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ECOLOGY & BIODIVERSITY

PROPOSED RONDAVEL GRID CONNECTION NEAR KROONSTAD, FREE STATE PROVINCE

TERRESTRIAL AND FRESHWATER RESOURCE ECOLOGICAL ASSESSMENT

Version: 1

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Author: Gerhard Botha

PROPOSED RONDAVEL GRID CONNECTION NEAR KROONSTAD, FREE STATE PROVINCE

Report Title: Terrestrial and Freshwater Resource Ecological Assessment

Authors: Mr. Gerhard Botha

Project Name: Proposed Rondavel Grid Connection near Kroonstad, Free State Province

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I. DECLARATION OF CONSULTANTS INDEPENDENCE

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

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August 2021

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.

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Refer to Appendix 3 for curriculum vitae, Appendix 4 for relevant work experience and Appendix 5 for SACNASP Registration.

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TERRESTRIAL AND FRESHWATER RESOURCE ECOLOGICAL ASSESSMENT

1. INTRODUCTION

Client

Savannah Environmental (Pty) Ltd. on behalf of South Africa Mainstream Renewable Power Developments (Pty) Ltd.

Project

South Africa Mainstream Renewable Power Developments (Pty) Ltd is proposing to connect the Rondavel Solar PV facilities to the grid via a dedicated grid connection solution, to be known as Rondavel Grid Connection

Proposed Activity

South Africa Mainstream Renewable Power Developments (Pty) Ltd is proposing the construction and operation of grid connection infrastructure for the proposed 100MWac Rondavel Solar Energy Facility, near the town of Kroonstad in the Moqhaka Local Municipality (Fezile Dabi District) of the Free State Province of South Africa

The proposed grid solutions comprise the following:

» On-site substation (located within the respective Solar PV Facility), consisting of:
  - 33/132 kV Eskom substation;
  - Associated equipment, infrastructure and buildings;
  - Access and maintenance roads; and
  - Temporary and permanent laydown areas.

» Distribution Lines:
  - 132kV distribution line from the onsite 33/132 kV Eskom substation via a loop in loop out into the Eskom 132 kV Kroonstad Munic– Theseus 1 Switching Station (S/Stn) powerline, or direct connection with the destination Eskom substation (Kroonstad Municipality 132/66kV substation).

The proposed developments traverse the following farm parcels namely:

Alternative 1:

- » Remaining extent of the farm Rondavel No. 627
- » Portion 1 of the farm Rondavel No. 627
- » Portion 0 of the farm Rondavel No. 627
- » Remaining extent of the farm Boschplaat No. 330
- » Remaining extent of the farm Salie No. 1837

Alternative 2:

- » Remaining extent of the farm Rondavel-Noord No. 1475
- » Portion 1 of the farm Naseby Thorns No. 288
- » Portion 0 of the farm Leeuwkrantz No. 1384
- » Remaining extent of the farm Dorp Gronden Van Kroonstadt No. 460
- » Portion 225 of the farm Dorp Gronden Van Kroonstadt No. 460
- » Portion 226 of the farm Dorp Gronden Van Kroonstadt No. 460

Alternative 3:

- » Remaining extent of the farm Rondavel-Noord No. 1475
- » Remaining extent of the farm Waterloo No. 1383

It is the Developer's intention to bid the Vrede solar PV facility under the Renewable Energy Independent Power Producer Procurement (REIPPP) Programme. The power generated from the solar PV facility will be sold to Eskom and fed into the national electricity grid through the proposed grid connections solutions. The development of the facility and grid connection infrastructure will also assist with achieving the energy mix as set out in the Integrated Resources Plan (IRP).

The Rondavel Grid Connection will loop into either the Kroonstad Munic – Kroonstad SW STN 1 132kV power line, or connect directly with the Kroonstad Municipality 132/66kV substation, depending on which alternative is constructed. The assessment of the grid connection infrastructure will consider a corridor with a width of up to 260m.

The proposed infrastructure will be appropriately placed within the respective power line corridors and switching station study area through consideration and avoidance of environmental sensitivities and other energy infrastructure on the affected properties. The pylon structures of the power lines will be up to 32m high and the power line will be developed within the servitude of up to 40m wide.

Three alternative routes are being considered for the Rondavel Grid Connection:

- Alternative 1: 3 054m
- Alternative 2: 3 902m
- Alternative 3: 1 474m

Access to the grid connection corridors are possible via existing smaller farm roads in close proximity, primarily off the Regional R 34 tarred road running south from Kroonstad town. During construction, a service track along the length of the power line servitude of up to 12m wide will be established to allow for large crane movement. This track will also be utilised for maintenance purposes during the course of the operation of the power line. Where the power lines traverses drainage lines, road crossing infrastructure (e.g. culverts) may be developed within the drainage line. The switching station/substations will be accessed via the already separately authorised access roads for the respective solar PV facilities. Other associated infrastructure includes temporary laydown area/s that will be rehabilitated upon completion of the construction phase.

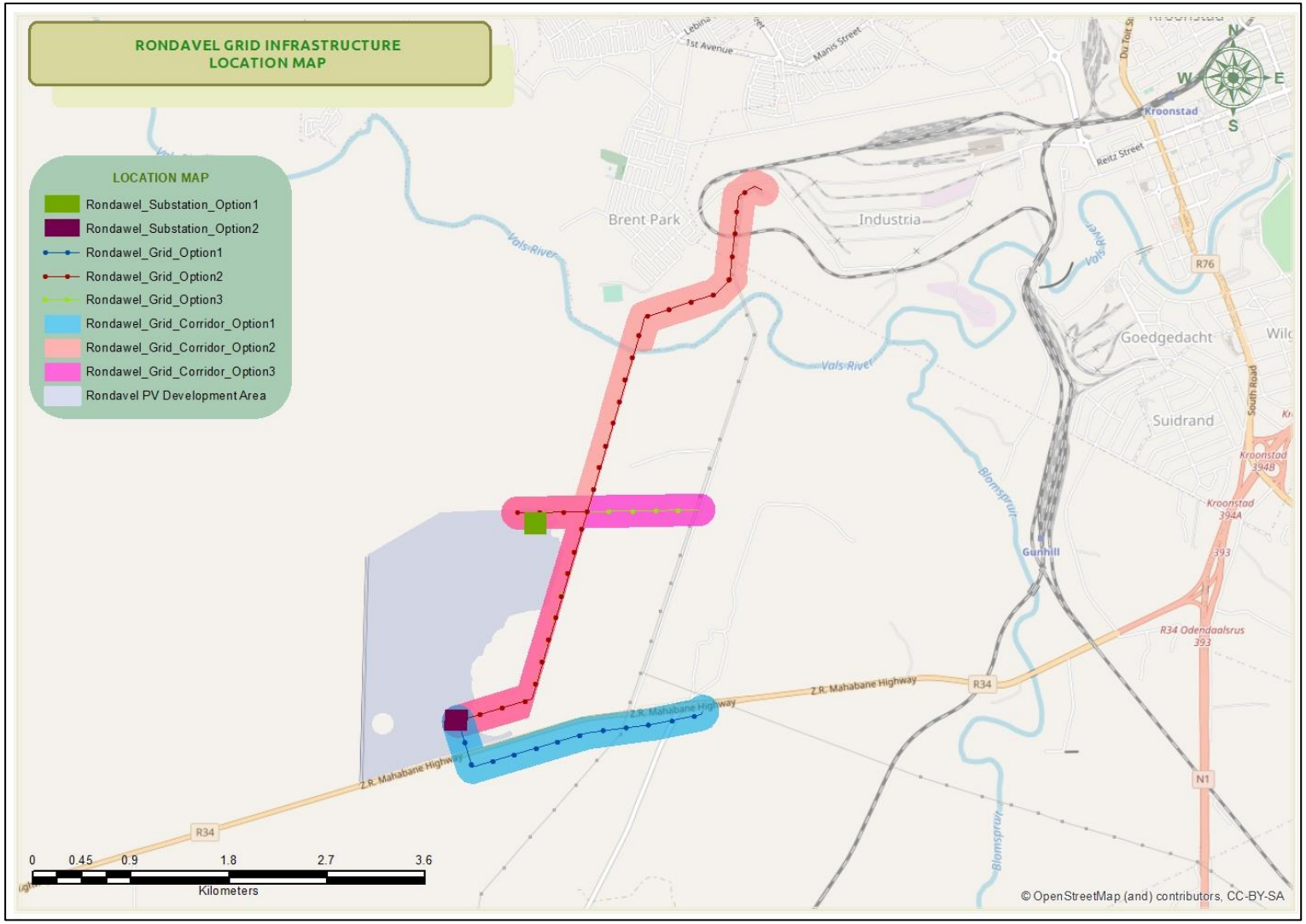

Figure 1: Proposed location of the Rondavel Grid Infrastructure

Terms of reference

To conduct a terrestrial and freshwater resource ecological study for an environmental basic assessment of the target areas where the establishment of the grid connection infrastructure is proposed to be located and provide a professional opinion on terrestrial ecological issues pertaining to the target area to aid in future decisions regarding the proposed project.

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 make reference to this report. Whenever such recommendations, statements or conclusions form part of a main report relating to the current investigation, this report must be included in its entirety.

Relevant legislation

The following legislation was taken into account whilst compiling this report:

Provincial

» The Free State Nature Conservation Bill, 2007

The above-mentioned Nature Conservation Bill accompanied by all amendments is regarded by the Free State Department: Economic, Small Business Development, Tourism and Environmental Affairs (DESTEA) as the legally binding, provincial documents, providing regulations, guidelines and procedures with the aim of protecting game and fish, the conservation of flora and fauna and the destruction of problematic (vermin and invasive) species.

National

» National Water Act (Act No. 36 of 1998);
» National Environmental Management Act / NEMA (Act No 107 of 1998), and all amendments and supplementary listings and/or regulations;
» Environment Conservation Act (ECA) (No 73 of 1989) and amendments;
» National Environmental Management Act: Biodiversity Act / NEMA:BA (Act No. 10 of 2004) and amendments;
» The National Water Act 36 of 1998

» General Authorisations (GAs): As promulgated under the National Water Act and published under GNR 398 of 26 March 2004.
» National Forest Act 1998 / NFA (No 84 of 1998);
» National Veld and Forest Fire Act (Act No. 101 of 1998); and
» Conservation of Agricultural Resources Act / CARA (Act No. 43 of 1983) and amendments.

International

» Convention on International Trade in Endangered Species of Fauna and Flora (CITES);
» The Convention on Biological Diversity;
» The Convention on the Conservation of Migratory Species of Wild Animals; and
» The RAMSAR Convention.

2. METHODOLOGY

GIS (Mapping/Spatial Analysis)

Data sources from the literature and GIS spatial information have been consulted and used where necessary in the study.

A National Aeronautics and Space Administration (NASA) Shuttle Radar Topography Mission (SRTM) (V3.0, 1 arcsec resolution) Digital Elevation Model (DEM) have been obtained from the United States Geological Survey (USGS) Earth Explorer website. Basic desktop terrain analysis has been performed on this DEM using ArcGis (10.4.1) software that encompassed a slope, landforms and channel network analyses in order to detect potential outcrops, ridges, landscape depressions and drainage networks.

The above-mentioned spatial data along with Google Earth Imagery (Google Earth ©) have been utilized to identify and delineate habitat/ecosystem features/units.

Additional existing data layers that were incorporated into this assessment, in order to determine important (sensitive) terrestrial and freshwater entities are summarised below in Table 1:

Table 1: Data coverages used to inform the ecological and freshwater resource assessment.

	Data/Coverage Type	Relevance	Source
Biophysical Context	**1:50 000 Relief Line** (5m Elevation Contours GIS Coverage)	Desktop mapping of terrain and habitat features as well as drainage network.	National Geo-Spatial Information (NGI)
	1:50 000 River Line (GIS Coverage)	Highlight potential on-site and local rivers and wetlands and map local drainage network.	CSIR (2011)

	Free State Province Land-Cover (from SPOT5 Satellite imagery circa 2009)	Shows the land-use and disturbances/transformations within and around the impacted zone.	DETEA (2009)
	South African Vegetation Map (GIS Coverage)	Classify vegetation types and determination of reference primary vegetation.	Mucina *et al.* (2018)
	NFEPA: river and wetland inventories (GIS Coverage)	Highlight potential on-site and local rivers and wetlands.	CSIR (2011)
	NBA 2018 National Wetland Map 5 (GIS Coverage)	Highlight potential on-site and local wetlands	SANBI (2018)
	NBA 2018 Artificial Wetlands (GIS Coverage)	Highlight potential on-site and local artificial wetlands	SANBI (2018)
	DWA Eco-regions (GIS Coverage)	Understand the regional biophysical context in which water resources within the study area occur	DWA (2005)
Conservation and Distribution Context	**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)
	Terrestrial Critical Biodiversity Areas of the Fee State (GIS Coverage)	Determination of provincial terrestrial conservation priorities and biodiversity buffers.	DESTEA (2015)
	SAPAD – South Africa Protected Areas Database (GIS Coverage)	Shows the location of protected areas within the region	http://egis.environment.gov.za DEA (2020)
	SACAD – South Africa Conservation Areas Database (GIS Coverage)	Shows the location of conservation areas within the region	http://egis.environment.gov.za DEA (2020)
	Strategic Water Source Areas for Surface Water (SWSA-sw) (GIS Coverage)	Shows the location of the development area relative to areas that contribute significantly to the overall water supply of the country	CSIR (2017)

TERRESTRIAL ECOLOGY (BIODIVERSITY)

Habitat and Floristic Analysis

Literature Study

The Botanical Database of Southern Africa (BODATSA) have been consulted in order to obtain a list of species recorded within the area. This species list provided an indication of the potential diversity expected within the area, the potential presence of range restricted species and other Species of Conservation Concern (SCC). The Red List of South African

Plants website (SANBI, 2016) was also utilized to provide the most current account of the national status of flora. Based on this analysis of available floristic literature, as well as the identification and delineation of habitat units, a list of SCC likely to occur within the project site was generated.

Additional information regarding ecosystems, vegetation types, and SCC include the following sources:

» The Vegetation of South Africa, Lesotho and Swaziland (Mucina & Rutherford, The Vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19., 2018);
» Grassland Ecosystem Guidelines: landscape interpretation for planners and managers (SANBI, 2013); and
» Red List of South African Plants (Raimondo, et al., 2009; SANBI, 2016).

Botanical Survey Methods (Floristic Analysis and Habitat Delineation)

Prior to the site visit, the vegetation was delineated into homogenous units using satellite imagery, existing land cover maps and a SRTM DEM. Sampling of floristic (Flora SCC) and habitat data was done simultaneously by combining to scientifically recognised methods, namely the plot method and the timed random meanders, wherein a timed meander will be conducted and at a specified time plot sampling (all floristic data including cover-abundance) will be conducted.

The timed random meander method is a highly efficient method for conducting floristic analysis specifically in detecting flora SCC and maximising floristic coverage. In addition, the method is time and cost effective and highly suited for compiling flora species lists and therefore gives a rapid indication of flora diversity. The timed meander search was performed based on, as mentioned a slight adaptation (addition of plots) of the original technique described by Goff et al. (1982). Suitable habitat for SCC were identified according to Raimondo et al. (2009) and targeted as part of the timed meanders.

At several sites (plots) within each homogeneous unit, a survey of total visible floristic composition and the relative cover percentage of each species were recorded, following established vegetation survey techniques (Mueller-Dombois & Ellenberg 1974; Westhoff & Van der Maarel 1978). These vegetation survey methods have been used as the basis of a national vegetation survey of South Africa (Mucina et al. 2000) and are considered an efficient method of describing vegetation and capturing species information. Notes were additionally made of the general habitat and any other features, biotic and abiotic, that might have an influence on the composition of landscape components and functioning of the landscape. All floristic and environmental data was captured using Braun-Blanquet Data Sheets.

Phytosociological analysis was carried out using the standard TurboVeg phytosociological database (Hennekens and Schaminée 2001) and TWINSPAN classification techniques with JUICE (Tichý 2002). The assessment did not cover an extensive area necessary to fully describe plant communities; hence, the vegetation is simply described in terms of 'vegetation units', which may be associations within plant communities. Extrapolation of vegetation units from survey sites to entire sample area was done by traversing the larger area without doing additional surveys as such and mapping this on Google Earth satellite data.

Plant species nomenclature follows Germishuizen and Meyer (2003), Henderson (2001) and Bromilow (2010).

Faunal Analysis

Literature Study

The list of mammal and herpetofaunal species predicted to occur in the region and their respective likelihood of occurrence within the study area was generated based on known distributions and habitat suitability, based on online and literature sources such as MammalMap, ReptileMap, FrogMap and the ReptileAtlas as well as field guides such as, Skinner & Chimimba (2005), Apps (ed. 2012), Stuart & Stuart (1998), Bates *et al* (2014), Minter *et al*. (2004), Branch (2009) and Du Preez and Carruthers (2009). The literature study focussed on querying the online database to generate species lists for the 2727CA, 2727CC, 2727CB and 2727CD quatre degree squares (QDS).

The predicted list is typically heavily influenced by factors other than just distribution or biome type. Factors such as habitat suitability, current land use, current levels of disturbance and structural integrity of the habitats all influence the potential for predicted species to occur in the vicinity of the study area. There is a high likelihood that not all mammal species known to occur within the region will be located within the study area and surrounding areas. Therefore, a 'Likelihood of Occurrence' (LOO) and a 'Species of Conservation Concern' review will be applied to any potential omissions in the data set. For the LOO analysis, a full summary of Red List faunal species (IUCN, 2017), as well as other SCC will be tabulated, with a LOO applied.

Likelihood of Occurrences will be based upon available spatial imagery and will be based on:

» Habitat suitability;
» Overlap with known distributions;
» Rarity of the species; and
» Current Impacts.

Mammal distribution data were obtained from the following sources:
» The Mammals of the Southern African Subregion (Skinner & Chimimba, 2005);
» The 2016 Red List of Mammals of South Africa, Lesotho and Swaziland (www.ewt.org.za) (EWT, 2016);
» Animal Demography Unit (ADU) - MammalMap Category (MammalMap, 2017) (mammalmap.adu.org.za);
» Stuarts' Field Guide to Mammals of Southern Africa – Including Angola, Zambia & Malawi (Suart & Stuart, 2015)
» A Field Guide to the Tracks and Signs of Southern, Central and East African Wildlife (Stuart & Stuart, 2013).
» Smither's Mammals of Southern Africa (Apps, ed. 2012)

Herpetofauna distribution and species data were obtained from the following sources:
» South African Reptile Conservation Assessment (SARCA) (sarca.adu.org);
» A Guide to the Reptiles of Southern Africa (Alexander & Marais, 2007);
» Field guide to Snakes and other Reptiles of Southern Africa (Branch, 1998);
» Atlas and Red list of Reptiles of South Africa, Lesotho and Swaziland (Bates et al.,
» 2014);
» A Complete Guide to the Frogs of Southern Africa (du Preez & Carruthers, 2009);
» Animal Demography Unit (ADU) - FrogMAP (frogmap.adu.org.za);
» Atlas and Red Data Book of Frogs of South Africa, Lesotho and Swaziland (Mintner et
» al., 2004); and
» Ensuring a future for South Africa's frogs (Measey, 2011).

Faunal Survey Methods

A. Mammal Assessment

Likelihood of Occurrence

There is a high likelihood that not all mammal species known to occur within the study area and surrounding areas will be located during the survey. Therefore, a 'Likelihood of Occurrence' (LOO) and a 'Species of Special Consideration (SCC)' review was applied to any potential omissions in the data set. For the LOO analysis, a full summary of Red List mammals (IUCN, 2017), as well as other SCC was tabulated, with a LOO applied. The relevant species of special consideration were addressed separately based on the data collected during the fieldwork, in context to the development and the effects on the species (both ecologically and spatially).

Likelihood of Occurrences are based upon:
» Habitat suitability;
» Overlap with known distributions;

» Rarity of the species; and
» Current Impacts.

Spoor Tracking

Spoor tracking enabled detailed sampling of mammalian species without the need for trapping or direct observation. All spoor, including footprints, den sites, burrows, hairs, scrapings and diggings were recorded and documented by detailed geo-referenced photography. Spoor tracking took place during general fieldwork, during specific timed spoor tracking drives/transects and at carefully chosen locations such as roads and other areas with highly trackable substrates. In addition, all camera trap sites (see below) were subjected to spoor tracking.

Camera trapping

The use of camera trapping has long been considered as a valuable ecological census tool in the field of African Mammalogy and this method was a primary focus of the field study. Baited cameras were deployed during survey. Bait stations were chosen based on available cover around the area, the presence of any promising signs (e.g. tracks, scats, tree scrapings) and the likelihood of possible habitat for important species. The baits used consisted of a mixture of pilchards and oats that was pureed to a fine pulp. Cameras were set to record 3 images, with a 40 second delay between events. Four cameras were deployed.

Nocturnal surveys and daytime observations

Nocturnal Surveys: This technique is an essential tool in mammalian sampling, simply because most of the target species are only active after dark. A high-powered spotlight was used from the vehicle to illuminate nocturnal species. Some mammal species were located from vocalisations. A single night drive of 2 hours was carried out during the study.

Direct Observations: All mammals observed during the sampling period, their geographic coordinates and the surrounding habitat were recorded. This data was used to supplement the overall habitat analysis to give context to the area. Animals were encountered through driving, normal routine movement through the study area, active searching of refugia and finally, through spotlighting at night.

Sherman Trapping

Sherman trapping was done for three trap nights. Three trap lines were deployed and traps were placed on the ground and baited with a mixture of peanut butter, olive oil, oats and marmite. Two trap lines comprised of 30 traps each whilst the third trap line comprised of

20 traps. The distance between each trap varied between 15 and 20 meters and was dependent on the transition between habitats. Each trap line traversed as many habitats as possible. Captured animals were moved from the traps into clear plastic bags, identified, photographed and then released unharmed. The specific period of sampling is regarded as the most preferable period for sampling as the rodent population and activity is typically at its highest during autumn.

B. Herpetofauna Assessment

Due to the limited time available for the field survey, no trapping was performed in order to maximise prime active searching time by eliminating the need to install, service and dismantle the traps. Instead, the survey aimed to focus on intensive active searching.

Active Searching

Reptiles were searched for on foot within the study area during the day and night. Specific habitat types were selected, beforehand, where active sampling was focused intently (point samples). The habitat of these point samples was described and photographs were taken. Active searching for reptiles occurred for approximately 1 hour per point sample and involved:

» Photographing active reptiles from a distance with a telephoto lens (300m telephoto lens);
» Lifting up and searching under debris, rocks or logs (rocks and logs were always returned to their original positions);
» Scanning for any signs of reptiles such as shed skins, the positive identification of which was taken as an observation of that species; and
» Catching observed reptiles by hand. All captured reptiles were photographed and released unharmed.

Nocturnal herpetofauna were searched for by driving slowly on the roads during a single night. Amphibians (frogs and toads) are nocturnal and were searched for by torchlight during a single night at the pans, and the watercourse. Each amphibian encountered at a particular site was identified and photographed where possible. Positive identification of acoustic signals (males call to attract females) was also used as a means of identifying amphibians.

Opportunistic sampling

Reptiles, especially snakes, are incredibly elusive and difficult to observe. Consequently, all possible opportunities to observe reptiles were taken in order to augment the standard sampling procedures described above. As a result, the other participating biodiversity specialists assisted through opportunistically taking photographs of reptiles and amphibians

within the study area. These images were copied for proper identification and added to the list of random observations unless a specific location of the observation was provided.

FRESHWATER RESOURCES

The delineation and classification of freshwater resources were conducted using the standards and guidelines produced by the Department of Water and Sanitation (DWS) (DWAF, 2005 & 2007) and the South African National Biodiversity Institute (SANBI, 2009). These methods are contained in the attached Appendix 1, which also includes wetland definitions, wetland conservation importance, and Present Ecological State (PES) assessment methods used in this report.

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 2 below.

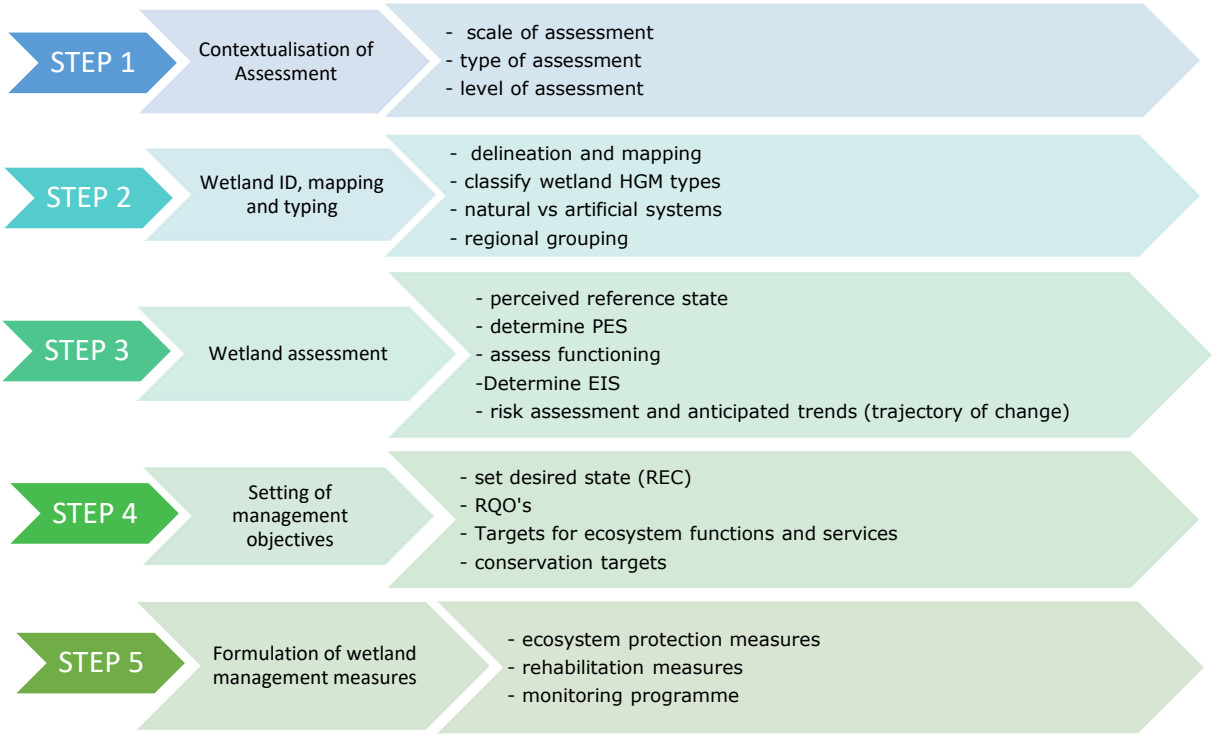

Figure 2: Proposed decision support framework for wetland assessment in South Africa (after Ollis et al., 2014)

Data Scouring and Review

***Vegetation**:*

» Vegetation types and their conservation status were extracted from the South African National Vegetation Map (Mucina and Rutherford 2006) as well as the National List of Threatened Ecosystems (2011), where relevant.
» Critical Biodiversity Areas for the site and surroundings were extracted (CBA Map obtained from the SANBI Database).
» The IUCN conservation status of the species in the list was also extracted from the database and is based on the Threatened Species Programme, Red List of South African Plants (Version 2017.1).
» Nkurenkuru Ecology and Biodiversity, 2021. Proposed Vrede Solar Energy Facility Near Kroonstad, Free State Province: *Terrestrial Ecological Study and Assessment.* Unpublished report Prepared by Nkurenkuru Ecology and Biodiversity for Savannah Environmental. April 2021.
» Kooij, M.S., Scheepers, J.C., Bredenkamp, G.J. & Theron, G.K. (1992). The Vegetation of the Kroonstad Area: A description of the Grassland Communities. *S.Afr.J.Bot*. **58(3)**: 155-164.
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» Fuls, E.R., Bredenkamp, G.J. & Van Rooyen, N. (1992). The Hydrophilic Vegetation of the Vredefort – Kroonstad – Lindley – Heilbron Area, Northern Orange Free State. *S.Afr.J.Bot*. **58(4)**: 231-235

Ecosystem:

» Freshwater and wetland information were extracted from the National Freshwater Ecosystem Priority Areas assessment, NFEPA (Nel et al. 2011). This includes rivers, wetlands, and catchments defined under the study.
» Important catchments and protected areas expansion areas were extracted from the National Protected Areas Expansion Strategy 2008 (NPAES).

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 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 Management Series: WET-HEALTH. A technique for rapidly assessing wetland health (Macfarlane *et al*. 2008)
Freshwater Resource Functions and Services	Wetland Management Series: WET-EcoServices. A technique for rapidly assessing ecosystem services supplied by wetlands (Kotze *et al.* 2008)
Freshwater Ecological Importance and Sensitivity (EIS)	EIS (Ecological Importance and Sensitivity) assessment tool (DWAF 1999c; Rountree & Malan, 2013)
Buffers for rivers and watercourses	The national Preliminary Guideline for the Determination of Buffer Zones for River, Wetlands and Estuaries (MacFarlane *et al.,* 2014).

Assumptions, Limitations and Gaps in the Information Presented

General Assumptions and Limitations

» This report deals exclusively within a defined area (300m survey area) and the impacts upon biodiversity and natural ecosystems in that area and immediate surrounding landscape including all downstream freshwater/aquatic resources that may potentially be impacted and which fall within the Regulated Area (500m) as defined by the DWS.
» All relevant project information provided by the proponent and engineering design team to the ecological 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 NC Province at the time of the assessment.

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.

» Infield soil and vegetation sampling were only undertaken within a specific focal area in the vicinity of the proposed development, while the remaining water resource/HGM units were delineated at a desktop level with limited accuracy.
» 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.
» With ecology being dynamic and complex, there is the likelihood that some aspects (some of which may be important) may have been overlooked.
» All vegetation information recorded outside of the immediate development footprint was based on the onsite observations of the author and no formal in-depth vegetation sampling was undertaken (apart from a few focal areas/transects within the riparian zones of the downstream water resources that still fall within the regulated area boundary). Furthermore, the vegetation within these areas' information provided for the areas just outside of the development footprint only gives an indication of the dominant and/or indicator species and only provides a general indication of the composition of the vegetation communities. Thus, the vegetation information provided for these areas is somewhat limited in terms of true botanical applications i.e. accurate and detailed species list, phytosociological classification, and rare / Red Data Species identification.
    - This approach for these areas well outside of the development footprint is however regarded as acceptable as the vegetation structure and composition of these areas will not be impacted by the development and vegetation sampling was merely to inform the riparian boundary and transitional zones and to inform the current Ecological Status.
» No formal aquatic faunal survey was undertaken (including macro-invertebrate sampling).
» No water sampling and analysis was undertaken.
» The lists of amphibians, reptiles, and mammals for the study area are based on those observed in the vicinity of the site as well as those likely to occur in the area based on their distribution and habitat preferences. This represents a sufficiently conservative and cautious approach that takes the study limitations into account.

» 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 and cost constraints and therefore, the representation of the species sampled at the time of the site visit should be critically evaluated.

- The site was sampled outside of the wet season.
- However, the area received a reasonable fair amount of late autumn rain allowing for some geophytes and graminoids to be fairly well represented (distinguishable) during the time of the inspection
- The footprint was covered in detail with the result that the results are considered highly reliable and it is unlikely that there are any significant species or features present that were not recorded.

Baseline Ecological Assessment – Limitations and Assumptions

» All assessment tools utilised within this study were applied only to the resources and habitats located within the 'survey area/servitude area' and which are at risk of being impacted by the proposed development. Any resource located outside of the servitude 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 assessment practitioner'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 currently available tools and techniques to undertake assessments of freshwater resources, the area 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.
» PES and EIS were only determined for the affected/regulated areas even though upstream and downstream as well as catchment impacts were considered (based on available desktop information).
» The PES and EIS assessments undertaken are largely qualitative assessment tools and thus the results are open to professional opinion and interpretation. We have made an effort to substantiate all claims where applicable and necessary.
» The Ecological Importance and Sensitivity (EIS) assessment did not specifically address the finer-scale biological aspects of the rivers such as fauna (amphibians and invertebrates).

Criteria used to Assess the Site Sensitivity

The broad-scale ecological sensitivity map of the site was produced by integrating the available ecological and biodiversity information available in the literature and various

spatial databases (e.g. SIBIS, BGIS). The ecological sensitivity of the different units identified during the field work was rated according to the following scale:

Table 3: Explanation of sensitivity rating

Sensitivity	Factors contributing to sensitivity	Examples of qualifying features
VERY HIGH	Indigenous natural areas that include any of the following: ▪ Critical habitat for range restricted species of conservation concern that have a distribution range of less than 10 km^2 ▪ Presence of species of conservation concern listed on the IUCN Red List of Threatened Species or South Africa's National Red List website as Critically Endangered, Endangered or Vulnerable according to the IUCN Red List 3.1. Categories and Criteria or listed as Nationally Rare ▪ Habitats/Vegetation types with high conservation status (low proportion remaining intact, highly fragmented, habitat for species that are at risk). ▪ Protected habitats (areas protected according to national/provincial legislation, e.g. National Forests Act, Draft Ecosystem List of NEM:BA, Integrated Coastal Zone Management Act, Mountain Catchment Areas, Lake Areas Development Act). These areas/habitats are irreplaceable in terms of species of conservation concern May also be positive for the following: ▪ High intrinsic biodiversity value (high species richness and/or turnover, unique ecosystems) ▪ High value ecological goods and services (e.g. water supply, erosion control, soil formation, carbon storage, pollination, refugia, food production, raw materials, genetic resources, cultural value) ▪ Low ability to respond to disturbance (low resilience, dominant species very old).	▪ CBA 1 areas ▪ Remaining areas of vegetation type listed in Draft Ecosystem List of NEM:BA as Critically Endangered, Endangered, or Vulnerable. ▪ Protected forest patches. ▪ Confirmed presence of populations of species of conservation concern (Critically Endangered, Endangered, Vulnerable & Rare)
HIGH	Indigenous natural areas that are positive for any of the following: ▪ High intrinsic biodiversity value (moderate/high species richness and/or turnover). ▪ Confirmed habitat highly suitable for species of conservation concern (Those species listed on the IUCN Red List of Threatened Species or South Africa's National Red List website as Critically Endangered, Endangered or Vulnerable according to the IUCN Red List 3.1. Categories and Criteria).	▪ CBA 2 "critical biodiversity areas". ▪ Confirmed habitat where species of conservation concern could potentially occur (habitat is suitable, but no confirmed records). ▪ Habitat containing individuals of extreme age.

Sensitivity	Factors contributing to sensitivity	Examples of qualifying features
	▪ Moderate ability to respond to disturbance (moderate resilience, dominant species of intermediate age). ▪ Moderate conservation status (moderate proportion remaining intact, moderately fragmented, habitat for species that are at risk). ▪ Moderate to high value ecological goods & services (e.g. water supply, erosion control, soil formation, carbon storage, pollination, refugia, food production, raw materials, genetic resources, cultural value). These areas/habitats are unsuitable for development due to a very likely impact on species of conservation concern May also contain the following: ▪ Protected habitats (areas protected according to national/provincial legislation, e.g. National Forests Act, Draft Coastal Zone Management Act, Mountain Catchment Areas Act, Lake Areas Development Act)	▪ Habitat with low ability to recover from disturbance. ▪ Habitat with exceptionally high diversity (richness or turnover). ▪ Habitat with unique species composition and narrow distribution. ▪ Ecosystem providing high value ecosystem goods and services.
Medium	Suspected habitat for species of conservation concern based either on there being records for this species collected I the past prior to 2002 or being a natural area included in a habitat suitability model (Those species listed on the IUCN Red List of Threatened Species or South Africa's National Red List website as Critically Endangered, Endangered or Vulnerable according to the IUCN Red List 3.1. Categories and Criteria). Indigenous natural areas that are contain one or two of the following factors, ▪ Moderate intrinsic biodiversity value (moderate species richness and/or turnover). ▪ Moderate to moderate low ability to respond to disturbance (moderate resilience, dominant species of intermediate age). ▪ Moderate conservation status (moderate proportion remaining intact, moderately fragmented, habitat for species that are at risk). ▪ Moderate value ecological goods & services (e.g. water supply, erosion control, soil formation, carbon storage, pollination, refugia, food production, raw materials, genetic resources, cultural value).	▪ CBA 2 "corridor areas", ESA 1 and ESA2. ▪ Habitat with moderate diversity (richness or turnover). ▪ Suspected habitat for species of conservation concern.
Low	Degraded or disturbed indigenous natural vegetation No Natural habitat remaining	

Assessment of Impacts

The Environmental Impact Assessment methodology assists in the evaluation of the overall effect of a proposed activity on the environment. This includes an assessment of the significant direct, indirect, and cumulative impacts. The significance of environmental impacts is to be assessed by means of the criteria of extent (scale), duration, magnitude (severity), probability (certainty) and direction (negative, neutral or positive).

» The **nature**, which includes a description of what causes the effect, what will be affected and how it will be affected.

» The **extent**, wherein it is indicated whether the impact will be local (limited to the immediate area or site of development) or regional,

Immediate area	1
Whole site (entire surface right)	2
Neighboring areas	3
Regional	4
Global (Impact beyond provincial boundary and even beyond SA boundary)	5

» The **duration**, wherein it was indicated whether:

Lifetime of the impact will be of a very short duration (0 – 1 year)	1
The lifetime of the impact will be of a short duration (2 – 5 years)	2
Medium-term (5 -15 years)	3
Long term (> 15 years)	4
Permanent	5

» The **magnitude**, quantified on a scale from 0 – 10,

small and will have no effect on the environment	2
minor and will not result in an impact on processes	4
moderate and will result in processes continuing but in a modified way	6
high (processes are altered to the extent that they temporarily cease)	8
very high and results in complete destruction of patterns and permanent cessation of processes	10

» The **probability** of occurrence, which describes the likelihood of the impact actually occurring. Probability was estimated on a scale of 1 -5,

very improbable (probably will not happen)	1
improbable (some possibility, but low likelihood)	2
probable (distinct possibility)	3
highly probable (most likely)	4
definite (impact will occur regardless of any prevention measures)	5

» The **significance**, was determined through a synthesis of the characteristics described above and can be assessed as;

- **LOW**,
- **MEDIUM** or
- **HIGH**;

» the **status**, which was described as either positive, negative or neutral.
» the degree of which the impact can be reversed,
» the degree to which the impact may cause irreplaceable loss of resources,
» the degree to which the impact can be mitigated.

The significance was calculated by combining the criteria in the following formula:

S=(E+D+M)P where;

» S = Significance weighting
» E = Extent
» D = Duration
» M = Magnitude
» P = Probability

The significance weightings for each potential impact are as follows;

Table 4: Rating table used to rate level of significance.

RATING	CLASS	MANAGEMENT DESCRIPTION
< 30	**Low (L)**	Where the impact would not have a direct influence on the decision to develop the area.
30 - 60	**Medium (M)**	Where the impact could influence the decision to develop in the area unless it is effectively mitigated.
> High	**High (H)**	Where the impact must have an influence on the decision process to develop in the area.

3. THE IMPORTANCE OF BIODIVERSITY AND CONSERVATION

The term 'Biodiversity' is used to describe the wide variety of plant and animal species occurring in their natural environment or 'habitat'. Biodiversity encompasses not only all living things but also the series of interactions that sustain them, which are termed ecological processes. South Africa's biodiversity provides an important basis for economic growth and development; and keeping our biodiversity intact is vital for ensuring the on-going provision of ecosystem services, such as the production of clean water through good catchment management. The role of biodiversity in combating climate change is also well recognised and further emphasises the key role that biodiversity management plays on a global scale (Driver et al., 2012). Typical pressures that natural ecosystems face from human activities include the loss and degradation of natural habitat, invasive alien species, pollution, and waste and climate change (Driver et al.,2012). High levels of infrastructural and agricultural development typically restrict the connectivity of natural ecosystems, and maintaining connectivity is considered critical for the long-term persistence of both ecosystems and species, in the face of human development and global climatic change.

Loss of biodiversity puts aspects of our economy and quality of life at risk and reduces socioeconomic options for future generations as well. In essence, then, sustainable development is not possible without it.

4. CONSERVATION AND FUNCTIONAL IMPORTANCE OF AQUATIC ECOSYSTEMS

Water affects every activity and aspiration of human society and sustains all ecosystems. "Freshwater ecosystems" refer to all inland water bodies whether fresh or saline, including rivers, lakes, wetlands, sub-surface waters, and estuaries (Driver *et al*., 2011). South Africa's freshwater ecosystems are diverse, ranging from sub-tropical in the north-eastern part of the country, to semi-arid and arid in the interior, to the cool and temperate rivers of the fynbos. Wetlands and rivers form a fascinating and essential part of our natural heritage and are often referred to as the "kidneys" and "arteries" of our living landscapes and this is particularly true in semi-arid countries such as South Africa (Nel *et al*., 2013). Rivers and their associated riparian zones are vital for supplying freshwater (South Africa's most 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 channeled 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.

5. DESKTOP ANALYSIS

Land use and Land Cover

The Free State Province Land-Cover dataset (2009) were queried as part of the desktop study. Land-cover is a critical information component for a wide range of regional and local planning and management activities, especially in terms of resource conservation and environmental monitoring. The Free State Province Land-Cover dataset I a digital, seamless, vegetation and land-cover map of the entire Free State Province, suitable for 1:50 000 scale (or coarser) GIS modelling applications. This dataset was developed using 2009 SPOT5 satellite imagery. Furthermore, this vegetation and land-cover dataset is compatible with the latest South African land-cover classification standards. In addition to the land-cover data, a comprehensive set of digital aerial reference photographs, acquired as part of the land-cover map accuracy verification field survey process has been supplied as a geo-referenced GIS database.

