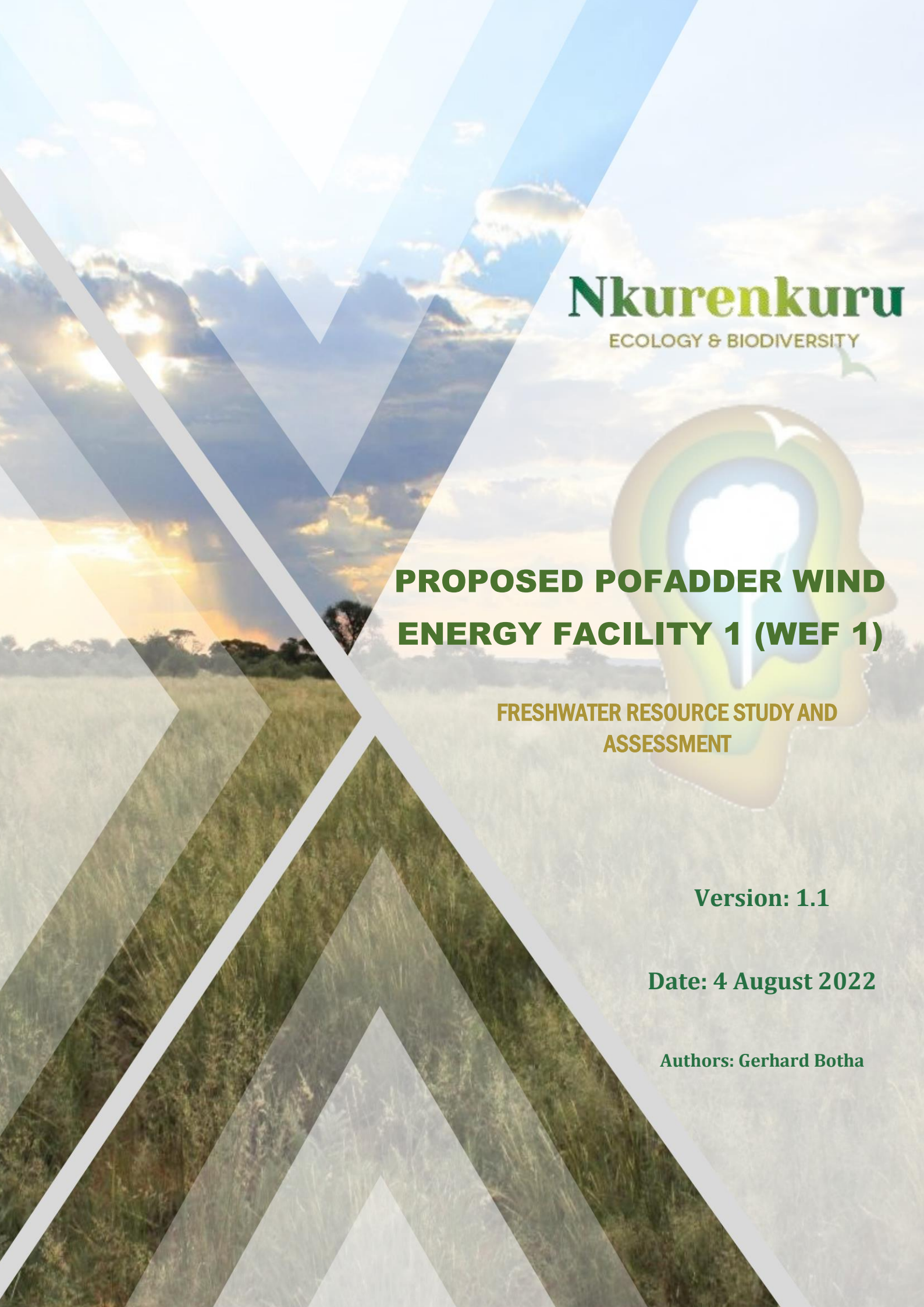

Nkurenkuru
ECOLOGY & BIODIVERSITY

# PROPOSED POFADDER WIND ENERGY FACILITY 1 (WEF 1)

## FRESHWATER RESOURCE STUDY AND ASSESSMENT

**Version: 1.1**

**Date: 4 August 2022**

**Authors: Gerhard Botha**

**Report Title:** Pofadder Wind Energy 1, Northern Cape Province: Freshwater Resource Study and Assessment

**Authors:** Mr. Gerhard Botha

**Project Name:** Pofadder Wind Energy Facility 1, Northern Cape Province

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# I. DECLARATION OF CONSULTANT INDEPENDENCE

The consultants hereby declare that they:

- act/ed as the independent specialists in this application;
- regard the information contained in this report as it relates to specialist input/study to be true and correct at the time of publication;
- do not, and will not, have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA Environmental Impact Assessment Regulations, 2014, and any specific environmental management Act;
- do not, and will not, have any vested interest(s) in the proceedings of the proposed activities;
- have disclosed, to the applicant, EAP, and competent authority(-ies), any information that have, or may have, the potential to influence the decision of the competent authority(-ies) or the objectivity of any report, plan, or document required in terms of the NEMA Environmental Impact Assessment Regulations 2014, and any specific environmental management Act;
- are fully aware of, and meet, the responsibilities in terms of the NEMA Environmental Impact Assessment Regulations 2014 (specifically in terms of regulation 13 of GN No. R. 326), and any specific environmental management Act, and that failure to comply with these requirements may result in disqualification;
- have provided the competent authority(-ies) with access to all necessary information at their disposal at the time of publication regarding the application, whether such information is favourable to the applicant or not; and
- are aware that a false declaration is an offense in terms of regulation 48 of GN No. R. 326.

**REPORT AUTHORS**:

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BSc (Hons) Zoology and Botany; MSc Botany (Phytosociology) from 2011 to present.

August 2022

# II. STATEMENT OF WORK

» This study has been executed in accordance with and meet the responsibilities in terms of:
  - NEMA, the Environmental Impact Assessment Regulations, 2014 (specifically in terms of regulation 13 of GN No. R. 326);
  - Procedures to be followed for the assessment and minimum criteria for reporting of identified environmental themes in terms of section 24(5)(a) and (h) of the National Environmental Management Act, 1998, when applying for Environmental Authorisation:
    - 3(c): Protocol for the assessment and reporting of environmental impacts on terrestrial animal species.
    - 3(d): Protocol for the assessment and reporting of environmental impacts on terrestrial plant species.

**REPORT AUTHORS**:

**Gerhard Botha** Pr.Sci.Nat 400502/14 (Botanical and Ecological Science)

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# 1. INTRODUCTION

## 1.1. Applicant

Pofadder Wind Facility 1 (Pty) Ltd.

## 1.2. Project

The project will be known as Pofadder WEF 1.

## 1.3. Proposed Activity

The applicant Pofadder Wind Facility 1 (Pty) Ltd is proposing the development of a commercial Wind Energy Facility (WEF) and associated infrastructure on a site located approximately 20km South East of Pofadder within the Kai !Garib Local Municipality and the Z F Mgcawu District Municipality in the Northern Cape Province.

A preferred project site with an extent of approx. 3600ha has been identified as a technically suitable area for the development of the Pofadder WEF 2, which will comprise of up to 30 turbines with a combined contracted capacity of up to 200MW. The project site is located on the following properties:

- The Farm Ganna-Poort 202;
- The Farm Lovedale 201; and
- Portion 3 of the Farm Sand Gat 150.

Two additional WEF's are concurrently being considered on the properties and are assessed by way of separate impact assessment processes contained in the 2014 Environmental Impact Assessment Regulations (GN No. R982, as amended) for listed activities contained Listing Notices 1, 2 and 3 (GN R983, R984 and R985, as amended). These projects are known as Pofadder Wind Energy Facility 2 and Pofadder Wind Energy Facility 3. The Pofadder WEF 1 project site is proposed to accommodate the following infrastructure, which will enable the wind farm to supply a contracted capacity of up to 224MW:

- Up to 28 wind turbines, each with a maximum of 8 MW output per turbine, with a maximum export capacity of approximately 224 MW. This will be subject to allowable limits in terms of the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). The final number of turbines and layout of the WEF will, however, be dependent on the outcome of the Specialist Studies conducted during the EIA process;
- Each wind turbine will have a maximum hub height and rotor diameter of up to 200 m;
- Concrete turbine foundations and turbine hardstands;

- Each turbine will have a circular foundation with a diameter of up to 32 m and this will be placed alongside the 45 m wide hardstand resulting in an area of about 45 m x 32 m that will be permanently disturbed for the turbine foundation. The combined permanent footprint for the turbines will be approximately 4.2 ha;
- Each turbine will have a crane hardstand of approximately 70 m x 45 m. The permanent footprint for turbine crane hardstands will be approximately 9 ha;
- Each turbine will have a blade hardstand of approximately 80 m x 45 m (3 600 $m^2$). The combined permanent footprint for blade hardstands will be approximately 10 ha;
- One new 33/132 kV on-site substation occupying an area of approximately 1.6 ha;
- The wind turbines will be connected to the proposed on-site substation via medium voltage (33 kV) underground cables, which will mainly run alongside the access roads. Where burying of cables is not possible due to technical, geological, environmental or topographical constraints, cables will be overhead via 33 kV monopoles;
- The main access road will be 8 – 12 m wide (to allow vehicles to pass);
- Internal roads with a width of 6 – 8 m will provide access to each wind turbine. Existing farm roads will be upgraded and used wherever possible, although new site roads will be constructed where necessary;
- A 12 m wide corridor may be temporarily impacted during construction and rehabilitated to 6 m wide corridor after construction. The internal gravel roads will have an approximate 6 – 8 m wide surface and there will be up to 12 m wide impacted during the construction phase, with additional space required for cut and fill, side drains and other stormwater control measures, turning areas and vertical and horizontal turning radii to ensure safe delivery of the turbine components;
- Pofadder WEF 1 will have a total road network of approximately 48 km;
- One construction laydown / staging area of up to approximately 7 ha (to be rehabilitated following construction). It should be noted that no on-site labour camps will be required in order to house workers overnight as all workers will be accommodated in the nearby towns, and transported daily to site (by bus);
- The gate house and security house will occupy an area of up to 0.5 ha.
- Battery Energy Storage System (BESS) of approximately 3.6 ha;
- One permanent Operation and Maintenance (O&M) building (including offices, warehouses, workshops, canteen, visitors centre and staff lockers) occupying an area of up to 1 ha;
- A temporary site camp establishment and concrete batching plant occupying an area of up to 1.6 ha; and
- Galvanized palisade fencing to be used at the substations with the maximum height of the fencing to be up to 3.5 m.
- Water will either be sourced from either the Local Municipality, supplied from a private contractor and trucked in, from existing boreholes located within the application site or from a new borehole if none of these options are available.

The EA applications for the three wind farm projects and gridline are being undertaken in parallel as they are co-dependent, i.e. one will not be developed without the other.

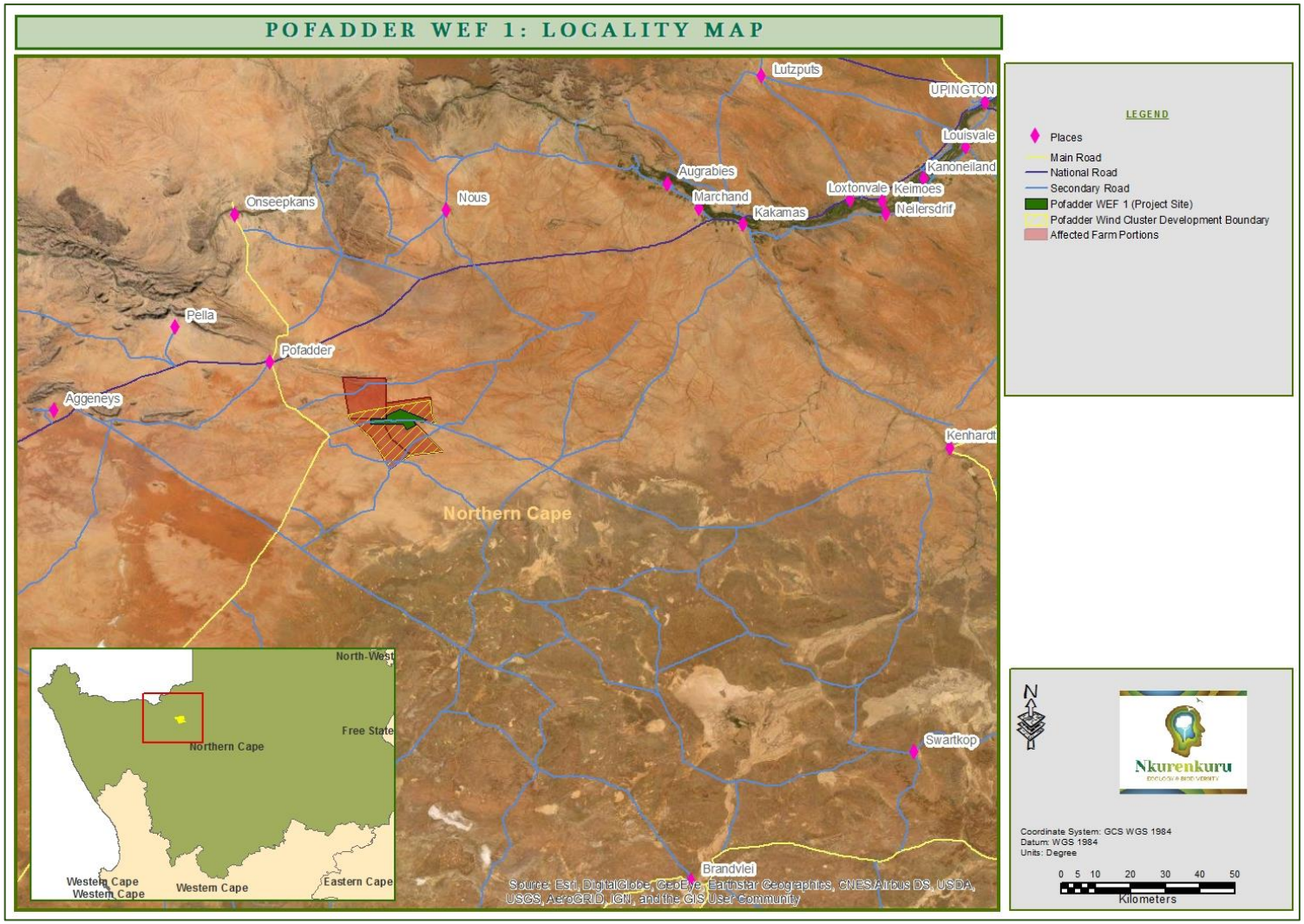


Figure 1: Locality of the project site earmarked for the development of the Pofadder WEF1 south-east of the town Pofadder in the Northern Cape Province. Inset map shows the main map extent (red square) within the Northern Cape.

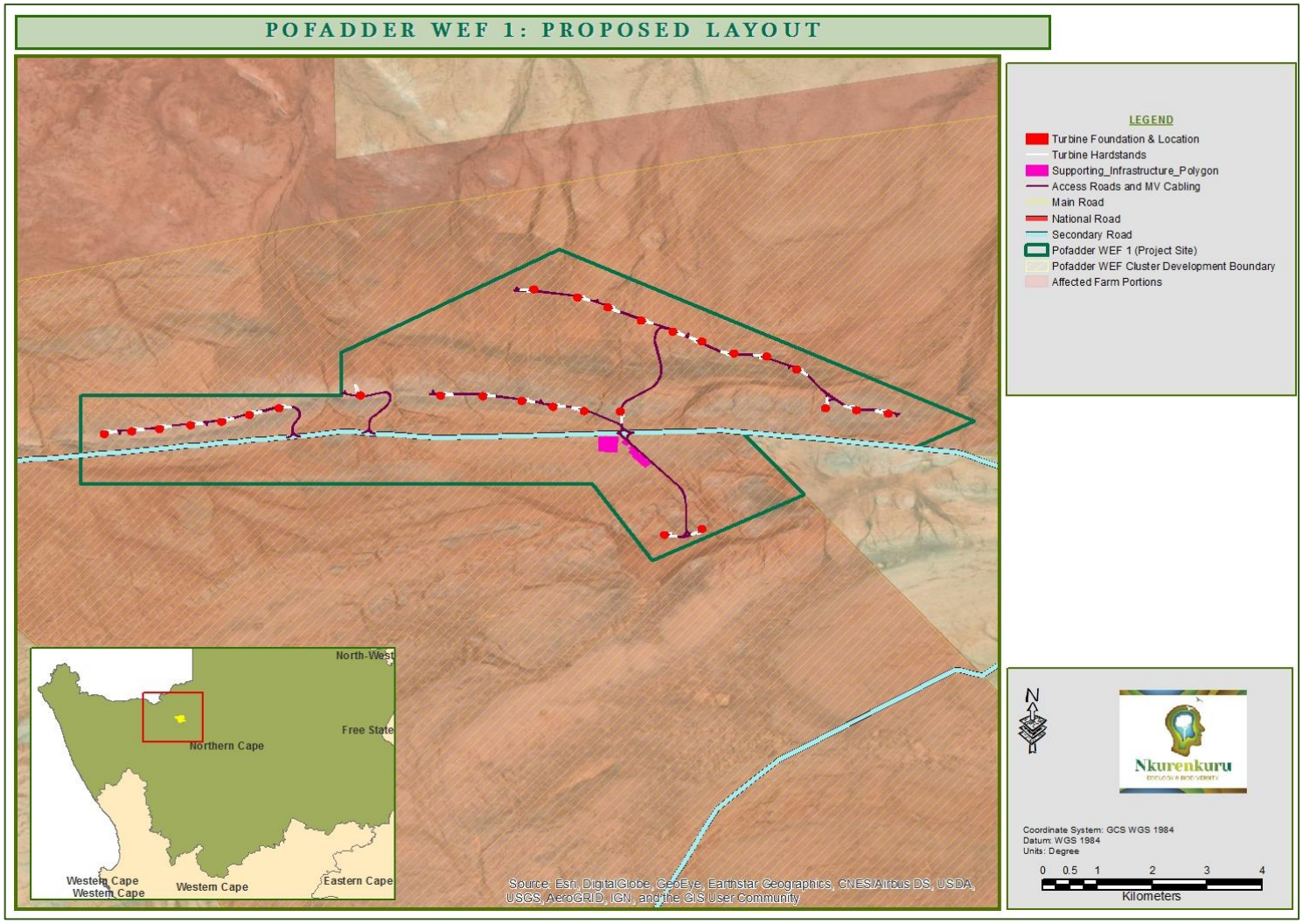


Figure 2: Proposed layout of the Pofadder WEF 1. There are two access roads: one to the west coming from the direction of Pofadder WEF 1, and one to the east coming from the direction of Kenhardt.

## 1.4. Terms of Reference (ToR)

The primary objective of the specialist freshwater resource assessment was to provide information to guide the proposed Wind Energy Facility development with respect to the potential impacts on the affected freshwater ecosystems within the project site. The focus of this study was solely on the specific Hydrogeomorphic Units (HGMs), within a radius of 500m of the proposed footprint and which will likely be impacted by the proposed development.

The focus of the work involved the undertaking of a specialist assessment of freshwater resource features, which included the following tasks:

- Desktop identification and delineation of potential freshwater resource areas affected by the proposed development, or occurring within a 500m radius of the proposed development using available imagery, contour information and spatial datasets in a Geographical Information System (GIS);
- Undertaking a rapid water resource screening and risk assessment to determine which desktop delineated/mapped watercourses/wetlands are likely to be measurably affected by the proposed activities. This was used to flag watercourses/wetlands for further infield assessments as well as identify those watercourses/wetlands to be unaffected and not require further assessment (i.e. wetlands/rivers within adjacent catchments, upstream or some distance downstream of the predicted impact zone);
- Site-based (detailed in-field) delineation of the outer wetland boundary of wetland/watercourse areas within the project focal area and which were flagged during the desktop screening/risk assessment;
- Classification of wetlands and riparian areas and assessment of conservation significance based on available data sets;
- Description of the biophysical characteristics of the delineated freshwater habitats based on onsite observations and sampling (i.e. hydrology, soils, vegetation, existing impacts etc.);
- Baseline functional assessment of wetland habitats based on field investigations, involving the:
    - PES (Present Ecological State/Condition) of the delineated wetland units;
    - EIS (Ecological Importance and Sensitivity) of the delineated wetland units;
    - Direct and indirect ecosystem services (functions) importance of the delineated wetland units only.
- Impact assessment and identification of mitigation measures to reduce the significance of potential aquatic impacts for both the construction and operational phases of the pipeline project. For this section the same methodology and layout approach within the existing report was followed in order to maintain uniformity and coherence between the two reports.
- Compilation of a specialist wetland assessment report detailing the methodology and findings of the assessment, together with relevant maps and GIS information.

## 1.5. Conditions of this Report

Findings, recommendations, and conclusions provided in this report are based on the authors' best scientific and professional knowledge and information available at the time of compilation. No form of this report may be amended or extended without the prior written consent of the author. Any recommendations, statements, or conclusions drawn from or based on this report must clearly cite or refer to this report. Whenever such recommendations, statements or conclusions form part of the main report relating to the current investigation, this report must be included in its entirety.

## 1.6. Relevant Legislation

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

### 1.6.1. South African Constitution 108 of 1996

Section 24 of Chapter 2 of the Bill of Rights No. 108 of 1996 states that everyone has the right to:

(a) to an environment that is not harmful to their health or well-being; and
(b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that—
    (i) prevent pollution and ecological degradation;
    (ii) promote conservation; and
    (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

### 1.6.2. National Environmental Management Act 107 of 1998

Wetlands and other watercourses defined in the NWA are also protected in the National Environmental Management Act (Act 107 of 1998), (NEMA). The act lists several activities that require authorisation before they can be implemented. NEMA lists various activities that require authorisation when located within 32 m or less from the edge of a wetland or other watercourse type.

### 1.6.3. National Water Act (Act No. 36 of 1998)

According to the National Water Act (Act No. 36 of 1998), a water resource is defined as: "a watercourse, surface water, estuary, or aquifer. A watercourse in turn refers to

(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. Reference to a watercourse includes, where relevant, its bed and banks."

A wetland is defined as: "land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances support or would support vegetation typically adapted to life in saturated soil."

Chapter 4 of the Act deals with the regulation of the use of water and the requirements for controlled activities, general authorisations, and licenses. In general, a water use must be licensed unless: it is listed in Schedule 1 of the Act as an existing lawful water use, or is permissible under a general authorisation, or if a responsible authority waives the need for a license.

According to the Department of Water and Sanitation (DWS), any activity that falls within the temporary zone of a wetland or the 1:100 year floodline (whichever is greater) qualifies as a Section 21 water use activity (depending on the use) and will thus require either a general authorization or Water Use License (WUL). According to the NWA, an application for a WUL should be submitted to the DWS if any of the above activities are to be undertaken.

Section 21 of the National Water Act (NWA Act No. 36 of 1998) covers the following activities, which might be applicable to the proposed project. According to Section 21 of the NWA and in relation to the river ecosystem, the following activity is considered a use, and therefore requires a water use license:

» 21 (c) impeding or diverting the flow of water in a watercourse;
» 21 (i) altering the bed, banks, course or characteristics of a watercourse;

In terms of Section 22 (1), a person may only undertake the abovementioned water uses if it is appropriately authorised:

22(1) A person may only use water

(a) without a licence
    (i) if that water use is permissible under Schedule 1;

(ii) if that water use is permissible as a continuation of an existing lawful use; or
(iii) if that water use is permissible in terms of a general authorisation issued under section 39;
(b) if the water use is authorised by a licence under this Act; or
(c) if the responsible authority has dispensed with a licence requirement under subsection (3).

#### 1.6.4. National Water Act (Act No. 36 of 1998)

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

# 2. METHODOLOGY

## 2.1. Assessment Approach and Philosophy

### 2.1.1. Aquatic Biodiversity

The delineation and classification of freshwater resources were conducted using the standards and guidelines produced by the DWS (DWAF, 2005 & 2007) and the South African National Biodiversity Institute (SANBI, 2009).

In addition to these guidelines, the general approach to freshwater habitat assessment was furthermore based on the proposed framework for wetland assessment as proposed within the Water Research Commission's (WRC) report titled: "Development of a decision-support framework for wetland assessment in South Africa and a Decision-Support Protocol for the rapid assessment of wetland ecological condition" (Ollis et. al., 2014). A schematic illustration of the proposed decision-support framework for wetland assessment in South Africa is provided in Figure 3 below.

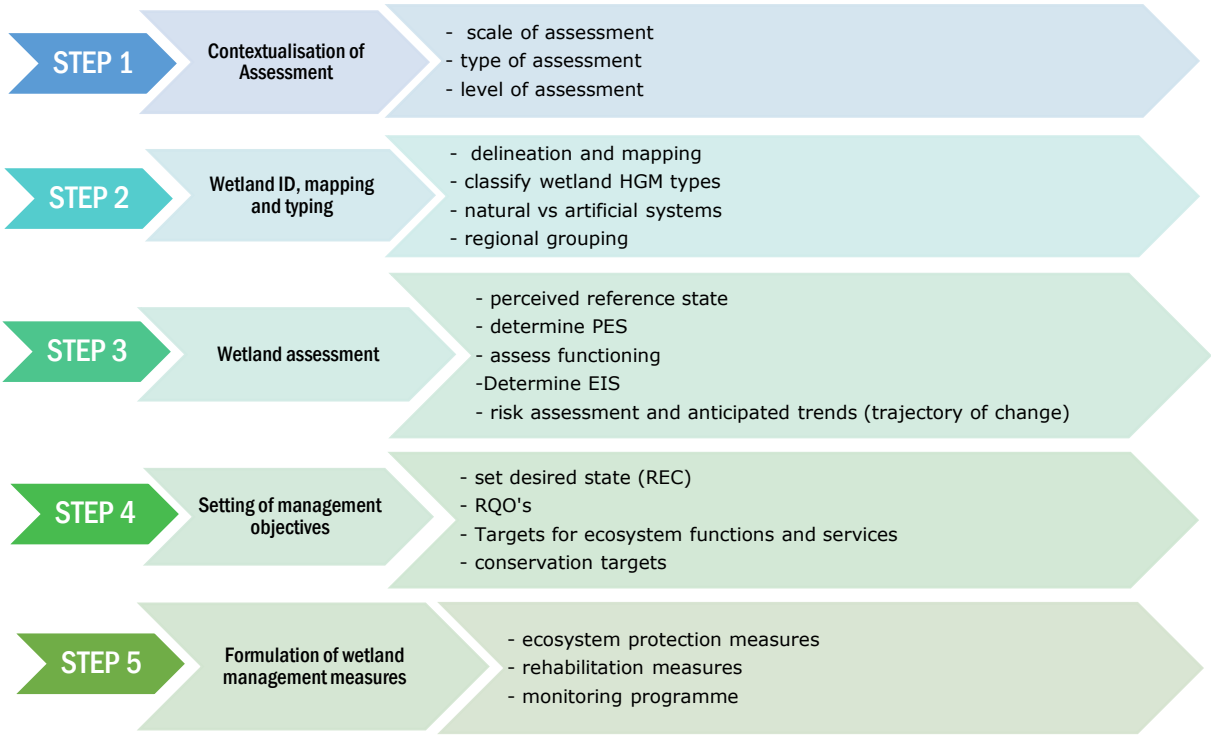


Figure 3: Proposed decision support framework for wetland assessment in South Africa (after Ollis et al., 2014)

## 2.2. Data Exploration and Review

Data sources from the literature and GIS spatial information was consulted and used where necessary in the study and include the following (also refer to Table 1: Information and data coverages used to inform the ecological assessment.

| | Data/Coverage Type | Relevance | Source |
|---|---|---|---|
| Biophysical Context | **Colour Aerial Photography** | Desktop mapping of habitat/ecological features | National Geo-Spatial Information (NGI) |
| | **Latest Google Earth™ imagery** | To supplement available aerial photography | Google Earth™ On-line |
| | **1:50 000 Relief Line (20m Elevation Contours GIS Coverage)** | Desktop mapping of terrain and habitat features as well as drainage network. | Surveyor General |
| | **1:50 000 River Line** (GIS Coverage) | Highlight potential on-site and local rivers and wetlands and map local drainage network. | CSIR (2011) |
| | **South African Vegetation Map** (GIS Coverage) | Classify vegetation types and determination of reference primary vegetation | Mucina & Rutherford (2012; 2018); Dayaram et al., 2018 |
| | **NFEPA: river and wetland inventories** (GIS Coverage) | Highlight potential on-site and local rivers and wetlands | CSIR (2011) |
| Conservation and Distribution Context | **Northern Cape Biodiversity Conservation Plan** (GIS Coverage) | Determination of provincial terrestrial/freshwater conservation priorities and biodiversity buffers | SANBI (2016) |
| | **NFEPA: River, wetland and estuarine FEPAs (GIS Coverage)** | Shows location of national aquatic ecosystems conservation priorities | CSIR (2011) |
| | **National Biodiversity Assessment – Threatened Ecosystems (GIS Coverage)** | Determination of national threat status of local vegetation types | SANBI (2011) |

The desktop delineation of all freshwater resources within 500m of the proposed development / activities was undertaken by analysing available 20m contour lines and colour aerial photography supplemented by Google Earth (TM) imagery where more recent imagery was needed. Digitization and mapping were undertaken using QGIS 3.8.2 and ArcMap 10.4.1 GIS software. All of the mapped freshwater resources were then broadly subdivided into distinct resource units (i.e. classified as ephemeral channels and drainage lines, washes and ephemeral rivers and wetlands). This was undertaken based on aerial photographic analysis and professional experience in working in the region. Please note that the desktop map was updated as part of the finalisation of the assessment to include the detailed delineation of the units occurring within the study area.

Following the desktop identification and mapping exercise, freshwater resource features where confirmed and their boundaries refined in-field

for a summary):

***Vegetation:***

» South African National Vegetation Map (SANBI, 2018); (Mucina & Rutherford, 2006) and National List of Threatened Ecosystems (NEM:BA, 2011): vegetation types and their respective conservation statuses. The latest version of the National

Vegetation Map was also consulted to check for any updates of the respective regions (Dayaram, et al., 2019); (SANBI, 2018).

» Botanical Database of Southern Africa (BODATSA), hosted by the South African National Biodiversity Institute (SANBI; https://posa.sanbi.org; also referred as POSA: Plants of Southern Africa): information on plant species recorded for the Quarter Degree Squares 2919BA, 2919BB, 2919BD and 2920AA. This is a larger area than required and is a conservative approach that ensures all species possibly occurring within the site have been represented. It also accounts for the fact that the site itself might not be well represented in national databases.
» Threatened Species Programme, Red List of South African Plants (SANBI, 2021): The IUCN conservation statuses of all listed species were extracted from this database.

***Ecosystem:***

» Freshwater and wetland information was extracted from the National Freshwater Ecosystem Priority Areas assessment (Nel, et al., 2011). This includes rivers, wetlands, and catchments defined in the study area.
» Important catchments and protected areas expansion areas were extracted from the National Protected Areas Expansion Strategy 2008 (Government of South Africa, 2008).
» Critical Biodiversity Areas for the site and surroundings (CBA Map for Northern Cape; obtained from SANBI Biodiversity GIS (BGIS), specifically http://bgis.sanbi.org/Projects/Detail/203.

Table 1: Information and data coverages used to inform the ecological assessment.

| | Data/Coverage Type | Relevance | Source |
|---|---|---|---|
| Biophysical Context | **Colour Aerial Photography** | Desktop mapping of habitat/ecological features | National Geo-Spatial Information (NGI) |
| | **Latest Google Earth™ imagery** | To supplement available aerial photography | Google Earth™ On-line |
| | **1:50 000 Relief Line (20m Elevation Contours GIS Coverage)** | Desktop mapping of terrain and habitat features as well as drainage network. | Surveyor General |
| | **1:50 000 River Line** (GIS Coverage) | Highlight potential on-site and local rivers and wetlands and map local drainage network. | CSIR (2011) |
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Following the desktop identification and mapping exercise, freshwater resource features where confirmed and their boundaries refined in-field

## 2.3. Baseline Freshwater Resource Assessment

The methods of data collection, analysis and assessment employed as part of the baseline freshwater habitat assessment are briefly discussed in this section.

The on-site / in-field assessment of the freshwater resource indicators was conducted on the 24th to 26th October 2021. The area was, prior to the time of the survey, experiencing an extensive drought period, however during the inspection, the conditions were slightly more favourable, as the area received some precipitation just prior to the site visit, resulting in slightly more favourable survey conditions. All of the dam features and natural freshwater features were slightly inundated (±10% capacity) during the inspection. However, the presence of inundation is not a prerequisite for the accurate delineation of freshwater resource features as other indicators were used as described below.

