FEPA) features associated with the proposed Project include river FEPA's and upstream management areas (Figure 5-3). Descriptions of these FEPA categories are provided in Table 5-1.

Table 5-1 – Descriptions of the different river FEPA features present within the project area

FEPA Category	Description
River FEPA and associated sub-quaternary catchment	River FEPAs achieve biodiversity targets for river ecosystems and threatened/near threatened fish species and were identified in rivers that are currently in a good condition (A or B ecological category). Their FEPA status indicates that the surrounding land and smaller stream network should remain in a good condition in order to contribute to national biodiversity goals and support sustainable use of water resources.
Upstream Management areas	These are sub-quaternary catchments in which human activities need to be managed to prevent degradation of downstream river FEPAs and Fish Support Areas

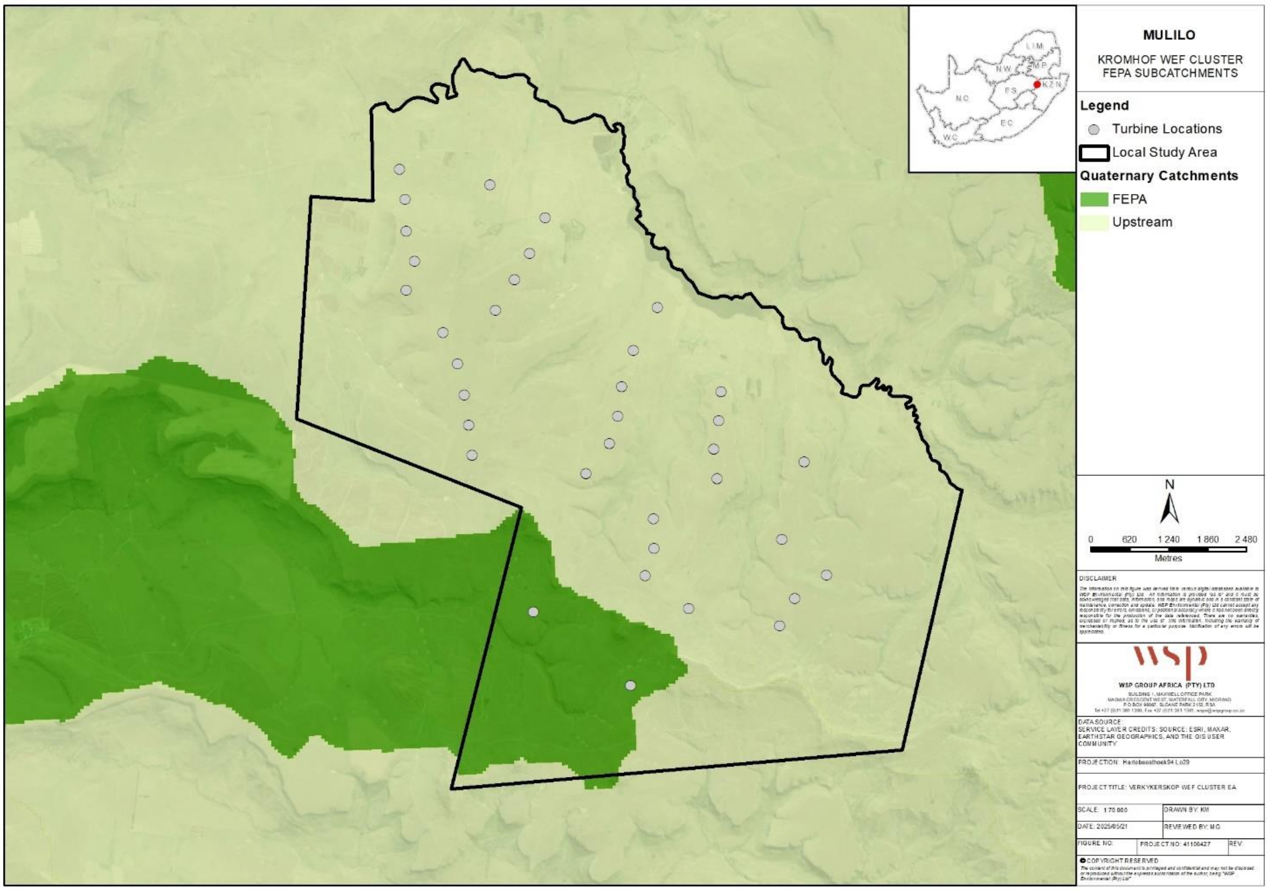


Figure 5-3 – Riverine Freshwater Ecosystem Priority Area map

5.3 STRATEGIC WATER SOURCE AREAS (SWSA)

Strategic Water Source Areas (SWSAs) have historically been defined based on the production of relatively large volumes of runoff which sustain lowland areas downstream. SWSAs are areas such as water catchments, which produce disproportionately greater volumes of water per unit area than other areas.These areas either: (a) supply a disproportionate (i.e. relatively large) quantity of mean annual surface water runoff in relation to their size and so are considered nationally important; or (b) have high groundwater recharge and where the groundwater forms a nationally important resource; or (c) areas that meet both criteria (a) and (b) (Le Maitre et al., 2018).

The proposed Project Area is situated within the Northern Drakensberg Surface Water SWSA (Figure 5-4). The primary objective of SWSAs is to maintain ecosystem functionality across the whole catchment, particularly mindful of activities which impact water quality and quantity (Le Maitre & Lötter, 2021).

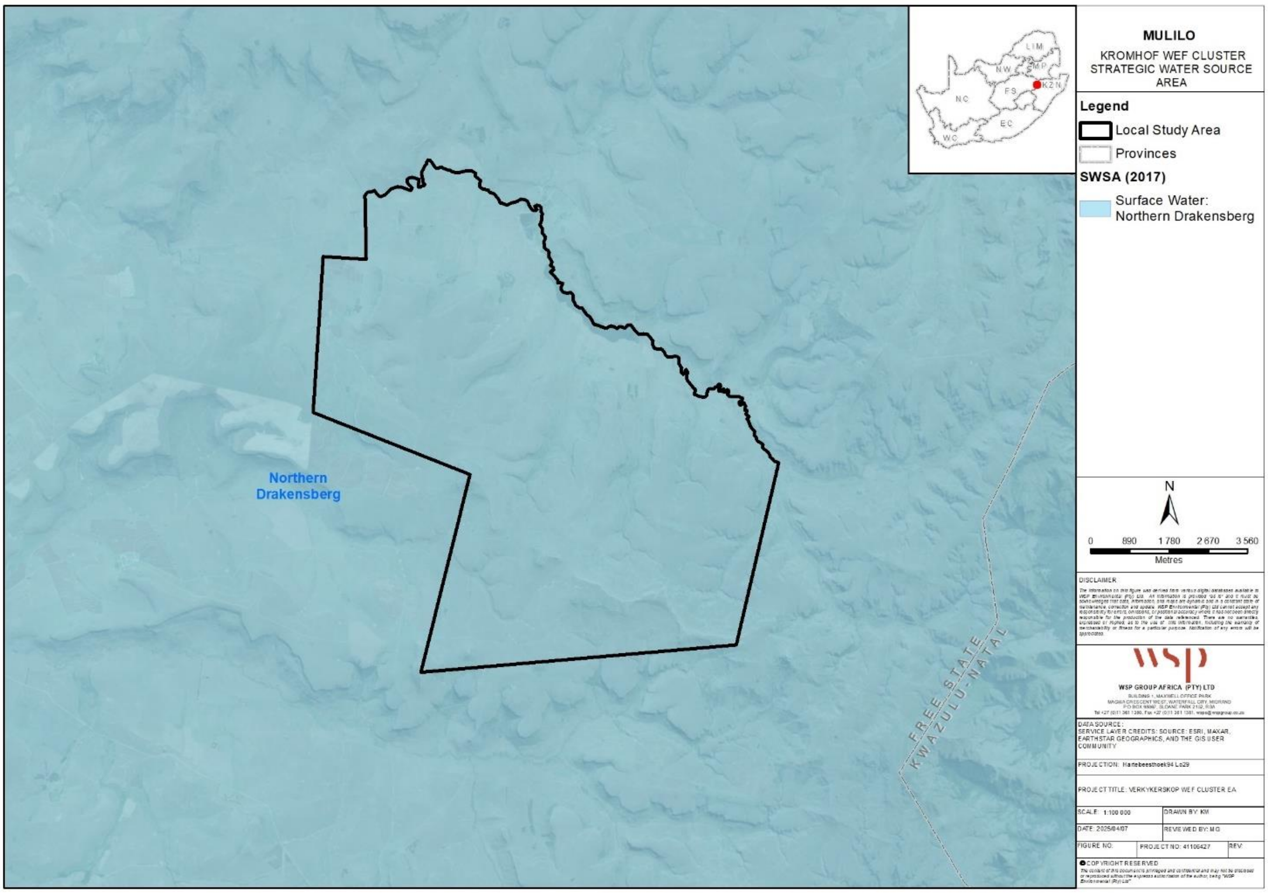


Figure 5-4 - SWSA associated with the proposed Project

5.4 NATIONAL WETLAND MAP 5 (NWM5)

The South African National Wetland Map version 5 (NWM5) portrays the most up-to-date spatial data for the extent and types of estuarine and inland aquatic (freshwater) ecosystems of South Africa (Van Deventer et al., 2019). The project strives to conserve a sample of freshwater ecosystems and diversity of species as well as the ecosystem processes which generate and maintain diversity (Nel et al., 2011).

The proposed project area in relation to wetlands mapped as part of the National Wetland Map 5 project is illustrated on Figure 5-5. The NWM5 recognises wetland systems that intersect with the proposed development footprint, particularly along the northern boundary which displays the massive extent of the Meul River floodplain system. It must be acknowledged that the data included in the NWM5 is informed by various spatial datasets that have been compiled at a national and regional scale to inform biodiversity planning at these levels. At a project level, the NWM5 data may be too coarse and requires verification to determine wetland extent and classification accurate at a local scale. The revised wetland extent and classification for the project area based on the site-specific assessment is presented in Section 6.

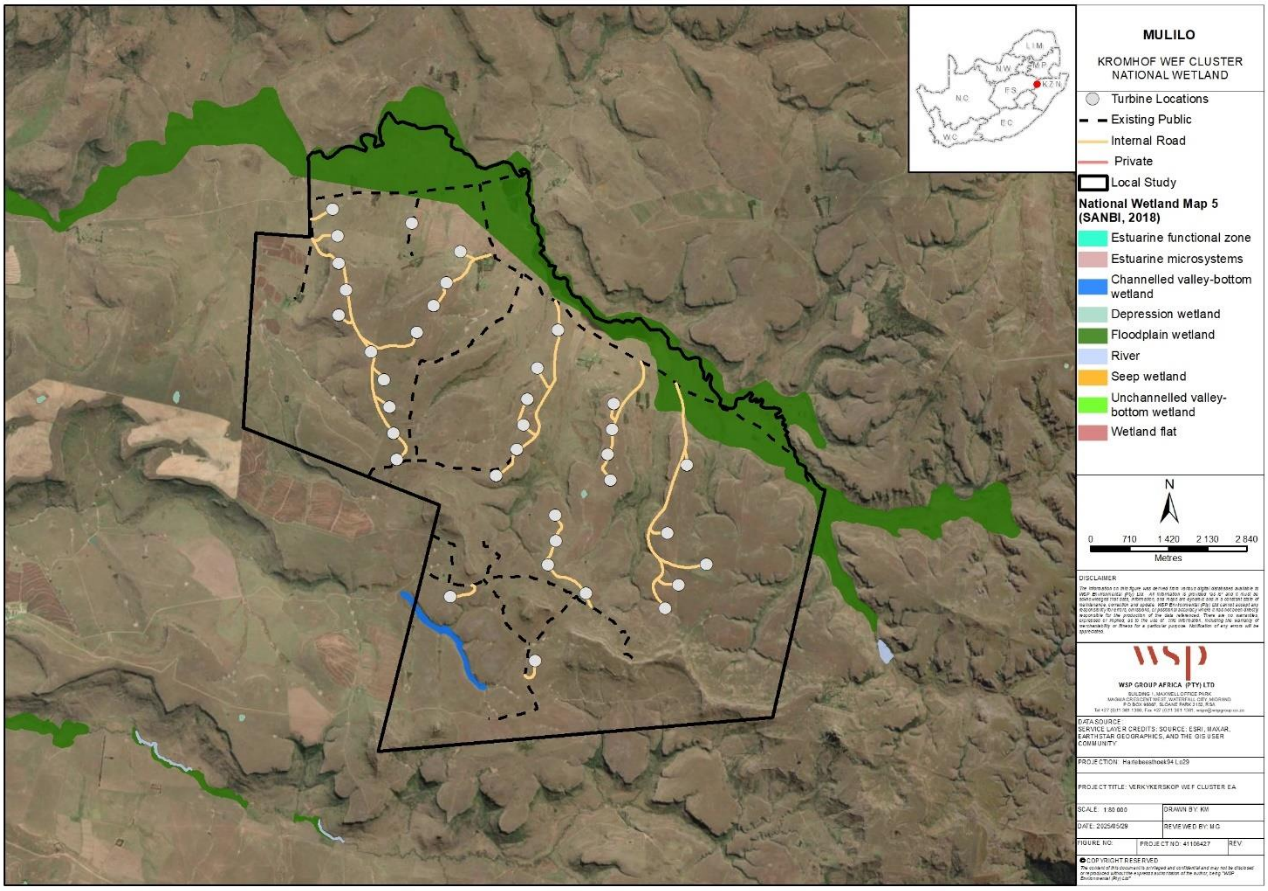


Figure 5-5 - National Wetland Map 5 for the proposed Kromhof project area

5.5 DESKTOP PRESENT ECOLOGICAL STATE, IMPORTANCE AND SENSITIVITY

The Present Ecological Status (PES) for the Dwaalspruit (SQR C81L-02695) is *Largely Natural* (Ecological Category B) with an Ecological Importance (EI) and Ecological Sensitivity (ES) class of *High* respectively. This SQR is expected to host a total of 63 aquatic macroinvertebrates taxa (Table 5-2) and only two fish species (Table 5-4).

The PES for the Meul River (SQR C81L-02594) is *Largely Natural* with an EI class of *High* and an ES class of *Very High.* This SQR is expected to host a total of 63 aquatic macroinvertebrates taxa (Table 5-3) and eight fish species (Table 5-4).

The expected macroinvertebrate community assemblage is comprised of taxa with a wide variety of tolerance/sensitivity to water quality and flow conditions, whilst the sensitivities of the expected fish species range from tolerant to moderately intolerant.

It should be noted that the DWS (2016) PESEIS database lists expected biota at catchment level and with the species richness in headwater streams known to be lower compared to downstream reaches (Richardson, 2019), not all the biota was expected at the sampled sites. This was taken into consideration in the determination of biotic integrity in the latter sections of the report.

Table 5-2 –Expected aquatic biota for the Dwaalspruit (SQR C81L-02695 (DWS, 2016)

Family Names		
Turbellaria[1,c]	Corixidae[1,b]	Hydraenidae[2,b]
Oligochaeta[1,a]	Gerridae[1,b]	Hydrophilidae[1,a]
Hirudinea[1,a]	Blephariceridae[5,4]	Empididae[2,c]
Potamonautidae[1,c]	Hydrometridae[2,b]	Psephenidae[3,d]
Atyidae[2,a]	Naucoridae[2,c]	Athericidae[3,a]
Hydracarina[2,a]	Nepidae[1,b]	Ceratopogonidae[1,b]
Perlidae[4,d]	Pleidae[1,b]	Chironomidae[1,a]
Baetidae > 2 sp[4,a]	Notonectidae[1,b]	Culicidae[1,b]
Caenidae[2,b]	Veliidae/mesoveliidae[1,b]	Dixidae[3,b]
Heptageniidae[4,d]	Ecnomidae[2,c]	Muscidae[1,a]
Prosopistomatidae[5,d]	Planorbinae[1,b]	Ephydridae
Leptophlebiidae[3,b]	Hydropsychidae 2 sp[2,d]	Simuliidae[1,c]
Tricorythidae[3,e]	Philopotamidae[3,d]	Tabanidae[1,b]
Chlorocyphidae[3,b]	Thiaridae[1,2]	Lymnaeidae[1,b]
Synlestidae/Chlorolestidae[2,b]	Tipulidae[1,b]	Ancylidae[2,a]
Coenagrionidae[1,c]	Hydroptilidae[3,c]	Physidae[1,b]
Lestidae[2,b]	Ancylidae[2,a]	Belostomatidae[1,b]
Aeshnidae[2,a]	Leptoceridae[2,c]	Corbiculidae[1,b]
Corduliidae[2,b]	Dytiscidae[1,b]	Sphaeriidae[1,b]
Gomphidae[2,c]	Elmidae/dryopidae[2,d]	Helodidae[4,a]

Family Names		
Libellulidae[1,c]	Gyrinidae[1,c]	
Crambidae[4,c]	Haliplidae[1,b]	
Superscript definitions:		
Sensitivity toward water quality modifications: 1=Tolerant; 2=Moderately Tolerant; 3=Moderately Intolerant; 4=Intolerant		
Sensitivity toward no-flow conditions: A=Tolerant; B=Moderately Tolerant; C=Moderately Intolerant; D=Intolerant		

Table 5-3 – Expected aquatic biota for the Meul River SQR C81L-02594 (DWS, 2016)