According to this dataset approximately almost the entire footprint is undeveloped comprising of various forms of grasslands and wetland features. The most prominent impact within the SEF footprint is transport networks.

Due to the relatively large scale of the map 1:50 000 and the fact that this land cover map was compiled back in 2009, variations in the land-use and vegetation cover may be present

or may have changed of a period of time. As such, current (and historical) available areal and satellite imagery was analysed at a much closer elevation, of between 770 and 3.5km.

The results of this spatial analysis were as follows:

Land cover and land-use changes often indicate major impacts on biodiversity, especially if those changes show the loss of natural habitat due to urban sprawl, cultivation, etc.

It was confirmed that the majority of the site comprise of a grassland comprising of a relative high coverage of dwarf and larger shrubs. According to Mucina and Rutherford (2006), where this type of grassland is characterized by dwarf karoo bushes and Acacia karroo (also known as *Vachellia karroo*) shrubs, it is typically an indication of degraded, overgrazed and trampled low-lying clayey areas. The prominent land use activity within this area is livestock grazing, and the condition described above (overgrazing) is likely applicable to this area. Patches of highly degraded grasslands are most likely associated with watering and feeding points as well as areas located near kraals.

Also prominent within the area are freshwater wetland features such as wetlands and non-perennial watercourses (usually comprising of *Acacia karroo* dominated thicket-type riparian fringes and floodplain wetlands). Such a freshwater resource feature is located along the eastern portion of the SEF footprint and flows in a northern direction towards the Vals River which is the most important and prominent drainage feature within the region. The SEF footprint is located adjacent and north of the R34 route.

Regional/Local Biophysical Setting

The development footprint is, situated approximately 13.3km (south-west) from the town of Kroonstad (central) (Figure 1) within the Moqhaka Local Municipality and the Fezile Dabi District Municipality in the Free State Province. The site is accessible via the R34 route, which links Kroonstad with Welkom.

The Rondavel Solar Energy Facility will have a generating capacity of up to 75MW and will cover an area of approximately 182 ha.

Land use within the project site is mostly for farming. Farming practices consist of livestock farming (cattle) farming with some "free" roaming small game and larger introduced game such as Kudu (*Tragelaphus strepsiceros*), Nyala (*Tragelaphus angasii*), Waterbuck (*Kobus ellipsiprymnus*) and Plains Zebra (*Equus quagga*). Due to the low land capability of the dominant soil forms within the project site, the area has never been cultivated and as such the vegetation within the project area can be regarded as primary. In terms of the surrounding landscape, most farmers also utilize their lands as natural grazing for livestock

(primarily cattle). However, the breeding of scarce and large game has become increasingly popular within the area and include game such as African Savanna Buffalo (*Syncerus caffer*), Nyala (*Tragelaphus angasii*), Roan Antelope (*Hippotragus equinus*), Sable Antelope (*Hippotragus niger*), Waterbuck (*Kobus ellipsiprymnus*), Lechwe (*Kobus leche*) and Common Reedbuck (*Redunca arundinum*). Crop production is not a common feature within the area, with old cultivated areas being transformed into pastures. A few pivots are located a few properties to the east where arable land is available.

Prominent anthropogenic features within the region include the R34 route as well as the S172 secondary route to the south east, smaller dirt and twin track routes, cattle and game fences (mostly electrified), homesteads, kraals, cattle feeding and watering points, reservoirs and small farm dams (mostly instream) and power lines. Apart from these anthropogenic features, most of the region is poorly developed and, as mentioned, predominantly used for livestock and game farming.

The site lies in an area considered to be a local steppe climate (BSk according to Köppen-Geiger Climate Classification). The site thus falls within a cold semi-arid region arid area, with a mean annual temperature of 16.6°C and a mean annual precipitation of 545mm (predominantly mid-summer). The driest month is July with 7mm whilst the greatest amount of precipitation occurs in December with an average of 107mm. January is the warmest month of the year with an average temperature of 22.4°C, whilst the coldest month is June with an average temperature of 8.8°C. The first occurrence of frost may be experienced as early as the onset of May and marks the end of the growing season (average frost incidence of 43 days a year).

The development site occurs predominantly within the Quaternary Catchment C60G (Middle Vaal Management Area), which is drained by the Vals River and associated tributaries. Such as mall tributary is located within the eastern portion of the development area, flowing mostly in a north-north-east direction to terminate directly into the Vals River approximately 1.5km to the north (Figure 5).

The Hydrological Characteristics of project site are summarised as follows:
» Mean Annual Precipitation = 545 mm;
» Mean Annual Runoff = 10.3 – 25.8mm; and
» Mean Annual Evaporation = 1 600 – 1 700mm

The Rondavel Solar project is located within the Highveld ecoregion (Kleynhans *et al.*, 2005). The Highveld ecoregion comprises high lying plains with a moderate to low relief, as well as various grassland vegetation types (with moist types to the west and south). Several large rivers have their sources in this region, including the Vet, Modder, Riet, Vaal, Olifants, Steelpoort, Marico, Crocodile (west), Crocodile (east) and the Great Usutu River.

According to Partridge *et al*. (2010) the Highveld Geomorphic Province is an extensive grassland region occupying the eastern interior plateau and is mostly drained by the tributaries of the Vaal River. South of the Vaal River the province is underlain by near-horizontal Karoo strata (intruded by dolerite dykes and sills). Much of the province is, gently undulating and is dominated by the late Cretaceous African erosion surface, which remains intact on many of the broad interfluves (Partridge & Maud, 1987). The dominant drainage direction is westerly, partly because of the influence of the pre-Karoo topography, and partly because of warping along the Griqualand–Transvaal axis, whose activity was largely contemporaneous with uplift of the Ciskei–Swaziland axis (Partridge & Maud, 1987). The shallow, open valleys reflect minor incision in the early Miocene Post-African I cycle. Many of the Highveld rivers have incised their channel beds to just below the bedrock surface and are strongly influenced by the relationship between the softer Karoo shales and sandstones and the position and breaching of dolerite sills and dykes (Tooth *et al.,* 2004). Meandering patterns are typical within the sandstones and shales (above local hydraulic barriers usually dolerite dykes and sills), while straight channels occur where the rivers breach the dolerite (Tooth *et al.,* 2002, 2004).

The sub-Province Southern Highveld is drained by south-bank Vaal River tributaries. The rivers rise in the Eastern Escarpment Hinterland in the south before flowing northwest into the Vaal River valley. The valley cross-sectional profiles are broader than in the North-eastern Highveld, but narrower than those of the North-western Highveld. There is also a broad trend from north to south, with narrower valley cross-sectional profiles and flatter slopes in the north and broader valley forms and steeper slopes in the south. Significantly, however, the average valley slopes are flatter than in the other two sub-provinces. The sub-province is therefore characterised predominantly by BF[1] and WF sediment storage surrogate descriptors. With the exception of the Wilge River (which has a logarithmic BFC[2]), the concave longitudinal profiles are predominantly exponential.

Wetlands within the region are mostly depression (pan) wetlands within the relatively flat plains where a slight change in geomorphology and underlying geology may result in the collection of water and saturated soil conditions. Most of the pans are endorheic. The more undulating and steeper slopes to the north and south contain a higher diversity of wetland types due to the greater variation in geomorphology resulting in different drainage systems. Seepages are a common feature along the steeper slopes where the underlying bedrock is typically near the surface. Most of these seepages are typically groundwater fed. Benchlands or discrete areas of mostly level or nearly level high ground, interrupting the surrounding steeper slopes, typically contain wetland flats which are usually groundwater fed. Channelled valley-bottom wetlands are typically associated with the higher reaches and tributaries of the watercourses whilst some floodplain wetlands are associated with the lower and more gradual reaches of the Vals and Vet Rivers.

[1] BF & WF: Sediment storage surrogate descriptor indicative of high sediment storage capability.
[2] BFCs: Macro-reach Best Fit Curves

A summary of the biophysical features and the setting of the project site and surroundings are summarised in Table 5.

Table 5: Summary of the biophysical setting of the proposed development area.

Biophysical Aspect	Desktop Biophysical Details		Source
Physiography			
Landscape Description	A relative flat plains-dominated landscape with a small isolated koppies/outcrop located north-east of the development footprint. As already described, large tracts of land have been transformed for cultivation purposes. These plains are typically dominated by low-tussock grasslands with a prominent karroid element. Shrubby trees, such as Acacia karroo (also known as Vachellia karroo) may also be a common feature, especially near watercourses and wetland areas. Depression wetlands are a common feature within this landscape, as well as valley-bottom wetlands (usually channelled), which tend to drain in a north-eastern/eastern direction towards the Blomspruit River.		Google Earth
Dominant Land Type	Bd21		ARC
Dominant Terrain Type	Symbol	Description	ARC
	A2	Level plains or plateaus with a local relief between 30-90m	
Geomorphic Province	Southern Highveld		Partridge et al., 2010
Geology	Mudrock and subordinate sandstone of the Adelaide Subgroup (Beaufort Group). Occasional dolerite sills may also be present.		ARC & SA Geological Dataset
Soils (General)	Soils with a plinthic catena characterised by loamy red yellow and greyish sand with a high base status		ARC
Prominent Soil Forms	Avalon, Westleigh, Valsrivier. The lower lying areas such as depressions, valley bottom wetlands and watercourses are typically characterised by Dundee, Bonheim and Valsrivier soil types		ARC
Susceptibility to Wind Erosion	Class	Description	ARC
	3a (Wind), & 1 (Water)	Land with moderate wind erosion susceptibility and a low susceptibility to water erosion. Generally, level to gently sloping. Soils have a favourable erodibility index.	
Climate			
Köppen-Geiger Climate Classification	BSk (Cold semi-arid climate)		Climate-data.org
Mean annual temperature	16.6°C		Climate-data.org
Warmest Month & Av. Temp.	January: 22.4°C		Climate-data.org
Coldest Month & Av. Temp.	June: 8.8°C		Climate-data.org
Rainfall Seasonality	Mid-summer (January – February)		DWAF, 2007
Mean annual precipitation	545 mm		Schulze, 1997
Mean annual runoff	10.3 mm up to 25.8mm		Schulze, 1997
Mean annual evaporation	1 600 – 1 700 mm		Schulze, 1997
Surface Hydrology			
Wetland vegetation group	Dry Highveld Grassland (Group 3 & 4)		CSIR, 2011

Water management area	Middle Vaal WMA (09)			DWA
Quaternary catchment	Name (Symbol)			DWA
	C60H (Primary), C60G & C60F			
Main collecting river(s) in the catchment	Tributaries of the Vals River including Blomespruit to the east and Otterspruit to the west.			CSIR, 2011
Closest river to the project site	Tributary of the Otterspruit (~3.8km to the west).			Google Earth
Geomorphic Class	Symbol	Description	Slope (%)	CSIR, 2011
	V4	Upper foothills	0.005 – 0.019	
	V4, V2	Lower foothills	0.001 - 0.005	
	Description			
	Watercourses to the west correspond more with Lower Foothill systems, whist the watercourses to the east are more typical of Upper Foothill systems. » Upper Foothill systems tend to be moderately steep streams dominated by bedrock or boulders. Reach types may include plain-bed, pool-riffle or pool-rapid reach types. Length of pools and riffles/rapids are usually similar. Narrow flood plain of sand, gravel or cobble often present. » Lower Foothill systems typically have lower gradient mixed bed alluvial channels with sand and gravel dominating the bed, locally may be bedrock controlled. Reach types typically include pool-riffle or pool-rapid, sand bars common in pools. Pools of significantly greater extent than rapids or riffles. Flood plan often present.			
Vegetation Overview				
Biome	Grassland Biome (Dry Highveld Grassland Bioregion)			Mucina & Rutherford, 2018
Vegetation Types	» Western portion of the project site including the SEF footprint: Vaal-Vet Sandy Grassland. » Eastern portion of the project site including north-eastern most corner of the SEF footprint: Central Free State Grassland			Mucina & Rutherford, 2018
Vegetation & Landscape Feature	<u>Vaal-Vet Sandy Grassland:</u> Plainns-dominated landscape with some scattered, slightly irregular undulating plains and hills. Mainly low-tussock grasslands with and abundant karroid element. Dominance of *Themeda triandra* is an important feature of this vegetation unit. Locally low cover of *T. triandra* and the associated increase in *Elionurus muticus, Cymbopogon pospischilii* and *Aristida congesta* is attributed to heavy grazing. <u>Central Free State Grassland</u>: Undulating plains supporting short grassland, in natural condition dominated by *Themeda triandra* while *Eragrostis curvula* and *E. chloromelas* become dominant in degraded habitats. Dwarf karoo bushes establish in severely degraded clayey bottomlands. Overgrazed and trampled low-lying areas with heavy clayey soils are prone to *Acacia karroo* (also known as *Vachellia karroo*) encroachment.			Mucina & Rutherford, 2006
BODATSA Data	Regional: Total Species Observed			

	491	2020-08-02_231620030-BRAHMSOnlineData
	Indigenous Flora	
	419	
	Non-indigenous Flora	
	52	
	South African Endemic Flora	
	29	
	Threatened Flora	
	Data Deficient: 1 Species; Endangered: 1 Species Not Evaluated: 19 Species	

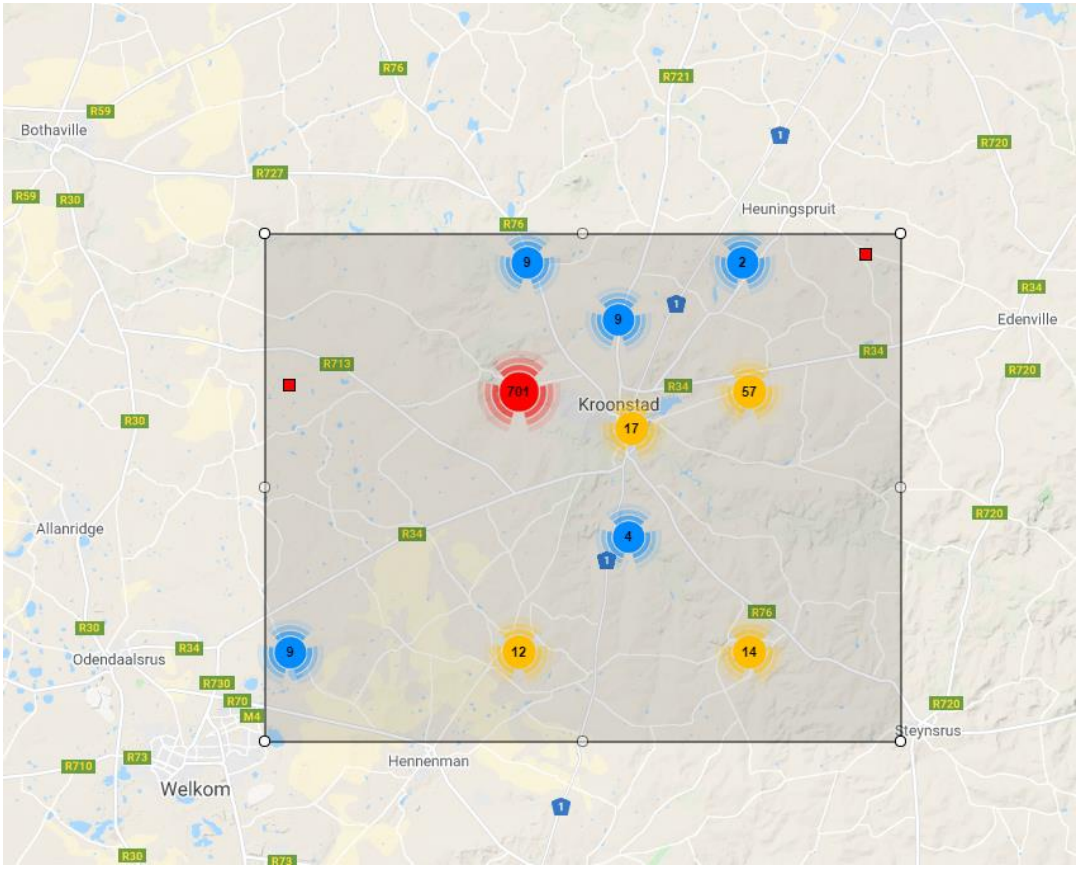

Figure 3: Extracted area and sample locations from POSA. Extracted data was used to compile a plant species list of species that may potentially occur within the project site and provide an indication of potential conservation important species that may be found within the area.

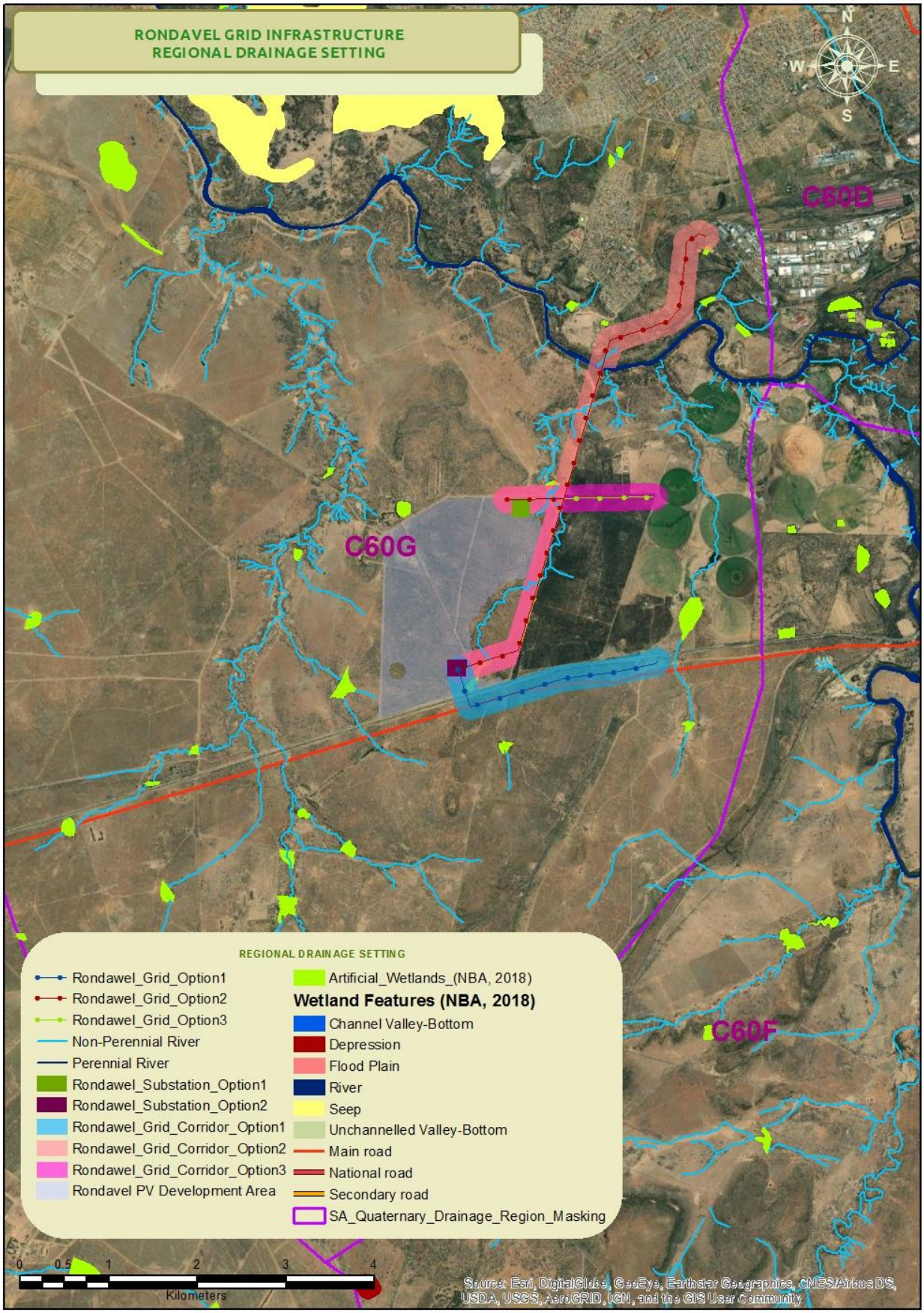

Figure 4: Regional drainage setting.

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 6).

Table 6: Summary of the conservation context details for the study area.

Conservation Planning Dataset		Relevant Conservation Feature	Location in Relationship to Project Site	Conservation Planning Status
NATIONAL LEVEL CONSERVATION PLANNING CONTEXT	National Protected Areas Expansion Strategy	Focus Area	Located within the Free State Highveld Focus Area	Free State Highveld Focus Area
	Protected Areas and Conservation Areas (PACA) Database	South African Conservation Area (SACA)	Well outside of any SACA:	Not Classified
		South African Protected Area (SAPA)	Outside of any SAPA: Located approximately 1.4 km from a Private Nature Reserve	Not Classified
	Strategic Water Source Areas for groundwater (SWSA-gw)	Areas with high groundwater availability and of national importance	Located within the Kroonstad SWSA-gw	Located within important groundwater recharge area.
	Vegetation Types	Central Free State Grassland	Vegetation of Study Area	Least Threatened
	Threatened Ecosystems	Central Free State Grassland	Ecosystems of Study Area	Not listed
	National Freshwater Ecosystem Priority Area	River FEPA	Located outside of any River FEPAs	Not Classified
		Wetland FEPA	No Wetland FEPAs located within project site.	Not Classified
PROVINCIAL AND REGIONAL LEVEL	NCBSP: Critical Biodiversity Areas	Ecological Support Areas ESA1 & 2	Corridors/linkages between the upland (terrestrial) areas and important water resource features such as the Vals and Blomspruit Rivers.	ESA

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 outside of any SWSA for surface water but is located within a SWSA for groundwater; namely the Kroonstad SWSA-gw (Figure 7).

Due to the nature of the grid infrastructure development (limited use of chemicals, hazardous and toxic materials), it is unlikely that such a development will have a significant impact on groundwater quality. However, the developments may very slightly influence local infiltration. This impact will however be extremely small and can be successfully mitigated through careful planning and with effective mitigation measures in place.

National Protected Areas Expansion Strategy

Focus areas for land-based protected area expansion are large, intact, and unfragmented areas of high importance for biodiversity representation and ecological persistence, suitable for the creation or expansion of large protected areas. Focus Areas present the best opportunities for meeting the ecosystem-specific protected area targets set in the NPAES and were designed with a strong emphasis on climate change resilience and requirements for protecting freshwater ecosystems. These areas should not be seen as future boundaries of protected areas, as in many cases only a portion of a particular focus area would be required to meet the protected area targets set in the NPAES.

According to the NPAES spatial data (Holness, 2010), the entire project site is located within the Free State Highveld Focus Area (Figure 4). Subsequently, the potential impact of this development on the ability for this Focus Area to fulfil its function in the future will be assessed during this impact assessment.

Protected Areas and Conservation Areas (PACA) database

The South African Protected Areas Database (SAPAD) contains spatial data for the conservation estate of South Africa. It includes spatial and attribute information for both formally protected areas and areas that have less formal protection. Data is collected by parcels which are aggregated to protected area level.

The definition of protected areas used in this document follows the definition of a protected area as defined in the National Environmental Management: Protected Areas Act, (Act 57 of 2003). Chapter 2 of the National Environmental Management: Protected Areas Act, 2003 sets out the "System of Protected Areas", which consists of the following kinds of protected areas –

» Special nature reserves,

- National parks,
- Nature reserves and
- Protected environments (1-4 declared in terms of the National Environmental Management: Protected Areas Act, 2003);
- World heritage sites declared in terms of the World Heritage Convention Act;
- Marine protected areas declared in terms of the Marine Living Resources Act;
- Specially protected forest areas, forest nature reserves, and forest wilderness areas declared in terms of the National Forests Act, 1998 (Act No. 84 of 1998); and
- Mountain catchment areas declared in terms of the Mountain Catchment Areas Act, 1970 (Act No. 63 of 1970).

The types of conservation areas that are currently included in the database are the following:

- Biosphere reserves
- Ramsar sites
- Stewardship agreements (other than nature reserves and protected environments)
- Botanical gardens
- Transfrontier conservation areas
- Transfrontier parks
- Military conservation areas
- Conservancies

Taken together, protected areas and conservation areas make up the conservation estate.

According to the PACA database, no Conservation Areas are located in close proximity to the project site, however the Boslaagte Private Nature Reserve is listed as a National Protected Area. This nature reserve is located approximately 1.4km to the south of the proposed SEF footprint (Figure 4). Such nature reserves are typically well cordoned off with game fences, often with some electrified wires, furthermore the R34 route (major road) is located between these two areas, as such it is unlikely that this development will have a significant impact on the nature reserve as well as its associated fauna and flora.

National Level of Conservation Priorities (Threatened Ecosystems)

The vegetation types of South Africa have been categorised according to their conservation status which is, in turn, assessed according to the degree of transformation and rates of conservation. The status of a habitat or vegetation type is based on how much of its original area still remains intact relative to various thresholds. On a national scale these thresholds are, as depicted in the table below, determined by the best available scientific approaches (Driver *et al*. 2005). The level at which an ecosystem becomes Critically Endangered differs from one ecosystem to another and varies from 16% to 36% (Driver *et al*. 2005).

Table 7: Determining ecosystem status (from Driver et al. 2005). *BT = biodiversity target (the minimum conservation requirement.

Habitat remaining (%)			
	80–100	least threatened	LT
	60–80	vulnerable	VU
	*BT–60	endangered	EN
	0–*BT	critically endangered	CR

The National List of Ecosystems that are Threatened and in need of protection (GN1002 of 2011), published under the National Environment Management: Biodiversity Act (Act No. 10 of 2004), lists national vegetation types that are afforded protection on the basis of rates of transformation. The threshold for listing in this legislation is higher than in the scientific literature, which means there are fewer ecosystems listed in the National Ecosystem List versus in the scientific literature.

Table 8: Conservation status of the vegetation type occurring in and around the study area.

Vegetation Type	**Target (%)**	**Conserved (%)**	**Transformed (%)**	**Conservation Status**	
				Driver *et al.*, 2005; Mucina & Rutherford, 2006	National Ecosystem List (NEM:BA)
Central Free State Grassland	24%	0.8%	23.5%	Least Concerned	Not Listed

According to current layout the entire SEF footprint is located within the Least Concerned Central Highveld Grassland (Figure 5).

The presence, extent and condition of the remaining natural grasslands will be determined and assessed during this assessment. Furthermore, the potential impact of the development on this vegetation types and its attributed conservation target will be assessed (in isolation and cumulative with other similar projects). Due to the fact that this vegetation unit still comprise of large 'natural' (untransformed) areas and due to the relatively small extent of the SEF footprint, this development will not likely have an impact on the conservation status of this vegetation type.

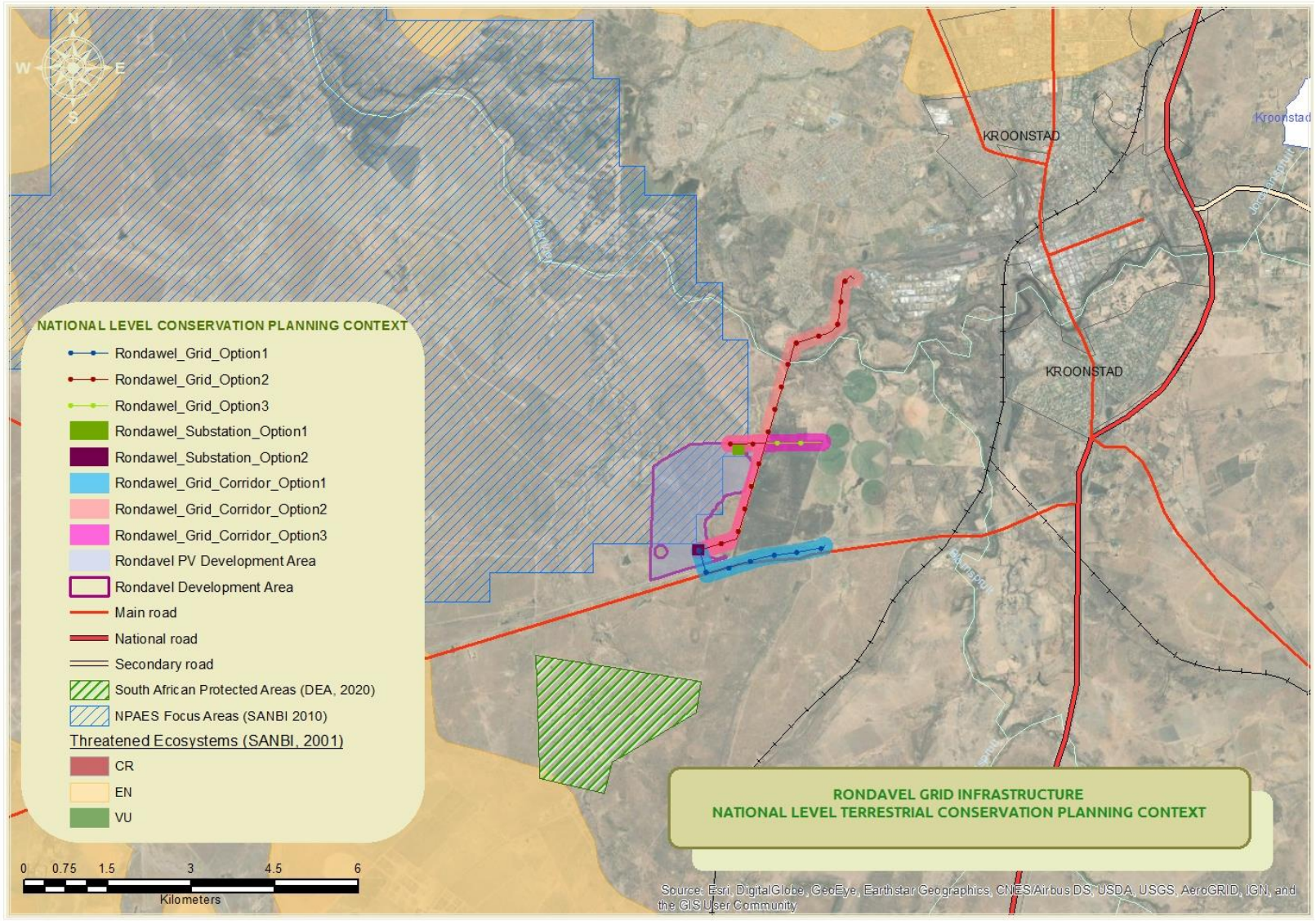

Figure 5: National Level Terrestrial Conservation Planning Context

Figure 6: National Level Aquatic Conservation Planning Context.

Critical Biodiversity Areas and Broad Scale Ecological Processes

The SEF footprint falls within the planning domain of the Free State Province Biodiversity Conservation Assessment which maps Critical Biodiversity Areas and Ecological Support Areas within the Free State Province. The entirety of the footprint falls within an ESA1 (Figure 7).

Typically, natural features are classified according to the different categories on the basis of the following criteria's:

» **Critical Biodiversity Areas (CBAs)** that contain three types of areas:
- Irreplaceable areas, which are essential in meeting targets set for the conservation of biodiversity in Free State.
- Areas that are important for the conservation of biodiversity in Free State.
- Conserved areas, which include all existing level 1 and 2 protected areas.

Level 1 and Level 2 protected areas are proclaimed in terms of relevant legislation (National Environmental Management Protected Areas Act, 2003 (Act No 57 of 2003) specifically for the protection of biodiversity (or for the purposes of nature conservation).

» **Ecological Support Areas (ESAs).** ESAs are an imperative part of the Free State Biodiversity Plan to ensure sustainability in the long term. ESAs are part of the entire hierarchy of biodiversity, but it is not possible to include all biodiversity features in them. Landscape features associated with ESAs (termed spatial surrogates for ESAs) that are essential for the maintenance and generation of biodiversity in sensitive areas, and therefore that require sensitive management were incorporated into Biodiversity Plan.

Critical Biodiversity Areas
No CBAs are located within the SEF's proposed footprint.

Ecological Support Areas 1
Most of the southern half of the project site is located within an ESA1. The ESA 1 functions as a linkage/corridor (comprising of natural vegetation) between the major freshwater resource features (Vals and Blomspruit watercourses and associated tributaries) and their fringing terrestrial habitats. Due to the large extent of this ESA1, and the availability of ample natural to near natural areas between the Vals River and the fringing terrestrial habitats, within the surrounding area, the development will unlikely have an impact on this ESA, and its ability to function as an important corridor.

Ecological Support Areas 2
The northern and eastern portion of the project site is located predominantly within an ESA2. This ESA2 functions much the same as the ESA1 but is located on secondary

grassland and somewhat disturbed areas, thus providing these functions to a more limited extent of that provided by the ESA1

» **Substation Alternatives 1 & 2:** Both of these options are located entirely within an ESA1
» **Grid Route Alternative 1:** This route option will traverse ESA1 in it entirety.
» **Grid Route Alternative 2:** This route option will mostly be located within an ESA2 with sections traversing ESA1.
» **Grid Route Alternative 3:** This route option will traverse both ESA 1 and 2, with ESA 1 forming the bulk of the corridor area.

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.

A review of the NFEPA coverage for the study area (Figure 6) revealed that no River FEPAs are located within the development area or the project site. Furthermore, the NFEPA coverage for the project site shows that now Wetland FEPAs are located within the SEF footprint as well as development area.

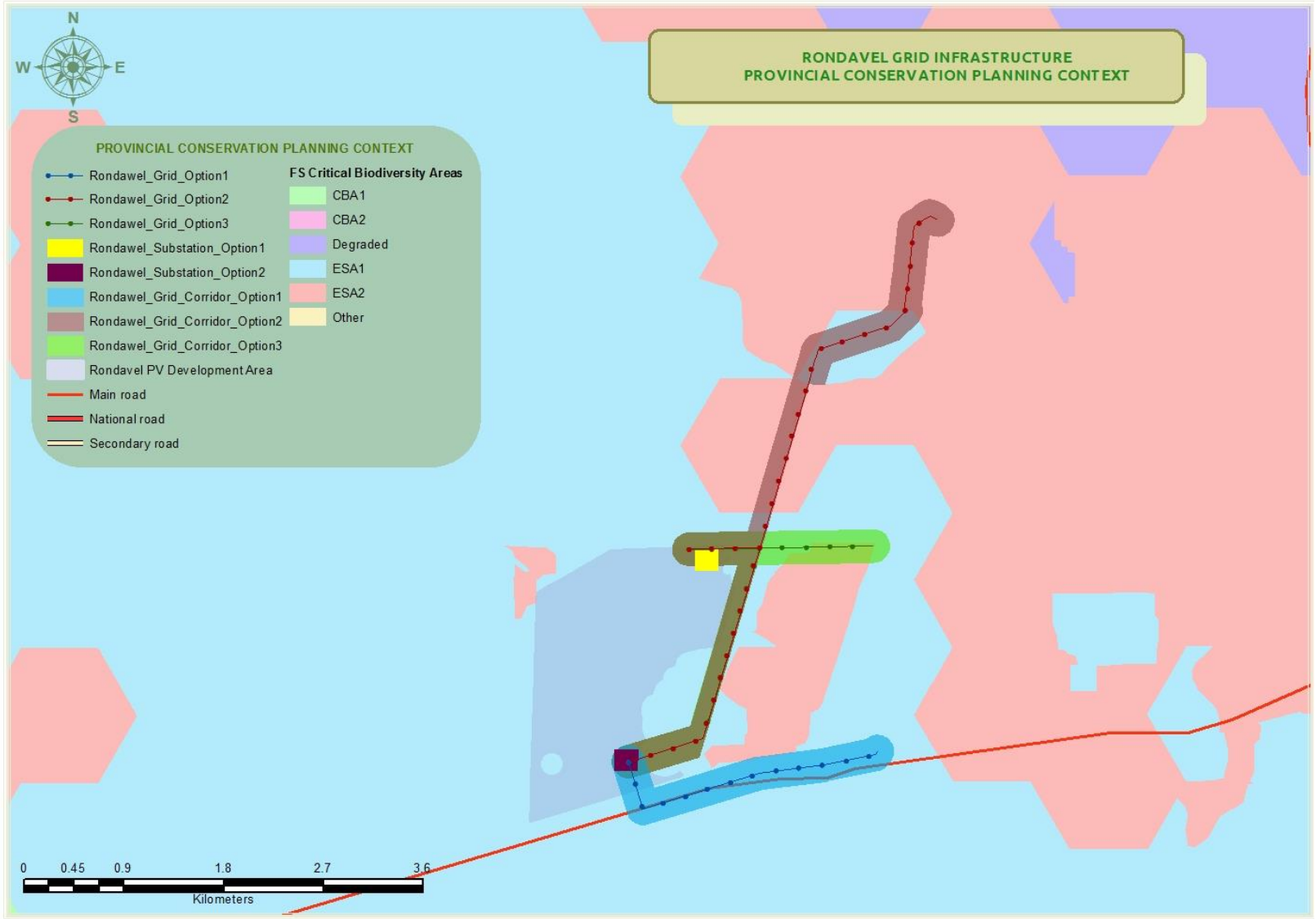

Figure 7: Provincial Level Conservation Planning Context – CBA Map (Free State Province Biodiversity Conservation Assessment).

6. FINDINGS OF THE FRESHWATER RESOURCE BASELINE ASSESSMENT

The baseline habitat assessment, informed by on-site data collection, focused primarily on wetland units rated as being at **Moderate to High risk** of being impacted by the proposed activities (as per section above). This section sets out the findings of the baseline assessment of those water resources units and includes:

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

The on-site / in-field assessment of the wetlands indicators was conducted by Gerhard Botha from Nkurenkuru Biodiversity and Ecology on the 18th to the 20th of March 2021 and the 10th of April 2021.

Within the potential area of influence for the Rondavel Grid Options, there are two channelled valley-bottom wetlands, a broad watercourse with a well-developed riparian fringe (Vals River) and two highly disturbed seepage wetlands at risk of being impacted by the proposed development. The larger channelled valley-bottom (CVB) wetland is regarded as an important drainage feature within the micro-catchment area and flows primarily in a north-to-north-east direction to terminate directly into the Vals River which is the primary drainage feature of the region and an important tributary of the Vaal River.

Appart from the seepage wetlands which has undergone sever degradation the remaining freshwater resource features are mostly, naturally systems, however artificial (anthropogenically) modifications to the morphology of sections of CVB wetland 1 are mainly due the construction of small, instream gravel dams, which tend to be inundated extended periods of time.

A dominant feature of the channelled valley bottom wetland is the patches of woody riparian habitats lining sections the outer edges of these valley bottom wetlands and portions of the channel. The height and density of the forb and tree/shrub layer is highly variable throughout the extent of the valley-bottom wetland.

This section of the Vals River is also characterized by a Riparian fringe, however this riparian fringe is extremely densely covered by tall to medium trees.

Ultimately, five (5) freshwater resource features were identified and delineated, which were located in close proximity to the development area.

Classification, Delineation and Description of Surface Water Resource Features

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).

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

Soil and vegetation sampling in conjunction with the recording of topographical features enabled the delineation of five wetland units at risk of being impacted by the proposed development.

Surface Water Resource Classification

Channelled Valley-bottom Wetland (CVB)

Two channelled valley-bottom wetlands have been identified within the eastern portion of the broader project area; however, only the larger CVB wetland will be crossed by the poer line options. In terms of the substation alternatives, both alternatives are located outside of the boundaries of these wetland features, but still within relative close proximity (within 35m). CVB systems are characterised by their location within moderately well-defined valley floors with the presence of an active channel, but without typical diagnostic floodplain features. Flows within these systems are characteristically confined within a defined channel.

» CVB wetland 1 flows predominantly in a north-to-north-eastern direction to terminate directly into the Vals River. This wetland feature is approximately 5.67 km in length and covers a total area of approximately 49.7ha with a catchment area of approximately 840.216ha. In terms of the portion of the wetland feature located within the potential area of influence (PAOI), approximately 38ha of the CVB wetland is located within the POAI (78.179% of total surface area). Furthermore, approximately 65% of the development area is located within this wetland's catchment. This wetland is highly variable, in terms of morphology. The upper portion of the CVB wetland comprise of a narrow, shallow channel, which may become almost diffuse in some areas, and a very narrow terrace area. As the CVB wetland flows underneath the R34, the wetland becomes wider with a pronounced channel which may become locally moderately deep (~1.8m in some areas), due to channel erosion and trampling. Towards the northern portion of the project area the wetland comprise of a narrow channel sections fringed by a fairly wide terrace areas to the west of the channel and as the wetland exits the project area, the effects of erosion becomes more pronounced with the wetland comprising of a deep and wide channel (up to 54m wide and 4.3m deep) and with very narrow terraces (even absent in some areas). Other prominent impacts that have had

an impact on the morphology of this wetland includes a number of small instream gravel reservoirs/dams.

» CVB wetland 2 is, as mentioned, a fairly short and small wetland (0.81ha and 337m) feeding into CVB wetland 1. This wetland is entirely located within the project area. Furthermore, its catchment area expands an area of approximately 12.6h of which more than 95% is located within the project area. This wetland comprises a fairly narrow (<6m) and moderately to shallow channel (between 1m and 1.7m). Similarly, to CVB wetland 1, the channel morphology is highly varying due to the effects of channel erosion and trampling.

Dominant water inputs to these wetlands are from the watercourse/channel flowing through the wetland, predominantly as surface flow resulting from flooding, or as a form of overland flow from adjacent hillslopes and other smaller watercourses and valley-bottom wetlands, with substantially less groundwater discharge. Water generally exits a channelled valley-bottom wetland in the form of diffuse surface or subsurface flow in the adjacent river (in this case the Vals River), with infiltration into the ground and evapotranspiration of water also being potentially significant.