The assessments undertaken as part of this study are listed in Table 2 below along with the relevant published guidelines and assessment tools / methods / protocols utilised. A more comprehensive description of the methods listed below is included in Appendix 1.

Table 2: Summary of methods used in the assessment of delineated freshwater resources.

| Method/Technique | Reference for Methods / Tools Used |
|---|---|
| Freshwater Resource Delineation | A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005). |
| Freshwater Resource Classification | National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis et al, 2013) |
| Freshwater Resource Condition/PES | Wetland Index of Habitat Integrity (DWAF, 2007). |
| Freshwater Ecological Importance and Sensitivity (EIS) | EIS (Ecological Importance and Sensitivity) assessment tool (DWAF 1999c; Rountree & Malan, 2013) |
| Buffers for rivers and watercourses | Recommended buffers are in line with the watercourse and wetland buffers that have been recommended in the Strategic Environmental Assessment for Wind and Solar Photovoltaic Energy in South Africa (CSIR, 2015) and are deemed appropriate to the aquatic features and the proposed activities within the study area. Recommendations are made based on the wetlands functioning and site characteristics |

## 2.4. Criteria used to Assess the Site Sensitivity during the Scoping Phase

Refer to Appendix 2 for the Environmental Impact Assessment (EIA) Method statement as provided by SiVest.

## 2.5. Assumptions and Limitations

### 2.5.1. General Assumptions and Limitations

- This report deals exclusively within a defined area as well as downstream freshwater/aquatic resources that may potentially be impacted and which fall within the Regulated Areas (500 m) as defined by DWS.
- All relevant project information provided by the applicant and engineering design team to the specialist was correct and valid at the time that it was provided.
- Additional information used to inform the assessment was limited to data and GIS coverage's available for the Northern Cape Province at the time of the assessment.

### 2.5.2. Sampling Limitations and Assumptions

- » While disturbance and transformation of habitats can lead to shifts in the type and extent of ecosystems, it is important to note that the current extent and classification are reported on here.
- » The delineation of the outer boundary of riparian areas is based on several indicators, including topography (macro-channel features), the presence of alluvial deposition and vegetation indicators. The boundaries mapped in this specialist report, therefore, represent the approximate boundary of riparian habitat as evaluated by an assessor familiar and well-practiced in the delineation technique.
- » The accuracy of the delineation is based solely on the recording of the relevant onsite indicators using a GPS. GPS accuracy will, therefore, influence the accuracy of the mapped sampling points and therefore resource boundaries and an error of 3 – 5m can be expected. All soil/vegetation/terrain sampling points were recorded using a Garmin etrex Touch 35 Positioning System (GPS) and captured using Geographical Information Systems (GIS) for further processing.
- » Any freshwater resources that fall outside of the affected catchment (but still within the 500m DWS regulated area) and are not at risk of being impacted by the specific activity were not delineated or assessed. Such features were flagged during a baseline desktop assessment before the site visit.
- » Sampling by its nature means that generally not all aspects of ecosystems can be assessed and identified.
- » While every care is taken to ensure that the data presented are qualitatively adequate, inevitably conditions are never such that that is possible. The nature of the vegetation, seasonality, human intervention etc. limit the veracity of the material presented.
- » No water sampling and analysis was undertaken.
- » The vegetation information provided is based on onsite/ infield observations and not formal vegetation plots. As such, the species list provided only gives an indication of the dominant and/or indicator wetland/riparian species and thus only provides a general indication of the composition of the vegetation communities.
- » No faunal sampling and/or faunal searches were conducted and the assessment was purely wetland and riverine habitat based.
- » Probably the most significant potential limitation associated with such a sampling approach is the narrow temporal window of sampling.
    - Ideally, a site should be visited several times, during different seasons to ensure that the full complement of plant and animal species present is captured.
    - However, this is rarely possible due to time constraints and therefore, the representation of the species sampled at the time of the site visit should be critically evaluated.
    - The site was sampled on both occasions (site visits), following the wet season; however, the Spring season is regarded as a preferred season for such studies.

- The footprint was covered in detail and results are considered highly reliable and it is unlikely that there are any significant species or features present that were not recorded.

### 2.5.3. Baseline Assessment – Limitations and Assumptions

» All assessment tools utilised within this study were applied only to the resources and habitats located within the development footprint as well as the 500m DWS "regulated area" around the footprint area, and which are at risk of being impacted by the proposed development. Any resource located outside of the DWS "regulated area" and which is not a risk of being impacted was not assessed.
» It should be noted that the most appropriate assessment tools were selected for the analysis of the specific features and resources that may potentially be impacted by the proposed development. The selection was based on the specialist's knowledge and experience of these tools and their attributes and shortcomings.
» Furthermore, it should be noted that these assessment techniques and tools are currently the most appropriate available tools and techniques to undertake assessments of freshwater resources, there are however rapid assessment tools that rely on qualitative information and expert judgment. While these tools have been subjected to peer review processes, the methodology for these tools is ever-evolving and will likely be further refined in the near future. For the purposes of this assessment, the assessments were undertaken at rapid levels with somewhat limited field verification. It, therefore, provides an indication of the PES of the portions of the affected systems rather than providing a definitive measure.
» The PES, EIS and functional assessments undertaken are largely qualitative assessment tools and thus the results are open to professional opinion and interpretation. We have made an effort to substantiate all claims where applicable and necessary.
» The assessment of impacts and recommendation of mitigation measures was informed by the site-specific ecological concerns arising from the field survey and based on the assessor's working knowledge and experience with similar development projects.
» The impact descriptions and assessment are based on the author's understanding of the proposed development based on the site visit and information provided.
» Evaluation of the significance of impacts with mitigation takes into account mitigation measures provided in this report and standard mitigation measures to be included in the Environmental Management Programme (EMPr).

# 3. CONSERVATION AND FUNCTIONAL IMPORTANCE OF AQUATIC ECOSYSTEMS

Water affects every activity and aspiration of human society and sustains all ecosystems. "Freshwater ecosystems" refer to all inland water bodies whether fresh or saline, including rivers, lakes, wetlands, sub-surface waters, and estuaries (Driver et al., 2011). South Africa's freshwater ecosystems are diverse, ranging from sub-tropical in the north-eastern

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

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

considered fundamental to the sustainable management of South Africa's water resources in the context of the reconstruction and development of the country.

# 4. DESKTOP ANALYSIS

## 4.1. Regional/Local Biophysical Setting

The study site is located primarily within the D81F Quaternary Catchment (QDR) whilst a fairly small portion of the project site extends into the Quaternary Drainage Region D81G, however, according to the proposed layout almost all of the infrastructure will be restricted to the D81F QDR. Both of these QDRs are located within the Lower Orange Water Management Area). The main drainage feature within the region is the Kaboep, which drains directly into the Orange River some 80km to the north-west. Furthermore, the Kaboep River drains a very small portion of the project site directly whilst the largest portion of the project site is drainage by smaller drainage networks and tributaries of the Kaboep River. All of the rivers within the region are regarded as Ephemeral and are typically lower foothill rivers comprising of floodplains that are either slightly confined (V4) on both side or only to one side (V2) (Rowntree & Wadeson, 1999).

The Hydrological Characteristics of the project site are summarised as follows:

- Mean Annual Precipitation = 88-106 mm;
- Mean Annual Runoff = 0.3 – 0.5 mm;
- Mean Annual Evaporation = > 2600 mm; and
- Hydrological Zone = L.

Almost all of the watercourses within the region are still in a largely natural state with minor modifications (PES: B) (DWS, 2014)

The Pofadder WEF1 project is located within the Nama Karoo Level 1 ecoregion (26.02 level 2 ecoregion) (Kleynhans, et al., 2005). The Nama Karoo ecoregion incorporates a number of northward flowing rivers, with the main system into which these rivers flow being the Orange River. The characteristics of the ecoregion are:

- Topography is diverse, but plains with a moderate to high relief and lowlands, hills and mountains with moderate to high relief are dominant. Vegetation consists almost exclusively of Nama Karoo vegetation types;
- Most of the rivers in the region are seasonal to ephemeral,
- Perennial rivers that traverse this region are the Riet and Orange;
- Rainfall is moderate to low in the east, decreasing to arid in the west. Coefficient of variation of annual precipitation is moderate to high in the east to very high in the west;
- Drainage density is generally low, but medium to high in some parts;

» Median annual simulated runoff is moderate to low in the east, decreasing to arid in the west, and
» Mean annual temperature is moderate to low in the east, increasing to moderate to high in the west.

The proposed development area is situated within the Northern Cape Pan Veld Geomorphic Province (Partridge, et al., 2010). The main feature of this province, which straddles the uplifted Griqualand–Transvaal axis, is the frequency of pans (some of vast size e.g., Verneukpan and Grootvloer) that are remnants of earlier (Cretaceous) drainage systems (De Wit, 1993). Each pan has its own endoreic drainage network. These pans can be regarded as discontinuous groundwater windows, in which the substantial excess of evaporation over precipitation under the prevailing hot, dry climate, leads to rapid concentration of dissolved solids within each discrete basin. Some of the pans are linked by now defunct palaeo-valleys which, under the more humid conditions of the Miocene, contained substantial rivers. These drainage systems were disrupted both by progressive aridification and by uplift along the Griqualand–Transvaal axis, causing the dismembering of several (Partridge & Maud, 2000).

Four main drainage systems traverse this geographic province; from east to west these are the Boesak, Vis/Hartbees and Brak rivers. The rivers to the east (Boesak and Vis/Hartbees) display remarkable uniformity, with flat slopes, wide valley cross-sectional profiles, concave longitudinal profiles and exponential BFCs (Macro-reach Best Fit Curves: aggregading alluvial river systems where there is no significant lateral input of water or sediment). The sediment storage surrogate descriptors are consequently WF (a sediment storage surrogate descriptor indicative of high sediment storage capability).

A summary of the biophysical features and the setting of the project site and surroundings are summarised in Table 3 below.

**Table 3:** Summary of the biophysical setting of the projects site as well as the surroundings

| Biophysical Aspect | Desktop Biophysical Details | Source |
|---|---|---|
| **Physiography (for affected property)** | | |
| Av. Elevation a.m.s.l | 1019m | Google Earth & ArcGis |
| Max. Elevation a.m.s.l | 1053m | Google Earth & ArcGis |
| Min. Elevation a.m.s.l | 986m | Google Earth & ArcGis |
| Av. slope | 2.65% (Min: 0% and Max: 13.74%) | Google Earth & ArcGis |
| Landscape Description (Figure 6) | A fairly low linear, quartz ridge runs across the centre of the project site from west to east. The remainder of the project site is gently undulating comprising of sandy, and gravelly plains, smaller, low ridges and quartz outcrops.<br><br>Numerous small drainage lines originate in the higher lying areas of the ridges, to either dissipate into the lower lying sandy planes, or feed into short, sandy, alluvial washes.<br><br>The linear ridge system acts as a watershed with most of the drainage lines flowing either in a northern or southern | Google Earth & Mucina and Rutherford, 2006, ArcGis, ARC, Todd, 2021 and Own visual observations. |

| | | |
|---|---|---|
| | direction away from the ridge system. Most of the small alluvial washes are located to the north and east of the project site and flow predominantly in a north-eastern to eastern direction towards the larger alluvial washes. These larger alluvial washes, tend to also flow for short distances, although their channels can become relative broad. These larger alluvial washes are tributaries of the Kaboep River located to the east and north-east of the project site. This river is also ephemeral and comprise of a broad alluvial channel, with numerous, shallow, braided micro-channels. The small ephemeral washes cutting through the linear ridge system contain small gravel dams just above the areas of narrowing, where they cut through the ridge. The upper reach of the Kaboep River also contains two larger sized gravel dams; however, these dam features are located just outside of the project site (to the east).<br><br>A very mall depression wetland is located almost in the centre of the project site, just south of the ridge system.<br><br>These quartz outcrops, ridges and drainage features contribute to spatial heterogeneity, within a landscape that would otherwise have been quite monotonous.<br><br>» The bulk of the WEF development will be located within the northern half of the project site (north of the linear ridge system), with most of the turbines and hardstands located within the gentler sloping, mid- and foot slope areas of the linear ridge system. As mentioned, these areas are fairly gentle sloping and is covered by very mainly shallow soils covered by quartz gravels and stones. Furthermore, a fair number of turbines will be located within the irregular, plains comprising of fairly shallow, gravelly, sandy-loam to sandy soils. No turbines will be located within drainage lines, washes, wetland depressions, quartz outcrops, as well as the steeper upper slopes of the linear ridge system.<br>» In terms of access and underground MV cabling routes, most of these routes will be located within the gentle sloping portions of the linear ridge and the irregular plains. The planned access and cable routes will cross nine small drainage lines and will only cross on small ephemeral wash feature. The planned routes will avoid the larger ephemeral wash, outcrops, depression wetlands and the steeper upper slopes of the linear ridge system.<br>» The proposed internal grid line will manly traverse the irregular plains and will occasionally cross/span small quartz outcrops.<br>» The remaining supporting infrastructure, will be restricted to the irregular plain south of the linear ridge system. | |

<table>
<tr><td rowspan="3">Land Type Classification (Figure 7)</td><td>Symbol</td><td colspan="2">Description</td><td></td></tr>
<tr><td>Ag61</td><td colspan="2">North-western and western portion of the project site (predominantly the area north of the linear ridge).</td><td rowspan="2">ARC</td></tr>
<tr><td>Ag25</td><td colspan="2">South-eastern and eastern portion of the project site (predominantly the area south of the linear ridge).</td></tr>
<tr><td rowspan="3">Terrain Type</td><td>Symbol</td><td>Land Type</td><td>Description</td><td rowspan="3">ARC</td></tr>
<tr><td>A2</td><td>Ag61</td><td>Level plains or plateaus with some relief.</td></tr>
<tr><td>B3</td><td>Ag25</td><td>Rolling or broken plains or plateaus with some relief.</td></tr>
<tr><td>Geomorphic Province</td><td colspan="3">Northern Cape Pan Veld</td><td>Partridge et al., 2010</td></tr>
<tr><td>Geology and Soils</td><td colspan="3">The project site is located within the Namaqualand Metamorphic Complex. The rocks of the Namaqualand Metamorphic Complex have undergone several phases of deformation and tectonic duplication. Most of the area is covered by recent (Quaternary) sand and superficial cover (calcretes). Within some areas the underlying gneisses (Quarzo-feldspathic Gneiss) and metasediments (eg. Glassy Quartz), of the Bushmanland Group (Mokolian age), become exposed as low ridges and outcrops. of are exposed.<br><br>The soils of most of the area are red-yellow apedal soils, freely drained, with a high base status and less than 300mm deep, however the aeolain sands thin out significantly around the ridges, outcrops and hills, where these sands tend to be mixed with gravel and stones.<br><br>Alluvial sand and silt are encountered in most of the dry water courses and also in topographic depressions from which there is no outward drainage. When it rains, water stagnates in these depressions and a thin veneer of silt and clay accumulates. This results in the development of pans, commonly accompanied by dust-bowl conditions.</td><td>ARC & SA Geological Dataset, Almond (2010)</td></tr>
<tr><td rowspan="4">Prominent Soil Forms</td><td>Terrain Position</td><td colspan="2">Soil Forms</td><td rowspan="4">ARC</td></tr>
<tr><td>Crest</td><td colspan="2">Typically comprise of bare solid rock, fractured rock and shallow, rocky soils (shallow profiles underlain by rock or lithic material) with the dominant soil forms being Mispah, and Rock and occasionally Clovely and Glenrosa.</td></tr>
<tr><td>Mid-slope</td><td colspan="2">Also typically associated with shallow, rocky soil profiles and/or bare rock and include the soil forms, Mispah, Hutton and bare rock.</td></tr>
<tr><td>Toe-slope</td><td colspan="2">Soils of varying depth, from shallow soils underlain by rock or lithic material to slightly deeper sand soils. The dominant soil forms are Mispah and Hutton with the occasional exposure of bare rock.</td></tr>
</table>

| | | | |
|---|---|---|---|
| | Valley bottom, depression and floodplain | Slightly deeper soils with some occasional soil, profiles. The most prominent soil forms found within the valley bottoms is Clovelly. Where alluvial/colluvial sediments have accumulated, forming deeper soil profiles (associated with depression and ephemeral wash systems) Dundee are the dominant soil form, and occasionally Oakleaf. | |
| **Climate** | | | |
| Köppen-Geiger Climate Zone | BWh (Arid, Hot, Desert) | | Climate-data.org |
| Mean annual temperature | 19.4°C | | Climate-data.org |
| Warmest Month & Av. Temp. | January: 26.2°C | | Climate-data.org |
| Coldest Month & Av. Temp. | July: 11.5°C | | Climate-data.org |
| Mean Frost Days (per year) | 6 | | Cape Farm Mapper |
| Rainfall Seasonality | Late summer to autumn (Highest in January and March) | | DWAF, 2007 |
| Mean annual precipitation | 88 - 106 mm | | Schulze, 1997 |
| Mean annual runoff | 0.3 – 0.5 mm | | Schulze, 1997 |
| Mean annual evaporation | >2600 mm | | Schulze, 1997 |
| **Surface Hydrology (for proposed development area)** | | | |
| DWA Ecoregions | 26.02 (Nama Karoo) | | DWA, 2005 |
| Wetland vegetation group (Figure 8) | Nama Karoo Bushmanland | | CSIR, 2011 |
| Water management area | Lower Orange Water Management Area | | DWA |
| Quaternary catchment | The majority of the property falls within the D81F (QC) whilst a relatively small portion to the west is located within D81G (QC). | | DWA |
| | Name (Symbol) | Extent ($km^2$) | |
| | D81F | 2407 | |
| | D81F | 2630 | |
| Sub Quaternary Catchments | Name (Symbol) | Extent ($km^2$) | DWA |
| | 3856: Half of the development footprint | 285 | |
| | 3951: Little more than 30% of the development footprint. | 159 | |
| | 3835: Less than 20% of the development footprint | 731 | |
| **Vegetation Overview (for affected property)** | | | |
| Biome | Nama-Karoo with outliers of Succulent Karoo (associated with inselbergs) | | Mucina & Rutherford, 2018 |
| Vegetation Types (Figure 9) | Nama-Karoo: Bushmanland Arid Grassland & Bushmanland Basin Grassland<br>Succulent-Karoo: Bushmanland Inselberg Shrubland<br><br>Ephemeral Washes and depressions, even though not indicated within VegMap, are most likely consistent with the description Bushmanland Vloere (Inland Azonal). | | Mucina & Rutherford, 2018 |

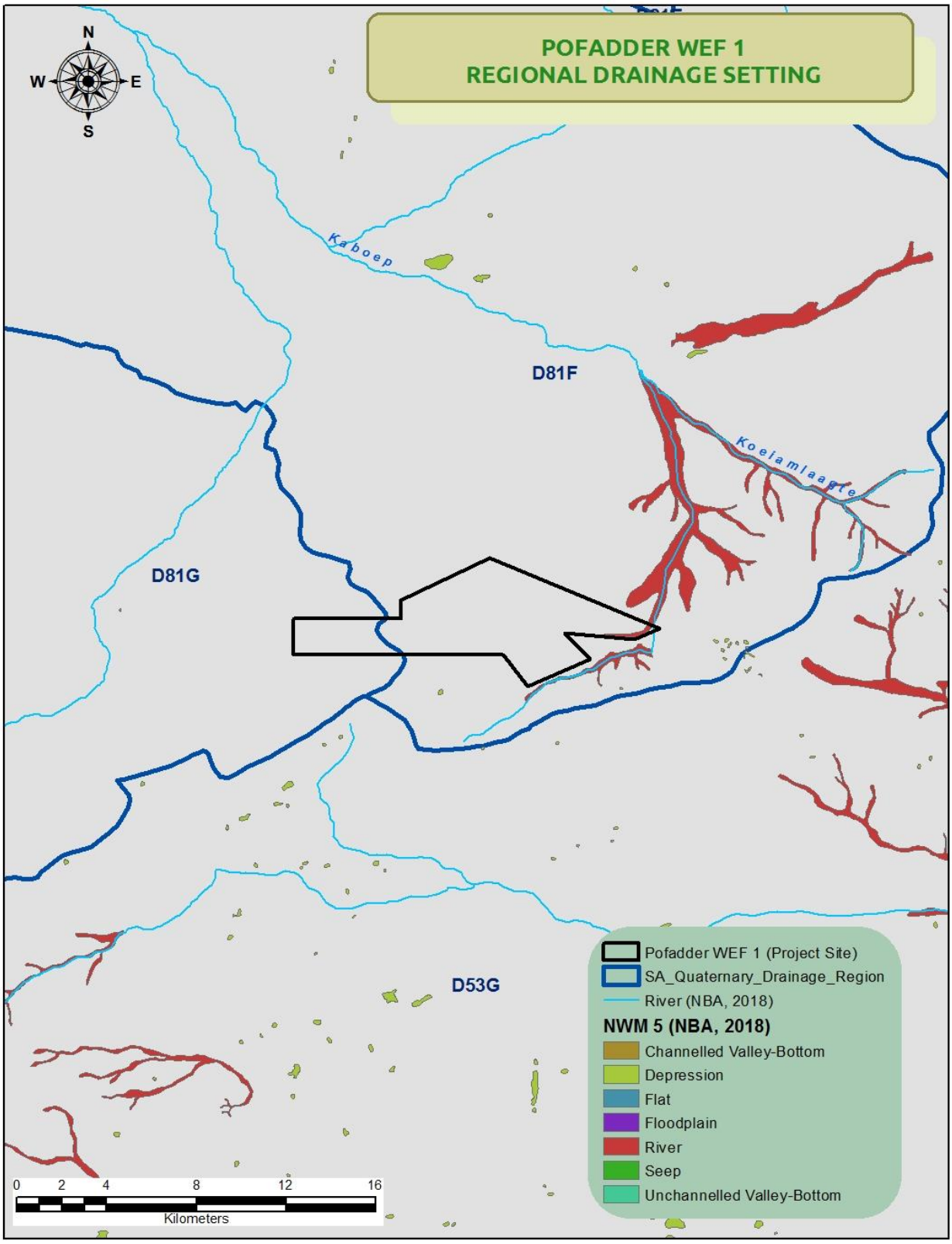


Figure 4: Regional drainage setting.

## 4.2. Conservation Planning / Context

Understanding the conservation context and importance of the study area and surroundings is important to inform decision making regarding the management of the aquatic resources in the area. In this regard, national, provincial, and regional conservation planning information available and was used to obtain an overview of the study site (

Table 4).

Table 4: Information and data coverages used to inform the ecological assessment.

| Conservation Planning Dataset | | Relevant Conservation Feature | Location in Relationship to Project Site | Conservation Planning Status |
|---|---|---|---|---|
| | **Strategic Water Source Areas for groundwater and surface water.** | Areas with high groundwater availability and of national importance | Well outside of any Strategic Water Source Area | Not Classified |
| | **National Freshwater Ecosystem Priority Area** | River FEPAs (priority sub quaternary catchment areas) | One FEPA1 Priority Quaternary Catchment<br>» The portion of this catchment that is located within the project site is very small (<10 of FEPA catchment will be impacted by proposed development.<br>» Approximately 50% project site is located within this FEPA catchment and includes 12 wind turbines, hardstand access road, underground cabling and a small portion of the internal grid. | 1X FEPA 1 Priority Catchment |
| | | | » Remaining 50% of project site is located within 2 Upstream catchments.<br>» Only a very small percent of the Upstream catchment located to the west will be impacted (<5%), with 6 wind turbines and hardstands as well as some access routes and underground cabling, located within this catchment.<br>» The Upstream catchment to the east is fairly small and the proposed development will impact approximately 18% of this catchment. Infrastructure located within this catchment include; 8 wind turbines and hardstands, most of the internal grid lie, access routes and underground cables, temporary laydown areas, on-site substation, batching plant and the O&M buildings. | 2X Upstream FEPA Catchments |

| Conservation Planning Dataset | | Relevant Conservation Feature | Location in Relationship to Project Site | Conservation Planning Status |
|---|---|---|---|---|
| | | Kaboep River (FEPA ID: 3929) – Upstream FEPA River | » The Kaboep River flows in a north-eastern direction, with a very small section flowing through the project site (<210m), however all of the proposed infrastructure is located well away from this river. | FEPA 1 Priority River |
| | | Wetlands | According to the NFEPA spatial data no wetland features are located within the project site. | No wetland features within the projects site. |
| Conservation and Distribution Context | NCBSP: Critical Biodiversity Areas | Ecological Support Areas ESA1 | » Larger Non-FEPA River Features and 500m buffer areas.<br>» Small portions of this ESA1 extend into the southern and south-eastern corners of the project site<br>» One wind turbine planned within the 500m buffer area | ESA |
| | NCBSP: Critical Biodiversity Areas | Critical Biodiversity Areas CBA2 | » Portions of FEPA1 prioritized catchments;<br>» Located well outside of the project site. | CBA2 |
| | | Critical Biodiversity Areas CBA1 | » FEPA River and 500m buffer area.<br>» Located well outside of the project site. | CBA1 |

### 4.2.1. Strategic Water Source Areas (SWSAs)

Strategic Water Source Areas (SWSAs) are defined as areas of land that either:

- » 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;
- » have high groundwater recharge and where the groundwater forms a nationally important resource;
- » areas that meet both criteria mentioned above.

They include transboundary Water Source Areas that extend into Lesotho and Swaziland.

The project site is located well outside of any SWSA (groundwater and surface water) and as such the proposed development will not impact such areas.

### 4.2.2. National Freshwater Ecosystem Priority Areas (2011) Database

The National Freshwater Ecosystems Priority Areas (NFEPA) (2011) database provides strategic spatial priorities for conserving South Africa's freshwater ecosystems and

supports the sustainable use of water resources. The spatial priority areas are known as Freshwater Ecosystem Priority Areas (FEPAs).

FEPAs were identified based on:

» Representation of ecosystem types and flagship free-flowing rivers.
» Maintenance of water supply areas in areas with high water yield.
» Identification of connected ecosystems.
» Preferential identification of FEPAs that overlapped with"
    - Any free-flowing river
    - Priority estuaries identified in the National Biodiversity Assessment 2011.
    - Existing protected areas and focus areas for protected area expansion identified in the National Protected Area Expansion Strategy.

FEPA maps show various different categories, each with different management implications. The categories include river FEPAs and associated sub-quaternary catchments, wetland FEPAs, wetland clusters, Fish Support Areas (FSAs) and associated sub-quaternary catchments, fish sanctuaries, phase 2 FEPAs and associated sub-quaternary catchments, and Upstream Management Areas (UMAs).

A review of the NFEPA coverage for the study area (Figure 5) revealed that one FEPA1 priority quaternary catchment include a portion of the project site. Such FEPA1 priority quaternary catchments are drained by FEPA Rivers that meet biodiversity targets for river ecosystems and threatened fish species, and are currently in a good condition (A or B ecological category). Although FEPA status applies to the actual river reach within such a sub-quaternary catchment. The mapping of the whole sub-quaternary catchment indicates that the surrounding land and smaller stream network need to be managed in a way that maintains the good condition (A or B ecological category) of the river reach (Nel, et al., 2011).

The FEPA catchment is moderately in size and less than 10% of the catchment will be impacted by the proposed development. However, a fairly large portion of the development site is located within this FEPA catchment (50% of the project site). Twelve wind turbines and hardstands as well access roads and cabling are planned within this catchment. Due to the nature of the development, this development will not result in a significant/detrimental transformation of this catchments and its drainage characteristics. Potential impacts on local drainage characteristics can be significantly and successfully mitigated.

The remaining 50% of the project site is located within two (2) Upstream sub-quaternary catchments also known as "Upstream Management Area" (UMA), one to the east and one to the west. These UMAs represent sub-quaternary catchments in which human activities need to be managed to prevent degradation of downstream river FEPAs and Fish Support Areas but do not include management areas for wetland FEPAs, which need to be determined at a finer scale (Nel, *et al*., 2011). Most of the delineated watercourses,

draining these sub-quaternary catchments, will not impacted by the prosed development. As for the few the few drainage lines and the one minor ephemeral wash that will be impacted by the development, impacts on these features will only be to a limited extent as a result of route crossings and underground cabling. With the necessary mitigation measures in place, impacts on the significance of these impacts can be even furthermore reduced.

No FEPA rivers are located in close proximity to the project site and as such none of these rivers will be impacted by the proposed development. Furthermore, only one Upstream river traverses the project site (Kaboep River). A very small portion of this river (<210m) traverse the south-eastern corner of the project site. All proposed infrastructure is however, located well away from this FEPA river. The Kaboep River largely flows in a north-western direction, to eventually feed directly into the Orange River some 96.7 km. This river is classified as a Lower Foothill River (according to geomorphological zonation) with a V2 (floodplain confined on one side) valley form (Nel, et al., 2011). According to DWAFs 1999 Present Ecological State for mainstream rivers this watercourse was classified as Largely Natural (Class B) (Kleynhans, 2000). As mentioned, this FEPA river will not be directly impacted by the proposed Pofadder 1 WEF development.

A number of natural, predominantly small freshwater wetlands have been listed within the region, according to the NFEPA spatial coverage (Nel, et al., 2011). Almost all of these wetlands have been classified either as wetland flats or seepages. Furthermore, none of these wetlands are classified as FEPA wetlands. According to the spatial data no wetland features are located within the project site, or within close proximity to the project site (Nel, et al., 2011). Subsequently this development will not impact any important FEPA wetland features. It is also important to consider SANBI's 2018 wetland map. This map indicates that there are numerous more wetland within the region. This map indicates a moderately sized alluvial wetland, extending into the south-eastern corner of the project site. This alluvial wetland is associated with the Kaboep River and as mentioned non infrastructure is planned within close proximity to this river and subsequently also to alluvial wetland. As such this wetland feature will not be directly impacted by the proposed Pofadder 1 WEF development.

During the in-field wetland delineation this moderately broad alluvial floodplain wash, was confirmed, as well as a small depression wetland located south of the linear ridge system. It was also confirmed that none of these wetland features will be impacted by the proposed development (refer to section 0 and Figure 7).

Subsequently, no FEPA and/or Upstream rivers as well as FEPA wetlands will be directly impacted by the proposed development. Furthermore, due to the nature of WEF developments, the development of the Pofadder 1 WEF will not result in any significant/detrimental transformations of the FEPA1 and Upstream prioritized sub-quaternary catchments and their associated drainage characteristic. Potential impacts on local drainage characteristics can be significantly and successfully mitigated.

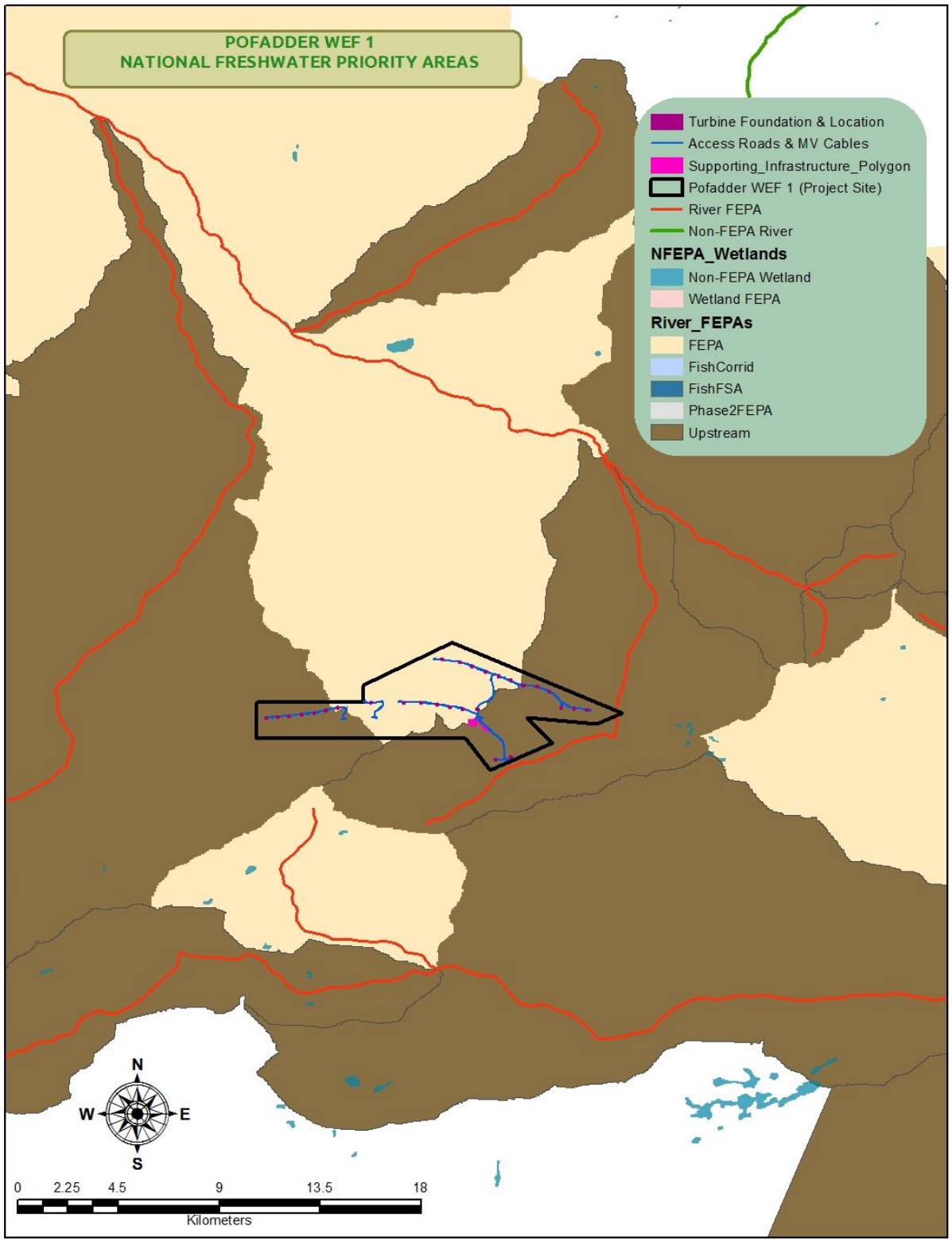


Figure 5: Map showing the location of the study site relative to the Freshwater Ecosystem Priority Areas (FEPAs)

### 4.2.3. Critical Biodiversity Areas and Broad Scale Ecological Processes

Critical Biodiversity Areas (CBA) have been identified for all municipal areas of the Northern Cape Province and are published by SANBI (http://bgis.sanbi.org/). This biodiversity assessment identifies CBAs representing biodiversity priority areas that should be maintained in a natural to near-natural state. CBA maps show the most efficient selection and classification of land portions to be safeguarded so that ecosystem functioning is maintained and national biodiversity objectives are met (see Table 5 for CBA land management objectives).