Family Names		
Turbellaria[1,c]	Crambidae[4,c]	Hydrophilidae[1,a]
Oligochaeta[1,a]	Belostomatidae[1,b]	Psephenidae[3,d]
Hirudinea1,a	Corixidae[1,b]	Athericidae[3,a]
Potamonautidae[1,c]	Gerridae[1,b]	Blephariceridae[5,4]
Atyidae[2,a]	Hydrometridae[2,b]	Ceratopogonidae[1,b]
Hydracarina[2,a]	Naucoridae[2,c]	Chironomidae[1,a]
Perlidae4,d	Nepidae[1,b]	Culicidae[1,b]
Baetidae > 2 sp[4,a]	Pleidae[1,b]	Dixidae[3,b]
Caenidae[2,b]	Notonectidae[1,b]	Empididae[2,c]
Heptageniidae[4,d]	Veliidae/mesoveliidae[1,b]	Ephydridae
Leptophlebiidae[3,b]	Ecnomidae[2,c]	Muscidae[1,a]
Prosopistomatidae[5,d]	Hydropsychidae 2 sp[2,d]	Simuliidae[1,c]
Tricorythidae[3,e]	Philopotamidae[3,d]	Tabanidae[1,b]
Chlorocyphidae[3,b]	Hydroptilidae[3,c]	Tipulidae[1,b]
Synlestidae/Chlorolestidae[2,b]	Leptoceridae[2,c]	Ancylidae[2,a]
Coenagrionidae[1,c]	Dytiscidae[1,b]	Lymnaeidae[1,b]
Lestidae[2,b]	Elmidae/dryopidae[2,d]	Physidae[1,b]
Aeshnidae[2,a]	Gyrinidae[1,c]	Thiaridae[1,2]
Corduliidae[2,b]	Haliplidae[1,b]	Planorbinae[1,b]
Gomphidae[2,c]	Helodidae[4,a]	Corbiculidae[1,b]
Libellulidae[1,c]	Hydraenidae[2,b]	Sphaeriidae[1,b]
Superscript definitions:		
Sensitivity toward water quality modifications: 1=Tolerant; 2=Moderately Tolerant; 3=Moderately Intolerant; 4=Intolerant		
Sensitivity toward no-flow conditions: A=Tolerant; B=Moderately Tolerant; C=Moderately Intolerant; D=Intolerant		

Table 5-4 – Expected fish species per river reach of focus and their conservation status

Fish Species	Common Name	IUCN Status	Dwaalspruit	Meul River
Austroglanis sclateri	Rock Catfish	Least Concern		●
Clarias gariepinus	Sharptooth catfish	Least Concern		●
Enteromius anoplus	Chubbyhead Barb	Least Concern	●	●
Enteromius pallidus	Goldie Barb	Least Concern	●	●
Enteromius paludinosus	Straightfin barb	Least Concern		●
Labeo capensis	Orange River Mudfish	Least Concern		●
Labeo umbratus	Moggel	Least Concern		●
Labeobarbus aebeus	Smallmouth yellowfish	Least Concern		●

6 SITE-SPECIFIC FINDINGS

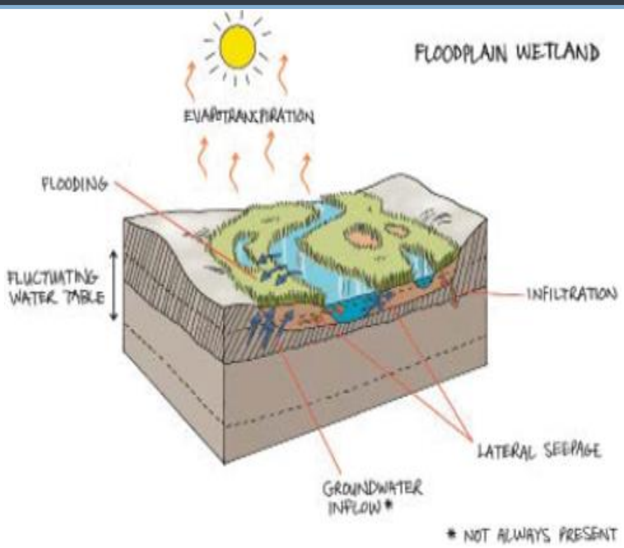
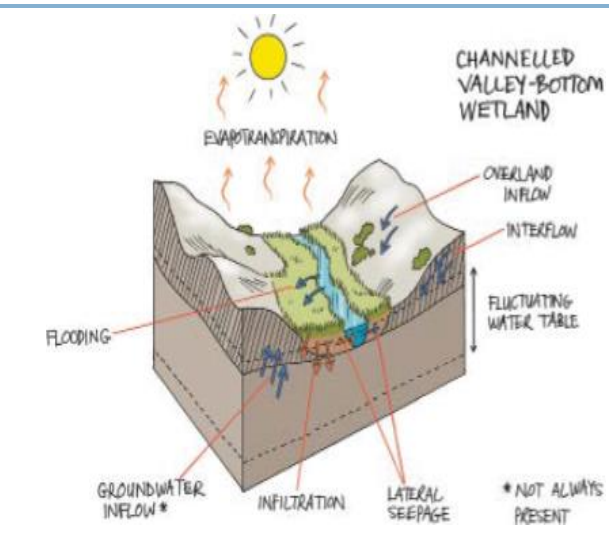
6.1 WETLAND ECOLOGY

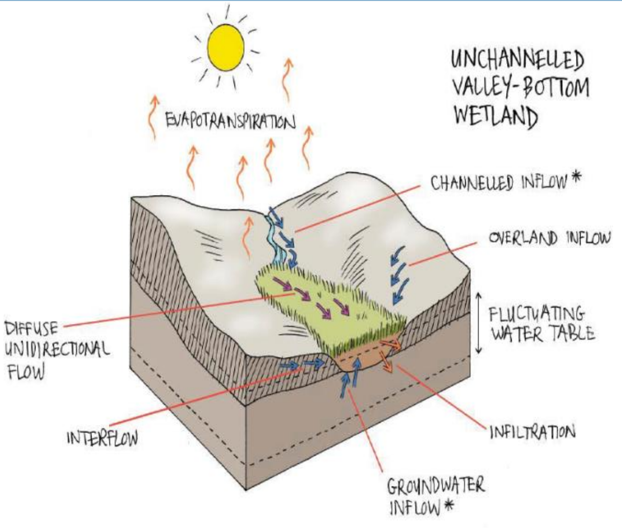
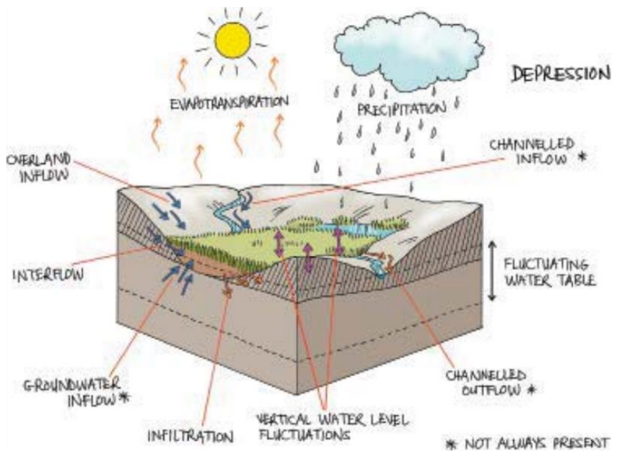
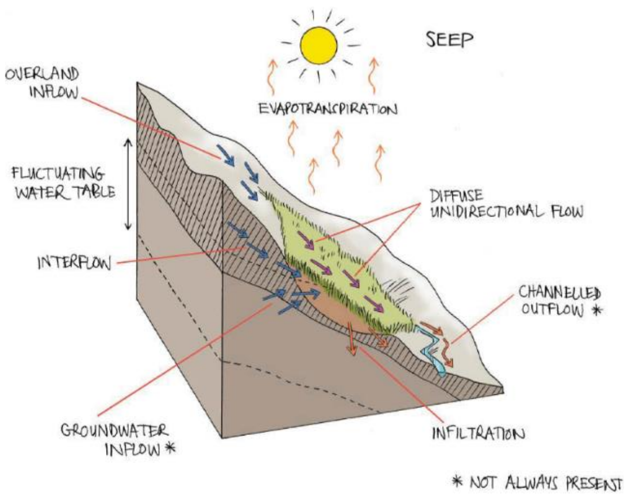
6.1.1 WETLAND DELINEATION, CLASSIFICATION AND CHARACTERISTICS

The study area presents a unique setting which results in two distinct drainage areas (north and central) which have naturally developed due to the topography – the Meul River and tributaries to the north and the Dwaalspruit and tributaries to the south.

The desktop evaluation, and subsequent field survey revealed the presence of one hundred and thirty-five (135) HGM units, falling into the following wetland HGM types: Floodplain, valley bottom (channelled and unchanneled) and hillslope seepage wetlands. An illustration and general description of these wetland HGM types, as per DWAF (2008) and Ollis et al., (2013) is provided in Table 6-1.

Table 6-1 - HGM units present at the proposed study site (DWAF, 2008; Ollis et al., 2013)

Classification	Illustration	Description
Floodplain		A wetland area located on mostly flat or gently-sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, and intermittently inundated by overtopping of the associated channel. Characteristic depositional features of floodplain wetlands include point bars, scroll bars, oxbow lakes and levees.
Channelled Valley Bottom		Channelled valley-bottom wetlands must be considered as wetland ecosystems that are distinct from, but sometimes associated with, the adjacent river channel itself, which must be classified as a 'river'. These valley-bottom wetlands are characterised by their location on valley floors, the absence of characteristic floodplain features and the presence of a river channel flowing through the wetland.

<table>
<tr>
<td>Unchanneled Valley Bottom</td>
<td>
</td>
<td>Unchanneled valley-bottom wetlands are characterised by their location on valley floors, an absence of distinct channel banks, and the prevalence of diffuse flows. In some cases, an unchanneled valley bottom wetland could occur at the downstream end of a seep, where a slope grades into a valley near the head of a drainage line. Water characteristically moves through the wetland in the form of diffuse surface or subsurface flow, but the outflow may be in the form of either diffuse or concentrated surface flow</td>
</tr>
<tr>
<td>Depression</td>
<td>
</td>
<td>Depression—a wetland or aquatic ecosystem with closed (or near-closed) elevation contours, which increases in depth from the perimeter to a central area of greatest depth and within which water typically accumulates. Most depressions occur either where the water table intercepts the land surface (such as on coastal plains along the South African coastline), or in semi-arid settings where a lack of sufficient water inputs prevents areas where water accumulates from forming a connection with the open drainage network</td>
</tr>
<tr>
<td>Hillslope Seepage Wetland</td>
<td>
</td>
<td>Wetland area situated on a gentle to steep sloping land that facilitates the dominance of colluvial, unidirectional movement of material and water (mainly in the form of interflow) downslope. Water inputs are primarily via subsurface flows from an up-slope direction. Seeps are characterised by their association with geological formations (lithologies) and topographic positions that either cause groundwater to discharge to the land surface or rain-derived water to ‘seep’ down-slope as subsurface interflow.</td>
</tr>
</table>

A summary of the wetland HGM types identified and delineated within the area of assessment is provided in Table 6-2 and illustrated in Figure 6-1.

Table 6-2 - Summary of wetland characteristics for systems within the Kromhof project boundary

Wetland Type	Extent (Ha)
Floodplain	275.11Ha
Channel Valley Bottom	24.75Ha
Unchanneled Valley Bottom	146.13Ha
Depression	0.03Ha
Seepage	519.11Ha
Total Area of Wetlands	**965.41Ha**

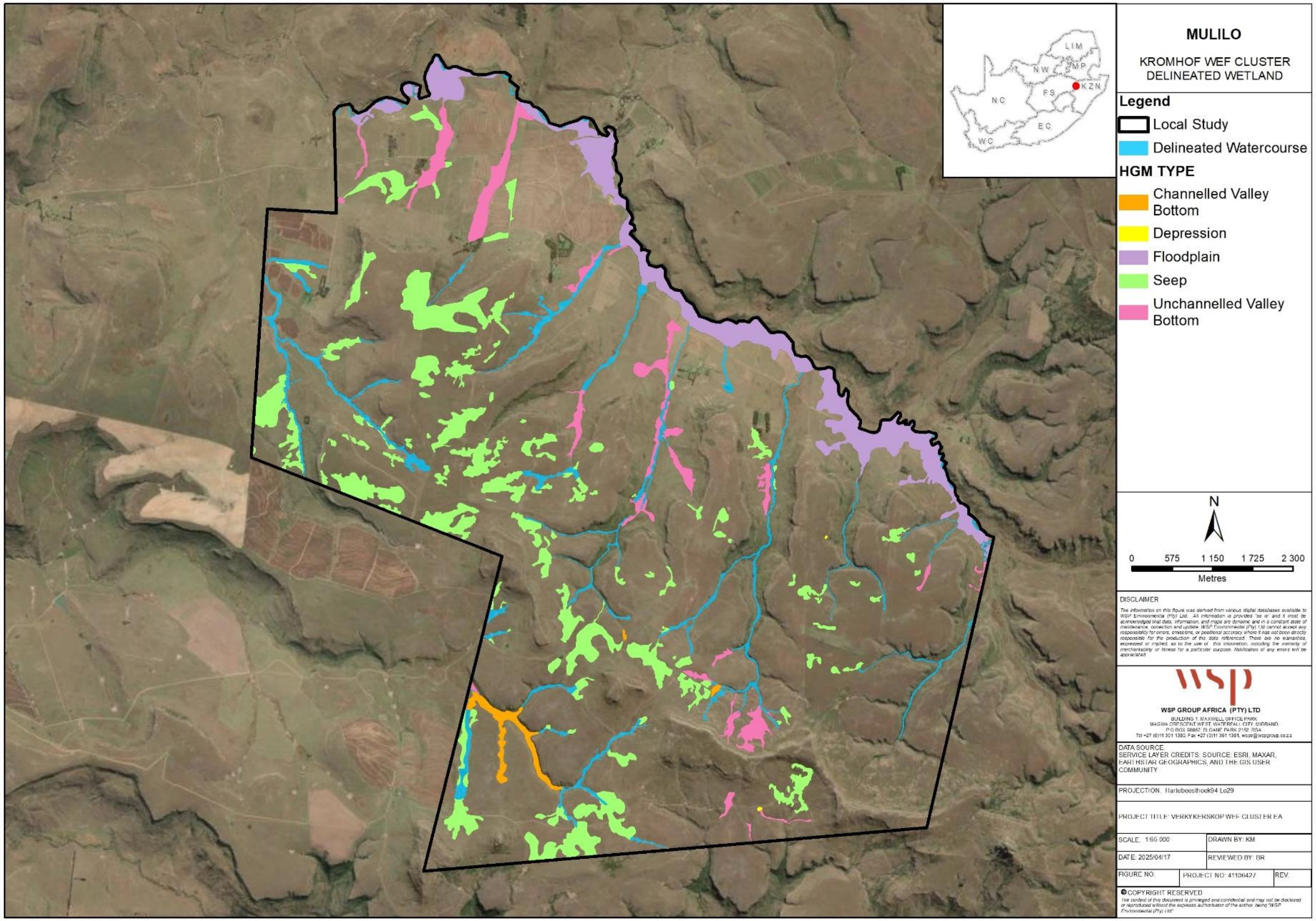


Figure 6-1 - Extent and classification of wetland HGM units identified within the proposed Kromhof project boundary

Floodplain Wetlands

Floodplain wetlands, as the name implies, generally occur on a plain and are typically characterised by a suite of geomorphological features associated with river-derived depositional processes, including point bars, scroll bars, oxbow lakes and levees. Floodplain wetlands must be considered as wetland ecosystems that are distinct from but associated with the adjacent river channel itself, which must be classified as a 'river'. Regular (or significant historical) water and sediment contributions from an associated river channel are what characterise the dynamic nature of a floodplain wetland. Another key characteristic of most floodplain wetlands is that they are generally located on a plain in terms of their landscape setting. Floodplain wetlands can contribute significantly towards flood attenuation, enhancement of water quality, and biodiversity support. The Meul River floodplain extends along the northern boundary of the proposed Kromhof study area, with portions therein classified as a FEPA wetland.

Figure 6-2 - Typical Floodplain wetland habitats (A and B) observed within the proposed Kromhof project footprint associated with the Meul River

Channelled Valley Bottom Wetlands

Channelled valley-bottom (CVB) wetlands must be considered as wetland ecosystems that are distinct from, but sometimes associated with, the adjacent river channel itself, which must be classified as a 'river'. These valley-bottom wetlands are characterised by their location on valley floors, the absence of characteristic floodplain features and the presence of a river channel flowing through the wetland.

CVB systems tend to contribute less towards flood attenuation and sediment trapping as a consequence of the typical high flow velocities within the channel. Under low and medium flows, transport of sediment through, and out, of the system are more likely to be the dominant processes. Numerous valley bottom wetland systems exhibit signs of erosion, likely due to land-use changes (i.e., from natural to cultivated fields) and altered hydrology likely due to farm road crossings and dams. However, these wetlands still have the potential to remove toxicants and nitrates especially from the water being delivered from adjacent hillslopes. The proposed Kromhof WEF facility contains multiple CVB wetland systems. Typical hydrophilic vegetation observed within these systems includes species such as *Eleocharis dregeana, Juncus sp., Kyllinga erecta, Cyperus sp.,* and *Paspalum dilatatum* amongst others.