» Dominant water inputs for CVB wetland 1 is also quite variable and comprise mainly of overland flow and to a lesser extent lateral inflow within the upper regions south of the R34 route. North of the R34 route and within the project area, overland flow is still the most significant form of water input, however, lateral inflow (and outflow) becomes more prominent towards the northern portion of the project area. Channelled flow is still not very significant, with CVB wetland 2 being the most significant source. North of the project area, overland flow as a form of water input, is much less significant, with channelled flow being the most prominent (a few small channelled tributaries feed into the wetland in this section). Due to channel deepening (channel erosion), lateral inflow (and outflow) is likely to play an insignificant role (channel being deeper than the rest of the wetland). Water generally moves through this wetland as diffuse surface flow although occasional short-lived concentrated flows will occur during flooding events. Inundation would naturally be temporary (days to few weeks) with the eroded and trampled depression within the channels being inundated for longer periods of time. The artificial dams within the wetland would typically be seasonally inundated with the larger dams potentially being permanently inundated. Inundation of the fringing terraces is seldom to very short lived.
» For CVB wetland 2, overland flow is probably the most important source of water input whilst water movement through the wetland would typically be diffuse surface flow, however, concentrated flow is expected to be slightly more frequent than within CVB wetland 1. Inundation will be very short lived (few days) apart from the deeper micro-depression within the channel which may be inundated for a few weeks.

Vals River and Riparian fringe (CVB)

The Vals river tributary of the Vaal River originates in the Eastern Free State near the town of Bethlehem and flows through a mostly agricultural area before joining the Vaal River near Bothaville. It is mostly impacted by agricultural activities but also by urban runoff from towns as well as more industrial impacts at Kroonstad. It is a major water source for Sedibeng Water in Bothaville.

The Vals River will only be crossed by Grid Route Option 2. This portion of the Vals River is characterised by its location within a well-defined valley floor with the presence of a board active channel, minimal floodplain features and a well-developed Riparian fringe.

Seepage Wetlands

Soil and vegetation sampling in conjunction with the recording of topographical features enabled the delineation of two seepage wetlands within the surveyed corridor for Grid Route Option 2. These seepage wetlands are located on a gently sloping midslope to footslope side fed primarily by lateral subsurface water inputs from shallow groundwater occurring over an impermeable substrate. Water movement is largely driven by colluvial unidirectional movement. Water movement and through flow is generally as interflow with diffuse overland flow (sheetwash) becoming more prominent during and after rainfall events. Outflow can either be contained within a channel or without a channel. Storm water outlets from the Brentpark residential area has also significantly impacted these wetlands' hydrology (increase in water input and change in flood peaks and intensity).

Surface Water Resource Delineation

The soils in the study area provided a good indication, for all wetland, of the level of wetness of the soils and proved to be the most reliable indicator for most of the assessment (apart from areas where significant soil disturbance have occurred) used to delineate the outer wetland boundaries (i.e. boundary between temporary wetland and upland/terrestrial areas). While soil form and saturation periods varied across the study area, the overwhelming portion of the wetland comprised of temporary saturated soils, whilst the channel and immediate fringing terraces comprised of seasonal saturated soils. Permanent saturated soils were very scarce and is indicative of a predominantly seasonal system.

The typical permanent saturated wetland soils comprised dark grey, dark grey brown, very dark grey brown and light grey clay to clay loam (may become pale brown to pale yellow deeper in the soil profile) characterised by low chromas (2.5Y/3/2; 2.5Y/4/1; 2.5Y/4/2; 2.5Y/7/2, 2.5/8/3 and 2.5Y/8/4 or when Gley: N/4 5PB/2.5-4 becoming 5-7) with distinct moderately to abundant (15-40%) high chroma mottles (yellow, orange and red redox concentrations), sometimes associated with black spots of manganese concentrations, are indicative of the seasonal saturated zones. Organic material within the seasonal zone was generally moderate.

The temporary wetland areas varied from greyish brown to grey sandy clay, sandy clay loam soils (becoming pale brown deeper in the soil profile (2.5Y/5/1, 2.5Y/5/2, 2.5Y7/4 and 2.5Y/7/3) few mottling (<7%). Mottles within the temporary zone vary from orange to red and are small to faint. Moderate to little organic material occurs within this hydrogeomorphic zone.

Prominent soil form recorded within the project area includes:

» Permanent saturated Zone: Rensburg (Vertic – Gley)
» Seasonal Saturated Zone: Arcadia (Vertic – Lithic), Glen (Vertic – Pedocutanic), Idutywa Orthic A - Prismacutanic – Gleyic), Sepane (Orthic A – Pedocutanic – Gleyic)
» Temporary Saturated Zone: Sepane (Orthic A – Pedocutanic – Gleyic), Bakwena (Vertic – Soft Carbonate – Lithic), Pindene (Orthic A – Yellow-Brown Apedal – Gleyic).

Soil forms that were mostly recorded along the course of the Vals River riparian zones (including floodplain areas) are Katspruit, Kroonstad, Tukulu, Oakleaf, Dundee and Rensburg.

The origin of most onsite wetlands is considered strongly linked to their typographical/geographical location as well as the presence of an impermeable clay layer found to occur or at the surface or generally at 30-60cm depth that results in a poorly drained 'perched' water table resulting in wetland formation. This is coupled with the relatively gentle topographic gradient across much of the study area.

Vegetation was generally found to be a good indicator of the presence of wetland habitat and in some cases the level of soil wetness. There is a relative clear, distinct transition from terrestrial/dryland grasses towards true wetland plants (hydrophytes). However, the temporary wetland zone was in some areas almost indistinguishable from the surrounding upland (terrestrial sites).

Vegetation of the Channelled Valley-Bottom Wetlands

These CVB wetlands are characterized by highly variable morphology and hydro-geomorphology (as a result of the varying morphology – frequent variations in elevation), longitudinal and laterally. The effects of erosion and dam features have also contributed to heterogeneity of especially CVB wetland 1. The vegetation of these wetlands is an expression of these variations, and in terms of the wetland portions located within the project area, are also largely heterogenous, and in some areas may form a mosaic pattern of distribution.

Vegetation of the permanent saturated zones (Channels):

This hydro-geomorphological zone occurs as small, discontinuous patches, along the channel of the CVB wetlands where they form where there is a local drop in elevation (micro-depressions) along the channel, mainly created by a form of disturbance such as trampling, erosion and dam construction. These areas tend to collect and store surface water for moderately long periods of time (few months during the wet season). Soils tend to be dark to light grey clay to clay loam. The vegetation of these areas tends to be sparse and poor in diversity dominated by floating and submerged hydrophytic forbs and graminoids (Forbs: 15 – 30%; Grasses: 40 – 55% and Sedges: 10 – 20%) such as *Paspalum distichum, Persicaria decipiens* and *Schoenoplectus muricinux*. Other plants species frequently observed included; *Marsilea macrocarpa, Cyperus Eragrostis, Falkia oblonga* and *Leersia hexandra*.

Vegetation of the seasonal saturated zone (Channels):

The majority of the channel is seasonally saturated and may be temporarily inundated following significant precipitation events. This hydro-geomorphological zone is characterized by a fairly low growing, hydrophytic, graminoid and forb dominated vegetation cover (graminoid: 60-70%; forbs: 20-30%), located on grey to light greyish brown clay to clay-loam soils with varying concentrations of organic material (normally moderately-low). Occasionally, larger shrubs such as *Asparagus laricinus*, and *Searsia pyrioides* may slightly encroach into this zone. Vegetation coverage may become locally sparse, especially in areas that has been recently disturbed (trampling and erosion). Key species includes: *Persicaria decipeins, Cyperus eragrostis, Cyperus longus var. tenuiflorus, Cyperus denudatus, Paspalum diladatum, P. distichum, Cynodon dactylon* and *Eragrostis micrantha*. Other common species within this zone include; *Senecio inornatus, Falkia oblanga, Buchnera reducta, Crinum bulbispermum* and *Setaria pallide-fusca.*

Vegetation of the seasonal saturated zone (terrace):

Seasonal saturated zones fringing the channels tend to be narrow, however favourable underlying geology and local topography may result in larger seasonal saturated zone as was found to the north of CVB wetland 1 (near the north-eastern boundary of the project area) where a fairly broad seasonal zone exist. CVB wetland 2 contains a narrow seasonal zone throughout its extent. This zone is dominated by a tall, dense wet grassland (80-90%) on grey to dark grey brown clay to clay-loam soils, and is characterised by *Eragrostis planiculmis, Paspalum dilatatum, Setaria nigrirostris, Eragrostis micrantha* and *Echinochloa holubii*. Other key species include; *Berkheya radula, Haplocarpha scaposa, Verbena bonariensis, Cyperus longus, Setaria pallide-fusca* and *Sporobolus africanus*,

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Vegetation of the temporary saturated zone (terrace):

The temporary saturated zone covers the largest extent of these wetland features and is characterized by a medium to medium-short mixed moisture grassland comprising a mixture of facultative wetland and facultative upland species. The grass component forms the dominant cover (70-90%). The highest diversity of plant species was recorded within this area with 53 species observed within this zone. This higher plant species diversity is a result of the transitional location of this zone resulting elements of both the wetland and terrestrial being present. Where the seasonal zone transitions into the temporary zone the grass layer tends to be taller with similarities with the seasonal zone and include species such as; *Echinochloa holubii, Eragrostis micrantha, Eragrostis plans, Paspalum dilatatum* and *Setaria nigririostris*. As one moves to the outer edge the grass cover becomes a bit shorter and comprise a mixture of wetland and terrestrial plants such as *Themeda triandra, Eragrostis plana, Cynodon dactylon, Eragrostis chloromelas, E. gummiflua, Panicum coloratum, Sporobolus africanus* and *Eragrostis micrantha*. The forb layer also slightly increases in coverage towards the outer boundary and is characterized with *Verbena officinalis, Berkheya radula, Helichrysum aureonitens, Tagetes minuta, Monsonia burkeana*, *Buchnera reducta* and *Hermannia depressa*. Shrubs such as *Lycium laricinus* and *Acacia karroo*, are also scattered through sections of this zone and may in, some isolated localities become slightly encroaching. , however forbs become more prominent (Seasonal saturated zones fringing the channels tend to be narrow, however favourable underlying geology and local topography may result in larger seasonal saturated zone as was found to the north of CVB wetland 1 (near the north-eastern boundary of the project area) where a fairly broad seasonal zone exist. CVB wetland 2 contains a narrow seasonal zone throughout its extent. This zone is dominated by a tall, dense wet grassland (80-90%) on grey to dark grey brown clay to clay-loam soils, and is characterised by *Eragrostis planiculmis, Paspalum dilatatum, Setaria nigrirostris, Eragrostis micrantha* and *Echinochloa holubii*. Other key species include; *Berkheya radula, Haplocarpha scaposa, Verbena bonariensis, Cyperus longus, Setaria pallide-fusca* and *Sporobolus africanus*

Riparian zone (temporary saturated high-terrace):

Elevated (high terrace areas with a convex shape) areas along the channels and outer fringes of the wetland boundaries, where saturation is very seldom. However, saturation of soils occurs sufficient enough for the display of wetland indicators. Soils tend to be

moderately deep, dark clay (vertic) to loam clay with fairly high concentrations of organic material and typically overly lithic material. The riparian habitat does not form a continuous plant community but display a patchy distribution, varying greatly in size, height, and vegetation structure. The tree and tall shrub layer are the dominant canopy cover (70 – 95%), whist the forb/herb layer forms the dominant ground cover (up to 40%). Low straggling and climbing shrubs forbs are also a prominent feature within these areas and may cover up to 40% of a plant releve within this habitat. Where the tree/tall shrub canopy becomes more open, grass species becomes a more significant feature. The tree/tall shrub layer is dominated by *Acacia karroo, Diospyros lycioides, Ziziphus mucronata, Asparagus laricinus* and *Searsia pyrioides*, whist the forb layer is characterized by *Achyranthes aspera, Bidens Pilosa, Tagetes minuta, Pavonia senegalensis*, and *Sida dregei.* Common straggling and climbing forbs and shrubs include; *Pentharrhinum insipidum* and *Asparagus cooperi*. Occasionally the tree layer thins out and these areas are then typically dominated by *Searsia pyrioides* and *Asparagus laricinus* and to a lesser extent shrubby growth forms of *Acacia karroo*. Within these areas the grass coverage increases with the lower plant strata characterized by, *Cynodon dactylon, Themeda triandra, Sporobolus fimbriatus, Setaria verticillata, Paspalum dilatatum* and *Eragrostis plana*. Other common species recorded within this habitat includes: *Sida cordifolia, Solanum lichtensteinii, Verbena aristigera, Ehretia rigida, Gymnosporia heterophylla* and *Celtis africana.*

Vegetation of the Seepage Wetlands

These seepage wetlands have been significantly modified/transformed and degraded and this is expressed by the vegetation cover. These wetlands contain numerous moisture loving weeds and alien plants.

Vegetation of the permanent saturated zones:

*Agrostis lachnantha, *Alternanthera sessilis, Arundinella nepalensis, Carex glomerabilis, Cycnium tubulosum, Cyperus laevigatus, C. longus, Echinochloa holubii, Eleocharis dregeana, Eragrostis heteromera, Fuirena pubescens, Leersia hexandra, Marsilea capensis, Mimulus gracilis, Paspalum distichum, *Paspalum urvillei, Persicaria decipiens, *Persicaria lapathifolia, *Rumex crispu,s Typha capensis, *Verbena bonariensis*

Vegetation of the seasonal saturated zone:

*Andropogon appendiculatus, *Bromus catharticus, *Cirsium vulgare, Cyperus laevigatus, C. longus, Cynodon dactylon, Cynodon transvaalensis, Eragrostis heteromera, E. micrantha, E. plana, Falckia oblonga, Hemarthria altissima, Imperata cylindrica, Kyllinga erecta, *Melilotus alba, Mimulus gracilis, *Oenothera rosea, *Paspalum dilatatum, Plantago lanceolata, Platycarpha parvifolia, *Rumex crispus, Senecio erubescen,s Setaria incrassata Vahlia capensis, *Verbena bonariensis*

Vegetation of the temporary saturated zone (terrace):

*Andropogon appendiculatu,s *Bromus catharticus, *Cirsium vulgare, Conyza podocephala, Cynodon dactylon, C. transvaalensis, Cyperus esculentus, Eragrostis plana, Falckia oblonga, Helichrysum acutatum, Hemarthria altissima, Imperata cylindrica, *Oenothera rosea, *Paspalum dilatatum, *Pennisetum clandestinum, Plantago lanceolata, Platycarpha parvifolia, Pycreus macranthus, Salvia runcinate, Setaria incrassate, Senecio erubescens, Sporobolus africanus, Stachys hyssopoides, Themeda triandra, Vahlia capensis *Verbena officinalis*

Vegetation of the Vals River's Riparian Zone

Vegetation of the River Bank:

*Asparagus laricinus, *Bromus catharticus, Cullen tomentosum, Cynodon dactylon, Cyperus esculentus, Diospyros lycioides, Echinochloa holubii, Eragrostis plana, Eucalyptus camaldulensis, Gymnosporia buxifolia, Hemarthria altissima, Imperata cylindrica, *Malvastrum coromandelianum, *Melia azedarach, Cyperus longus, Juncus effuses, Lagarosiphon major, Leptochloa fusca, Persicaria decipiens, *Persicaria lapathifolia, Phragmites australis, Potamogeton thunbergii, Schoenoplectus brachyceras, Typha capensis, *Melilotus alba, *Paspalum dilatatum, *Paspalum urvillei, *Pennisetum clandestinum, Plantago lanceolata, Pollichia campestris, *Populus x canescens, Salvia runcinate, Searsia pyroides, Setaria incrassate, *Sphaeralcea bonariensis, Vachellia karroo, *Verbena bonariensis,s V. officinalis, Ziziphus mucronata, *Xanthium strumarium*

Vegetation of the Active Channel

*Cyperus longus, Juncus effuses, Lagarosiphon major, Leptochloa fusca, Persicaria decipiens, *Persicaria lapathifolia, Phragmites australis, Potamogeton thunbergii, Schoenoplectus brachyceras, Typha capensis.*

Present Ecological State

Present Ecological State of Wetland Features

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

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

The results of the wetland PES assessment are presented in Table 9.

» The channelled valley bottom wetland has been assessed as being 'Moderately Modified' ('C' PES) which implies *a moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact*.
» The seepage wetlands (W6) has been assessed as being significantly modified ('E' PES), with a great/significant change in ecosystem processes and loss of natural habitat and biota, however, some remaining natural habitat features are still recognizable.

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

<u>Channelled Valley Bottom Wetland 1:</u>

» Hydrological Health:
- The hydrological character has been moderately impacted mainly in terms of water distribution and retention.
  - The most significant factor contributing to these modifications/alterations are the modification to the existing channel.
  - Especially the channel located north of the proposed development area has been significantly modified through erosion, which as widened and deepened the channel within this section. This has resulted in more confined flows and a reduction in lateral and overbank flow into the adjacent habitat areas.
  - Within the development area erosion and trampling by livestock has resulted in localised deepening of the channel, creating pools which will retain surface water for longer periods of time and reduce potential overbank and lateral flow into the adjacent portions of the wetland (as a result of the lowering of the channel below the adjacent wetland areas.
- Numerous small to medium-small gravel dams have been constructed within the watercourse impacting/impeding the natural flow of water along the wetland.
- The R34 crossing has also slightly impacted local water distribution.
- Hardened surfaces within the catchment is regarded is relative low (R34 and a few gravel roads) and along with the fact that a fairly dense vegetation is still present within the catchment, means that water inputs and flooding patterns have likely not been significantly modified (although the elevation of the R34 may impact surface flow somewhat at a local scale).

» Geomorphological Health:
    - The effects of instream dam construction, channel erosion (widening and deepening) as well as infilling has had a significant impact on the geomorphological integrity of the wetland and has resulted in moderate modification to the natural geomorphology of the channelled valley bottom wetland.

» Vegetation Health:
    - The integrity of the vegetation structure has been moderately impacted.
    - Grazing, trampling and erosion of the channel resulted in a general reduction in the vegetation coverage. Apart from a reduction in coverage, an alteration to the species composition has also occurred, to some extent, with micro-depression found along the channel (a result of trampling and erosion) now comprising of floating and submerged forbs and some sedges, the remaining channel is now characterized mainly by low growing grasses and a few sedges as well as some bare patches. Historically, these channels were likely covered by a much denser and taller sedge and grass cover.
    - Natural vegetation within portions of the seasonal and temporary saturated zones have been completely taken over by the alien plant *Paspalum dilatatum*.
    - The invasive alien plant (IAP); *Verbena officinalis* is a common feature within the temporary saturated zone.
    - Other IAPs recorded within the wetland include; *Cirsium vulgare; Xantium spinosum, Xantium strumarium* and *Verbena bonariensis*.
    - Furthermore, *Asparagus laricinus*, and to a lesser extent *Acacia (Vachellia) karroo*, have become slightly encroaching within the temporary saturated zone (some locations).

<u>Channelled Valley Bottom Wetland 2:</u>

» Hydrological Health:
    - The hydrological character has been slightly to moderately impacted, also mainly with regards to water distribution and retention.
        - Similarly, to CVB wetland 1 the most significant factor contributing to these modifications/alterations are the modification to the existing channel which has been exposed to trampling and erosion, deepening and slightly widening some portions of the channel. This in turn has resulted in more confined flows and a reduction in lateral and overbank flow into the adjacent habitat areas.
        - Modifications/alterations within the catchment is minimal, with some hardened surfaces, and as such water input and flooding peaks has mainly remained natural.

» Geomorphological Health:
- The effects of instream channel erosion (widening and deepening) and trampling have resulted in the moderate modification of the natural geomorphological integrity of the wetland.

» Vegetation Health:
- Modifications to the vegetation structure and composition are probably the most significant impact to this wetland feature and is mainly as a result of the modification of the geomorphology (soil disturbance through erosion and trampling).
- Grazing, trampling and erosion of the channel has resulted in a general reduction in vegetation coverage. Apart from a reduction in coverage, an alteration to the species composition has also occurred, to some extent, with micro-depression found along the channel (a result of trampling and erosion) now comprising of floating and submerged forbs and some sedges, the remaining channel is now characterized mainly by low growing grasses and a few sedges as well as some bare patches. Historically, these channels were likely covered by a much denser and taller sedge and grass cover.
- The alien plant, *P. dilatatum* has established itself, especially within the seasonal and temporary saturated portion of the wetland, forming local dense stands.
- IAPs recorded within the wetland include; *Cirsium vulgare; Xantium spinosum, Xantium strumarium* and *Verbena bonariensis, V. officinalis*.
- Furthermore, *Asparagus laricinus*, and *Acacia (Vachellia) karroo*, have become slightly encroaching in temporary saturated zone (some locations).

<u>Seepage Wetlands:</u>

» Hydrological Health:
- The hydrological character has been significantly impacted mainly in terms of water inputs, patterns, distribution and retention.
  - The most significant factors contributing to these modifications/alterations are the modification to the existing channel, reduction of roughage and artificial water input via storm water outlets from residential areas.
  - Sheet and channel erosion are also a prominent feature within these wetlands.
  - Within the development area erosion and trampling by livestock has resulted in the formation of localised channels.
- Hardened surfaces and storm water outlets within the catchment is regarded is moderate to high, and along with the fact that the coverage of vegetation within the catchment has been impacted and reduced, means that water inputs and flooding patterns have been significantly modified.

» Geomorphological Health:

- The effects of trampling, erosion, channel incision/erosion has had a significant impact on the geomorphological integrity of the wetlands and has resulted in a clear modification to the natural geomorphology of the seepage wetlands.

» Vegetation Health:

- The integrity of the vegetation structure has been severely impacted.
- Grazing, trampling and erosion has resulted in a reduction in the vegetation coverage. Apart from a reduction in coverage, an alteration to the species composition has also occurred, with micro-depressions and channels found within the wetlands (a result of trampling and erosion) now comprising predominantly of species that are not typically associated with natural seepage wetlands and includes the alien plant, *Persicaria lapathifolia*.
- Natural vegetation within portions of the seasonal and temporary saturated zones have been completely taken over by the alien plant, *Paspalum dilatatum*.
- The invasive alien plant (IAP); *Verbena officinalis* is a common feature within the temporary saturated zone.
- Other IAPs recorded within the wetland include; *Cirsium vulgare; Xantium spinosum, Xantium strumarium, Persicaria lapathifolia,* and *Verbena bonariensis*.

Table 9: Summary of the Present Ecological Scores (PES) of the affected Hydrogeomorphic units.

Hydro-geomorphic Unit	Hydrology	Geomorphology	Vegetation	Overall PES
Channelled Valley Bottom 1	C: Moderately Modified (PES Score: 3.5)	C: Moderately Modified (PES Score: 3.5)	C: Moderately Modified (PES Score: 2.5)	C: Moderately Modified (PES Score: 3.2)
Channelled Valley Bottom 2	C: Moderately Modified (PES Score: 2)	C: Moderately Modified (PES Score: 2)	C: Moderately Modified (PES Score: 2.2)	C: Moderately Modified (PES Score: 2.1)
Seepage Wetlands	E: Significantly Modified (PES Score: 6.9)	F: Severely Modified (PES Score: 8.2)	E: Significantly Modified (PES Score: 6.4)	E: Significantly Modified (PES Score: 7.1)

Present Ecological State of the Vals River

The Present Ecological State (PES) refers to the health or integrity of an ecosystem defined as a measure of deviation from the reference state. The 'habitat integrity' of a river refers to the "maintenance of a balanced composition of physic-chemical and habitat characteristics on a temporal and spatial scale that is comparable to the characteristics of natural habitats of the region" (Kleynhans, 1996). It is seen as a surrogate for the assessment of biological responses to driver changes. The Index of habitat Integrity (IHI) is a measure of the Present Ecological State (PES) which infers the health or integrity of a river system and includes both in-stream habitats as well as riparian habitat adjacent to the main channel.

Habitat integrity for instream and riparian habitats was assessed separately based on the following indicators of habitat integrity:

- Water abstraction
- Flow modification
- Inundation
- Bed modification
- Bank erosion
- Channel modification
- Water quality
- Solid waste disposal
- Vegetation removal
- Exotic vegetation

The results of the IHI assessment are summarised in Table 10 and shown graphically in Figure 8 below.

Table 10: Summary results of the river IHI (Index of habitat Integrity)

INSTREAM IHI	
Base Flows	-1.0
Zero Flows	0.0
Floods	-1.0
HYDROLOGY RATING	**0.7**
pH	2.0
Salts	3.0
Nutrients	2.5
Water Temperature	0.0
Water clarity	4.5
Oxygen	1.5
Toxics	2.0
PC RATING	**2.0**
Sediment	3.5
Benthic Growth	1.0
BED RATING	**1.8**
Marginal	0.5
Non-marginal	1.5
BANK RATING	**1.0**
Longitudinal Connectivity	0.5
Lateral Connectivity	1.5
CONNECTIVITY RATING	**0.9**
INSTREAM IHI %	**73.9**
INSTREAM IHI EC	**C**
INSTREAM CONFIDENCE	**4.6**

RIPARIAN IHI	
Base Flows	-1.0
Zero Flows	-0.5
Moderate Floods	-1.0
Large Floods	-0.5
HYDROLOGY RATING	**0.8**
Substrate Exposure (marginal)	1.0
Substrate Exposure (non-marginal)	1.5
Invasive Alien Vegetation (marginal)	2.0
Invasive Alien Vegetation (non-marginal)	4.5
Erosion (marginal)	1.5
Erosion (non-marginal)	1.0
Physico-Chemical (marginal)	1.0
Physico-Chemical (non-marginal)	0.0
Marginal	2.0
Non-marginal	4.5
BANK STRUCTURE RATING	**4.0**
Longitudinal Connectivity	1.0
Lateral Connectivity	2.0
CONNECTIVITY RATING	**1.5**
RIPARIAN IHI %	**52.8**
RIPARIAN IHI EC	**D**
RIPARIAN CONFIDENCE	**4.8**

Instream habitat integrity within the study area was rated as Moderately Modified (C) mainly due to bed modification as a result of sedimentation deposition and removal occurring within this area. These high loads of suspended solids carried downstream during high flows significantly impact water quality during these periods, however, some stability as obtained during the low and zero flow periods.

The riparian habitat index within the study area was rated as Largely Modified (D) due to the high level of Alien Woody Plant species present within the riparian areas as well as the fact that some modification of the bank has occurred as well as some local disruption in connectivity, especially lateral connectivity.

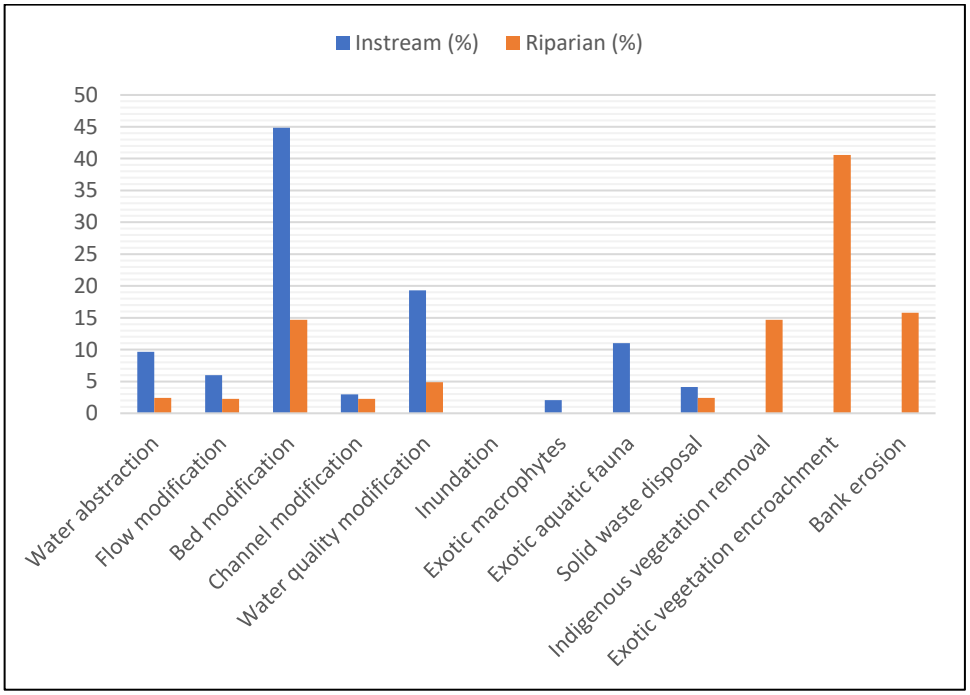

Figure 8: Graph comparing the level of instream and riparian habitat modification expressed as a percentage as a result of a number of modifying determinants for this section of the Vals River using the IHI method.

Ecological Importance and Sensitivity (EIA) Assessment

Ecological Importance and Sensitivity of Wetland Features

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 and indicates the following:

» As a general consequence of the moderate level of wetland degradation caused by the range of existing impacts to wetlands (discussed in section, above), wetland functioning has been slightly reduced at varying levels.
» The channelled valley-bottom wetland 1 is considered to be of 'High' EIS, linked with its relative high importance in providing biodiversity maintenance and water quality enhancement services primarily as well as its moderate-low sensitivity to external impacts. Wetland unit 1 provides a valuable corridor for movement (fauna and likely avifauna) as well as hydrological connectivity with important lower lying aquatic and wetland ecosystems as well as with surrounding terrestrial habitats. Furthermore, water quality enhancement and maintenance are vital for functionality and services provided by important downstream ecosystems.
» Channelled valley-bottom wetland 2 is considered to be of low to moderate importance to biodiversity maintenance, and moderate importance in terms of the maintenance of water quality. However due to the small size of the wetland and the potential extent and frequency of habitats being flooded, this wetland is moderately sensitive to external impacts.
» In comparison to Unit W1, Units W2 was found to be the least important at providing ecosystem services with most services ranging between moderately-low and moderate. As mentioned, the most notable services were identified as water quality enhancing services which were rated as being mostly of moderate importance. All other services were usually assessed as being of low importance. However, this being said, CVB wetland 2 is closely associated within CVB1, and these two wetlands should be considered as a whole and as such CVB2 should be upgraded to 'High' sensitive.
» These two wetlands combined, contribute significantly to habitat heterogeneity within the area and as such increase habitat and niche diversity within the area and can be considered as important habitats for fauna and flora at a local scale.
    - Approximately 38 plant species have been recorded within the wetland habitats and which are highly restricted to these wetland habitats.
    - The densely grass covered seasonal and temporary saturated wetland area as well as the immediate fringing terrestrial habitat contained the highest biodiversity within the project area.
    - A total of 15 amphibians are potentially associated with the habitats created by the wetland features, with four species being observed/confirmed during the site survey.

- Approximately five reptile's species have their distribution including the project area and is largely restricted to such wetland/moist habitats.
- The highest diversity of smaller mammals where recorded within the temporary and seasonal saturated grassland. These smaller mammal species, e.g. rodents, for the basis of the trophic food chain and sustain the local faunal meso-predators as well as raptors. There was a clear decrease in trapping success (Sherman traps) as one move further from the wetland habitats.
- Especially CVB wetland 1 can be regarded as potentially important corridor connecting the Vals River with the higher lying grassland habitats.
- Small invertebrates associated with the wetland pools and grassy wetland sections as well as the numerous fruiting trees associated with the riparian fringe, creates valuable foraging and nesting habitat for numerous avifaunal species.
- Faunal species recorded within the wetland habitats include:
    - Amphibians: Rattling frog (*Semnodactylus wealii*); Common platanna (*Xenopus laevis*); Boettger's caco (*Cacosternum boettgeri*); Nata Sand Frog (*Tomopterna natalensis*)
    - Reptiles: Thin-tailed legless skink (*Acontias gracilicauda*) and Delalande's Beaked Blind Snake (*Rhinotyphlops lalandei*)
    - Small Mammals: Tiny musk shrew (*Crocidura fuscomurina*), Cape porcupine (*Hystrix africaeaustralis*), Four striped grass mouse (*Rhabdomys pumilio*), Mastromys coucha (*Southern multimammate mouse*), Angoni vlei rat (*Otomys angoniensis*)
    - Small antelope: Common duiker (*Sylvicapra grimmia*)
    - Introduced Mammals: Common Warthog (*Phacochoerus africanus*), Nyala (*Tragelaphus angasii*), Waterbuck (*Kobus ellipsiprymnus*) and Greater Kudu (*Tragelaphus strepsiceros*)

» The following South African endemic and near-endemic biota were observed within the wetland habitat (even though endemic to South Africa, these species are not extremely range restricted):
    - Rattling frog (*Semnodactylus weallii*) and Thin-tailed Legless Skink (*Acocantias gracilicauda*),

» No species of conservation concern (red listed, CITES or nationally protected species) were recorded within the wetland habitats, however suitable habitat persist for numerous SCC. The following species have a high likelihood of occurrence within the wetland habitats:
    - Giant bullfrog - *Pyxicephalus adspersus* (Near Threatened), South African hedgehog – *Atelerix frontalis* (Near Threatened), Serval - *Leptailurus serva* (Near Threatened)

» The seepage wetlands are considered to be of low importance to biodiversity maintenance, and low importance in terms of the maintenance of water quality. However due to the small size of the wetland and the potential extent and frequency of habitats being flooded, this wetland is moderately sensitive to external impacts.

Table 11: Score sheet for determining the ecological importance and sensitivity for the identified wetland units.

DETERMINANT		IMPORTANCE SCORES (0-4) AND RATINGS		
		Channelled Valley-bottom Wetland 1	Channelled Valley-bottom Wetland 1	Seepage Wetlands
PRIMARY DETERMINANTS	Rare & Endangered Species	3	2	0
	Populations of Unique Species	2	1	0
	Species/taxon Richness	3	2	1
	Diversity of Habitat Types or Features	4	2	1
	Migration route/breeding and feeding site for wetland species	2	1	1
	Sensitivity to Changes in the Natural Hydrological Regime	2	3	1
	Sensitivity to Water Quality Changes	3	3	1
	Flood Storage, Energy Dissipation & Particulate/Element Removal	3	2	1
MODIFYING DETERMINANTS	Protected Status	4	4	2
	Ecological Integrity	2	3	0
TOTAL		28	23	9
MEDIAN		3	2	1
OVERALL ECOLOGICAL SENSITIVITY & IMPORTANCE		**B High**	**C Moderate**	**D Low**

Ecological Importance and Sensitivity of the Vals River

The Ecological Importance and Sensitivity (EIS) of river and riparian areas 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).

The outcomes of a rapid instream and riparian habitat ecological importance and sensitivity assessment (using the DWAF EIS tool for rivers) is summarised below in Table 12.

In terms of ecosystem importance and ecological sensitivity, this section of the Vals River is considered to be of Moderate Importance, containing features that are considered to be

ecologically important and sensitive at a local scale and typically having a small role in providing ecological services at the local scale

Table 12: Score sheet for determining the ecological importance and sensitivity for the affected aquatic ecosystem:

DETERMINANT		IMPORTANCE SCORES (0-4) AND RATINGS	Comments
PRIMARY DETERMINANTS	Rare & Endangered Species	2	Potential habitat for *Austroglanis sclateri* (Endemic), *Anonyx capensis Near Threatened)* as well as *Hydrictis maculicollis* (Near Threatened).
	Populations of Unique Species	0	None recorded during survey.
	Species/taxon Richness	2	Due to disturbances. Riparian habitat highly invaded with exotic trees and shrubs. Low diversity of fish species
	Diversity of Habitat Types or Features	3	Mainly seasonal and ephemeral grassy edges, dense riparian thicket (trees and shrubs), incised channels
	Migration route/breeding and feeding site for wetland species	2	Potential migration route for fish species.
	Sensitivity to Changes in the Natural Hydrological Regime	0	This portion of river is naturally perennial.
	Sensitivity to Water Quality Changes	1	Increase in turbidity, total suspended solids as well as microbial activity especially during high flow periods (upstream sources)
	Flood Storage, Energy Dissipation & Particulate/Element Removal	1	
MODIFYING DETERMINANTS	Protected Status	2	Ecological Support Area
	Ecological Integrity	2	
TOTAL		15	
MEDIAN		2	
OVERALL ECOLOGICAL SENSITIVITY & IMPORTANCE		**C Moderate**	

Aquatic Buffer Zones

The recommended buffers provided below are relevant for all activities pertaining to the development apart from the placement of pylons and single-track access road to the pylon locations, which is allowed within the recommended buffer areas. The location of the on-site substation, laydown areas, storage areas, refuelling areas, construction camps etc. are not allowed within the recommended buffer areas.

Buffers represent zones in which construction or habitat degradation would risk direct or indirect impacts on aquatic features and local hydrology. The main objective of the establishment and protection of buffers around aquatic features is to ensure that these features are protected from direct and indirect impacts.

The national Preliminary Guideline for the Determination of Buffer Zones for River, Wetlands and Estuaries (MacFarlane *et al.,* 2014) was used to determine a desktop-level buffer width, which was based on the types of impacts associated with above-ground construction and operation of power infrastructure. The generic buffer for this type of activity is **55 m** for all aquatic ecosystems located in an area with moderate low rainfall and with low rainfall intensity (MacFarlane *et al.,* 2014).

It is recommended that this generic buffer be reduced to the following, specifically due to the flat terrain (i.e. a flatter slope will mean that water flowing across the buffer will flow slowly, thus increasing the chance of sediment and pollutants settling out, and increasing the effectiveness of the buffer):

» Aquatic features of high sensitivity: 30m buffer

In terms of No-Go Zones the buffer areas, as mentioned, should be regarded as No-Go areas for all activities apart from the placement of the pylons and access to the pylon locations. Where pylons can be placed outside of the buffer areas, whilst still being capable of spanning the wetland features, this should rather be considered, than placing pylons within the buffer areas.

Furthermore, the wetland features themselves should be regarded as No-Go areas for all activities, apart from the spanning of these features where avoidance is not possible. Only existing road crossings should be used.

7. FINDINGS OF THE TERRESTRIAL ECOLOGICAL BASELINE ASSESSMENT

Regional Terrestrial Ecological Overview

Vegetation Overview

Broad Vegetation Types

The overall project area is situated within the grassland biome. This biome is centrally located in southern Africa, and adjoins all except the desert, fynbos and succulent Karoo

biomes (Mucina & Rutherford, 2006). Major macroclimatic traits that characterise the grassland biome include:

» Seasonal precipitation; and
» The minimum temperatures in winter (Mucina & Rutherford, 2006).

The grassland biome is found chiefly on the high central plateau of South Africa, and the inland areas of KwaZulu-Natal and the Eastern Cape. The topography is flat and rolling but includes the escarpment itself. Altitude varies from near sea level to 2 850 m above sea level.

Grasslands are dominated by a single layer of grasses. The amount of cover depends on rainfall and the degree of grazing. The grassland biome experiences summer rainfall and dry winters with frost (and fire), which are unfavourable for tree growth. Thus, trees are typically absent, except in a few localized habitats. Geophytes (bulbs) are often abundant. Frosts, fire and grazing maintain the grass dominance and prevent the establishment of trees.

The grassland biome comprises many different vegetation types. The entirety of the SEF footprint is located within the Central Free State Grassland vegetation type (Gh6) according to Mucina & Rutherford (2006) (Figure 6).

A. Central Free State Grassland

The Central Free State Grassland vegetation type is found in the Free State and marginally into Gauteng Province. This vegetation type typically comprises of undulating plains supporting short grassland, in natural condition dominated by *Themeda triandra* while *Eragrostis curvula and E. chloromelas* become dominant in degraded habitats. Dwarf karoo bushes establish in severely degraded clayey bottomlands. Overgrazed and trampled low-lying areas with heavy clayey soils are prone to *Acacia karroo* encroachment (Mucina & Rutherford, 2006).

Important Plant Taxa

Important plant taxa are those species that have a high abundance, a frequent occurrence or are prominent in the landscape within a particular vegetation type (Mucina & Rutherford, 2006). The following species are important in the Central Free State Grassland.

Graminoids: *Aristida adscensionis* (d), *A. congesta* (d), *Cynodon dactylon* (d), *Eragrostis chloromelas* (d), *E. curvula* (d), *E. plana* (d), *Panicum coloratum* (d), *Setaria sphacelata* (d), *Themeda triandra* (d), *Tragus koelerioides* (d), *Agrostis lachnantha*, *Andropogon appendiculatus, Aristida bipartita, A. canescens, Cymbopogon pospischilii, Cynodon transvaalensis, Digitaria argyrograpta, Elionurus muticus, Eragrostis lehmanniana, E. micrantha, E. obtusa, E. racemosa, E. trichophora, Heteropogon contortus, Microchloa caffra, Setaria incrassata, Sporobolus discosporus* (Mucina & Rutherford, 2006).

Herbs: *Berkheya onopordifolia* var. *onopordifolia, Chamaesyce inaequilatera, Conyza pinnata, Crabbea acaulis, Geigeria aspera* var. *aspera, Hermannia depressa, Hibiscus pusillus, Pseudognaphalium luteo-album, Salvia stenophylla, Selago densiflora, Sonchus dregeanus* (Mucina & Rutherford, 2006).

Geophytic Herbs: *Oxalis depressa, Raphionacme dyeri* (Mucina & Rutherford, 2006).

Succulent Herb: *Tripteris aghillana var. integrifolia* (Mucina & Rutherford, 2006).

Low Shrubs: *Felicia muricata* (d), *Anthospermum rigidum* subsp. *pumilum, Helichrysum dregeanum, Melolobium candicans, Pentzia globosa* (Mucina & Rutherford, 2006).