Table 5: Relationship between Critical Biodiversity Areas categories (CBAs) and land management objectives.

| CBA category | Land Management Objective |
|---|---|
| **Protected Areas (PA) & CBA 1** | ***Natural landscapes:***<br>» Ecosystems and species are fully intact and undisturbed.<br>» Areas with high irreplaceability or low flexibility in terms of meeting biodiversity pattern targets. If the biodiversity features targeted in these areas are lost then targets will not be met.<br>» Landscapes that are at or past their limits of acceptable change. |
| **CBA 2** | ***Near-natural landscapes:***<br>» Ecosystems and species largely intact and undisturbed.<br>» Areas with intermediate irreplaceability or some flexibility in terms of the area required to meet biodiversity targets. There are options for loss of some components of biodiversity in these landscapes without compromising the ability to achieve targets.<br>» Landscapes that are approaching but have not passed their limits of acceptable change. |
| **ESA** | ***Functional landscapes:***<br>» Ecosystem moderately to significantly disturbed but still able to maintain basic functionality.<br>» Individual species or other biodiversity indicators may be severely disturbed or reduced.<br>» Areas with low irreplaceability with respect to biodiversity pattern targets only. |
| **ONA (Other Natural Areas) and Transformed** | ***Production landscapes***:<br>» Manage land to optimise sustainable utilisation of natural resources. |

Only the aquatic CBA and ESA features will be discussed in this section as the terrestrial CBA and ESA features will be discussed within the Terrestrial Ecological Report.

A very small extent (<3%) of ESA is located within the project site (within the southern and south-eastern corners of the project site) (Figure 6). A description of the aquatic biodiversity categories located within the project site as well as the features underlying these categories and remarks based on the visit, are provided below in Table 6 below.

According to the current layout of the Pofadder 1 WEF, a very limited area of ESA will be impacted. Subsequently, it is unlikely that this development will have a significant impact on these ESAs located within the project site, and it is furthermore highly unlikely that this development will impact the province's conservation targets.

With the necessary mitigation measures in place the impacts associated with the proposed development will be reduced even furthermore. Refer to Sections 5.4, 5.5 & 6 for a description of the site sensitivity and suitability.

To conclude, based on a detailed site- and desktop survey, no CBA1 or CBA2 will be impacted. Furthermore, a very small/limited impact is planned to occur within ESAs and will lead to a very limited loss of ESA (with the necessary mitigation measures in place). However, this loss of ESA is regarded as acceptable and will not threaten the province's conservation targets.

Table 6: Reasons underlying the aquatic ESA, CBA1 and CBA2 status of the affected property and surrounding area.

| Feature | CBA 1 | CBA 2 | ESA | Other | Remarks |
|---|---|---|---|---|---|
| **Larger River Features (1:500 000) and 500m Buffers** | | | **X** | | » The Non-FEPA river flowing in a north-eastern direction, as well as its associated 500m buffer area.<br>» Small portions of this ESA1 extend into the southern and south-eastern corners of the project site<br>» All primary and larger ephemeral washes and alluvial floodplains along with their buffer areas have been classified either as Very High or High Sensitive areas that should be regarded as "No-Go" areas.<br>» 100m Buffers around the primary and larger ephemeral washes was determined to be acceptable, and will allow for the persistence of the current present ecological status as well as functions and services provided by these aquatic features.<br>» According to the current layout, very limited infrastructure is planned within this ESA, as well as any other freshwater resource features:<br>• Only one pylon planned within the associated 500m buffer area according to the CBA spatial data<br>• No activities planned within the watercourse itself.<br>» Furthermore, a small portion of this 500m buffer area will be impacted through the use/construction of access routes and the lying of underground MV cabling.<br>» The following recommendations are provided regarding development within or near these larger watercourse features:<br>• The use/upgrade of existing roads and watercourse crossings is acceptable and should be the preferred options (rather than the construction of new road infrastructure);<br>• Where no suitable existing roads and watercourse crossings exist, the construction of new access roads and watercourse crossings can be allowed.<br>• All underground cabling should be laid either within access roads or next to access roads (as close as possible).<br>• Any other activities and infrastructure, other than the above-mentioned infrastructure (roads and cabling), may not occur/be located within these watercourse features as well as their associated buffer areas.<br>» With the implementation of the above-mentioned recommendation measures, it is highly unlikely that the proposed development will threaten the ESA as well as the other delineated watercourse features' integrity, as well as functions and services. |
| **FEPA-River and 500m Buffers** | **X** | | | | » The large ephemeral wash to the south-west, listed as a FEPA-River as well as a 500m buffer area.<br>» According to the current layout, the proposed development is located well outside of this CBA1 and the proposed development will not impact this feature. |

| | | | | | |
|---|---|---|---|---|---|
| **Sub-Quaternary Catchment of FEPA-Rivers** | | **X** | | **X** | » The bulk of the FEPA1 prioritized and Upstream catchments have been classified as Other Natural Areas whilst approximately 50% of the FEPA1 prioritized catchment associated with the FEPA-river to the south-west of the project site have been classified as CBA2.<br>• According to the current layout, the proposed development is located well outside of these ESAs and the proposed development will not impact this features. |
| **Wetlands (Non-FEPA)** | | | **X** | | » All Non-FEPA Wetlands have been classified as ESAs.<br>» According to the current layout, the proposed development is located well outside of this CBA2 and the proposed development will not impact this feature. |

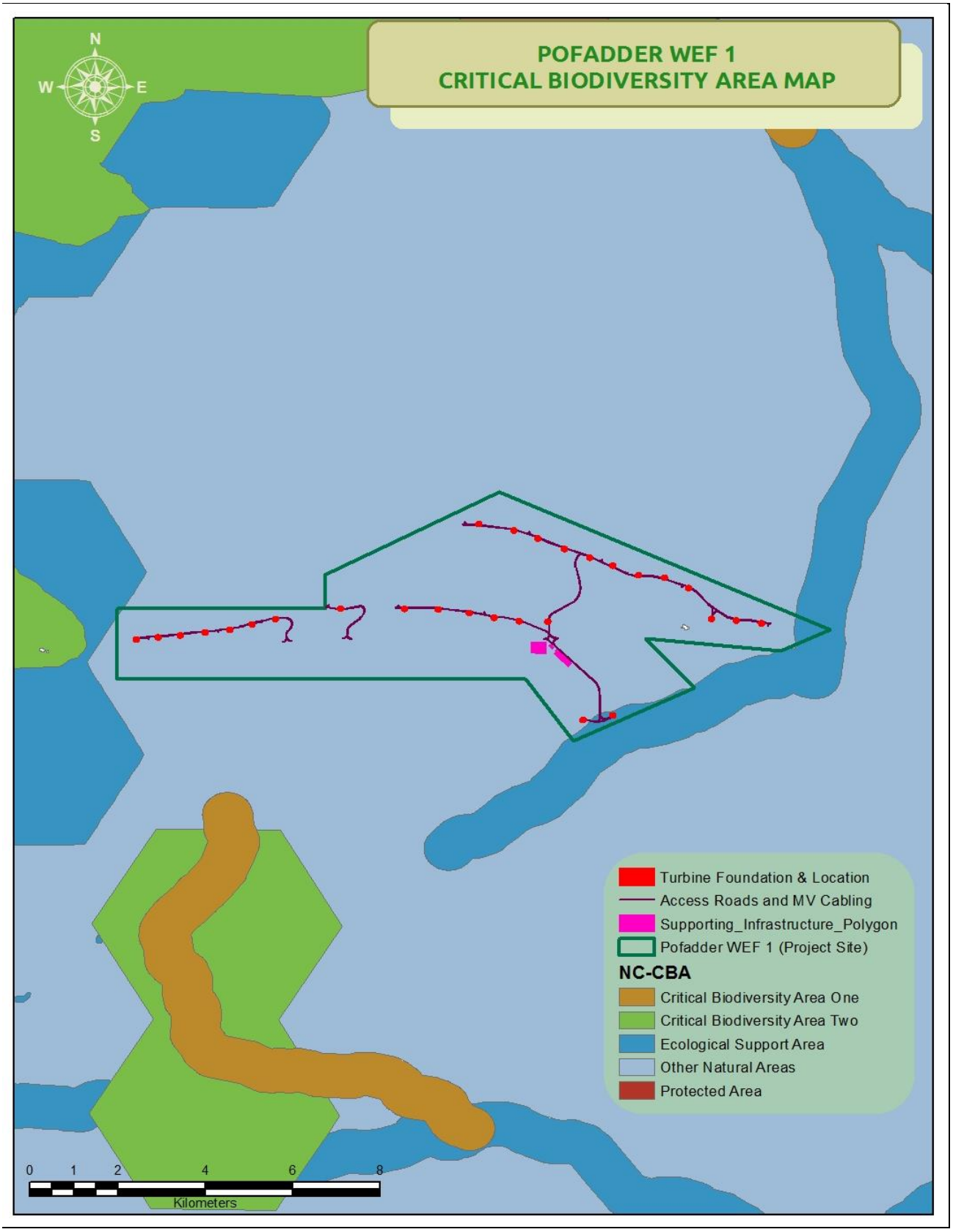


Figure 6: Provincial Level Aquatic Conservation Planning Context.

# 5. AQUATIC/FRESHWATER RESOURCE BASELINE ASSESSMENT

This section sets out the findings of the baseline assessment of those water resources units and includes:

- » Delineation, Classification and Habitat Descriptions;
- » Present Ecological State (PES) Assessment;
- » Ecological Importance and Sensitivity (EIS) Assessment;

The on-site / in-field assessment of the freshwater resource indicators was conducted by Gerhard Botha from Nkurenkuru Biodiversity and Ecology on the 24th to 26th of October 2021.

- » Ultimately, 71 freshwater resource features were identified and delineated within the 500m regulated area and include; 1 primary drainage feature (stream order 2), twelve smaller/minor streams/washes (stream order 3-4, but mainly stream order 3) and fifty-eight drainage/channel features (Figure7 7).
- » However, of these 71 freshwater resource features, only ten features will be directly impacted by the proposed location.
    - Nine drainage lines, and
    - One minor ephemeral wash
- » These freshwater resource features will only be impacted through access and underground cable route crossings.
- » No other infrastructure is located within any freshwater resource feature.
- » Only one small endorheic depression wetland features have been identified and delineated within the project site.
    - This wetland feature is however located well away from any infrastructure.

All of the freshwater resource features on and around the site are intermittent or ephemeral, being inundated only for brief periods each year, with periods of drought that are unpredictable in duration.

A dominant feature of the site is the alluvial floodplains or washes of various sizes. These systems are difficult to classify, as their hydrological and geomorphological characteristics (the way water and sediment flows into, through and out of these features) are difficult to determine, and there is a limited understanding on the ecological functioning and importance of these alluvial features. They are typically characterised by multiple channels that traverse a floodplain, valley floor or alluvial fan. Surface water may flow along a particular channel in one year, but due to their being little topographic definition or gradient across the landscape, a parallel channel may be eroded the following year, leading to a network of channels. Some freshwater ecologists call these features "dendritic drainage systems", while others refer to them as washes or floodplains. They tend to be classified as rivers rather than wetlands as they show very few wetland characteristics in the strictest sense.

The primary drainage feature within the region, is the Kaboep River which eventually terminates into the Orange River. This river flows along the southern and south-eastern boundary of the project site, with only a small portion of this watercourse feature extending into the project site (south-eastern corner of the project site) A dominant feature within this reach of the Kaboep River, is the fairly brood alluvial floodplain and two gravel dam structures (located just outside of the project site.) Most of the smaller washes and drainage lines drain either in a northern to north-eastern direction, or in a south-eastern direction, depending on what side of the linear ridge, the freshwater resource features are located. Freshwater features located north of the linear ridge drain largely in a northern to north-eastern direction, whilst the freshwater resource features located south of the ridge drain in a south-eastern direction. A few of the drainage features merely dissipate into the sandy substrates of the planes, however most of these smaller freshwater drainage features eventually confluence with the Kaboep River.

## 5.1. Aquatic/Freshwater Resource Delineation

The water body delineation and classification were conducted using the standards and guidelines produced by the DWS (DWAF, 2005 & 2007) and the South African National Biodiversity Institute (2009) (refer to Figure 7).

For the DWS definitions of different hydrological features refer to Appendix 1.

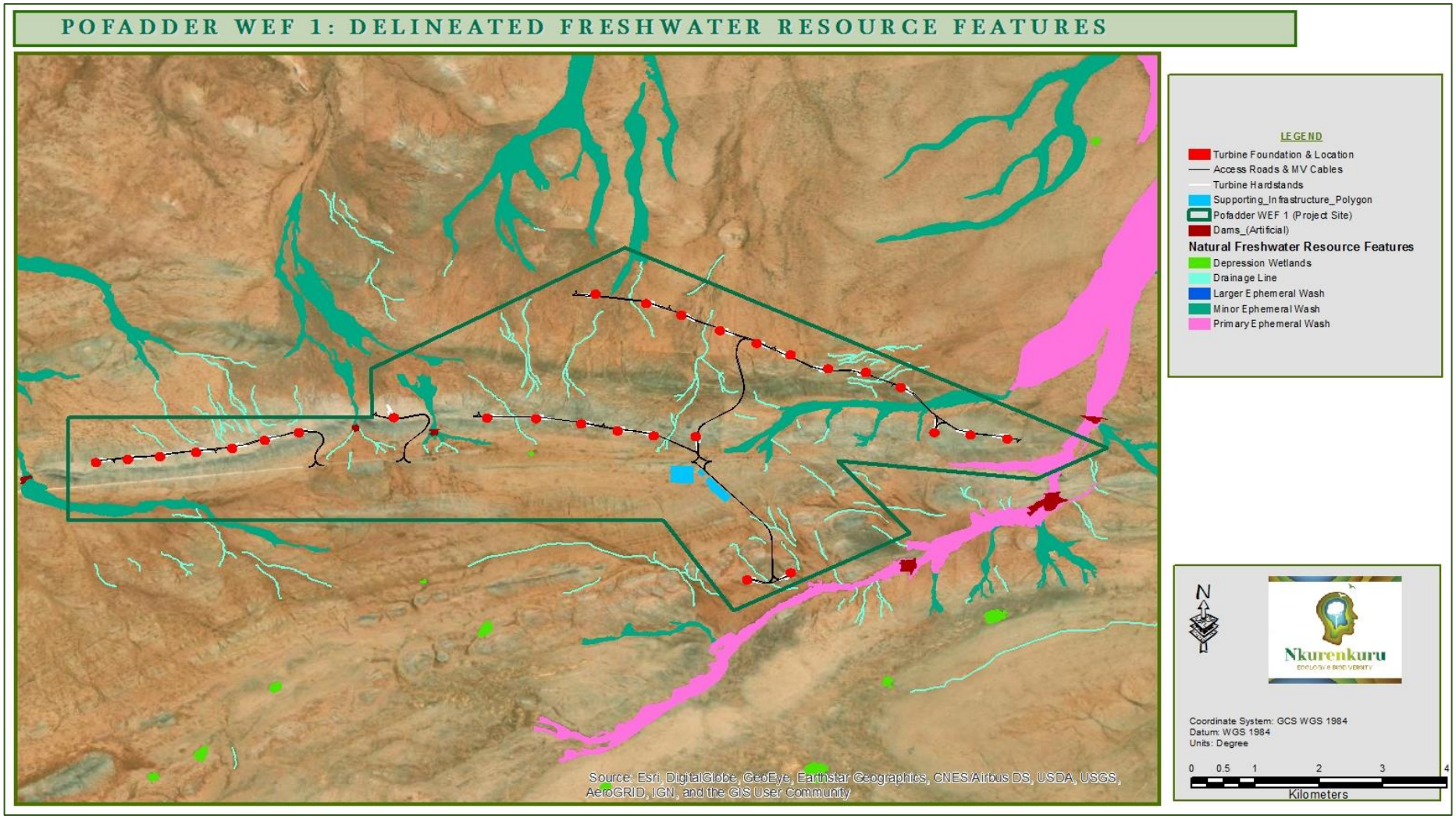


Figure 7: Aquatic/Freshwater Resource Features delineated and classified within the project site for the Pofadder WEF1 development.

## 5.2. Classification and Description of Surface Water Resource Features

### Wetland Features:

Soil and vegetation sampling in conjunction with the recording of topographical features enabled the delineation of one wetland units within the project site (Figure 7). Wetland ecosystems are in general the dominant drainage features in this landscape and comprised of ephemeral depressions (endorheic) hydrogeomorphic (HGM) units. Depression wetlands, also known as pans, form within shallowed-out basins within the flatter landscape areas and are generally closed systems that are inward draining (endorheic). This depression wetland is located outside of the proposed WEF development footprint and this wetland will not be impacted by the proposed development.

Such depression wetlands make up the majority of the lentic (non-flowing) systems of the greater landscape. This depression wetland is endorheic, i.e. isolated from other surface water ecosystems, usually with inflowing surface water but no outflow. There is generally little or no direct connection with groundwater, and this pan tends to be fed by unchanneled overland flow and interflow following rainfall events. Interflow is the lateral movement of water, usually derived from precipitation, that occurs in the upper part of the unsaturated zone between the ground surface and the water table. This water generally enters directly into a wetland or other aquatic ecosystem, without having occurred first as surface runoff, or it returns to the surface at some point down-slope from its point of infiltration. This depression wetland does however contain a small drainage line, which started as a small erosion feature.

Endorheic pans are the most common wetland type in arid and semi-arid environments (Allan et al., 1995), and are generally thought to form as a result of the synergy of a number of factors and processes, including low rainfall, sparse vegetation, flat to gently sloping topography, disrupted drainage, geology (e.g. dolerite sills and dykes) grazing and deflation. The Bushmanland endorheic pans, or "vloere" as they are called locally, are one of the most extensive salt pan systems in South Africa (Mucina et al., 2006). These pans are highly variable in size and form.

Inundation periods for this wetland is very short-lived (days to a few weeks) following sufficient precipitation. Similarly, the frequency is highly variable, from less than once a year to once every few decades. The flat, central portion of this pan is mostly devoid of vegetation, with a zonation of plants occurring around the margin.

### Ephemeral Streams and Washes:

One major/primary wash, and 12 minor streams/washes were identified and delineated (Figure 7).

Arid streams and rivers can typically include discontinuous, ephemeral, compound, alluvial fan, anastomosing, and single-threaded channels, which vary due to a range of gradients (slopes), sediment sizes, and volumes and rates of discharge. Discontinuous ephemeral stream systems and alluvial fans are most prevalent in, but not restricted to, piedmont (foot hill) settings, while compound channels, anastomosing rivers, and single-thread channels with adjacent floodplains generally occupy the valley bottoms (Beven &Kirby 1993). Ephemeral and intermittent streams are the dominant stream types within the arid parts of southern Africa

The "master variable" responsible for shaping such an ephemeral watercourse is associated with the flow regime of the system, which includes variations and patterns in surface flow magnitude, frequency, duration, and timing (Poff et al., 1997). It follows that the size and shape of a watercourse is controlled in large part by the dominant discharge in a particular region (Lichvar & Wakeley, 2004). Fluvial morphology is frequently associated with extreme discharge events; streams and floodplains trap sediments and nutrients in addition to attenuating flood waters (Graf 1988; Leopold 1994).

These delineated features represent larger and wider watercourses that include broad watercourses that may lack distinct channel development and are referred to as Washes or Wadis in Arabia, Arroyos in Spanish, and Laagtes in Afrikaans. These washes are all classified as Lower Foothill River in terms of the national classification system. Washes are typically discontinuous, diffuse channels on a flat topography in dry environments. Washes that lack distinct channel features do often display braided channel configuration referred to as bar and swale topography. Discontinuous streams can also display a stream pattern characterized by alternating erosional and depositional reaches. A summary of the classification and description of the various ephemeral washes/streams identified within the DWS regulated area are provided below in Table 7.

Smaller Ephemeral Channels and Drainage Lines:

Represent linear and narrow watercourses in the form of headwater drainage lines (second order drainage lines and channels). A total of fifty-eight (58) drainage lines where identified within the project site (Figure 7). These features were captured as lines during the delineation process and are expected to be consistent with the NWA watercourse definition of 'natural channels that flow regularly or intermittently'. They can be marginal in nature with discontinuous or poorly developed channels that represent swales due to poor channel development in arid areas with low rainfall, high evapotranspiration and high infiltration in areas with sandy soils. No hydromorphic (wetland soil) or hydrophyte (wetland plant) indicators were recorded in these watercourses. Aerial imagery interpretations identified linear features with textural changes that were regarded to be associated with areas of preferential flows during cyclic surface flow events that can occur at frequencies that are several years apart. These features were considered as drainage lines and ephemeral channels.

These drainage systems differ from downstream reaches due to a closer linkage with hillslope processes, higher temporal and spatial variation, and their need for different protection measures from land use activities (Gomi et al. 2002). These drainage lines are never or very seldom in connection with the zone of saturation and they consequently never have base flow and are unlikely to support wetland conditions.

These drainage lines can contain discontinuous channels due to lower annual rainfall, longer rainfall intervals, and low runoff versus infiltration ratio due to greater transmission losses (Lichvar et al., 2004). Discontinuous channels are more common on low gradient topographies (e.g. basins and plains) in arid and semi-arid environments, with deeper substrates that result in lower energy fluctuations and greater water recharge into the surrounding soils during flow events.

These systems form part of a continuum between hillslopes and stream channels, which can be generally classified into four topographic units (Gomi et al. 2002):

- Hillslopes have divergent or straight contour lines with no channelised flow.
- Zero-order basins have convergent contour lines and form unchannelised hollows.
- Transitional channels (temporary or ephemeral channels) can have defined channel banks, as well as discontinuous channel segments along their length, and emerge out of zero-order basin. They form the headmost definable portion of the drainage line network (first-order channels) and can have either ephemeral or intermittent flow.
- Well defined first and second-order streams that are continuous with either intermittent or perennial flow.

Table 7: Summary of delineated freshwater resource features.

| Stream/ Wash | Summary | | General Description |
|---|---|---|---|
| Primary/Major Ephemeral Washes | Longitudinal Zone | Lower Foothill | The ephemeral Kaboep River is the most important hydrological features within project site and immediate surroundings.<br><br>This ephemeral wash appears to contain very old, well-established and stable floodplains – typical of the pre-river optimal runoff accumulation and flow systems of southern African drier ecosystems. In fact, the formation of cut-out sand-filled washes and larger rivers is actually the result of slow but persistent destabilisation of these floodplains. Historical records of the mid 18-hundreds by missionaries show that these floodplains, due to their configuration and seasonal abundance of grazing, were not only the preferred migration routes for wildlife, but were also used by indigenous tribesmen to drive large herds of livestock between winter- and summer grazing fields over vast distances (e.g. Vedder 1991).<br><br>The ecosystem processes here can be summarised as follows:<br>» This wash is a relatively continuous fluvial system, accumulating runoff from higher undulating areas towards the Orange River, but always with the possibility of a unidirectional flow of water to lower-lying areas<br>» This system is relatively wide, occasionally with wider lower-lying plains, thus runoff is seldom concentrated in a narrower channel<br>» As there is unidirectional flow of water, and, depending on rainfall volumes, flows may be high, there is accumulation of silts and sandy loams, but not an accumulation of excess minerals (as in pans where the water ends up).<br>» The deeper alluvial deposits enable a higher retention of water during moist seasons, which enables the establishment of a relatively permanent vegetation layer (shrubs and grasses) |
| | Valley Confinement | Mostly broad floodplain. Channels, where present, incised into floodplains which may occasionally be confined in some locations (mostly on one side) | |
| | Channel Classification | Mostly diffuse. Shallow channels may form in some locations along these washes. Channels may be single to multiple | |
| | Channel pattern | Shallow meandering to Multi-thread (braided) with moderate sinuosity | |
| | Length of Reach | 21.5 km (Total length of river ±96.7km) | |
| | Slope | ~1.7% | |
| | Drainage Direction | Reach: North-eastern direction, however apart from this reach the river tends to flow in a north-western direction. | |
| | Width | Varying. Between 300 m and 700 m | |

| | | | |
|---|---|---|---|
| | Morphological Units | Flat sand bed, with the occasional shallow channel (single or multiple), or alluvial plane bed | » Fine-grained soils (accumulated from thousands of years of occasional runoff) generally have a low infiltration rate and surface layers dry out very quickly, but the vegetation layer does not only slow down accumulated runoff, but also significantly increases moisture infiltration to such degree that ground water reserves can also be significantly replenished.<br>o Note that excessive minerals are effectively filtered out by these layers of fine-textured soils before being able to get into the ground water, and then periodically flushed out to lower-lying large pan systems<br>» Whilst there is thus a high permanent shrub component, reaching up to 6 m height in places and providing nesting, shelter, browsing, there is also the potential for a strong palatable dwarf shrub and herbaceous (grass) layer, which will provide valuable grazing beyond the rainfall season.<br>» The larger – wider and longer these valley floor systems - the more valuable they become as migration corridors for game and livestock.<br><br>Areas of higher soil deposition/accumulations within these larger ephemeral washes are unique features with their composition and ecosystem processes intermediary between large pans and the typical ephemeral washes. Soils within these sections have been deposited through thousands of years by runoff events from surrounding higher-lying areas. However, if flooding events are large enough there is some unidirectional flow either into lower-lying drainage lines or associated pans. Otherwise, runoff will accumulate and remain stationary similar to pan systems, thus soils generally appear to have a higher mineral content (higher than valley floors), but do not reach the high mineral accumulation levels of pans. This, as well as underlying geology (often with a high amount of surface rockiness), leads to very differential water infiltration and retention levels, and thus also a very varied mosaic of vegetation. Some of these areas show numerous developments of small washes, whilst others have distinct banded vegetation interspersed with large bare patches. After sufficient rainfall events, it can be expected that the herbaceous layer will change significantly. The prevalence of standing |
| | Sediment | » Deeper accumulations of fine-grained silt and occasional coarse sand on extensive valley floors<br><br>» Channel centres with deeper alluvial deposits, with or without rock boulders, banks usually with clay-enriched soils | |
| | Key plant species | *Rhigozum trichotomum, Lycium pumilum, Salsola rabieana, Rosenia humilis, Phaeoptilum spinosum, Asparagus bechuanicus, Stipagrostis ciliata, Salsola tuberculata, Eriocephalus pauperrimus, Pentzia incana, Plinthus cryptocarpus, Aristida congesta.*<br><br>Areas of high soil accumulation is characterized with:<br>*Rhigozum trichotomum, Salsola melanantha, Salsola tuberculata, Parkinsonia africana, Stipagrostis ciliata, Eriocephalus pauperrimus, Eriocephalus ericoides, Salsola namaqualandica, Lycium pumilum, Enneapogon desvauxii* | |

| | | | |
|---|---|---|---|
| | | | surface water is expected to be extremely limited, hence it is expected that invertebrate populations will not show the same dynamics as in pans. However, occasional high grass cover will lead to a seasonal preferred grazing area. Again, the slightly higher salinity of the soils leads to a shorter-lived and less sustainable herb layer than the valley floors. This variety of soil surface characteristics and topsoil depth creates a diverse range of microhabitats, and accordingly species composition varies across these different sections and is overall very high although local species diversity is average. |
| **Minor Ephemeral Washes** | Longitudinal Zone | Mostly lower foothills | These smaller washes are typically found within smaller valley floor areas, indicating that these smaller valley floors do not have the same flood-buffering capacities as the larger ephemeral washes. Generally, the steeper the surrounding undulating low slopes, the larger the drainage lines with a more pronounced and deeper sand-bed in the centre, resulting from many centuries of accumulation of sands.<br><br>The riparian vegetation consists of a relatively dense low shrub. High shrub cover within the riparian vegetation is extremely variable, ranging from almost none to dense stands of *Lycium*, *Phaeoptilum* and *Rhigozum.*<br><br>These smaller, more isolated valley floor systems in general were found to be more prone to degradation – often visible by the formation of smaller washes and/or occasional dense encroachment by spiny high shrubs, most notably of *Rhigozum trichotomum*. It was then also quite significant that these smaller valley floor systems had a much lower apparent utilisation by livestock and game, although the presence of smaller fauna (birds, rodents) still seemed higher than on surrounding plains. |
| | Valley Confinement | More isolated valley floor systems. Valley floors confined mainly on one side, but may occasionally become confined on both sides (where the watercourses cut through ridges). Channels are typically shallow incised. | |
| | Channel Classification | Highly varying. Sections may be diffuse whilst other portions may contain very shallow channels. Channels mostly single, however occasionally multiple channels may be present. | |
| | Channel pattern | Where present, mostly slightly meandering with straight sections. Lower reaches may become slightly braided with a few shallow channels. | |
| | Length | Highly Varying: between 99 m to 3.5 km (~ 700 m) | |
| | Slope | ~1.9%. | |
| | Drainage Direction | Various directions. Drain mostly towards the larger ephemeral washes. | |
| | Width | Highly varying: Between 20m and 250m (~ 70 m) | |
| | Morphological Units | Flat sand bed, with the occasional shallow channel (single or multiple), or alluvial plane bed | |

| | | | |
|---|---|---|---|
| | Sediment | Shallow to somewhat deeper accumulations of fine to moderately grained, light red, alluvial sand with minor silt silt along small ephemeral washes between quart, calcrete and sandy plains. | |
| | Key plant species | *Lycium bosciifolium, Rhigozum trichotomum, Plinthus cryptocarpus, Pentzia globosa, Pentzia incana, Galenia africana, Sericocoma heterochiton, Setaria verticillata* | |
| **Drainage Lines/Channels** | Longitudinal Zone | Upper Foothill Headwater Drainage Lines | Represent linear and narrow watercourses in the form of headwater drainage lines. These drainage systems differ from downstream reaches due to a closer linkage with hillslope processes, higher temporal and spatial variation. These drainage lines are never or very seldom in connection with the zone of saturation and they consequently never have base flow and are unlikely to support wetland conditions.<br><br>The riparian vegetation consists of a relatively sparse low shrub layer dominated by *Rhigozum trichotomum.* |
| | Valley Confinement | Narrowly V-shaped | |
| | Channel Classification | Single and straight | |
| | Channel pattern | Narrow drainage channels over bedrock or coarse and/or medium gravel, overlying bedrock | |
| | Length | ~210 m (Max: 591 m and Min: 27 m) | |
| | Slope | ~2.2% | |
| | Drainage Direction | Various directions | |
| | Width | Seldomly wider than 10m | |
| | Sediment | Mainly bare bedrock or bedrock covered by course coarse gravel and in some locations a thin layer of gritty sand. | |
| | Key plant species | *Plinthus cryptocarpus, Pentzia globosa, Lycium bosciifolium, Pentzia incana, Rhigozum trichotomum* | |
| **Depression Wetland** | Size | 0.4ha | Fine silt and clay particles that have been layered here are fine enough to have filtered out most of the dissolved salts/minerals that have been washed off higher-lying areas. These minerals were accumulated because runoff accumulating here is not distributed or moved over larger areas, but will gradually either evaporate or infiltrate, hence the sodic content of the alluvial deposits in the pans is generally higher than in all other fluvial systems. |
| | Slope | 1.7% | |
| | Landscape Unit | Valley Floor | |
| | Outflow Drainage | No outflow (Endorheic) | |
| | Inflow Drainage | Via unchanneled overland flow (diffuse) | |
| | Hydroperiod | Saturation Period: Intermittently<br>Inundation Period: Intermittently to rarely inundated | |
| | Drainage Direction | Various directions | |

| | | | |
|---|---|---|---|
| | Sediment | Orthic A horizon overlying a loose, friable, sandy to grainy-sandy, "faded" E horizon. In some, isolated localities, this E horizon may overly a Neocutanic B horizon, however the presence of this horizon was relative scarce. The dominant soil form is Fernwood, although Vilafontes were also recorded (where a Neucutanic B horizon underlies the E horizon).<br><br>Typically, the orthic A horizons of the center portions of these wetland areas comprise of light reddish brown to almost pink soil which transition into soils with slightly darker hues and chromas (light brown to reddish yellow to red along the peripheries of the depression wetlands). According to the Munsell Soil Chart (Munsell Soil Chart, 2009) the hue, chroma and value of the Orthic A horizons varied, from the interior to the outer periphery, from 2.5YR//4 to 7.5YR/6/4 to 7.5YR/6/8 to 2.5YR/5/8. In some areas these top horizons may contain a low amount of silt. Underlying the Orthic A horizon are, as mentioned a paler, structureless E horizon. Soils within this horizon have undergone iron reduction with lateral flow through this horizon and have resulted in the lighter, somewhat bleached colouring. Most of the soil samples taken indicated a pink E horizon (7.5YR/8/4 or 7/4).<br><br>From the reduced soil characteristic, it is clear that these depression wetlands experience occasional saturation and are regarded as ephemeral systems that are likely only saturated for short periods of time following sufficient rainfall events, and may remain dry for extended periods of time (several years). | Inundation of pans with standing water will be scarce, but thorough wetting of the soils will result in deep, 'sticky' muds. Even very shallow and short-lived surface water resulting from sufficiently large rainfall events will not only serve as surface water for fauna, but due to the higher mineral content be a breeding ground for several specially adapted invertebrates. These may then appear in very large numbers, becoming a valuable source of food to birds and reptiles. Less saline zones on the outer edges of the pans will change into a short-lived green belt of low vegetation, which will provide mostly habitat for invertebrates to lay eggs for the next generation.<br><br>The mostly spiny vegetation persisting in these pans can withstand the higher soil salinity, but this is at the cost of reduced growth, hence the apt defence against grazers to minimise damage to above-ground plant structures in a harsh environment. The contribution of these pans to grazing will only be on and around the outer edges of these pans, where seasonal higher soil moisture in less saline soils can support more palatable vegetation during periods of rainfall. |
| | Key plant species | *Rosenia spinescens, Salsola rabieana, Stipagrostis ciliata, Salsola tuberculata, Rosenia humilis, Monechma incanum, Lycium pumilum* | |

## 5.3. Present Ecological State (PES)

The surface water resource features (wetlands, larger washes and drainage lines) have been assessed based on the three wetland driving processes (responsible for wetland formation and maintenance); Hydrology, Geomorphology and Water Quality as well as Vegetation Alteration (provides an indication of the intensity of human land use activities).