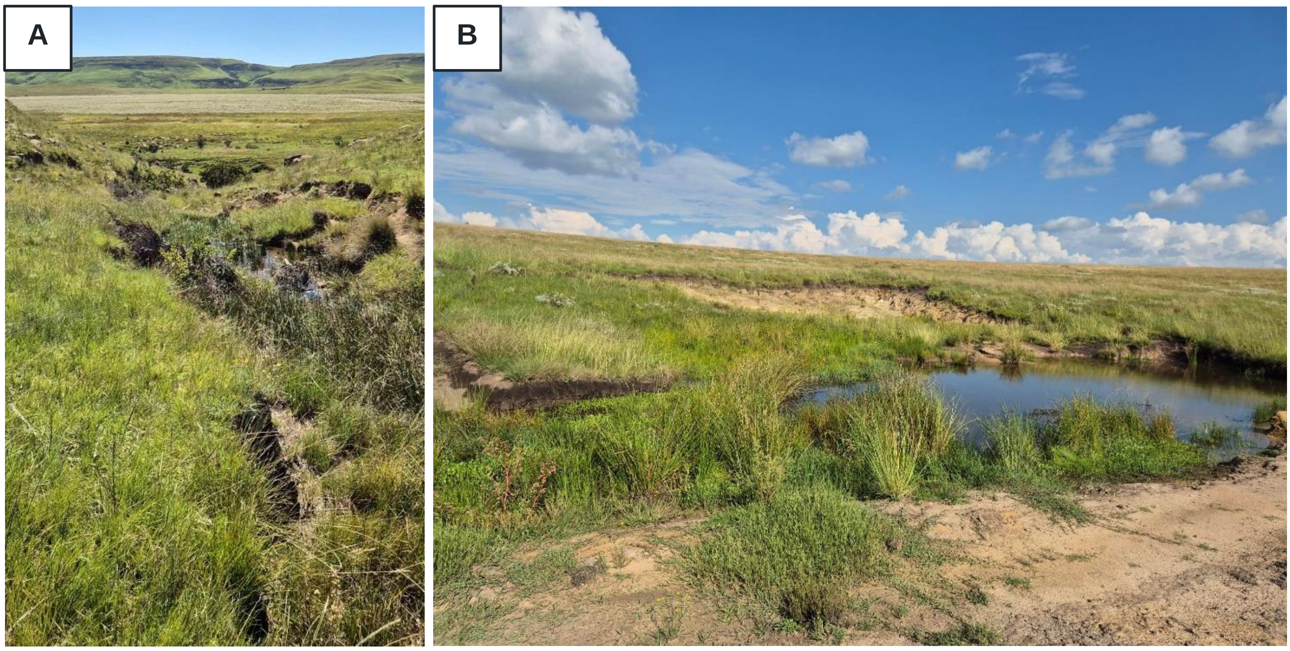


Figure 6-3 - Typical Channelled Valley Bottom (CVB) wetland habitats (A and B) observed within the proposed Kromhof project footprint

Unchanneled Valley Bottom Wetlands

Unchanneled valley-bottom (UVB) wetlands are characterised by their location on valley floors, an absence of distinct channel banks, and the prevalence of diffuse flows. In some cases, an unchanneled valley bottom wetland could occur at the downstream end of a seep, where a slope grades into a valley near the head of a drainage line. Water characteristically moves through the wetland in the form of dispersed surface or subsurface flow, but the outflow may be in the form of either diffuse or concentrated surface flow. Therefore, due to the diffused flow, these wetlands have a higher ability to remove nitrates and toxicants. UVB systems also assist in streamflow augmentation, sediment trapping and erosion control, however these are dependent on the type of vegetation present (Kotze, 2005). In addition to the biodiversity associated with these systems it is expected that they play an important role in retaining water in the landscape. Typical vegetation observed within these wetlands on site include *Helichrysum aureonitens, Paspalum dilatatum*, *Typha capensis, Kyllinga erecta* and *Cyperus sp*.

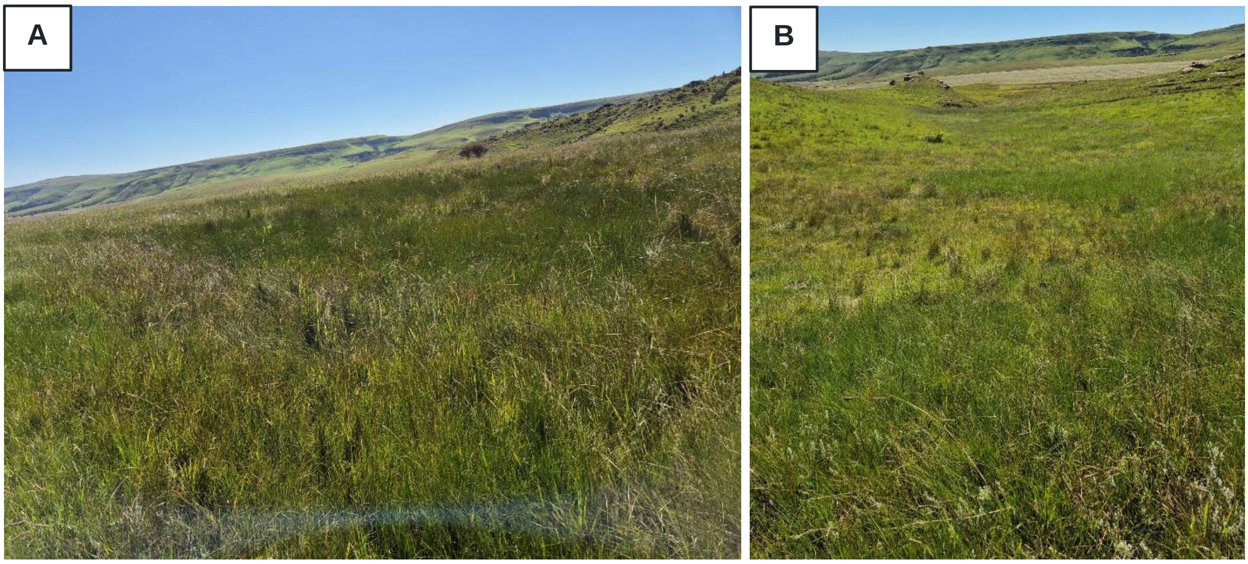


Figure 6-4 - Typical Unchanneled Valley Bottom (UVB) wetland habitats (A and B) observed within the proposed Kromhof project footprint

Hillslope Seepage Wetlands

Hillslope seepage wetlands are situated on gentle to steep sloping land that facilitates the dominance of colluvial, unidirectional movement of material and water (mainly in the form of interflow) downslope. Water inputs are primarily via subsurface flows from an up-slope direction. Seeps are characterised by their association with geological formations (lithologies) and topographic positions that either cause groundwater to discharge to the land surface or rain-derived water to 'seep' down-slope as subsurface interflow.

Seepage wetlands are expected to contribute to some surface flow attenuation until the wetland soils become fully saturated. The accumulation of organic matter and fine sediment within seepage wetlands allows for the reduction of sub-surface water movement down the slope. Termed as the "plugging effect", this phenomenon increases the storage capacity of the slope above the wetland and prolongs the contribution of water to the stream system during low flow periods (Kotze et al., 2005). Seepage systems are the most dominant wetland type identified within the Kromhof WEF footprint. The vegetation community is typically a short to medium height grass-sedge assemblage, with common plant species including *Scirpoides burkei*, *Cyperus sp., Helichrysum aureonitens, Kyllinga erecta, Pycreus nitidus, Monopsis decipiens, Isolepsis sp., and Juncus sp.*

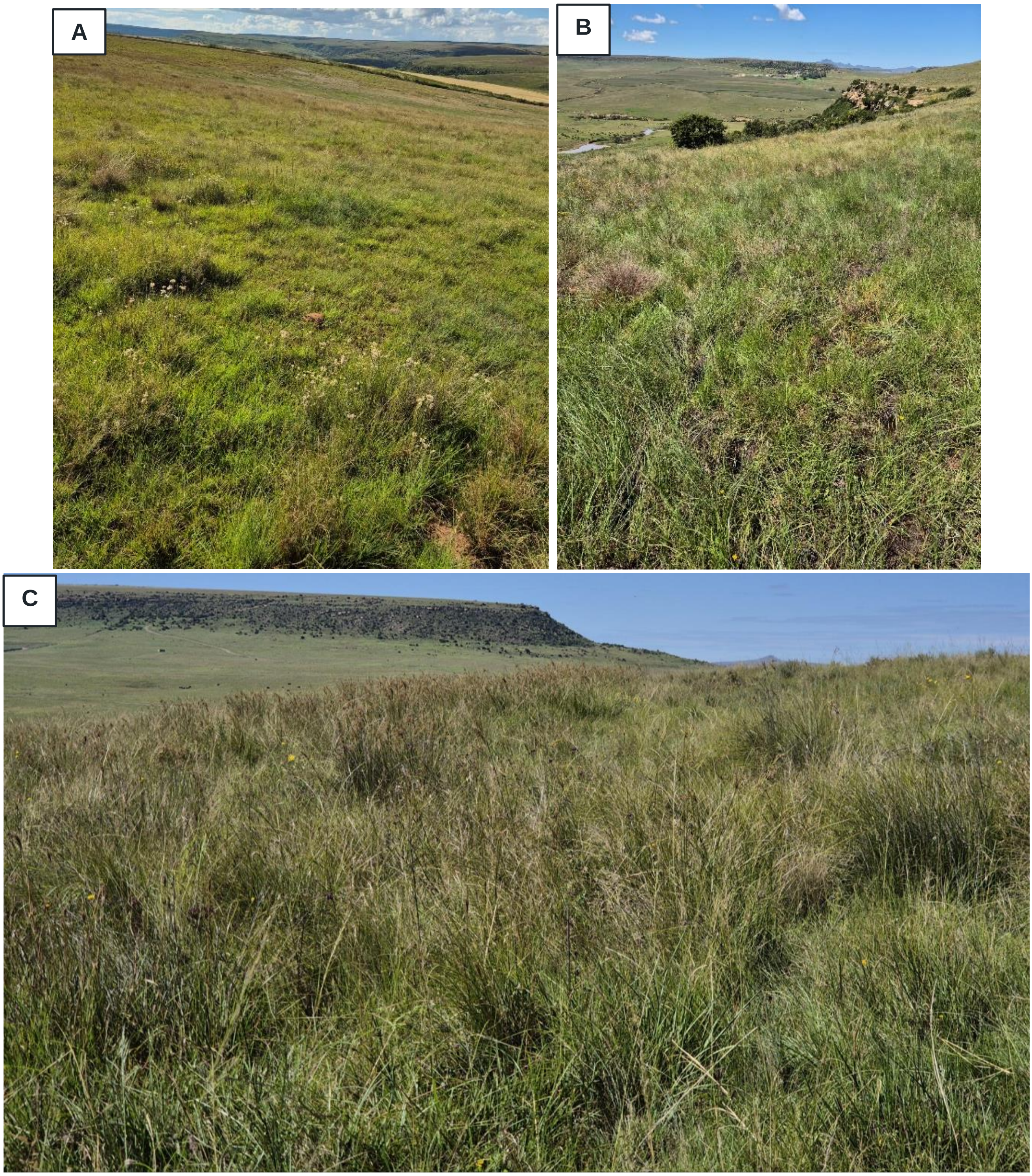


Figure 6-5 - Typical Hillslope Seepage wetland habitats (A, B and C) observed within the proposed Kromhof project footprint

Depression/Pan Wetlands

Depressional (including Pans) systems are wetlands ecosystems with closed (or near-closed) elevation contours, which increases in depth from the perimeter to a central area of greatest depth and within which water typically accumulates. Most depressions occur either where the water table intercepts the land surface (such as on coastal plains along the South African coastline), or in semi-arid settings where a lack of sufficient water inputs prevents areas where water accumulates from forming a connection with the open drainage network. Depressions present a unique setting as they are generally isolated systems. However, these wetlands are able to capture runoff because of their inward draining nature, and thus they reduce the volume of surface water that would otherwise reach the stream system and contribute to storm flows. Depending on their link to groundwater sources, depressions may vary in saturation period from ephemeral to permanent. Open water was noted in the larger depression wetlands at the time of the site surveys, and typical vegetation observed within the pan systems of the study area include *Eleocharis dregeana and Cyperus sp.*

Figure 6-6 - Typical depression/pan wetland habitats observed within the proposed Kromhof project footprint

6.1.2 WETLAND PRESENT ECOLOGICAL STATE (PES)

The state of the four main functional aspects of wetland conditions is considered for the WET-Health assessment. These are: (1) hydrology, (2) geomorphology, (3) water quality and (4) vegetation. The assessment of the ecological status of each of these functional aspects follows a broadly similar approach and is used to determine which impacts have affected the health status of the wetland. The WET-Health level 1A assessment was applied due to the large number of wetland units present across the study area (>100). This level of assessment is primarily a desktop assessment which relies on landuse data to infer level of impact. However, the landuse data used for the assessment was scrutinised to ensure alignment with the observations made during the site survey, and resultant PES scores were modified based on expert knowledge where the outcomes were considered to not reflect the conditions on site. The assessment of the PES for these wetlands is presented below.

HYDROLOGICAL IMPACTS AFFECTING PES

Hydrological impacts experienced by the wetland groups relate to the presence of numerous farm dams, agricultural practices and road networks within the catchments. Roads that are located in close proximity to, or within, wetlands create preferential flow paths for surface runoff after rains, resulting in an increase in lateral and longitudinal soil erosion and mobilisation of sediment. Another impact identified due to roads is the impoundment and pooling of water at road crossings. Agricultural activities situated within the study area can also have a negative indirect impact on the hydrology of the systems. In spite of this prolonged impact to the wetlands' supporting hydrology, areas of largely natural wetland habitat were still found to occur.

GEOMORPHOLOGICAL IMPACTS AFFECTING PES

Major geomorphological impacts on the wetlands are associated with erosion gullies which have formed as a result of the naturally steep slopes and concentration of flow paths. The erosion channels have altered the geomorphological template and processes operating within the affected wetlands. Eroded sediments are transported into downstream areas leading to sedimentation and altered geomorphological structure.

WATER QUALITY IMPACTS AFFECTING PES

Observations made during the site visit suggest that while the clarity of the water flowing through the open water systems was relatively clear (low turbidity), it must be noted that the majority of the wetlands are found either within agricultural plantations or in close proximity to crop lands. Therefore, the potential for nutrient loading is possible, as agricultural practices use fertilizers that may leach into the downstream wetland environments. This has had a negative effect on the overall score for the water quality component of the PES assessments and is reflected especially for the wetlands found directly within the agricultural plantations.

VEGETATION IMPACTS AFFECTING PES

Vegetation impacts to the wetland relate to reduced surface roughness/reduced vegetation cover, changes in vegetation species composition in the wetland resulting from overgrazing and the presence of alien invasive species. Additional impacts on wetland vegetation are those associated with agriculture which occupies viable wetland habitat and reduced species diversity.

COMBINED PES

The above-described impacts and noted changes to the wetland habitat drivers (hydrology and geomorphology) and responders (water quality and vegetation) have caused the assessed wetlands to deviate from their assumed natural state. The outcomes of the PES assessment found the wetlands to currently lie along a spectrum of modification, ranging from pristine/natural (Category A) to largely modified (Category D). The majority of wetlands were found to range from natural to largely natural systems (PES categories A to B). Given the position of these wetlands towards the upper ends of the catchments, with limited significant landuse change, this outcome is anticipated.

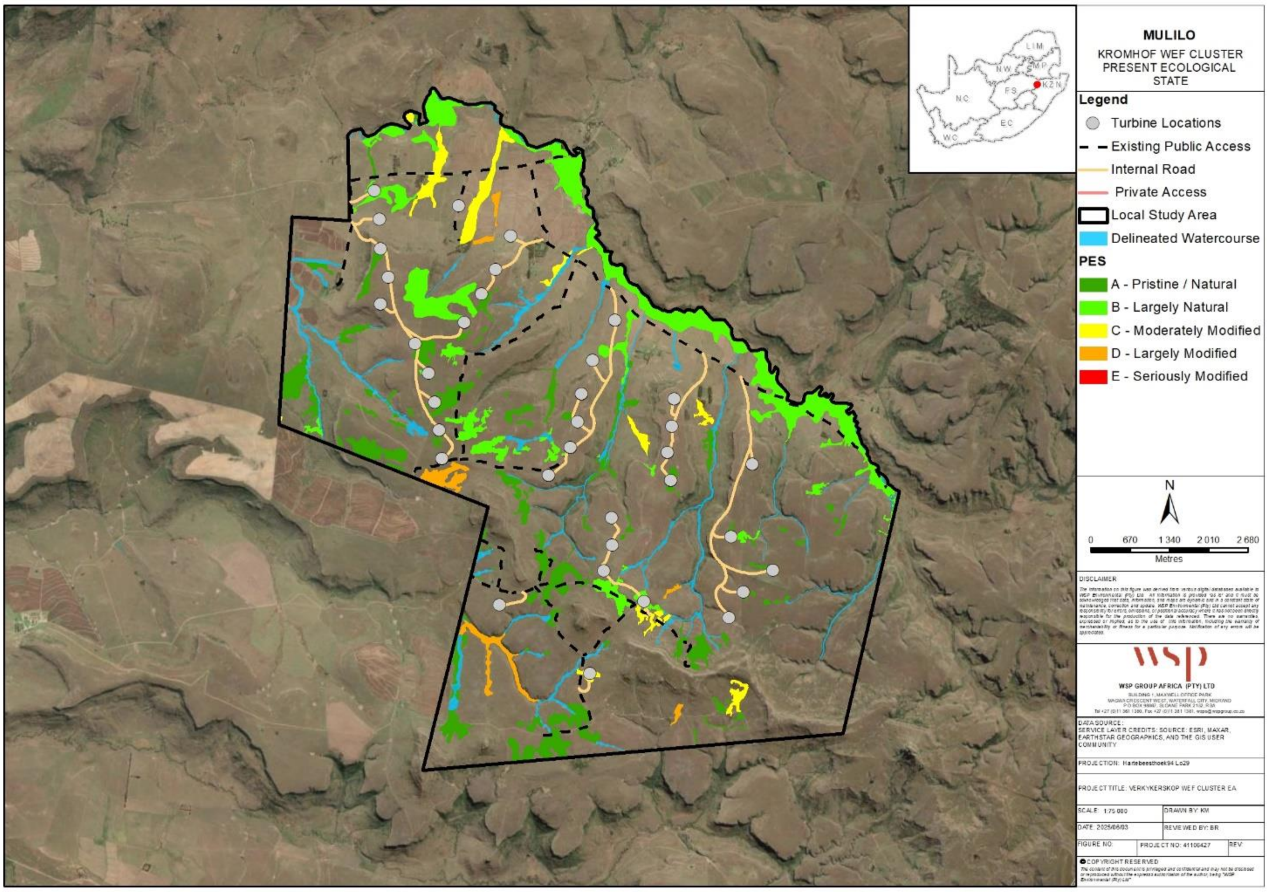


Figure 6-7 - PES of the wetlands within the Kromhof project area

6.1.3 WETLAND IMPORTANCE AND SENSITIVITY (IS) ASSESSMENT

The ecological importance of a wetland is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. Ecological sensitivity refers to the system's ability to tolerate disturbance and its capacity to recover from disturbance once it has been impacted (Kleynhans et al., 1998). The IS assessment considers biodiversity, rarity, uniqueness and fragility of the resource. The intrinsic ecological value of the resource and its importance to the functioning of neighbouring ecosystems are the main concerns. Further considerations that informed the IS assessment include:

- The location of the study area within a vegetation type - Eastern Free State Sandy Grassland - listed as Vulnerable in the Free State Biodiversity Sector Plan (2024).
- The Critical Biodiversity Area for the Greater Free State

- The loss of natural vegetation and habitats due to current and past cultivation within the wetlands.
- The types of wetland present, and the condition and potential functionality of the systems.