Figure 9: Vegetation Types (SANBI, 2018)

Plant Species of Conservation Concern Previously recorded within the Region

Based on the Plants of Southern Africa (BODATSA-POSA, 2020) database, 491 plant species are expected to occur in the project area. Figure 5 shows the extent of the grid that was used to compile the expected species list based on the Plants of Southern Africa (BODATSA-POSA, 2020) database. The list of expected plant species is provided in Appendix 1. Of the 491-plant species, only one species is listed as being a Species of Conservation Concern (SCC) namely *Anacampseros recurvata* subsp. *buderiana*. It is likely that this individual has been wrongfully identified as this species is Endemic to the quartz plains and outcrops of the Richtersveld. As such the Likelihood of Occurrence for this species within the project area is highly unlikely.

Faunal Overview

Mammals

The IUCN Red List Spatial Data lists 73 mammal species that could be expected to occur within the vicinity of the project site (Appendix 4). Of these species, 8 are medium to large conservation dependant species, such as *Ceratotherium simum* (Southern White Rhinoceros) and *Equus quagga* (Plains Zebra) that, in South Africa, are generally restricted to protected areas such as game reserves. These species are not expected to occur in the project site and are removed from the expected SCC list. Of the remaining 65 small to medium sized mammal species, ten (10) are listed as being of conservation concern on a regional or global basis (Table 13).

The list of potential species includes:

- One (1) that is listed as Endangered (EN) on a regional basis;
- Four (4) that are listed as Vulnerable (VU) on a regional basis; and
- Five (5) that are listed as Near Threatened (NT) on a regional scale.

Table 13: List of mammal species of conservation concern that may occur in the project area as well as their global and regional conservation statuses (IUCN, 2017; SANBI, 2016)

Species	Common Name	Conservation Status		Likelihood of Occurrence
		Red Data	IUCN	
Anonyx capensis	Cape Clawless Otter	NT	NT	Very High
Atelerix frontalis	South African Hedgehog	NT	LC	Very High
Felis nigripes	Black-footed Cat	VU	VU	Low
Hydrictis maculicollis	Spotted-necked Otter	VU	NT	High
Leptailurus serval	Serval	NT	LC	Very High
Lycaon pectus	African Wild Dog	EN	EN	Very Low
Mystromys albicaudatus	White-tailed Rat	VU	EN	Moderate
Panthera pardus	Leopard	VU	VU	Low
Parahyaena brunnea	Brown Hyena	NT	NT	Moderate

Species	Common Name	Conservation Status		Likelihood of Occurrence
		Red Data	IUCN	
Poecilogale albinucha	African Striped Weasel	NT	LC	High

Aonyx capensis (Cape Clawless Otter) is the most widely distributed otter species in Africa (IUCN, 2017). This species is predominantly aquatic, and it is seldom found far from water. The only suitable habitat within the project site, is within the Vals River and its associated riparian and floodplain habitats (high likelihood of occurrence within this area). Based on the absence of any perennial rivers or wetlands within the southern portions of the project area the likelihood of occurrence of this species occurring in the southern portion of the project area is considered to be unlikely. However, during years of exceptional high rainfall and flooding, such species may potentially move up and down between the lower portion of the valley bottom-wetland, and the Vals River to the north of the development footprint, in search of food.

Atelerix frontalis (South African Hedgehog) has a tolerance of a degree of habitat modification and occurs in a wide variety of semi-arid and sub-temperate habitats (IUCN, 2017). Based on the Red List of Mammals of South Africa, Lesotho and Swaziland (2016), *A. frontalis* populations are decreasing due to the threats of electrocution, veld fires, road collisions, predation from domestic pets and illegal harvesting. Although the species is cryptic and therefore not often seen, there is suitable habitat in the project area and therefore the likelihood of occurrence is rated as very high.

Felis nigripes (Black-footed cat) is endemic to the arid regions of southern Africa. This species is naturally rare, has cryptic colouring is small in size and is nocturnal. These factors have contributed to a lack of information on this species. The habitat in the project area can be considered suitable for the species, however due to regular human activity within the area the likelihood of occurrence is rated as low.

Hydrictis maculicollis (Spotted-necked Otter) inhabits freshwater habitats where water is, unpolluted, and rich in small to medium sized fishes (IUCN, 2017). The perennial Vals River provide suitable habitat for this species and the likelihood of occurrence is High.

Leptailurus serval (Serval) occurs widely through sub-Saharan Africa and is commonly recorded from most major national parks and reserves (IUCN, 2017). The Serval's status outside reserves is not certain, but they are inconspicuous and may be common in suitable habitat as they are tolerant of farming practices provided there is cover and food available. In sub-Saharan Africa, they are found in habitat with well-watered savanna long-grass environments and are particularly associated with reedbeds and other riparian vegetation types. Due to the presence of some natural terrestrial- and wetland grassland areas, the likelihood of occurrence for this species is rated as Very High.

Lycaon pictus (African Wild Dog) is categorised as Endangered on both a regional and an international scale. Population size is continuing to decline as a result of ongoing habitat fragmentation, conflict with human activities, and infectious disease. African Wild Dogs are generalist predators, occupying a range of habitats including short-grass plains, semi-desert, bushy savannas and upland forest. This species mainly occurs in recognised protected areas but a few free ranging groups can still be found in South Africa. The likelihood of occurrence in the project area is rated as low.

Panthera pardus (Leopard) has a wide distributional range across Africa and Asia, but populations have become reduced and isolated, and they are now extirpated from large portions of their historic range (IUCN, 2017). Impacts that have contributed to the decline in populations of this species include continued persecution by farmers, habitat fragmentation, increased illegal wildlife trade, excessive harvesting for ceremonial use of skins, prey base declines and poorly managed trophy hunting (IUCN, 2017). Although known to occur and persist outside of formally protected areas, the densities in these areas are considered to be low. The likelihood of occurrence in the project area is regarded as Low.

Parahyaena brunnea (Brown Hyaena) is endemic to southern Africa. This species occurs in dry areas, generally with annual rainfall less than 100 mm, particularly along the coast, semidesert, open scrub and open woodland savanna. Given its known ability to persist outside of formally protected areas the likelihood of occurrence of this species in the project area is moderate to good. This species is known to persist outside of protected areas and even within agricultural lands and as such the likelihood of occurrence is regarded as Moderate.

Poecilogale albinucha (African Striped Weasel) is usually associated with savanna habitats, although it probably has a wider habitat tolerance (IUCN, 2017). Due to its secretive nature, it is often overlooked in many areas where it does occur. There is sufficient habitat for this species in the project area and the likelihood of occurrence of this species is therefore considered to be High.

Reptiles

Based on the IUCN Red List Spatial Data (IUCN, 2017) and the ReptileMap database provided by the Animal Demography Unit (ADU, 2017) twenty-eight (28) reptile species are expected to occur in the project area (Appendix 3). Two reptile species of conservation concern is expected to be present in the project area, namely *Smaug giganteus* (Sungazer or Ouvolk) and *Chamaesaura aenea* (Coppery Grass Lizard) (Table 9).

Smaug giganteus (Sungazer or 'Ouvolk') is categorised as Vulnerable on both a regional and an international scale. It is endemic to South Africa, where it is found only in the

grasslands of the northern Free State and the southwestern parts of Mpumalanga (IUCN, 2017). Habitat loss due to agriculture is a continuing threat. Large portions of the grassland habitat are underlain by coal beds of varying quality and extent, and exploitation of coal for fuel has and will result in further habitat loss. The landowner confirmed the presence of Sungazer within the adjacent property (more open, grassland), however this reptile species is absent from the development area. This was confirmed during the site visit and according to potential habitat available the likelihood of populations of Sungazers establishing within the development area, if kept natural, is Low.

Chamaesaura aenea (Coppery Grass Lizard) is categorised as near threatened on both an international and a regional scale. A population reduction of over 20% in the last 18 years (three generations) is inferred from the transformation of large parts of the Grassland Biome. They are threatened by transformation of land for crop farming and plantations, overgrazing by livestock, infrastructural development, frequent anthropogenic fires and use of pesticides. The likelihood of occurrence in the project area is rated as Moderate.

Amphibians

Based on the IUCN Red List Spatial Data (IUCN, 2017) and the AmphibianMap database provided by the Animal Demography Unit (ADU, 2017) twenty (16) amphibian species are expected to occur in the project area (Appendix 4).

One amphibian species of conservation concern could be present in the project area according to the above-mentioned sources, namely *Pyxicephalus adspersus* (Giant Bullfrog) (Table 14).

The Giant Bull Frog (*Pyxicephalus adspersus*) is a species of conservation concern that may possibly occur in the project area. The Giant Bull Frog is listed as near threatened on a regional scale. It is a species of drier savannahs. It is fossorial for most of the year, remaining buried in cocoons. They emerge at the start of the rains, and breed in shallow, temporary waters in pools, pans and ditches (IUCN, 2017). There appears to be moderate suitable habitat for this species in the project area and therefore the likelihood of occurrence is regarded as Moderate.

Table 14: List of herpetofaunal species of conservation concern that may occur in the project area as well as their global and regional conservation statuses (IUCN, 2017; SANBI, 2016)

Species	Common Name	Conservation Status		Likelihood of Occurrence
		Red Data	IUCN	
Amphibians				
Pyxicephalus adspersus	Giant Bullfrog	VU	VU	Moderate
Reptiles				
Smaug giganteus	Sungazer	NT	NT	Low
Chamaesaura aenea	Coppery Grass Lizard	NT	LC	Moderate

Fine Scale Vegetation Patterns

In this section, the different habitats and vegetation patterns observed within the study site (including the proposed power line servitude) are described.

As mentioned, the combination of releve (plot) and timed meander floristic sampling for conduction species biodiversity and assemblage analysis, is highly efficient, especially in terms of detecting SCC, AIPs and determining their density, distribution and associations/interactions with other flora.

In terms of releve sampling, the Zurich-Montpellier (Braun-Blanquet) school of total floristic compositions was followed. Total floristic coverage was sampled within 30 plots, which were randomly placed, but in a stratified manner within floristic uniform areas (pre-defined). Minimum plot sizes were determined, at site and was based on physiognomic-physiographic unit sampled. For dry and moist grassland, wetland, trampled and disturbed weed units plot sizes of 16m^2 were selected whist 25m^2 plot sizes were selected for the scrub communities, and 100m^2 plot sizes for the riparian and thicket units. These plot sizes are in accordance with the sizes recommended by Brown *et a*. (2013).

As these are field-based observations taken directly from the site, they are of greater reliability and pertinence than the results of the National Vegetation Map which is at a coarse scale and does not represent the detail of the site adequately. The habitat map derived for the study area (including the proposed development site) is provided in Figure 10.

Vegetation of the study area is historically consisted of Central Free State Grassland. At a finer scale four phytosociological studies of the Kroonstad area and surroundings, were conducted in the past and which has relevance to the project area:

» Kooij, M.S., Scheepers, J.C., Bredenkamp, G.J. and Theron, G.K. 1991. *The Vegetation of the Kroonstad Area, Orange Free State I: Vlei and Bottomland Communities*. S.Afr.J.Bot. **57(4).** Pg. 213-219.

» Kooij, M.S., Scheepers, J.C., Bredenkamp, G.J. and Theron, G.K. 1992. *The Vegetation of the Kroonstad Area: A Description of the Grassland Communities*. S.Afr.J.Bot. ***58(3).*** Pg. 155-164.
» Fuls, E.R., Bredenkamp, G.J. and Van Rooyen, N. 1992. The hydrophilic vegetation of the Vredefort-Kroonstad-Lindley-Heilbron Area, Northern Orange Free State Province. S.Afr.J.Bot. **58(4).** Pg. 231-235.
» Fuls, E.R., Bredenkamp, G.J. and Van Rooyen, N. 1992. Plant Communities of the Rocky Outcrops of the Northern Orange Free State South Africa. *Vegetatio*. **103.** Pg. 79-92.

According to these studies, the vegetation of the project area contains similarities to:

» Rocky dolerite outcrops:
  o *Diheteropogon amplectens – Aristida diffusa – Aristida canescens* Sub association.
» Riparian wetland:
  o *Acacia karroo – Celtis africana* Ravine Thornveld
» Grass Wetland:
  o *Echinocloa holubii – Cyperus longus* Wetland
» Shrubland/Thornveld:
  o *Acacia karroo – Melica decumbens* Bottomland Thornveld
  o *Acacia karroo – Eragrostis chloromelas* Upland Thornveld

At the time of the vegetation survey, the herbaceous as well as geophytic layer was well developed and as such the time of the survey is regarded optimal. However, it is highly possible that a few additional species, can be expected to emerge outside of the period within which the survey was conducted. This is confirmed by preliminary statistical analysis of the survey data:

Number of (indigenous) species observed:	149
Second-order jack-knife estimate:	167
Number of weeds and alien invasive species excluded from statistics:	40

The 207 species that could be expected to be present in the project area is only a rough estimate and has been used as a comparative tool to help assess the conservation value and sensitivities of habitats. A list of species that has been recorded in the wider area on the SANBI database is provided in Appendix 2.

Of the 189 species recoded within the project area, basal cover throughout the study area was largely dominated by grass species. A total of 52 grass species were recorded, although the bulk of the project area were largely dominated by only few of these species. The overall dominance of Increaser II, Climax and Sub-Climax species (28 species) are indicative of a heavy, long term grazing regime which as resulted in the decline of palatable decreaser species, and which has been replaced by less palatable, densely tufted grasses.

Forb species were also fairly abundant within the project area with 74 species recorded. Dwarf shrubs, tall shrubs and small trees, even though low in diversity, within the project area (dwarf shrubs: 8 species; shrubs: 8 species and small trees: 5 species), were also significantly present within the project area.

Of the 189 species recorded within the project area, none were SCC, however three provincially protected species were recorded namely; *Boophone disticha, Crinum bulbispermum* and *Olea europaea* subsp. *africana*. Only tree individuals of *O. europaea* was recorded within the project area, just above the sheet ledge to the west of the project site. *Boophone disticha* was mainly recorded along the upper eastern slope and the plateau, however *B. disticha* was sparsely scattered throughout this area, with a population size. *Crinum bulbispermum* was fairly regularly observed within the channels of the valley-bottom wetlands and the wetland areas fringing the channels, especially around the edges of the pools. The local population of *C. bulbispermum* will not be impacted by the proposed development as the wetland area, with which this species is associated with, will be avoided.

Fine Scale Vegetation Patterns (Habitats)

The project area can be described as a low lying, gentle undulating landscape with a mostly convex land shape (low hill), however along the eastern boundary the land shape becomes concave with the lower area or bottom land section containing a valley bottom wetland habitat which drains into a northern direction towards the Vals River. The average slope of the area is around 2.7% with an average elevation gain/loss of 18m. The following land unit were identified within the project area; low sheet and ledge outcrops (predominantly sandstone) along the eastern and western slopes and summit/plateau of the hill, dolerite outcrop to the south east and a bottomland/valley flat, predominantly along the eastern boundary. The soils of the project area tend to be predominantly shallow to moderately deep with the occasional deeper soil pocket. The bottomlands/valley flats are dominated by cay (vertic) and clay-loam soils which may overlay lithic material or hard rock. The dolerite outcrop is covered by a shallow soil layer which may be absent. The soil tends to be gritty, sandy loam with an abundance of surface rock, gravel and stones. The remaining portion of the project area is covered by a fairly shallow sandy loam to sandy clay loam layer (clay loam is also present in a few areas), overlying lithic material and hard rock. Surface rock and bedrock are typically present along the edge of the plateau/summit and upper slopes.

On the basis of the major (first-level) division obtained by TWINSPAN classification, the entire phytosociological table was divided into three smaller tables/clusters, one containing the releves/plots representing the moist bottomland habitats and associated vegetation types, those releves representing the shrub-grassland and their associated vegetation types and those releves associated with the highly degraded and transformed grassland.

The second division divided the bottomland habitats according to the prominence of woody species, and distinguished the woody riparian wetland from the grass and forb dominated wetland areas which was further divided (3rd division of bottomland habitats) along a moisture gradient differentiating between the communities associated with the different hydro-geomorphological zones. In terms of the upland shrub-grassland, three additional divisions were made; namely the vegetation cluster with strongly associated with the shrub, *Asparagus laricinus,* the vegetation cluster associated with the grass, *Aristida diffusa* and the vegetation cluster associated with severely degraded and .

According to associations/habitats, communities and sub-communities where identified within the project area.

» **Association 1**: Wetlands and associated riparian fringe

- Association 1 A: Grass and forb dominated wetland areas
  - Community 1.A.1: *Cyperus eragrostis – Marsilea macrocarpa* Permanent Inundated Channels
  - Community 1.A.2: *Paspalum diladatum – Persicaria decipeins* Seasonal Saturated Channels
  - Community 1.A.3: *Eragrostis planiculmis – Echinochloa holubii* Seasonal Saturated Wetland Terrace
  - Community 1A.4: *Eragrostis plana – Eragrostis chloromelas* Temporary Saturated Wetland Terrace
- Association 1 B: Riparian wetland
  - Community 1.B: *Searsia pyroides – Celtis africana* Riparian Woodland

» **Association 2**: Upland shrub-grassland

- Community 2.1: *Acacia karroo – Asparagus laricinus* Shrub Grassland on Low Lying Hills and Plains.
- Community 2.2: *Acacia karroo – Aristida diffusa* Shrub Grassland of Dolerite Outcrops.
- Community 2.3: *Helichrysum rugulosum – Digitaria eriantha* Secondary Grassland (Pasture)

» **Association 3**: Severely Degraded and Transformed Grassland

- Community 3: *Acacia karroo – Asparagus laricinus* Shrub Grassland on Low Lying Hills and Plains.

- Community 2.1: *Acacia karroo – Aristida diffusa* Shrub Grassland of Dolerite Outcrops.

A. Shrub Grassland on Low Lying Hills and Plains:

The majority of the project area's vegetation cover can be described as a low shrub grassland with a highly varying (height and density) woody component. The lower vegetative layer is also varying in terms of the grass – forb – dwarf shrub relationship. The woody component is dominated by *Acacia* (*Vachellia karroo*) and *Asparagus laricinus, although Gymnosporia heterophylla, Searsia lancea, S. pyroides and Diospyros lycioides* were also relatively frequently observed. The plateau, eastern slope and dolerite ridge tend to be more open with the woody coverage varying between 25-40%. The shrub layer is quite low and seldomly exceeds 4m. The western portion of the project area (gentle westerly slope) is much more densely covered by low growing shrubs with an average coverage of between 40% and 60% and with a maximum coverage of 70%. The lower strata are typically dominated by medium tall (1.3 – 1.5m) grass species such as *Eragrostis chloromelas, Themeda triandra, Eragrostis trichophora, E. obtusa*, and *Aristida congesta*. Other common grass species of the area includes; *Cynodon hirsutus, C. dactylon, Elionurus muticus, Panicum coloratum, Eragrostis lehmanniana* and *E. gummiflua, E. barbinodis, E. curvula, E. superba* and *Sporobolus ioclados*. Coverage of the grass layer may vary between 55 and 80%. The forb and dwarf shrub layer are also well represented within the area and is characterized by *Barleria obtusa, Pentzia globosa, Berkheya pinnatifida, Bidens pilosa, Monsonia burkeana, Achyranthes aspera, Tagetes minuta* and *Indigofera comosa*. Other common forbs and dwarf shrubs includes; *Crabbea acaulis, Geigeria aspera, Nidorella resedifolia, Tagetes minuta, Zinnia peruviana, Hermannia depressa, Hibiscus pusillus, Physalis viscosa, Lippia javanica, Delosperma floribundum, Kalanchoe rotundifolia, Portulaca oleraceae,* and *Felicia muricata.* No SCC were recorded within the area, however the provincially protected *Boophone disticha* and *Olea europaea* subsp. *africana* was recorded. In terms of weeds and invasive alien plants, *Bidens Pilosa, Tagetes minuta* and *Zinnia peruviana* were the most frequent recorded. The invasive alien succulent plant *Opuntia ficus-indica* was also frequently encountered. Other noteworthy invasive alien and weedy plants recorded includes; *Schkuhria pinnata, Physalis viscosa, Verbena aristigera, Opuntia humifusa* and *Portulaca oleraceae*.

As described above, this area has been subjected to a relative long term, heavy grazing regime and has resulted in the replacement and reduction in the coverage of palatable decreaser grass species, with less palatable Increaser II and II species and has allowed for the encroachment of woody (*Acacia karroo* and especially *Asparagus laricinus*) and karroid species (*Pentzia globosa, Felicia muricata* and *Indigofera comosa*).

Bredenkamp et al. (1991) states that continued grazing and harvester termite infestation, within the north eastern Free State Province results in the dominance shift, successively from *Themeda triandra* to *Panicum coloratum* and to *Eragrostis chloromelas* and then finally

to *Sporobolus ioclados var. usitatus*. They furthermore state that these stages in the retrogression of originally good stands of *Themeda* veld are not, at first, accompanied by marked reduction in basal cover as prominence is assumed by one grass at the expense of another. However, the productivity and palatability of the pasture drops steadily with retrogression. Despite its high basal cover and palatability, *Panicum coloratum* produces a smaller mass of herbage than *Themeda triandra*. *Eragrostis chloromelas* produce relatively small quantities of forage of indifferent to poor quality. *Sporobolus ioclados var. usitatus* may have a high basal cover, but it produces little herbage. Together with species of *Cynodon* and *Aristida*, dominance by *Sporobolus ioclados* var. *usitatus* represents the last perennial grass stage before the veld commences to break down to a critical level of denudation and degradation. This critical threshold level is heralded by the incursion of short-lived grasses, karoo bushes and weeds, such as *Aristida* species, *Chloris virgata, Tragus racemosus, Pentzia globosa, Chrysocoma ciliata. Chamaesyces inequilatera* and *Nidorella resedifolia*. If site degradation continues beyond this critical threshold, it may be extremely difficult or impossible to reverse the trend, except by applying costly measures. According to the above statement, the project area is in moderately to advanced stage of retrogression (disturbance), however a moderately stable vegetation cover still persists allowing services and functions to continue albeit in a modified and somewhat restricted manner.

B. Shrub Grassland on old cultivated lands (Secondary Grassland):

To the east, large areas have been transformed in the past for cultivation purposes. Approximately 15% of the project area appears to be historically cultivated (> 30 years), and appears to have been re-established by grasses and low shrubs (plagioclimax grassland), with the only evidence, from available spatial data, being feint ploughing contour lines. These areas are also now being utilised as grazing. The vegetation cover can be described as a medium tall grassland with an abundance of forbs. Shrubs in the form of *Acacia* (*Vachellia karroo*) and *Asparagus laricinus,* and *Gymnosporia heterophylla* are also relative prominent within this area, however these shrubs tend to be relative low growing (2.5 – 3m) and sparsely distributed through this secondary grassland (total coverage of 15 – 20%). The lower strata are typically dominated by medium tall (1.3 – 1.5m) grasses and a fair abundance of forbs. Diagnostic species include: *Helechrysum rugulosum, Digitaria eriantha, Eragrostis chloromelas, Eragrostis curvula*. Dominant species include: *Verbena officinalis, Conyza bonariensis, Berkheya onopordifolia, Seriphium plumosum, Felicia muricata, Cynodon dactylon, Eragrostis lehmanniana, Panicum coloratum, Helichrysum dregeanum.* No SCC were recorded within the area, however the provincially protected *Boophone disticha* was recorded. In terms of weeds and invasive alien plants, *Bidens Pilosa, Tagetes minuta* and *Zinnia peruviana* were the most frequent recorded. The invasive alien succulent plant *Opuntia ficus-indica* was also frequently encountered. Other noteworthy invasive alien and weedy plants recorded includes; *Schkuhria pinnata, Physalis viscosa, Verbena aristigera* and *Portulaca oleraceae*.

C. Shrub Grassland on Dolerite Outcrops:

Towards the south eastern corner, a relative low dolerite outcrop persists. Soils tend to be very sallow and are mostly of a sandy loam to sandy clay loam texture with some gravel and overlies hard rock and lithic material. An abundance of surface rocks and boulders cover the entire area. This outcrop is covered by a dry open grassland. The woody component is still quite prominent and is characterized by low growing trees and shrubs covering between 15 and 30% of the total surface area. The dominant tree/shrub species is *Acacia karroo*. Other noteworthy trees/shrubs are *Gymnosporia heterophylla* and *Searsia pyroides.* As in the case of the previous described habitat/vegetation assemblage, the grass layer of the rocky outcrop shows signs of moderate degradation (overgrazing) and is dominated by wiry, tufted, medium to short (0.7m) grasses such as *Aristida congesta, A diffusa, Eragrostis lehmanniana, E. chloromelas* and *E. superba*. Other graminoids frequently observed within this habitat was *Eragrostis racemosa, E. curvula, Heteropogon contortus, Panicum coloratum, Themeda triandra, Enneapogon desvauxii* and *Triraphis andropogonoides*. The grass layer is the dominant layer of this habitat and may cover between 70 and 80% of this habitat, of which the combination of *A. diffusa, E. lehmanniana*, *E. superba and A. congesta* make up between 55 and 70%. Even though this habitat type is characterized by numerous dwarf shrubs and forbs, it is especially weed and alien plants, such as *Bidens pilosa, Zinnia peruviana* and *Helichrysum rugulosum*, that are prominent. The forb layer rarely exceeds 30% and is typically between 15 and 20%. Other noteworthy forbs and dwarf shrubs include, *Pentzia incana, Achyranthes aspera, Monsonia burkeana, Corchorus confuses, Hermannia depressa, Hibiscus aethiopicus, H. pusillus, Felicia muricata* and *Indigofera comosa*.

No SCC were recorded within the area, however the provincially protected *Orbea lutea* was recorded. In terms of weeds and invasive alien plants, *Bidens pilosa, Tagetes minuta, Schkuhria pinnata, Portulaca oleraceae* and *Zinnia peruviana* were the most frequent recorded.

D. Highly Transformed and Disturbed Grassland:

This vegetation unit is associated with fire breaks, access roads, kraals, watering and feeding points for cattle and areas where the vegetation has been recently disturbed. This unit comprise of a mixture of short grasses and forb, of which most are regarded as weeds such as *Cynodon dactylon, Urochloa panicoides, Aristida congesta, Eragrostis barbinodis, Eragrostis lehmannana, Verbena aristigera, Conyza bonariensis, Nidorela resedifolia, Schkuhria pinnata, Tagetes minuta, Bidens pilosa* and *Physalis viscosa.* Other species frequently observed within this grassland were; Cotula podocephala, Corchorus confuses, *Atriplex semibacata, Felicia muricata, Indgofera comosa,* I*. daleoides, Eragrostis chloromelas, E. superba,* and *E. trichophora*

No SCC were recorded within the area.

E. Wetlands

The valley-bottom areas to the east contains natural wetland features fed predominantly by overland flow (surface flow) from the surrounding hills and slopes. These water inputs are then drained, predominantly as contained surface flow along a primary channel, in a northern direction towards the Vals River. These channelled valley bottom wetlands are of a seasonal to temporary nature (saturation), however a few patches of permanent saturated area exist and is mainly associated with the instream dams and other micro-depression found along the channel. These micro-depressions and the dam features are typically, seasonally inundated, however the larger dams may be inundated for extended periods of time. The soils of these wetlands tend to be moderately deep, dark grey to dark grey brown and are typically either clayey (vertic soils) or clay-loam (duplex soils). Shallower portions, typically overly lithic material. This wetland features are relative heterogenous and is a result of the varying saturation zones and the varying geomorphology of the wetland. This has resulted in a mosaic pattern expressed by the vegetation communities.

No SCC were observed within the wetland habitat, however Crinum bulbispermum, a geophyte provincially protected, has been recorded at relative frequent intervals along the channels of the wetland features.

Both of these wetlands have undergone some form of modification with the larger of the two wetlands being the most significantly impacted. Modifications to the wetlands include:

<u>Larger Valley-Bottom Wetland Feature</u>

» The hydrological character has been moderately impacted mainly in terms of water distribution and retention.
    - The most significant factor contributing to these modifications/alterations are the modification to the existing channel.
    - Especially the channel located north of the proposed development area has been significantly modified through erosion, which has widened and deepened the channel within this section. This has resulted in more confined flows and a reduction in lateral and overbank flow into the adjacent habitat areas.
    - Within the development area erosion and trampling by livestock has resulted in localised deepening of the channel, creating pools which will retain surface water for longer periods of time and reduce potential overbank and lateral flow into the adjacent portions of the wetland (as a result of the lowering of the channel below the adjacent wetland areas.
» Numerous small to medium-small gravel dams have been constructed within the watercourse impacting/impeding the natural flow of water along the wetland.

- The R34 crossing has also slightly impacted local water distribution.
- Hardened surfaces within the catchment is regarded is relative low (R34 and a few gravel roads) and along with the fact that a fairly dense vegetation is still present within the catchment, means that water inputs and flooding patterns have likely not been significantly modified (although the elevation of the R34 may impact surface flow somewhat at a local scale).

» The effects of instream dam construction, channel erosion (widening and deepening) as well as infilling has had a significant impact on the geomorphological integrity of the wetland and has resulted in moderate modification to the natural geomorphology of the channelled valley bottom wetland.

» The integrity of the vegetation structure has been moderately impacted.

- Grazing, trampling and erosion of the channel resulted in a general reduction in the vegetation coverage. Apart from a reduction in coverage, an alteration to the species composition has also occurred, to some extent, with micro-depression found along the channel (a result of trampling and erosion) now comprising of floating and submerged forbs and some sedges, the remaining channel is now characterized mainly by low growing grasses and a few sedges as well as some bare patches. Historically, these channels were likely covered by a much denser and taller sedge and grass cover.
- Natural vegetation within portions of the seasonal and temporary saturated zones have been completely taken over by the alien plant *Paspalum dilatatum*.
- The invasive alien plant (IAP); *Verbena officinalis* is a common feature within the temporary saturated zone.
- Other IAPs recorded within the wetland include; *Cirsium vulgare; Xantium spinosum, Xantium strumarium* and *Verbena bonariensis*.
- Furthermore, *Asparagus laricinus*, and to a lesser extent *Acacia (Vachellia) karroo*, have become slightly encroaching within the temporary saturated zone (some locations).

<u>Small Valley-Bottom Wetland Feature</u>

» The hydrological character has been slightly to moderately impacted, also mainly with regards to water distribution and retention.

- Similarly, to CVB wetland 1 the most significant factor contributing to these modifications/alterations are the modification to the existing channel which has been exposed to trampling and erosion, deepening and slightly widening some portions of the channel. This in turn has resulted in more confined flows and a reduction in lateral and overbank flow into the adjacent habitat areas.
- Modifications/alterations within the catchment is minimal, with some hardened surfaces, and as such water input and flooding peaks has mainly remained natural.

» The effects of instream channel erosion (widening and deepening) and trampling have resulted in the moderate modification of the natural geomorphological integrity of the wetland.

» Modifications to the vegetation structure and composition are probably the most significant impact to this wetland feature and is mainly as a result of the modification of the geomorphology (soil disturbance through erosion and trampling).
  - Grazing, trampling and erosion of the channel has resulted in a general reduction in vegetation coverage. Apart from a reduction in coverage, an alteration to the species composition has also occurred, to some extent, with micro-depression found along the channel (a result of trampling and erosion) now comprising of floating and submerged forbs and some sedges, the remaining channel is now characterized mainly by low growing grasses and a few sedges as well as some bare patches. Historically, these channels were likely covered by a much denser and taller sedge and grass cover.
  - The alien plant, *P. dilatatum* has established itself, especially within the seasonal and temporary saturated portion of the wetland, forming local dense stands.
  - IAPs recorded within the wetland include; *Cirsium vulgare; Xantium spinosum, Xantium strumarium* and *Verbena bonariensis, V. officinalis*.
  - Furthermore, *Asparagus laricinus*, and *Acacia (Vachellia) karroo*, have become slightly encroaching in temporary saturated zone (some locations).

i. Permanent saturated zones (Channels):

This hydro-geomorphological zone occurs as small, discontinuous patches, along the channel of the CVB wetlands where they form where there is a local drop in elevation (micro-depressions) along the channel, mainly created by a form of disturbance such as trampling, erosion and dam construction. These areas tend to collect and store surface water for moderately long periods of time (few months during the wet season). Soils tend to be dark to light grey clay to clay loam. The vegetation of these areas tends to be sparse and poor in diversity dominated by floating and submerged hydrophytic forbs and graminoids (Forbs: 15 – 30%; Grasses: 40 – 55% and Sedges: 10 – 20%) such as *Paspalum distichum, Persicaria decipiens* and *Schoenoplectus muricinux*. Other plants species frequently observed included; *Marsilea macrocarpa, Cyperus Eragrostis, Falkia oblonga* and *Leersia hexandra*.

ii. Seasonal saturated zone (Channels):

This hydro-geomorphological zone occurs as small, discontinuous patches, along the channel of the CVB wetlands where they form where there is a local drop in elevation (micro-depressions) along the channel, mainly created by a form of disturbance such as trampling, erosion and dam construction. These areas tend to collect and store surface water for moderately long periods of time (few months during the wet season). Soils

tend to be dark to light grey clay to clay loam. The vegetation of these areas tends to be sparse and poor in diversity dominated by floating and submerged hydrophytic forbs and graminoids (Forbs: 15 – 30%; Grasses: 40 – 55% and Sedges: 10 – 20%) such as *Paspalum distichum, Persicaria decipiens* and *Schoenoplectus muricinux*. Other plants species frequently observed included; *Marsilea macrocarpa, Cyperus Eragrostis, Falkia oblonga* and *Leersia hexandra*.

iii. Seasonal saturated zone (terrace):

Seasonal saturated zones fringing the channels tend to be narrow, however favourable underlying geology and local topography may result in larger seasonal saturated zone as was found to the north of the project area (near the north-eastern boundary of the project area) where the wetland had a fairly broad seasonal zone. The smaller CVB wetland contains a narrow seasonal zone throughout its extent. This zone is dominated by a tall, dense wet grassland (80-90%) on grey to dark grey brown clay to clay-loam soils, and is characterised by *Eragrostis planiculmis, Paspalum dilatatum, Setaria nigrirostris, Eragrostis micrantha* and *Echinochloa holubii*. Other key species include; *Berkheya radula, Haplocarpha scaposa, Verbena bonariensis, Cyperus longus, Setaria pallide-fusca* and *Sporobolus africanus*

iv. Temporary saturated zone (terrace):

The temporary saturated zone covers the largest extent of these wetland features and is characterized by a medium to medium-short mixed moisture grassland comprising a mixture of facultative wetland and facultative upland species. The grass component forms the dominant cover (70-90%). The highest diversity of plant species was recorded within this area with 53 species observed within this zone. This higher plant species diversity is a result of the transitional location of this zone resulting elements of both the wetland and terrestrial being present. Where the seasonal zone transitions into the temporary zone the grass layer tends to be taller with similarities with the seasonal zone and include species such as; *Echinochloa holubii, Eragrostis micrantha, Eragrostis plans, Paspalum dilatatum* and *Setaria nigririostris*. As one moves to the outer edge the grass cover becomes a bit shorter and comprise a mixture of wetland and terrestrial plants such as *Themeda triandra, Eragrostis plana, Cynodon dactylon, Eragrostis chloromelas, E. gummiflua, Panicum coloratum, Sporobolus africanus* and *Eragrostis micrantha*. The forb layer also slightly increases in coverage towards the outer boundary and is characterized with *Verbena officinalis, Berkheya radula, Helichrysum aureonitens, Tagetes minuta, Monsonia burkeana*, *Buchnera reducta* and *Hermannia depressa*. Shrubs such as *Lycium laricinus* and *Acacia karroo*, are also scattered through sections of this zone and may in, some isolated localities become slightly encroaching.

v. Riparian Woodland:

Elevated (high terrace areas with a convex shape) areas along the channels and outer fringes of the wetland boundaries, where saturation is very seldom. However, saturation of soils occurs sufficient enough for the display of wetland indicators. Soils tend to be moderately deep, dark clay (vertic) to loam clay with fairly high concentrations of organic material and typically overly lithic material. The riparian habitat does not form a continuous plant community but display a patchy distribution, varying greatly in size, height, and vegetation structure. The tree and tall shrub layer are the dominant canopy cover (70 – 95%), whist the forb/herb layer forms the dominant ground cover (up to 40%). Low straggling and climbing shrubs forbs are also a prominent feature within these areas and may cover up to 40% of a plant releve within this habitat. Where the tree/tall shrub canopy becomes more open, grass species becomes a more significant feature. The tree/tall shrub layer is dominated by *Acacia karroo, Diospyros lycioides, Ziziphus mucronata, Asparagus laricinus* and *Searsia pyrioides*, whist the forb layer is characterized by *Achyranthes aspera, Bidens Pilosa, Tagetes minuta, Pavonia senegalensis*, and *Sida dregei.* Common straggling and climbing forbs and shrubs include; *Pentharrhinum insipidum* and *Asparagus cooperi*. Occasionally the tree layer thins out and these areas are then typically dominated by *Searsia pyrioides* and *Asparagus laricinus* and to a lesser extent shrubby growth forms of *Acacia karroo*. Within these areas the grass coverage increases with the lower plant strata characterized by, *Cynodon dactylon, Themeda triandra, Sporobolus fimbriatus, Setaria verticillata, Paspalum dilatatum* and *Eragrostis plana*. Other common species recorded within this habitat includes: *Sida cordifolia, Solanum lichtensteinii, Verbena aristigera, Ehretia rigida, Gymnosporia heterophylla* and *Celtis africana.*

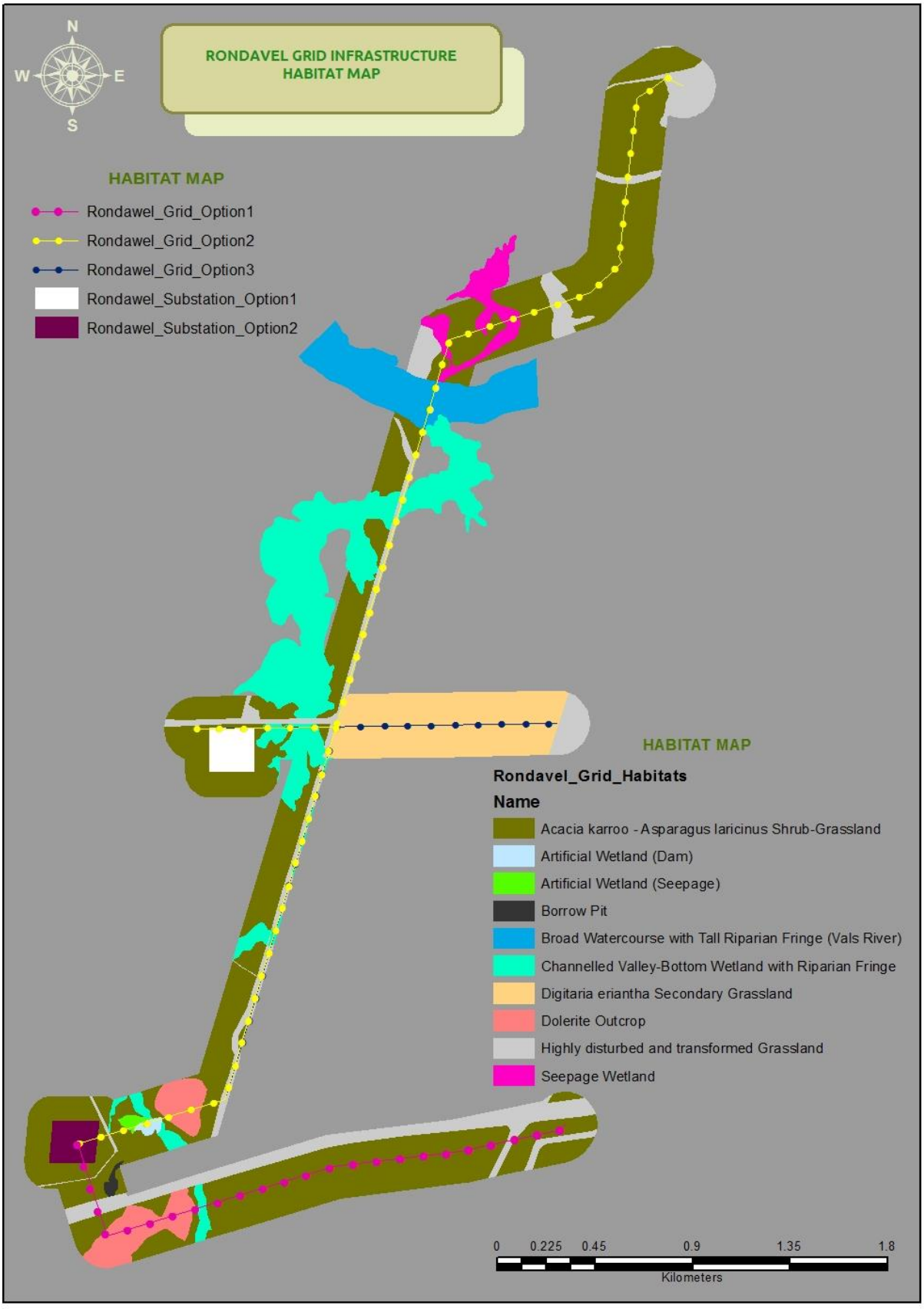

Figure 10: Delineated habitat units.

Plant Species of Conservation Concern (SCC)

During the survey no plant SCC was recorded. However, four provincially protected species were recorded, as listed within the Free State Nature Conservation Bill (2007), namely; *Boophone disticha, Crinum bulbispermum, Orbea lutea* and *Olea europaea subsp. africana.* It is recommended that a pre-construction walk-through is done by a registered botanical specialist, prior to the start of the construction phase, during which, these protected plants are identified and mapped. This information should then be used to apply for the necessary floral permits (from DESTEA) in order to gain permission for the removal, relocation, disturbance or destruction of these species

Mammals

This section represents the results from the field survey conducted from the 18th – 20th of March 2021 and the 10th of April 2021 (end of wet season).