The results of the PES assessments are summarised in Tables 8 and 9 below.

Table 8: Summary results of the river IHI (Index of Habitat Integrity) assessment.

| Freshwater Resource Feature | HABITAT COMPONENT | | |
|---|---|---|---|
| | Instream PES Category with % Intact | Riparian PES Category with % Intact | Overall PES (weighted 60:40) |
| Primary Ephemeral Wash | A: Natural/Unmodified (94% intact) | B: Largely Natural (89% intact) | A: Natural/Unmodified (92% intact) |
| | | | |
| Minor Ephemeral Washes | B: Largely Natural (86% intact) | B: Largely Natural (83% intact) | B: Largely Natural (85% intact) |
| | | | |
| Drainage Channels | A: Unmodified (94% intact) | B: Largely Natural (81% intact) | B: Largely Natural (89% intact) |

Table 9: Results of Level 1 Wet-Health Assessment.

| Hydro-geomorphic Unit | Hydrology | Geomorphology | Vegetation | Overall PES |
|---|---|---|---|---|
| Depression Wetland | A: Natural/Unmodified (PES Score: 0) | A: Natural/Unmodified (PES Score: 0) | C: Moderately Modified (PES Score 2) | A: Natural/Unmodified (PES Score: 0.57) |

Very little change has occurred to the hydrological and geomorphological characteristics of most of the freshwater resource features. The vegetation characteristics of all of these freshwater resource features have been impacted by grazing in the past and have allowed for some encroachment of especially *Rhigozum trichotomum* within the ephemeral wash and drainage systems and *Rosenia spinescens* within some portions of the depression wetland. The smaller ephemeral washes that cut through the linear ridge have been dammed by small gravel dams just above their points of narrowing. The primary ephemeral wash has been dammed at two locations to the east of the project site (outside of the project site). Other, "minor" impacts include twin track crossings, farm fences, soil capping and sheet erosion. A few of the ephemeral washes to the north and east are crossed by the larger gravel access route.

Subsequently, the majority of these freshwater systems are still in a mostly natural, functional condition.

## 5.4. Wetland Ecological Importance and Sensitivity (EIS)

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

Ecological Importance and Sensitivity is a concept introduced in the reserve methodology to evaluate a wetland in terms of:

» Ecological Importance;
» Hydrological Functions; and
» Direct Human Benefits

A summary of the EI&S importance assessment scores and ratings for wetlands is provided in Table 10 below (also refer to Figures 8) and indicates the following:

» Depression Wetlands
- This depression wetland is considered to be ecologically important and sensitive.
- Ecosystem functions include:
  - Depression wetlands capture runoff due to their inward draining nature, reducing the volume of surface water that would either simply disappear into the soil or exit the area via drainage and stream channels.
  - This collection and retention of water, following rainfall events play an important role in the maintenance of biodiversity and the creation of special niche habitats.
  - Furthermore, temporary to ephemeral wet pans provide the opportunity for the precipitation of minerals including phosphate minerals because of the concentrating effects of evaporation. Additionally, Nitrogen recycling is also an important function of these wetlands.
- Such depression wetlands are known to contain important/unique invertebrate populations like branchiopods, crustaceans, and dipterans. These invertebrates can lay dormant (cysts/eggs) for many years and will hatch during periods of flooding providing, along reactivated algae, a valuable source of food for various faunal species, especially migrating and water birds, including Lesser Flamingos (Phoeniconaias minor) which is regarded as Near Threatened.
- As mentioned above such depression wetlands may provide important feeding sites for local and migrating faunal species.
- The contribution of these pans to grazing will only be on and around the outer edges of these pans, where seasonal higher soil moisture in less saline soils can support more palatable vegetation during periods of rainfall.

- The ephemeral nature of the wetlands mean that the wetlands will be fairly sensitive to further reductions and changes in the natural hydrological regime. This may have a significant impact on the floral composition of these areas and may result in a reduction in water supply and a collapse in invertebrate populations.

» Major Ephemeral Streams/Washes

- All major ephemeral streams/washes are considered to be ecologically important and sensitive.
- The braided channel network and "vloere" of most of the washes contribute slightly to diversity in vegetation and geomorphological structure but more significantly to patchiness.
- Furthermore, deeper pools within these systems may contain important/unique invertebrate populations like branchiopods, crustaceans, and dipterans. These invertebrates can lay dormant (cysts/eggs) for many years and will hatch during periods of flooding providing, along reactivated algae, a valuable source of food for various faunal species, especially migrating and water birds.
- The morphological heterogeneity of these features and their associated vegetation contribute to habitat diversity within the region and valuable resources, not only for faunal species associated with these habitats, but for faunal species in general.
  - The softer sand of the floodplains is preferred by burrowing species such as Bat-eared Fox, Cape Porcupine, Aardvark, Aardwolf and small rodents etc.
  - The patches of taller shrubs attract and provide nesting and feeding site for numerous avifaunal species and provide shelter and browsing for antelope species such as Kudu, Steenbok and Common Duiker
- Dry watercourses are known to serve as important migration routes and corridors, especially the more extensive habitats.
- These systems provide inter alia the following ecosystem services
  - Convey floodwaters.
  - Help ameliorate flood damage.
  - Maintain water quality and quantity.
  - Provide habitat for plants, aquatic organisms, and wildlife; and determine the physical characteristics and biological productivity of downstream environments.

» Smaller Ephemeral Washes/Streams and Drainage Features

- All smaller ephemeral washes and drainage channels are considered to be of high ecologically importance and sensitivity.
- These smaller, valley floor and drainage systems in general were found to be more prone to degradation – often visible by the formation of smaller washes and/or occasional dense encroachment by spiny high shrubs, most notably of Rhigozum trichotomum. It was then also quite significant that

these smaller valley floor systems had a much lower apparent utilisation by livestock and game, although the presence of smaller fauna (birds, rodents) still seemed higher than on surrounding rocky plains.

- These systems convey floodwater into and out of the ecologically important and sensitive larger washes and subsequently play an important role in the maintenance of these, more important, system.
- Furthermore, the vegetation of these drainage lines help reduces flood damage to downstream habitats and subsequently contribute to the maintenance of biological productivity of downstream environments.

Table 10: Score sheet for determining the ecological importance and sensitivity for the identified surface water resource features.

| DETERMINANT | | IMPORTANCE SCORES (0-4) AND RATINGS | | | |
|---|---|---|---|---|---|
| | | **Major Ephemeral Washes** | **Minor Ephemeral Washes** | **Ephemeral Drainage Lines** | **Depression Wetland** |
| **PRIMARY DETERMINANTS** | Rare & Endangered Species | 3 | 3 | 0 | 1 |
| | Populations of Unique Species | 2 | 2 | 0 | 2 |
| | Species/taxon Richness | 2 | 1 | 1 | 1 |
| | Diversity of Habitat Types or Features | 4 | 3 | 1 | 2 |
| | Migration route/breeding and feeding site for wetland species | 4 | 2 | 2 | 4 |
| | Sensitivity to Changes in the Natural Hydrological Regime | 3 | 2 | 3 | 3 |
| | Sensitivity to Water Quality Changes | 2 | 3 | 2 | 3 |
| | Flood Storage, Energy Dissipation & Particulate/Element Removal | 3 | 3 | 3 | 3 |
| **MODIFYING DETERMINANTS** | Protected Status | 3 | 1 | 1 | 1 |
| | Ecological Integrity | 4 | 3 | 4 | 4 |
| **TOTAL** | | 26 | 26 | 30 | 24 |
| **MEDIAN** | | 2.5 | 4 | 3 | 2.5 |
| **OVERALL ECOLOGICAL SENSITIVITY & IMPORTANCE** | | **A Very High** | **B High** | **C Moderate** | **B High** |

According to the current layout of the development footprint, all "Very High" sensitive ephemeral wash systems are located well away from planned infrastructure, and the development will not have a direct impact on these features.

The "High" sensitivity areas coincide with the smaller ephemeral washes (tributaries of the primary ephemeral wash) and the depression wetland. In order to avoid any detrimental impacts on these minor ephemeral features' functions, services and ecological drivers a 50m buffer is recommended around the ephemeral washes and depression wetlands (refer to Section 5.5). Development within these freshwater resource features as well as their

buffer areas should be largely restricted. The use/upgrade of existing access routes and minimal construction of new routes and the laying of underground mv cables are the only activities allowed within these areas. According to the current layout, only one such ephemeral wash feature will be impacted by the proposed development, through a single access road and the lying of an underground mv cable. With the necessary mitigation measures in place, this watercourse crossing can be regarded as acceptable and will not impact the ecosystems integrity and ability to perform its important ecological functions and services. All other minor ephemeral wash features as well as the depression wetland along with their buffer areas (refer to Section 5.5) will be successfully avoided.

The drainage lines ephemeral washes and depression wetlands are slightly less important than the ephemeral wash features and are subsequently regarded as "Medium/Moderate" sensitive. In order to avoid any detrimental impacts on these features' functions, services and ecological drivers a 35m buffer is recommended around the drainage lines. Development within these drainage lines as well as their buffer areas should be largely restricted. The use/upgrade of existing access routes and minimal construction of new routes and the laying of underground mv cables are the only activities allowed within these areas. According to the current layout, only nine such feature will be impacted by the proposed development, through the construction of access roads and the lying of an underground mv cables. With the necessary mitigation measures in place, these watercourse crossings can be regarded as acceptable and will not impact these ecosystems' integrity and ability to perform its ecological functions and services.

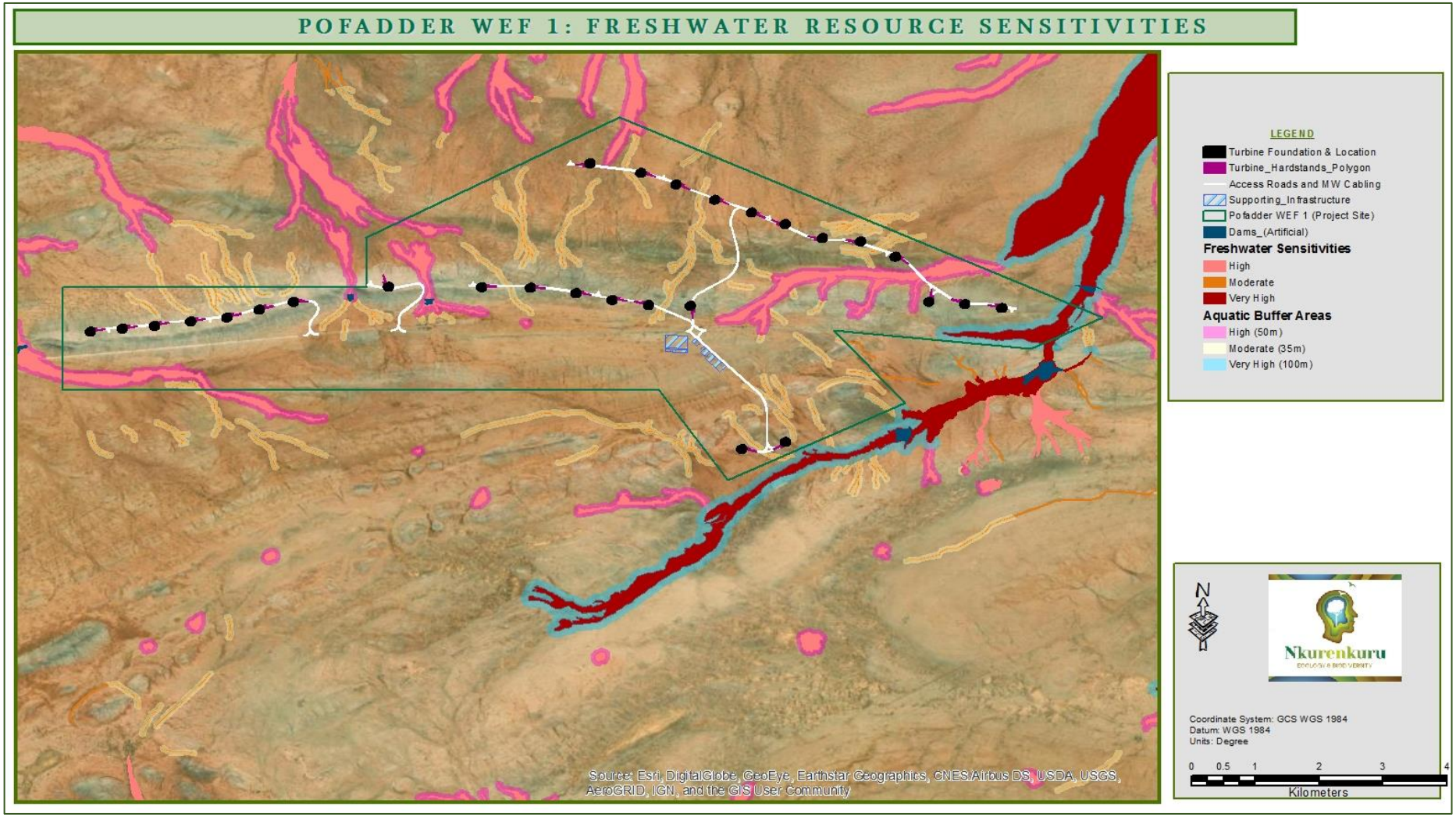


Figure 8: Aquatic/Freshwater Resource Sensitivity mapping of the Pofadder WEF 1's project site.

## 5.5. Wetland Buffer Zones

The recommended buffers are in line with the watercourse and wetland buffers that have been recommended in the Strategic Environmental Assessment for Wind and Solar Photovoltaic Energy in South Africa (CSIR, 2015) and are deemed appropriate to the aquatic features and the proposed activities within the project site.

» For the Kaboep River and larger ephemeral washes, 100m buffer areas, measured from the outer edge of channel or delineated floodplain is recommended (whichever is the furthest).
  - These buffer areas regarded as "Very High" sensitive features due to their associated with the "Very High" sensitive freshwater resource features.
  - These buffer areas should be regarded as no-go areas for the location of wind turbines, construction camps, substations, batching plants, laydown areas or any other building infrastructure.
  - In terms of access roads, it recommended that existing farm roads are used as far as possible (with the potential of being upgraded) with the construction of new access roads where now viable existing options exist.
  - Where the construction of new access roads are unavoidable, strict mitigation and monitoring measures should be implemented.
» For the minor ephemeral washes, 50m buffer areas, measured from the outer edge of channel or delineated floodplain is recommended (whichever is the furthest)
  - These buffer areas regarded as "High" sensitive features due to their associated with the "High" sensitive freshwater resource features.
  - These buffer areas should be regarded as no-go areas for the location of wind turbines, construction camps, substations, batching plants, laydown areas or any other building infrastructure.
  - In terms of access roads, it recommended that existing farm roads are used as far as possible (with the potential of being upgraded), however the construction of new access roads within these buffer areas are permitted, with the implementation of strict mitigation measures.
» For the depression wetlands, 50m buffer areas, measured from the outer edge of delineated wetland is recommended.
  - These buffer areas regarded as "High" sensitive features due to their associated with the "High" sensitive freshwater resource features.
  - These buffer areas should be regarded as no-go areas for the location of wind turbines, construction camps, substations, batching plants, laydown areas or any other building infrastructure.
  - In terms of access roads, it recommended that existing farm roads are used.
» For the small drainage channels, 32m buffer areas, measured from the outer edge of channel is recommended.

- These buffer areas regarded as "medium" sensitive features due to their associated with the "medium" sensitive freshwater resource features.
- These buffer areas should be regarded as no-go areas for the location of wind turbines, construction camps, substations, batching plants, laydown areas or any other building infrastructure.
- In terms of access roads, it recommended that existing farm roads are used as far as possible (with the potential of being upgraded), however the construction of new access roads within these buffer areas is permitted, with the implementation of strict mitigation measures.

## 5.6. Recommended Ecological Condition of Freshwater Resource Features

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

Based on the natural to largely natural ecological condition of the aquatic ecosystems (mostly a PES of B and the majority of the headwater drainage features being classified as A), their high to medium ecological importance and sensitivity and the catchment context of these freshwater resource features, the recommended management objective for all water resource units was assessed as being to 'maintain the current status quo of aquatic ecosystems without any further loss of integrity (PES) or functioning'.

It is highly unlikely that the proposed development will result in deterioration of the present ecological state, provided the recommended mitigation measures are implemented.

# 6. ASSESSMENT OF PROPOSED IMPACTS

## 6.1. Identification of Potential Impacts and Associated Activities (General)

Freshwater ecosystems, are particularly vulnerable to human activities and these activities can often lead to irreversible damage or longer term, gradual/cumulative changes to these ecosystems. When making inferences on the impact of development activities on aquatic ecosystems it is important to understand that these impacts speak specifically to their effect on the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) or functional importance/value of aquatic ecosystems. All of these are linked to the physical components and processes of aquatic ecosystems, including hydrology, geomorphology and vegetation as well as the biota that inhabit these ecosystems. Anthropogenic activities can generally impact either directly (e.g. physical change to habitat) or indirectly (e.g. changes to water quantity & quality). Figure 14 shows how impacts to aquatic ecosystems such as habitat loss, flow modification and pollution can have a number of negative ecological consequences for the receiving aquatic environment, ranging from loss of sensitive species to reduced ecosystem goods & services provision.

Freshwater resource ecological impacts associated specifically with Pofadder WEF is discussed below. Potential impacts have been split into Construction- and Decommissioning Phase Impacts and Operational Phase Impacts.

According to the proposed layout, construction, operation and decommission will lead to potential direct and potential indirect loss of / or damage to freshwater resource features. This may potentially lead to localised loss of freshwater resources and may in-turn lead to downstream impacts that affect a greater extent of freshwater resources or impact on function and biodiversity. Where these habitats are already stressed due to degradation and transformation, the loss may lead to increased vulnerability (susceptibility to future damage) of the habitat. Physical alteration to freshwater resource features can have an impact on the functioning of those features.

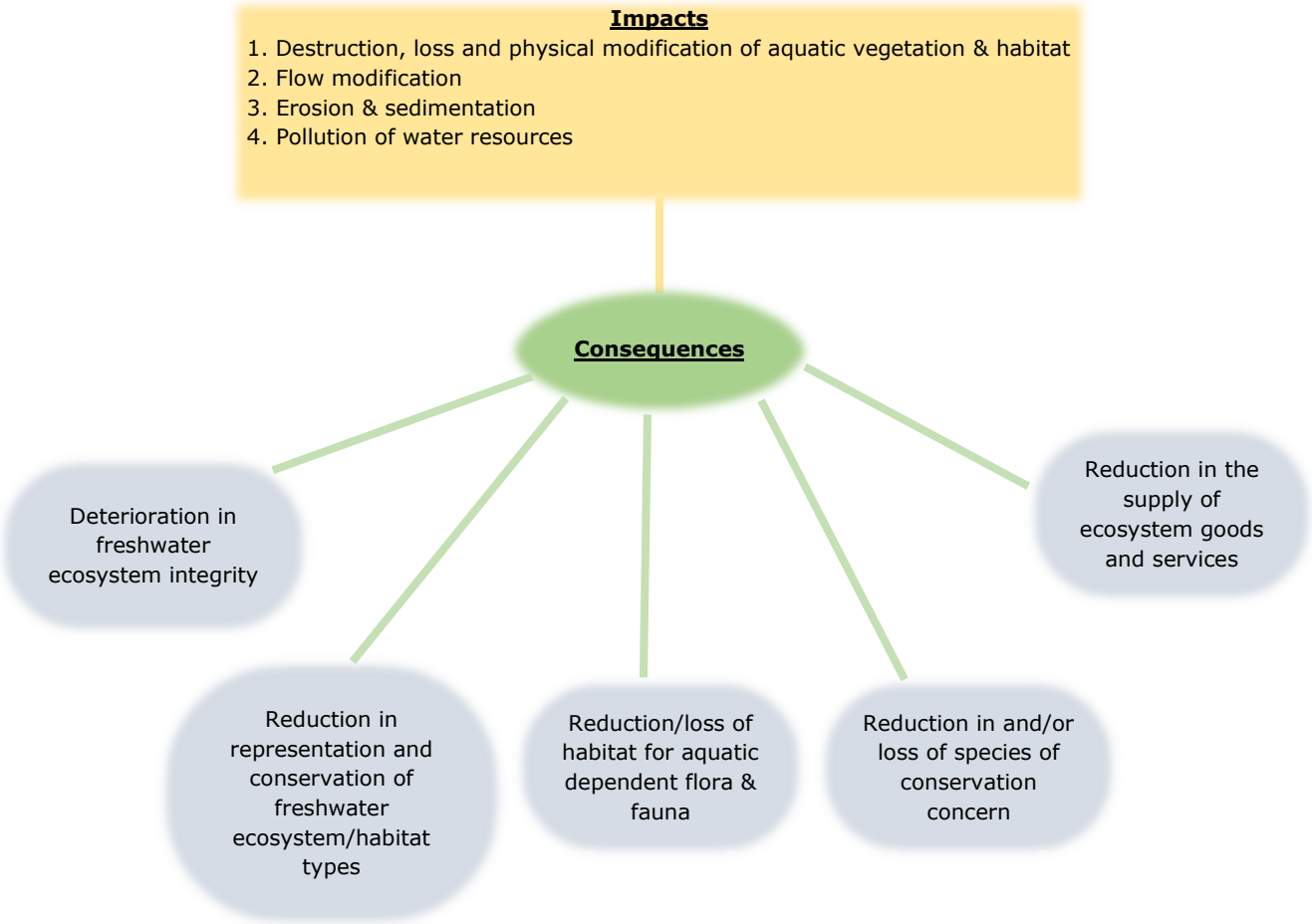


Figure 9: Negative ecological consequences for Freshwater Resource Features as a result of direct and indirect anthropogenic impacts.

### 6.1.1. Impact of Proposed Turbines and Supporting Infrastructure

Construction and Planning Phase

The Pofadder WEF 1 development is anticipated to require high intensity disturbance of a limited surface area at the site of each wind turbine. Concrete foundations for the turbine towers will need to be constructed as well as permanent hard standing bases of compacted gravel adjacent to each turbine location for the cranes used to construct the turbines. An internal substation, Battery Energy Storage Facility (3.6ha), warehouse, batching plant, and an Operational and Maintenance Building would also need to be constructed within the site. Temporary laydown areas and a construction site would need to be placed within the site for the construction works.

All of the above-mentioned supporting infrastructure are located well outside any freshwater resource features as well as their associated buffer areas and as such impacts on freshwater resource features will be avoided.

In terms of the location of the wind turbines, no wind turbines are located within any of the delineated freshwater resource features as well as their recommended buffer areas and as such direct impacts on freshwater resource features will be avoided.

Activities during the construction phase of the project could be expected to result in some disturbance of vegetation cover for clearing and preparation of the turbine and supporting infrastructure, this may potentially lead to some indirect impacts on downslope freshwater resource features. There is also the potential for some water quality impacts associated with the batching of concrete, from hydrocarbon spills or associated with the other construction activities on the site. Only a limited amount of water is utilised during construction for the batching of concrete for wind turbines and other construction activities.

Generally, with mitigation measures in place, impacts will be localised, short-term and of low intensity and is expected to have a low to very low overall significance in terms of its impact on the identified aquatic ecosystems in the area.

Operation Phase:

During the operation phase the turbines will operate continuously, unattended and with low maintenance required for the duration of the WEFs life (±20 years). The WEF is likely to be monitored and controlled remotely, with maintenance only taking place when required. The hard surfaces created by the development may lead to increased runoff, in particular on surfaces with a steeper gradient. This may lead to increased erosion and sedimentation of the downslope areas.

Subsequently, a localised long-term impact (more than 20 years) of low intensity (depending on the distance between the turbines and the freshwater features) could be expected that would have a very low overall significance post-mitigation in terms of its impact on the identified freshwater resource features in the area.

Decommission Phase:

During decommissioning, the potential freshwater impacts will be very similar to that of the Construction Phase, although the potential for water quality and flow related risks will be lower.

### 6.1.2. Impact of Proposed Associated Linear Infrastructure (Access Roads, MV Cabling and Internal Grid Line

Construction and Planning Phase

The internal access roads and MV Cabling will need to cross some freshwater resource features, some of which will be on existing gravel roads.

The proposed construction will involve the upgrade of the existing local road network and where no available routes are available, new routes will be constructed. It is envisaged that most of the proposed road development will be an upgrade of existing infrastructure, with only limited construction of new road sections and will include some of the typical activities described in the table below (Table 9 listing the activities likely to be associated with this development), taken from the South African pavement engineering manual, Chapter 12: Construction Equipment and Method Guidelines (SANRAL).

Table 11: Activities likely to be associated with this development.

| Road Construction Activity | IMPORTANCE SCORES (0-4) AND RATINGS |
|---|---|
| Roadbed preparation | Clearing of vegetation and associated organic material (roughly 200 mm) below the natural ground level and potentially up to 5m to the sides of the planned route.<br>» Where necessary, and possible, subsurface drainage is provided to drain the roadbed and ensure that dry conditions prevail.<br>» The quality of the in-situ soils are assessed to ensure compliance with the minimum requirements. Any unsuitable material is removed and replaced or treated to facilitate compaction of the pavement layers over this layer.<br>The roadbed must be effectively compacted to achieve the required density and in-situ shear strength. |
| Fills | Construction of fill embankments, either earth or rock fills will be required. |
| Cuts | Cutting back and stabilization of steep banks to prevent erosion. |
| Borrow Pit Establishment | Excavation, crushing and processing of appropriate stone materials required for construction. |
| Crushed stone base | This involves the construction of crushed stone and crushed slag-based layers. A crushed stone base is the most popular base in pavements constructed in South Africa. |
| Compaction of soils and gravels | Compaction of material layers is one of the most important determinants of the performance of a constructed fill or pavement structure. The effect of compaction on a material is to improve particle interlock and to reduce the voids between the particles. |
| Cementitious stabilisation | Stabilising road building material with cementitious agents such as cement and lime, or blends of cement with mineral components such as fly ash, ground granulated blast furnace slag and limestone is common practice in South Africa. |
| Modification of materials | In many situations, the available gravels do not meet the necessary requirements for the pavement layer. In these cases, the materials can be modified. Several physical or natural methods of modification are available, which are used depending on the availability of materials. Should the necessary material not be available, then chemical modification may be used. |
| Concrete pavements | Concrete pavements are rigid pavement structures that are generally constructed using slipform or side form pavers. |
| Proprietary products | The construction of layers using proprietary products is essentially the same as the construction of granular layers. The products are typically used as a compaction aid for granular materials. The manufacturer may, however, have special requirements that should be followed. |

| | |
|---|---|
| Construction of watercourse crossings | This includes the construction of culverts and bridges where the road crosses watercourses. These crossings are designed according to SANRAL's Drainage manual with a key focus on limiting the risk of damage to the road from flooding. |
| Installation of road drainage | Surface drainage involves the installation of a drainage system to effectively remove water from the road surface in order to limit risks to road users. This includes the construction of surface drainage, minor culverts and discharge points to deflect flows away from the road surface and sensitive embankments. |
| Cold recycling | Recovery and reuse of material from an existing pavement without the addition of heat. The cold recycling process, which has become a very popular construction method since the introduction of in-situ recycling machines. The shortage of construction material, especially in built-up areas, has resulted in the process becoming very popular as a rehabilitation option for strengthening pavement layers |

In terms of watercourse crossings, the following methods/options will most likely be used:

» For seasonal to ephemeral watercourses with sandy substrates and gentle gradients:
  - Stabilising of road structures up to level of watercourse bed, so water continues to flow across the road.
» For larger seasonal watercourses with stronger flows, deeper channels and steeper embankments:
  - Building up of the road structure to level of terrestrial land adjacent to river bed, with culver systems incorporated for water to pass below road.

The major direct impacts associated with the internal roads relate to the:

» Transformation and/or loss of habitat within the rivers and riparian areas (e.g. habitat infilling for road fill embankments, alteration of profiles at crossings)
» Transformation and/or loss of indigenous vegetation within the riparian zones;
» Potential invasive alien plant growth;
» Potential flow and water quality impacts; and
» Potential impacts on the soil (erosion of watercourse channels).

Freshwater riverine vegetation and habitat can be impacted directly through the complete removal or partial disturbance of existing indigenous riparian and vegetation during the construction of the watercourse crossings (stripping of vegetation and infilling), leading to the deterioration in the ecological condition of aquatic vegetation and availability of habitat supporting aquatic biota. This is associated with the construction footprint being located within or across a watercourse and by machinery and workers accessing the site. In many cases, clearing and disturbance is not only limited to the construction zone and may include areas used by machinery and workers to access the site and to construct temporary drainage, storm water and erosion control measures. The result is either the complete loss or the disturbance and partial loss of indigenous vegetation communities and habitat in the broader area. Likely secondary consequences of such direct physical disturbance

impacts include a reduction in channel bank stability, exposed bank erosion and in-stream and riparian habitat sedimentation down slope and downstream. Also, in general, with increased human presence associated with construction projects, increased pressure on natural resources may result through the hunting/poaching/trapping of fauna as well as the harvesting of indigenous plants for various uses. Noise and dust caused by human activities can also affect the use of adjoining habitat by various species. The construction/upgrade of the watercourse crossings will result in the trampling and destruction of watercourse vegetation. Excavation activities associated with the road crossings and the installation of the underground cables, will require complete and permanent (for road crossings) removal of vegetation within the watercourses. Movement of construction vehicles within the construction sites will also result in trampling of vegetation within the watercourses and riparian zones and could extend beyond the immediate watercourse crossing footprints for access purposes.