The IS assessment for the study area wetlands was conducted for all HGM units potentially affected by the proposed infrastructure (those falling within 500m of the proposed infrastructure footprints) with the results illustrated in Figure 6-8.

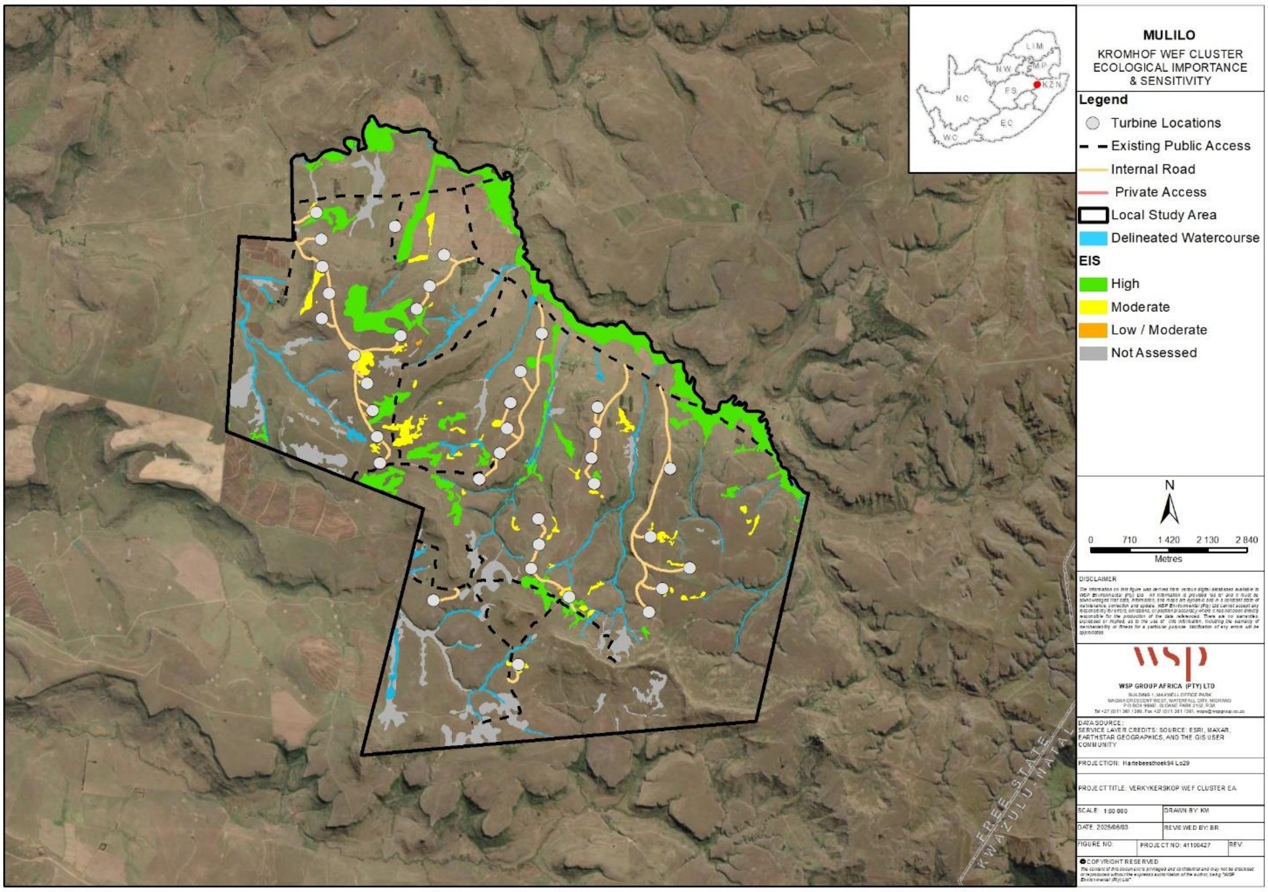


Figure 6-8 - IS of the wetlands within the Kromhof project area

6.1.4 RECOMMENDED ECOLOGICAL CATEGORY (REC) AND WATER RESOURCE MANAGEMENT OBJECTIVES

The future management of the freshwater ecosystems within the project area should be informed by the Recommended Ecological Category (REC) and associated recommended management objectives for the water resources. The REC is the target or desired state of resource units required to meet water resource management objectives and quality targets. It is determined through the consideration of the PES, IS and realistic opportunities to improve the PES that is driven by the context / setting (Table 6-3). These results need to be interpreted in terms of the viability / feasibility of improvement and the desired characteristics of the wetlands based on the context of the catchment in terms of existing impacts/threats and future development pressures.

Table 6-3 - PES/IS derived Matrix for the Determination of REC and Management Objectives for Water Resources

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

Based on this matrix and the catchment context, the minimum recommended management objective for the assessed wetlands is highlighted in Figure 6-9 below.

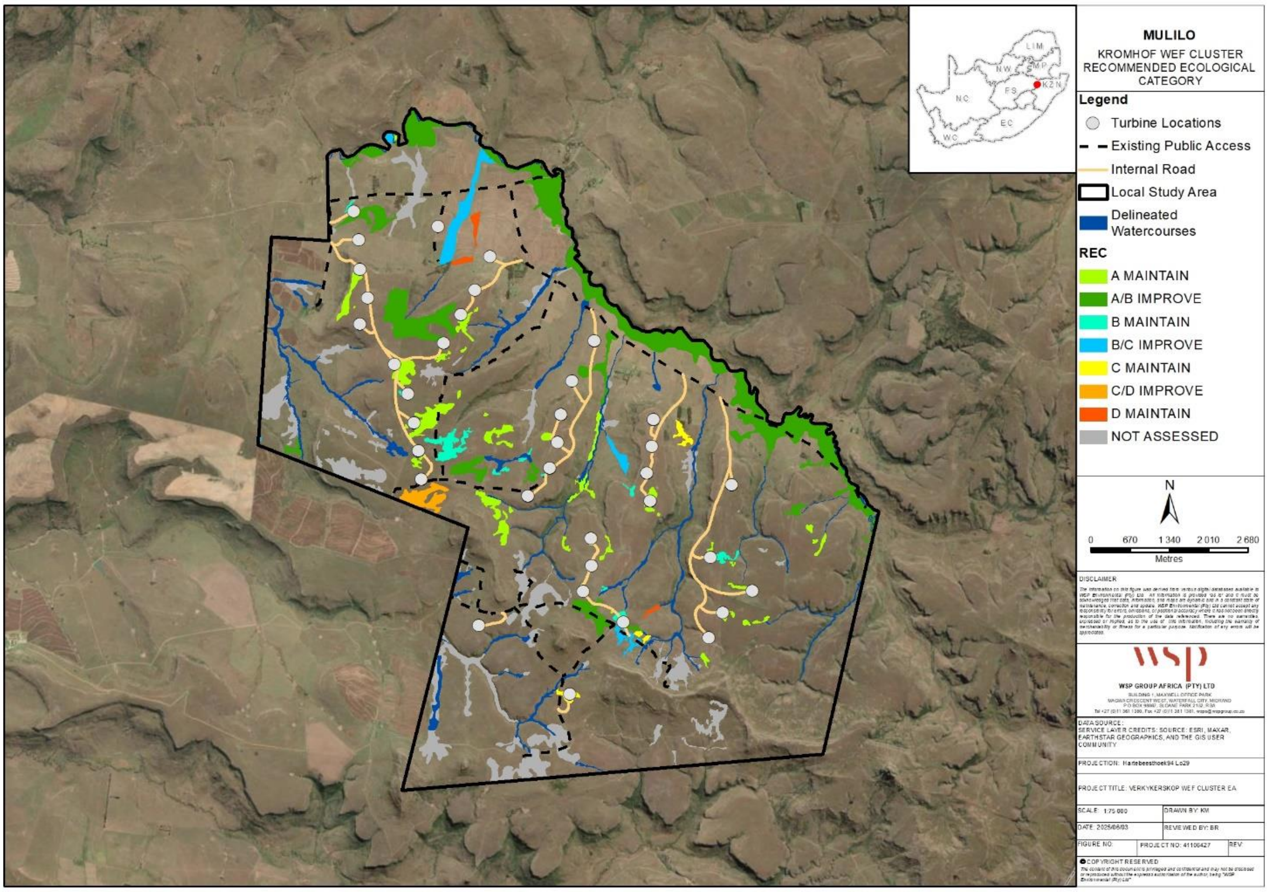


Figure 6-9 - The REC for the wetlands within the Kromhof study area

The above REC's for the wetlands are determined based on a generic matrix that does not take into consideration the context of the wetlands being considered. Given the current and likely future land uses within the landscape that supports these wetlands, it is highly unlikely that a PES category of A/B improve can be achieved in any of the wetland systems. A more realistic target would be to maintain the current PES of the wetlands in the long term or allow for limited and managed decline in PES in systems where activities known to affect wetland integrity are authorised.

6.2 AQUATIC ECOLOGY

Two field surveys were conducted on the 2nd to 5th July 2024, representative of the low flow season and on the 3rd to 7th March 2025, representative of the high flow season. Results are discussed in the below sections.

6.2.1 PHYSICAL STREAM CONDITIONS

The proposed Project area predominantly occurs within a mountainous area, and as such the geomorphological zonation of the river's ranges from Mountain Headwater streams to Lower Foothill streams. The geomorphological zone of a river influences the physical structure, the material from which the channel is formed, the shape of the channel, the hydraulic conditions, and in turn the fauna and flora which inhabits the river reach (Rowntree et al., 2000). Descriptions of the geomorphological zones found in the current study are provided in Table 6-4 and photographs taken during the field survey are provided in Figure 6-10.

Table 6-4 - Geomorphological zonation of the assessed river channels (Rowntree et al., 2000)

Zone	Class	Description
Mountain headwater stream	**A**	A very steep gradient stream dominated by vertical flow over bedrock with waterfalls and plunge pools. Normally first or second order. Reach types include bedrock fall and cascades. In the current study, the mountain headwater streams were observed to be ephemeral i.e. flows expected for a short period following high rainfall events.
Upper Foothills	**D**	Moderately steep, cobble-bed or mixed bedrock-cobble bed channel, with plain-bed, pool-riffle or pool-rapid reach types. Length of pools and riffles/rapids similar. Narrow flood plain of sand, gravel or cobble often present.
Lower Foothills	**E**	Lower gradient mixed bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock controlled. Reach types typically include pool- riffle or pool-rapid, sand bars common in pools. Pools of significantly greater extent than rapids or riffles. Flood plain often present.

Figure 6-10 - Representative photos of the riverine geomorphological zones and physical conditions of rivers within the project area. Letters A, D and E represent the zone classes

6.2.2 IN SITU WATER QUALITY

The variables temperature, pH, electrical conductivity and dissolved oxygen were measured onsite by means of portable water meters. The obtained data were referenced against various water quality guidelines shown in Table 6-5 and the results are presented in Table 6-5.

These data are important to assist in the interpretation of biological results due to the direct influence water quality has on aquatic life forms and provide an indication of the physio-chemical status of the water at a sampling site at the time of the survey.

The water quality at each of the assessed sites was natural based on the measured parameters during the low and high flow surveys, except at sites CL7, CL9 and CL14. Sites CL7 and CL9 recorded below the recommended dissolved oxygen levels during the high and low flow surveys respectively. The EC levels at site CL14 was high during the low flow survey. These water quality modifications were attributed to the extensive erosion and limited to no flow conditions at the time of the surveys (Figure 6-11). Erosion increases sediment and nutrient loads in water bodies and lack of flow in aquatic systems reduce the dilution effect, leading to high concentrations of pollutants in water.

The improvement in water quality at sites CL9 and CL14 during the high flow survey can be attributed to the significant rains in the project area prior to the filed survey, leading to increased flows and thus eliciting a dilution effect which potential contributed to the improved water quality at sites.

Table 6-5 - Sources for the recommended water quality guidelines for aquatic ecosystems

Variable	Guideline limit	Source
Temperature	5 – 30 ˚C	South African Water Quality Guidelines: *Aquatic Ecosystems (Volume 7)* (Department of Water Affairs And Forestry, 1996)
pH	6 – 8	
Dissolved Oxygen % Saturation	80 – 120 %	
Dissolved Oxygen concentration	> 5 mg/ℓ	Minimum Dissolved Oxygen concentration for aquatic macroinvertebrates (Nebeker et al., 1996)
Electrical Conductivity	< 500 µS/cm	Conductivity guideline value of 500 µS/cm stipulated in U.S. U.S. Environmental Protection Agency (2010)

Table 6-6 - *In situ* water quality data

Sites	Time	Temp. (ºC)	pH	EC (µS/cm)	DO (mg/ℓ)	DO (%)
TWQR	**-**	**5 - 30º**	**6 – 8**	**<500**	**>5.0**	**80 - 120**
Low flow survey						
CL1	13:20	10.9	7.78	92	6.11	84.6
CL2	13:49	10.2	7.74	72	7.72	84.2
CL3	11:49	9.60	7.83	85	7.92	85.8
CL4	15:29	10.9	7.48	255	6.48	81.8
CL7	Dry					
CL8						
CL9	14:38	10.6	7.62	486	3.12	57.3
CL14	12:20	12.8	7.4	544	8.75	109
CL15	10:40	9.3	7.23	41	7.2	102.6
High flow survey						
CL1	14:22	20.5	7.71	56	6.62	99.4
CL2	11:44	20.2	7.06	47	9.31	112.8
CL3	10:40	19.9	7.60	148	9.01	108.6
CL4	09:36	19.5	7.90	59	8.12	97.9

CL7	12:31	19.7	6.73	132	3.81	61.3
CL8	Dry					
CL9	14.36	19.6	6.72	114	6.89	93.1
CL14	08:44	20.2	7.34	378	7.23	114.6
CL15	16:28	25.9	6.94	45	8.10	113.5
EC = Electrical Conductivity; DO = Dissolved Oxygen. Red highlights represent values which have either exceeded or fallen below the guideline values						

Figure 6-11 - Potential contributors of poor modified water quality at selected sites. Left – CL7; Middle – CL9; Right – CL14.

6.2.3 HABITAT ASSESSMENT

Habitat quality and availability plays a critical role in the occurrence of aquatic biota. For this reason, habitat evaluation is conducted simultaneously with biological evaluations in order to facilitate the interpretation of results (Ollis et al., 2006). The quality of the instream and riparian habitat influences the structure and function of the aquatic community in a stream; therefore, assessment of the habitat is critical to any assessment of ecological integrity.

In the current study, the instream and riparian habitat assessment was based on the Index of Habitat Integrity (IHI) and the aquatic macroinvertebrate habitat integrity was based on the Integrated Habitat Assessment System (IHAS).

6.2.4 INDEX OF HABITAT INTEGRITY (IHI)

The IHI is a tool developed to asses river habitat integrity and forms part of the River EcoStatus Monitoring Program (REMP) (Kleynhans, 2007a). A desktop level and reach-based Habitat Integrity (IHI) was applied and observations made during the field survey were used to supplement the data used within the index. Results are presented in Table 6-7.

Based on the field work findings, sites CL1, CL2, CL3 and CL15 occur within the headwater streams where human impacts are limited. The instream and riparian habitats were generally in a Largely natural state, which means that a small change in natural habitats and biota may have taken place, but the ecosystems are essentially unchanged. This is with exception of the instream habitat at CL15, where a large dam has led to flow and channel modifications, ultimately leading to a Moderately modified state. Additional impacts noted on site were informal roads and stream crossings.

Streams associated with sites CL4, CL7, CL8, CL9 and CL14 are subject to large scale farming impacts such as dams and larger crop lands, consequently the instream and riparian habitats were in a Largely Modified state, with exception of CL4 and CL7 where the riparian habitat was in a Moderately Modified state due to relatively well vegetated riverbanks with less erosion and channel modifications. The IHI could not be conducted for the instream habitat at CL7 and CL8 due to dry conditions. No significant changes were noted at all sites and associated stream during the low and high flow surveys, the IHI categories remined the same.