Overall, mammal diversity in the project area was moderate, with eleven (18) mammal species being physically recorded based on direct observations, camera trap photographs, Sherman traps, and/or the presence of visual tracks & signs. Of these 18 species four species are have been introduced into the area (highlighted in blue below). This data represent strong evidence as to a moderate diverse and functional mammal assemblage populating the study area. No species of SCC were observed in the project area, but due to the habitat type it is very likely that other SCC's could occur here. Two provincially protected species were observed namely Aardwolf (*Proteles cristatus*) and Aardvark (*Orycteropus afer*).

Species	Common Name	Conservation Status	
		Regional (SANBI, 2016)	IUCN (2017)
Lepus saxatilis	Scrub Hare	LC	LC
Hystrix africaeaustralis	Cape Porcupine	LC	LC
Cryptomys hottentotus	African Mole-rat	LC	LC
Proteles cristatus	Aardwolf	LC	LC
Rhabdomys pumilio	Four-Striped Grass Mouse	LC	LC
Otomys angoniensis	Angoni Vlei Rat	LC	LC
Mastomys coucha	Southern Multimammate Mouse	LC	LC
Tiny musk shrew	*Crocidura fuscomurina*	LC	LC
Xerus inauris	South African Ground Squirrel	LC	LC
Canis mesomelas	Black-back Jacal	LC	LC
Cynictis penicillata	Yellow Mongoose	LC	LC
Sylvicapra grimmia	Common Duiker	LC	LC
Raphicerus campestris	Steenbok	LC	LC
Phacochoerus africanus	Warthog	LC	LC

Orycteropus afer	Aardvark	LC	LC
Equus quagga	Plains Zebra	LC	LC
Tragelaphus strepsiceros	Greater Kudu	LC	LC
Kobus ellipsiprymnus	Waterbuck	LC	LC
Tragelaphus angasii	Nyala	LC	LC

As mentioned in the methods section above, extensive wet season trapping took place in along three transects which traversed all of the habitats present at site with the rank moist grass vegetation associated with the wetlands deemed as the most preferable habitat for small mammals. This was indeed the case with regular trapping of rodents, especially along the edges of the wetland habitats, extending into the dry grassland (normally near low shrubs) fringing these wetlands. Both *Mastomys coucha* (Southern Multimammate Mouse) and *Rhabdomys pumilio* (Four Striped-Grass Mouse) was fairly regularly trapped within these areas.

Mammal Species of Conservation Concern (SCC)

As mentioned, no mammal SCC was recorded. However, due to preferential habitat availability, there is a likelihood for some SCC to inhabit the development site, including South African Hedgehog – *Atelerix frontalis* (Near Threatened), Serval – *Leptailurus serval* (Near Threatened).

Mammal Habitat Analysis

A. *Acacia karoo* - Asparagus laricinus Shrub-Grassland

These habitats provide relative good refugia and forage for small mammal species, which in turn form the basis for the trophic food chain. These grasslands are also regarded as important breeding and foraging sites for mammal species. The entire development footprint will be located within this habitat. The grasses in this habitat is moderately dense and of fair forage value. However, some encroaching of shrubs and small trees have had an impact on the total grass coverage. Positive effects are from moderate-high structural complexity and fairly strong foraging potential and overall, the species diversity for this area was moderate-low, with species from most trophic levels present. Overall diversity, connectivity and sensitivity of these areas can be regarded as Moderate.

Species recorded within this area includes:

- Large and Meso Carnivores: Aardwolf, Black-back jackal
- Small Carnivores: Yellow mongoose
- Ungulates: Steenbok, Warthog, Plains Zebra, Waterbuck, Greater kudu
- Fossorial Mammals: African mole-rat
- Small Mammals: Cape porcupine, Scrub hare, Four-striped grass mouse

» Medium Sized Mammals: Aardvark

B. Highly Disturbed/Transformed Grassland

As discussed in the botanical section, this habitat type represents fire breaks, farm tracks access roads and severely trampled areas. The vegetation cover within these areas are either sparse, or frequently mowed, removed. The soils within these areas are also usually hard and compacted. These hard and compacted areas, with a sparse vegetation cover is a preferred habitat for small borrowing mammals such as the South African Ground Squirrel, White-tailed Mongoose and Suids. The almost completely transformed habitat also may provide temporary foraging habitat for meso and small carnivores due to the presence of rodents and other small to medium sized mammals. Larger mammals typically use these areas as routes to and from foraging areas and they seldomly inhabit these areas on a permanent basis. The overall diversity, connectivity and sensitivity of these areas were Low

Species recorded within this area includes:

» Large and Meso Carnivores: Black-back jackal
» Small Carnivores: Yellow mongoose
» Ungulates: Steenbok, Warthog, Plains Zebra, Waterbuck, Greater kudu
» Fossorial Mammals: African mole-rat
» Small Mammals: Scrub hare

C. Dolerite Outcrop

These habitat shows excellent potential for mammal species. Such rocky outcrops are mixed with rocky refugia (which provide structural complexity) to provide a moderately sensitive habitat, especially for small mammals. Species diversity within the rocky grasslands of the project area where however very low and it must be reiterated that the poor and unusual poor Sherman trapping has deprived the habitat of its true potential total diversity. The rock areas also provided excellent refugia for larger species (especially hyrax and porcupines and meso-predators such as black-backed jackal. The associated grasslands surrounding rock refugia provided cover and foraging habitat for potential herbivores such as rabbits, steenbok and duikers. The overall diversity, sensitivity and connectivity to other habitats is considered to be Moderate.

Species recorded within this area includes:

» Large and Meso Carnivores: Black-back jackal
» Ungulates: Steenbok
» Fossorial Mammals: African mole-rat
» Small Mammals: Scrub hare

D. Wetlands with riparian fringes

Wetlands occur naturally or have been somewhat modified throughout the study area and support surrounding agricultural practices. These wetlands along with their vegetation are extremely heterogenous and provides highly structural complexity and breeding/foraging habitats for various mammal species. These wetland features furthermore contribute to habitat heterogeneity within the area and as such increase habitat and niche diversity within the larger area. The highest diversity of smaller mammals where recorded within the temporary and seasonal saturated grassland. These smaller mammal species, e.g. rodents, for the basis of the trophic food chain and sustain the local faunal meso-predators as well as raptors. There was a clear decrease in trapping success (Sherman traps) as one move further from the wetland habitats. Furthermore, these wetland habitats can be regarded as potentially important corridors connecting the Vals River with the higher lying grassland habitats. The overall diversity, connectivity and sensitivity of these areas were Moderate to High

Species recorded within this area includes:

- Large and Meso Carnivores: Black-back jackal
- Small Carnivores: Yellow mongoose
- Ungulates: Steenbok, Warthog, Plains Zebra, Waterbuck, Greater kudu
- Small Mammals: Cape porcupine, Four-striped grass mouse, Tiny musk shrew, Angoni vlei rat and Southern multimammate mouse
- Medium Sized Mammals: Aardvark

Herpetofauna

Herpetofauna diversity was considered to be moderate-low with three (3) reptile species and four (4) amphibian species being observed or recorded in the development site. No species of SCC were observed in the project area.

Species	Common Name	Conservation Status	
		Regional (SANBI, 2016)	IUCN (2017)
Acontias gracilicauda	Thin-tailed Legless Skink	LC	LC
Afroablepharus wahlbergii	Walhberg's Snake-eyed Skink	LC	LC
Leptotyphlops scutifrons	Peters' Thread Snake	LC	LC
Cacosternum boettgeri	Boettger's Caco	LC	LC
Semnodactylus wealii	Rattling Frog	LC	LC
Xenopus laevis	Common platanna	LC	LC
Tomopterna natalensis	Natal Sand Frog	LC	LC

8. COMBINED HABITAT SENSITIVITY

All Wetland and Riparian Features High Sensitivity and No-Go Area

Conservation status	**High**
	» Mostly natural moist grassland.
	» Provide valuable ecosystem functions and services.
	» Ecological Support Area
	» FS DTEEA Wetland Policy (Now DESTEA):
	  ○ No net loss of wetlands and functioning
	» No Plant or Animal SCC
	  ○ However, habitat suitability exists for some SCC and the following SCC have a high likelihood of occurrence:
	  ▪ Giant Bullfrog (Pyxicephalus adspersus): Near Threatened
	  ▪ Serval (*Leptailurus serval*): Near Threatened
	  ▪ South African hedgehog (*Atelerix frontalis*): Near Threatened.
	» Provincially protected flora:
	  ○ *Crinum bulbispermum*
	» Endemic Plants & Animals:
	  ○ Rattling frog *(Semnodactylus weallii),* Thin-tailed Legless Skink *(Acocantias gracilicauda)*

Ecosystem function	» Vegetation as grazing and stabilisation of soils, » Accumulate and slows down (seasonal and temporary saturated terrace) runoff from higher lying areas, » Maximises infiltration of runoff into soils and filtering of runoff before it seeps further into lower-lying river systems, » High importance in providing biodiversity maintenance » High importance in terms of water quality enhancement services. Water quality enhancement and maintenance are vital for functionality and services provided by important downstream ecosystems. » Moderate to High sensitivity to external impacts. » Valuable corridor for movement (fauna and likely avifauna) as well as hydrological connectivity with important lower lying aquatic, other wetland ecosystems as well as with surrounding terrestrial habitats.
Stability	» High where the vegetation layer is dense, » Medium to low if soils become bare » Moderate to High sensitivity to external impacts.
Reversibility of degradation	» Habitat will be difficult to recreate after significant modification, rehabilitation of vegetation and ecosystem functionality after disturbance will be problematic and slow
Rating	» ***High sensitivity (No-Go Area)***

General Development Recommendations:

- The recommended buffers (30m) are relevant for all activities pertaining to the development apart from the placement of pylons and single-track access road to the pylon locations, which is allowed within the recommended buffer areas. The location of the on-site substation, laydown areas, storage areas, refuelling areas, construction camps etc. are not allowed within the recommended buffer areas. Where pylons can be placed outside of the buffer areas, whilst still being capable of spanning the wetland features, this should rather be considered, than placing pylons within the buffer areas. Thus, in terms of No-Go Zones the buffer areas, as mentioned, should be regarded as such for all activities apart from the placement of the pylons and access to the pylon locations.
- Furthermore, the wetland features themselves should be regarded as No-Go areas for all activities, apart from the spanning of these features where avoidance is not possible. Only existing road crossings should be used.
- Monitoring of erosion and invasive alien plants should occur on a regular basis during the construction phase and should be carried out throughout the operational phase, where such features are observed swift actions should be taken in order to remediate these impacts in order to avoid the potential spread of erosion into the wetland areas as well as the establishment of invasive alien plants.

Dolerite Outcrop

Conservation status	**Medium**
	» Mostly natural, dry shrubby grassland.
	» Provide valuable ecosystem functions and services.
	» Ecological Support Area
	» Fairly unique and isolated habitat:
	  ○ Provide structural complexity (rocky refugia)
	» Contribute to habitat and niche diversity at a local scale
	» No Plant or Animal SCC
	  ○ However, habitat suitability exists for some SCC and the following SCC have a high likelihood of occurrence:
	  ▪ South African hedgehog (*Atelerix frontalis*): Near Threatened.
	» Provincially protected flora:
	  ○ *Orbea lutea subsp. lutea*
	  ○ *Boophone disticha*

Ecosystem function	» Contribute to habitat and niche diversity (local scale) and the maintenance thereof
	» Rocky refugia for habitat sensitive fauna:
	» Stable Vegetation cover for:
	  ○ Grazing;
	  ○ Maintenance of pollinator populations,
	  ○ Soil conservation and stabilisation,
	  ○ Accumulation and slowing down of runoff;

	○ Maximising of infiltration of runoff into soils ○ Filtering of runoff; ○ Buffering for lower lying valley-bottom wetlands against potential disturbances and thus vital for the protection of these sensitive habitats against deterioration. » High sensitivity to external impacts.
Stability	» High if habitat is kept intact ○ Clearing and monitoring of weeds and invasive species. ○ Erosion control
Reversibility of degradation	» Limited possibility, will require intervention, clearing of invasives needed to improve ecosystem functionality » Much of the original species diversity may be lost if original vegetation is significantly impacted
Rating	» ***Medium Sensitivity***

General Development Recommendations:

- » Development within these habitats are acceptable.
- » To prevent the onset of accelerated erosion, it is recommended that vegetation clearing be limited to clearing high shrubs, all invasive trees and other alien invasives. Grading should only be done where absolutely necessary and to mitigate existing erosion channels. If extensive grading will become necessary, it will be advisable to create contour buffer strips to slow down runoff and prevent erosion, which could develop into gully erosion damaging the development in the long run as well.
- » All indigenous shrubs that will be cleared should be shredded and added to the soil as mulch.
- » Alien species must be removed entirely from site and not used as mulch to prevent the spread of regenerative material.

Acacia karroo - Asparagus laricinus Shrub-Grassland

Conservation status	**Medium** » Moderately degraded grassland ○ Fairly advanced in terms of retrogression of indigenous grass species. ○ Encroachment of especially *Asaparagus laricinus* and to a lesser extent *Acacia karroo*. » Moderate invasion of AIPs: ○ *Opuntia ficus-indica* ○ *Opuntia humifusa* » However still capable of providing ecosystem functions and services. » Ecological Support Area

	» Rocky areas: provide structural complexity (rocky refugia) » No Plant or Animal SCC o However, habitat suitability exists for some SCC and the following SCC have a high likelihood of occurrence: ▪ South African hedgehog (*Atelerix frontalis*): Near Threatened. ▪ Serval (*Leptailurus serval*): Near Threatened » Provincially protected flora: o *Boophone disticha* o *Olea europaea susp. africana* » Provincially protected fauna: o Aardvark *(Orycteropus afer)* o Aardwolf *(Proteles cristatus),* o Golden starbust baboon spider *(Harpactira hamiltoni)* » Endemic fauna and flora: o Golden starbust baboon spider *(Harpactira hamiltoni)* o Skaapvygie *(Delospema floribundum)*
Ecosystem function	» Stable Vegetation cover for: o Grazing; o Maintenance of pollinator populations, o Soil conservation and stabilisation, o Accumulation and slowing down of runoff; o Maximising of infiltration of runoff into soils o Filtering of runoff; o Buffering for lower lying valley-bottom wetlands against potential disturbances and thus vital for the protection of these sensitive habitats against deterioration. » Moderate sensitivity to external impacts.
Stability	» Medium to high if habitat is kept intact o Clearing and monitoring of weeds and invasive species will be necessary. o Monitoring and partial clearing of encroaching indigenous woody plants.
Reversibility of degradation	» Habitat will be difficult to recreate after significant modification, » Rehabilitation of vegetation and ecosystem functionality after disturbance will be problematic and slow o Clearing of invasives is needed to improve ecosystem functionality » Management and partial clearing of encroaching indigenous woody plants
Rating	» ***Medium Sensitivity***

General Development Recommendations:

» Development within these habitats are acceptable.

» To prevent the onset of accelerated erosion, it is recommended that vegetation clearing be limited to clearing high shrubs, all invasive trees and other alien

invasives. Grading should only be done where absolutely necessary and to mitigate existing erosion channels. If extensive grading will become necessary, it will be advisable to create contour buffer strips to slow down runoff and prevent erosion, which could develop into gully erosion damaging the development in the long run as well.

» All indigenous shrubs that will be cleared should be shredded and added to the soil as mulch.
» Alien species must be removed entirely from site and not used as mulch to prevent the spread of regenerative material.

Acacia karroo – Asparagus laricinus Shrub-Grassland

Conservation status	**Low** » Re-established/re-seeded grassland on historically cultivated areas (Secondary grassland) » Low invasion of AIPs: o *Opuntia ficus-indica* » However some ecosystem functions and services have returned. » Ecological Support Area » No Plant or Animal SCC o However, habitat suitability exists for some SCC and the following SCC have a high likelihood of occurrence: ▪ South African hedgehog (*Atelerix frontalis*): Near Threatened. ▪ Serval (*Leptailurus serval*): Near Threatened » Provincially protected flora: o *Boophone disticha* » Provincially protected fauna: o Aardvark *(Orycteropus afer)* o Aardwolf *(Proteles cristatus),* » Endemic fauna and flora: o Skaapvygie *(Delospema floribundum)*
Ecosystem function	» Stable Vegetation cover for: o Grazing; o Maintenance of pollinator populations, o Soil conservation and stabilisation, o Accumulation and slowing down of runoff; o Maximising of infiltration of runoff into soils o Filtering of runoff; o Buffering for lower lying valley-bottom wetlands against potential disturbances and thus vital for the protection of these sensitive habitats against deterioration. » Moderate sensitivity to external impacts.
Stability	» Medium to high if habitat is kept intact o Clearing and monitoring of weeds and invasive species will be necessary.

	○ Erosion control will be important
Reversibility of degradation	» Possible, will require intervention such as erosion control and over sowing, » Clearing of invasives is needed to improve ecosystem functionality
Rating	» ***Low Sensitivity***

General Development Recommendations:

- » Development within these habitats are acceptable.
- » To prevent the onset of accelerated erosion, it is recommended that vegetation clearing be limited to clearing high shrubs, all invasive trees and other alien invasives. Grading should only be done where absolutely necessary and to mitigate existing erosion channels. If extensive grading will become necessary, it will be advisable to create contour buffer strips to slow down runoff and prevent erosion, which could develop into gully erosion damaging the development in the long run as well.
- » All indigenous shrubs that will be cleared should be shredded and added to the soil as mulch.
- » Alien species must be removed entirely from site and not used as mulch to prevent the spread of regenerative material.

Severely Degraded and Transformed Grassland

Conservation status	**LOW** » Severely degraded and transformed grassland associated with access roads, fire breaks and trampled areas around livestock watering and feeding points. » In terms of the fire breaks and most of the farm tracks, a fairly stable vegetation cover persists. » Low diversity of fauna and flora. » No Plant and Animal SCC recorded. » No Provincially Protected Fauna and Flora recorded. » No Endemic Fauna and Flora recorded. » These areas are characterized with numerous weeds and some invasive alien plants.
Ecosystem function	» Permanent vegetation cover for stabilising, maintaining and nourishing soil as well as for slowing down runoff to increase infiltration into the soil.

Stability	» Medium to high if habitat is kept intact o Clearing and monitoring of weeds and invasive species will be necessary. o Erosion control will be important
Reversibility of degradation	» Possible, will require intervention such as erosion control and over sowing, » Clearing of invasives is needed to improve ecosystem functionality
Rating	» ***Low Sensitivity***

General Development Recommendations:

- » Development within this area is acceptable
- » Existing access roads and tracks to be used as far as possible.
- » Monitoring of erosion should occur on a regular basis during the construction phase and should be carried out throughout the operational phase, where such features are observed swift actions should be taken in order to remediate these impacts in order to avoid the potential spread of erosion into the downslope wetland areas.

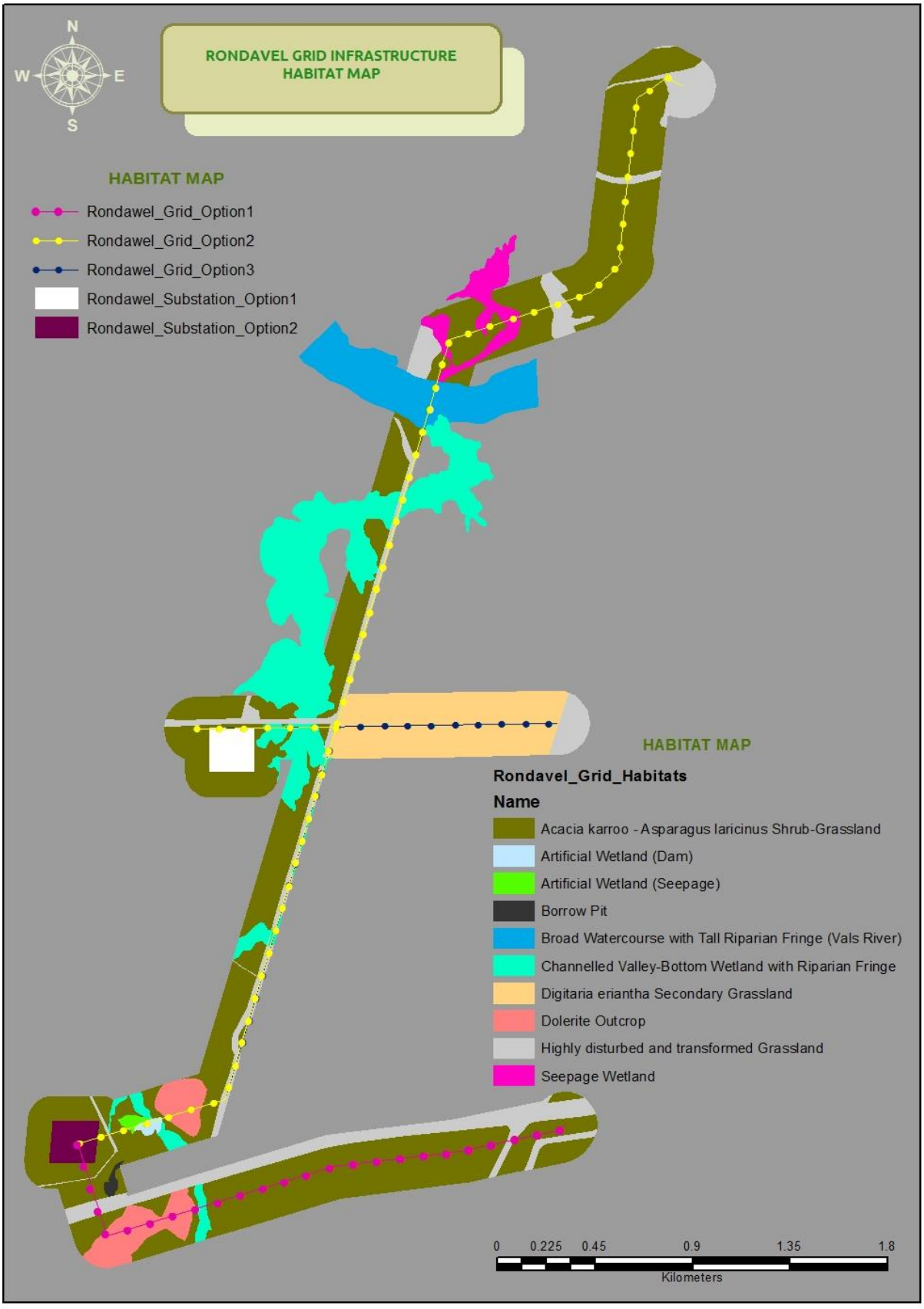

Figure 11: Terrestrial Ecological Importance and Sensitivity Map

9. ASSESSMENT OF PROPOSED IMPACTS

Assumptions

The following is assumed and/or known:

- » A thorough botanical walkthrough of all footprint areas will be conducted to detect and relocate, where possible, all plant species of conservation concern by a suitably qualified botanist before the commencement of activities.
- » Throughout the duration of the project life cycle the footprint will be routinely cleared of all alien invasive plants if detected.
- » The site establishment itself will be associated with clearing of vegetation within the footprint of the power line only.
- » After the decommissioning of the power line, a continuous vegetation layer will be the most important aspect of ecosystem functionality within and beyond the project site.

- A weakened or absent vegetation layer not only exposes the soil surface but also lacks the binding and absorption capacity that creates the buffering functionality of vegetation to prevent or lessen erosion as a result of floods.

Localised vs. cumulative impacts: some explanatory notes

Ecosystems consist of a mosaic of many different patches. The size of natural patches affects the number, type, and abundance of species they contain. At the periphery of patches, influences of neighbouring patches become apparent, known as the 'edge effect'. Patch edges may be subjected to increased levels of heat, dust, desiccation, disturbance, invasion of exotic species, and other factors. Edges seldom contain rare species, habitat specialists, or species that require larger tracts of undisturbed core habitat. Fragmentation due to development reduces core habitat and greatly extends edge habitat, which causes a shift in the species composition, which in turn puts great pressure on the dynamics and functionality of ecosystems (Perlman & Milder, 2005).

Cumulative impacts of developments on population viability of species can be reduced significantly if new developments are kept as close as possible to existing developed and/or transformed areas or, where such is not possible, different sections of development be kept as close together as possible.

For the proposed on-site substation location, due to its extent/size, proposed location within a historically cultivated area (secondary grassland), away from any freshwater resource features, the construction and operation of the on-site substation is expected to have a **very limited contribution** to the cumulative impacts of the area and will **not:**

- » compromise the ecological functioning of the larger "natural" environment; and

» disrupt the connectivity of the landscape for fauna and flora and impair their ability to respond to environmental fluctuations.

In terms of the power line route options, both options, due to their extent and the nature of such linear developments, is also expected to have a **limited contribution** to the cumulative impacts of the area. Grid Alternative 2 will however traverse historically cultivated (secondary grassland) lands and it is thus expected that this power line route option will contribute the least to potential cumulative impacts within the area.

Excessive clearing of vegetation can and will influence runoff and stormwater flow patterns and dynamics, which could cause excessive accelerated erosion of plains and intermittent drainage lines, and this could also have detrimental effects on the lower-lying areas.

- Rehabilitation and revegetation of all surfaces disturbed or altered during the operational phase are desirable.

Disturbance of indigenous vegetation creates a major opportunity for the establishment of invasive species and the uncontrolled spread of alien invasives into adjacent rangelands.

» A regular monitoring and eradication protocol must be part of all the developments' long-term management plans.

After decommissioning, a continuous vegetation layer will be the most important aspect of ecosystem functionality within and beyond the project site.

- A weakened or absent vegetation layer not only exposes the soil surface; but, lacks the binding and absorption capacity that creates the buffering functionality of vegetation to prevent or lessen erosion as a result of floods.

Identification of Potential Terrestrial and Fresh Water Resource Ecological Impacts and Associated Activities

Potential impacts resulting from the proposed project would stem from a variety of different activities and risk factors associated with the site-establishment and operation phases of the project including the following:

Construction and Operation Phase

» Human presence and uncontrolled access to the site may result in negative impacts on fauna and flora through poaching of fauna and uncontrolled collection of plants for traditional medicine or other purposes.
» Site clearing for site establishment of the construction camp and for the construction of the foundations for the pylons required for the power line.

- » Vegetation clearing could impact locally listed plant species. Vegetation clearing would also lead to the loss of vegetation communities and habitats for fauna and potentially the loss of faunal species, habitats, and ecosystems. On a larger and cumulative scale (if numerous and uncontrolled power line developments are allowed to occur in the future) the loss of these vegetation communities and habitats may potentially lead to a change in the conservation status of the affected vegetation type, as well as the ability of this vegetation type and associated features to fulfil its ecological responsibilities (functions).
- » Soil compaction and increased erosion risk would occur due to the loss of plant cover and soil disturbance created during the construction phase. This may potentially impact the downstream watercourses and aquatic habitats. These potential impacts may result in a reduction in the buffering capacities of the landscape during extreme weather events.
- » Invasion by alien plants may be attributed to excessive disturbance to vegetation, creating a window of opportunity for the establishment of these alien invasive species. Also, regenerative material of alien invasive species may be introduced to the project site by machinery traversing through areas with such plants or materials that may contain regenerative materials of such species.
- » The power line will require management and if this is not done effectively, it could impact adjacent intact areas through impacts such as erosion and the invasion of alien plant species.

Cumulative Impacts

- » The loss of unprotected vegetation types on a cumulative basis from the broad area may impact the country's ability to meet its conservation targets.
- » Transformation of intact habitat would contribute to the fragmentation of the landscape and would potentially disrupt the connectivity of the landscape for fauna, avifauna, and flora and impair their ability to respond to environmental fluctuations.

Assessment of Impacts

On-Site/Facility Substation Options

- » Both substation options are located within similar habitats and it is this envisaged that the potential impacts associated with the development of these substations will be very similar. As such these two options will not be assessed separately but a single impact assessment will be done which will be applicable to both options.
- » All wetland features are located outside of the development footprints for both substation options and wetland vegetation will thus not be directly impacted. However

due to these substations' proximity to wetland features, these wetlands may however be impacted indirectly.

Impact 1 (Terrestrial Ecology): *Potential Impacts on vegetation and listed protected plant species (Construction Phase).*

Impact Nature: Vegetation clearing will lead to the loss of current habitat and is an inevitable consequence of this type of activity. The extent of the proposed footprint, is however, small and located within a secondary grassland (historically cultivated area). Furthermore, no species of conservation concern were recorded within the proposed footprint.

The loss of local vegetation within the footprint is expected to be of relatively minor significance when considered on a broad scale.

	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (3)	Minor (1)
Probability	Highly Probable (4)	Improbable (2)
Significance	**Medium (32)**	**Low (12)**
Status	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	» Pre-construction environmental induction for all construction staff on-site to ensure that basic environmental principles are adhered to. This includes awareness as to no littering, appropriate handling of pollution and chemical spills, avoiding fire hazards, remaining within demarcated construction areas, etc. » Demarcate all areas to be cleared with construction tape or similar material where practical. However, caution should be exercised to avoid using material that might entangle fauna. » Contractor's EO to provide supervision and oversight of vegetation clearing activities and other activities which may cause damage to the environment, especially at the initiation of the project, when the majority of vegetation clearing is taking place. » Ensure that laydown areas, construction camps and other temporary use areas are located in areas of low and medium sensitivity and are properly fenced or demarcated as appropriate and practically possible. » All vehicles to remain within demarcated construction areas and no unnecessary driving in the veld outside these areas should be allowed. » Regular dust suppression during construction, if deemed necessary, especially along access roads. » No fires should be allowed on-site.	
Residual Impacts	Some residual vegetation loss will result from the development, equivalent to the operational footprint.	

Impact 2 (Terrestrial Ecology): *Potential Faunal Impacts (Construction Phase, Decommission Phase and during maintenance – Operational Phase).*

Impact Nature: Disturbance, transformation, and loss of habitat will have a negative effect on resident fauna during construction.

There are fauna residents within the site, and these will be impacted during the construction of the on-site substation. However, faunal diversity and density within the site were very low, and post-mitigation impacts are likely to be Low and of Local significance only.

Increased levels of noise, pollution, disturbance, and human presence during the construction and decommissioning phases may affect the local fauna. Sensitive and shy fauna would move away from the area during these phases and may only move back and inhabit the area post-decommission. Some slow-moving species would not be able to avoid the activities and might be killed.

	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (5)	Small (2)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (30)**	**Low (14)**
Status	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Noise and disturbance during the construction, decommission and during maintenance phases cannot be avoided but would be transient in nature and with appropriate mitigation; no long-term impacts from the construction phase can be expected.	
Mitigation	» Site access should be controlled and no unauthorised persons should be allowed onto the site. » Any fauna directly threatened by the associated activities should be removed to a safe location by a suitably qualified person. » The collection, hunting or harvesting of any plants or animals at the site should be strictly forbidden. Personnel should not be allowed to wander off the demarcated site. » Fires should not be allowed on site. » All hazardous materials should be stored in the appropriate manner to prevent contamination of the site. Any accidental chemical, fuel and oil spills that occur at the site should be cleaned up in the appropriate manner as related to the nature of the spill. » All construction vehicles should adhere to a low speed limit (30km/h) to avoid collisions with susceptible species such as snakes and tortoises. » Construction vehicles limited to a minimal footprint on site (no movement outside of the earmarked footprint).	
Residual Impacts	Due to the nature of this development, there will be a permanent loss of habitat and forage for fauna. However, due to the relatively small footprint of the development and the fact that this area has historically been disturbed and also contain a very low faunal diversity this potential residual impact can be regarded as low.	

Impact 3 (Terrestrial Ecology): *Potential increased erosion risk during construction and decommission.*

Impact Nature: During construction/decommission, there will be a lot of disturbed and loose soil at the site which will render the area vulnerable to erosion. Erosion is one of the greater risk factors associated with the development and it is therefore critically important that proper erosion control structures are built and maintained over the lifespan of the project.		
	Without Mitigation	**With Mitigation**
Extent	Local to neighbouring areas (2)	Local (1)
Duration	Medium-term (3)	Short-term (1)
Magnitude	Moderate (6)	Small (1)
Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (44)**	**Low (9)**
Status	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	» 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. » All bare areas due to the project activities should be re-vegetated with locally occurring species, to bind the soil and limit erosion potential where applicable. » An erosion control management plan should be utilised to prevent erosion » 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. » Any storm-water within the site must be handled in a suitable manner, i.e. trap sediments, and reduce flow velocities » Stormwater from the substations and other hard stand areas, must be managed using appropriate channels and swales when located within steep areas. » Storm water run-off infrastructure must be maintained to mitigate both the flow and water quality impacts of any storm water leaving the substation sites. » Construction of gabions and other stabilisation features to prevent erosion, if deemed necessary. » Re-instate as much of the eroded area to its pre-disturbed, "natural" geometry (no change in elevation and any banks not to be steepened) where possible. » Roads and other disturbed areas should be regularly monitored for erosion problems and problem areas should receive follow-up monitoring by the EO to assess the success of the remediation. » Topsoil must be removed and stored separately from subsoil. Topsoil must be reapplied where appropriate as soon as possible in order to	

	encourage and facilitate rapid regeneration of the natural vegetation on cleared areas.
Residual Impacts	The loss of fertile soil and soil capping resulting in areas which cannot fully rehabilitate itself with a good vegetation cover. With appropriate avoidance and mitigation residual impacts will be very low.

Impact 4 (Terrestrial Ecology): *Altered runoff patterns due to rainfall interception by infrastructure and compacted areas resulting in high levels of erosion (Operational Phase)*

Impact Nature: The presence of an extensive area of hardened surface during operation will generate a lot of runoff which will pose a significant erosion risk, if not managed. Erosion is one of the greater risk factors associated with this type of development, and it is therefore essential that proper erosion control structures are built and maintained over the lifespan of the project.

	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Permanent (5)	Short-term (1)
Magnitude	Minor (2)	Small (1)
Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (32)**	**Low (9)**
Status	Negative	Negative
Reversibility	Low	High
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	» Regular monitoring of the site (minimum of twice annually) to identify possible areas of erosion is recommended, particularly after large summer thunder storms have been experienced. » All bare areas due to the project activities should be re-vegetated with locally occurring species, to bind the soil and limit erosion potential where applicable. » Alternatively, soil surfaces where no revegetation seems possible will have to be covered with gravel or small rock fragments to increase porosity of the soil surface, slow down runoff and prevent wind- and water erosion. » Monitor the area below and around the panels regularly after larger rainfall events to determine where erosion may be initiated and then mitigate by modifying the soil micro-topography and revegetation efforts accordingly. » Due to the nature and larger runoff surfaces, the development area should be adequately landscaped and rehabilitated to contain expected accelerated erosion. » Runoff may have to be specifically channelled or storm water adequately controlled to prevent localised rill and gully erosion. » Any erosion problems observed should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur. » Roads and other disturbed areas should be regularly monitored for erosion problems and problem areas should receive follow-up monitoring to assess the success of the remediation.	

Residual Impacts	The loss of fertile soil and soil capping resulting in areas which cannot fully rehabilitate itself with a good vegetation cover. With appropriate avoidance and mitigation residual impacts will be very low.

Impact 5 (Terrestrial Ecology): *Potential increased alien plant invasion during the construction, operational and decommissioning phase.*

Impact Nature: The disturbed and bare ground that is likely to be present at the site during and after construction would leave the site vulnerable to alien plant invasion for some time if not managed. Furthermore, the National Environmental Management Biodiversity Act (Act No. 10 of 2004), as well as the Conservation of Agricultural Resources Act, (Act No. 43 of 1983) requires that listed alien species are controlled in accordance with the Act.

	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Permanent (5)	Short-term (1)
Magnitude	Minor (2)	Small (1)
Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (32)**	**Low (9)**
Status	Negative	Negative
Reversibility	Low	High
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	» A site-specific eradication and management programme for alien invasive plants must be implemented during construction. » Regular monitoring by the operation and maintenance team for alien plants at the within the power line servitude must occur and could be conducted simultaneously with erosion monitoring. » When alien plants are detected, these must be controlled and cleared using the recommended control measures for each species to ensure that the problem is not exacerbated or does not re-occur and increase to problematic levels. » Clearing methods must aim to keep disturbance to a minimum. » No planting or importing any listed invasive alien plant species (all Category 1a, 1b and 2 invasive species) to the site for landscaping, rehabilitation or any other purpose must be undertaken.	
Residual Impacts	If the above recommended mitigation measures are strictly implemented and some re-establishment and rehabilitation of natural vegetation is allowed the residual impact will be very low.	

Impact 6 (Freshwater/Aquatic): *Impact on localized surface water quality due to construction, decommission and maintenance activities*

Impact Nature: During pre-construction, construction, decommissioning and to a **limited degree** the operational phase, chemical pollutants (hydrocarbons from equipment and vehicles, cleaning fluids, cement powder, wet concrete, shutter-oil, etc.) associated with site-clearing machinery and construction activities could be washed downslope into the nearby wetland features.		
	Without Mitigation	**With Mitigation**
Extent	Local (2)	Local (1)
Duration	Short-term (2)	Short-term (2)
Magnitude	Moderate (6)	Minor (2)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (30)**	**Low (10)**
Status	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	Low	Low
Can impacts be mitigated?	Yes, to a large extent.	
Mitigation	» Implement appropriate measures to ensure strict use and management of all hazardous materials used on site » Implement appropriate measures to ensure strict management of potential sources of pollutants (e.g. litter hydrocarbons from vehicles and machinery, cement during construction, etc.) » Implement appropriate measures to ensure the containment of all contaminated water through careful run-off management on the development site. » Implement appropriate measures to ensure strict control over the behaviour of construction workers. » 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.	
Residual Impacts	Residual impacts will be negligible after appropriate mitigation.	

Impact 7 (Freshwater/Aquatic): *Increase in sedimentation and erosion within the freshwater resource features during construction, operation decommission*

Impact Nature: For the construction and decommissioning phases 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 and earthworks, within the wetland features' catchments, that are associated with construction activities. Possible ecological consequences associated with this impact may include: » Deterioration in freshwater ecosystem integrity; and » Reduction/loss of habitat for aquatic dependent flora & fauna. For the wetlands, the primary threat related to such development (total clearing of vegetation and construction of hard standing surfaces), is increased run-off, sediment inputs, as well as turbidity. This is especially during

vegetation clearing and excavation activities. An increase in volume and velocity of surface water flow from the cleared construction areas and hard standing surfaces, into the wetlands, may result in erosion and an increase in sediment inputs into the wetlands in the vicinity of the development area.		
	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Very Short (1)
Magnitude	Moderate (6)	Small (2)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (33)**	**Low (8)**
Status	Negative	Slightly negative
Reversibility	Moderate	High
Irreplaceable loss of resources	Local and potential loss of downstream resources	Unlikely
Can impacts be mitigated?	Yes, to a large extent.	
Mitigation	As all identified wetlands are located outside of the development footprint, most potential impacts on the wetlands will be of an indirect nature and as such the following mitigation measures, although not directly associated with the wetlands, are recommended in order to avoid the encroachment of erosion into these habitats or a reduction in water quality due to an increase in sedimentation into these systems: » 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. » All bare areas, as a result of the development, should be revegetated with locally occurring species, to bind the soil and limit erosion potential. » Silt traps should be used where there is a danger of topsoil or material stockpiles eroding and entering streams and other sensitive areas. » Topsoil should be removed and stored separately and should be re-applied where appropriate as soon as possible, to encourage and facilitate the rapid regeneration of the natural vegetation on cleared areas. » Where practical, phased development and vegetation clearing should be applied so that cleared areas are not left un-vegetated and vulnerable to erosion for extended periods. » Construction of gabions and other stabilisation features to prevent erosion if deemed necessary. » 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. » All wetland features and their recommended buffer areas are regarded as No-Go areas in terms of this aspect of the grid infrastructure development. » Vegetation within the buffer areas should be preserved and maintained.	
Residual Impacts	Due to the extent and nature of the development, residual impacts are unlikely to occur if the recommended mitigation measures are implemented.	

Rondavel Grid Connection

» For all grid options (1 – 3), the impacts relating to terrestrial ecology are very similar and as such the impact assessment conducted below, relating to terrestrial ecology, is applicable to all three gridline alternatives.
» In terms of impacts on freshwater resource/aquatic features; grid options 1 and 3 will have very similar potential impacts on freshwater resource features and as such these options have been grouped together. However, due to the extent of important and sensitive freshwater resource features that will be crossed by Grid Option 2, this option will have a more significant impact on freshwater resource features and as such this option has been assessed separately.

Impact 1 (Terrestrial Ecology): *Potential Impacts on vegetation and listed protected plant species (Construction Phase).*

Impact Nature: Vegetation clearing will lead to the loss of current habitat within the grid connection corridor and is an inevitable consequence of this type of activity. The extent of this grid connection corridor, is however, relatively small and the vegetation types within the affected area have a relatively wide distribution and are regarded as Least Concern.

The most likely consequences include:

» local loss of habitat (to an extent as a natural ground covering will be maintained where possible);
» very small and local disturbance to processes maintaining local biodiversity and ecosystem goods and services; and
» a potential loss of a few local protected species.

The development footprints for both options are primarily homogenous in terms of habitat types and vegetation cover thus providing for easier and more accurate calculation of potential impacts, more effective recommendations and implementation of management and mitigation measures, and furthermore lowering the impact and beta diversity. Only a very small portion of natural to near-natural Vaal Vet Sandy Grassland will be traversed by both options. Gridline alternative 2 will largely traverse historically cultivated lands (secondary grassland). The loss of local vegetation within the footprint is expected to be of relatively minor significance when considered on a broad scale.