Local loss of riparian and instream vegetation and habitat, the vicinity of the construction area. Careless and uncontrolled construction activities can result in a deterioration in the Present Ecological Status of these watercourse reaches as well as reduce the ability of these features to fulfil their functions and services. However, the magnitude/severity of these impacts can be greatly reduced (to acceptable levels) through the implementation of effective mitigation measures. Such mitigation measures will ensure that the RECs of the affected watercourse reaches are preserved and that impacts are restricted to a local scale (within the vicinity of the construction area). The preparation of the roadbed involves the complete removal of all existing indigenous vegetation and topsoil within the road footprint. The impact from clearing and disturbance is not limited to the construction zone however and will include areas used by machinery and workers to access the site and to construct ancillary infrastructure such as road drainage and erosion control measures. The result is either the complete loss (within the road bed and embankment footprint) or the disturbance and partial loss of indigenous vegetation communities (broader road reserve), impacting directly on the ecological condition and functionality of these ecosystems.

Potential indirect impacts associated with the internal roads may include the following:

- Habitat fragmentation: Fragmentation of habitat and reduced ecological connectivity
  - Alteration in faunal movement and floral dispersal (impacting plant species recruitment):
  - Interruption of important movement/migration corridors.
- Reduced habitat patch size and core to edge ratio
  - Increased stress to sensitive habitats and species, alteration of the composition of communities and the displacement of sensitive species.
- Increased intensity of edge disturbances, as a result of construction activities (e.g. noise, dust and light pollution)
  - Alteration of the composition of communities and the displacement of freshwater fauna sensitive to human presence, noise pollution and light pollution.

- Increased intensity of dust pollution, smothering of vegetation with dust, increased plant stress and mortality, alteration of plant species composition, degradation in habitat condition.

» Invasion of construction corridor with alien invasive species and increased alien invasive propagule sources within proximity to the freshwater habitats. Increased alien invasive plant invasion, alteration of plant species composition, degradation of freshwater habitat.

Based on the current layout one minor ephemeral wash and nine small drainage lines will be crossed by access roads and mv cabling. A localised short- and longer-term impact of low significance is expected on the identified freshwater resource ecosystems in the area at the points at which the infrastructure will need to cross of rivers/drainage lines or wetland areas, during and after the construction phase. The disturbance would largely take place during the construction phase. However, a long-term disturbance of the aquatic habitat at the road crossings could also be expected during the operation phase.

Operation Phase:

An impact of low significance is expected on any of the aquatic features that would be associated with maintenance activities and the fact that there will be an increase in the extent of road surface area as a result of the upgraded of the existing access roads and the potential construction of new watercourse crossings (only where no existing watercourse crossing exists).

A localized longer-term impact of low intensity may occur, that is expected to have a low overall significance in terms of its impact on the identified aquatic ecosystems in the area.

The longer-term maintenance activities during the operation phase: Road development and trenching (underground cables) across watercourses and in the vicinity of watercourses is likely to introduce unnatural disturbance to the aquatic ecosystems and habitat and generally promotes the establishment of disturbance-tolerant species, including colonization by Invasive Alien Plants (IAPs), weeds and pioneer plant species, particular where there is an existing seed source for these plants nearby. Although this impact is initiated during the construction phase of the project, it is likely to persist well into the operation phase. IAPs can have far-reaching detrimental effects on native biota and has been widely accepted as being a leading cause of biodiversity loss in South Africa. They typically have rapid reproductive turnover and are able to outcompete native species for environmental resources, alter soil stability, promote erosion, change litter accumulation and soil properties and promote of suppress fire. In addition, certain alien plants exacerbate soil erosion whilst others contribute to a reduction in stream flows thereby potentially increasing sediment inputs and altering natural hydrology of receiving watercourses.

Potential impacts associated with the internal roads may include the following:

» Direct transformation and modification of habitat
  - Direct destruction and/or disturbance of aquatic habitats during maintenance and repair activities. This may intern have an effect on local functionality and biota.
  - Indirect impacts resulting from the alteration of hydrological and geomorphic processes as a result of activities outside of and within the freshwater resource features.

» The increase in road surface will likely result in an increase in surface runoff / stormwater discharges to the freshwater resource features. Road networks tend to intercept, direct and concentrate flows which potentially may change the volume and timing of peak flows reaching aquatic ecosystems. This increase in peak discharge may significantly increase the stream power, thereby increasing the risk of erosion and channel incision. In addition, the diversion of flow through culverts at road crossings will narrow the width of the flow / concentrate flows and increase the velocity of flows at the culvert outlets. These impacts may result in the following consequences:
  - Stream bed and bank erosion (incision and widening)
  - Increase in sediment inputs to downstream freshwater ecosystems/habitats, subsequently affecting the movement of water and water quality.

Due to the nature of the development, there will be some permanent local loss of vegetation and habitat (road surface, stormwater infrastructure). However, there is a potential for some rehabilitation along the disturbed underground cable routes and areas adjacent the watercourse crossing infrastructure. Due to the aridity and harsh, erratic conditions that characterize the region, rehabilitation of these disturbed areas will be restricted and slow. Thus, it is extremely important to restrict disturbances and activities to a small as possible footprint area, preventing any unnecessary disturbances, outside of these footprints. Also as previously mentioned (Construction Phase), most of these watercourse crossings will be long already disturbed areas (upgrade of existing watercourse crossings). Subsequently, the extent of permanent habitat/vegetation loss will be reduced to an acceptable level without threatening the impacted watercourse reaches' RECs. These disturbed areas may also, furthermore, be prone to the invasion of IAPs, however the magnitude/threat of this impact is regarded as moderate due to the low presence of IAPs within the area as well as the harsh climatic conditions.

Decommission Phase:

During decommissioning, the potential freshwater impacts will be very similar to that of the Construction Phase, although the potential for water quality and flow related risks will be lower

### 6.1.3. Assessment of Impacts

| CONSTRUCTION PHASE |
|---|

| ***Impact 1: Loss of riparian systems and disturbance of the alluvial water courses during the construction.*** | | |
|---|---|---|
| **Environmental Parameter** | Direct physical destruction or disturbance of aquatic habitat caused by vegetation clearing, disturbance of riparian habitat, encroachment/colonisation of habitat by invasive alien plants and alteration of river geomorphological profiles (including stream beds and banks). | |
| **Issue/Impact/Environmental Effect/Nature** | Possible ecological consequences may include:<br>» Reduction in representation and conservation of freshwater ecosystem/habitat types;<br>» Reduction in the supply of ecosystem goods & services;<br>» Reduction/loss of habitat for aquatic dependent flora & fauna; and<br>» Reduction in and/or loss of species of conservation concern (i.e. rare, threatened/endangered species).<br><br>As already mentioned,<br>» Internal roads and the underground cabling option are the only two aspects that will directly impact aquatic habitats through the direct disturbance and replacement of the of riparian/aquatic zones along the crossing points,<br><br>These disturbances will be the greatest during the construction and again in the decommissioning phases as the related disturbances could result in the loss and/or damage to vegetation and alteration of natural geomorphological and hydrological processes within the freshwater resource features. Compacted soils are also not ideal for supporting vegetation growth as they inhibit seed germination. | |
| | | |
| | **Pre-Mitigation Impact Rating** | **Post Mitigation Impact Rating** |
| **Extent** | **2** | **1** |
| **Probability** | **4** | **4** |
| **Reversibility** | **3** | **3** |
| **Irreplaceable loss** | **2** | **2** |
| **Duration** | **4** | **4** |
| **Intensity/Magnitude** | **3** | **1** |
| **Total** | **45** | **14** |
| **Status** | **Negative** | **Negative** |
| **Significance** | **High** | **Low** |
| | | |
| **Mitigation:**<br><br><u>Wind Turbines and supporting infrastructure (excluding roads and mv cabling)</u> | » The recommended buffer areas between the delineated freshwater resource features and proposed project activities should be maintained.<br>» Vegetation clearing should occur in in a phased manner to minimise erosion and/or run-off.<br>» Any areas disturbed during the construction phase should be encouraged to rehabilitate as fast and effective as possible and where deemed necessary by the ECO or Contractor's EO, artificial rehabilitation (e.g. re-seeding with collected or commercial indigenous | |

| | |
|---|---|
| | seed mixes) should be applied in order to speed up the rehabilitation process in critical areas (e.g. steep slopes and unstable soils). |
| **Mitigation:**<br><br>Internal Access Roads | » Existing crossings should be utilized/upgraded;<br>» Where no existing crossings are available the construction of new crossings can be considered.<br>o Where new water course crossings are required, the engineering team must provide an effective means to minimise the potential upstream and downstream effects of sedimentation and erosion (erosion protection) as well minimise the loss of riparian vegetation (reduce footprint as much as possible).<br>o All crossings over watercourses should be such that the flow within the channels is not impeded and should be constructed perpendicular to the river channel.<br>o The erosion and stormwater management measures included in the stormwater management plan for the Pofadder WEF 1 must be implemented.<br>o Where new roads need to be constructed, the existing road infrastructure should be rationalised and any unnecessary roads decommissioned and rehabilitated to reduce the disturbance of the area within the river beds.<br>o During the construction phases, monitor culverts to see if erosion issues arise and if any erosion control is required.<br>o Where possible, culvert bases must be placed as close as possible with natural levels in mind so that these don't form additional steps / barriers.<br>o Vegetation clearing should occur in a phased manner to minimise erosion and/or run-off.<br>o Any areas disturbed during the construction phase should be encouraged to rehabilitate as fast and effective as possible and were deemed necessary by the ECO or Contractor's EO, artificial rehabilitation (e.g. re-seeding with collected or commercial indigenous seed mixes) should be applied in order to speed up the rehabilitation process in critical areas (e.g. steep slopes and unstable soils).<br>o All alien plant re-growth must be monitored, and should it occur, these plants should be eradicated.<br><br>» Road infrastructure and cable alignments should coincide as far as possible to minimise the impact.<br>» Any disturbed areas should be rehabilitated and monitored to ensure that these areas do not become subject to erosion or invasive alien plant growth.<br>» During construction, disturbance to the freshwater ecosystems should be limited as far as possible.<br>o Disturbed areas may need to be rehabilitated and revegetated.<br>» Mitigation and follow up monitoring of residual impacts (alien vegetation growth and erosion) may be required. |
| **Mitigation:**<br><br>Underground MV cabling | » The underground MV cabling, where crossing watercourses, can be laid within the access roads (existing), or if not possible, within the shoulder or at least within 3m of the road shoulder.<br>» Ideally the construction disturbance footprint should be kept to an area no wider than 5 m.<br>» All material stockpiles should be located outside freshwater resource features. |

| | |
|---|---|
| | » Excavated soils should be stockpiled on the upslope side of the excavated trench so that eroded sediments off the stockpile are washed back into the trench;<br>» Excavated soils will need to be replaced in the same order as excavated from the trench, i.e. sub-soil must be replaced first and topsoil must be replaced last (this will maximise opportunity for re-vegetation of disturbed areas).<br>» Closure and rehabilitation of the disturbed areas should commence as soon as the laying of underground cable has been completed.<br>» The areas where vegetation is destroyed and disturbed will however need to be monitored against invasion by alien vegetation and, if encountered, will need to be removed.<br>» If natural re-vegetation is unsuccessful, seeding and planting of the area will need to be implemented.<br>» There should be reduced activity at the site after large rainfall events when the soils are wet.<br>» No driving off of hardened roads should occur immediately following large rainfall events until soils have dried out and the risk of bogging down has decreased.<br>» Any disturbed areas should be rehabilitated and monitored to ensure that these areas do not become subject to erosion.<br>» During decommissioning, disturbance to the freshwater ecosystems should be limited as far as possible.<br>» Disturbed areas may need to be rehabilitated and revegetated. |

| **Impact 2: Increase in sedimentation and erosion.** | | |
|---|---|---|
| **Environmental Parameter** | Alteration in the physical characteristics of freshwater resource features as a result of increased turbidity and sediment deposition | |
| **Issue/Impact/Environmental Effect/Nature** | Caused by soil erosion and earthworks that are associated with construction activities.<br><br>Possible ecological consequences associated with this impact may include:<br>» Deterioration in freshwater ecosystem integrity; and<br>» Reduction/loss of habitat for aquatic dependent flora & fauna.<br><br>This may furthermore, influence water quality downstream | |
| | | |
| | **Pre-Mitigation Impact Rating** | **Post Mitigation Impact Rating** |
| **Extent** | **2** | **1** |
| **Probability** | **3** | **2** |
| **Reversibility** | **3** | **2** |
| **Irreplaceable loss** | **2** | **1** |
| **Duration** | **4** | **1** |
| **Intensity/Magnitude** | **3** | **2** |
| **Total** | **42** | **14** |
| **Status** | **Negative** | **Negative** |
| **Significance** | **Medium** | **Low** |

| | |
|---|---|
| **Mitigation:**<br><br>Wind Turbines and supporting infrastructure (excluding roads and mv cabling) | » The recommended buffer areas between the delineated freshwater resource features and proposed project activities should be maintained.<br>» Vegetation clearing should occur in a phased manner to minimise erosion and/or run-off.<br>» Any erosion problems observed to be associated with the project infrastructure should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur.<br>» All bare areas, as a result of the development, should be revegetated with locally occurring species, to bind the soil and limit erosion potential.<br>» There should be reduced activity at the site after large rainfall events when the soils are wet. No driving off of hardened roads should occur immediately following large rainfall events until soils have dried out and the risk of bogging down has decreased.<br>» Any stormwater within the site must be handled in a suitable manner, i.e. trap sediments, and reduce flow velocities<br>» Stormwater from hardstand areas, buildings and the substation must be managed using appropriate channels and swales when located within steep areas. |
| **Mitigation:**<br><br>Internal Access Roads | » The duration of construction work within the watercourses must be minimised as far as practically possible through proper planning and phasing.<br>» Vegetation clearing should occur in a phased manner to minimise erosion and/or run-off.<br>» Any areas disturbed during the construction phase should be encouraged to rehabilitate as fast and effective as possible and were deemed necessary by the ECO or Contractor's EO, artificial rehabilitation (e.g. re-seeding with collected or commercial indigenous seed mixes) should be applied in order to speed up the rehabilitation process in critical areas (e.g. steep slopes and unstable soils).<br>» Any erosion problems observed during the construction phase should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur.<br>» Silt traps should be used where there is a danger of topsoil eroding and entering streams and other sensitive areas.<br>o These silt traps must be regularly monitored and maintained and replaced / repaired immediately as and when required. These measures should be regularly checked, maintained and repaired when required to ensure that they are effective<br>» Construction of gabions and other stabilisation features to prevent erosion must be undertaken, if deemed necessary.<br>» Under no circumstances must new channels be created for flow diversion and conveyance purposes unless approved as part of an EA or WUL<br>» No stormwater runoff must be allowed to discharge directly into any water course along roads, and flows should thus be allowed to dissipate over a broad area covered by natural vegetation.<br>» There should be reduced activity during the construction phase at the site after large rainfall events when the soils are wet. No driving off of hardened roads should occur immediately following large rainfall events until soils have dried out and the risk of bogging down has decreased.<br><br>» Existing crossings should be utilized/upgraded; |

| | |
|---|---|
| | » Where no existing crossings are available the construction of new crossings can be considered.<br>o Where new water course crossings are required, the engineering team must provide an effective means to minimise the potential upstream and downstream effects of sedimentation and erosion (erosion protection) as well minimise the loss of riparian vegetation (reduce footprint as much as possible).<br>o All crossings over watercourses should be such that the flow within the channels is not impeded and should be constructed perpendicular to the river channel.<br>o During the construction phase, monitor culverts to see if erosion issues arise and if any erosion control is required.<br>o Where possible, culvert bases must be placed as close as possible with natural levels in mind so that these don't form additional steps / barriers.<br>o Vegetation clearing should occur in a phased manner to minimise erosion and/or run-off.<br>» Any areas disturbed during the construction phase should be encouraged to rehabilitate as fast and effective as possible and were deemed necessary by the ECO or Contractor's EO, artificial rehabilitation (e.g. re-seeding with collected or commercial indigenous seed mixes) should be applied in order to speed up the rehabilitation process in critical areas (e.g. steep slopes and unstable soils). |
| **Mitigation:**<br><br><u>Underground MV Cables</u> | » The underground MV cabling, where crossing watercourses, can be laid within the access roads (existing), or if not possible, within the shoulder or at least within 3m of the road shoulder.<br>» All construction activities occurring directly within the watercourses to take place within the dry season.<br>» Ideally the construction disturbance footprint should be kept to an area no wider than 5 m.<br>» Regular monitoring for erosion.<br>o Any erosion problems observed, to be associated with the relating activity, should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur.<br>o Silt traps should be used where there is a danger of topsoil or material stockpiles eroding and entering streams and other sensitive areas.<br>o Construction of gabions and other stabilisation features to prevent erosion, if deemed necessary.<br>» Closure and rehabilitation of the disturbed areas should commence as soon as the laying of underground cable has been completed.<br>o Soils should be landscaped to the natural landscape profile with care taken to ensure that no preferential flow paths or berms remain.<br>» The areas where vegetation is destroyed and disturbed will however need to be monitored against invasion by alien vegetation and, if encountered, will need to be removed.<br>» If natural re-vegetation is unsuccessful, seeding and planting of the area will need to be implemented.<br>» There should be reduced activity at the site after large rainfall events when the soils are wet.<br>» No driving off of hardened roads should occur immediately following large rainfall events until soils have dried out and the risk of bogging down has decreased. |

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|---|---|
| | » Watercourse areas other than the immediate areas of crossing are to be demarcated as no-go areas for vehicles and construction personnel. The immediate crossings within a watercourse area is therefore permissible for trenching as well as the associated machinery, vehicles and construction personnel.<br>» Excavated soils should be stockpiled on the upslope side of the excavated trench so that eroded sediments off the stockpile are washed back into the trench;<br>» Excavated soils will need to be replaced in the same order as excavated from the trench, i.e. sub-soil must be replaced first and topsoil must be replaced last (this will maximise opportunity for re-vegetation of disturbed areas). |
| **Impact 3: Potential impact on localised surface water quality.** | |
| **Environmental Parameter** | Alteration or deterioration in the physical, chemical and biological characteristics of water resources (i.e. water quality) such as wetlands & rivers as a result of water/soil pollution. The term 'water quality' must be viewed in terms of the fitness or suitability of water for a specific use (DWAF, 2001). In the context of this impact assessment, water quality refers to its fitness for maintaining the health of aquatic ecosystems. Possible ecological consequences associated with this impact may include:<br>» Deterioration in freshwater ecosystem integrity; and<br>» Reduction in and/or loss of species of conservation concern (i.e. rare, threatened/endangered species). |
| **Issue/Impact/Environmental Effect/Nature** | During preconstruction and construction, chemical pollutants (hydrocarbons from equipment and vehicles, cleaning fluids, cement powder, wet concrete, shutter-oil, etc.) associated with site-clearing machinery, construction and maintenance activities could be washed downslope via the ephemeral systems. |

| | **Pre-Mitigation Impact Rating** | **Post Mitigation Impact Rating** |
|---|---|---|
| **Extent** | **2** | **1** |
| **Probability** | **2** | **1** |
| **Reversibility** | **2** | **1** |
| **Irreplaceable loss** | **2** | **2** |
| **Duration** | **1** | **1** |
| **Intensity/Magnitude** | **3** | **1** |
| **Total** | **27** | **6** |
| **Status** | **Negative** | **Negative** |
| **Significance** | **Medium** | **Low** |

| | |
|---|---|
| **Mitigation:** | » Implement appropriate measures to ensure strict use and management of all hazardous materials used on site<br>» Implement appropriate measures to ensure Strict management of potential sources of pollutants (e.g. litter, hydrocarbons from vehicles and machinery, cement during construction etc.) |

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| Wind Turbines and all other supporting infrastructure | » Implement appropriate measures to ensure containment of all contaminated water by means of careful run-off management on the development site.<br>» Implement appropriate measures to ensure strict control over the behavior of construction workers.<br>» Working protocols incorporating pollution control measures (including approved method statements by the contractor) should be clearly set out in the Construction Environmental Management Plan (CEMP) for the project and strictly enforced.<br>» Appropriate ablution facilities should be provided for construction workers during construction and on-site staff during the operation of the substation and WEF. |

| **OPERATIONAL PHASE** | | |
|---|---|---|
| **Impact 4: Impact on riparian systems through the possible increase in surface runoff on riparian form and function during the operation and decommissioning phases.** | | |
| **Environmental Parameter** | Alteration to the hydrological character of the freshwater resource features | |
| **Issue/Impact/Environmental Effect/Nature** | This might occur during the operation phase, when hard or compacted surfaces (hard engineered surfaces, roads etc.) increase the volume and velocity of the surface runoff. This could impact the hydrological regime through the increase in flows that are concentrated in certain areas. If flows are too concentrated with high velocities, scour and erosion may occur, with a complete reduction or disturbance of riparian habitat. | |
| | | |
| | **Pre-Mitigation Impact Rating** | **Post Mitigation Impact Rating** |
| **Extent** | **2** | **1** |
| **Probability** | **3** | **3** |
| **Reversibility** | **3** | **1** |
| **Irreplaceable loss** | **2** | **1** |
| **Duration** | **4** | **4** |
| **Intensity/Magnitude** | **3** | **2** |
| **Total** | **42** | **20** |
| **Status** | **Negative** | **Negative** |
| **Significance** | **Medium** | **Low** |
| | | |
| **Mitigation:**<br><br>Wind Turbines and supporting infrastructure (excluding roads and mv cabling) | » Any storm-water within the site must be handled in a suitable manner as per the management measures in stormwater management plan<br>» Stormwater from hardstand areas, buildings and the substation must be managed using appropriate channels and swales when located within steep areas.<br>» No stormwater runoff must be allowed to discharge directly into the watercourses. | |

| | |
|---|---|
| | ○ The runoff should rather be dissipated over a broad area covered by natural vegetation or managed using appropriate channels and swales when located within steep embankments.<br>» Stormwater run-off infrastructure must be maintained to mitigate both the flow and water quality impacts of any stormwater leaving the WEF site. |
| **Mitigation:**<br><br><u>Internal Access Roads</u> | » No stormwater runoff must be allowed to discharge directly into any water course along roads, and flows should thus be allowed to dissipate over a broad area covered by natural vegetation.<br>» For the crossing of small seasonal to ephemeral watercourses with sandy substrates and gentle gradients:<br>○ Road structures should be stabilized up to the level of the watercourse bed to allow for natural flow across the road.<br>○ It is crucial that the road surface is level within the watercourse without any flow concentration.<br>» Where the road structure will be built up to the level of the terrestrial land adjacent to the river bed (larger seasonal watercourses with stronger flows, deeper channels and steeper embankments):<br>○ Engineering team must provide an effective means to allow/simulate natural flow patterns without the consecration/modification of flow through the culverts which must be incorporated into the detailed stormwater management plans based on the final design of the Pofadder WEF 1.<br>○ Culverts should be sized to transport not only water, but other materials that might be mobilized (i.e. debris) and cause blockages to flow.<br>○ Appropriate erosion protection measures must be installed to reduce bed erosion / scour.<br>» The base (invert) of culverts must be aligned with the natural ground level of the bed of the channel to limit risks of erosion. Where necessary, additional measures such as drop-inlets or stepped inlet weirs must be constructed to address such risks. |
| **Mitigation:**<br><br><u>Underground Grid Line Option</u> | » The underground grid line, where crossing watercourses, can be laid within the access roads (existing), or if not possible, within the shoulder or at least within 3m of the road shoulder.<br>» Refer to the mitigation measures provided below addressing sedimentation and erosion. |

| **Impact 5: Increase in sedimentation and erosion** | | |
|---|---|---|
| **Environmental Parameter** | Alteration in the physical characteristics of freshwater resource features as a result of increased turbidity and sediment deposition | |
| **Issue/Impact/Environmental Effect/Nature** | For the operation phase, this refers to the alteration in the physical characteristics of freshwater resource features as a result of increased turbidity and sediment deposition, caused by soil erosion, as well as instability and collapse of unstable soils during project operation. Possible ecological consequences associated with this impact may include:<br><br>» Deterioration in freshwater ecosystem integrity; and<br>Reduction/loss of habitat for aquatic dependent flora & fauna. | |
| | | |
| | **Pre-Mitigation Impact Rating** | **Post Mitigation Impact Rating** |
| **Extent** | **2** | **2** |

| | | |
|---|---|---|
| **Probability** | **4** | **3** |
| **Reversibility** | **2** | **2** |
| **Irreplaceable loss** | **2** | **1** |
| **Duration** | **4** | **1** |
| **Intensity/Magnitude** | **3** | **2** |
| **Total** | **42** | **18** |
| **Status** | **Negative** | **Negative** |
| **Significance** | **Medium** | **Low** |
| | | |
| **Mitigation:**<br><br>Wind Turbines, Substation, Laydown Areas, Batching Plant | » Any erosion problems observed to be associated with the project infrastructure should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur.<br>» All bare areas, as a result of the development, should be revegetated with locally occurring species, to bind the soil and limit erosion potential.<br>» Any stormwater within the site must be handled in a suitable manner, i.e. trap sediments, and reduce flow velocities<br>» Stormwater from hardstand areas, buildings and the substation must be managed using appropriate channels and swales when located within steep areas.<br>» Stormwater run-off infrastructure must be maintained to mitigate both the flow and water quality impacts of any storm water leaving the WEF site. | |
| **Mitigation:**<br><br>Access Roads | » Any disturbed areas should be encouraged to be rehabilitated as fast and effective as possible and were deemed necessary by the ECO or Contractor's EO, artificial rehabilitation (e.g. re-seeding with collected or commercial indigenous seed mixes) should be applied in order to speed up the rehabilitation process in critical areas (e.g. steep slopes and unstable soils).<br>» Any erosion problems observed should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur.<br>» Silt traps should be used where there is a danger of topsoil eroding and entering streams and other sensitive areas.<br>o These silt traps must be regularly monitored and maintained and replaced / repaired immediately as and when required. These measures should be regularly checked, maintained and repaired when required to ensure that they are effective | |
| **Mitigation:**<br><br>Underground MV Cabling | » Regular monitoring for erosion.<br>o Any erosion problems observed, to be associated with the relating activity, should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur.<br>o Silt traps should be used where there is a danger of topsoil or material stockpiles eroding and entering streams and other sensitive areas.<br>» The areas where vegetation is destroyed and disturbed will need to be monitored against invasion by alien vegetation and, if encountered, will need to be removed.<br>» If natural re-vegetation is unsuccessful, seeding and planting of the area will need to be implemented. | |

| DECOMMISSIONING PHASE | | |
|---|---|---|
| **Impact 6: Loss of riparian systems and disturbance of the alluvial water courses.** | | |
| **Environmental Parameter** | Direct physical destruction or disturbance of aquatic habitat caused by vegetation disturbance of riparian habitat, encroachment/colonisation of habitat by invasive alien plants and alteration of river geomorphological profiles (including stream beds and banks). | |
| **Issue/Impact/Environmental Effect/Nature** | Possible ecological consequences may include:<br>» Reduction in representation and conservation of freshwater ecosystem/habitat types;<br>» Reduction in the supply of ecosystem goods & services;<br>» Reduction/loss of habitat for aquatic dependent flora & fauna; and<br>» Reduction in and/or loss of species of conservation concern (i.e. rare, threatened/endangered species).<br><br>As already mentioned,<br>» Internal roads and the underground cabling option are the only two aspects that will directly impact aquatic habitats through the direct disturbance and replacement of the of riparian/aquatic zones along the crossing points,<br><br>These disturbances will be the greatest during the construction and again in the decommissioning phases as the related disturbances could result in the loss and/or damage to vegetation and alteration of natural geomorphological and hydrological processes within the freshwater resource features. Compacted soils are also not ideal for supporting vegetation growth as they inhibit seed germination. | |
| | | |
| | **Pre-Mitigation Impact Rating** | **Post Mitigation Impact Rating** |
| **Extent** | **2** | **1** |
| **Probability** | **4** | **4** |
| **Reversibility** | **3** | **3** |
| **Irreplaceable loss** | **2** | **2** |
| **Duration** | **4** | **4** |
| **Intensity/Magnitude** | **3** | **1** |
| **Total** | **45** | **14** |
| **Status** | **Negative** | **Negative** |
| **Significance** | **High** | **Low** |
| | | |
| **Mitigation:** | » Any areas disturbed during the decommissioning phase should be encouraged to be rehabilitated as fast and effective as possible and where deemed necessary by the ECO or Contractor's EO, artificial rehabilitation (e.g. re-seeding with collected or commercial indigenous | |

| | |
|---|---|
| Wind Turbines and supporting infrastructure (excluding roads and mv cabling) | seed mixes) should be applied in order to speed up the rehabilitation process in critical areas (e.g. steep slopes and unstable soils). |
| **Mitigation:**<br><br>Internal Access Roads & Underground MV cabling Option | » During decommissioning, disturbance to the freshwater ecosystems should be limited as far as possible.<br>▪ Disturbed areas will need to be rehabilitated and revegetated<br>▪ Mitigation and follow up monitoring of residual impacts (alien vegetation growth and erosion) will be required. |

| **Impact 7: Increase in sedimentation and erosion.** | | |
|---|---|---|
| **Environmental Parameter** | Alteration in the physical characteristics of freshwater resource features as a result of increased turbidity and sediment deposition | |
| **Issue/Impact/Environmental Effect/Nature** | Caused by soil erosion and earthworks that are associated with decommissioning activities.<br><br>Possible ecological consequences associated with this impact may include:<br>» Deterioration in freshwater ecosystem integrity; and<br>» Reduction/loss of habitat for aquatic dependent flora & fauna.<br><br>This may furthermore, influence water quality downstream | |
| | **Pre-Mitigation Impact Rating** | **Post Mitigation Impact Rating** |
| **Extent** | **2** | **1** |
| **Probability** | **3** | **2** |
| **Reversibility** | **3** | **2** |
| **Irreplaceable loss** | **2** | **1** |
| **Duration** | **4** | **1** |
| **Intensity/Magnitude** | **3** | **2** |
| **Total** | **42** | **14** |
| **Status** | **Negative** | **Negative** |
| **Significance** | **Medium** | **Low** |

| | |
|---|---|
| **Mitigation:**<br><br>Wind Turbines and supporting infrastructure (excluding roads and mv cabling) | » Any erosion problems observed should be rectified immediately and monitored thereafter to ensure that they do not re-occur.<br>» There should be regular monitoring for erosion for at least 2 years after decommissioning by the applicant to ensure that no erosion problems develop as a result of the disturbance, and if they do, to immediately implement erosion control measures.<br>» All bare areas, affected by the development, should be re-vegetated with locally occurring species, to bind the soil and limit erosion potential where applicable.<br>» There should be reduced activity at the site after large rainfall events when the soils are wet. No driving off of hardened roads should occur immediately following large rainfall events until soils have dried out and the risk of bogging down has decreased. |

| | |
|---|---|
| **Mitigation:**<br><br>Internal Access Roads & Underground MV Cabling Option | » The duration of decommissioning work within the watercourses must be minimised as far as practically possible through proper planning and phasing.<br>» Watercourse areas other than the immediate impact areas are to be demarcated as no-go areas for vehicles and construction personnel. The immediate decommissioning site within a watercourse area is therefore permissible for activities associated with the decommissioning phase.<br>» Any areas disturbed during the construction phase should be encouraged to rehabilitate as fast and effective as possible and were deemed necessary by the ECO or Contractor's EO, artificial rehabilitation (e.g. re-seeding with collected or commercial indigenous seed mixes) should be applied in order to speed up the rehabilitation process in critical areas (e.g. steep slopes and unstable soils).<br>» Any erosion problems observed during the construction and operational phases should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur.<br>» There should be regular monitoring for erosion for at least 2 years after decommissioning by the applicant to ensure that no erosion problems develop as a result of the disturbance, and if they do, to immediately implement erosion control measures.<br>» Silt traps should be used where there is a danger of topsoil eroding and entering streams and other sensitive areas.<br>o These silt traps must be regularly monitored and maintained and replaced / repaired immediately as and when required. These measures should be regularly checked, maintained and repaired when required to ensure that they are effective<br>» Excavated soils should be stockpiled on the upslope side of the excavated trench so that eroded sediments off the stockpile are washed back into the trench;<br>» Excavated soils will need to be replaced in the same order as excavated from the trench, i.e. sub-soil must be replaced first and topsoil must be replaced last (this will maximise opportunity for re-vegetation of disturbed areas).<br>» There should be reduced activity during the decommissioning phase at the site after large rainfall events when the soils are wet. No driving off of hardened roads should occur immediately following large rainfall events until soils have dried out and the risk of bogging down has decreased. |
| **Impact 8: Potential impact on localised surface water quality.** | |
| **Environmental Parameter** | Alteration or deterioration in the physical, chemical and biological characteristics of water resources (i.e. water quality) such as wetlands & rivers as a result of water/soil pollution. The term 'water quality' must be viewed in terms of the fitness or suitability of water for a specific use (DWAF, 2001). In the context of this impact assessment, water quality refers to its fitness for maintaining the health of aquatic ecosystems. Possible ecological consequences associated with this impact may include:<br><br>» Deterioration in freshwater ecosystem integrity; and<br><br>» Reduction in and/or loss of species of conservation concern (i.e. rare, threatened/endangered species). |

| | | |
|---|---|---|
| **Issue/Impact/Environmental Effect/Nature** | During decommissioning, chemical pollutants (hydrocarbons from equipment and vehicles, cleaning fluids, cement powder, wet concrete, shutter-oil, etc.) associated with site-clearing machinery, construction and maintenance activities could be washed downslope via the ephemeral systems. | |
| | | |
| | **2** | **1** |
| **Extent** | **2** | **1** |
| **Probability** | **2** | **1** |
| **Reversibility** | **2** | **2** |
| **Irreplaceable loss** | **1** | **1** |
| **Duration** | **3** | **1** |
| **Intensity/Magnitude** | **27** | **6** |
| **Total** | **Negative** | **Negative** |
| **Status** | **Medium** | **Low** |
| **Significance** | **2** | **1** |
| | | |
| **Mitigation Measures** | » Implement appropriate measures to ensure strict use and management of all hazardous materials used on site<br>» Implement appropriate measures to ensure Strict management of potential sources of pollutants (e.g. litter, hydrocarbons from vehicles and machinery, cement during construction etc.)<br>» Implement appropriate measures to ensure containment of all contaminated water by means of careful run-off management on the development site.<br>» Implement appropriate measures to ensure strict control over the behavior of construction workers.<br>» Working protocols incorporating pollution control measures (including approved method statements by the contractor) should be clearly set out in the Construction Environmental Management Plan (CEMP) for the project and strictly enforced.<br>» Appropriate ablution facilities should be provided for construction workers during construction and on-site staff during the operation of the substation and WEF. | |

## 6.2. Cumulative Impacts

Existing renewable energy projects that were considered in terms of their potential cumulative terrestrial ecological impacts, that are in an approximate 30 km radius of the Pofadder WEF 1, are illustrated below in Figure 10. Apart from the other two Pofadder Wind Energy Facilities (WEF 2 and WEF 3), only four other renewable facilities are located within the 30km radius namely:

» The proposed 300MW Paulputs Wind Energy Facility to the north;
» The 100MW Poortjies Wind Energy Facility to the west;

- 140MW Khai-Mai Wind Energy Facility to the west; and
- Namies South Solar PV Facility to the west.