Table 6-7 - Habitat Integrity scores (IHI)

River Reach	Habitat Component	IHI Score	Category	Major Impacts
Sites CL1, CL2 & CL3	In-stream	80.3	B	Flow and channel modification
	Riparian	85.6	B	
CL4	In-stream	59.4	D	Flow and channel modification; exotic vegetation encroachment and inundation
	Riparian	60.6	C	
CL7	In-stream	Dry		Flow and channel modification
	Riparian	63.08	C	
CL8	In-stream	Dry		Channel modification
	Riparian	58.52	D	
CL9	In-stream	45.56	D	Flow and channel modification
	Riparian	48.76	D	
CL14	In-stream	48.64	D	Flow and channel modification
	Riparian	51.52	D	
CL15	In-stream	62.72	C	Flow and channel modification
	Riparian	83.48	B	

6.2.4.1 Integrated Habitat assessment system

The Integrated Habitat Assessment System (IHAS) was developed by McMillan (1998) for use in conjunction with the South African Scoring System (SASS5) bioassessment. Results from the current study are provided Table 6-8.

The SASS5 bioassessment was not conducted at CL7, CL8 and CL15 during the low flow survey and at CL7 and CL8 during the high flow survey due to poor macroinvertebrate habitat availability (i.e., lack of flow and/or shallow water). Therefore, IHAS could not be conducted at these sites during the two surveys.

The assessed sites presented variable macroinvertebrate habitat integrity ranging from Poor to Adequate. Although, the IHAS scores generally improved during the high flow survey at all the sites, the IHAS categories remined the same throughout the sites except at sites CL2 and CL9 where the increase in flows (Figure 6-12) resulted in an improvement from Poor to Adequate habitat integrity.

Table 6-8 – Integrated Habitat Assessment System (IHAS) scores

Site	Sampling Habitat				IHAS	
	Stones-in-Current	Vegetation	Other Habitat / General	Physical Stream Condition	Score	Description
Low Flow Survey						
CL1	14	5	14	28	61	Adequate
CL2	14	6	12	22	54	Poor
CL3	8	6	12	22	48	Poor
CL3	8	0	15	24	47	Poor
CL4	8	0	15	24	47	Poor
CL7	N/A					
CL8						
CL9	6	0	12	24	42	Poor
CL14	11	0	15	21	47	Poor
CL15	N/A					
High Flow Survey						
CL1	14	6	14	28	62	Adequate
CL2	15	7	14	22	58	Adequate
CL3	8	6	14	24	52	Poor
CL4	10	0	15	24	49	Poor
CL7	N/A					
CL8						
CL9	10	6	14	28	58	Adequate
CL14	12	0	16	22	50	Poor
CL15	13	7	15	25	60	Poor
Maximum possible scores for Stones-in-Current = 20; Vegetation = 15; Other Habitat/General = 20; Physical Stream Condition = 45						

Figure 6-12 - Flow conditions at CL2 and CL9 during the low flow (Left) and high flow (Right) surveys.

6.2.5 AQUATIC MACROINVERTEBRATES – ECOLOGICAL CONDITION

The SASS5 protocol was conducted to sample macroinvertebrates. This protocol provides a general indication of the current state of the macroinvertebrate community and subsequently the 'health' of the river ((Dickens & Graham, 2002).

The SASS5 data obtained was used in the MIRAI (Thirion, 2008) to determine the Present Ecological State (PES, or Ecological Category) of the associated macroinvertebrate assemblage. The MIRAI provides a habitat-based cause-and-effect basis to interpret the deviation of the aquatic macroinvertebrate community from the reference condition. Results for the SASS5 and site-based MIRAI are shown in Table 6-9.

The SASS5 and site-based MIRAI could not be conducted at sites CL7 and CL8 during both surveys and at CL15 during the low flow survey. This was due to the lack of macroinvertebrate habitat availability (i.e., lack of flow or shallow water).

A total of 26 macroinvertebrate taxa/families were collected during the low flow survey at the six sampled sites. The total number of sampled macroinvertebrate taxa/families increased to 29 during the high flow survey. The slight increase in the number of taxa may have been due to one extra site sampled during the high flow survey (seven sites in total), as well as the improvement in the integrity of all biotope (i.e., vegetation and physical stream condition) which potentially attracted more taxa to inhabit the sites.

The community assemblages were similar throughout the sites and were dominated by pollution-tolerant taxa, however few moderately sensitive taxa were collected i.e. Leptophlebiidae, Trichorythidae, and Aeshnidae; and a single taxon that is highly sensitive i.e. Oligoneuridae (Table 6-10)

Based on the MIRAI, the ecological condition of the aquatic macroinvertebrate communities was Largely Modified (Ecological Category D) at all the sites during both surveys, except at site CL2. The ecological condition at sites CL2 improved to Moderately Modified during the high flow survey. This was attributed to an increase in the number of higher scoring invertebrates the high flow survey at this site.

Table 6-9 - SASS5 data and the Macroinvertebrate Response Assessment Index

Site	SASS5	# of Taxa	ASPT	MIRAI	
				Score	EC
Low flow survey					
CL1	37	8	4.6	40.8	D
CL2	71	12	5.9	42.0	D
CL3	62	15	4.1	47.4	D
CL4	43	8	5.4	46.4	D
CL7	No flow				
CL8					
CL9	31	6	5.2	45.3	D
CL14	31	8	3.9	38.9	D
CL15	No flow				

Site	SASS5	# of Taxa	ASPT	MIRAI	
				Score	EC
High flow survey					
CL1	40	9	4.4	40.1	D
CL2	104	16	6.5	60.3	C
CL3	69	12	5.8	50.8	D
CL4	34	7	4.9	42.1	D
CL7	No flow				
CL8					
CL9	82	16	5.1	48.5	D
CL14	43	10	4.3	46.4	D
CL15	56	12	4.7	41.7	D
ASPT = Average Score Per Taxon; MIRAI = Macroinvertebrate Response Assessment Index					

Table 6-10 - Collected sensitive aquatic macroinvertebrates

Taxon	Sensitivity Score		Sites collected	Photograph of Collected specimen
Leptophlebiidae	9	Moderate Sensitivity	CL2 CL3 CL4	
Trichorythidae	9		CL2	

Taxon	Sensitivity Score		Sites collected	Photograph of Collected specimen
Aeshnidae	8		CL1 CL2 CL3 CL4 CL9 CL14	
Chlorocyphidae	10		CL9	
Oligoneuridae	15	High Sensitivity	CL2 CL3	

6.2.6 ICHTHYOFAUNA – ECOLOGICAL CONDITION

The composition of fish communities is often altered by anthropogenic activities in the catchment. Changes in water quality, flows and habitat can result in the absence or addition of species, ultimately altering the biotic integrity of the system. Thus, fish can effectively give an indication into the degree of modification of the aquatic environment. Fish sampling was undertaken by means of the electroshocking technique at each site. The collected fish specimens were identified in the field and released back into the river. A list of collected fish species within the study area is provided in Table 6-11.

Only three species were collected from two of the assessed sites. Both species are indigenous, and their conservation statuses are Least Concern according to the IUCN (IUCN, 2025). The low diversity of fish species was considered normal for headwater streams (Richardson, 2019) despite the nearby previously sampled DWS site C8MEUL-UNSPE listing a total of 10 species, including the alien *Cyprinus carpio* (Carp). This site is located adjacent a farm dam within a side channel approximately 300m from site CL4 (27°55'56.71"S 29°31'49.58"E). The relatively high fish diversity within this stream was likely linked with human activities associated with the neighbouring farm, i.e. the introduction of nutrients and the introduction of alien species for example.

The Fish Response Assessment Index (FRAI) was applied to determine the ecological integrity of the fish community assemblages within the monitoring sites for the current study. The FRAI results indicate that most of the sites were in a Seriously Modified condition due to the lack of fish. This however should be interpreted with caution as the assessed sites occur within headwater streams. Site CL3 indicated a Largely Modified condition for both low flow and high flow surveys whilst site CL9 indicated Largely Modified condition during the high flow survey.

The presence of fish at sites CL3 and CL9 was attributed to several factors including availability of nutrients and habitat. Both sites are located downstream of pasture and cultivated lands, thus are subjected to nutrient input (fertilizers) through surface runoff). Site CL3 is located within a relatively wider and deeper stream and thus provides bigger habitat space.

Table 6-11 - Collected fish species and FRAI data per site

<table>
<tr><th colspan="2"></th><th>CL1</th><th>CL2</th><th>CL3</th><th>CL4</th><th>CL7</th><th>CL8</th><th>CL9</th><th>CL14</th><th>CL15</th></tr>
<tr><td colspan="9">Low flow survey</td><td></td><td></td></tr>
<tr><td colspan="2">Clarias gariepinus</td><td>-</td><td>-</td><td>-</td><td>-</td><td colspan="2" rowspan="7">No flow</td><td>1</td><td>-</td><td rowspan="7">No flow</td></tr>
<tr><td colspan="2">Enteromius anoplus</td><td>-</td><td>-</td><td>5</td><td>-</td><td>4</td><td>-</td></tr>
<tr><td colspan="2">Enteromius neefi</td><td>-</td><td>-</td><td>13</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td colspan="2">Diversity</td><td>0</td><td>0</td><td>2</td><td>0</td><td>2</td><td>0</td></tr>
<tr><td colspan="2">Abundance</td><td>0</td><td>0</td><td>18</td><td>0</td><td>5</td><td>0</td></tr>
<tr><td rowspan="2">FRAI</td><td>Score</td><td>20.0</td><td>20.0</td><td>52.5</td><td>20.0</td><td>30.25</td><td>20.0</td></tr>
<tr><td>Ecological Category</td><td>E</td><td>E</td><td>D</td><td>E</td><td>E</td><td>E</td></tr>
<tr><td colspan="9">High flow survey</td><td></td><td></td></tr>
<tr><td colspan="2">Enteromius anoplus</td><td>-</td><td>-</td><td>17</td><td>-</td><td colspan="2" rowspan="5">No flow</td><td>7</td><td>-</td><td>-</td></tr>
<tr><td colspan="2">Diversity</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td colspan="2">Abundance</td><td>0</td><td>0</td><td>17</td><td>0</td><td>7</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">FRAI</td><td>Score</td><td>20.0</td><td>20.0</td><td>42.6</td><td>20.0</td><td>30.65</td><td>20.0</td><td>20.0</td></tr>
<tr><td>Ecological Category</td><td>E</td><td>E</td><td>D</td><td>E</td><td>E</td><td>E</td><td>E</td></tr>
</table>

6.2.7 INTEGRATED ECOSTATUS DETERMINATION

The EcoStatus is defined as: "*The totality of the features and characteristics of the river and its riparian areas that bear upon its ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services*" (Iversen *et al*., 2000). Thus, the EcoStatus represents an integrated ecological state representing the drivers (hydro-morphology and physio-chemical) and responses (riparian vegetation, aquatic invertebrates and fish; Kleynhans & Louw, 2008). The integrated EcoStatus for the sampled sites are presented in Table 6-12.

Following integration of the defined ecological conditions obtained for the riparian component (i.e. IHI from riparian vegetation assessment) and the instream biological integrity (i.e. MIRAI from aquatic invertebrates and FRAI from fish), it was determined that most of the assessed sites represented an integrated EcoStatus of Largely Modified during both surveys. Site CL3 however presented Moderately Modified condition during both surveys and CL2 improved from Largely Modified to

Moderately Modified condition during the high flow survey. The improvement in the MIRAI score contributed to the subsequent improvement in the EcoStatus category.

In relation to the Recommended Ecological Category (REC) of *Moderately Modified* (EC of C) for river instream habitat and biota – gazetted in April 2016 (*classes and resource quality objectives of water resources for catchments of the Upper Vaal*) (DWS, 2016) – most of the assessed sites were observed to be in a slightly deteriorated state whilst some of the sites achieved the REC. The slightly deteriorated ecological category may be attributed to the ephemeral nature of some of the watercourses.

Table 6-12 - Integrated EcoStatus categories for the current study – EcoStatus version 1.02 (Kleynhans and Louw, 2007)

Site	Response Indices				EcoStatus	
	Riparian Veg. EC	MIRAI EC	FRAI EC	Instream EC	Score	Category
Low Flow Survey						
CL1	80.3	40.8	20	32.8	54.9	**D**
CL2	80.3	42	20	33.5	55.3	**D**
CL3	80.3	47.4	52.5	49.4	63.8	**C**
CL4	60.6	46.4	20	36.2	47.5	**D**
CL7	63.08	-	-	57.88	-	**-**
CL8	58.52	-	-	-	-	**-**
CL9	48.76	45.3	30.25	40.36	45.08	**D**
CL14	51.52	38.9	20.0	32.85	43.30	**D**
CL15	83.48	-	-	62.72	-	**-**
High Flow Survey						
CL1	80.3	40.1	20	32.3	54.6	**D**
CL2	80.3	60.3	20	44.7	61.3	**C**
CL3	80.3	50.8	42.6	47.6	62.8	**C**
CL4	60.6	42.1	20.0	33.6	46.1	**D**
CL7	63.08	-	-	57.88	-	**-**
CL8	58.52	-	-	-	-	**-**
CL9	48.76	48.5	30.65	42.76	46.08	**D**
CL14	51.52	46.4	20.0	35.97	44.29	**D**
CL15	83.48	41.7	20.0	34.75	62.03	**C**
EC = Ecological Category						

7 SITE SENSITIVITY VERIFICATION

The findings of the site sensitivity verification exercise, based on the data gathering activities conducted to date (review and consolidation of available desktop data, site sensitivity verification site visits) are summarised below.

Theme	Screening tool sensitivity	Site-based sensitivity	Motivation
Aquatic Biodiversity	Low & Very High	Very High	• Presence of perennial and non-perennial riverine systems with functional ecosystems • Presence of extensive wetland systems within the project area including systems in a largely natural to natural condition, and including systems highlighted as FEPA wetlands

8 IMPACT ASSESSMENT

This section identifies and assesses the significance of the impacts likely to arise during the proposed activities and provides a description of the mitigation required to limit the magnitude of the potential impact on the aquatic biodiversity receptors.

The proposed Project activities and placement of infrastructure to be considered as part of the impact assessment are listed in Table 8-1.

Table 8-1 - Project activities per phase

Phase	Activity
Construction	▪ Bush clearing and soil disturbance ▪ Bulk earthworks ▪ Development of required service infrastructure on the site ▪ Site establishment ▪ Construction of project components (i.e., Turbine hardstand; laydown and storage area; BESS)
Operational	▪ Maintenance of infrastructure ▪ Vegetation management around the turbines ▪ Handling and disposal of general and hazardous waste

8.1 PRE-CONSTRUCTION ENVIRONMENTAL PLANNING

8.1.1 SENSITIVE AREAS

Freshwater ecosystems should be avoided irrespective of their sensitivity and ecosystem threat status. As such, all freshwater ecosystem boundaries should be considered high sensitivity and avoided wherever possible. The watercourses (rivers, wetlands and drainage lines) within the PAOI collect, retain, and convey surface water in the landscape to the Wilge and Klip Rivers which subsequently drain into the Vaal River, a flagship river in South Africa due to its economic importance, amongst other factors. The wetlands and rivers also fall within a surface water SWSA and therefore activities which impact water quality and quantity should be avoided. A sensitivity map showing watercourses that are likely to be impacted by the proposed Project activities is presented in Figure 8-1.

It should be noted that Kromhof Wind Power undertook biodiversity specialist assessments prior to establishing layout plans for the proposed infrastructure, which allowed for the avoidance of sensitive habitats to the extent possible.

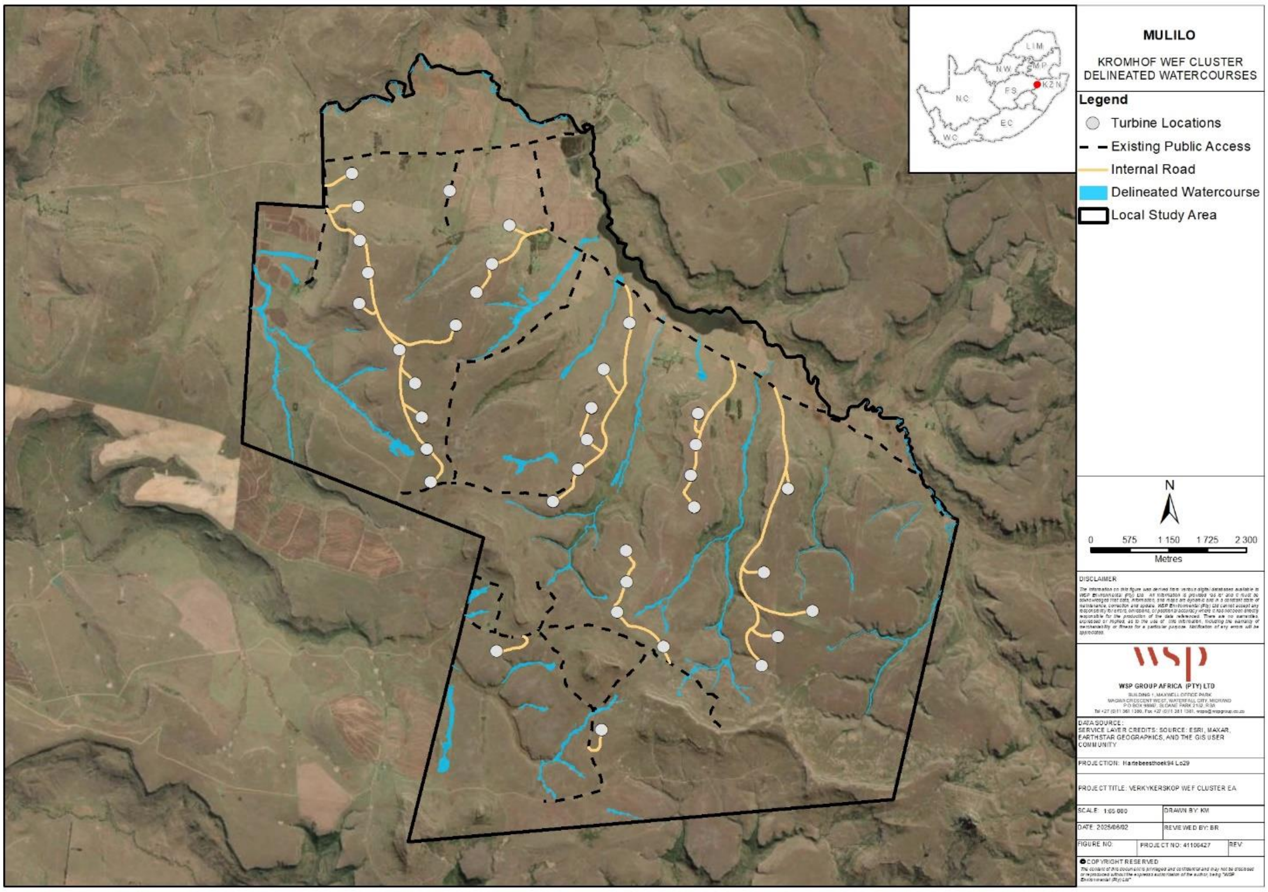


Figure 8-1 - Sensitivity map of watercourses associated with the proposed Project

8.1.2 BUFFER ZONES

Buffer zones are areas adjacent to the delineated wetland and watercourse boundaries that should be maintained in a natural state to limit the risk of certain activities or landuse changes impacting on the integrity of the wetlands/watercourses. Protection may also extend to peak runoff/flood flows and the buffer zone may also provide feeding / breeding areas for river or wetland fauna and accordingly enhance the corridor function of drainage lines. In terms of the guidelines presented by Macfarlane and Bredin (2017), an appropriate buffer strip surrounding the riparian / wetland habitat is required to protect the habitat and the water resource. The appropriate buffer strip width is dependent on the following (Kotze, et al., 2009):

- The type of adjacent land use;
- The sensitivity of the wetland/river; and
- The scarcity and quality of the water resource.