	ALTERNATIVE 1, 2 & 3	
	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Minor (4)	Small (3)
Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (36)**	**Low (24)**
Status	Negative	Negative
Reversibility	Low	Moderate

Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	» Pre-construction walk-through of the power line route/corridor to locate species of conservation concern that can be translocated or avoided. » Vegetation clearing to commence only after walkthrough has been conducted and necessary permits obtained. » Pre-construction environmental induction for all construction staff on-site to ensure that basic environmental principles are adhered to. This includes awareness as to no littering, appropriate handling of pollution and chemical spills, avoiding fire hazards, remaining within demarcated construction areas, etc. » Demarcate all areas to be cleared with construction tape or similar material where practical. However, caution should be exercised to avoid using material that might entangle fauna. » Contractor's EO to provide supervision and oversight of vegetation clearing activities and other activities which may cause damage to the environment, especially at the initiation of the project, when the majority of vegetation clearing is taking place. » Vegetation clearing to be kept to a minimum. No unnecessary vegetation to be cleared. » Ensure that laydown areas, construction camps and other temporary use areas are located in areas of low and medium sensitivity and are properly fenced or demarcated as appropriate and practically possible. » All vehicles to remain within demarcated construction areas and no unnecessary driving in the veld outside these areas should be allowed. » Existing tracks should be used for access wherever possible. » The morphology and hydrology of the wetland features not be altered by unnecessary excavations, dumping of soil or other waste. » No fires should be allowed on-site.	
Residual Impacts	Some residual vegetation loss will result from the development, equivalent to the operational footprint of the power line.	

Impact 2 (Terrestrial Ecology): *Potential Faunal Impacts (Construction Phase, Decommission Phase and during maintenance – Operational Phase).*

Impact Nature: Disturbance, transformation, and loss of habitat will have a negative effect on resident fauna during construction.

There are fauna residents within the site, and these will be impacted during the construction of the power line. However, faunal diversity and density within the site are low, and post-mitigation impacts are likely to be Low and of Local significance only.

Increased levels of noise, pollution, disturbance, and human presence during the construction phase may affect the local fauna. Sensitive and shy fauna would move away from the area during the construction phase and may move back into the area upon completion of the construction phase. Some slow-moving species (i.e. tortoise & snakes) would not be able to avoid the activities and might be killed.

Faunal diversity and density within the site are low and post-mitigation impacts are likely to be Low and of Local significance only.

	ALTERNATIVE 1, 2 & 3	
	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)

Duration	Short-term (2)	Short-term (2)
Magnitude	Minor (4)	Small (2)
Probability	Highly Probable (4)	Probable (3)
Significance	**Low (28)**	**Low (15)**
Status	Negative	Negative
Reversibility	Moderate	Moderate to High
Irreplaceable loss of resources	Unlikely	Unlikely
Can impacts be mitigated?	Noise and disturbance during the construction, decommission and during maintenance phases cannot be avoided but would be transient in nature and with appropriate mitigation; no long-term impacts from the construction phase can be expected.	
Mitigation	» All personnel should undergo environmental induction with regards to fauna and in particular awareness about not harming or collecting species such as snakes, tortoises which are often persecuted out of superstition, or Giant Girdled Lizards/Ouvolk which is traded illegally. » Site access should be controlled and no unauthorised persons should be allowed onto the site. » Any fauna directly threatened by the associated activities should be removed to a safe location by a suitably qualified person. » The collection, hunting or harvesting of any plants or animals at the site should be strictly forbidden. Personnel should not be allowed to wander off the demarcated site. » Fires should not be allowed on site. » All hazardous materials should be stored in the appropriate manner to prevent contamination of the site. Any accidental chemical, fuel and oil spills that occur at the site should be cleaned up in the appropriate manner as related to the nature of the spill. » All construction vehicles should adhere to a low speed limit (30km/h) to avoid collisions with susceptible species such as snakes and tortoises. » Construction vehicles limited to a minimal footprint on site (no movement outside of the earmarked footprint).	
Residual Impacts	There will be minimal residual impact as the facility will have low operational impacts on fauna, after the construction phase.	

Impact 3 (Terrestrial Ecology): *Potential increased erosion risk during construction and decommission.*

Impact Nature: During construction/decommission, there will be a lot of disturbed and loose soil at the site which will render the area vulnerable to erosion. It is critically important that proper erosion control structures are built and maintained over the lifespan of the project.		
	ALTERNATIVE 1 & 2	
	Without Mitigation	**With Mitigation**
Extent	Local (2)	Local (1)
Duration	Medium-term (3)	Short-term (1)
Magnitude	Moderate (5)	Small (2)

Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (40)**	**Low (12)**
Status	Negative	Negative
Reversibility	Low	Moderate to High
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	» Any erosion problems observed to be associated with the access road and/or hardened/engineered surfaces should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur. » All bare areas due to the project activities should be re-vegetated with locally occurring species, to bind the soil and limit erosion potential where applicable. » An erosion control management plan should be utilised to prevent erosion » 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. » Construction of gabions and other stabilisation features to prevent erosion, if deemed necessary. » Re-instate as much of the eroded area to its pre-disturbed, "natural" geometry (no change in elevation and any banks not to be steepened) where possible. » Roads and other disturbed areas should be regularly monitored for erosion problems and problem areas should receive follow-up monitoring by the EO to assess the success of the remediation. » Topsoil must be removed and stored separately from subsoil. Topsoil must be reapplied where appropriate as soon as possible in order to encourage and facilitate rapid regeneration of the natural vegetation on cleared areas.	
Residual Impacts	The loss of fertile soil and soil capping resulting in areas which cannot fully rehabilitate itself with a good vegetation cover. With appropriate avoidance and mitigation residual impacts will be very low.	

Impact 4 (Terrestrial Ecology): *Potential increased alien plant invasion during the construction, operational and decommissioning phase.*

Impact Nature: The disturbed and bare ground that is likely to be present at the site during and after construction would leave the site vulnerable to alien plant invasion for some time if not managed. Furthermore, the National Environmental Management Biodiversity Act (Act No. 10 of 2004), as well as the Conservation of Agricultural Resources Act, (Act No. 43 of 1983) requires that listed alien species are controlled in accordance with the Act.		
	ALTERNATIVE 1 & 2	
	Without Mitigation	**With Mitigation**
Extent	Local (2)	Local (1)
Duration	Permanent (5)	Short-term (1)
Magnitude	Minor (4)	Small (1)

Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (44)**	**Low (9)**
Status	Negative	Negative
Reversibility	Low	High
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	» A site-specific eradication and management programme for alien invasive plants must be implemented during construction. » Regular monitoring by the operation and maintenance team for alien plants at the within the power line servitude must occur and could be conducted simultaneously with erosion monitoring. » When alien plants are detected, these must be controlled and cleared using the recommended control measures for each species to ensure that the problem is not exacerbated or does not re-occur and increase to problematic levels. » Clearing methods must aim to keep disturbance to a minimum. » No planting or importing any listed invasive alien plant species (all Category 1a, 1b and 2 invasive species) to the site for landscaping, rehabilitation or any other purpose must be undertaken.	
Residual Impacts	If the above recommended mitigation measures are strictly implemented and some re-establishment and rehabilitation of natural vegetation is allowed the residual impact will be very low.	

Impact 5: *Loss of riparian systems and disturbance of the alluvial water courses during the construction, operation and decommissioning phase*

Impact Nature: The physical removal/disturbance of the narrow strips of riparian zones and disturbance of any alluvial watercourses by pylon construction and road crossings, being replaced by hard engineered surfaces during construction. This biological impact would however be localised, as a large portion of the remaining catchment would remain intact.

According to the current layouts/routes, Options 1 and 3 will only cross a few smaller freshwater resource features, whilst Option 2 will cross numerous freshwater resource features including the Vals River and its associated riparian fringe.

These disturbances will be the greatest during the construction and again in the decommissioning phases as the related disturbances could result in loss and/or damaged vegetation.

	Route Options 1 and 3		**Route Option 2**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Extent	Local (1)	Local (1)	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)	Long-term (4)	Long-term (4)
Magnitude	Minor (4)	Small (2)	Moderate (6)	Small (3)
Probability	Highly Probable (4)	Probable (3)	Highly Probable (4)	Probable (3)
Significance	**Medium (36)**	**Low (21)**	**Medium (44)**	**Low (24)**
Status	Negative	Negative	Negative	Negative
Reversibility	Low – Destruction of drainage systems and associated vegetation will not be remedied easily.	Low – Destruction of drainage systems and associated vegetation will not be remedied easily.	Low – Destruction of drainage systems and associated vegetation will not be remedied easily.	Low – Destruction of drainage systems and associated vegetation will not be remedied easily.

Irreplaceable loss of resources	Local loss of resources	Very limited loss of local resources	Local loss of resources	Very limited loss of local resources
Can impacts be mitigated?	Yes, to a large degree			
Mitigation:	» No pylons must be placed within the delineated wetland/riparian habitats; however, the power line may span these features. » Use as far as possible the existing roads. » Where watercourse 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 (small footprint). » No vehicles must refuel within watercourses/ riparian vegetation. » With micro adjustments of the pylon positions, it is possible to place pylons outside of any wetland habitats. » Any activities within the wetlands apart from the spanning of the powerline should be avoided and the wetland features should, for all other activities be regarded as no-go areas.			
Residual Impacts	Possible impact on the remaining catchment due to changes in run-off characteristics in the development site. However, due to the extent of this development this potential residual impact is regarded as low.			

Impact 6: *Impact on localized surface water quality during the construction, operation and decommissioning phase*

Impact Nature: During pre-construction, construction, decommissioning and to a **limited degree** the operational phase (during maintenance), chemical pollutants (hydrocarbons from equipment and vehicles, cleaning fluids, cement powder, wet concrete, shutter-oil, etc.) associated with site-clearing machinery and construction activities could be washed downslope via the ephemeral systems.

	Route Options 1 and 3		**Route Option 2**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Extent	Local (2)	Local (1)	Local (2)	Local (1)
Duration	Long-term (2)	Short-term (2)	Long-term (2)	Short-term (2)
Magnitude	Minor (4)	Small (2)	Moderate (6)	Small (2)
Probability	Probable (3)	Improbable (2)	Probable (3)	Improbable (2)
Significance	**Low (24)**	**Low (10)**	**Medium (30)**	**Low (10)**

Status	Negative	Negative	Negative	Negative
Reversibility	Moderate	High	Moderate	High
Irreplaceable loss of resources	Local and potential loss of downstream resources	Unlikely	Local and potential loss of downstream resources	Unlikely
Can impacts be mitigated?	Yes, to a large degree			
Mitigation:	» Implement appropriate measures to ensure strict use and management of all hazardous materials used on site » Implement appropriate measures to ensure strict management of potential sources of pollutants (e.g. litter hydrocarbons from vehicles and machinery, cement during construction, etc.) » Implement appropriate measures to ensure the containment of all contaminated water through careful run-off management on the development site. » Implement appropriate measures to ensure strict control over the behaviour of construction workers. » 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.			
Residual Impacts	Residual impacts will be negligible after appropriate mitigation.			

Impact 7: *Increase in sedimentation and erosion during the construction, operational and decommissioning phase*

Impact Nature: For the construction and decommissioning phases 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 and earthworks that are associated with construction activities. Possible ecological consequences associated with this impact may include:

» Deterioration in freshwater ecosystem integrity; and
» Reduction/loss of habitat for aquatic dependent flora & fauna.

This may furthermore, influence water quality downstream.

	Route Options 1 and 3		**Route Option 2**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Extent	Local (1)	Local (1)	Local (1)	Local (1)
Duration	Long-term (4)	Very Short (1)	Long-term (4)	Very Short (1)

Magnitude	Minor (3)	Small (1)	Moderate (5)	Small (1)
Probability	Highly Probable (4)	Improbable (2)	Highly Probable (4)	Improbable (2)
Significance	**Medium (32)**	**Low (6)**	**Medium (40)**	**Low (6)**
Status	Negative	Negative	Negative	Negative
Reversibility	High	High	High	High
Irreplaceable loss of resources	Very limited loss of local resources	No irreplaceable loss of local resources	Very limited loss of local resources	No irreplaceable loss of local resources
Can impacts be mitigated?	Yes, to a large extent			
Mitigation:	» Use only the existing service roads when crossing any watercourses/wetlands. » 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. » All bare areas, as a result of the development, should be revegetated with locally occurring species, to bind the soil and limit erosion potential. » Silt traps should be used where there is a danger of topsoil or material stockpiles eroding and entering streams and other sensitive areas. » Topsoil should be removed and stored separately and should be re-applied where appropriate as soon as possible, to encourage and facilitate the rapid regeneration of the natural vegetation on cleared areas. » Where practical, phased development and vegetation clearing should be applied so that cleared areas are not left un-vegetated and vulnerable to erosion for extended periods. » Construction of gabions and other stabilisation features to prevent erosion if deemed necessary. » 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.			
Residual Impacts	Due to the extent and nature of the development, residual impacts are unlikely to occur if the recommended mitigation measures are implemented.			

Impact 8: *Impact on riparian systems through the increase in surface runoff on riparian form and function during the operational phase*

Impact Nature: The addition of hardened and compacted areas around the pylons. Service roads have the potential to further increase areas of hardening. The aforementioned will increase the runoff generated on site due to the addition of areas of hard surfaces and could lead to increased erosion risk, potentially reducing or disturbing important/sensitive downstream riparian habitats.				
	Route Options 1 and 3		**Route Options 2 and 4**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Extent	Local (1)	Local (1)	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)	Long-term (4)	Long-term (4)
Magnitude	Minor (4)	Small (1)	Moderate (5)	Small (2)
Probability	Highly Probable (4)	Improbable (2)	Highly Probable (4)	Improbable (2)
Significance	**Medium (36)**	**Low (12)**	**Medium (40)**	**Low (14)**
Status	Negative	Negative	Negative	Negative
Reversibility	Low – Destruction of drainage systems and associated vegetation will not be remedied easily.	Low – Destruction of drainage systems and associated vegetation will not be remedied easily.	Low – Destruction of riparian vegetation will not be remedied easily.	Low – Destruction of riparian vegetation will not be remedied easily.
Irreplaceable loss of resources	Local loss of resources	Very limited loss of local resources	Local loss of resources	Very limited loss of local resources
Can impacts be mitigated?	Yes, to a large degree			
Mitigation:	» 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. » Construction of gabions and other stabilisation features to prevent erosion if deemed necessary.			
Residual Impacts	Altered streambed morphology. Due to the extent and nature of the development this residual impact is unlikely to occur.			

Cumulative Impacts (On-site Substation & Gridline)

Cumulative Impact 1: *Reduced ability to meet conservation obligations and targets*

Impact Nature: The loss of unprotected vegetation types on a cumulative basis from the broader area impacts the Province's ability to meet its conservation targets.		
	ON-SITE SUBSTATION AND BOTH GRIDLINE ALTERNATIVES	
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects within the area**
Extent	Local (1)	Regional (2)
Duration	Long Term (4)	Long-Term (4)
Magnitude	Small (0)	Minor (2)
Probability	Very Improbable (1)	Highly Improbable (2)
Significance	**Low (5)**	**Low (16)**
Status	Neutral	Slightly Negative
Reversibility	Low	Low
Irreplaceable loss of resources	Highly unlikely	Unlikely
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	» The development footprint should be kept to a minimum and natural vegetation should be encouraged to return to disturbed areas. » Reduce the footprint of the facility within sensitive habitat types as much as possible. » Mitigation measures of the current site should align with neighbouring sites and other developments in the area.	

Cumulative Impact 2: *Impacts on Broad-Scale Ecological Processes*

Impact Nature: Transformation of intact habitat could potentially compromise ecological processes of ESAs as well as ecological functioning of important habitats and would contribute to the fragmentation of the landscape and would potentially disrupt the connectivity of the landscape for fauna and flora and impair their ability to respond to environmental fluctuations.		
	ON-SITE SUBSTATION AND BOTH GRIDLINE ALTERNATIVES	
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects within the area**
Extent	Local (1)	Regional (2)
Duration	Long Term (4)	Long-Term (4)
Magnitude	Small (0)	Minor (2)
Probability	Very Improbable (1)	Highly Improbable (2)
Significance	**Low (5)**	**Low (16)**

Status	Neutral	Slightly Negative
Reversibility	Low	Low
Irreplaceable loss of resources	Highly unlikely	Unlikely
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	» The development footprint should be kept to a minimum and natural vegetation should be encouraged to return to disturbed areas. » Mitigation measures of the current site should align with neighbouring sites and other developments in the area.	

Cumulative Impact 3: *Compromise ecological processes as well as ecological functioning of important terrestrial habitats.*

Impact Nature: Transformation of intact terrestrial habitats 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 impair their ability to respond to environmental fluctuations. This in turn may lead to;

- » A change in the status of impacted vegetation type, subsequently also reducing the ability to meet national conservation obligations and targets;
- » A reduction in biodiversity and even the loss of some species from the area;
- » Fracturing and isolation of landscapes may cut off important migration routes and prevent genetic variability thus reducing "genetic health" which may in turn lead to weaker species incapable to adapt and react to potential environmental changes and consequently also to a reduction in biodiversity and the extinction of some species from certain areas.
- » The loss of CBA's which may lead to the province, being incapable to meet their required biodiversity pattern a process targets.

The loss of important corridors essential for some species to allow for movement between important habitat types crucial for the survival of these species.

	ON-SITE SUBSTATION AND BOTH GRIDLINE ALTERNATIVES (1 & 2)	
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects within the area**
Extent	Local (1)	Local (1)
Duration	Long Term (4)	Long Term (4)
Magnitude	Small (1)	Small (1)
Probability	Highly Improbable (1)	Highly Improbable (1)
Significance	**Low (6)**	**Low (6)**
Status	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes	

Mitigation	» The development footprint should be kept to a minimum and natural vegetation should be encouraged to return to disturbed areas. »

Cumulative Impact 4: *Compromise ecological processes as well as ecological functioning of important freshwater/aquatic habitats.*

Impact Nature: Transformation of intact freshwater resource habitats could potentially compromise ecological processes as well as ecological functioning of important habitats and would contribute to habitat fragmentation and potentially 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

	ONLY GRIDLINE ALTERNATIVE 1	
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects within the area**
Extent	Local (1)	Local (1)
Duration	Long Term (4)	Long Term (4)
Magnitude	Small (2)	Moderate (6)
Probability	Highly Improbable (1)	Improbable (2)
Significance	**Low (7)**	**Low (22)**
Status	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes	
Mitigation	» The development footprint should be kept to a minimum and natural vegetation should be encouraged to return to disturbed areas. » Use existing service roads when crossing the watercourses. » Avoid placing pylons within the boundaries of the wetlands/watercourses. » Avoid any activities within the wetlands apart from the spanning of the powerline.	

Summary and Comparison of the Impact Assessments done for the substation options.

A summary of the assessment of impacts done for the Vrede Solar PV Facilities' substation options/alternatives are detailed below and include the identification of the preferred alternative, in terms of its potentials impacts on terrestrial as well as freshwater resource features. The overall impact significance provided in the table below are essentially a combination of the aspects assessed above and their impact significance ratings, with the implementation of mitigation measures.

Take note that "not-preferred" does not necessarily mean that such an option contains a fatal flaw and may not be considered at all (unless specified as such). If not specified otherwise, it merely means that in terms of the available options this is not the most preferable and may need some layout adjustments/amendments in order to avoid any sensitive features.

<table>
<tr><th>PV Solar Project</th><th>Substation Option 1</th><th>Substation Option 2</th><th>Reasons (incl. potential issues)</th></tr>
<tr><td rowspan="7">Rondavel PV Solar Facility</td><td colspan="2">Overall Impact Significance in terms Freshwater/Aquatic Resource Features</td><td rowspan="7">» Both substation options are located outside of the boundaries of delineated wetland features, however both options are located in relatively close proximity to such features (still outside of the recommended buffer areas).
» Both substation options are located in very similar habitat types which is not regarded as sensitive.
» Furthermore, both substation options are located outside of any conservation important areas (Threatened Ecosystems, and Critical Biodiversity Areas).
» No Plant or Animal Species of Conservation Concern were recorded within the proposed footprint areas of the substation options.
» Due to the above provided reasons, both options are regarded as favorable, however, it is when one takes into account the power line route options from these substations, that Options 1, edges out the second option as the preferred location. This is because substation options 1 along with grid route option 3 will combined have the least significant impact on the environment as the least amount of freshwater resource will have to be crossed (only once) and the majority of the power line route will traverse a secondary grassland (historically cultivated area).</td></tr>
<tr><td colspan="2">Both options are very similar in terms of their potential impacts on freshwater resource features.

Mainly Medium prior to Mitigation and Low/Unlikely with Mitigation considered</td></tr>
<tr><td colspan="2">Overall Impact Significance in terms Terrestrial Ecological Features</td></tr>
<tr><td colspan="2">Both options are very similar in terms of their potential impacts on terrestrial features.

Mainly Low to Medium prior to Mitigation and Low with Mitigation considered</td></tr>
<tr><td colspan="2">Preference</td></tr>
<tr><td>Most Favorable/Preferred</td><td>Favorable</td></tr>
</table>

Summary and Comparison of the Impact Assessments done for the two gridline alternatives.

A summary of the assessment of impacts done for the Rondavel Solar PV Facilities' gridline options/alternatives are detailed below and include the identification of the preferred alternative, in terms of its potentials impacts on terrestrial as well as freshwater resource features. The overall impact significance provided in the table below are essentially a combination of the aspects assessed above and their impact significance ratings, with the implementation of mitigation measures.

Take note that "not-preferred" does not necessarily mean that such an option contains a fatal flaw and may not be considered at all (unless specified as such). If not specified otherwise, it merely means that in terms of the available options this is not the most preferable and may need some layout adjustments/amendments in order to avoid any sensitive features.

<table>
<tr><th>PV Solar Project</th><th>Alternative Grid Option 1</th><th>Alternative Grid Option 2</th><th>Alternative Grid Option 3</th><th>Reasons (incl. potential issues)</th></tr>
<tr><td rowspan="8">Rondavel PV Solar Facility</td><td colspan="3">Overall Impact Significance in terms Freshwater/Aquatic Resource Features</td><td rowspan="8">» All grid route options are located outside of any conservation important areas (Threatened Ecosystems, and Critical Biodiversity Areas).
» No Plant or Animal Species of Conservation Concern were recorded within the proposed footprint areas of the grid route options.
» All three grid route options will cross freshwater resource features, however options 1 and 3 will cross only smaller features with option 3 crossing such features the least amount.
» Route option 2 will cross freshwater resource features numerous times, including a broad section of the Vals River.
» If grid route option 3 were to be selected along with substation option 1, potential impacts on freshwater as well as terrestrial resource will be the lowest as;
o the least amount of freshwater resource will have to be crossed (only once); and
o the majority of the power line route will traverse a secondary grassland (historically cultivated area).
» Due to the reasons provided above, Grid Route Option 3 is regarded as the Preferred option</td></tr>
<tr><td colspan="2">Both options are very similar in terms of their potential impacts on freshwater resource features.

Mainly Low to Medium prior to Mitigation and Low/Unlikely with Mitigation considered</td><td>Medium prior to mitigation and low with mitigation considered</td></tr>
<tr><td colspan="3">Overall Impact Significance in terms Terrestrial Ecological Features</td></tr>
<tr><td colspan="3">All three options are more or less similar in terms of their potential impacts on terrestrial features.

Mainly Low to Medium prior to Mitigation and Low with Mitigation considered</td></tr>
<tr><td colspan="3">Preference</td></tr>
<tr><td>Favorable</td><td>Not Preferred</td><td>Most Favorable/Preferred</td></tr>
</table>

10. CONCLUSION AND RECOMMENDATIONS

The study area falls within the Central Free State Grassland. This grassland type is not listed as a threatened ecosystem.

Nkurenkuru Ecology and Biodiversity undertook a terrestrial ecological (fauna and flora) study for an environmental impact assessment of the target areas where the establishment of the solar energy facility and associated infrastructure is proposed to be located and provide a professional opinion on terrestrial ecological issues pertaining to the target area to aid in future decisions regarding the proposed project.

This study has been commissioned to meet the requirements of the EIA process in the form of an Environmental Impact 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.

Furthermore, according to the guidelines specified within GN509 of 2016 all wetlands within a radius of 500m of the facility footprint were identified and those with a high and moderate risk of being impacted was delineated, mapped and classified

A site visit was conducted on the 18th to 20th of March and the 10th of March. On-site conditons were regarded as preferable (optimal) for such a survey and as such the data collected can be regarded reliable and satisfactory.

In terms of the preferred Substation route option:

» Both Substation Options are acceptable however, Grid Rout Option 1 is the most favourable and preferred route choice from a terrestrial and freshwater resource perspective based on the following:
  - Both substation options are located outside of the boundaries of delineated wetland features, however both options are located in relatively close proximity to such features (still outside of the recommended buffer areas).
  - Both substation options are located in very similar habitat types which is not regarded as sensitive.
  - Furthermore, both substation options are located outside of any conservation important areas (Threatened Ecosystems, and Critical Biodiversity Areas).
  - No Plant or Animal Species of Conservation Concern were recorded within the proposed footprint areas of the substation options.

- Due to the above provided reasons, both options are regarded as favorable, however, it is when one takes into account the power line route options from these substations, that Options 1, edges out the second option as the preferred location. This is because substation options 1 along with grid route option 3 will combined have the least significant impact on the environment as the least amount of freshwater resource will have to be crossed (only once) and the majority of the power line route will traverse a secondary grassland (historically cultivated area).

In terms of the preferred grid route option:

» Grid Rout Options 1 and 3 are both acceptable, whilst Grid Route Option 2 is the least acceptable and subsequently Not Preferred options. Grid Route Option 3 is however, the most favourable and preferred route choice from a terrestrial and freshwater resource perspective based on the following:
  - All grid route options are located outside of any conservation important areas (Threatened Ecosystems, and Critical Biodiversity Areas).
  - No Plant or Animal Species of Conservation Concern were recorded within the proposed footprint areas of the grid route options.
  - All three grid route options will cross freshwater resource features, however options 1 and 3 will cross only smaller features with option 3 crossing such features the least amount.
  - Route option 2 will cross freshwater resource features numerous times, including a broad section of the Vals River.
  - If grid route option 3 were to be selected along with substation option 1, potential impacts on freshwater as well as terrestrial resource will be the lowest as;
    - the least amount of freshwater resource will have to be crossed (only once); and
    - the majority of the power line route will traverse a secondary grassland (historically cultivated area).
  - Due to the reasons provided above, Grid Route Option 3 is regarded as the Preferred option

A combined terrestrial and aquatic ecological sensitivity map of the site has been compiled based on the findings of this study (refer to Figures 11).

The sensitive areas identified, are as follow:

High Sensitivity and No-Go Area:

» <u>All freshwater resource features and associated riparian fringes:</u> The freshwater resource features and their associated vegetation provide various unique habitats and niches (contribute to habitat and species diversity), are a potential suitable

habitat for Pyxicephalus adspersus – Giant Bullfrog (Near Threatened), Cape Clawless Otter (Near Threatened) and Spotted-necked Otter (Near Threatened) and fulfil vital ecological functions and services such as flood attenuation, stream flow augmentation, erosion control and the enhancement of water quality (sediment trapping, removal and storage of phosphates, nitrates and toxicants). The areas, even if small, must therefore be treated as No-Go zones.

On the Rondavel Solar Energy Facility project site, there are two seepage wetland features, two channelled valley-bottom wetlands and the perennial Vals River.

The findings of the baseline wetland assessment suggest the following Present Ecological Status' for the delineated wetland features:

- Seepage Wetland: E (Significantly Modified)
- Channelled Valley Bottom Wetland: C (Moderately Modified)
- Section of Vals River: Instream - C (Moderately Modified); Riparian – D (Largely Modified)

» Following the Ecological Importance and Sensitivity (EIS) assessment, it was found that both seepage wetlands are considered to be of low ecologically importance and sensitivity (Class D: Low EI&S). The larger channelled valley-bottom wetland was determined to be of high importance and sensitivity (Class B: High EI&S) whist the smaller channelled valley-bottom wetland was determined to be of moderate importance and sensitivity (Class C: Moderate. EI&S). The assessed section of the Vals River was determined to be of moderate importance and sensitivity (Class C: Moderate EI&S).

High Sensitivity

» 30m buffer areas around freshwater resource features: These buffer areas are recommended around the identified wetland features in order to prevent any degradation of the wetland features. These buffer areas should also be regarded as No-Go Zones for some of the associated that may cause exacerbated damage or threaten these wetland features as these areas' features are crucial for the maintenance of the functions and services provided by the freshwater resource features.

Medium Sensitivity

» Dolerite Outcrop: Mostly natural, dry, shrubby grassland that provides a fairly unique habitat for fauna within the area (rocky refugia). This habitat is sensitive to external impacts. Development of the grid line within this habitat is however, still acceptable.

» *Acacia karoo – Asparagus laricinus* Shrub-Grassland: Moderately degraded shrub-grassland. It is clear from the baseline data collected that this area has been significantly impacted by long term overgrazing which has resulted in the transformation of the grass layer and has allowed for the encroachment of especially *Asparagus laricinus* and to a lesser extent *Acacia karroo*. Development within this habitat is acceptable.

Low Sensitivity

» Re-established grassland on historical cultivated areas: These areas have been left fallow for an extended period of time and the re-establishment of mostly indigenous vegetation have been allowed to such an extent that the vegetation can be regarded as stable (plagioclimax), providing most of the functions and services associated with natural grassland. Development within these habitats are acceptable.

» Highly Transformed and Disturbed Grassland: This includes access roads and disturbed road shoulders, farm roads, fire breaks, trampled and overgrazed grassland, woodlots and small plantations as well as fallow and old cultivated areas. Development within these habitats are acceptable. The entire development is largely situated within this habitat. Development within this habitat is regarded as acceptable.

Overall, no significant terrestrial ecological flaws that could pose a problem to the proposed development were identified during the assessment. All impacts were determined low negative with the implementation of mitigation measures, with no remaining high or moderate significance impacts determined for the project post-mitigation. In addition, all cumulative impacts were determined low in isolation as well as low in the broader project context. The proposed development is therefore supported from a terrestrial ecological on condition that the mitigation measures provide in this report are implemented.

The most significant potential impacts expected to occur with the development of the proposed grid infrastructure:

» Reduction of a stable vegetation cover and associated below-ground biomass that currently increases soil surface porosity, water infiltration rates and thus improves the soil moisture availability. Without the vegetation, the soil will be prone to extensive surface capping, leading to accelerated erosion and further loss of organic material and soil seed reserves from the local environment.
» Disturbed vegetation in the study area carries a high risk of invasion by alien invasive plants, which may or may not be present in the study area or nearby. The control and continuous monitoring and eradication of alien invasive plants will form and integral part of the environmental management of the facility from construction up to decommissioning.

General Development Recommendations

- To prevent the onset of accelerated erosion, it is recommended that Vegetation clearing within the development footprint is kept to a minimum. No unnecessary vegetation to be cleared.
- Grading should only be done where absolutely necessary and to mitigate existing erosion channels. If extensive grading will become necessary, it will be advisable to create contour buffer strips to slow down runoff and prevent erosion, which could develop into gully erosion damaging the development in the long run as well.
- All indigenous shrubs that will be cleared should be shredded and added to the soil as mulch.
- Alien species must be removed entirely from site and not used as mulch to prevent the spread of regenerative material.
- A buffer area of 30m have been recommended around all wetland features. The recommended buffers (30m) are relevant for all activities pertaining to the development apart from the placement of pylons and single-track access road to the pylon locations, which is allowed within the recommended buffer areas.
- The wetland features themselves should be regarded as No-Go areas for all activities, apart from the spanning of these features where avoidance is not possible. Only existing road crossings should be used.
- As mentioned, the location of the on-site substation, laydown areas, storage areas, refuelling areas, construction camps etc. are not allowed within the recommended buffer areas. Where pylons can be placed outside of the buffer areas, whilst still being capable of spanning the wetland features, this should rather be considered, than placing pylons within the buffer areas.
- All wetland features along with their associated 30m buffers should be maintained in similar natural conditions.
- An effective storm water management plan should be compiled by a suitable specialist and the effectivity of the plan should be regularly assessed and revised if necessary.
- Any storm-water within the site must be handled in a suitable manner, i.e. trap sediments, and reduce flow velocities
- Stormwater from hard stand areas, buildings and substation must be managed using appropriate channels and swales when located within steeper areas.
- The runoff should be dissipated over a broad area covered by natural vegetation or managed using appropriate channels and swales.
- Storm water run-off infrastructure must be maintained to mitigate both the flow and water quality impacts of any storm water leaving the Solar PV site.
- No stormwater runoff must be allowed to discharge directly into freshwater resource features along roads, and flows should thus be allowed to dissipate over a broad area covered by natural vegetation.
- During the construction and operational /decommissioning phase, monitor the development footprint and wetland areas to see if erosion issues arise and if any erosion control is required.

  - 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.
  - All bare areas, as a result of the development, should be revegetated with locally occurring species, to bind the soil and limit erosion potential.
  - Site rehabilitation should aim to restore surface drainage patterns, natural soil and vegetation as far as is feasible.
  - An erosion control management plan should be utilised to prevent erosion
  - Any storm-water within the site must be handled in a suitable manner
  - All alien plant re-growth must be monitored and should it occur these plants should be eradicated.
  - Mitigation and follow up monitoring of residual impacts (alien vegetation growth and erosion) may be required.
- » Store hydrocarbons off site where possible, or otherwise implement hydrocarbon storage using impermeable floors with appropriate bunding, sumps and roofing.
- » Handle hydrocarbons carefully to limit spillage.
- » Ensure vehicles are regularly serviced so that hydrocarbon leaks are limited.
- » Designate a single location for refuelling and maintenance, outside of any freshwater resource features.
- » Keep a spill kit on site to deal with any hydrocarbon leaks.
- » Remove soil from the site which has been contaminated by hydrocarbon spillage.

In addition, all impacts were determined low negative with the implementation of mitigation measures, with no remaining high or moderate significance impacts determined for the project post-mitigation. In addition, all cumulative impacts were determined low in isolation as well as low in the broader project context. With these recommendations and mitigation measures in place, impacts on terrestrial and surface water resource integrity and functioning can be reduced to a sufficiently low level 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 Rondawel Grid Infrastructure project detailed in this report could be authorised from a surface water resource perspective.

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12. APPENDICES

Appendix 1: Methodology - Ecology (Biodiversity)

Methods to be followed during Field Sampling and Assessment

As part of the BA process, a detailed field survey of the vegetation of the development footprint was undertaken (from the 4th to 7th of March 2020) with the main purpose of:

» Inspecting the various habitat, vegetation, and landscape units that are present the mining site and to correlate such observations with the results of the desktop study.
» Identifying all observed species that were recorded within the development footprint.
» Providing a list of protected and red list species.
» Noting the presence of sensitive habitats such quartz patches, drainage lines, and unique edaphic environments,

These features were mapped onto satellite imagery of the site.

Aspects of biodiversity that were used to guide the interpretation and assessment of the study area are summarized below (Table 15).

Table 15: Summary of the different aspects of biodiversity considered in the assessment of the study site.

Intrinsic / Ecological Values
Species-level aspects of biodiversity
» Protected species of flora; » Threatened Species (Red Data List); » Keystone species performing a key ecological role; » Large or congregatory species population; » Endemic species or species with restricted ranges; » Previously unknown species.
Community & ecosystem-level aspects of biodiversity
» Distinct or diverse communities or ecosystems; » Unique ecosystems; » Locally adapted communities or assemblages; » Species-rich or diverse ecosystems; » Communities with a high proportion of endemic species or species with restricted ranges; » Communities with a high proportion of threatened and/or declining species; » The main uses and users of the area and its ecosystem goods and services: important ecosystem services, valued ecosystem goods, valued cultural areas.
Community & ecosystem-level aspects of biodiversity
» Key ecological processes (e.g. seed dispersal, pollination, primary production, carbon sequestration); » Areas with large congregations or species and/or breeding grounds; » Migration routes/corridors; » Importance as a link or corridor to other fragments of the same habitat, to protected or threatened or valued biodiversity areas;

» Importance and role in the landscape with regard to a range of 'spatial components of ecological processes', comprising processes tied to fixed physical features (e.g. soil or vegetation interfaces, river or sand movement corridors, upland-lowland interfaces) and flexible processes (e.g. upland-lowland gradients and macro-climatic gradients), as well as important movement or migration corridor for species.

The following methods were used to assess mapped terrestrial habitat:

Vegetation Species Composition:

The vegetation species composition was documented during field surveys to estimate the relative abundance of indigenous species vs alien/exotic species. The level of naturalness was subjectively rated per habitat unit assessed using the table below:

% Indigenous Cover	Level of Naturalness	Score
> 90	Natural	5
75 – 90	High	4
31 – 74	Moderate	3
6 – 30	Low	2
1 – 5	Very Low	1
0	Non (transformed)	0

Grass composition:

The ecological status of grasses refers to the grouping of grasses based on their reaction to different levels of grazing and disturbance (Van Oudtshoorn, 2006). It can either become more dominant (increaser type) or less dominant (decreaser type). The status of species indicates the ecological or veld condition, as per the table below which was used to guide the condition rating of grasslands:

Abundant Grass Status	Description
Decreaser	Abundant in good veld, palatable climax species, that decrease when veld is overgrazed
Increaser I	Grasses that are abundant in the underutilised veld, unpalatable, and robust climax species.
Increaser II	Abundant in overgrazed veld, mostly pioneer and subclimax species that quickly establish on new ground.
Increaser III	Commonly found in overgrazed veld, usually unpalatable, dense climax grasses that are strong competitors
Invaders	Invader species

Structural intactness of habitat:

The structural intactness of habitat is rated based on visual assessments in the field and rated according to the matrix below which compares the present structure of habitat with the estimated reference structure (natural state):

Structural Intactness Matrix	Present State				
Reference State	Continuous	Clumped	Scattered	Sparse	Very Sparse
Continuous	5	4	3	2	1
Clumped	4	5	4	3	2
Scattered	3	4	5	4	3
Sparse	2	3	4	5	4
Very Sparse	1	2	3	4	5

The existing level of disturbance:

The existing level of disturbance was documented based on the presence of on-site and adjacent anthropogenic impacts such litter/pollution, soil erosion, vegetation removal/clearing, grazing/harvesting, cultivation, housing development, etc. which were documented in the field and used to provide a qualitative rating of the level of habitat disturbance according to the ratings in the table below:

Level of disturbance	Score
None	5
Low	4
Medium	3
High	2
Very High	1
Extreme (no natural vegetation remains)	0

Present Ecological Status:

The scores assigned to each habitat unit based on the rating tables (shown above) were then used to provide an overall PES (Present Ecological State) rating that describes the condition or integrity for each habitat unit based on the following calculation:

» **PES = (Level of disturbance + Structural Intactness + % indigenous) / 3**

<u>Assessing species of conservation concern:</u>

Species of conservation concern are species that have high conservation importance in terms of preserving South Africa's biodiversity. A description of the different SANBI categories of species of conservation concern is provided in Table 16, below.

Table 16: South African Red List Categories for species of conservation significance (adapted from SANBI, on-line at http://redlist.sanbi.org/redcat.php).

Present State			
Species of Conservation Concern		Extinct (EX)	A species is Extinct when there is no reasonable doubt that the last individual has died. Species should be classified as Extinct only once exhaustive surveys throughout the species' known range have failed to record an individual.
		Extinct in the Wild (EW)	A species is Extinct in the Wild when it is known to survive only in cultivation or as a naturalized population (or populations) well outside the past range.
		Regionally Extinct (RE)	A species is Regionally Extinct when it is extinct within the region assessed (in this case South Africa), but wild populations can still be found in areas outside the region.
	Threatened Species	Critically Endangered, Possibly Extinct (CR PE)	Possibly Extinct is a special tag associated with the category Critically Endangered, indicating species that are highly likely to be extinct, but the exhaustive surveys required for classifying the species as Extinct has not yet been completed. A small chance remains that such species may still be rediscovered.
		Critically Endangered (CR)	A species is Critically Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Critically Endangered, indicating that the species is facing an extremely high risk of extinction.
		Endangered (EN)	A species is Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Endangered, indicating that the species is facing a very high risk of extinction.
		Vulnerable (VU)	A species is Vulnerable when the best available evidence indicates that it meets at least one of the five IUCN criteria for Vulnerable, indicating that the species is facing a high risk of extinction.
		Near Threatened (NT)	A species is Near Threatened when available evidence indicates that it nearly meets any of the IUCN criteria for Vulnerable, and is, therefore, likely to become at risk of extinction in the near future.
		Critically Rare	A species is Critically Rare when it is known to occur at a single site, but is not exposed to any direct or plausible potential threat and does not otherwise qualify for a category of threat according to one of the five IUCN criteria.
		Rare	A species is Rare when it meets at least one of four South African criteria for rarity, but is not exposed to any direct or plausible potential threat and does not qualify for a category of threat according to one of the five IUCN criteria.
		Declining	A species is Declining when it does not meet or nearly meet any of the five IUCN criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened, but there are threatening processes causing a continuing decline of the species.
		Data Deficient – Insufficient Information (DDD)	A species is DDD when there is inadequate information to make an assessment of its risk of extinction, but the species is well defined. Listing of species in this category indicates that more information is required and that future research could show that threatened classification is appropriate.
Other		Data Deficient – Taxonomically Problematic (DDT)	A species is DDT when taxonomic problems hinder the distribution range and habitat from being well defined so that an assessment of the risk of extinction is not possible.
		Least Concern (LC)	A species is Least Concern when it has been evaluated against the IUCN criteria and does not qualify for any of the above categories. Species classified as Least Concern are considered at low risk of extinction. Widespread and abundant species are typically classified in this category.
		Not Evaluated (NE)	species is Not Evaluated when it has not been evaluated against the criteria. The national Red List of South African plants is a comprehensive assessment of all South African indigenous plants, and therefore all species are assessed and given

			a national Red List status. However, some species included in Plants of southern Africa: an online checklist are species that do not qualify for national listing because they are naturalized exotics, hybrids (natural or cultivated), or synonyms. These species are given the status Not Evaluated and the reasons why they have not been assessed are included in the assessment justification.