All four of these renewable facilities only encroach slightly into the 30km radius, with the bulk of their development footprints located outside of the 30km radius.

Of the proposed seven renewable energy facilities, Pofadder WEF 1,2, and 3 as well as the Paulputs WEF are located within the Kaboep River's catchment and are subsequently the only WEFs likely to have a cumulative impact on this important freshwater resource feature. From the available spatial data, it appears that only the development site for the Paulputs WEF will impact the Kaboep River directly, whilst the other WEF will only impact smaller tributaries of this river.

For all of these Wind Energy Facilities, Freshwater Resource Studies and Assessments were undertaken as part of the EIA process and all of these studies recommended aquatic buffers. The conclusions drawn from these studies were very similar, in that the proposed layouts of these facilities indicated limited impacts on their aquatic environments as the proposed structures for the most part, have either avoided the delineated watercourses and wetlands with the exception of unavoidable water course crossings by the proposed access roads. The use of existing roads, as far as possible, was also a common recommendation. Based on the findings of these studies the relevant specialists found no objection to the authorisation of any of these WEFs inclusive of their recommended mitigation measures and alternatives.

Land use in the area currently consists of low-density livestock farming due to the limited water supply and poor carrying capacity of the cover vegetation. Current land and water use impacts on the tributaries of the Kaboep River within the larger study area is therefore very low. The nature of the proposed WEF projects allows them to have minimal impact on the surface water features, since the turbines can be placed far enough away from the freshwater features so as to not impact on them.

Probably the most significant potential impact associated with these projects are as a result of the associated infrastructure, most notably access road and their water course crossings, which can be mitigated such that its impact on the aquatic ecosystems will be of a low significance. For all of these projects concerned, the road layouts have been revised in such a manner that all of the important wetland areas / rivers were avoided and where possible existing roads have been used. This further reducing the impacts on the aquatic ecosystems, but also providing an opportunity to improve the current road crossings, by providing better erosion protection measures and through the construction of low water crossings or properly sized box culverts instead of pipe culverts that are prone to blocking. Thus, these project designs, post mitigation, will prove to have a net benefit to the river and catchment. All of the projects have indicated that this is their intention with regard to mitigation, i.e. selecting the best possible routes to minimise the local and regional impacts and improving the drainage or hydrological conditions with these rivers the cumulative impact could be seen as a net benefit.

Subsequently it can be concluded that the cumulative impact of the proposed project would not be significant provided mitigation measures are implemented.

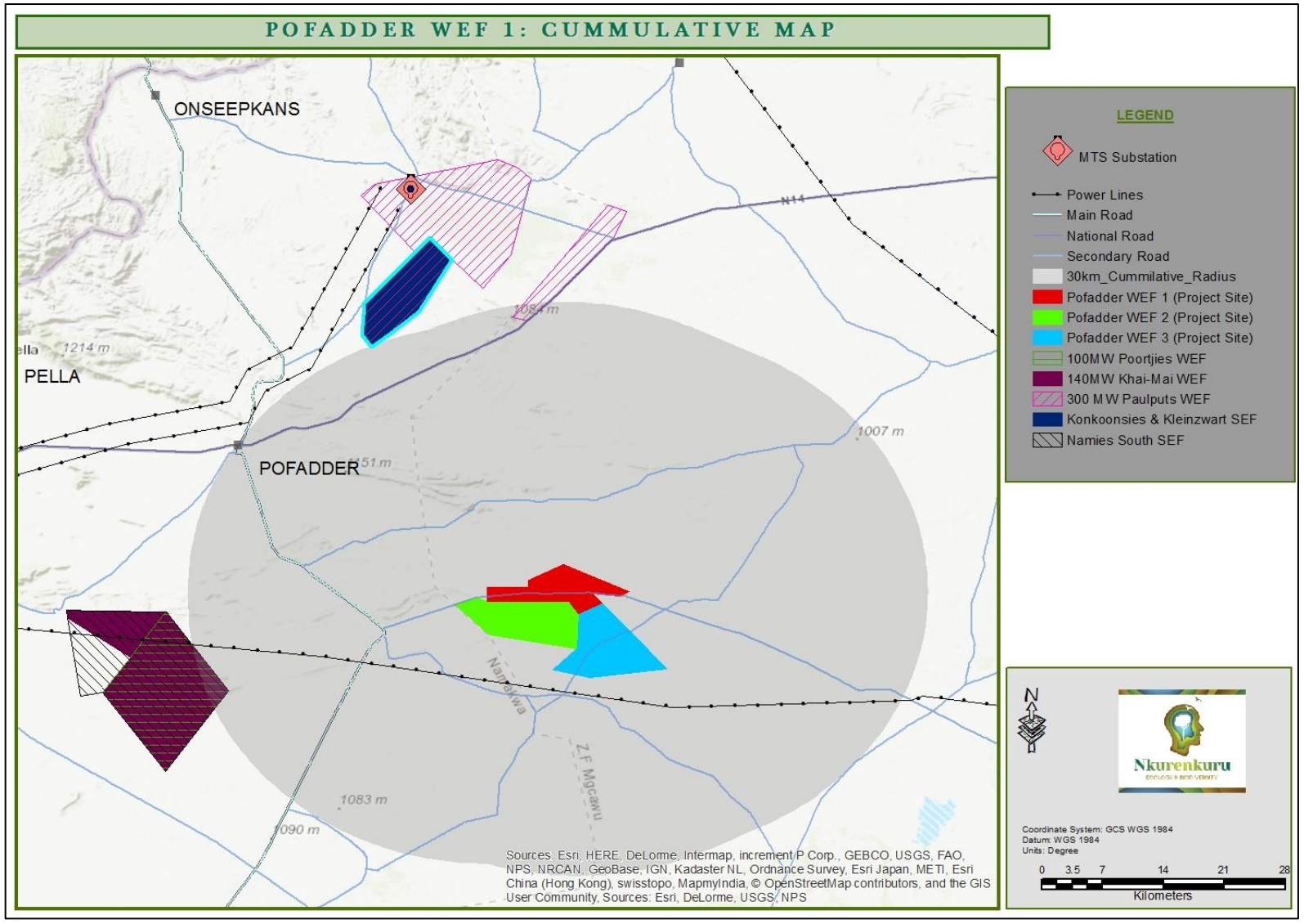


Figure 10: Location Map of the proposed Pofadder WEF 1relative to the other renewable facilities planned within a radius of 30 km.

| CUMULATIVE IMPACTS | | |
|---|---|---|
| **Impact 9: Impact ecological processes as well as ecological functioning of important habitats associated with the Kaboep River.** | | |
| **Environmental Parameter** | Compromised ecological processes as well as ecological functioning of important habitats associated with the Kaboep River | |
| **Issue/Impact/Environmental Effect/Nature** | Transformation of intact freshwater resource habitat could potentially compromise ecological processes as well as ecological functioning of important habitats and would contribute to habitat fragmentation and potential disruption of habitat connectivity and furthermore impair their ability to respond to environmental fluctuations. This is especially of relevance for larger watercourses and wetlands serving as important groundwater recharge and floodwater attenuation zones, important microhabitats for various organisms and important corridor zones for faunal movement | |
| | | |
| | **Pre-Mitigation Impact Rating** | **Post Mitigation Impact Rating** |
| **Extent** | **2** | **2** |
| **Probability** | **2** | **1** |
| **Reversibility** | **2** | **2** |
| **Irreplaceable loss** | **2** | **1** |
| **Duration** | **4** | **3** |
| **Intensity/Magnitude** | **3** | **2** |
| **Total** | **36** | **18** |
| **Status** | **Negative** | **Negative** |
| **Significance** | **Medium** | **Low** |
| | | |
| **Mitigation:**<br><br>Wind Turbines and supporting infrastructure (excluding roads and mv cabling) | » The potential stormwater impacts of the proposed developments should be mitigated on-site to address any erosion or water quality impacts.<br>» Good housekeeping measures as stipulated in the EMPr for the project should be in place where construction activities take place to prevent contamination of any freshwater features.<br>» Where possible, infrastructure should coincide with existing infrastructure or areas of disturbance (such as existing roads).<br>» Disturbed areas should be rehabilitated through reshaping of the surface to resemble that prior to the disturbance and vegetated with suitable local indigenous vegetation. | |
| **Mitigation:**<br><br>Internal Access Roads & MV Cabling Option | » Existing crossings should be utilized/upgraded<br>» The construction of new crossings should may only be considered where no other viable option exists.<br>» Where new water course crossings are required, the engineering team must provide an effective means to minimise the potential upstream and downstream effects of sedimentation and erosion (erosion protection) as well minimise the loss of riparian vegetation (reduce footprint as much as possible). | |

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| | » All crossings over watercourses should be such that the flow within the channels is not impeded and should be constructed perpendicular to the river channel,<br>» Where new roads need to be constructed, the existing road infrastructure should be rationalised and any unnecessary roads decommissioned and rehabilitated to reduce the disturbance of the area within the river beds.<br>» During the construction and operation /decommissioning phases, monitor culverts to see if erosion issues arise and if any erosion control is required.<br>» Where possible culvert bases must be placed as close as possible with natural levels in mind so that these don't from additional steps / barriers.<br>» Vegetation clearing should occur in a phased manner to minimise erosion and/or run-off.<br>» Any areas disturbed during the construction phase should be encouraged to rehabilitate as fast and effective as possible and were deemed necessary by the ECO or Contractor's EO, artificial rehabilitation (e.g. re-seeding with collected or commercial indigenous seed mixes) should be applied in order to speed up the rehabilitation process in critical areas (e.g. steep slopes and unstable soils).<br>» All alien plant re-growth must be monitored and should it occur these plants should be eradicated.<br>» For new internal roads to the turbines, these should be located, as far as possible, outside of the recommended freshwater resource buffer areas.<br>» Road infrastructure and cable alignments should coincide as far as possible to minimise the impact.<br>» Any disturbed areas should be rehabilitated and monitored to ensure that these areas do not become subject to erosion or invasive alien plant growth.<br>» During decommissioning, disturbance to the freshwater ecosystems should be limited as far as possible.<br>o Disturbed areas may need to be rehabilitated and revegetated.<br>» Mitigation and follow up monitoring of residual impacts (alien vegetation growth and erosion) may be required. |

# 7. CONDITIONS FOR INCLUSION IN THE EMPR.

| Impact/Aspect | Mitigation/Management Actions | *Responsibility* | *Methodology* | Mitigation/Management Objectives and Outcomes | *Frequency* |
|---|---|---|---|---|---|
| ***Planning Phase*** | | | | | |
| ***Loss of riparian systems and disturbance of the alluvial water courses: Construction of road and MV cable watercourse crossings*** | | | | | |
| Construction of road and MV cable watercourse crossings | » Existing crossings should be utilized/upgraded.<br>» Where it is possible the underground MV cables should be laid within the roads in order to avoid any unnecessary disturbance to the vegetation of the watercourses.<br>» All crossings over watercourses should be such that the flow within the channels is not impeded and should be constructed perpendicular to the river channel.<br>» Furthermore, for all watercourse crossings, the engineering team must provide an effective means to minimise the loss of riparian vegetation (small as possible footprint).<br>» Where possible, culvert bases must be placed as close as possible with natural levels in mind so that these don't form additional steps / barriers. | Project Company | » Design-Layout taking into account the location, nature, morphology and ecological drivers of the watercourses to be crossed. | » To ensure selection of best environmental option for positioning alignment of proposed infrastructure<br>» To minimise direct impacts/damage to vegetation associated with freshwater resource features | Once-off during the Design Phase |
| | » Vegetation rehabilitation management plan.<br>• Minimum requirements are listed under the Construction and Operational Phase EMPr | Project Company and relevant specialist | » Compilation of a Vegetation Rehabilitation plan taking into account the various vegetation units, patterns and key plant species, as identified within the terrestrial and aquatic ecological reports. | » To ensure optimal rehabilitation of temporary disturbed areas (post-construction), with a stable, natural occurring vegetation cover, resembling as far as possible the vegetation composition, patterns and structure of the surrounding vegetation cover. | |

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| | | | | » To ensure optimal rehabilitation of development footprint (post-decommissioning), with a stable, natural occurring vegetation cover, resembling as far as possible the vegetation composition, patterns and structure of the surrounding vegetation cover. | |
| ***Loss of riparian systems and disturbance of the alluvial water courses: Construction of Wind Turbines and supporting infrastructure (excluding roads and mv cable watercourse crossings)*** | | | | | |
| Wind Turbines and supporting infrastructure (excluding roads and mv cable watercourse crossings). | » The recommended buffer areas between the delineated freshwater resource features and proposed project activities should be implemented.<br>» Sites for storing, mixing, and handling topsoil piles (if necessary) or any introduced materials, including all machinery or processing implements, should be placed in an ecologically least sensitive area and at least 100 m from any drainage area.<br>» Other components of the proposed development that may under no circumstance be located in or within 100 m of any drainage systems would include:<br>• Man-camps and/or ablution facilities<br>• Any form of waste/soil/overburden disposal<br>• Any form of storage of materials or machinery<br>• Offices, and<br>• Substations and switching stations<br>• Battery Energy Storage Facilities | | » Design-Layout taking into account delineated sensitive habitat features and their ecological importance and sensitivity | » To avoid indirect damage/impacts to downslope freshwater resource features and associated vegetation.<br>» | Once-off during the Design Phase |

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| ***Increase in sedimentation and erosion: Construction of road and MV cable watercourse crossings*** | | | | | |
| Construction of road and MV cable watercourse crossings | » Compile a comprehensive erosion control and stormwater management plan for the footprint area as part of the final design of the project | Project Company and relevant specialist | » Design-Layout taking into account the location and nature of the specific infrastructure as well as the location, nature and morphology of the area wherein the infrastructure will be placed | » To minimise erosion of soil from site during construction.<br>» To maintain watercourses'' RECs<br>» To avoid downstream impacts including:<br>• erosion;<br>• sedimentation;<br>• destabilisation of banks and channels. | Once-off during the Design Phase |
| | » Vegetation rehabilitation management plan.<br>• Minimum requirements are listed under the Construction and Operational Phase EMPr | | » Compilation of a Vegetation Rehabilitation plan taking into account the various vegetation units, patterns and key plant species, as identified within the terrestrial ecological report. | » To maintain watercourses' RECs<br>» To stabilise previously disturbed areas.<br>» To ensure the continuation of the watercourses' functions and services.<br>» To ensure optimal rehabilitation of development footprint. | |
| | » Where new watercourse crossings are required and/or where existing routes will have to be upgraded and widened, the engineering team must provide an effective means to minimise the potential effects of sedimentation and erosion (erosion protection).<br>» Design and construct any necessary erosion protection works where the infrastructure intersects the channel banks in order to prevent scouring or outer-bank erosion. Protection works to be considered include | Project Company | » Design-Layout taking into account the location, nature, morphology and ecological drivers of the watercourses to be crossed. | » To simulate, as close as possible natural flow patterns in order to avoid erosion due to channelling, bank scouring, destabilisation of channel banks etc. | Once-off during the Design Phase |

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| | gabions, reno mattresses or other stabilising structures to armour them.<br>» Structures that cater for through flows (e.g. culverts) should not only allow for the maximum volume of flows but should distribute flows naturally so not to concentrate flows downstream, which could induce erosion/scouring.<br>» No stormwater runoff must be allowed to discharge directly into any water course along roads, and flows should thus be allowed to dissipate over a broad area covered by natural vegetation. | | | | |
| ***Increase in sedimentation and erosion: Construction of Wind Turbines and supporting infrastructure (excluding roads and mv cable watercourse crossings)*** | | | | | |
| Wind Turbines and supporting infrastructure (excluding roads and mv cable watercourse crossings). | » Compile a comprehensive erosion control and stormwater management plan for the footprint area as part of the final design of the project | Project Company and relevant specialist | » Design-Layout taking into account the location and nature of the specific infrastructure as well as the location, nature and morphology of the area wherein the infrastructure will be placed | » Prevent upstream erosional features from spreading into the aquatic buffer areas and the resource features themselves.<br>» To allow for natural runoff patterns into the downslope freshwater resource features.<br>» To avoid unnatural amounts of sediments carried into the downstream freshwater resource features form their catchments. | Once-off during the Design Phase |
| | » Vegetation rehabilitation management plan and Alien Invasive Plant (AIP) Management Plan.<br>• Minimum requirements are listed under the Construction and Operational Phase EMPr | Project Company and relevant specialist | » Compilation of a Vegetation Rehabilitation plan taking into account the various vegetation units, patterns and key plant species, as identified within the terrestrial ecological report. | | Once-off during the Design Phase |

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| | » Stormwater from hard stand areas, buildings and substation must be managed using appropriate channels and swales when located within steep areas.<br>» No stormwater runoff must be allowed to discharge directly into the watercourses.<br>» The runoff should rather be dissipated over a broad area covered by natural vegetation. | Project Company | » Design-Layout taking into account the location and nature of the specific infrastructure as well as the location, nature and morphology of the area wherein the infrastructure will be placed | | Once-off during the Design Phase |
| ***Potential impact on localised surface water quality: All associated infrastructure*** | | | | | |
| All associated infrastructure | » Working protocols incorporating pollution control measures (including approved method statements by the contractor) should be clearly set out in the Construction Environmental Management Plan (CEMP) for the project and strictly enforced. | Project Company | » Construction Environmental Management Plan | » To ensure that the storage and handling of chemicals and hydrocarbons on-site does not cause pollution to the environment or harm to persons<br>» To comply with waste management legislation<br>» To avoid environmental harm from waste disposal | Once-off during the Design Phase |
| ***Impact on riparian systems through the possible increase in surface runoff on riparian form and function during the operation: Road and MV cable watercourse crossings*** | | | | | |
| Road and MV cable watercourse crossings | » No stormwater runoff must be allowed to discharge directly into any water course along roads, and flows should thus be allowed to dissipate over a broad area covered by natural vegetation.<br>» For the crossing of small seasonal to ephemeral watercourses with sandy substrates and gentle gradients: | Project Company | » Design-Layout taking into account the location, nature, morphology and ecological drivers of the watercourses to be crossed. | » To simulate, as close as possible natural flow patterns in order to avoid erosion due to channelling, bank scouring, destabilisation of channel banks etc. | Once-off during the Design Phase |

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| | ○ Road structures should be stabilized up to the level of the watercourse bed to allow for natural flow across the road.<br>○ It is crucial that the road surface is level within the watercourse without any flow concentration.<br>» Where the road structure will be built up to the level of the terrestrial land adjacent to the river bed (larger seasonal watercourses with stronger flows, deeper channels and steeper embankments):<br>○ Engineering team must provide an effective means to allow/simulate natural flow patterns without the consecration/modification of flow through the culverts which must be incorporated into the detailed stormwater management plans based on the final design of the Pofadder WEF 1.<br>○ Culverts should be sized to transport not only water, but other materials that might be mobilized (i.e. debris) and cause blockages to flow.<br>○ Appropriate erosion protection measures must be installed to reduce bed erosion / scour.<br>» The base (invert) of culverts must be aligned with the natural ground level of the bed of the channel to limit risks of erosion. Where necessary, additional measures such as drop-inlets or stepped inlet weirs must be constructed to address such risks. | | | | |

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| | » The underground grid line, where crossing watercourses, can be laid within the access roads (existing), or if not possible, within the shoulder or at least within 3m of the road shoulder. | | | | |
| ***Construction Phase*** | | | | | |
| ***Loss of riparian systems and disturbance of the alluvial water courses: Construction of road and MV cable watercourse crossings*** | | | | | |
| Construction of road and MV cable watercourse crossings | » The working servitude within the watercourses must be demarcated on both sides using orange hazard netting prior to construction commencing. | Project Company, monitored by ECO/EO | » Taking into account the final design-layout, and any sensitive areas, demarcate the absolute minimal development footprint, and ensure that the appointed contractor is made aware of where what activities and impacts are allowed and disallowed. | » Minimise and maintain damage of watercourse vegetation the development footprint.<br>» Prevent any residual or cumulative impacts arising.<br>» To ensure the persistence/maintenance of the REC | Prior to commencement of construction activities |
| | » All sensitive aquatic habitats outside of the demarcated construction area must be considered 'No-Go' areas for the duration of the construction phase.<br>» No physical damage should be done to any aspects of the channel and banks of watercourses other than those necessary to complete the works as specified.<br>» Vegetation clearing should occur in a phased manner to minimise erosion and/or run-off.<br>» There should be reduced activity at the site after large rainfall events when the soils are wet. | Contractor/ ECO/EO | » At all times be acutely aware of the specified development footprint, and remain within this area avoiding any disturbance of vegetation outside of these areas.<br>» The ECO will also need to prepare an induction and training programme to educate the contracting team on the EMPr commitments.<br>» Contractor to develop an internal reporting structure to monitor compliance with the commitments given in the EMPr as construction progresses. | | Throughout construction and decommissioning Phases |
| Excavation and trenching within watercourses | » Avoid stockpiling materials in vegetated areas that will not be cleared.<br>» All material stockpiles should be located outside freshwater resource features. | | | » Minimise and maintain damage of watercourse vegetation the development footprint. | Throughout construction and decommissioning Phases |

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| | » Excavated soils should be stockpiled on the upslope side of the excavated trench so that eroded sediments off the stockpile are washed back into the trench;<br>» Excavated soils will need to be replaced in the same order as excavated from the trench, i.e. sub-soil must be replaced first and topsoil must be replaced last (this will maximise opportunity for re-vegetation of disturbed areas).<br>» Closure and rehabilitation of the disturbed areas should commence as soon as the laying of underground cable has been completed. | | » The EMPr should be enforced and monitored for compliance by a suitably qualified/trained ECO (Environmental Control Officer) with any additional supporting EO's (Environmental Officers) having the required competency skills and experience to ensure that environmental mitigation measures are being implemented and appropriate action is taken where potentially adverse environmental impacts are highlighted through monitoring and surveillance.<br>» The ECO will need to be responsible for conducting regular site-inspections of the construction, processes, reporting back to the relevant environmental authorities with findings of these investigations. | » Prevent any residual or cumulative impacts arising.<br>» To ensure the persistence/maintenance of the REC | |
| Alien Invasive Plants | » All alien plant re-growth must be monitored, and should it occur, these plants should be eradicated.<br>» Any disturbed areas should be rehabilitated and monitored to ensure that these areas do not become subject to erosion or invasive alien plant growth. | | » The ECO will need to prepare an induction and training programme to educate the contracting team on the EMPr commitments relating to the management/eradication of AIPs. | » The successful reduction in the treat (significance) posed by Alien Invasive Plants.<br>» Recreate a non-invasive, acceptable vegetation cover that will facilitate the establishment of desirable and/or indigenous species | Throughout construction and operational phase as well as after the decommissioning phase |

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| | » Mitigation and follow up monitoring of residual impacts (alien vegetation growth and erosion) may be required. | | » The EMPr and IAP Management Plan should be enforced and monitored for compliance by a suitably qualified/trained ECO (Environmental Control Officer) with any additional supporting EO's (Environmental Officers) having the required competency skills and experience to ensure that environmental mitigation measures are being implemented and appropriate action is taken where potentially adverse environmental impacts are highlighted through monitoring and surveillance.<br>» The ECO will need to be responsible for conducting regular site-inspections of the construction, and operational processes, reporting back to the relevant environmental authorities with findings of these investigations. | | |
| ***Loss of riparian systems and disturbance of the alluvial water courses: Construction of Wind Turbines and supporting infrastructure (excluding roads and mv cable watercourse crossings)*** | | | | | |
| Construction of Wind Turbines and supporting infrastructure (excluding roads and mv cable | » The recommended buffer areas between the delineated freshwater resource features and proposed project activities should be maintained. | Project Company, monitored by ECO/EO | » Taking into account the final design-layout, and any sensitive areas, demarcate the absolute minimal development footprint, and ensure that the appointed contractor is made | » No indirect damage to downslope freshwater resource features and their associated vegetation. | Prior to commencement of construction activities |

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| watercourse crossings) | | | aware of where what activities and impacts are allowed and disallowed. | | |
| | » Vegetation clearing should occur in a phased manner to minimise erosion and/or run-off.<br>» Any erosion problems observed to be associated with the project infrastructure should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur.<br>» There should be reduced activity at the site after large rainfall events when the soils are wet. No driving off of hardened roads should occur immediately following large rainfall events until soils have dried out and the risk of bogging down has decreased.<br>» Any stormwater within the site must be handled in a suitable manner, i.e. trap sediments, and reduce flow velocities<br>» Stormwater from hardstand areas, buildings and the substation must be managed using appropriate channels and swales when located within steep areas. | Contractor/ ECO/EO | » The ECO will also need to prepare an induction and training programme to educate the contracting team on the EMPr commitments.<br>» Contractor to develop an internal reporting structure to monitor compliance with the commitments given in the EMPr as construction progresses.<br>» The EMPr should be enforced and monitored for compliance by a suitably qualified/trained ECO (Environmental Control Officer) with any additional supporting EO's (Environmental Officers) having the required competency skills and experience to ensure that environmental mitigation measures are being implemented and appropriate action is taken where potentially adverse environmental impacts are highlighted through monitoring and surveillance. | » No indirect damage to downslope freshwater resource features and their associated vegetation. | Throughout construction and decommissioning phase |

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| | | | » The ECO will need to be responsible for conducting regular site-inspections of the construction, processes, reporting back to the relevant environmental authorities with findings of these investigations. | | |
| ***Increase in sedimentation and erosion: Construction of road and MV cable watercourse crossings*** | | | | | |
| Construction of road and MV cable watercourse crossings | » All construction activities occurring directly within the watercourses to take place within the dry season.<br>» The erosion and stormwater management measures included in the stormwater management plan for the Pofadder WEF 1 must be implemented.<br>» The duration of construction work within the watercourses must be minimised as far as practically possible through proper planning and phasing.<br>» During the construction phases, monitor culverts to see if erosion issues arise and if any erosion control is required.<br>» Any erosion problems observed during the construction phase should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur.<br>» Vegetation clearing should occur in a phased manner to minimise erosion and/or run-off.<br>» Any disturbed areas should be rehabilitated and monitored to ensure that these areas do not become subject to erosion | Contractor/ ECO/EO | » The ECO will also need to prepare an induction and training programme to educate the contracting team on the EMPr commitments.<br>» Contractor to develop an internal reporting structure to monitor compliance with the commitments given in the EMPr as construction progresses.<br>» The EMPr should be enforced and monitored for compliance by a suitably qualified/trained ECO (Environmental Control Officer) with any additional supporting EO's (Environmental Officers) having the required competency skills and experience to ensure that environmental mitigation measures are being implemented and appropriate | » To minimise erosion of soil from site during construction.<br>» To maintain watercourses'' RECs<br>» To avoid downstream impacts including:<br>• erosion;<br>• sedimentation;<br>• destabilisation of banks and channels. | Throughout construction and decommissioning phase |

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| | » Silt traps should be used where there is a danger of topsoil eroding and entering streams and other sensitive areas.<br>» These silt traps must be regularly monitored and maintained and replaced / repaired immediately as and when required. These measures should be regularly checked, maintained and repaired when required to ensure that they are effective<br>» Construction of gabions and other stabilisation features to prevent erosion must be undertaken, if deemed necessary.<br>» Under no circumstances must new channels be created for flow diversion and conveyance purposes unless approved as part of an EA or WUL<br>» There should be reduced activity during the construction phase at the site after large rainfall events when the soils are wet. No driving off of hardened roads should occur immediately following large rainfall events until soils have dried out and the risk of bogging down has decreased.<br>» Closure and rehabilitation of the disturbed areas should commence as soon as the laying of underground cable has been completed.<br>» Soils should be landscaped to the natural landscape profile with care taken to ensure that no preferential flow paths or berms remain | | action is taken where potentially adverse environmental impacts are highlighted through monitoring and surveillance.<br>» The ECO will need to be responsible for conducting regular site-inspections of the construction, processes, reporting back to the relevant environmental authorities with findings of these investigations. | | |

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| | » Any areas disturbed during the construction phase should be encouraged to rehabilitate as fast and effective as possible and were deemed necessary by the ECO or Contractor's EO, artificial rehabilitation (e.g. re-seeding with collected or commercial indigenous seed mixes) should be applied in order to speed up the rehabilitation process in critical areas (e.g. steep slopes and unstable soils).<br>» All rehabilitated areas must be monitored to ensure that these areas do not become subject to erosion or invasive alien plant growth. | Contractor/ ECO/EO | » The ECO will need to prepare an induction and training programme to educate the contracting team on the EMPr commitments relating to site rehabilitation.<br>» Contractor to develop an internal reporting structure to monitor compliance with the commitments given in the EMPr as construction progresses.<br>» The EMPr and Rehabilitation Management Plan should be enforced and monitored for compliance by a suitably qualified/trained ECO (Environmental Control Officer) with any additional supporting EO's (Environmental Officers) having the required competency skills and experience to ensure that environmental mitigation measures are being implemented and appropriate action is taken where potentially adverse environmental impacts are highlighted through monitoring and surveillance.<br>» The ECO will need to be responsible for conducting regular site-inspections of the | » Recreate a non-invasive, acceptable vegetation cover that will facilitate the establishment of desirable and/or indigenous species<br>» Prevent accelerated erosion of ecosystem degradation | After construction and throughout operational phase as well as after the decommissioning phase |

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| | | | construction, and operational processes, reporting back to the relevant environmental authorities with findings of these investigations. | | |
| ***Increase in sedimentation and erosion: Construction of Wind Turbines and supporting infrastructure (excluding roads and mv cable watercourse crossings)*** | | | | | |
| Construction of Wind Turbines and supporting infrastructure (excluding roads and mv cable watercourse crossings) | » No unnecessary vegetation clearance may be allowed.<br>» Vegetation clearing should occur in a phased manner to minimise erosion and/or run-off.<br>» Any erosion problems observed to be associated with the project infrastructure should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur.<br>» There should be reduced activity at the site after large rainfall events when the soils are wet.<br>» No driving off of hardened roads should occur immediately following large rainfall events until soils have dried out and the risk of bogging down has decreased.<br>» Any stormwater within the site must be handled in a suitable manner, i.e. trap sediments, and reduce flow velocities | Contractor/ ECO/EO | » The ECO will need to prepare an induction and training programme to educate the contracting team on the EMPr commitments.<br>» Contractor to develop an internal reporting structure to monitor compliance with the commitments given in the EMPr as construction progresses.<br>» The EMPr should be enforced and monitored for compliance by a suitably qualified/trained ECO (Environmental Control Officer) with any additional supporting EO's (Environmental Officers) having the required competency skills and experience to ensure that environmental mitigation measures are being implemented and appropriate action is taken where potentially adverse environmental impacts are | » Prevent upstream erosional features from spreading into the aquatic buffer areas and the resource features themselves.<br>» To allow for natural runoff patterns into the downslope freshwater resource features.<br>» To avoid unnatural amounts of sediments carried into the downstream freshwater resource features form their catchments. | Throughout construction and decommissioning phase |

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| | | | highlighted through monitoring and surveillance.<br>» The ECO will need to be responsible for conducting regular site-inspections of the construction, processes, reporting back to the relevant environmental authorities with findings of these investigations. | | |
| **Potential impact on localised surface water quality** | | | | | |
| All associated infrastructure | » Implement appropriate measures to ensure strict use and management of all hazardous materials used on site<br>» Waste should be stored on site in clearly marked containers in a demarcated area.<br>» All waste material should be removed at the end of every working day to designated waste facilities at the main construction camp/suitable waste disposal facility.<br>» All waste must be disposed of offsite.<br>» Implement appropriate measures to ensure strict management of potential sources of pollutants (e.g. litter, hydrocarbons from vehicles and machinery, cement during construction etc.)<br>» Implement appropriate measures to ensure containment of all contaminated water by means of careful run-off management on the development site.<br>» Implement appropriate measures to ensure strict control over the behavior of construction workers. | Contractor/ ECO/EO | » Observation and supervision of chemical storage and handling practices and vehicle maintenance throughout construction phase<br>» A complaints register must be maintained, in which any complaints from the community will be logged. Complaints must be investigated and, if appropriate, acted upon<br>» Observation and supervision of waste management practices throughout construction phase<br>» Waste collection to be monitored on a regular basis<br>» Waste documentation completed<br>» An incident reporting system must be used to record non-conformances to the EMP/IWWMP | » To ensure that the storage and handling of chemicals and hydrocarbons on-site does not cause pollution to the environment or harm to persons<br>» To ensure that the storage and maintenance of machinery on-site does not cause pollution of the environment or harm to persons<br>» To comply with waste management legislation<br>» To minimise production of waste<br>» To ensure appropriate waste storage and disposal<br>» To avoid environmental harm from waste disposal | Throughout construction, maintenance and decommissioning phase |

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| | » Appropriate ablution facilities should be provided for construction workers during construction and on-site staff during the operation of the substation and WEF.<br>» Vehicles to refuel within a designated area, at least 100m from any freshwater resource feature.<br>» Place spill kits on site which are operated by trained staff members for the adhoc remediation of minor chemical and hydrocarbon spillages. | | » An appointed ECO must monitor indicators listed above to ensure that they have been met for the construction phase.<br>» Public complaints register must be developed and maintained on site. | | |
| ***Operational Phase*** | | | | | |
| ***Increase in sedimentation and erosion*** | | | | | |
| Entire development footprint | » All culverts, stormwater run-off infrastructure erosion prevention features/infrastructure must be monitored and maintained.<br>» Any erosion problems observed to be associated with the project infrastructure should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur. | Contractor, ECO to control | » Project site and infrastructure annually monitored by EO<br>» The EO should be responsible for driving this process. | » Ensure that all culverts, stormwater run-off infrastructure and erosion prevention features are functioning optimally,<br>» No disturbance or degradation of freshwater resource features occur throughout the operational phase. | Throughout the operational phase |

# 8. CONCLUSION AND RECOMMENDATIONS

Nkurenkuru Ecology and Biodiversity was appointed by Pofadder Wind Facility (Pty) Ltd to undertake the freshwater resource and biodiversity study and assessment for the proposed Pofadder Wind Energy Facility 1. The proposed wind energy facility will comprise of up to 28 wind turbines with a generating capacity of 224MW. The proposed facility will be located within the following properties:

- The Farm Ganna-Poort 202;
- The Farm Lovedale 201; and
- Portion 3 of the Farm Sand Gat 150.