To protect the aquatic ecosystems from impacts linked to activities during the construction phase and the operational phase of this development, appropriate buffer zones are calculated using ‘The Estuary, River and Wetland Buffer Guidelines’ model (Macfarlane et al. 2017). This tool measures the relative risk of construction and operational phases, taking into consideration the specific conditions on the site, and potential mitigation measures that could be implemented in line with best practise.

Watercourses within the PAOI were delineated at a desktop level by analysing available digital elevation contours and colour aerial photography. The delineation encompassed polygon features representing riparian habitat.

The recommended aquatic buffer width is 25m for each of the riverine systems and 30m for wetland systems (Figure 8-2). Therefore, the planned construction and operational activities (excluding linear watercourse crossings, such as roads) should avoid taking place within 25m of the edge of the riparian zones and 30m of the delineated edge of the wetlands wherever feasible.

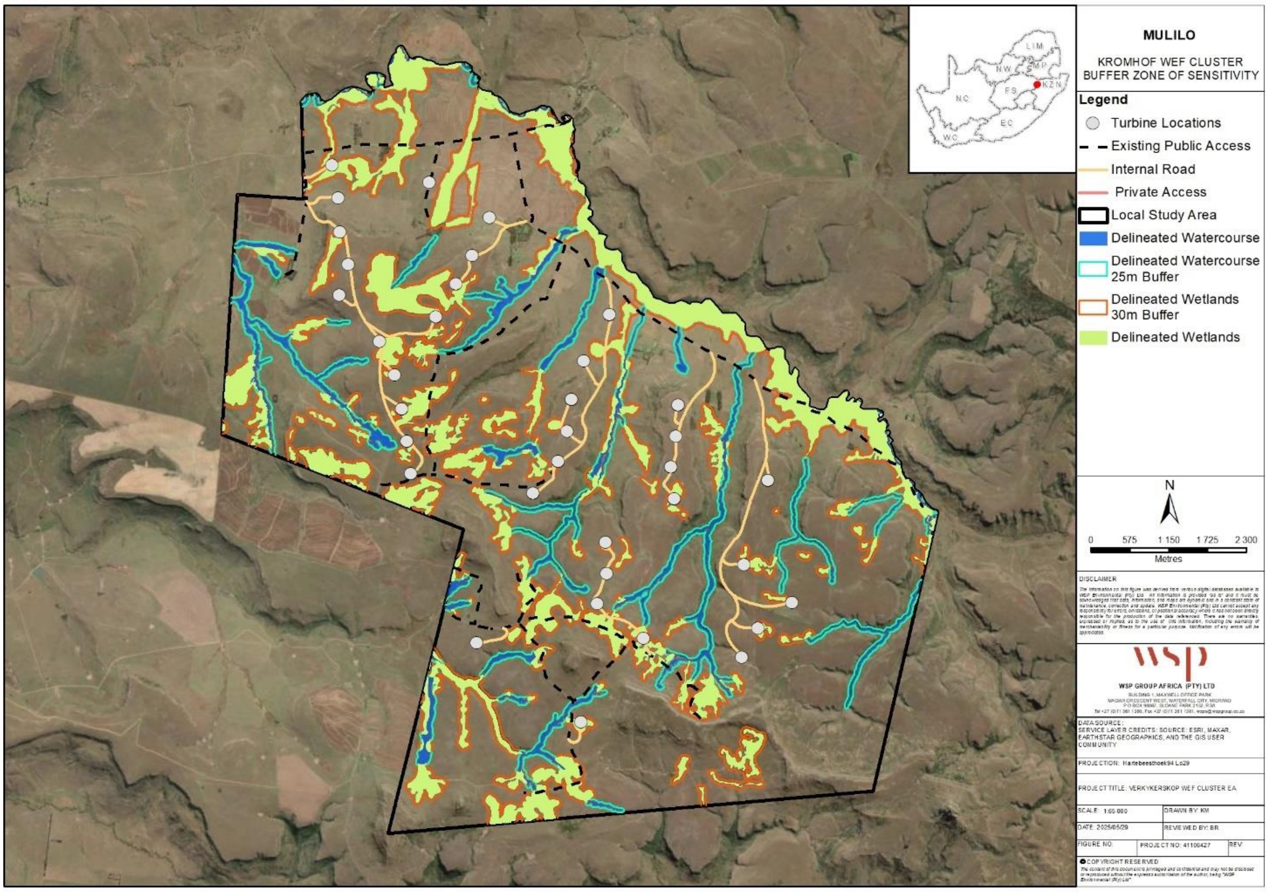


Figure 8-2 - Map showing recommended buffers width for watercourses and wetland habitats

8.2 ASSESSMENT OF POTENTIAL IMPACTS TO WETLAND HABITAT

8.2.1 CONSTRUCTION PHASE IMPACTS

Construction phase impacts on wetland systems can arise from both direct and indirect impacts on the receiving environment due to clearing of land within wetlands or their immediate catchments in advance of project development, and resultant loss of biodiversity. The earthworks and activities involved during the construction phase of the Project can potentially exert negative impacts on sensitive ecosystems including loss of wetland habitat, catchment landcover changes resulting in increased sediment entry to downstream systems and contamination of water bodies from construction-related sources. These impacts are addressed in terms of alteration to wetland hydrology, geomorphology, water quality and vegetation.

8.2.1.1 Impact Description

8.2.1.1.1 Direct wetland habitat loss

Loss of wetland habitat will occur wherever project footprints (Wind Turbine Structures (WTGs), overlap directly with wetland habitat. This loss of wetland habitat is conservatively assumed to be permanent. At this stage in the project, the WTG locations have been provided as point data only, though the approximate extent of each turbine footprint (turbine hard standing) is known to be approximately 0.8 ha. In order to estimate wetlands that may be affected by the footprint of each turbine, a 50m circular buffer has been applied to each WTG point location which equates to an area of approximately 0.8ha and represents an estimated WTG footprint. This means that although a WTG point location may fall adjacent to, but outside of a wetland, the assumed footprint could extend into the wetland habitat. In such cases, a degree of wetland habitat loss has been assumed, and the results have been presented in Table 8-2. However, depending on the shape and orientation of the final WTG footprints, assumed wetland loss could be avoided. The expected wetlands to be affected are based on these preliminary modelled footprints and may be subject to change once the footprint design is finalised.

The original Kromhof Turbine location footprint presented in the scoping phase initially intersected with various sensitive habitats and therefore the layout has been significantly reduced and revised as a measure to avoid (as far as possible) sensitive environmental habitats to a greater extent. The currently proposed turbine footprint does still infringe on wetland habitat. Portions of these wetlands will be lost within the permanent infrastructure footprints; however, no complete loss of wetland systems is anticipated, and the impact is expected to be localised. The wetlands directly affected are highlighted (in red) in Figure 8-3. The wetlands that will be impacted by the proposed development are detailed in Table 8-2. Given the potential direct impact to wetland habitat anticipated, it may not be possible to maintain the current PES of the affected wetlands through the project life cycle, and managed decline may be a more realistic management objective for these wetlands if the project proceeds as proposed. Wetland loss associated with the turbine footprints can be avoided if the turbines are shifted to remain fully outside of all wetland habitats. If this can be achieved, this impact will fall away. However, as the feasibility of adjusting the layout is not currently known, this option to avoid the impact has not been considered in the “with-mitigation” scenario. If the turbines remain within wetland habitat, but are removed, and the footprints suitably rehabilitated at closure, the duration of the impact will be reduced and the reversibility increased. This rehabilitation measure has been considered in the “with mitigation” scenario, and results in a lowering of the impact duration and overall impact score. Removal of the turbines and rehabilitation of the affected wetland habitat will reduce the overall impact, however, the feasibility of removing the turbines and fully rehabilitating the footprints has not been confirmed at this stage in the project.

Table 8-2 – Identified wetlands that will be impacted by the proposed Kromhof WEF infrastructure development

WETLAND ID	WETLAND TYPE	PES	IS	REC	HIGH LEVEL ESTIMATE OF AREA OF POTENTIAL WETLAND LOSS	PROPOSED INFRASTRUCTURE	TURBINE POINT LOCATION WITHIN WETLAND HABITAT (Y/N)	MODELLED FOOTPRINT AREA EXTENDING INTO WETLAND HABITAT (0.8HA) (Y/N)
W90	Seep	A	Moderate	A Maintain	0.17Ha	Turbine (WTG56)	N	Y
W187	Seep	C	Moderate	C Maintain	0.66Ha	Turbine (WTG90)	Y	Y
W205	Seep	A	Moderate	A Maintain	0.4Ha	Turbine (WTG78)	N	Y
W208	Seep	A	Moderate	A Maintain	0.02Ha	Turbine (WTG75)	N	Y
W210	Seep	A	Moderate	A Maintain	0.15Ha	Turbine (WTG72)	Y	Y
W211	Seep	A	Moderate	A Maintain	0.8Ha	Turbine (WTG68)	N	Y
W216	Seep	B	High	A/B Improve	0.03Ha	Turbine (WTG65)	N	Y
W217	Seep	A	High	A/B Improve	0.21Ha	Turbine (WTG63)	N	Y
W234	Seep	A	Moderate	A Maintain	0.08Ha	Turbine (WTG81)	N	Y
W241	Seep	B	High	B Maintain	0.27Ha	Turbine (WTG87)	N	Y
W262	Seep	A	High	A Maintain	0.1Ha	Turbine (WTG77)	N	Y
W291	Seep	A	Moderate	A Maintain	0.7Ha	Turbine (WTG86)	Y	Y

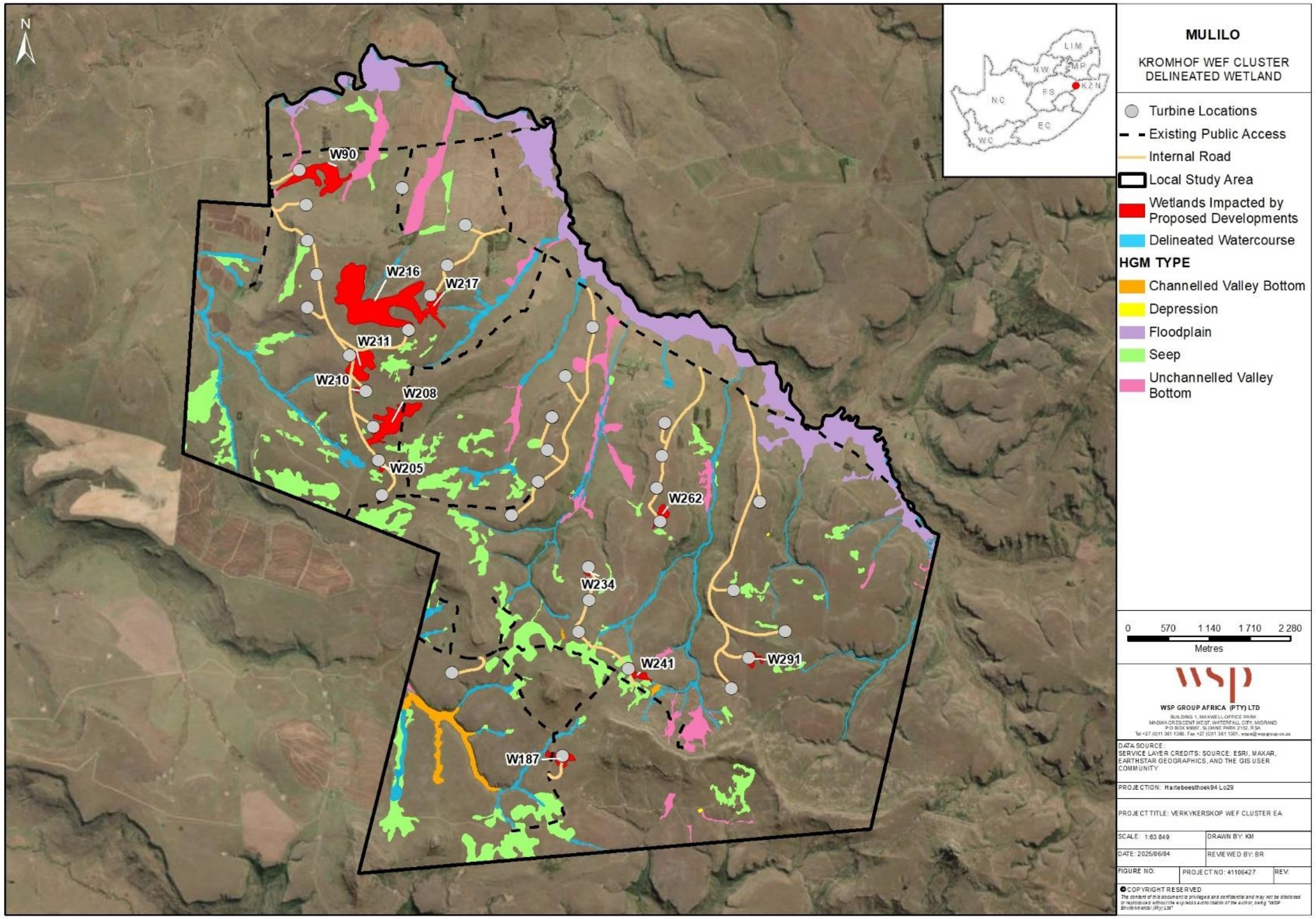


Figure 8-3 - Identified wetlands that will be impacted by the proposed Kromhof WEF infrastructure development

8.2.1.1.2 Wetland habitat degradation through alteration of the hydrological regime

The increase of hardened surfaces due to development of the wind turbine foundations and temporary laydown infrastructure will result in compacted soils and could result in increased surface runoff volumes and velocities entering downstream wetlands, which can lead to an increase in erosion/scours.

With the implementation of recommended mitigation measures, such as diffuse distribution of clean surface runoff around the WEF foundations to affected downslope wetland systems, the impact significance can be reduced.

8.2.1.1.3 Wetland habitat degradation through alteration of geomorphological processes

Sediment transport into wetland habitat and erosion of wetland soils can have significant effects on wetland integrity, having knock-on effects to flow patterns, vegetation composition and structure, and water quality.

Wetland erosion can occur along concentrated flow paths or areas that are void of vegetation. As a consequence of hardened surfaces i.e. WTGs foundation structures in close proximity to wetlands, it can be expected that flow velocities will increase, resulting in a higher erosive potential.

However, with mitigation measures such as limiting vegetation removal to the project footprint and revegetating exposed soils immediately post construction, the erosion potential can be reduced.

8.2.1.1.4 Wetland habitat degradation through water quality degradation

The risk of water quality degradation is covered extensively within the Aquatic Impact Assessment (Section 8.3). However, some potential impacts and sources of water quality contaminants have been highlighted below:

- Utilisation of machinery and vehicles: accidental spillage of hydrocarbons may seep into the soil profile and enter into watercourses, altering the water quality of watercourses.
- Concrete mixing & batching: compaction of soils and contamination of soil profile.
- Potential application of herbicide to clear land: excess nutrients may enter surface runoff and enter downstream watercourses, promoting algal growth and impacting on macro-invertebrate species.
- Sedimentation during earthworks can result in excessive turbidity to downstream watercourses

8.2.1.1.5 Wetland habitat degradation through vegetation disturbances

A key driver of invasion by alien plants is high disturbance. Therefore, grubbing of soil and earthwork activities during the construction phase will provide for the ideal environment for alien invasive plants (AIPs) to proliferate. Exotic species are often more prevalent near infrastructural disturbances than further away. Typical consequences of this include the loss of indigenous vegetation, change in vegetation structure and habitat, increased water consumption and impaired wetland functioning.

However, with the development of an auditable AIP Management Plan for the project, and the strict implementation of the recommended active control and monitoring measures throughout the construction phase, the impact significance can be reduced.

8.2.1.2 Proposed Construction Phase Mitigation Measures

General mitigation

- An ECO should be appointed at the outset of the construction to monitor construction activities and adherence to environmental controls and management measures proposed. Frequent inspection of the site must be done to ensure that the integrity of sensitive areas is maintained at all times
- Schedule development activity in the dry season to prevent increased surface runoff, erosion and sedimentation risk, as well as to avoid disturbance to biodiversity during critical periods i.e. periods of courtship, breeding, nesting etc.
- As part of the induction process, all construction activity staff should be educated about the importance and sensitivity of environmental areas (such as NFEPA wetlands) near or within the development activity site.