As mentioned, flora of conservation significance (including threatened, protected and rare species) likely to occur in the various habitats of the study area were assessed at a desktop level using the outputs of SANBI's PRECIS (National Herbarium Pretoria Computerized Information System) electronic database. This information was used to identify potential habitat in the project area that could support these species based on information on each species' particular habitat preferences which were obtained from SANBI online species database. Special attention was given to the identification of any of these Red Data species as well as the identification of suitable habitat for Red Data species observed during field investigations.

Ecological Mapping

Mapping has been done by comparing georeferenced ground survey data to the visual inspection of available Google-Earth Imagery (which is a generalised colour composite image without any actual reflectance data attached to it) and in that way extrapolating survey reference points to the entire study area. Delineations are therefore approximate, and due to the intricate mosaics and often gradual mergers of vegetation units, generalisations had to be made. Mapped units will thus show where a certain vegetation unit is predominant, but smaller inclusions of another vegetation type in this area do exist but have not been mapped separately. The latter would require a supervised classification of georeferenced raw SPOT or similar satellite imagery (with all reflectance data), which has not been available to this project due to the high cost of such imagery.

Sensitivity Analysis and Criteria

The determination of specific ecosystem services and the sensitivity of ecosystem components, both biotic and abiotic, is rather complex and no single overarching criterion will apply to all habitats studied. The main aspects of an ecosystem that need to be incorporated in a sensitivity analysis, however, include the following:

» Describing the nature and number of species present, taking into consideration their conservation value as well as the probability of such species to survive or re-establish itself following disturbances, and alterations to their specific habitats, of various magnitudes
» Identifying the species or habitat features that are 'key ecosystem providers' and characterising their functional relationships (Kremen 2005)

» Determining the aspects of community structure that influence function, especially aspects influencing stability or rapid decline of communities (Kremen 2005)
» Assessing key environmental factors that influence the provision of services (Kremen 2005)
» Gaining knowledge about the spatial-temporal scales over which these aspects operate (Kremen 2005).

This implies that in the sensitivity analysis not only aspects that currently prevail on the area should be taken into consideration, but also if there is a possibility of a full restoration of the original environment and its biota, or at least the rehabilitation of ecosystem services resembling the original state after an area has been significantly disturbed.
According to the above, sensitivity classes have been summarised as follows:

» **Vert High Sensitivity:** Areas that contain critical and/or unique habitats have a very high sensitivity; such areas usually serve as habitats for rare/endangered species or perform critical and irreplaceable ecological roles. Very high sensitivity areas are no-go areas and developments in such areas should be avoided at all costs.
» **High Sensitivity:** High sensitivity areas are those that usually have a high biodiversity value or important ecological roles, and it is expected that impacts on such areas will likely be high; these areas include natural or transformed land. It might be difficult to mitigate all impacts appropriately in high sensitivity areas, and thus development within these areas is undesirable and should proceed with caution.
» **Medium Sensitivity:** The impacts on medium sensitivity areas are likely to be mostly local with the risk of secondary impacts (such as erosion) being low; these areas include natural or previously transformed land. On the condition that appropriate mitigation measures are implemented, development within medium sensitivity areas will have a relatively little ecological impact.
» **Low Sensitivity:** The impact on ecological processes and plant diversity in a low sensitivity area is likely to be negligible. Areas of low sensitivity are those areas where natural vegetation has already been transformed, for example as a result of intensive agricultural practices such as crop production. The majority of developments would have a little ecological impact in low sensitivity areas. The majority of the site is a Low Sensitivity area since it has already been heavily transformed due to past mining activities.

Appendix 2: Methodology – Freshwater Resource

The assessment was initiated with a survey of the pertinent literature, past reports and the various conservation plans that exist for the study region. Maps and Geographical Information Systems (GIS) were then employed to ascertain, which portions of the proposed development, could have the greatest impact on the wetlands and associated habitats.

A three-day site visit was then conducted to ground-truth the above findings, thus allowing critical comment of the development when assessing the possible impacts and delineating the wetland areas.

» The following equipment were utilized during field work.
  - Canon EOS 450D Camera
  - Garmin Etrex Legend GPS Receiver
  - Bucket Soil Auger
  - Munsell Soil Colour Chart (2000)
  - Braun-Blanquet Data Form (for vegetation recording and general environmental recordings).

Wetland and riparian areas were then assessed on the following basis:

» Identification and delineation of wetlands and riparian areas according to the the procedures specified by DWAF (2005a).
» Vegetation type – verification of type and its state or condition based, supported by species identification using Germishuizen and Meyer (2003), Vegmap (Mucina and Rutherford, 2006 as amended) and the South African Biodiversity Information Facility (SABIF) database.
» Plant species were further categorised as follows:
  - Terrestrial: species are not directly related to any surface or groundwater base-flows and persist solely on rainfall.
  - Facultative: species usually found in wetlands (inclusive of riparian systems) (67 – 99% of occurrences), but occasionally found in terrestrial systems (non-wetland) (DWAF, 2005)
  - Obligate: species that are only found within wetlands (>99% of occurrences) (DWAF, 2005).
» Assessment of the wetland type based on the NWCS method discussed below and the required buffers.
» Mitigation or recommendations required.

Data sources consulted

The following date sources and GIS spatial information provided in the table below was consulted to inform the assessment. The data type, relevance to the project and source of the information has been provided.

Table 17: Information and data coverages used to inform the wetland assessment

Data/Coverage Type	Relevence	Source
Colour Aerial Photography (2009)	Mapping of wetlands and other features	National Geo-Spatial Information
Latest Google Earth™ imagery	To supplement available aerial photography	Google Earth™ On-line
Proposed power line routes and substation locations.	Shows location to the porposed powerline routes and impacted zone	Client
NFEPA wetland Coverage	Shows location fo FEPA river and wetland sites.	CSIR (2011)
National Land-Cover	Shows the land-use and disturbances/transformations within and around the impacted zone.	DEA (2015)
SA National Land-Cover	Shows the expected land caracteristics including land form & shape, geology, soil types and slope gradients.	AGIS (2014)
Quaternary Drainage Regions	Indicates the drainage region and major tributaries and water sources.	DWS (2009)
Present Ecological State of watercourses	Shows the present ecological state of the affected non-perennial watercourses	Kleynhans (1999)

National Wetland Classification System (NWCS 2010)

Since the late 1960's, wetland classification systems have undergone a series of international and national revisions. These revisions allowed for the inclusion of additional wetland types, ecological and conservation rating metrics, together with a need for a system that would allude to the functional requirements of any given wetland (Ewart-Smith et al., 2006). Wetland function is a consequence of biotic and abiotic factors, and wetland classification should strive to capture these aspects.

The South African National Biodiversity Institute (SANBI) in collaboration with a number of specialists and stakeholders developed the newly revised and now accepted National Wetland Classification Systems (NWCS 2010). This system comprises a hierarchical

classification process of defining a wetland based on the principles of the Hydrogeomorphic (HGM) approach at higher levels, with including structural features at the finer or lower levels of classification (SANBI 2009).

Wetlands develop in a response to elevated water tables, linked either to rivers, groundwater flows or seepage from aquifers (Parsons, 2004). These water levels or flows then interact with localised geology and soil forms, which then determines the form and function of the respective wetlands. Water is thus the common driving force, in the formation of wetlands (DWAF, 2005). It is significant that the HGM approach has now been included in wetland classification as the HGM approach has been adopted throughout the water resources management realm with regard the determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) and WET-Health assessments for aquatic environments. All of these systems are then easily integrated using the HGM approach in line with the Eco-classification process of river and wetland reserve determinations used by the Department of Water Affairs.

The NWCS process is provided in more detail in the methods section of the report, but some of the terms and definitions used in this document are present below:

Definition Box Present

Ecological State is a term for the current ecological condition of the resource. This is assessed relative to the deviation from the Reference State. Reference State/Condition is the natural or pre-impacted condition of the system. The reference state is not a static condition, but refers to the natural dynamics (range and rates of change or flux) prior to development. The PES is determined per component - for rivers and wetlands this would be for the drivers: flow, water quality and geomorphology; and the biotic response indicators: fish, macroinvertebrates, riparian vegetation and diatoms. PES categories for every component would be integrated into an overall PES for the river reach or wetland being investigated. This integrated PES is called the EcoStatus of the reach or wetland.

EcoStatus is the overall PES or current state of the resource. It represents the totality of the features and characteristics of a river and its riparian areas or wetland that bear upon its ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services. The EcoStatus value is an integrated ecological state made up of a combination of various PES findings from component EcoStatus assessments (such as for invertebrates, fish, riparian vegetation, geomorphology, hydrology and water quality).

Reserve: The quantity and quality of water needed to sustain basic human needs and ecosystems (e.g. estuaries, rivers, lakes, groundwater and wetlands) to ensure ecologically sustainable development and utilisation of a water resource. The Ecological Reserve pertains specifically to aquatic ecosystems.

Reserve requirements: The quality, quantity and reliability of water needed to satisfy the requirements of basic human needs and the Ecological Reserve (inclusive of instream requirements).
Ecological Reserve determination study: The study undertaken to determine Ecological Reserve requirements.
Licensing applications: Water users are required (by legislation) to apply for licenses prior to extracting water resources from a water catchment.
Ecological Water Requirements: This is the quality and quantity of water flowing through a natural stream course that is needed to sustain instream functions and ecosystem integrity at an acceptable level as determined during an EWR study. These then form part of the conditions for managing achievable water quantity and quality conditions as stipulated in the Reserve Template.
Water allocation process (compulsory licensing): This is a process where all existing and new water users are requested to reapply for their licenses, particularly in stressed catchments where there is an over-allocation of water or an inequitable distribution of entitlements.
Ecoregions are geographic regions that have been delineated in a top-down manner on the basis of physical/abiotic factors. • NOTE: For purposes of the classification system, the 'Level I Ecoregions' for South Africa, Lesotho and Swaziland (Kleynhans et al. 2005), which have been specifically developed by the Department of Water Affairs & Forestry (DWAF) for rivers but are used for the management of inland aquatic ecosystems more generally, are applied at Level 2A of the classification system. These Ecoregions are based on physiography, climate, geology, soils and potential natural vegetation.

Wetland definition

Although the National Wetland Classification System (SANBI, 2009) is used to classify wetland types it is still necessary to understand the definition of a wetland. Wetland definitions as with classification systems have changed over the years. Terminology currently strives to characterise a wetland not only on its structure (visible form), but also to relate this to the function and value of any given wetland.

The Ramsar Convention definition of a wetland is widely accepted as "**areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres**" (Davis 1994). South Africa is a signatory to the Ramsar Convention and therefore its extremely broad definition of wetlands has been adopted for the proposed NWCS, with a few modifications.

Whereas the Ramsar Convention included marine water to a depth of six metres, the definition used for the NWCS extends to a depth of ten metres at low tide, as this is

recognised seaward boundary of the shallow photic zone (Lombard et al., 2005). An additional minor adaptation of the definition is the removal of the term 'fen' as fens are considered a type of peatland. The adapted definition for the NWCS is, therefore, as follows (SANBI, 2009):

WETLAND: an area of marsh, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed ten metres.

This definition encompasses all ecosystems characterised by the permanent or periodic presence of water other than marine waters deeper than ten metres. The only legislated definition of wetlands in South Africa, however, is contained within the National Water Act (Act No. 36 of 1998) (NWA), where wetlands are 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 supports, or would support, vegetation adapted to life in saturated soil." This definition is consistent with more precise working definitions of wetlands and therefore includes only a subset of ecosystems encapsulated in the Ramsar definition. It should be noted that the NWA definition is not concerned with marine systems and clearly distinguishes wetlands from estuaries, classifying the later as a watercourse (SANBI, 2009). The DWA is however reconsidering this position with regard the management of estuaries due to the ecological needs of these systems with regard to water allocation. Table 12 provides a comparison of the various wetlands included within the main sources of wetland definition used in South Africa.

Although a subset of Ramsar-defined wetlands was used as a starting point for the compilation of the first version of the National Wetland Inventory (i.e. "wetlands", as defined by the National Water Act, together with open waterbodies), it is understood that subsequent versions of the Inventory include the full suite of Ramsar-defined wetlands in order to ensure that South Africa meets its wetland inventory obligations as a signatory to the Convention (SANBI, 2009).

Wetlands must therefore have one or more of the following attributes to meet the above definition (DWAF, 2005):

- A high-water table that results in the saturation at or near the surface, leading to anaerobic conditions developing in the top 50cm of the soil.
- Wetland or hydromorphic soils that display characteristics resulting from prolonged saturation, i.e. mottling or grey soils
- The presence of, at least occasionally, hydrophilic plants, i.e. hydrophytes (water loving plants).

It should be noted that riparian systems that are not permanently or periodically inundated are not considered true wetlands, i.e. those associated with the drainage lines.

Table 18: Comparison of ecosystems considered to be 'wetlands' as defined by the proposed NWCS, the National Water Act (Act No. 36 of 1998), and ecosystems are included in DWAF's (2005) delineation manual.

Ecosystem	NWCS "wetland"	National Water Act wetland	DWAF (2005) delineation manual
Marine	YES	NO	NO
Estuarine	YES	NO	NO
Waterbodies deeper than 2 m (i.e. limnetic habitats often describe as lakes or dams)	YES	NO	NO
Rivers, channels and canals	YES	NO[3]	NO
Inland aquatic ecosystems that are not river channels and are less than 2 m deep	YES	YES	YES
Riparian[4] areas that are permanently / periodically inundated or saturated with water within 50 cm of the surface	YES	YES	YES3
Riparian areas that are not permanently / periodically inundated or saturated with water within 50 cm of the surface	NO	NO	YES[5]

Wetland importance and function

South Africa is a Contracting Party to the Ramsar Convention on Wetlands, signed in Ramsar, Iran, in 1971, and has thus committed itself to this intergovernmental treaty, which provides the framework for the national protection of wetlands and the resources they could provide. Wetland conservation is now driven by the South African National Biodiversity Institute, a requirement under the National Environmental Management: Biodiversity Act (No 10 of 2004).

Wetlands are among the most valuable and productive ecosystems on earth, providing important opportunities for sustainable development (Davies and Day, 1998). However,

[3] Although river channels and canals would generally not be regarded as wetlands in terms of the National Water Act, they are included as a 'watercourse' in terms of the Act.

[4] According to the National Water Act and Ramsar, riparian areas are those areas that are saturated or flooded for prolonged periods would be considered riparian wetlands, opposed to non –wetland riparian areas that are only periodically inundated and the riparian vegetation persists due to having deep root systems drawing on water many meters below the surface.

[5] The delineation of 'riparian areas' (including both wetland and non-wetland components) is treated separately to the delineation of wetlands in DWAF's (2005) delineation manual.

wetlands in South Africa are still rapidly being lost or degraded through direct human induced pressures (Nel et al., 2004).

The most common attributes or goods and services provided by wetlands include:

» Improve water quality;
» Impede flow and reduce the occurrence of floods;
» Reeds and sedges used in construction and traditional crafts;
» Bulbs and tubers, a source of food and natural medicine;
» Store water and maintain base flow of rivers;
» Trap sediments; and
» Reduce the number of water borne diseases.

In the past wetland conservation, has focused on biodiversity as a means of substantiating the protection of wetland habitat. However not all wetlands provide such motivation for their protection, thus wetland managers and conservationists began assessing the importance of wetland function within an ecosystem.

Table 18 summarises the importance of wetland function when related to ecosystem services or ecoservices (Kotze et al., 2008). One such example is emergent reed bed wetlands that function as transformers converting inorganic nutrients into organic compounds (Mitsch and Gosselink, 2000).

Table 19: Summary of direct and indirect ecoservices provided by wetlands from Kotze et al., 2008.

Wetland benefits (goods and services)	**Indirect benefits**	Hydrological benefits	Water purification
			Sustained stream flow
			Flood reduction
			Ground water recharge/discharge
			Erosion control
		Biodiversity conservation – integrity & irreplaceability	
		Chemical cycling	
	Direct benefits	Water supply	
		Provision of harvestable resources	
		Socio-cultural significance	
		Tourism and recreation	
		Education and research	

Relevant wetland legislation and policy

Locally the South African Constitution, seven (7) Acts and two (2) international treaties allow for the protection of wetlands and rivers. These systems are protected from the destruction or pollution by the following:

» Section 24 of The Constitution of the Republic of South Africa;

- » Agenda 21 – Action plan for sustainable development of the Department of Environmental Affairs and Tourism (DEAT) 1998;
- » The Ramsar Convention, 1971 including the Wetland Conservation Programme (DEAT) and the National Wetland Rehabilitation Initiative (DEAT, 2000);
- » National Environmental Management Act (NEMA), 1998 (Act No. 107 of 1998) inclusive of all amendments, as well as the NEM: Biodiversity Act;
- » National Water Act, 1998 (Act No. 36 of 1998);
- » Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983); and
- » Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002).
- » Nature and Environmental Conservation Ordinance (No. 19 of 1974)
- » National Forest Act (No. 84 of 1998)
- » National Heritage Resources Act (No. 25 of 1999)

Apart from NEMA, the Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983) will also apply to this project. The CARA has categorised a large number of invasive plants together with associated obligations of the land owner. A number of Category 1 & 2 plants were found at all of the sites investigated; thus, the contractors must take extreme care further spread of these plants doesn't occur. This should be done through proper stockpile management (topsoil) and suitable rehabilitation of disturbed areas after construction.

An amendment of the National Environmental Management was promulgated late December 2011, namely the Biodiversity Act or NEM:BA (Act No 10 of 2004), which lists 225 threatened ecosystems based on vegetation type (Vegmap, 2006 as amended). Should a vegetation type or ecosystem be listed, actions in terms of NEM:BA are triggered.

Other policies that are relevant include:

- » Provincial Nature Conservation Ordinance (PNCO) – Protected Flora. Any plants found within the sites are described in the ecological assessment.
- » National Freshwater Ecosystems Priority Areas – CSIR 2011 draft. This mapping product highlights potential rivers and wetlands that should be earmarked for conservation on a national basis.

National Wetland Classification System method

During this study, due to the nature of the wetlands and watercourses observed, it was decided that the newly accepted National Wetlands Classification System (NWCS) be adopted. This classification approach has integrated aspects of the HGM approached used in the WET-Health system as well as the widely accepted eco-classification approach used for rivers.

The NWCS (SANBI, 2009) as stated previously, uses hydrological and geomorphological traits to distinguish the primary wetland units, i.e. direct factors that influence wetland

function. Other wetland assessment techniques, such as the DWAF (2005) delineation method, only infer wetland function based on abiotic and biotic descriptors (size, soils & vegetation) stemming from the Cowardin approach (SANBI, 2009).

The classification system used in this study is thus based on SANBI (2009) and is summarised below:
The NWCS has a six-tiered hierarchical structure, with four spatially nested primary levels of classification (Figure 15). The hierarchical system firstly distinguishes between Marine, Estuarine and Inland ecosystems (**Level 1**), based on the degree of connectivity the particular systems has with the open ocean (greater than 10 m in depth). **Level 2** then categorises the regional wetland setting using a combination of biophysical attributes at the landscape level, which operate at a broad bioregional scale. This is opposed to specific attributes such as soils and vegetation. **Level 2** has adopted the following systems:

» Inshore bioregions (marine)
» Biogeographic zones (estuaries)
» Ecoregions (Inland)

Level 3 of the NWCS assess the topographical position of inland wetlands as this factor broadly defines certain hydrological characteristics of the inland systems. Four landscape units based on topographical position are used in distinguishing between Inland systems at this level. No subsystems are recognised for Marine systems, but estuaries are grouped according to their periodicity of connection with the marine environment, as this would affect the biotic characteristics of the estuary.

Level 4 classifies the hydrogeomorphic (HGM) units discussed earlier. The HGM units are defined as follows:

(i) Landform – shape and localised setting of wetland
(ii) Hydrological characteristics – nature of water movement into, through and out of the wetland
(iii) Hydrodynamics – the direction and strength of flow through the wetland.

These factors characterise the geomorphological processes within the wetland, such as erosion and depositing, as well as the biogeochemical processes.

Level 5 of the assessment pertains to the classification of the tidal regime within the marine and estuarine environments, while the hydrological and inundation depth classes are determined for the inland wetlands. Classes are based on frequency and depth of inundation, which are used to determine the functional unit of the wetlands and are considered secondary discriminators within the NWCS.

Level 6 uses of six descriptors to characterise the wetland types on the basis of biophysical features. As with Level 5, these are non-hierarchal in relation to each other and are applied in any order, dependent on the availability of information.

The descriptors include:
(i) Geology;
(ii) Natural vs. Artificial;
(iii) Vegetation cover type;
(iv) Substratum;
(v) Salinity; and
(vi) Acidity or Alkalinity.
It should be noted that where sub-categories exist within the above descriptors, hierarchical systems are employed, thus are nested in relation to each other.

The HGM unit (Level 4) is the **focal point of the NWCS**, with the upper levels (Figure 15 – Inland systems only) providing means to classify the broad bio-geographical context for grouping functional wetland units at the HGM level, while the lower levels provide more descriptive detail on the particular wetland type characteristics of a particular HGM unit. Therefore Level 1 – 5 deals with functional aspects, while Level 6 classifies wetlands on structural aspects.

In the past wetland conservation, has focused on biodiversity as a means of substantiating the protection of wetland habitat. However not all wetlands provide such motivation for their protection, thus wetland managers and conservationists began assessing the importance of wetland function within an ecosystem.

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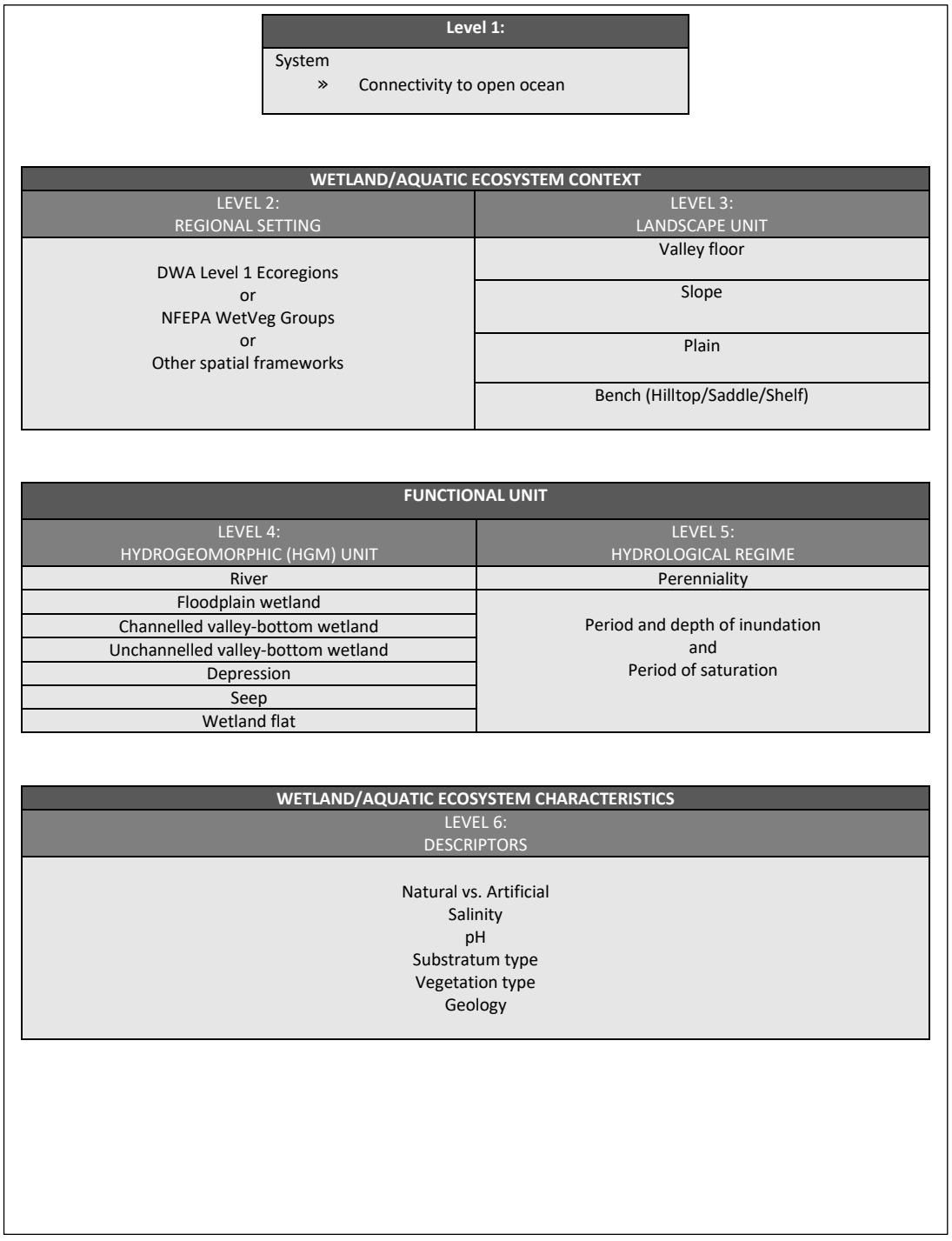

Figure 12: Basic structure of the National Wetland Classification System, showing how 'primary discriminators' are applied up to Level 4 to classify Hydrogeomorphic (HGM) Units, with 'secondary discriminators' applied at Level 5 to classify the hydrological regime, and 'descriptors' applied at Level 6 to categorise the characteristics of wetlands classified up to Level 5 (From SANBI, 2009).

Wetland condition and conservation importance assessment

Wetland functional assessment

» ***WET-Health Assessment (Wetland integrity/Present Ecological State)***

The Wet-Health tool (Macfarlane *et al.* 2008) was used to assess the Present Ecological State (PES) of wetlands by highlighting specific impacts within wetlands and within wetland catchment areas. For the purposes of this study, a Level 1 assessment was undertaken. While this is a rapid assessment, it is regarded as adequate to inform an assessment of existing impacts on wetland condition.

The WET-Health tool provides an appropriate framework for undertaking an assessment to indicate the functional importance of the wetland system that could be impacted by the proposed development. The assessment also helps to identify specific impacts thereby highlighting issues that should be addressed through mitigation and rehabilitation activities. The Level 1 assessment, approach relies on a combination of desktop and on-site indicators to assess various aspects of wetland condition, including:
Hydrology: defined as the distribution and movement of water through a wetland and its soils.
Geomorphology: defined as the distribution and retention patterns of sediment within the wetland.
Vegetation: defined as the vegetation structural and compositional state.

Each of these modules follows a broadly similar approach and is used to evaluate the extent to which anthropogenic changes have impacted upon wetland functioning or condition. While the impacts considered vary considerably across each module, a standardized scoring system is applied to facilitate the interpretation of results (Table 20). Scores range from 0 indicating no impact to a maximum of 10 which would imply that impacts had totally destroyed the functioning of a particular component.

Table 20: Guideline for interpreting the magnitude of impacts on wetland integrity (after Macfarlane *et al*. 2008)

IMPACT CATEGORY	DESCRIPTION	SCORE
None	No discernible modification or the modification is such that it has no impact on this component of wetland integrity.	0 – 0.9
Small	Although identifiable, the impact of this modification on this component of wetland integrity is small.	1 – 1.9
Moderate	The impact of this modification on this component of wetland integrity is clearly identifiable, but limited	2 – 3.9
Large	The modification has a clearly detrimental impact on this component of wetland integrity. Approximately 50% of wetland integrity has been lost.	4 – 5.9
Serious	The modification has a highly detrimental effect on this component of wetland integrity. Much of the wetland integrity has been lost but remaining integrity is still clearly identifiable.	6 – 7.9

Critical	The modification is so great that the ecosystem processes of this component of wetland integrity are almost totally destroyed, and 80% or more of the integrity has been lost.	8 - 10

Impact scores obtained for each of the modules reflect the degree of change from natural reference conditions. Resultant health scores fall into one of six health categories (A-F) on a gradient from "unmodified/natural" (Category A) to "severe/complete" deviation from natural" (Condition F) as depicted in Table 21, below. This classification is consistent with DWAF categories used to evaluate the present ecological state of aquatic ecosystems.

Table 21: Guideline for interpreting the magnitude of impacts on wetland integrity (after Macfarlane *et al*. 2008)

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

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

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

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

Appendix 3: Listed Plant Species

List of plant species of conservation concern which are known to occur in the vicinity of study area. The list is derived from the POSA website (*NE – Note Evaluated).

Family	Taxon	IUCN	Ecology
Acanthaceae	*Blepharis integrifolia (L.f.) E.Mey. ex Schinz var. integrifolia*	LC	Indigenous
Acanthaceae	*Justicia orchioides L.f. subsp. glabrata Immelman*	LC	Indigenous; Endemic
Acanthaceae	*Blepharis subvolubilis C.B.Clarke*	LC	Indigenous
Acanthaceae	*Barleria macrostegia Nees*	LC	Indigenous
Acanthaceae	*Dicliptera leistneri K.Balkwill*	LC	Indigenous; Endemic
Acanthaceae	*Crabbea acaulis N.E.Br.*	LC	Indigenous
Acanthaceae	*Dicliptera clinopodia Nees*	LC	Indigenous
Acanthaceae	*Dyschoriste burchellii (Nees) Kuntze*	LC	Indigenous
Agavaceae	*Chlorophytum fasciculatum (Baker) Kativu*	LC	Indigenous
Aizoaceae	*Chasmatophyllum musculinum (Haw.) Dinter & Schwantes*	LC	Indigenous
Aizoaceae	*Ruschia sp.*		
Aizoaceae	*Hereroa glenensis (N.E.Br.) L.Bolus*	LC	Indigenous; Endemic
Aizoaceae	*Delosperma mahonii (N.E.Br.) N.E.Br.*	LC	Indigenous
Aizoaceae	*Braunsia apiculata (Kensit) L.Bolus*	LC	Indigenous; Endemic
Aizoaceae	*Delosperma sp. L.Bolus*		
Alliaceae	*Tulbaghia acutiloba Harv.*	LC	Indigenous
Alliaceae	*Tulbaghia sp.*		
Amaranthaceae	*Salsola glabrescens Burtt Davy*	LC	Indigenous
Amaranthaceae	*Amaranthus hybridus L. subsp. hybridus var. hybridus*		Not indigenous; Naturalised
Amaranthaceae	*Chenopodium album L.*		Not indigenous; Naturalised; Invasive
Amaranthaceae	*Sericorema sericea (Schinz) Lopr.*	LC	Indigenous
Amaranthaceae	*Aerva leucura Moq.*	LC	Indigenous
Amaranthaceae	*Guilleminea densa (Humb. & Bonpl. ex Schult.) Moq.*		Not indigenous; Naturalised; Invasive
Amaranthaceae	*Alternanthera pungens Kunth*		Not indigenous; Naturalised
Amaranthaceae	*Salsola kali L.*		Not indigenous; Naturalised; Invasive
Amaranthaceae	*Sericorema remotiflora (Hook.f.) Lopr.*	LC	Indigenous
Amaranthaceae	*Dysphania carinata (R.Br.) Mosyakin & Clemants*		Not indigenous; Naturalised; Invasive
Amaranthaceae	*Amaranthus thunbergii Moq.*	LC	Indigenous
Amaranthaceae	*Atriplex semibaccata R.Br.*		Not indigenous; Naturalised; Invasive
Amaryllidaceae	*Gethyllis transkarooica D.Mull.-Doblies*	LC	Indigenous
Amaryllidaceae	*Boophone disticha (L.f.) Herb.*	LC	Indigenous
Amaryllidaceae	*Nerine hesseoides L.Bolus*	LC	Indigenous; Endemic
Amaryllidaceae	*Ammocharis coranica (Ker Gawl.) Herb.*	LC	Indigenous
Amaryllidaceae	*Nerine laticoma (Ker Gawl.) T.Durand & Schinz*	LC	Indigenous

Amaryllidaceae	*Crinum bulbispermum (Burm.f.) Milne-Redh. & Schweick.*	LC	Indigenous
Amaryllidaceae	*Brunsvigia radulosa Herb.*	LC	Indigenous
Amaryllidaceae	*Haemanthus montanus Baker*	LC	Indigenous
Anacampserotaceae	*Anacampseros recurvata Schonland subsp. buderiana (Poelln.) Gerbaulet*	EN	Indigenous; Endemic
Anacampserotaceae	*Anacampseros ustulata E.Mey. ex Fenzl*	LC	Indigenous; Endemic
Anacampserotaceae	*Anacampseros sp.*		
Anacardiaceae	*Smodingium argutum E.Mey. ex Sond.*	LC	Indigenous; Endemic
Anacardiaceae	*Searsia rigida (Mill.) F.A.Barkley var. rigida*	LC	Indigenous; Endemic
Anacardiaceae	*Searsia pyroides (Burch.) Moffett var. pyroides*	LC	Indigenous
Anacardiaceae	*Searsia lancea (L.f.) F.A.Barkley*	LC	Indigenous
Apiaceae	*Deverra burchellii (DC.) Eckl. & Zeyh.*	LC	Indigenous
Apiaceae	*Conium chaerophylloides (Thunb.) Sond.*	LC	Indigenous
Apocynaceae	*Raphionacme hirsuta (E.Mey.) R.A.Dyer*	LC	Indigenous
Apocynaceae	*Stenostelma capense Schltr.*	LC	Indigenous
Apocynaceae	*Xysmalobium brownianum S.Moore*	LC	Indigenous
Apocynaceae	*Araujia sericifera Brot.*		Not indigenous; Naturalised; Invasive
Apocynaceae	*Orbea lutea (N.E.Br.) Bruyns subsp. lutea*	LC	Indigenous
Apocynaceae	*Cordylogyne globosa E.Mey.*	LC	Indigenous
Apocynaceae	*Brachystelma foetidum Schltr.*	LC	Indigenous
Apocynaceae	*Brachystelma ramosissimum (Schltr.) N.E.Br.*	LC	Indigenous
Apocynaceae	*Asclepias aurea (Schltr.) Schltr.*	LC	Indigenous
Apocynaceae	*Asclepias gibba (E.Mey.) Schltr. var. media N.E.Br.*	LC	Indigenous
Apocynaceae	*Asclepias gibba (E.Mey.) Schltr. var. gibba*	LC	Indigenous
Apocynaceae	*Asclepias stellifera Schltr.*	LC	Indigenous
Aponogetonaceae	*Aponogeton junceus Lehm.*	LC	Indigenous
Asparagaceae	*Asparagus laricinus Burch.*	LC	Indigenous
Asparagaceae	*Asparagus suaveolens Burch.*	LC	Indigenous
Asparagaceae	*Asparagus bechuanicus Baker*	LC	Indigenous
Asparagaceae	*Asparagus cooperi Baker*	LC	Indigenous
Asparagaceae	*Asparagus setaceus (Kunth) Jessop*	LC	Indigenous
Asphodelaceae	*Trachyandra asperata Kunth var. asperata*	LC	Indigenous
Asphodelaceae	*Bulbine abyssinica A.Rich.*	LC	Indigenous
Asphodelaceae	*Aloe subspicata (Baker) Boatwr. & J.C.Manning*		Indigenous
Asphodelaceae	*Bulbine asphodeloides (L.) Spreng.*	LC	Indigenous
Asphodelaceae	*Trachyandra asperata Kunth var. basutoensis (Poelln.) Oberm.*	LC	Indigenous
Asphodelaceae	*Trachyandra saltii (Baker) Oberm. var. saltii*	LC	Indigenous
Asphodelaceae	*Trachyandra asperata Kunth var. nataglencoensis (Kuntze) Oberm.*	LC	Indigenous
Asphodelaceae	*Trachyandra saltii (Baker) Oberm.*		Indigenous
Asphodelaceae	*Bulbine capitata Poelln.*	LC	Indigenous
Asphodelaceae	*Aloe grandidentata Salm-Dyck*	LC	Indigenous
Asphodelaceae	*Bulbine narcissifolia Salm-Dyck*	LC	Indigenous
Asphodelaceae	*Trachyandra laxa (N.E.Br.) Oberm. var. rigida (Suess.) Roessler*	LC	Indigenous

Asphodelaceae	*Bulbine frutescens (L.) Willd.*	LC	Indigenous
Asphodelaceae	*Trachyandra asperata Kunth var. macowanii (Baker) Oberm.*	LC	Indigenous
Asteraceae	*Tagetes minuta L.*		Not indigenous; Naturalised; Invasive
Asteraceae	*Litogyne gariepina (DC.) Anderb.*	LC	Indigenous
Asteraceae	*Osteospermum spinescens Thunb.*	LC	Indigenous
Asteraceae	*Pseudognaphalium luteoalbum (L.) Hilliard & B.L.Burtt*	LC	Not indigenous; cryptogenic
Asteraceae	*Nolletia ciliaris (DC.) Steetz*	LC	Indigenous
Asteraceae	*Erigeron bonariensis L.*		Not indigenous; Naturalised; Invasive
Asteraceae	*Helichrysum rugulosum Less.*	LC	Indigenous
Asteraceae	*Senecio consanguineus DC.*	LC	Indigenous
Asteraceae	*Tolpis capensis (L.) Sch.Bip.*	LC	Indigenous
Asteraceae	*Dicoma macrocephala DC.*	LC	Indigenous
Asteraceae	*Felicia muricata (Thunb.) Nees subsp. muricata*	LC	Indigenous
Asteraceae	*Platycarphella parvifolia (S.Moore) V.A.Funk & H.Rob.*	LC	Indigenous; Endemic
Asteraceae	*Dicoma anomala Sond. subsp. anomala*	LC	Indigenous
Asteraceae	*Dimorphotheca zeyheri Sond.*	LC	Indigenous
Asteraceae	*Acanthospermum glabratum (DC.) Wild*		Not indigenous; Naturalised
Asteraceae	*Arctotis venusta Norl.*	LC	Indigenous
Asteraceae	*Denekia capensis Thunb.*	LC	Indigenous
Asteraceae	*Zinnia peruviana (L.) L.*		Not indigenous; Naturalised; Invasive
Asteraceae	*Hilliardiella capensis (Houtt.) H.Rob., Skvarla & V.A.Funk*		Indigenous
Asteraceae	*Helichrysum pumilio (O.Hoffm.) Hilliard & B.L.Burtt subsp. pumilio*	LC	Indigenous; Endemic
Asteraceae	*Seriphium plumosum L.*		Indigenous
Asteraceae	*Haplocarpha scaposa Harv.*	LC	Indigenous
Asteraceae	*Helichrysum dregeanum Sond. & Harv.*	LC	Indigenous
Asteraceae	*Tarchonanthus camphoratus L.*	LC	Indigenous
Asteraceae	*Pentzia globosa Less.*	LC	Indigenous
Asteraceae	*Conyza podocephala DC.*		Indigenous
Asteraceae	*Helichrysum nudifolium (L.) Less. var. nudifolium*	LC	Indigenous
Asteraceae	*Nidorella resedifolia DC. subsp. resedifolia*	LC	Indigenous
Asteraceae	*Pentzia viridis Kies*	LC	Indigenous; Endemic
Asteraceae	*Hilliardiella elaeagnoides (DC.) Swelank. & J.C.Manning*		Indigenous
Asteraceae	*Lasiospermum pedunculare Lag.*	LC	Indigenous; Endemic
Asteraceae	*Senecio laevigatus Thunb. var. laevigatus*	LC	Indigenous; Endemic
Asteraceae	*Bidens pilosa L.*		Not indigenous; Naturalised
Asteraceae	*Senecio asperulus DC.*	LC	Indigenous
Asteraceae	*Sonchus oleraceus L.*		Not indigenous; Naturalised; Invasive
Asteraceae	*Gazania krebsiana Less. subsp. arctotoides (Less.) Roessler*	LC	Indigenous
Asteraceae	*Osteospermum leptolobum (Harv.) Norl.*	LC	Indigenous; Endemic
Asteraceae	*Arctotis arctotoides (L.f.) O.Hoffm.*	LC	Indigenous