The affected properties are located approximately located approximately 20km South East of Pofadder within the Kai!Garib Local Municipality and the Z F Mgcawu District Municipality in the Northern Cape Province.

This study has been commissioned to meet the requirements of the EIA process in the form of a EIA Assessment as set out by the National Environmental Management Act (1998) and a Water Use Licence Application as set out by the National Water Act (Act 36 of 1998). Furthermore, this study should and has been done in accordance with the "newly" Gazetted Protocols 3(a),(c) and (d) in terms of Section 24(5)(a) and 24(5)(h) of NEMA (Published on the 20th of March 2020); and meet the requirements as set out within the Aquatic Biodiversity Protocol published in GN NO. 1105 of 30 October 2020.

According to the guidelines specified within GN509 of 2016 all wetlands within a radius of 500m of the facility footprint were identified and mapped.

- A total of 71 freshwater resource features were identified and delineated and include:
- One (1) large primary/major ephemeral wash namely the Kaboet River;
- Twelve (12) smaller ephemeral washes (mainly third order streams); and
- Fifty-eight (58) drainage channels.

Overall, with the exception of erosion, dams and present road crossings (most prominent impacts), these freshwater systems are still in a fairly natural, functional condition.

A summary of the sensitivities of the identified/delineated terrestrial and aquatic/freshwater resource features as well as general development recommendations for each feature are provided below in Table 12

**With mitigation measures in place, impacts on the freshwater resource features' integrity and functioning can be potentially reduced to sufficiently low levels. This would be best achieved by incorporating the recommended management & mitigation measures into an Environmental Management Programme (EMPr) for**

**the site, together with appropriate rehabilitation guidelines and ecological monitoring recommendations.**

**Based on the outcomes of this study it is my considered opinion that the proposed project detailed in this report could be authorised from a freshwater resource perspective.**

Table 12: Summary of the EIA phase sensitivity assessment.

| Feature | Scoping Phase Sensitivity | Remarks |
|---|---|---|
| **Drainage Lines and 35m Buffers** | **Medium** | » Nine small drainage lines will be crossed by access roads and underground cables.<br>» This is deemed acceptable, with the necessary mitigation measures in place, as these crossings will not impact the more important downstream freshwater resource features.<br>» Proposed Mitigation Measures includes:<br>• Undertake construction activities in the dry season.<br>• A detailed Storm Water and Erosion Management Plan;<br>• A detailed Plant Rehabilitation and Invasive Alien Plant Management Plan<br>• No activities may be allowed outside of the development area.<br>• Implement appropriate measures to ensure strict control over the behaviour of construction workers.<br>• The working servitude within these habitats must be demarcated on both sides using orange hazard netting prior to construction commencing and no activities may be allowed outside of the demarcated area.<br>• All freshwater habitats outside of the demarcated construction area must be considered 'No-Go<br>• Watercourse crossing should allow for the natural movement of water across the road crossing, without inhibiting the natural movement of water and may not result in changes to flow volumes and velocities, or create artificially inundated areas, but allow for the free-flow movement of water.<br>• No unnecessary vegetation clearance may be allowed.<br>• Any erosion observed to be associated with the project infrastructure should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur.<br>• Construction of gabions and other stabilisation features to prevent erosion if deemed necessary. |
| **Depression Wetlands and 50m buffers** | **High** | » This, feature will be avoided by the proposed development.<br>» Direct impacts on this feature is highly unlikely |
| **Minor Ephemeral Washes and 50m Buffer Areas** | **High** | » Only one such feature will be crossed by an access road and underground MV cables.<br>» This is deemed acceptable, with the necessary mitigation measures in place, as these crossings will not impact the more important downstream freshwater resource features. |

| | | |
|---|---|---|
| | | » Proposed Mitigation Measures includes:<br>• Undertake construction activities in the dry season.<br>• A detailed Storm Water and Erosion Management Plan;<br>• A detailed Plant Rehabilitation and Invasive Alien Plant Management Plan<br>• No activities may be allowed outside of the development area.<br>• Implement appropriate measures to ensure strict control over the behaviour of construction workers.<br>• The working servitude within these habitats must be demarcated on both sides using orange hazard netting prior to construction commencing and no activities may be allowed outside of the demarcated area.<br>• All freshwater habitats outside of the demarcated construction area must be considered 'No-Go<br>• Watercourse crossing should allow for the natural movement of water across the road crossing, without inhibiting the natural movement of water and may not result in changes to flow volumes and velocities, or create artificially inundated areas, but allow for the free-flow movement of water.<br>• No unnecessary vegetation clearance may be allowed.<br>• Any erosion observed to be associated with the project infrastructure should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur.<br>• Construction of gabions and other stabilisation features to prevent erosion if deemed necessary. |
| **Primary and Larger Ephemeral Washes and 100m Buffer Areas** | **Very High** | » This, feature will be avoided by the proposed development.<br>» Direct impacts on this feature is highly unlikely |

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# 10. APPENDICES

## Appendix 1 Methodology: Environmental Impact Assessment (SiVest)

The Environmental Impact Assessment (EIA) Methodology assists in evaluating the overall effect of a proposed activity on the environment. Determining of the significance of an environmental impact on an environmental parameter is determined through a systematic analysis.

### 10.1.1. Determination of Significance of Impacts

Significance is determined through a synthesis of impact characteristics which include context and intensity of an impact. Context refers to the geographical scale (i.e. site, local, national or global), whereas intensity is defined by the severity of the impact e.g. the magnitude of deviation from background conditions, the size of the area affected, the duration of the impact and the overall probability of occurrence. Significance is calculated as shown in Table 26.

Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The total number of points scored for each impact indicates the level of significance of the impact.

### 10.1.2. Impact Rating System

The impact assessment must take account of the nature, scale and duration of effects on the environment and whether such effects are positive (beneficial) or negative (detrimental). Each issue / impact is also assessed according to the various project stages, as follows:

- Planning;
- Construction;
- Operation; and
- Decommissioning.

Where necessary, the proposal for mitigation or optimisation of an impact should be detailed. A brief discussion of the impact and the rationale behind the assessment of its significance has also been included.

The significance of Cumulative Impacts should also be rated.

#### *10.1.2.1. Rating System Used to Classify Impacts*

The rating system is applied to the potential impact on the receiving environment and includes an objective evaluation of the possible mitigation of the impact. Impacts have been consolidated into one

(1) rating. In assessing the significance of each issue the following criteria (including an allocated point system) is used:

Table 13: Rating of impacts criteria

| | | |
|---|---|---|
| **ENVIRONMENTAL PARAMETER** | | |
| A brief description of the environmental aspect likely to be affected by the proposed activity (e.g. Surface Water). | | |
| **ISSUE / IMPACT / ENVIRONMENTAL EFFECT / NATURE** | | |
| Include a brief description of the impact of environmental parameter being assessed in the context of the project. This criterion includes a brief written statement of the environmental aspect being impacted upon by a particular action or activity (e.g. oil spill in surface water). | | |
| **EXTENT (E)** | | |
| This is defined as the area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales and as such bracketing ranges are often required. This is often useful during the detailed assessment of a project in terms of further defining the determined. | | |
| 1 | Site | The impact will only affect the site |
| 2 | Local/district | Will affect the local area or district |
| 3 | Province/region | Will affect the entire province or region |
| 4 | International and National | Will affect the entire country |
| **PROBABILITY (P)** | | |
| This describes the chance of occurrence of an impact | | |
| 1 | Unlikely | The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence). |
| 2 | Possible | The impact may occur (Between a 25% to 50% chance of occurrence). |
| 3 | Probable | The impact will likely occur (Between a 50% to 75% chance of occurrence). |
| 4 | Definite | Impact will certainly occur (Greater than a 75% chance of occurrence). |
| **REVERSIBILITY (R)** | | |
| This describes the degree to which an impact on an environmental parameter can be successfully reversed upon completion of the proposed activity. | | |
| 1 | Completely reversible | The impact is reversible with implementation of minor mitigation measures |
| 2 | Partly reversible | The impact is partly reversible but more intense mitigation measures are required. |
| 3 | Barely reversible | The impact is unlikely to be reversed even with intense mitigation measures. |
| 4 | Irreversible | The impact is irreversible and no mitigation measures exist. |

| | | |
|---|---|---|
| **IRREPLACEABLE LOSS OF RESOURCES (L)** | | |
| This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity. | | |
| 1 | No loss of resource. | The impact will not result in the loss of any resources. |
| 2 | Marginal loss of resource | The impact will result in marginal loss of resources. |
| 3 | Significant loss of resources | The impact will result in significant loss of resources. |
| 4 | Complete loss of resources | The impact is result in a complete loss of all resources. |
| **DURATION (D)** | | |
| This describes the duration of the impacts on the environmental parameter. Duration indicates the lifetime of the impact as a result of the proposed activity. | | |
| 1 | Short term | The impact and its effects will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (0 – 1 years), or the impact and its effects will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years). |
| 2 | Medium term | The impact and its effects will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years). |
| 3 | Long term | The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 50 years). |
| 4 | Permanent | The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered transient (Indefinite). |
| **INTENSITY / MAGNITUDE (I / M)** | | |
| Describes the severity of an impact (i.e. whether the impact has the ability to alter the functionality or quality of a system permanently or temporarily). | | |
| 1 | Low | Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible. |
| 2 | Medium | Impact alters the quality, use and integrity of the system/component but system/ component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity). |
| 3 | High | Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation. |

| | | |
|---|---|---|
| 4 | Very high | Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired (system collapse). Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation. |

**SIGNIFICANCE (S)**

Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. This describes the significance of the impact on the environmental parameter. The calculation of the significance of an impact uses the following formula:

**Significance = (Extent + probability + reversibility + irreplaceability + duration) x magnitude/intensity.**

The summation of the different criteria will produce a non-weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.

| Points | Impact Significance Rating | Description |
|---|---|---|
| | | |
| 5 to 23 | Negative Low impact | The anticipated impact will have negligible negative effects and will require little to no mitigation. |
| 5 to 23 | Positive Low impact | The anticipated impact will have minor positive effects. |
| 24 to 42 | Negative Medium impact | The anticipated impact will have moderate negative effects and will require moderate mitigation measures. |
| 24 to 42 | Positive Medium impact | The anticipated impact will have moderate positive effects. |
| 43 to 61 | Negative High impact | The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact. |
| 43 to 61 | Positive High impact | The anticipated impact will have significant positive effects. |
| 62 to 80 | Negative Very high impact | The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws". |
| 62 to 80 | Positive Very high impact | The anticipated impact will have highly significant positive effects. |

## Appendix 2 National Based Environmental Screening Tool.

**Please take not the Site Screening Survey was conducted prior to the Scoping Phase Assessment and was accompanied by a Screen Survey Site Visit. All the findings and recommendations were made based on the information available at the time. The information provided within this Report as well as the Scoping Phase Report was used to finalize the layout of the facility in order to avoid all sensitive features as recommended within this report and the scoping phase report.**

*Introduction and summary of the Screening Tool and the link between this tool and the newly gazetted Protocols for specialists.*

The Screening Tool, developed by the Department of Environmental Affairs ("DEA"), now Department Forestry and Fisheries of Environment, (DFFE), is a geospatial web-enabled application that aims to provide readily available information, known as 'spatial datasets', which enables applicants for Environmental Authorisation to screen their proposed site for environmental sensitivities.

The Screening Tool provides site specific information to assist an applicant throughout the EIA process. The information provided includes, for example, zoning identification, applicable Environmental Management Frameworks or bio-regional plans, project specific requirements such as specialist studies, and the minimum information to be included in the EIA report.

On 5 July 2019, the Minister of Environment, Forestry and Fisheries, Barbara Dallas Creecy, published a notice requiring that when submitting an application for environmental authorisation in terms of regulation 19 and regulation 21 of the Environmental Impact Assessment Regulations, 2014 (as amended) (the "EIA Regulations"), the applicant must submit the report generated by the National Web Based Screening Tool (the "Screening Tool") with the application. This notice came into effect in October 2019.

The South African National Biodiversity Institute (SANBI), through its Biodiversity and Land Use (BLU) Project and the Council for Scientific and Industrial Research (CSIR) has, since 2017, been supporting the Department of Environment Forestry and Fisheries (DEFF) in integrating biodiversity information into DEFF's web-based National Environmental Screening Tool (hereafter referred to as 'screening tool') and developing a set of biodiversity related protocols that an applicant needs to adhere to in the Environmental Authorisation (EA) process.

On 20 March 2020 the Minister of Forestry, Fisheries and the Environment gazetted Terrestrial and Aquatic Biodiversity Protocols for national implementation purposes.

The Screening Tool consists of a number of themes including agriculture, avifauna, terrestrial and aquatic biodiversity, plant and animal species, noise, defence and civil

aviation. Each of the themes consists of spatial datasets that correspond to the respective theme. Each dataset within the respective theme has been assigned a sensitivity level. Most of the themes within the Screening Tool make use of a four-tier sensitivity system, where delineated areas and features are assigned a sensitivity level of either "low (L)", "medium (M)", "high (H)" or "very high (VH)". Table 14 below describes the four sensitivity classes and their definitions.

Table 14: Summary of the sensitivity classes.

| Assessment | Description |
|---|---|
| **VERY HIGH** | Area is rates as being extremely sensitivity to development and the risk of finding sensitive biodiversity features at the site is very high. Consequently, the area will either have very high conservation or socio-economic value. |
| **High** | Area is rated as being highly sensitive to development and the risk of finding sensitive biodiversity features at the site is high. Consequently. The area will either have high conservation or socio-economic value |
| **Medium** | Area is rated as being of medium sensitivity to development and there is a medium to moderate risk of finding sensitive biodiversity features at the site. Consequently, the area will either have medium conservation or socio-economic value. |
| **Low** | Area is considered to have low levels of sensitivity and there is low risk of finding sensitive biodiversity features at the site. Consequently, the area has a low conservation or socio-economic value. |

A number of datasets were used for the biodiversity related themes. Table 15 identifies the datasets that underpin the various biodiversity related themes in the Screening Tool. For the Aquatic and Terrestrial Biodiversity Themes, all features that have known mapped features of sensitive biodiversity features are assigned a "very high" sensitivity. Where there are no known sensitive biodiversity features, a "low" sensitivity is assigned. Subsequently a two-tier sensitivity system has been applied to the Terrestrial Biodiversity Themes ("very high" and "low") and are based on the presence or absence of known sensitive biodiversity features respectively. In essence the "very high" and "low" sensitivity ratings should be interpreted as there being a greater and lower risk of finding important biodiversity in these areas respectively. It is important to note that all the "very high" delineated areas and features are sensitive but the degree to which these areas can be impacted upon is different for the different "very high" delineated areas and features, depending on the development type. The degree of impact on these areas can only be assessed with the EIA process.

Table 15: Summary of the datasets used to underpin the aquatic and terrestrial biodiversity themes and the sensitivity rating of these features.

| **Terrestrial & Aquatic Biodiversity Themes Datasets Used** | **Sensitivity** |
|---|---|
| Protected Areas (Terrestrial) | **Very High** |
| Critical Biodiversity Areas – CBAs (Terrestrial and Aquatic) | **Very High** |
| Ecological Support Areas – ESAs (Terrestrial and Aquatic) | **Very High** |
| Strategic Water Source Areas (Terrestrial & Aquatic) | **Very High** |
| National Freshwater Priority Areas (FEPA) catchments (Terrestrial & Aquatic) | **Very High** |
| Priority Areas for Protected Area Expansion (Terrestrial) | **Very High** |
| Indigenous Forest (Terrestrial) | **Very High** |
| Rivers (Aquatic) | **Very High** |
| Wetlands (Aquatic) | **Very High** |

| | |
|---|---|
| Estuaries (Aquatic) | **Very High** |
| Absence of above listed features | **Low** |

As for the Animal and Plant Species Themes, the four-tier sensitivity system have been implemented to the various data layers underpinning these themes, namely "Low", "Medium", "High" and "Very High". Species data have been separated from ecosystem/ landscape level data to provide for huge complexities in the species data, in addition to the high numbers of threatened species within South Africa that would need to be processed for inclusion into the screening tool. As such, it was decided to keep the species data separate for simpler integration within the Screening Tool. It should also be noted that the species guilds that will be covered in the Animal Species Protocol include mammals, reptiles, amphibians, butterflies and birds. A summary of the datasets used to underpin the Animal and Plant themes and their sensitivity rating are provided in Table 16 below.

Table 16: Summary of the datasets used to underpin animal and plant themes and the sensitivity rating of these features.

| **Plant and/or Animal Species Theme Data Sets Used** | **Sensitivity** |
|---|---|
| Critical habitat for range restricted species of conservation concern that have a global range of less than 10km$^2$. | **Very High** |
| Confirmed habitat for species of conservation concern. | **High** |
| Suspected habitat for species of conservation concern based either on there being records for this species collected in the past prior to 2020 or being a natural area included in a habitat suitability model. | **Medium** |
| Areas where no natural habitat remains. | **Low** |

## 10.2. Description/discussion of the sensitive features found within the project site, as identified within the screening tool and based on the findings of a site visit.

According to the Screening Report generated on the 20$^{th}$ of July 2022 (12:50:16) the following sensitivities (pertaining to terrestrial biodiversity) were identified within the project area:

Table 17: Summary of the development site's environmental sensitivities.

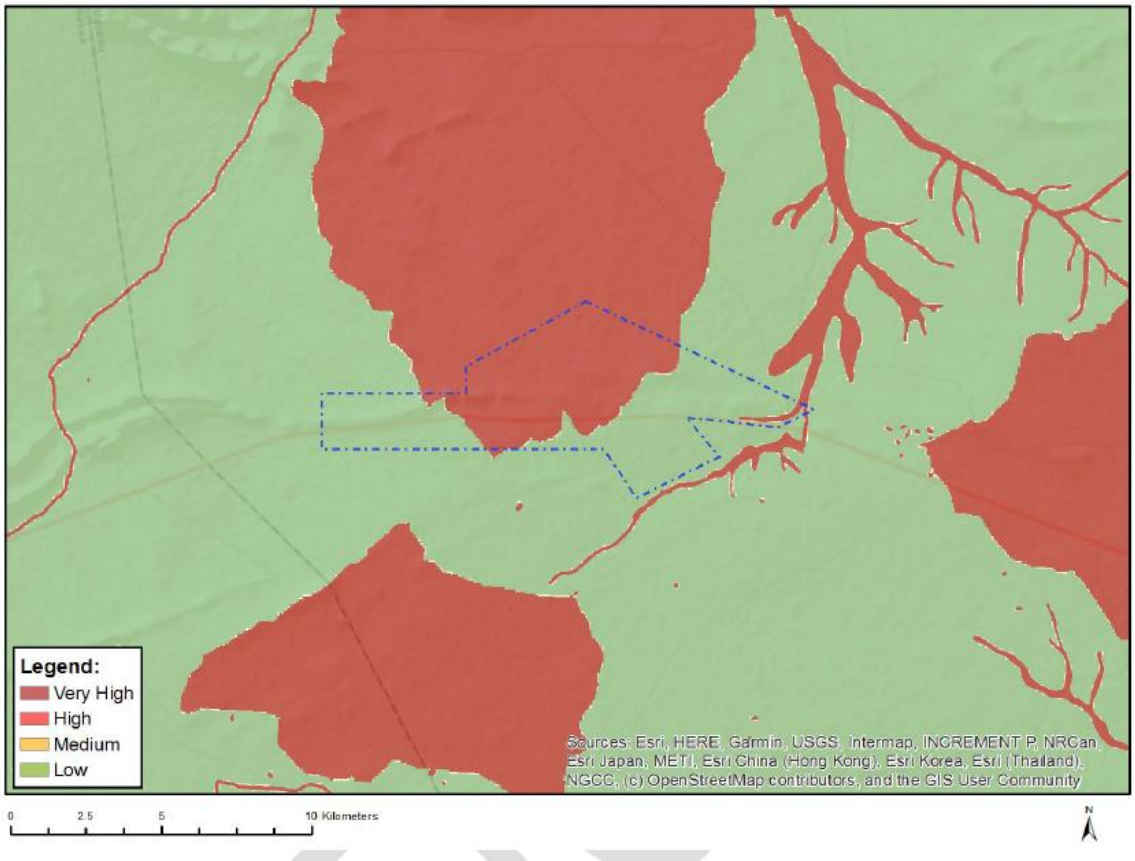
| **Theme** | **Very High Sensitivity** | **High Sensitivity** | **Medium Sensitivity** | **Low Sensitivity** |
|---|---|---|---|---|
| Aquatic Biodiversity Theme | X | | | |
| Animal Species Theme | | X | | |
| Plant Species Theme | | | X | |
| Terrestrial Biodiversity Theme | X | | | |

A description of the various applicable themes and their sensitivities are provided below as well the confirmation or refute of these sensitivities within the project site based on the findings of the site visit. Take note that this study and report addresses the terrestrial themes, however some of the terrestrial biodiversity themes relate to aquatic features

such NFEPA rivers and sub-quaternary catchments and as such these aspects are addressed to some extent where relevant.

***Aquatic Biodiversity Theme: Sensitivity***

| Feature | Sensitivity |
|---|---|
| Low Sensitivity | **Low Sensitivity** |
| Rivers | **Very High Sensitivity** |
| Wetland and Estuaries | **Very High Sensitivity** |
| Freshwater ecosystem priority area quinary catchment | **Very High Sensitivity** |




*DISCUSSION OF SENSITIVITY FEATURES BASED ON ON-SITE FINDINGS (FOLLOWING A SITE-VISIT)*

The majority of the "Very High Sensitive" areas identified within the affected properties are based primarily on the NFEPA coverage (mainly FEPA and Upstream Catchments) and SANBI's 2018 National Wetland Map 5 and 2018 National River Map.

The underlying features associated with the Very High sensitive areas within the development site can be summarised as follow:

Table 18: Reasons underlying the CBA1 and CBA2 status of the affected property.

| Feature | Very High | High | Medium | Low | Remarks |
|---|---|---|---|---|---|
| **Larger River Features identified within the NBA River Map (2018) (1:500 000)** | **X** | | | | » Four river features have been mapped within namely the Kaboep River draining the central-eastern and north eastern portion of the project site and three smaller unnamed rivers draining the central-western and south-western portion of the project site.<br>» All four river have been classified as Endangered aquatic ecosystems<br>» According to the current layout, none of these rivers will be directly impacted by the proposed development. |
| **Wetlands identified within the NBA Wetland Map 5 (2018) (1:5000)** | **X** | | | | » Eight depression wetlands have been mapped, mostly located within the eastern and southern portion of the project site.<br>» Two riverine wetlands (previously classified as valley floor wetland) have been mapped, and is associated with the Kaboep River the east and north-east of the project site.<br>» All eight of these wetlands have been classified as Critically Endangered aquatic ecosystem.<br>» According to the current layout, none of these rivers will be directly impacted by the proposed development. |
| **Sub-Quaternary Catchment of FEPA-Rivers** | **X** | | | | » Two FEPA 1 prioritized sub-quaternary catchments include portions of the project site (one in the north and the other in the south-west).<br>» Only five wind turbines and a limited extent of access roads and cabling are planned within these catchments. |

These freshwater resource features underlying the affected property as well as acceptable development recommendations are furthermore discussed in sections 4.2.2 and 4.2.3.

With meticulous implementation of recommended mitigation measures the proposed development of the Pofadder 1 WEF will not have an impact on these freshwater resource features.

Recommendations and additional requirements:

» An in-field delineation and classification of all freshwater resource features was done and the results are illustrated in Figure 7. The larger ephemeral washes and wetland features were either classified as Very High or High sensitive, whilst the smaller drainage systems were classified as Medium Sensitive. Furthermore, appropriate buffer areas for the freshwater resource features have been determined and area as follows:
  - Primary and large ephemeral washes (including associated alluvial floodplains: 100m buffers from the outer edge of the freshwater resource features.

- Minor ephemeral washes: 50m buffers from the outer edge of the freshwater resource features.
- Endorheic depression wetlands (pans): 50m buffers from the outer edge of the freshwater resource features.
- Small drainage lines: 35m buffers.

» All ephemeral washes and alluvial floodplains with their buffer areas should be regarded as "No-Go" areas apart from the following activities and infrastructure which may be allowed (although restricted to an absolute minimum footprint):
- only activities relating to the route access and cabling:
  - the use/upgrade of existing roads and watercourse crossings are the preferred options;
  - Where no suitable existing roads and watercourse crossings exist, the construction of new access roads and watercourse crossings can be allowed, however this should be deemed as a last resort.
  - All underground cabling should be laid either within access roads or next to access roads (as close as possible).

» All depression wetlands with their buffer areas should be regarded as "No-Go" areas for all activities associate with the proposed development.

» All drainage lines with their buffer areas should be regarded as "No-Go" areas apart from the following activities and infrastructure which may be allowed (although restricted to an absolute minimum footprint):
- only activities relating to the route access and cabling:
  - the use/upgrade of existing roads and watercourse crossings are the preferred options;
  - Where no suitable existing roads and watercourse crossings exist, the construction of new access roads and watercourse crossings can be allowed, however this should be deemed as a last resort.
  - All underground cabling should be laid either within access roads or next to access roads (as close as possible).

» In terms of activities and infrastructure planned within the FEPA1 prioritized sub-quaternary catchments: Mitigation measures should be considered for the development of the WEF, as careless and uncontrolled activities may lead to indirect negative impacts on the lower lying watercourses. Thus, the following mitigation measures should be considered;
- During the planning and design phase the following aspects should be considered and addressed:
  - Natural runoff patterns within the catchments: Provide mitigation measures that will manage/simulate these natural runoff patterns and prevent erosion.
  - Natural/normal water inputs, flow patterns and flood peaks associated with the lower lying watercourses: Provide mitigation measures in order to maintain these hydrological characteristics (drivers).

- Landscape/Ecological Connectivity: Provide mitigation measures that will prevent the fracturing of landscape (maintain connectivity between upland terrestrial habitats and downstream freshwater resource features)

Recommended Ecological Categories (RECs) of downstream freshwater resource features: Maintain these RECs.

## Appendix 3 Specialist Curriculum Vitae

# CURRICULUM VITAE:

### Gerhard Botha

| | | |
|---|---|---|
| **Name:** | : | Gerhardus Alfred Botha |
| **Date of Birth** | : | 11 April 1986 |
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| **Profession/Specialisation** | : | Ecological and Biodiversity Consultant |
| **Nationality:** | : | South African |
| **Years Experience:** | : | 8 |
| **Bilingualism** | : | Very good – English and Afrikaans |

## Professional Profile:

Gerhard is a Managing Director of Nkurenkuru Ecology and Biodiversity (Pty) Ltd. He has a BSc Honours degree in Botany from the University of the Free State Province and is currently completing a MSc Degree in Botany. He began working as an environmental specialist in 2010 and has since gained extensive experience in conducting ecological and biodiversity assessments in various development field, especially in the fields of conventional as well as renewable energy generation, mining and infrastructure development. Gerhard is a registered Professional Natural Scientist (Pr. Sci. Nat.)

## Key Responsibilities:

Specific responsibilities as an Ecological and Biodiversity Specialist include, inter alia, professional execution of specialist consulting services (including flora, wetland and fauna studies, where required), impact assessment reporting, walk through surveys/ground-truthing to inform final design, compilation of management plans, compliance monitoring and audit reporting, in-house ecological awareness training to on-site personnel, and the development of project proposals for procuring new work/projects.