Access Control

- The wetland zones should be cordoned off and clearly demarcated to prevent unauthorised access to sensitive areas during the construction phase (note this mitigation measure is only applicable where wetland and watercourses are in close proximity of construction activity).

Vegetation

- All invasive alien plant species should be removed and disposed of appropriately prior to construction activities. The construction activity site should be inspected regularly (as recommended in the auditable AIP management plan for the project) during the construction and operational phase to identify and remove emerging invasive alien plants (AIPs) species.
- The removal of alien vegetation should be undertaken manually by hand near sensitive areas. The use of heavy machinery should be kept to minimum near sensitive environments.
- Fauna found within the development activity zone should be moved to the closest natural or semi-natural habitat zone away from the construction activity site.

Erosion and sedimentation control

- Soil excavated during the construction activities should be kept in stockpiles outside of wetlands and watercourses and the determined buffers. The soil stockpiles should be draped with hessian to avoid downstream sedimentation of watercourses.
- If erosion of stockpiled sediments is a risk, sediment barriers draped in hessian should be utilised to avoid erosion of sediments into wetlands and watercourses.
- It is recommended that site engineers should inspect the erosion control measures to confirm their appropriateness and integrity.

Pollution control

- No dumping of any materials or storage of any equipment should be allowed within the sensitive areas, particularly the wetlands and riparian area.
- During the construction phase of the development activity, all waste should be removed to an appropriate waste facility and under no circumstance should waste materials or contaminants be discharged into the environment or buried.
- Washing and cleaning of equipment should also be done within berms or bunds, in order to trap any cement/sediment and prevent excessive soil erosion. These sites must be re-vegetated after development activity has been completed.

Surface water quality

- All construction activity materials including fuels and oil should be stored in demarcated areas that are contained within berms/bunds to avoid the spread of any contamination into sensitive areas.
- Proactive measures should be enforced to ensure that work vehicles are up to standard regarding maintenance and function. These measures should include routine leak checks prior to construction activity and decommissioning of vehicles and machinery not up to par.
- Dripping during the aforementioned leak checks and maintenance must be accommodated for by the provision of drip trays.
- Handling of hazardous substances should be kept to a minimum within the development activity site. Additionally, thorough training should be administered to site personnel regarding handling of the aforementioned substances.
- Regarding sanitation – portable chemical toilets should be made available to site personnel and should be located +- 30m away from sensitive environments. Waste from the toilets should be collected and disposed of appropriately by a waste contractor.
- An emergency “clean up kit” containing spillage clean up materials should be readily available on site to be used in event of a spill.
- Fuels, chemicals and other hazardous substances should be stored in the appropriate, marked containers with closed lids.
- All spillages or contaminations are to be immediately reported to the Site Manager and Environmental Control Officer so that appropriate clean up measures may be enacted.
- Temporary noise should be kept to a minimum with equipment, machinery and vehicles, especially in sensitive areas.
- The site must be inspected by the relevant ECO during the construction activity phase to ensure that the integrity sensitive areas is maintained at all times.
- Additionally, readiness and professional execution of the clean-up contingency plan as well as the mitigation and rehabilitation are essential to ensure that the integrity of the sensitive areas is not compromised.

8.2.1.3 Impact Assessment Results

The impact assessment results are detailed in Table 8-3.The wetland loss aspect associated with the turbine footprint can be entirely avoided if the turbines are shifted fully outside of the wetland habitats. However, the feasibility to adjusting the layout is currently unknown and therefore the option to avoid this impact has not been considered. If the turbines remain within wetland habitat, but are removed, and the footprints suitably rehabilitated at closure, the duration of the impact will be reduced and the reversibility increased. This rehabilitation measure has been considered in the "with mitigation" scenario, and results in a lowering of the impact duration and overall impact score. However, remaining wetland aspect impacts can be significantly reduced to low or very low impact ratings with the appropriate mitigation measures. It should be noted that the road network connecting the wind turbines was not made available at the time of the field surveys or at the time of compiling this report and is therefore excluded from this specialist impact assessment.

Table 8-3 – Wetland impact assessment ratings for the construction phase

Aspect	Description	Pre-Mitigation							Post-Mitigation						
		(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Wetland Loss	Partial loss of wetland habitat as a consequence of the proposed infrastructure development	3	1	5	5	5	**70**	**N4**	3	1	3	4	5	**55**	**N3**
Significance		**N4 - High**							**N3 - Moderate**						
Hydrology	Increase in surface run-off and flow velocity.	3	2	3	4	4	**48**	**N3**	2	1	3	2	2	**16**	**N2**
Significance		**N3 - Moderate**							**N2 - Low**						
Geomorphology	Sediment transport into wetland habitat and erosion of wetland soils	2	2	3	3	5	**50**	**N3**	2	1	3	2	2	**16**	**N2**
Significance		**N3 - Moderate**							**N2 - Low**						
Water Quality	Accidental point source pollution and excessive downstream sedimentation increasing turbidity of watercourses	3	2	3	3	3	**33**	**N3**	3	1	3	2	1	**9**	**N1**
Significance		**N3 – Moderate**							**N1 – Very Low**						
Vegetation	Invasion of Alien Invasive Plants (AIPs)	3	2	3	3	4	**44**	**N3**	2	1	1	2	2	**12**	**N1**
Significance		**N3 – Moderate**							**N1 – Very Low**						

8.2.2 OPERATIONAL PHASE IMPACTS

8.2.2.1 Impact Description

8.2.2.1.1 Wetland habitat degradation through alteration of the hydrological regime

The increased hardened surfaces as a result of the WTGs foundation base will allow for an increase in surface run-off into downstream watercourses and wetlands. This will eventually result in preferential flow paths which can turn into erosion gullies over time (if not appropriately mitigated).

Therefore, as a preventative measure, it is recommended that diffusion structures should be installed at the base of the Turbine foundation to ensure that flows rates are reduced which will assist erosion control and will prevent channel formation in the downstream wetland systems.

8.2.2.1.2 Wetland habitat degradation through vegetation disturbances

The potential establishment of alien invasive species in, and immediately adjacent to wetlands in the vicinity of the proposed development footprint will continue to be an impact of concern during the operational phase.

Although with the development of an auditable AIP Management Plan for the project, and the strict implementation of the recommended active control and monitoring measures throughout the operational phase, the impact significance can be reduced.

8.2.2.2 Proposed Operational Phase Mitigation Measures

Vegetation

- Identified areas of disturbance that have been stripped/void of vegetation as a consequence of earthwork activities during the construction phase should be appropriately landscaped and revegetated to avoid excessive sedimentation and reduce erosion.
- An auditable Alien Invasive Management plan for the project must be compiled, and the strict implementation of the recommended active control and monitoring measures must be undertaken.
- All invasive alien plant species should be removed and disposed of appropriately. The development activity site should be inspected regularly during the construction and operational phase to identify and remove emerging invasive alien plants (AIPs) species.
- The removal of alien vegetation should be undertaken manually by hand near sensitive areas. The use of heavy machinery should be kept to minimum near sensitive environments.

Erosion and sedimentation control

- A post construction site survey should be conducted by a wetland ecologist to determine the effectiveness of the proposed erosion control measures within wetland habitats. The post construction survey should occur as soon as the rehabilitation structures have been implemented (ideally during winter, when vegetation has withered away, and the surface can be accessed in its entirety).
- Site engineers should also conduct a post construction inspection of the erosion control measures to confirm their appropriateness and integrity.

Pollution control

- No dumping of any materials or storage of any equipment should be allowed within the sensitive areas, particularly the wetlands and riparian area.
- During all phases of the development activity, all waste should be removed to an appropriate waste facility and under no circumstance should waste materials or contaminants be discharged into the environment or buried.

Surface water quality

- The site must be inspected as per the aquatic biomonitoring programme (refer to section 8.5) to ensure that the integrity of sensitive areas is maintained at all times.

8.2.2.3 Impact Assessment Results

The impact assessment results are detailed in Table 8-4 and highlight that without appropriate mitigation measures, the identified aspects will result in an overall moderate impact to wetland habitat during the operational phase. However, if the mitigation measures are implemented, the impacts can be significantly reduced to low or very low impact ratings. It should be noted that the road network connecting the wind turbines was not made available at the time of the field surveys or at the time of compiling this report and is therefore excluded from this specialist impact assessment.

Table 8-4 – Wetland impact assessment ratings for the operational phase

Aspect	Description	Pre-Mitigation							Post-Mitigation						
		(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Hydrology	Increase in surface run-off and flow velocity.	3	2	3	4	4	**48**	**N3**	2	1	3	2	2	**16**	**N2**
Significance		**N3 - Moderate**							**N2 - Low**						
Vegetation	Invasion of Alien Invasive Plants (AIPs)	3	2	3	3	4	**44**	**N3**	2	1	1	2	2	**12**	**N1**
Significance		**N3 – Moderate**							**N1 – Very Low**						

8.2.3 DECOMMISSIONING PHASE IMPACTS

The decommissioning phase impacts are anticipated to mirror the construction phase impacts, with the exception of wetland loss anticipated during construction, which will not reoccur during decommissioning phase. Therefore, the significance of impacts will be similar, and avoidance and mitigation measures proposed to address and limit construction phase impacts can be applied to the decommissioning phase as well. A specific recommendation for the decommissioning phase, however, is that prior to removal of all infrastructure, a wetland rehabilitation plan should be compiled by a wetland ecologist, as part of the larger project closure and rehabilitation plan. The purpose of the wetland rehabilitation plan should be to rehabilitate wetland areas affected by the project footprints, and their removal, and return them to a sustainable, functional state.

8.3 ASSESSMENT OF POTENTIAL IMPACTS TO AQUATIC ECOSYSTEMS

8.3.1 CONSTRUCTION PHASE IMPACTS

The main foreseeable aquatic-related impacts associated with the construction phase are vegetation clearing, soil disturbance and the establishment of infrastructure. Vegetation clearing and soil disturbances result in bare land which increase surface runoff, erosion and subsequently the amount of suspended and dissolved solids and potentially pollutants from the construction site and or areas down gradient of the construction site (hazardous substances from unearthed soil, cement, and concrete composites) entering the associated watercourses. Similarly, the main impact associated with the establishment of infrastructure, is the mobilization of pollutants that reach associated watercourses.

8.3.1.1 Impact Description

Erosion and runoff into the associated aquatic ecosystems can result in increased sedimentation and degradation of habitat. This can directly alter aquatic habitats after deposition (Wood & Armitage, 1997), which in turn will negatively impact biotic community structures by displacing biota that favour the affected habitat. Suspended solids can also directly impact aquatic biota through the accumulation of silt on respiratory organs (i.e. gills) and by decreasing visibility (i.e. increasing turbidity), which will affect feeding habits of specific taxa. Erosion and runoff from cleared land can also alter water quality by increasing turbidity, as aforementioned, and by increasing the number of contaminants entering the watercourses. This is expected to alter the physio-chemistry of water and deter water quality sensitive biota.

Vegetation clearing near watercourses can result in the introduction of alien invasive species (both fauna and flora) which often negatively impact indigenous species. This can lead to the loss of invertebrates such as dragonflies, which in turn, has the potential to alter biological community structure. Most alien invasive trees are taller and characterised by a greater root depth and are responsible for the increased uptake of water thereby decreasing both surface water runoff and groundwater recharge. This can significantly affect hydrological conditions and river flows.

8.3.1.2 Mitigation Measures

The following impact mitigation and management measures are recommended to avoid/minimise potential impacts on the watercourse arising from the construction activities:

- Limit vegetation removal to the infrastructure footprint area only. Where removed or damaged, vegetation areas (riparian or aquatic related) should be revegetated as soon as possible;
- Bare land surfaces downstream of construction activities must be vegetated to limit erosion from the expected increase in surface runoff from infrastructure;
- Environmentally friendly barrier systems, such as silt nets or, in severe cases, use trenches downstream from construction sites to limit erosion and possibly trap contaminated runoff from construction;
- Storm water must be diverted from the construction site and managed in such a manner to disperse runoff and prevent the concentration of storm water flow;
- Water used at construction sites should be utilised in such a manner that it is kept on site and not allowed to run freely into nearby watercourses;
- Construction chemicals, such as cement and hydrocarbons should be used in an environmentally safe manner with correct storage as per each chemical’s specific storage descriptions;
- All vehicles must be frequently inspected for leaks;
- No material may be dumped or stockpiled within any rivers or drainage lines in the vicinity of the proposed Project, and must be removed immediately without destroying habitat;
- All waste must be removed and transported to appropriate waste facilities; and
- High rainfall periods (usually November to March) should be avoided during the construction phase to possibly avoid increased surface runoff in attempt to limit erosion and the entering of external material (i.e. contaminants and/or dissolved solids) into associated aquatic systems.

8.3.1.3 Impact Assessment

Impact assessment ratings for activities associated with the construction phase the Project are presented in Table 8-5. The proposed placement of the wind turbine structures (WTGs) are scattered around the Project boundary, with most being close to non-perennial streams. Potential impacts upon the watercourse were determined to range between low pre-mitigation and very low post-mitigation.

These impacts are expected to be reduced by avoiding construction in the rainy season, and effective implementation of the other recommended sediment and pollutant control mitigation measures.

Table 8-5 – Impact assessment ratings for the construction phase

Aspect	Description	Pre-Mitigation							Post-Mitigation						
		(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Water Quality	Modifications due to sedimentation, run-off of construction materials (cement etc.)	3	2	3	2	3	**30**	**N2**	3	1	3	2	1	**9**	**N1**
Significance		**N2 - Low**							**N1 - Very Low**						
Loss of Habitat	Direct disruption of riparian habitat	5	3	5	5	3	**54**	**N3**	5	3	5	5	1	**18**	**N2**
Significance		**N3 - Moderate**							**N2 - Low**						
Introduction of alien species	Altered ecosystem functioning due to competition with indigenous biota	3	3	3	5	3	**42**	**N3**	3	1	3	2	3	**27**	**N2**
Significance		**N3 - Moderate**							**N2 - Low**						

8.3.2 OPERATIONAL PHASE IMPACTS

Operational phase impacts relate to the ongoing risk of erosion, water quality, habitat modifications and the spread of alien invasive species.

8.3.2.1 Impact Description

Bare lands and paved surfaces have the potential to increase flow rates, sediment input, erosion, and contaminants in the associated watercourses if allowed to flow freely from the Project area. These influences will directly impact on water quality and aquatic habitat which in turn will negatively affect the aquatic biota.

Increased anthropogenic activities near watercourses increase the risk of introducing alien invasive species. Introduced fish species threaten local fish populations, through habitat destruction and predation for example. The continued spread of alien trees invading riparian zones will decrease river flows through uptake of water, thereby altering the hydrological regime of the watercourses.

8.3.2.2 Mitigation Measures

The following mitigation measures are recommended to guide the effective management of stormwater and alien invasive species:

- Runoff from the Project area should not be allowed to flow into the nearby watercourses, unless authorised by the DWS (or the competent authority);

- Bare surfaces downstream from the developments, where silt traps are not an option, should be well vegetated in order to attempt to limit erosion and runoff that might be carrying contaminants;
- Careful monitoring of the areas where dust suppression is proposed should be undertaken regularly; and
- Biannual aquatic biomonitoring assessments of the associated water courses should be conducted by an aquatic specialist to determine impacts, whereafter new mitigation actions should be implemented as per the specialist's recommendations. The annual programme comprises of biannual surveys during the construction phase and annual surveys during the operational phase. Monitoring should continue for at least two years or until there is no noticeable deviation in ecological condition from the baseline findings.

8.3.2.3 Impact Assessment

Impact assessment ratings for activities associated with the operational phase are presented in Table 8-6. The management and maintenance of infrastructure (clearing of vegetation around the WTGs for example) will result in bare surfaces and thus increased surface runoff and erosion. Potential impacts upon associated watercourses were determined to range from low pre-mitigation and very low post-mitigation.

Table 8-6 – Impact assessment ratings for the operational phase

Aspect	Description	Pre-Mitigation							Post-Mitigation						
		(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Water Quality	Leakages (e.g. oil and gasoline) from vehicles during maintenance	5	3	3	4	3	**45**	**N3**	5	3	3	4	1	**15**	**N1**
Significance		**N3 - Moderate**							**N1 - Very Low**						
Flow Regime	Increased surface flows due to impermeable surfaces	2	3	3	4	2	**24**	**N2**	2	3	3	4	1	**12**	**N1**
Significance		**N2 - Low**							**N1 - Very Low**						
Establishment of alien species	Altered ecosystem functioning due to competition with indigenous biota	3	3	3	5	3	**42**	**N3**	3	1	3	2	3	**27**	**N2**
Significance		**N3 - Moderate**							**N2 - Low**						

8.4 CUMULATIVE IMPACTS

The proposed Project area is located within a predominantly low density cultivated fields. Impacts associated with the land use activities include informal roads, farm dams, the use of fertilizers and pesticides, abstraction for irrigation, and livestock farming. Thus, some level of impact has occurred through habitat transformation within certain sections of the PAOI.

Should the proposed Project be authorised, associated activities are expected to contribute to water quality modifications through increases in sediment load and the spread of alien vegetation near watercourses. However, these impacts can be prevented through implementation of the management/mitigation measures recommended in this report. Furthermore, authorisation of the current project will require the monitoring of associated watercourses for compliance. This will be beneficial as it will aid in determining trends in ecological integrity of the aquatic ecosystems.

8.5 PROPOSED MONITORING

An aquatic biomonitoring programme has been developed for the monitoring of the aquatic ecosystems assessed for the Project. The programme is aimed at better determining the ecological health of the ecosystems over time, providing long term trends in ecosystem integrity as well as aiding in early detection of potential impacts that might severely affect the habitats and expected aquatic biota in the associated riverine systems.