Asteraceae	*Schkuhria pinnata (Lam.) Kuntze ex Thell.*		Not indigenous; Naturalised
Asteraceae	*Pentzia calcarea Kies*	LC	Indigenous
Asteraceae	*Oncosiphon piluliferus (L.f.) Kallersjo*	LC	Indigenous
Asteraceae	*Hertia ciliata (Harv.) Kuntze*	LC	Indigenous
Asteraceae	*Eriocephalus karooicus M.A.N.Mull.*	LC	Indigenous; Endemic
Asteraceae	*Cotula australis (Spreng.) Hook.f.*	LC	Indigenous
Asteraceae	*Geigeria burkei Harv. subsp. burkei var. burkei*	NE	Indigenous
Asteraceae	*Xanthium spinosum L.*		Not indigenous; Naturalised; Invasive
Asteraceae	*Helichrysum zeyheri Less.*	LC	Indigenous
Asteraceae	*Galinsoga parviflora Cav.*		Not indigenous; Naturalised
Asteraceae	*Cotula anthemoides L.*	LC	Indigenous
Asteraceae	*Geigeria aspera Harv. var. aspera*	LC	Indigenous
Asteraceae	*Helichrysum argyrosphaerum DC.*	LC	Indigenous
Asteraceae	*Berkheya radula (Harv.) De Wild.*	LC	Indigenous
Asteraceae	*Geigeria brevifolia (DC.) Harv.*	LC	Indigenous
Asteraceae	*Xanthium strumarium L.*		Not indigenous; Naturalised; Invasive
Asteraceae	*Berkheya onopordifolia (DC.) O.Hoffm. ex Burtt Davy var. onopordifolia*	LC	Indigenous
Asteraceae	*Cineraria erodioides DC. var. erodioides*	LC	Indigenous
Asteraceae	*Cotula sp.*		
Asteraceae	*Ifloga glomerata (Harv.) Schltr.*	LC	Indigenous
Asteraceae	*Helichrysum caespititium (DC.) Harv.*	LC	Indigenous
Asteraceae	*Senecio reptans Turcz.*	LC	Indigenous; Endemic
Asteraceae	*Osteospermum scariosum DC. var. scariosum*	NE	Indigenous
Asteraceae	*Lactuca inermis Forssk.*	LC	Indigenous
Asteraceae	*Gnaphalium confine Harv.*	LC	Indigenous
Asteraceae	*Gnaphalium filagopsis Hilliard & B.L.Burtt*	LC	Indigenous
Asteraceae	*Osteospermum muricatum E.Mey. ex DC. subsp. muricatum*	LC	Indigenous
Asteraceae	*Artemisia afra Jacq. ex Willd. var. afra*	LC	Indigenous
Asteraceae	*Felicia fascicularis DC.*	LC	Indigenous
Asteraceae	*Arctotis microcephala (DC.) Beauverd*	LC	Indigenous
Boraginaceae	*Heliotropium lineare (A.DC.) Gurke*	LC	Indigenous
Boraginaceae	*Trichodesma angustifolium Harv. subsp. angustifolium*	LC	Indigenous
Boraginaceae	*Ehretia alba Retief & A.E.van Wyk*	LC	Indigenous
Boraginaceae	*Anchusa riparia A.DC.*	LC	Indigenous
Boraginaceae	*Lappula heteracantha Ledeb.*		Not indigenous; Naturalised
Boraginaceae	*Anchusa capensis Thunb.*	LC	Indigenous
Boraginaceae	*Anchusa azurea Mill.*		Not indigenous; Naturalised
Boraginaceae	*Lithospermum cinereum A.DC.*	LC	Indigenous
Brassicaceae	*Rorippa nudiuscula Thell.*	LC	Indigenous
Brassicaceae	*Capsella bursa-pastoris (L.) Medik.*		Not indigenous; Naturalised
Brassicaceae	*Lepidium africanum (Burm.f.) DC. subsp. africanum*	LC	Indigenous

Brassicaceae	*Sisymbrium orientale L.*		Not indigenous; Naturalised
Campanulaceae	*Wahlenbergia denticulata (Burch.) A.DC. var. denticulata*	LC	Indigenous
Campanulaceae	*Wahlenbergia undulata (L.f.) A.DC.*	LC	Indigenous
Campanulaceae	*Wahlenbergia androsacea A.DC.*	LC	Indigenous
Caryophyllaceae	*Pollichia campestris Aiton*	LC	Indigenous
Caryophyllaceae	*Corrigiola litoralis L. subsp. litoralis var. litoralis*	NE	Indigenous
Caryophyllaceae	*Dianthus micropetalus Ser.*	LC	Indigenous
Caryophyllaceae	*Silene burchellii Otth ex DC. subsp. modesta J.C.Manning & Goldblatt*	LC	Indigenous
Celastraceae	*Gymnosporia buxifolia (L.) Szyszyl.*	LC	Indigenous
Colchicaceae	*Colchicum melanthioides (Willd.) J.C.Manning & Vinn. subsp. melanthioides*	LC	Indigenous
Colchicaceae	*Colchicum burkei (Baker) J.C.Manning & Vinn.*	LC	Indigenous
Commelinaceae	*Commelina africana L. var. lancispatha C.B.Clarke*	LC	Indigenous
Commelinaceae	*Commelina livingstonii C.B.Clarke*	LC	Indigenous
Commelinaceae	*Commelina benghalensis L.*	LC	Indigenous
Commelinaceae	*Commelina africana L. var. africana*	LC	Indigenous
Convolvulaceae	*Ipomoea oblongata E.Mey. ex Choisy*	LC	Indigenous
Convolvulaceae	*Convolvulus boedeckerianus Peter*	LC	Indigenous; Endemic
Convolvulaceae	*Convolvulus dregeanus Choisy*	LC	Indigenous; Endemic
Convolvulaceae	*Seddera capensis (E.Mey. ex Choisy) Hallier f.*	LC	Indigenous
Convolvulaceae	*Convolvulus sagittatus Thunb.*	LC	Indigenous
Convolvulaceae	*Ipomoea bolusiana Schinz*	LC	Indigenous
Convolvulaceae	*Falkia oblonga Bernh. ex C.Krauss*	LC	Indigenous
Convolvulaceae	*Ipomoea oenotheroides (L.f.) Raf. ex Hallier f.*	LC	Indigenous
Crassulaceae	*Crassula capitella Thunb. subsp. nodulosa (Schonland) Toelken*	LC	Indigenous
Crassulaceae	*Crassula deltoidea Thunb.*	LC	Indigenous
Crassulaceae	*Crassula natalensis Schonland*	LC	Indigenous
Crassulaceae	*Crassula vaillantii (Willd.) Roth*		Not indigenous; Naturalised
Crassulaceae	*Crassula lanceolata (Eckl. & Zeyh.) Endl. ex Walp. subsp. lanceolata*	LC	Indigenous
Crassulaceae	*Crassula lanceolata (Eckl. & Zeyh.) Endl. ex Walp. subsp. transvaalensis (Kuntze) Toelken*	LC	Indigenous
Crassulaceae	*Kalanchoe rotundifolia (Haw.) Haw.*	LC	Indigenous
Cucurbitaceae	*Cucumis myriocarpus Naudin subsp. myriocarpus*	LC	Indigenous
Cucurbitaceae	*Coccinia sessilifolia (Sond.) Cogn.*	LC	Indigenous
Cyperaceae	*Cyperus esculentus L. var. esculentus*	LC	Indigenous
Cyperaceae	*Kyllinga alba Nees*	LC	Indigenous
Cyperaceae	*Cyperus usitatus Burch.*	LC	Indigenous
Cyperaceae	*Cyperus congestus Vahl*	LC	Indigenous
Cyperaceae	*Cyperus semitrifidus Schrad.*	LC	Indigenous
Cyperaceae	*Cyperus marginatus Thunb.*	LC	Indigenous
Cyperaceae	*Cyperus eragrostis Lam.*		Not indigenous; Naturalised
Cyperaceae	*Afroscirpoides dioeca (Kunth) Garcia-Madr.*		Indigenous
Cyperaceae	*Kyllinga erecta Schumach. var. erecta*	LC	Indigenous

Cyperaceae	*Cyperus uitenhagensis (Steud.) C.Archer & Goetgh.*	LC	Indigenous
Cyperaceae	*Cyperus obtusiflorus Vahl var. flavissimus (Schrad.) Boeckeler*	LC	Indigenous
Cyperaceae	*Cyperus longus L. var. tenuiflorus (Rottb.) Boeckeler*	NE	Indigenous
Cyperaceae	*Isolepis setacea (L.) R.Br.*	LC	Indigenous
Cyperaceae	*Eleocharis dregeana Steud.*	LC	Indigenous
Cyperaceae	*Cyperus rupestris Kunth var. rupestris*	LC	Indigenous
Cyperaceae	*Bulbostylis humilis (Kunth) C.B.Clarke*	LC	Indigenous
Cyperaceae	*Scleria sp.*		
Cyperaceae	*Schoenoplectus muricinux (C.B.Clarke) J.Raynal*	LC	Indigenous
Cyperaceae	*Cyperus difformis L.*	LC	Indigenous
Cyperaceae	*Schoenoplectus decipiens (Nees) J.Raynal*	LC	Indigenous
Cyperaceae	*Cyperus denudatus L.f.*	LC	Indigenous
Cyperaceae	*Cyperus fastigiatus Rottb.*	LC	Indigenous
Cyperaceae	*Bulbostylis hispidula (Vahl) R.W.Haines subsp. pyriformis (Lye) R.W.Haines*	LC	Indigenous
Ebenaceae	*Diospyros lycioides Desf. subsp. lycioides*	LC	Indigenous
Elatinaceae	*Bergia pentheriana Keissl.*	LC	Indigenous
Equisetaceae	*Equisetum ramosissimum Desf. subsp. ramosissimum*	LC	Indigenous
Erpodiaceae	*Erpodium beccarii Mull.Hal.*		Indigenous
Euphorbiaceae	*Euphorbia pseudotuberosa Pax*	LC	Indigenous
Euphorbiaceae	*Euphorbia striata Thunb.*	LC	Indigenous
Euphorbiaceae	*Euphorbia inaequilatera Sond. var. inaequilatera*	NE	Indigenous
Euphorbiaceae	*Euphorbia clavarioides Boiss.*	LC	Indigenous
Euphorbiaceae	*Euphorbia prostrata Aiton*	NE	Not indigenous; Naturalised
Euphorbiaceae	*Euphorbia natalensis Bernh. ex Krauss*	LC	Indigenous
Fabaceae	*Senna italica Mill. subsp. arachoides (Burch.) Lock*	LC	Indigenous
Fabaceae	*Listia heterophylla E.Mey.*	LC	Indigenous
Fabaceae	*Indigofera zeyheri Spreng. ex Eckl. & Zeyh.*	LC	Indigenous
Fabaceae	*Chamaecrista biensis (Steyaert) Lock*	LC	Indigenous
Fabaceae	*Rhynchosia holosericea Schinz*	LC	Indigenous
Fabaceae	*Indigofera torulosa E.Mey. var. angustiloba (Baker f.) J.B.Gillett*	LC	Indigenous; Endemic
Fabaceae	*Indigofera cryptantha Benth. ex Harv. var. cryptantha*	LC	Indigenous
Fabaceae	*Dolichos angustifolius Eckl. & Zeyh.*	LC	Indigenous
Fabaceae	*Sesbania transvaalensis J.B.Gillett*	LC	Indigenous
Fabaceae	*Vachellia karroo (Hayne) Banfi & Galasso*	LC	Indigenous
Fabaceae	*Lessertia frutescens (L.) Goldblatt & J.C.Manning subsp. frutescens*	LC	Indigenous
Fabaceae	*Crotalaria distans Benth. subsp. distans*	LC	Indigenous
Fabaceae	*Trifolium africanum Ser. var. africanum*	NE	Indigenous
Fabaceae	*Melolobium calycinum Benth.*	LC	Indigenous
Fabaceae	*Rhynchosia confusa Burtt Davy*	NE	Indigenous
Fabaceae	*Eriosema salignum E.Mey.*	LC	Indigenous
Fabaceae	*Indigofera filipes Benth. ex Harv.*	LC	Indigenous

Fabaceae	*Erythrina zeyheri Harv.*	LC	Indigenous
Fabaceae	*Lotononis sparsiflora (E.Mey.) B.-E.van Wyk*	LC	Indigenous
Fabaceae	*Crotalaria burkeana Benth.*	LC	Indigenous
Fabaceae	*Indigofera alternans DC. var. alternans*	LC	Indigenous
Fabaceae	*Argyrolobium molle Eckl. & Zeyh.*	LC	Indigenous; Endemic
Fabaceae	*Crotalaria virgulata Klotzsch subsp. grantiana (Harv.) Polhill*	LC	Indigenous
Fabaceae	*Rhynchosia totta (Thunb.) DC. var. totta*	LC	Indigenous
Fabaceae	*Argyrolobium collinum Eckl. & Zeyh.*	LC	Indigenous
Fabaceae	*Rhynchosia minima (L.) DC. var. prostrata (Harv.) Meikle*	NE	Indigenous
Fabaceae	*Elephantorrhiza elephantina (Burch.) Skeels*	LC	Indigenous
Fabaceae	*Zornia milneana Mohlenbr.*	LC	Indigenous
Fabaceae	*Melolobium obcordatum Harv.*	LC	Indigenous
Fabaceae	*Leobordea divaricata Eckl. & Zeyh.*	LC	Indigenous
Fabaceae	*Crotalaria sphaerocarpa Perr. ex DC. subsp. sphaerocarpa*	LC	Indigenous
Fabaceae	*Medicago laciniata (L.) Mill. var. laciniata*	NE	Not indigenous; Naturalised
Fabaceae	*Lessertia frutescens (L.) Goldblatt & J.C.Manning subsp. microphylla (Burch. ex DC.) J.C.Manning & Boatwr.*	LC	Indigenous
Fabaceae	*Vicia sp.*		
Fabaceae	*Rhynchosia nervosa Benth. ex Harv. var. nervosa*	LC	Indigenous
Fabroniaceae	*Fabronia pilifera Hornsch.*		Indigenous
Fagaceae	*Quercus robur L.*		Not indigenous; Cultivated; Naturalised; Invasive
Fagaceae	*Quercus acutissima Carruth.*		Not indigenous; Cultivated; Naturalised
Gentianaceae	*Sebaea exigua (Oliv.) Schinz*	LC	Indigenous
Geraniaceae	*Pelargonium sidoides DC.*	LC	Indigenous
Geraniaceae	*Monsonia angustifolia E.Mey. ex A.Rich.*	LC	Indigenous
Gisekiaceae	*Gisekia pharnaceoides L. var. pharnaceoides*	LC	Indigenous
Hyacinthaceae	*Drimia capensis (Burm.f.) Wijnands*	LC	Indigenous; Endemic
Hyacinthaceae	*Albuca sp.*		
Hyacinthaceae	*Albuca prasina (Ker Gawl.) J.C.Manning & Goldblatt*		Indigenous
Hyacinthaceae	*Ledebouria cooperi (Hook.f.) Jessop*	LC	Indigenous
Hyacinthaceae	*Massonia jasminiflora Burch. ex Baker*	LC	Indigenous
Hyacinthaceae	*Albuca shawii Baker*	LC	Indigenous
Hyacinthaceae	*Ledebouria marginata (Baker) Jessop*	LC	Indigenous
Hyacinthaceae	*Albuca virens (Ker Gawl.) J.C.Manning & Goldblatt subsp. virens*	LC	Indigenous
Hyacinthaceae	*Drimia intricata (Baker) J.C.Manning & Goldblatt*	LC	Indigenous
Hyacinthaceae	*Eucomis autumnalis (Mill.) Chitt. subsp. clavata (Baker) Reyneke*	NE	Indigenous
Hyacinthaceae	*Ledebouria ovatifolia (Baker) Jessop*		Indigenous
Hyacinthaceae	*Dipcadi ciliare (Eckl. & Zeyh. ex Harv.) Baker*	LC	Indigenous; Endemic
Hyacinthaceae	*Schizocarphus nervosus (Burch.) Van der Merwe*	LC	Indigenous
Hyacinthaceae	*Dipcadi marlothii Engl.*	LC	Indigenous

Hyacinthaceae	*Dipcadi viride (L.) Moench*	LC	Indigenous
Hyacinthaceae	*Ornithogalum juncifolium Jacq. var. juncifolium*	NE	Indigenous
Hyacinthaceae	*Drimia multisetosa (Baker) Jessop*	LC	Indigenous
Hyacinthaceae	*Albuca setosa Jacq.*	LC	Indigenous
Hyacinthaceae	*Lachenalia ensifolia (Thunb.) J.C.Manning & Goldblatt*	LC	Indigenous; Endemic
Hyacinthaceae	*Ledebouria sp.*		
Hyacinthaceae	*Drimia sp.*		
Hyacinthaceae	*Drimia elata Jacq. ex Willd.*	DD	Indigenous
Hydrocharitaceae	*Lagarosiphon muscoides Harv.*	LC	Indigenous
Hypoxidaceae	*Hypoxis iridifolia Baker*	LC	Indigenous
Hypoxidaceae	*Hypoxis hemerocallidea Fisch., C.A.Mey. & Ave-Lall.*	LC	Indigenous
Hypoxidaceae	*Hypoxis rigidula Baker var. rigidula*	LC	Indigenous
Hypoxidaceae	*Hypoxis argentea Harv. ex Baker var. argentea*	LC	Indigenous
Iridaceae	*Lapeirousia plicata (Jacq.) Diels subsp. foliosa Goldblatt & J.C.Manning*		Indigenous
Iridaceae	*Gladiolus permeabilis D.Delaroche subsp. edulis (Burch. ex Ker Gawl.) Oberm.*	LC	Indigenous
Iridaceae	*Duthieastrum linifolium (E.Phillips) M.P.de Vos*	LC	Indigenous; Endemic
Iridaceae	*Tritonia laxifolia (Klatt) Benth. ex Baker*	LC	Indigenous
Iridaceae	*Gladiolus dalenii Van Geel subsp. dalenii*	LC	Indigenous
Iridaceae	*Moraea pallida (Baker) Goldblatt*	LC	Indigenous
Iridaceae	*Moraea simulans Baker*	LC	Indigenous
Kewaceae	*Kewa bowkeriana (Sond.) Christenh.*	LC	Indigenous
Lamiaceae	*Salvia runcinata L.f.*	LC	Indigenous
Lamiaceae	*Mentha longifolia (L.) Huds. subsp. polyadena (Briq.) Briq.*	LC	Indigenous
Lamiaceae	*Teucrium trifidum Retz.*	LC	Indigenous
Lamiaceae	*Salvia stenophylla Burch. ex Benth.*		Indigenous
Lamiaceae	*Salvia verbenaca L.*	LC	Not indigenous; Naturalised; Invasive
Lamiaceae	*Stachys hyssopoides Burch. ex Benth.*	LC	Indigenous
Lamiaceae	*Stachys spathulata Burch. ex Benth.*	LC	Indigenous
Leskeaceae	*Pseudoleskeopsis claviramea (Mull.Hal.) Ther.*		Indigenous
Linderniaceae	*Linderniella nana (Engl.) Eb.Fisch., Schaferh. & Kai Mull.*		Indigenous
Lobeliaceae	*Lobelia sonderiana (Kuntze) Lammers*	LC	Indigenous
Malvaceae	*Grewia flava DC.*	LC	Indigenous
Malvaceae	*Corchorus asplenifolius Burch.*	LC	Indigenous
Malvaceae	*Hermannia depressa N.E.Br.*	LC	Indigenous
Malvaceae	*Sphaeralcea bonariensis (Cav.) Griseb.*		Not indigenous; Naturalised
Malvaceae	*Hibiscus calyphyllus Cav.*	LC	Indigenous
Malvaceae	*Hibiscus trionum L.*		Not indigenous; Naturalised
Malvaceae	*Sida chrysantha Ulbr.*	LC	Indigenous
Malvaceae	*Hermannia sp.*		
Malvaceae	*Pavonia burchellii (DC.) R.A.Dyer*	LC	Indigenous
Malvaceae	*Hermannia quartiniana A.Rich.*	LC	Indigenous

Malvaceae	*Hibiscus pusillus Thunb.*	LC	Indigenous
Malvaceae	*Hermannia oblongifolia (Harv.) Hochr.*	LC	Indigenous; Endemic
Malvaceae	*Malva parviflora L. var. parviflora*		Not indigenous; Naturalised
Malvaceae	*Hibiscus microcarpus Garcke*	LC	Indigenous
Marsileaceae	*Marsilea sp.*		
Marsileaceae	*Marsilea macrocarpa C.Presl*	LC	Indigenous
Nyctaginaceae	*Commicarpus plumbagineus (Cav.) Standl. var. plumbagineus*	LC	Indigenous
Nyctaginaceae	*Commicarpus pentandrus (Burch.) Heimerl*	LC	Indigenous
Oleaceae	*Menodora africana Hook.*	LC	Indigenous
Oleaceae	*Ligustrum lucidum W.T.Aiton*		Not indigenous; Cultivated; Naturalised; Invasive
Ophioglossaceae	*Ophioglossum sp.*		
Orchidaceae	*Eulophia ovalis Lindl. var. ovalis*	LC	Indigenous
Orchidaceae	*Habenaria epipactidea Rchb.f.*	LC	Indigenous
Oxalidaceae	*Oxalis latifolia Kunth*		Not indigenous; Naturalised; Invasive
Oxalidaceae	*Oxalis depressa Eckl. & Zeyh.*	LC	Indigenous
Pedaliaceae	*Pterodiscus speciosus Hook.*	LC	Indigenous
Phrymaceae	*Mimulus gracilis R.Br.*	LC	Indigenous
Phyllanthaceae	*Phyllanthus maderaspatensis L.*	LC	Indigenous
Phyllanthaceae	*Phyllanthus parvulus Sond. var. parvulus*	LC	Indigenous
Plantaginaceae	*Veronica anagallis-aquatica L.*	LC	Indigenous
Plantaginaceae	*Plantago major L.*		Not indigenous; Naturalised
Plantaginaceae	*Plantago lanceolata L.*	LC	Indigenous
Poaceae	*Eragrostis trichophora Coss. & Durieu*	LC	Indigenous
Poaceae	*Eragrostis pseudobtusa De Winter*	NE	Indigenous; Endemic
Poaceae	*Pogonarthria squarrosa (Roem. & Schult.) Pilg.*	LC	Indigenous
Poaceae	*Dactyloctenium aegyptium (L.) Willd.*	LC	Indigenous
Poaceae	*Anthephora pubescens Nees*	LC	Indigenous
Poaceae	*Eragrostis curvula (Schrad.) Nees*	LC	Indigenous
Poaceae	*Sporobolus fimbriatus (Trin.) Nees*	LC	Indigenous
Poaceae	*Urochloa mosambicensis (Hack.) Dandy*	LC	Indigenous
Poaceae	*Digitaria sanguinalis (L.) Scop.*	NE	Not indigenous; Naturalised
Poaceae	*Agrostis lachnantha Nees var. lachnantha*	LC	Indigenous
Poaceae	*Eragrostis gummiflua Nees*	LC	Indigenous
Poaceae	*Hyparrhenia dregeana (Nees) Stapf ex Stent*	LC	Indigenous
Poaceae	*Eragrostis lehmanniana Nees var. lehmanniana*	LC	Indigenous
Poaceae	*Ehrharta erecta Lam. var. erecta*	LC	Indigenous
Poaceae	*Eustachys paspaloides (Vahl) Lanza & Mattei*	LC	Indigenous
Poaceae	*Eragrostis micrantha Hack.*	LC	Indigenous
Poaceae	*Digitaria tricholaenoides Stapf*	LC	Indigenous
Poaceae	*Aristida congesta Roem. & Schult. subsp. barbicollis (Trin. & Rupr.) De Winter*	LC	Indigenous
Poaceae	*Echinochloa colona (L.) Link*	LC	Indigenous

Poaceae	*Cynodon hirsutus Stent*	LC	Indigenous
Poaceae	*Cymbopogon caesius (Hook. & Arn.) Stapf*	LC	Indigenous
Poaceae	*Eragrostis obtusa Munro ex Ficalho & Hiern*	LC	Indigenous
Poaceae	*Aristida adscensionis L.*	LC	Indigenous
Poaceae	*Cymbopogon pospischilii (K.Schum.) C.E.Hubb.*	NE	Indigenous
Poaceae	*Setaria sphacelata (Schumach.) Stapf & C.E.Hubb. ex M.B.Moss var. sphacelata*	LC	Indigenous
Poaceae	*Echinochloa holubii (Stapf) Stapf*	LC	Indigenous
Poaceae	*Helictotrichon turgidulum (Stapf) Schweick.*	LC	Indigenous
Poaceae	*Eragrostis sp.*		
Poaceae	*Andropogon appendiculatus Nees*	LC	Indigenous
Poaceae	*Eragrostis chloromelas Steud.*	LC	Indigenous
Poaceae	*Panicum sp.*		
Poaceae	*Melinis repens (Willd.) Zizka subsp. repens*	LC	Indigenous
Poaceae	*Brachiaria eruciformis (Sm.) Griseb.*	LC	Indigenous
Poaceae	*Eleusine coracana (L.) Gaertn. subsp. africana (Kenn.-O'Byrne) Hilu & de Wet*	LC	Indigenous
Poaceae	*Chloris virgata Sw.*	LC	Indigenous
Poaceae	*Panicum stapfianum Fourc.*	LC	Indigenous
Poaceae	*Panicum schinzii Hack.*	LC	Indigenous
Poaceae	*Eragrostis racemosa (Thunb.) Steud.*	LC	Indigenous
Poaceae	*Aristida junciformis Trin. & Rupr. subsp. junciformis*	LC	Indigenous
Poaceae	*Bromus sp.*		
Poaceae	*Phalaris canariensis L.*	NE	Not indigenous; Naturalised
Poaceae	*Panicum coloratum L.*	LC	Indigenous
Poaceae	*Tragus berteronianus Schult.*	LC	Indigenous
Poaceae	*Sporobolus tenellus (Spreng.) Kunth*	LC	Indigenous
Poaceae	*Paspalum distichum L.*	LC	Not indigenous; Naturalised; Invasive
Poaceae	*Tragus koelerioides Asch.*	LC	Indigenous
Poaceae	*Setaria nigrirostris (Nees) T.Durand & Schinz*	LC	Indigenous
Poaceae	*Eragrostis superba Peyr.*	LC	Indigenous
Poaceae	*Tragus racemosus (L.) All.*	LC	Indigenous
Poaceae	*Aristida stipitata Hack. subsp. graciliflora (Pilg.) Melderis*	LC	Indigenous
Poaceae	*Enneapogon scoparius Stapf*	LC	Indigenous
Poaceae	*Digitaria argyrograpta (Nees) Stapf*	LC	Indigenous
Poaceae	*Trachypogon spicatus (L.f.) Kuntze*	LC	Indigenous
Poaceae	*Elionurus muticus (Spreng.) Kunth*	LC	Indigenous
Poaceae	*Hemarthria altissima (Poir.) Stapf & C.E.Hubb.*	LC	Indigenous
Poaceae	*Themeda triandra Forssk.*	LC	Indigenous
Poaceae	*Aristida congesta Roem. & Schult. subsp. congesta*	LC	Indigenous
Poaceae	*Aristida diffusa Trin. subsp. burkei (Stapf) Melderis*	LC	Indigenous
Poaceae	*Eragrostis biflora Hack. ex Schinz*	LC	Indigenous
Poaceae	*Eragrostis capensis (Thunb.) Trin.*	LC	Indigenous

Poaceae	*Aristida bipartita (Nees) Trin. & Rupr.*	LC	Indigenous
Poaceae	*Phragmites australis (Cav.) Steud.*	LC	Indigenous
Poaceae	*Hyparrhenia hirta (L.) Stapf*	LC	Indigenous
Poaceae	*Digitaria eriantha Steud.*	LC	Indigenous
Poaceae	*Setaria incrassata (Hochst.) Hack.*	LC	Indigenous
Poaceae	*Enneapogon cenchroides (Licht. ex Roem. & Schult.) C.E.Hubb.*	LC	Indigenous
Poaceae	*Sporobolus oxyphyllus Fish*	LC	Indigenous; Endemic
Poaceae	*Echinochloa crus-galli (L.) P.Beauv.*	LC	Indigenous
Poaceae	*Avena sativa L.*	NE	Not indigenous; Naturalised; Invasive
Poaceae	*Sporobolus sp.*		
Poaceae	*Urochloa panicoides P.Beauv.*	LC	Indigenous
Poaceae	*Brachiaria serrata (Thunb.) Stapf*	LC	Indigenous
Poaceae	*Leersia hexandra Sw.*	LC	Indigenous
Poaceae	*Setaria sphacelata (Schumach.) Stapf & C.E.Hubb. ex M.B.Moss var. torta (Stapf) Clayton*	LC	Indigenous
Poaceae	*Melica decumbens Thunb.*	LC	Indigenous
Poaceae	*Eragrostis lappula Nees*	LC	Indigenous
Poaceae	*Cynodon transvaalensis Burtt Davy*	LC	Indigenous
Poaceae	*Cynodon dactylon (L.) Pers.*	LC	Indigenous
Poaceae	*Setaria sp.*		
Poaceae	*Cymbopogon dieterlenii Stapf ex E.Phillips*	LC	Indigenous
Poaceae	*Triraphis andropogonoides (Steud.) E.Phillips*	LC	Indigenous
Poaceae	*Pennisetum villosum R.Br. ex Fresen.*	NE	Not indigenous; Naturalised; Invasive
Poaceae	*Eragrostis plana Nees*	LC	Indigenous
Polygalaceae	*Polygala hottentotta C.Presl*	LC	Indigenous
Polygonaceae	*Persicaria hystricula (J.Schust.) Sojak*	LC	Indigenous
Polygonaceae	*Persicaria lapathifolia (L.) Delarbre*		Not indigenous; Naturalised; Invasive
Polygonaceae	*Rumex lanceolatus Thunb.*	LC	Indigenous
Polygonaceae	*Rumex sagittatus Thunb.*	LC	Indigenous
Potamogetonaceae	*Potamogeton pectinatus L.*	LC	Indigenous
Potamogetonaceae	*Potamogeton crispus L.*	LC	Indigenous
Ranunculaceae	*Ranunculus multifidus Forssk.*	LC	Indigenous
Ranunculaceae	*Clematis brachiata Thunb.*	LC	Indigenous
Ranunculaceae	*Ranunculus trichophyllus Chaix*	LC	Indigenous
Rhamnaceae	*Ziziphus zeyheriana Sond.*	LC	Indigenous
Rhamnaceae	*Ziziphus mucronata Willd. subsp. mucronata*	LC	Indigenous
Ricciaceae	*Riccia angolensis Steph.*		Indigenous
Rubiaceae	*Anthospermum rigidum Eckl. & Zeyh. subsp. rigidum*	LC	Indigenous
Rubiaceae	*Cordylostigma virgatum (Willd.) Groeninckx & Dessein*		Indigenous
Rubiaceae	*Kohautia amatymbica Eckl. & Zeyh.*	LC	Indigenous
Rubiaceae	*Vangueria pygmaea Schltr.*	LC	Indigenous
Rubiaceae	*Galium capense Thunb. subsp. capense*	LC	Indigenous
Rubiaceae	*Nenax microphylla (Sond.) T.M.Salter*	LC	Indigenous

Rubiaceae	*Rubia petiolaris DC.*	LC	Indigenous
Ruscaceae	*Eriospermum porphyrium Archibald*	LC	Indigenous
Ruscaceae	*Eriospermum schinzii Baker*	LC	Indigenous
Salicaceae	*Salix mucronata Thunb. subsp. mucronata*	LC	Indigenous
Santalaceae	*Thesium costatum A.W.Hill var. costatum*	LC	Indigenous
Santalaceae	*Thesium hirsutum A.W.Hill*	LC	Indigenous; Endemic
Scrophulariaceae	*Aptosimum elongatum (Hiern) Engl.*	LC	Indigenous
Scrophulariaceae	*Gomphostigma virgatum (L.f.) Baill.*	LC	Indigenous
Scrophulariaceae	*Jamesbrittenia sp.*		
Scrophulariaceae	*Jamesbrittenia atropurpurea (Benth.) Hilliard subsp. atropurpurea*	LC	Indigenous
Scrophulariaceae	*Selago sp.*		
Scrophulariaceae	*Aptosimum procumbens (Lehm.) Steud.*	LC	Indigenous
Scrophulariaceae	*Buddleja saligna Willd.*	LC	Indigenous
Scrophulariaceae	*Nemesia fruticans (Thunb.) Benth.*	LC	Indigenous
Scrophulariaceae	*Chaenostoma patrioticum (Hiern) Kornhall*	LC	Indigenous
Solanaceae	*Lycium ferocissimum Miers*	LC	Indigenous
Solanaceae	*Solanum elaeagnifolium Cav.*		Not indigenous; Naturalised; Invasive
Solanaceae	*Datura ferox L.*		Not indigenous; Naturalised; Invasive
Solanaceae	*Solanum rostratum Dunal*		Not indigenous; Naturalised
Solanaceae	*Solanum lichtensteinii Willd.*	LC	Indigenous
Solanaceae	*Solanum supinum Dunal*		Indigenous
Solanaceae	*Lycium arenicola Miers*	LC	Indigenous
Solanaceae	*Nicotiana glauca Graham*		Not indigenous; Naturalised; Invasive
Solanaceae	*Solanum retroflexum Dunal*	LC	Indigenous
Solanaceae	*Cestrum parqui L'Her.*		Not indigenous; Naturalised; Invasive
Solanaceae	*Lycium horridum Thunb.*	LC	Indigenous
Solanaceae	*Solanum campylacanthum Hochst. ex A.Rich.*		Indigenous
Solanaceae	*Lycium schizocalyx C.H.Wright*	LC	Indigenous
Solanaceae	*Withania somnifera (L.) Dunal*	LC	Indigenous
Solanaceae	*Lycium pilifolium C.H.Wright*	LC	Indigenous
Solanaceae	*Lycium hirsutum Dunal*	LC	Indigenous
Solanaceae	*Datura stramonium L.*		Not indigenous; Naturalised; Invasive
Talinaceae	*Talinum caffrum (Thunb.) Eckl. & Zeyh.*	LC	Indigenous
Thymelaeaceae	*Lasiosiphon capitatus (L.f.) Burtt Davy*	LC	Indigenous
Thymelaeaceae	*Lasiosiphon burchellii Meisn.*	LC	Indigenous
Thymelaeaceae	*Lasiosiphon kraussianus (Meisn.) Meisn.*		Indigenous
Typhaceae	*Typha capensis (Rohrb.) N.E.Br.*	LC	Indigenous
Ulmaceae	*Ulmus parvifolia Jacq.*		Not indigenous; Cultivated; Naturalised; Invasive
Vahliaceae	*Vahlia capensis (L.f.) Thunb. subsp. capensis*	LC	Indigenous
Vahliaceae	*Vahlia capensis (L.f.) Thunb. subsp. vulgaris Bridson var. linearis E.Mey. ex Bridson*	NE	Indigenous

Verbenaceae	*Lippia scaberrima Sond.*	LC	Indigenous
Verbenaceae	*Lantana rugosa Thunb.*	LC	Indigenous
Verbenaceae	*Verbena officinalis L.*		Not indigenous; Naturalised
Verbenaceae	*Glandularia aristigera (S.Moore) Tronc.*		Not indigenous; Naturalised; Invasive
Verbenaceae	*Chascanum pinnatifidum (L.f.) E.Mey. var. pinnatifidum*	LC	Indigenous
Verbenaceae	*Verbena brasiliensis Vell.*		Not indigenous; Naturalised; Invasive
Xyridaceae	*Xyris gerrardii N.E.Br.*	LC	Indigenous
Zygophyllaceae	*Tribulus terrestris L.*	LC	Indigenous

Appendix 4: Listed of Mammals

List of Mammals which potentially occur at the project site.

Species	Common name	Conservation Status	
		Regional (SANBI, 2016)	IUCN (2017)
Aethomys ineptus	Tete Veld Rat	LC	LC
Aethomys namaquensis	Namaqua rock rat	LC	LC
Alcelaphus buselaphus	Hartebeest	LC	LC
Antidorcas marsupialis	Sclater's Shrew	LC	LC
Aonyx capensis	Cape Clawless Otter	NT	NT
Atelerix frontalis	South Africa Hedgehog	NT	LC
Atilax paludinosus	Water Mongoose	LC	LC
Canis mesomelas	Black-backed Jackal	LC	LC
Caracal caracal	Caracal	LC	LC
Ceratotherium simum	White Rhinoceros	NT	NT
Connochaetes gnou	Black Wildebeest	LC	LC
Connochaetes taurinus	Blue Wildebeest	LC	LC
Crocidura cyanea	Reddish-grey Musk Shrew	LC	LC
Cryptomys hottentotus	Common Mole-rat	LC	LC
Cynictis penicillata	Yellow Mongoose	LC	LC
Damaliscus pygargus	Blesbok	LC	LC
Desmodillus auricularis	Short-tailed Gerbil	LC	LC
Diceros bicornis	Black Rhinoceros	EN	CR
Eidolon helvum	African Straw-colored Fruit Bat	LC	NT
Elephantulus myurus	Eastern Rock Sengi	LC	LC
Eptesicus hottentotus	Long-tailed Serotine Bat	LC	LC
Felis nigripes	Black-footed Cat	VU	VU

Felis silvestris	African Wildcat	LC	LC
Genetta genetta	Small-spotted Genet	LC	LC
Gerbilliscus brantsii	Highveld Gerbil	LC	LC
Gerbilliscus leucogaster	Bushveld Gerbil	LC	LC
Herpestes sanguineus	Slender Mongoose	LC	LC
Hydrictis maculicollis	Spotted-necked Otter	VU	NT
Hystrix africaeaustralis	Cape Porcupine	LC	LC
Ichneumia albicauda	White-tailed Mongoose	LC	LC
Ictonyx striatus	Striped Polecat	LC	LC
Leptailurus serval	Serval	NT	LC
Lepus capensis	Cape Hare	LC	LC
Lepus saxatilis	Scrub Hare	LC	LC
Lepus victoriae	African Savanna Hare	LC	LC
Lycaon pictus	African Wild Dog	EN	EN
Mastomys coucha	Multimammate Mouse	LC	LC
Mellivora capensis	Honey Badger	LC	LC

Appendix 5: Listed of Reptiles

Reptile species expected to occur in the project area

Species	Common name	Conservation Status	
		Regional (SANBI, 2016)	IUCN (2017)
Acontias gracilicauda	Thin-tailed Legless Skink	LC	LC
Afroedura nivaria	Drankensberg Flat Gecko	LC	LC
Agama aculeata distanti	Eastern Ground Agama	LC	LC
Agama atra	Southern Rock Agama	LC	LC
Aparallactus capensis	Black-headed Centipede-eater	LC	LC
Boaedon capensis	Brown House Snake	LC	LC
Chamaeleo dilepis	Common Flap-neck Chameleon	LC	LC
Chamaesaura aenea	Coppery Grass Lizard	NT	NT
Dasypeltis scabra	Common egg eater	LC	LC
Duberria lutrix	Common Slug-eater	LC	LC
Elapsoidea sundevallii sundevallii	Sundevall's Garter Snake	LC	Unlisted
Hemachatus haemachatus	Rinkhals	LC	LC
Lamprophis aurora	Aurora House Snake	LC	LC
Lygodactylus capensis capensis	Common Dwarf Gecko	LC	Unlisted
Pachydactylus capensis	Cape Gecko	LC	Unlisted
Panaspis wahlbergii	Wahlberg's Snake-eyed Skink	LC	Unlisted

Prosymna ambigua	Angolan Shovel-snout	Unlisted	LC
Prosymna sundevallii	Sundevall's Shovel-snout	LC	LC
Psammophis crucifer	Cross-marked Grass Snake	LC	LC
Psammophylax rhombeatus rhombeatus	Spotted Grass Snake	LC	Unlisted
Psammophylax tritaeniatus	Striped Grass Snake	LC	LC
Pseudaspis cana	Mole Snake	LC	Unlisted
Smaug giganteus	Giant Dragon Lizard	VU	VU
Stigmochelys pardalis	Leopard Tortoise	LC	LC
Thelotornis capensis	Southern Twig Snake	LC	LC
Trachylepis capensis	Cape Skink	LC	Unlisted
Trachylepis punctatissima	Speckled Rock Skink	LC	LC
Trachylepis varia	Variable Skink	LC	LC
Varanus niloticus	Water Monitor	LC	Unlisted

Appendix 6: Listed of Amphibians

Amphibian species expected to occur in the project area

Species	Common name	Conservation Status	
		Regional (SANBI, 2016)	IUCN (2017)
Amietia angolensis	Angola River Frog	LC	LC
Amietia delalandii	Delalande's River Frog	LC	Unlisted
Amietia fuscigula	Cape River Frog	LC	LC
Breviceps adspersus	Bushveld Rain Frog	LC	LC
Cacosternum boettgeri	Common Caco	LC	LC
Kassina senegalensis	Bubbling Kassina	LC	LC
Phrynobatrachus natalensis	Snoring Puddle Frog	LC	LC
Poyntonophrynus vertebralis	Southern Pygmy Toad	LC	LC
Pyxicephalus adspersus	Giant Bullfrog	NT	LC
Schismaderma carens	African Red Toad	LC	LC
Schismaderma carens	Red Toad	LC	LC
Sclerophrys capensis	Raucous Toad	LC	LC
Sclerophrys gutturalis	Guttural Toad	LC	LC
Sclerophrys poweri	Power's Toad	LC	LC
Semnodactylus wealii	Rattling Frog	LC	LC
Strongylopus fasciatus	Striped Stream Frog	LC	LC
Tomopterna cryptotis	Tremelo Sand Frog	LC	LC
Tomopterna natalensis	Natal Sand Frog	LC	LC
Tomopterna tandyi	Tandy's Sand Frog	LC	LC
Xenopus laevis	Common Platanna	LC	LC

Appendix 7. Specialist CV.

CURRICULUM VITAE:

Gerhard Botha

Name:	:	Gerhardus Alfred Botha
Date of Birth	:	11 April 1986
Identity Number	:	860411 5136 088
Postal Address	:	PO Box 12500 Brandhof 9324
Residential Address	:	3 Jock Meiring Street Park West Bloemfontein 9301
Cell Phone Number	:	084 207 3454
Email Address	:	gabotha11@gmail.com
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

Appendix 8. Specialist's Work Experience and References

WORK EXPERIENCES

&

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

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

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

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) - Assisted Dr. Dave McDonald	Dark Fibre Africa
2011	Optic Fibre Infrastructure Network, City of Cape Town Municipality	Botanical Assessment (for EIA) - 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

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).