## Skills Base and Core Competencies

- Research Project Management
- Botanical researcher in projects involving the description of terrestrial and coastal ecosystems.
- Broad expertise in the ecology and conservation of grasslands, savannahs, karroid wetland, and aquatic ecosystems.
- Ecological and Biodiversity assessments for developmental purposes (BAR, EIA), with extensive knowledge and experience in the renewable energy field (Refer to Work Experiences and References)
- Over 3 years of avifaunal monitoring and assessment experience.
- Mapping and Infield delineation of wetlands, riparian zones and aquatic habitats (according to methods stipulated by DWA, 2008) within various South African provinces of KwaZulu-Natal, Mpumalanga, Free State, Gauteng and Northern Cape Province for inventory and management purposes.
- Wetland and aquatic buffer allocations according to industry best practice guidelines.
- Working knowledge of environmental planning policies, regulatory frameworks, and legislation
- Identification and assessment of potential environmental impacts and benefits.
- Assessment of various wetland ecosystems to highlight potential impacts, within current and proposed landscape settings, and recommend appropriate mitigation and offsets based on assessing wetland ecosystem service delivery (functions) and ecological health/integrity.
- Development of practical and achievable mitigation measures and management plans and evaluation of risk to execution
- Qualitative and Quantitative Research
- Experienced in field research and monitoring
- Working knowledge of GIS applications and analysis of satellite imagery data
- Completed projects in several Provinces of South Africa and include a number of projects located in sensitive and ecological unique regions.

## Education and Professional Status

### *Degrees:*

- *2015:* Currently completing a M.Sc. degree in Botany (Vegetation Ecology), University of the Free State, Bloemfontein, RSA.
- *2009:* B.Sc. Hons in Botany (Vegetation Ecology), University of the Free State, Bloemfontein, RSA.
- *2008:* B.Sc. in Zoology and Botany, University of the Free State, University of the Free State, Bloemfontein, RSA.

### *Courses:*

- *2013*: Wetland Management (ecology, hydrology, biodiversity, and delineation) – University of the Free State accredited course.
- *2014*: Introduction to GIS and GPS (Code: GISA 1500S) – University of the Free State accredited course.

### *Professional Society Affiliations:*

- The South African Council of Natural Scientific Professions: Pr. Sci. Nat. Reg. No. 400502/14 (Botany and Ecology).

## Employment History

- December 2017 – Current: Nkurenkuru Ecology and Biodiversity (Pty) Ltd
- 2016 – November 2017: ECO-CARE Consultancy
- *2015 - 2016*: Ecologist, Savannah Environmental (Pty) Ltd
- *2013 – 2014*: Working as ecologist on a freelance basis, involved in part-time and contractual positions for the following companies
    - Enviroworks (Pty) Ltd
    - GreenMined (Pty) Ltd
    - Eco-Care Consultancy (Pty) Ltd
    - Enviro-Niche Consulting (Pty) Ltd
    - Savannah Environmental (Pty) Ltd
    - Esicongweni Environmental Services (EES) cc
- *2010 - 2012*: Enviroworks (Pty) Ltd

## Publications

### *Publications:*

- Botha, G.A. & Du Preez, P.J. 2015. A description of the wetland and riparian vegetation of the Nxamasere palaeo-river's backflooded section, Okavango Delta, Botswana. S. *Afr. J. Bot*., **98**: 172-173.

### *Congress papers/posters/presentations:*

- Botha, G.A. 2015. A description of the wetland and riparian vegetation of the Nxamasere palaeo-river's backflooded section, Okavango Delta, Botswana. 41st Annual Congress of South African Association of Botanists (SAAB). Tshipise, 11-15 Jan. 2015.
- Botha, G.A. 2014. A description of the vegetation of the Nxamasere floodplain, Okavango Delta, Botswana. 10st Annual University of Johannesburg (UJ) Postgraduate Botany Symposium. Johannesburg, 28 Oct. 2014.

## Other

- Guest speaker at IAIAsa Free State Branch Event (29 March 2017)
- Guest speaker at the University of the Free State Province: Department of Plant Sciences (3 March 2017):

## References:

- Christine Fouché
  Manager: GreenMined (Pty) LTD
  Cell: 084 663 2399
- Professor J du Preez
  Senior lecturer: Department of Plant Sciences
  University of the Free State
  Cell: 082 376 4404

# CURRICULUM VITAE:

**Jan-Hendrik Keet, PhD**

**Address**: Unit 29 Avignon, Hillcrest Road
Land en Zeezicht, Somerset West
South Africa
7130
Email: jhkeet@hotmail.com
Phone: +27 71 451 4853

## Expertise and experience

- Current profession: Post Doctoral Researcher – Centre for Invasion Biology (Department of Botany and Zoology), Stellenbosch University
- Specialisation: Botany, ecology, invasive plant species, and invasion biology
- Years of experience: 7 years
- Published in various national and international scientific journals

## Skills and competencies

- Invasive species biology
- Plant biogeography and ecology
- Plant identification and taxonomy
- Vegetation surveys and mapping
- Soil microbiomes, function, and chemistry
- Geographic Information Systems
- Data analysis and Statistics in R Statistical Software

## Tertiary education

- *2015 – 2019: Stellenbosch University, Stellenbosch, South Africa. Doctor of Philosophy (Botany)*

- *2013 – 2014: University of the Free State, Bloemfontein, South Africa. Magister Scientiae (Botany)*
- *2012: University of the Free State, Bloemfontein, South Africa. Bachelor of Science Honours (Botany) - cum laude*
- *2009 – 2011: University of the Free State, Bloemfontein, South Africa. Bachelor of Science (Chemistry with Physics and Biology) - cum laude*

## Employment history

- *2011: Part-time demonstrator. Department of Plant Sciences, University of the Free State, Bloemfontein, South Africa*
- *2010: Part-time lab assistant. Department of Chemistry, University of the Free State, Bloemfontein, South Africa*
- *2007 – 2009: Shop Manager. Christian Tees, Brandwag Centre, Bloemfontein*

## Certifications

- *SAGIC Invasive Species Consultant (Cape Town, South Africa), March 2016*
- *GIS Intermediate (NQF level 5): Hydrological modelling and terrain analysis using digital elevation models (University of the Free State, South Africa), 2014*
- *Good Laboratory Practice seminar presented by Merck Millipore South Africa, 2012*
- *Laboratory Safety seminar presented by Merck Millipore South Africa, 2012*

## Appendix 4 Specialist Work Experience and References

# WORK EXPERIENCES

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# References

**Gerhard Botha**

**ECOLOGICAL RELATED STUDIES AND SURVEYS**

| Date Completed | Project Description | Type of Assessment/Study | Client |
|---|---|---|---|
| **2019** | Sirius Three Solar PV Facility near Upington, Northern Cape | Ecological Assessment (Basic Assessment) | Aurora Power Solutions |
| **2019** | Sirius Four Solar PV Facility near Upington, Northern Cape | Ecological Assessment (Basic Assessment) | Aurora Power Solutions |
| **2019** | Lichtenburg 1 100MW Solar PV Facility, Lichtenburg, North-West Province | Ecological Assessment (Scoping and EIA Phase Assessments) | Atlantic Renewable Energy Partners |
| **2019** | Lichtenburg 2 100MW Solar PV Facility, Lichtenburg, North-West Province | Ecological Assessment (Scoping and EIA Phase Assessments) | Atlantic Renewable Energy Partners |
| **2019** | Lichtenburg 3 100MW Solar PV Facility, Lichtenburg, North-West Province | Ecological Assessment (Scoping and EIA Phase Assessments) | Atlantic Renewable Energy Partners |
| **2019** | Moeding Solar PV Facility near Vryburg, North-West Province | Ecological Assessment (Basic Assessment) | Moeding Solar |
| **2019** | Expansion of the Raumix Aliwal North Quarry, Eastern Cape Province | Fauna and Flora Pre-Construction Walk-Through Assessment | GreenMined |
| **2018** | Kruisvallei Hydroelectric 22kV Overhead Power Line, Clarens, Free State Province | Faunal and Flora Rescue and Protection Plan | Zevobuzz |
| **2018** | Kruisvallei Hydroelectric 22kV Overhead Power Line, Clarens, Free State Province | Fauna and Flora Pre-Construction Walk-Through Assessment | Zevobuzz |
| **2018** | Proposed Kruisvallei Hydroelectric Power Generation Scheme in the Ash River, Free State Province | Ecological Assessment (Basic Assessment) | Zevobuzz |
| **2018** | Proposed Zonnebloem Switching Station (132/22kV) and 2X Loop-in Loop-out Power Lines (132kV), Mpumalanga Province | Ecological Assessment (Basic Assessment) | Eskom |
| **2018** | Clayville Thermal Plant within the Clayville Industrial Area, Gauteng Province | Ecological Comments Letter | Savannah Environmental |
| **2018** | Iziduli Emoyeni Wind Farm near Bedford, Eastern Cape Province | Ecological Assessment (Re-assessment) | Emoyeni Wid Farm Renewable Energy |
| **2018** | Msenge Wind Farm near Bedford, Eastern Cape Province | Ecological Assessment (Re-assessment) | Amakhala Emoyeni Renewable Energy |

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| **2017** | H2 Energy Power Station near Kwamhlanga, Mpumalanga Province | Ecological Assessment (Scoping and EIA phase assessments) | Eskom |
| **2017** | Karusa Wind Farm (Phase 1 of the Hidden Valley Wind Energy Facility near Sutherland, Northern Cape Province) | Ecological Assessment (Re-assessment) | ACED Renewables Hidden Valley |
| **2017** | Soetwater Wind Farm (Phase 2 of the Hidden Valley Wind Energy Facility near Sutherland, Northern Cape Province) | Ecological Assessment (Re-assessment) | ACED Renewables Hidden Valley |
| **2017** | S24G for the unlawful commencement or continuation of activities within a watercourse, Honeydew, Gauteng Province | Ecological Assessment | Savannah Environmental |
| **2016 - 2017** | Noupoort CSP Facility near Noupoort, Northern Cape Province | Ecological Assessment (Scoping and EIA phase assessments) | Cresco |
| **2016** | Buffels Solar 2 PV Facility near Orkney, North West Province | Ecological Assessment (Scoping and EIA phase assessments) | Kabi Solar |
| **2016** | Buffels Solar 1 PV Facility near Orkney, North West Province | Ecological Assessment (Scoping and EIA phase assessments) | Kabi Solar |
| **2016** | 132kV Power Line and On-Site Substation for the Authorised Golden Valley II Wind Energy Facility near Bedford, Eastern Cape Province | Ecological Assessment (Basic Assessment) | Terra Wind Energy |
| **2016** | Kalahari CSP Facility: 132kV Ferrum–Kalahari–UNTU & 132kV Kathu IPP–Kathu 1 Overhead Power Lines, Kathu, Northern Cape Province | Fauna and Flora Pre-Construction Walk-Through Assessment | Kathu Solar Park |
| **2016** | Kalahari CSP Facility: Access Roads, Kathu, Northern Cape Province | Fauna and Flora Pre-Construction Walk-Through Assessment | Kathu Solar Park |
| **2016** | Karoshoek Solar Valley Development – Additional CSP Facility including tower infrastructure associated with authorised CSP Site 2 near Upington, Northern Cape Province | Ecological Assessment (Scoping Assessment) | Emvelo |
| **2016** | Karoshoek Solar Valley Development –Ilanga CSP 7 and 8 Facilities near Upington, Northern Cape Province | Ecological Assessment (Scoping Assessment) | Emvelo |
| **2016** | Karoshoek Solar Valley Development –Ilanga CSP 9 Facility near Upington, Northern Cape Province | Ecological Assessment (Scoping Assessment) | Emvelo |
| **2016** | Lehae Training Academy and Fire Station, Gauteng Province | Ecological Assessment | Savannah Environmental |
| **2016** | Metal Industrial Cluster and Associated Infrastructure near Kuruman, Northern Cape Province | Ecological Assessment (Scoping Assessment) | Northern Cape Department of Economic Development and Tourism |
| **2016** | Semonkong Wind Energy Facility near Semonkong, Maseru District, Lesotho | Ecological Pre-Feasibility Study | Savannah Environmental |
| **2015 - 2016** | Orkney Solar PV Facility near Orkney, North West Province | Ecological Assessment (Scoping and EIA phase assessments) | Genesis Eco-Energy |
| **2015 - 2016** | Woodhouse 1 and Woodhouse 2 PV Facilities near Vryburg, North West Province | Ecological Assessment (Scoping and EIA phase assessments) | Genesis Eco-Energy |
| **2015** | CAMCO Clean Energy 100kW PV Solar Facility, Thaba Eco Lodge near Johannesburg, Gauteng Province | Ecological Assessment (Basic Assessment) | CAMCO Clean Energy |
| **2015** | CAMCO Clean Energy 100kW PV Solar Facility, Thaba Eco Lodge near Johannesburg, Gauteng Province | Ecological Assessment (Basic Assessment) | CAMCO Clean Energy |

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|---|---|---|---|
| **2015** | Sirius 1 Solar PV Project near Upington, Northern Cape Province | Fauna and Flora Pre-Construction Walk-Through Assessment | Aurora Power Solutions |
| **2015** | Sirius 2 Solar PV Project near Upington, Northern Cape Province | Fauna and Flora Pre-Construction Walk-Through Assessment | Aurora Power Solutions |
| **2015** | Sirius 1 Solar PV Project near Upington, Northern Cape Province | Invasive Plant Management Plan | Aurora Power Solutions |
| **2015** | Sirius 2 Solar PV Project near Upington, Northern Cape Province | Invasive Plant Management Plan | Aurora Power Solutions |
| **2015** | Sirius 1 Solar PV Project near Upington, Northern Cape Province | Plant Rehabilitation Management Plan | Aurora Power Solutions |
| **2015** | Sirius Phase 2 Solar PV Project near Upington, Northern Cape Province | Plant Rehabilitation Management Plan | Aurora Power Solutions |
| **2015** | Sirius 1 Solar PV Project near Upington, Northern Cape Province | Plant Rescue and Protection Plan | Aurora Power Solutions |
| **2015** | Sirius Phase 2 Solar PV Project near Upington, Northern Cape Province | Plant Rescue and Protection Plan | Aurora Power Solutions |
| **2015** | Expansion of the existing Komsberg Main Transmission Substation near Sutherland, Northern Cape Province | Ecological Assessment (Basic Assessment) | ESKOM |
| **2015** | Karusa Wind Farm near Sutherland, Northern Cape Province) | Invasive Plant Management Plan | ACED Renewables Hidden Valley |
| **2015** | Proposed Karusa Facility Substation and Ancillaries near Sutherland, Northern Cape Province | Ecological Assessment (Basic Assessment) | ACED Renewables Hidden Valley |
| **2015** | Eskom Karusa Switching Station and 132kV Double Circuit Overhead Power Line near Sutherland, Northern Cape Province | Ecological Assessment (Basic Assessment) | ESKOM |
| **2015** | Karusa Wind Farm near Sutherland, Northern Cape Province) | Plant Search and Rescue and Rehabilitation Management Plan | ACED Renewables Hidden Valley |
| **2015** | Karusa Wind Energy Facility near Sutherland, Northern Cape Province | Fauna and Flora Pre-Construction Walk-Through Assessment | ACED Renewables Hidden Valley |
| **2015** | Soetwater Facility Substation, 132kV Overhead Power Line and Ancillaries, near Sutherland, Northern Cape Province | Ecological Assessment (Basic Assessment) | ACED Renewables Hidden Valley |
| **2015** | Soetwater Wind Farm near Sutherland, Northern Cape Province) | Invasive Plant Management Plan | ACED Renewables Hidden Valley |
| **2015** | Soetwater Wind Energy Facility near Sutherland, Northern Cape Province | Fauna and Flora Pre-Construction Walk-Through Assessment | ACED Renewables Hidden Valley |
| **2015** | Soetwater Wind Farm near Sutherland, Northern Cape Province | Plant Search and Rescue and Rehabilitation Management Plan | ACED Renewables Hidden Valley |
| **2015** | Expansion of the existing Scottburgh quarry near Amandawe, KwaZulu-Natal | Botanical Assessment (for EIA) | GreenMined Environmental |
| **2015** | Expansion of the existing AFRIMAT quarry near Hluhluwe, KwaZulu-Natal | Botanical Assessment (for EIA) | GreenMined Environmental |
| **2014** | Tshepong 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus | Ecological Assessment (Basic Assessment) | BBEnergy |
| **2014** | Nyala 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus | Ecological Assessment (Basic Assessment) | BBEnergy |
| **2014** | Eland 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus | Ecological Assessment (Basic Assessment) | BBEnergy |
| **2014** | Transalloys circulating fluidised bed power station near Emalahleni, Mpumalanga Province | Ecological Assessment (for EIA) | Trans-Alloys |
| **2014** | Umbani circulating fluidised bed power station near Kriel, Mpumalanga Province | Ecological Assessment (Scoping and EIA) | Eskom |
| **2014** | Gihon 75MW Solar Farm: Bela-Bela, Limpopo Province | Ecological Assessment (for EIA) | NETWORX Renewables |

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|---|---|---|---|
| **2014** | Steelpoort Integration Project & Steelpoort to Wolwekraal 400kV Power Line | Fauna and Flora Pre-Construction Walk-Through Assessment | Eskom |
| **2014** | Audit of protected *Acacia erioloba* trees within the Assmang Wrenchville housing development footprint area | Botanical Audit | Eco-Care Consultancy |
| **2014** | Rehabilitation of the N1 National Road between Sydenham and Glen Lyon | Peer review of the ecological report | EKO Environmental |
| **2014** | Rehabilitation of the N6 National Road between Onze Rust and Bloemfontein | Peer review of the ecological report | EKO Environmental |
| **2011** | Illegally ploughed land on the Farm Wolwekop 2353, Bloemfontein | Vegetation Rehabilitation Plan | EnviroWorks |
| **2011** | Rocks Farm chicken broiler houses | Botanical Assessment (for EIA) | EnviroWorks |
| **2011** | Botshabelo 132 kV line | Ecological Assessment (for EIA) | CENTLEC |
| **2011** | De Aar Freight Transport Hub | Ecological Scoping and Feasibility Study | EnviroWorks |
| **2011** | The proposed establishment of the Tugela Ridge Eco Estate on the farm Kruisfontein, Bergville | Ecological Assessment (for EIA) | EnviroWorks |
| **2010 - 2011** | National long-haul optic fibre infrastructure network project, Bloemfontein to Beaufort West | Vegetation Rehabilitation Plan for illegally cleared areas | NEOTEL |
| **2010 - 2011** | National long-haul optic fibre infrastructure network project, Bloemfontein to Beaufort West | Invasive Plant Management Plan | NEOTEL |
| **2010 - 2011** | National long-haul optic fibre infrastructure network project, Bloemfontein to Beaufort West | Protected and Endangered Species Walk-Through Survey | NEOTEL |
| **2011** | Optic Fibre Infrastructure Network, Swartland Municipality | Botanical Assessment (for EIA)<br>- Assisted Dr. Dave McDonald | Dark Fibre Africa |
| **2011** | Optic Fibre Infrastructure Network, City of Cape Town Municipality | Botanical Assessment (for EIA)<br>- Assisted Dr. Dave McDonald | Dark Fibre Africa |
| **2010** | Construction of an icon at the southernmost tip of Africa, Agulhas National Park | Botanical Assessment (for EIA) | SANPARKS |
| **2010** | New boardwalk from Suiderstrand Gravel Road to Rasperpunt, Agulhas National Park | Botanical Assessment (for EIA) | SANPARKS |
| **2010** | Farm development for academic purposes (Maluti FET College) on the Farm Rosedale 107, Harrismith | Ecological Assessment (Screening and Feasibility Study) | Agri Development Solutions |
| **2010** | Basic Assessment: Barcelona 88/11kV substation and 88kV loop-in lines | Botanical Assessment (for EIA) | Eskom Distribution |
| **2011** | Illegally ploughed land on the Farm Wolwekop 2353, Bloemfontein | Vegetation Rehabilitation Plan | EnviroWorks |

## WETLAND DELINEATION AND HYDROLOGICAL ASSESSMENTS

| Date Completed | Project Description | Type of Assessment/Study | Client |
|---|---|---|---|
| **In progress** | Steynsrus PV 1 & 2 Solar Energy Facilities near Steynsrus, Free State Province | Wetland Assessment | Cronimet Mining Power Solutions |
| **2019** | Lichtenburg 1 100MW Solar PV Facility, Lichtenburg, North-West Province | Surface Hydrological Assessment (Scoping and EIA Phase) | Atlantic Renewable Energy Partners |
| **2019** | Lichtenburg 2 100MW Solar PV Facility, Lichtenburg, North-West Province | Surface Hydrological Assessment (Scoping and EIA Phase) | Atlantic Renewable Energy Partners |
| **2019** | Lichtenburg 3 100MW Solar PV Facility, Lichtenburg, North-West Province | Surface Hydrological Assessment (Scoping and EIA Phase) | Atlantic Renewable Energy Partners |
| **2019** | Moeding Solar PV Facility near Vryburg, North-West Province | Wetland Assessment (Basic Assessment) | Moeding Solar |
| **2018** | Kruisvallei Hydroelectric 22kV Overhead Power Line, Clarens, Free State Province | Wetland Assessment (Basic Assessment | Zevobuzz |
| **2017** | Nyala 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus | Wetland Assessment | BBEnergy |

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| **2017** | Eland 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus | Wetland Assessment | BBEnergy |
| **2017** | Olifantshoek 10MVA 132/11kV Substation and 31km Power Line | Surface Hydrological Assessment (Basic Assessment) | Eskom |
| **2017** | Expansion of the Elandspruit Quarry near Ladysmith, KwaZulu-Natal Province | Wetland Assessment | Raumix |
| **2017** | S24G for the unlawful commencement or continuation of activities within a watercourse, Honeydew, Gauteng Province | Aquatic Assessment & Flood Plain Delineation | Savannah Environmental |
| **2017** | Noupoort CSP Facility near Noupoort, Northern Cape Province | Surface Hydrological Assessment (EIA phase) | Cresco |
| **2016** | Wolmaransstad Municipality 75MW PV Solar Energy Facility in the North West Province | Wetland Assessment (Basic Assessment) | BlueWave Capital |
| **2016** | BlueWave 75MW PV Plant near Welkom Free State Province | Wetland Delineation | BlueWave Capital |
| **2016** | Harmony Solar Energy Facilities: Amendment of Pipeline and Overhead Power Line Route | Wetland Assessment (Basic Assessment) | BBEnergy |

## AVIFAUNAL ASSESSMENTS

| Date Completed | Project Description | Type of Assessment/Study | Client |
|---|---|---|---|
| **2019** | Sirius Three Solar PV Facility near Upington, Northern Cape | Avifauna Assessment (Basic Assessment) | Aurora Power Solutions |
| **2019** | Sirius Four Solar PV Facility near Upington, Northern Cape | Avifauna Assessment (Basic Assessment) | Aurora Power Solutions |
| **2019** | Moeding Solar PV Facility near Vryburg, North-West Province | Avifauna Assessment (Basic Assessment) | Moeding Solar |
| **2018** | Proposed Zonnebloem Switching Station (132/22kV) and 2X Loop-in Loop-out Power Lines (132kV), Mpumalanga Province | Avifauna Assessment (Basic Assessment) | Eskom |
| **2017** | Olifantshoek 10MVA 132/11kV Substation and 31km Power Line | Avifauna Assessment (Basic Assessment) | Eskom |
| **2016** | TEWA Solar 1 Facility, east of Upington, Northern Cape Province | Wetland Assessment (Basic Assessment | Tewa Isitha Solar 1 |
| **2016** | TEWA Solar 2 Facility, east of Upington, Northern Cape Province | Wetland Assessment | Tewa Isitha Solar 2 |

## ENVIRONMENTAL IMPACT ASSESSMENT

- Barcelona 88/11kV substation and 88kV loop-in lines – BA (for Eskom).
- Thabong Bulk 132kV sub-transmission inter-connector line – EIA (for Eskom).
- Groenwater 45 000 unit chicken broiler farm – BA (for Areemeng Mmogo Cooperative).
- Optic Fibre Infrastructure Network, City of Cape Town Municipality – BA (for Dark Fibre Africa (Pty) Ltd).
- Optic Fibre Infrastructure Network, Swartland Municipality – BA (for Dark Fibre Africa).
- Construction and refurbishment of the existing 66kV network between Ruigtevallei Substation and Reddersburg Substation – EMP (for Eskom).
- Lower Kruisvallei Hydroelectric Power Scheme (Ash river) – EIA (for Kruisvallei Hydro (Pty) Ltd).

- Construction of egg hatchery and associated infrastructure – BA (For Supreme Poultry).
- Construction of the Klipplaatdrif flow gauging (Vaal river) – EMP (DWAF).

## ENVIRONMENTAL COMPLIANCE AUDITING AND ECO

- National long haul optic fibre infrastructure network project, Bloemfontein to Laingsburg – ECO (for Enviroworks (Pty) Ltd.).
- National long haul optic fibre infrastructure network project, Wolmaransstad to Klerksdorp – ECO (for Enviroworks (Pty) Ltd.).
- Construction and refurbishment of the existing 66kV network between Ruigtevallei Substation and Reddersburg Substation – ECO (for Enviroworks (Pty) Ltd.).
- Construction and refurbishment of the Vredefort/Nooitgedacht 11kV power line – ECO (for Enviroworks (Pty) Ltd.).
- Mining of Dolerite (Stone Aggregate) by Raumix (Pty) Ltd. on a portion of Portion 0 of the farm Hillside 2830, Bloemfontein – ECO (for GreenMined Environmental (Pty) Ltd.).
- Construction of an Egg Production Facility by Bainsvlei Poultry (Pty) Ltd on Portions 9 & 10 of the farm, Mooivlakte, Bloemfontein – ECO (for Enviro-Niche Consulting (Pty) Ltd.).
- Environmental compliance audit and botanical account of Afrisam's premises in Bloemfontein – Environmental Compliance Auditing (for Enviroworks (Pty) Ltd.).

## OTHER PROJECTS:

- Keeping and breeding of lions (*Panthera leo*) on the farm Maxico 135, Ficksburg – Management and Business Plan (for Enviroworks (Pty) Ltd.)
- Keeping and breeding of lions (*Panthera leo*) on the farm Mooihoek 292, Theunissen – Management and Business Plan (for Enviroworks (Pty) Ltd.)
- Keeping and breeding of wild dogs (*Lycaon pictus*) on the farm Mooihoek 292, Theunissen – Management and Business Plan (for Enviroworks (Pty) Ltd.)
- Existing underground and aboveground fuel storage tanks, TWK AGRI: Pongola – Environmental Management Plan (for TWK Agricultural Ltd).
- Existing underground fuel storage tanks on Erf 171, TWK AGRI: Amsterdam – Environmental Management Plan (for TWK Agricultural Ltd).
- Proposed storage of 14 000 L of fuel (diesel) aboveground on Erf 32, TWK AGRI: Carolina – Environmental Management Plan (for TWK Agricultural Ltd).
- Proposed storage of 23 000 L of fuel (diesel) above ground on Portion 10 of the Farm Oude Bosch, Humansdorp – Environmental Management Plan (for TWK Agricultural Ltd).
- Proposed storage of 16 000 L of fuel (diesel) aboveground at Panbult Depot – Environmental Management Plan (for TWK Agricultural Ltd).
- Existing underground fuel storage tanks, TWK AGRI: Mechanisation and Engineering, Piet Retief – Environmental Management Plan (for TWK Agricultural Ltd).

- Existing underground fuel storage tanks on Portion 38 of the Farm Lothair, TWK AGRI: Lothair – Environmental Management Plan (for TWK Agricultural Ltd).

# WORK EXPERIENCES

# &

# References

**Jan-Hendrik Keet, PhD**

**Publications**


- Hirsch H, Allsopp MH, Canavan S, Cheek M, Geerts S, Geldenhuys CJ, Harding G, Hurley BP, Jones W, **Keet J-H**, Klein H, Ruwanza S, van Wilgen BW, Wingfield MJ, Richardson DM (**2019**) *Eucalyptus camaldulensis* in South Africa – past, present, future, *Transactions of the Royal Society of South Africa*, https://doi.org/10.1080/0035919X.2019.1669732.
- Le Roux JJ, Hui C, Castillo ML, Iriondo, JM, **Keet J-H**, Khapugin, AA, Médail F, Rejmánek M, Theron G, Yannelli FA, Hirsch H (**2019**) Recent anthropogenic plant extinctions differ in biodiversity hotspots and coldspots. *Current Biology*, https://doi.org/10.1016/j.cub.2019.07.063.
- **Keet J-H**, Ellis A G, Hui C, Le Roux JJ (**2019**) Strong spatial and temporal turnover of soil bacterial communities in South Africa's hyperdiverse fynbos biome. *Soil Biology and Biochemistry* **136:** 107541, https://doi.org/10.1016/j.soilbio.2019.107541.
- Le Roux JJ, Ellis AG, Van Zyl L-M, Hosking ND, **Keet J-H**, Yannelli F (**2018**) Importance of soil legacy effects and successful mutualistic interactions during Australian acacia invasions in nutrient-poor environments. *Journal of Ecology* **105**(6): 2071-2081, https://doi.org/10.1111/1365-2745.1296.
- **Keet J-H**, Ellis A G, Hui C, Le Roux JJ (**2017**) Legume–rhizobium symbiotic promiscuity and effectiveness do not affect plant invasiveness. *Annals of Botany* **119**(8): 1319-1331, https://doi.org/10.1093/aob/mcx028.
- Le Roux JJ, **Keet J-H**, Mutiti B, Ellis AG (**2017**) Cultivation may not dramatically alter rhizobial community diversity or structure associated with rooibos tea (*Aspalathus linearis* Burm.f.) in South Africa. *South African Journal of Botany* **110**: 87-96, https://doi.org/10.1016/j.sajb.2017.01.014.
- Le Roux JJ, Hui C, **Keet J-H**, Ellis AG (**2017**) Co-introduction vs ecological fitting as pathways to the establishment of effective mutualisms during biological invasions. *New Phytologist* **215**:1354–1360. https://doi.org/10.1111/nph.14593.
- Nsikani M, Novoa A, Van Wilgen B, **Keet J-H**, Gaertner M (**2017**) *Acacia saligna*'s soil legacy effects persist up to ten years after clearing: Implications for ecological restoration. *Austral Ecology* **42**(8): 880-889, https://doi.org/10.1111/aec.12515.

- **Keet J-H**, Cindi D, Du Preez PJ (**2016**) Assessing the invasiveness of *Berberis aristata* and *B. julianae* (Berberidaceae) in South Africa: management options and legal recommendations. *South African Journal of Botany* **105**: 299-28, https://doi.org/10.1016/j.sajb.2016.04.012.

**Conferences**

- 46th South African Association of Botanists conference (Qwa-Qwa, South Africa), January 2020, ***Alnus glutinosa* (L.) Gaertn. [Black Alder]: *an emerging invader in South Africa***
- International Association for Food Protection (IAFP; Louisville, Kentucky, USA), July 2019.
- Ecological Society of America Conference, (New Orleans, Louisiana, USA), August 2018 **Invasive legumes dramatically impact soil bacterial community structures but not function**
- Legumes for Life Workshop (Stellenbosch, South Africa), May 2018 **Legume-rhizobium symbiotic promiscuity and effectiveness do not affect plant invasiveness**
- Fynbos Forum Conference (Swellendam, South Africa), July 2017 **Assessing the impacts of invasive legumes on soil conditions and microbial community composition in a biodiversity hotspot**
- 43rd South African Association of Botanists Conference (Cape Town, South Africa), January 2017, **Legume-rhizobium symbiotic promiscuity and effectiveness do not affect plant invasiveness** *Best PhD presentation*
- 43rd Annual Research Symposium on the Management of Biological Invasions Conference (Worcester, South Africa), May 2016, **Legume-rhizobium symbiotic promiscuity does not determine plant invasiveness**
- Evolutionary dynamics of tree invasions: drivers, dimensions, and implications for management (Stellenbosch, South Africa), November 2015
- Neobiota: 8th International Conference on Biological Invasions (Antalya, Turkey), November 2014, **Assessing the threat and potential for management of Berberis spp. (Berberidaceae) in South Africa**
- 42nd Annual Symposium on the Management of Invasive Alien Plants (Karridene Beach Hotel, Durban, South Africa)
- XXth Association for the Taxonomic Study of the Flora of Tropical Africa International Conference (Stellenbosch, South Africa), January 2014
- 41st Annual Symposium on the Management of Invasive Alien Plants (Cape St. Francis, South Africa), May 2013

**EIA and other surveys**

- Specialist Invasive Alien Plant Species Report: Prepared for: Mpact Corrugated, Kuils River (Western Cape), July 2019
- Proposed Township development, Country view, Gauteng: Biodiversity Impact Assessment (Flora) – Specialist Report prepared for Zone Land Solutions (PTY) Ltd, July 2015
- Colenso Anthracite Coal Mining and Power Station Project: Biodiversity Impact Assessment (Flora) – Specialist Report prepared for Zone Land Solutions (PTY) Ltd, July 2015