Table 8-7 outlines the aquatic monitoring methods to be undertaken at the monitoring points set out above (see section 4.2.3.2) by a suitably qualified aquatic ecologist. The annual aquatic programme comprises of biannual surveys (in summer and winter) during the construction phase and annual surveys during the operations phase (in summer). Aquatic monitoring should continue for at least two years or until there is no noticeable deviation in ecological condition from the baseline findings. The wetland monitoring programme, as detailed in Table 8-7, should be undertaken for selected wetlands immediately prior to construction to set a detailed baseline for monitoring wetland condition. The PES assessment should be repeated within one year of construction completion, and again at a 3-year interval. This will determine the PES for the assessed aquatic ecosystems which will further determine whether the proposed Project is impacting the associated aquatic ecology and to what extent.

Table 8-7 – Proposed aquatic biomonitoring methods

Method and Aquatic Component of Focus	Details	Resource Quality Objective
Wetlands		

PES Assessment
WET-Health 1B or 2 to be undertaken in all directly affected wetland units to monitor change in wetland integrity, including wetland units:
• **W90**
  ○ 27°56'16.38"S; 29°30'5.53"E
• **W187**
  ○ 28° 0'44.21"S; 29°32'6.03"E
• **W205**
  ○ 27°58'30.27"S; 29°30'33.20"E
• **W208**
  ○ 27°58'11.00"S; 29°30'38.13"E
	Detailed WET-Health 1B or 2 assessments should be undertaken for selected wetlands immediately prior to construction to set a detailed baseline for monitoring wetland condition. The PES assessment should be repeated within one year of construction completion, and again at a 3-year interval. If stability of wetland PES is determined, monitoring can be halted.	Results must be compared to baseline results (pre-construction) to determine the degree of deterioration, if any.

Method and Aquatic Component of Focus	Details	Resource Quality Objective
• **W210** ○ 27°57'55.44"S; 29°30'21.10"E • **W211** ○ 27°57'43.95"S; 29°30'21.06"E • **W216** ○ 27°57'18.89"S; 29°30'24.25"E • **W217** ○ 27°57'16.24"S; 29°30'59.13"E • **W234** ○ 27°59'18.56"S; 29°32'19.81"E • **W241** ○ 28° 0'4.55"S; 29°32'41.39"E • **W262** ○ 27°58'51.22"S; 29°32'57.49"E • **W291** ○ 27°59'56.59"S; 29°33'44.18"E		
Fixed Point Photographic Monitoring A fixed-point photographic record should be established prior to construction for each of the wetlands identified for monitoring. Fixed point photography allows for changes to be seen over time within the wetland habitat. It also allows for rapid visual assessment of the system.	Fixed Point Photography (FPP) should align with the timing of the wetland PES assessments and should be established at the same time as the baseline wetland monitoring prior to construction. The photos should capture areas where change is anticipated as a consequence of the Project. The position (GPS coordinates) and orientation of the photos should be recorded, and the assessment ideally undertaken at a similar time of year during each monitoring episode.	Results must be compared to baseline results to determine the extent of change.

Method and Aquatic Component of Focus	Details	Resource Quality Objective
Rivers		
Water Quality: *In situ* water tests focusing on: ▪ Temperature; ▪ pH; ▪ Conductivity; ▪ Dissolved oxygen.	*In situ* water quality should be tested by means of portable meters at each monitoring site.	Results must be compared to baseline results (current report) to determine the extent of change.
Habitat Quality: Instream and riparian habitat integrity by means of the Index for Habitat Integrity (IHI); and Integrity of macroinvertebrate habitat by means of the Integrated Habitat Assessment System (IHAS).	The IHAS must be applied within sites presenting suitable aquatic macroinvertebrate habitat and the IHI must be applied at the same sites as in this report.	Results must be compared to baseline results (current report) and RQO: Instream Habitat Integrity category ≥ C (≥ 62).
Aquatic Macroinvertebrates: Aquatic Macroinvertebrate assemblages must be assessed by means of the SASS5 protocol (or latest version). The Macroinvertebrate Response Assessment Index (MIRAI) must be applied to determine the PES.	The SASS5 protocol and MIRAI index must be applied within sites presenting suitable aquatic macroinvertebrate habitat.	Results must be compared to baseline results (current report) and RQO: Macro-invertebrate ecological category:≥ C (≥ 62).
Fish: Fish assessments must be carried to species level where possible	Sampling of fish must be undertaken by means of the standard electro-narcosis technique at sites presenting suitable fish habitat.	Results must be compared to the baseline results and RQO: Fish ecological category: ≥ C (≥ 62)

9 CONCLUSION AND SPECIALIST RECOMMENDATIONS

The aquatic specialist study assessed the baseline conditions of the aquatic biodiversity associated with the proposed Wind Energy Facility, as well as the significance of potential impacts likely to arise during the construction and operational phases.

Extensive wetland habitat classified as Floodplain, Channelled and Unchanneled Valley Bottom, or Hillslope Seepage wetlands were identified, delineated and classified within the proposed Kromhof footprint. The Present Ecological State (PES) ranged from pristine systems situated in natural landscapes (Category A) to largely modified (Category D) wetlands with current impacts such as instream dams, agricultural plantations and road crossings. The Ecological Importance and Sensitivity of the wetlands ranged from Moderate to High across the study area.

In terms of the river systems, the drivers of biotic integrity were assessed, including *in situ* water quality and habitat integrity, as well as the response indicators aquatic macroinvertebrates and fish. The results obtained indicate that the Present Ecological State of the associated riverine systems ranged between moderately modified and largely modified. No aquatic species of conservation concern are expected to occur within the PAOI, nor were any recorded within the assessed streams during the field assessment.

To assess potential impacts to the river and wetland features, the project layout was overlayed against the delineated rivers and wetlands. The impact assessment focused on the proposed wind turbines. The road network and grid connections were excluded from this assessment. It was found that all infrastructures remain outside of the delineated rivers (watercourses). The majority of the proposed infrastructure lies outside of the delineated wetland habitats, with the exception of twelve (12) WTGs which extend into wetland boundaries.

Wetland loss associated with the turbine footprints can be avoided if the turbines are shifted to remain fully outside of all wetland habitats. If this can be achieved, this impact will fall away. However, the feasibility to adjusting the layout is currently unknown and therefore the option to avoid this impact has not been considered. If the turbines remain within wetland habitat, but are removed, and the footprints suitably rehabilitated at closure, the duration of the impact will be reduced and the reversibility increased. This rehabilitation measure has been considered in the “with mitigation” scenario, and results in a moderate impact.

The assessment of potential impacts to rivers determined that with appropriate mitigation measures applied, potential impacts can be reduced to low or very low significance. In addition to mitigation measures proposed in this report to address potential impacts, the following actions have been recommended based on the findings of the current study:

- The aquatic biomonitoring programme as detailed in Section 8.5 should be implemented to monitor any changes that occur within the receiving aquatic ecosystems in response to the proposed project activities, thereby allowing for adaptive management of any impacts that monitoring highlights
- The rivers and proposed 25m buffer should be considered as sensitive areas and all proposed infrastructures (WTGs) and the activities planned to remain outside of these areas, though this may not be applicable to linear infrastructure crossings that may be required.

- It is recommended from a best practice perspective that if there is opportunity to shift the turbines that currently fall within wetland habitat to areas outside of the wetland areas, this should be applied in any further design revisions.
- The wetlands and the proposed 30m buffer should be considered as sensitive areas and all proposed infrastructure and the activities planned so as to remain outside of these areas, with the exception of infrastructure that cannot feasibly be shifted.
- The proposed Project should adopt a water and habitat quality preservation mindset throughout the life of the Project to prevent the deterioration of the aquatic ecosystems

9.1 SPECIALIST OPINION

Based on the findings of this aquatic biodiversity specialist assessment study, potential negative impacts upon the receiving aquatic ecosystems are likely to occur. Impacts are predicted to range between very low to high, but all can be reduced with implementation of the proposed mitigation measures.

Based on the findings of the baseline studies and the outcomes of the impact assessment, and assuming that all mitigation measures are effectively implemented, the impact of the proposed Project components assessed to the aquatic environment is anticipated to be low to moderate. This can be further lowered if it is possible to relocate certain turbines outside of wetland habitat. Therefore, from an aquatic biodiversity perspective the project is not fatally flawed and can be considered for environmental authorisation. All mitigation, management and monitoring measures proposed in this report must be implemented as applicable through the project life cycle.

Should additional information come to light, or should the measures and actions recommended not be fully implementable, the specialist(s) reserve the right to revise the provided specialist opinion.

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Appendix A

METHODOLOGY

<table>
<tr><th>Methodology</th><th>Measurement description</th><th colspan="3">Guidelines/Description</th></tr>
<tr><td rowspan="6">*In Situ* Water Quality</td><td rowspan="6">Determined using portable field instruments:
- pH: Eutech pHTester2;
- Electrical Conductivity: Eutech ECTester11 Dual Range;
- Dissolved oxygen: Eutech CyberScan DO300; and
- Temperature: Eutech CyberScan DO300.</td><td>*In situ* water variable</td><td>Guideline</td><td>Guideline referenced</td></tr>
<tr><td>Temperature (ºC)</td><td>5 - 30</td><td rowspan="3">South African Water Quality Guidelines: *Aquatic Ecosystems (Volume 7)* (Department Of Water Affairs And Forestry, 1996)</td></tr>
<tr><td>pH</td><td>6 - 8</td></tr>
<tr><td>Dissolved Oxygen Saturation (%)</td><td>80 – 120</td></tr>
<tr><td>Dissolved Oxygen concentration (mg/ℓ)</td><td>>5</td><td>Minimum Dissolved Oxygen concentration for aquatic macroinvertebrates (Nebeker et al., 1996)</td></tr>
<tr><td>Electrical Conductivity (µS/m)</td><td>< 500</td><td>Conductivity guideline value of 500 µS/cm stipulated in U.S. U.S. Environmental Protection Agency (2010)</td></tr>
<tr><td>Habitat Assessment</td><td colspan="4">Habitat assessment can be defined as the evaluation of the structure, of the surrounding physical habitat, that influences the quality of the water resource, and the condition of the resident aquatic community (Barbour et al., 1999).
Habitat quality and availability plays a critical role in the occurrence of aquatic biota. For this reason, habitat evaluation is conducted simultaneously with biological evaluations in order to facilitate the interpretation of results.</td></tr>
</table>

<table>
<tr><th>Methodology</th><th>Measurement description</th><th>Guidelines/Description</th></tr>
<tr><td>Integrated Habitat Assessment System (IHAS)</td><td colspan="2">The quality of the instream and riparian habitat influences the structure and function of the aquatic community in a stream; therefore, assessment of the habitat is critical to any assessment of ecological integrity. The IHAS, Version 2 was developed specifically for use with the SASS5 index and rapid biological assessment protocols in South Africa (McMillan, 1998).
<table><tr><th>IHAS</th><th>Description</th></tr><tr><td>>65%</td><td>Good</td></tr><tr><td>55% – 65%</td><td>Adequate/Fair</td></tr><tr><td><55%</td><td>Poor</td></tr></table></td></tr>
<tr><td rowspan="2">Intermediate Habitat Integrity Assessment</td><td>Habitat integrity refers to the maintenance of a balanced, integrated composition of physico-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region (Kleynhans, 1996).</td><td><table><tr><th colspan="3">Descriptive classes for the assessment of modifications to habitat integrity (Kleynhans, 1996)</th></tr><tr><th>Score</th><th>Impact Category</th><th>Description</th></tr><tr><td>0</td><td>None</td><td>No discernible impact, or the factor is located in such a way that it has no impact on habitat quality diversity, size and variability.</td></tr><tr><td>1 – 5</td><td>Small</td><td>The modification is limited to a very few localities and the impact on habitat quality, diversity, size and variability is also very small.</td></tr><tr><td>6 – 10</td><td>Moderate</td><td>The modification is present at a small number of localities and the impact on habitat quality, diversity, size and variability is also limited.</td></tr><tr><td>11 – 15</td><td>Large</td><td>The modification is generally present with a clearly detrimental impact on quality habitat quality, diversity, size and variability. Large areas are, however, not influenced.</td></tr><tr><td>16 – 20</td><td>Serious</td><td>The modification is frequently present and the habitat quality, diversity, size and variability almost the whole of the defined section are affected. Only small areas are not influenced.</td></tr><tr><td>21 – 25</td><td>Critical</td><td>The modification is present overall with a high intensity; the habitat quality, diversity, size and variability in almost the whole of the defined section are detrimentally influenced.</td></tr></table></td></tr>
<tr><td colspan="2"><table><tr><th colspan="3">Intermediate habitat integrity assessment classes/categories (Kleynhans, 1996)</th></tr><tr><th>Score</th><th>Class (% of total)</th><th>Description</th></tr><tr><td>90 - 100</td><td>A</td><td>Unmodified, natural.</td></tr><tr><td>80 - 90</td><td>B</td><td>Largely natural with few modifications.</td></tr></table></td></tr>
</table>

Methodology	Measurement description		Guidelines/Description		
	60 - 79	C	Moderately modified.		
	40 - 59	D	Largely modified.		
	20 - 39	E	The loss of natural habitat, biota and basic ecosystem functions is extensive.		
	0 - 19	F	Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota.		
Aquatic Macroinvertebrates	Aquatic macroinvertebrates were sampled using the qualitative kick sampling method called South African Scoring System (SASS, *version 5*) (Dickens & Graham, 2002)and identified using the hand guide from Gerber & Gabriel (2002). The SASS5 data obtained was used in the Macroinvertebrate Response Assessment Index (MIRAI) (Thirion, 2008) to determine the Present Ecological State (PES, or Ecological Category) of the associated macroinvertebrate assemblages.		MIRAI Score	**Class**	**Description**
			90-100	A	Unmodified and natural. Community structures and functions comparable to the best situation to be expected. Optimum community structure for stream size and habitat quality.
			80-89	B	Largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged.
			60-79	C	Moderately modified. Community structure and function less than the reference condition. Community composition lower than expected due to loss of some sensitive forms. Basic ecosystem functions are still predominantly unchanged.
			40-59	D	Largely modified. Fewer species present then expected due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred.
			20-39	E	Seriously modified. Few species present due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred.
			0-19	F	Critically modified. Few species present. Only tolerant species present, if any.
Ichthyofauna	Fish samples were collected using an electro-fishing device (Smith-Root LR24). Based on a survey of available literature and previous		**FRAI Score (%)**		
			90 – 100	A	
			80 – 89	B	
			60 – 79	C	

Methodology	Measurement description	Guidelines/Description	
	assessments, an expected species list was compiled, utilising the following sources: Skelton (2001), (Kleynhans et al., 2007) and IUCN. The PES or Ecological Category of the fish assemblage of the watercourses associated with the Project Area was conducted by means of the Fish Response Assessment Index (FRAI) (Kleynhans, 2008)	40 – 59	D
		21 – 39	E
		0 – 20	F

Appendix B

AQUATIC MACROINVERTEBRATES

Taxon	SASS5 Score	CL1	CL2	CL3	CL4	CL8	CL9	CL14	CL15	CL1	CL2	CL3	CL4	CL8	CL9	CL14	CL15
		Low Flow Survey								High Flow Survey							
Oligochaeta	1			A								A			1		
Hirudinea	3			1													
Amphipoda	13																
Potamonautidae	3		A	1						1	B	A			A	A	A
Baetidae 1sp	4			B				A								A	
Baetidae 2spp	6	A			A		A			A			A				B
Baetidae >2spp	12		B								B	B			B		
Caenidae	6		A					A			A				A	A	1
Leptophlebiidae	9		A		A						B	B			1		A
Oligoneuridae	15										1	A					
Trichorythidae	9		1								B						
Chlorocyphidae (Jewels)	10						A										
Coenagrionidae	4	A	A	A				A		A	B	A					
Aeshnidae	8	1	1	1	A					A	A		A		A	A	
Gomphidae	6			1													
Libellulidae	4	A		1	A					A	1	1	A				
Belostomatidae	3							A							1	A	
Corixidae	3	A	B	B		No Flow	B	A	No Flow	A	1			No Flow		B	A
Gerridae	5						A								A		1
Notonectidae	3			A													A
Pleidae* (Pygmy backswimmers)	4							A								A	
Veliidae	5									A		1				A	1
Hydropsychidae 1sp	4				A						A	1	A		B		
Leptoceridae	6			A													
Dytiscidae	5														A		
Elmidae / Dryopidae* (Riffle beetles)	8														A		
Gyrinidae	5	A	A	A	A					A	A	A	A		1		A
Hydrophilidae	5	A	A	A													
Athericidae	10										1						
Ceratopogonidae	5			A			A	A								A	1
Chironomidae	2	A	A	A	A		A	A		A	B	A	A		A	A	
Culicidae	1																1
Simuliidae	5		A		A						A	1	A		A		A
Tipulidae	5										1						
Physidae	3														1		
Planorbinae* (Orb snails)	3														1		

Appendix C

SITE PHOTOS

<table>
<tr><th colspan="2">Site CL1</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Low Flow Survey</td><td>High Flow Survey</td></tr>
<tr><th colspan="2">Site CL2</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Low Flow Survey</td><td>High Flow Survey</td></tr>
<tr><th colspan="2">Site CL3</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Low Flow Survey</td><td>High Flow Survey</td></tr>
</table>

Site CL4	
No Photo	
Low Flow Survey	**High Flow Survey**
Site CL5	
	
Low Flow Survey	**High Flow Survey**
Site CL8	
	
Low Flow Survey	**High Flow Survey**
CL9	

	
Low Flow Survey	**High Flow Survey**
CL14	
	**No Photo**
Low Flow Survey	**High Flow Survey**
CL15	
No Photo	
Low Flow Survey	**High Flow Survey**

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