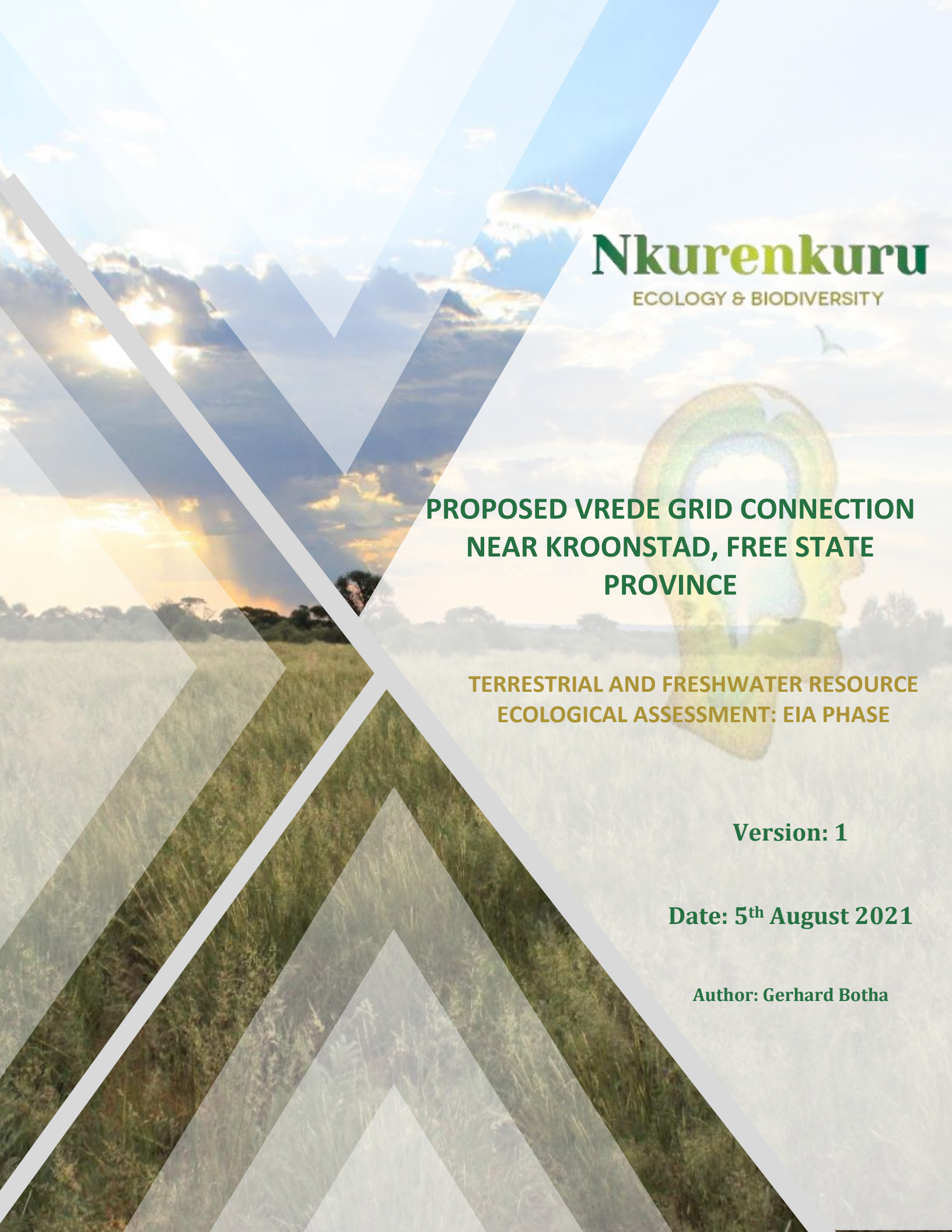

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ECOLOGY & BIODIVERSITY

PROPOSED VREDE GRID CONNECTION NEAR KROONSTAD, FREE STATE PROVINCE

TERRESTRIAL AND FRESHWATER RESOURCE ECOLOGICAL ASSESSMENT: EIA PHASE

Version: 1

Date: 5th August 2021

Author: Gerhard Botha

PROPOSED VREDE GRID CONNECTION NEAR KROONSTAD, FREE STATE PROVINCE

Report Title: Terrestrial and Freshwater Resource Ecological Assessment

Authors: Mr. Gerhard Botha

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

Status of report: Version 1

Date: 5th of August 2021

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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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Field of expertise: Fauna & flora, terrestrial biodiversity, wetland ecology, aquatic and wetland, aquatic biomonitoring, and wetland habitat evaluations. BSc (Hons) Zoology and Botany, MSc Botany (Phytosociology) from 2011 to present.

August 2021

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PROPOSED VREDE GRID CONNECTION NEAR KROONSTAD, FREE STATE PROVINCE

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 Vrede Solar PV facilities to the grid via a dedicated grid connection solution, to be known as Vrede 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 Vrede 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:

Both Alternative 1 and Alternative 2:
» Remaining extent of the farm Vrede No. 1152;
» Remaining Extent of the farm Gesukkel No. 1153;
» Remaining Extent of the farm Geduld No. 1156.

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 Vrede Grid Connection solution will loop into the existing Eskom 132kV Kroonstad Municipality – Theseus 1 132kV power line.

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.

Two alternative routes are being considered for the Vrede Grid Connection:
» Alternative 1: 1 579m
» Alternative 2: 2 905m

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.

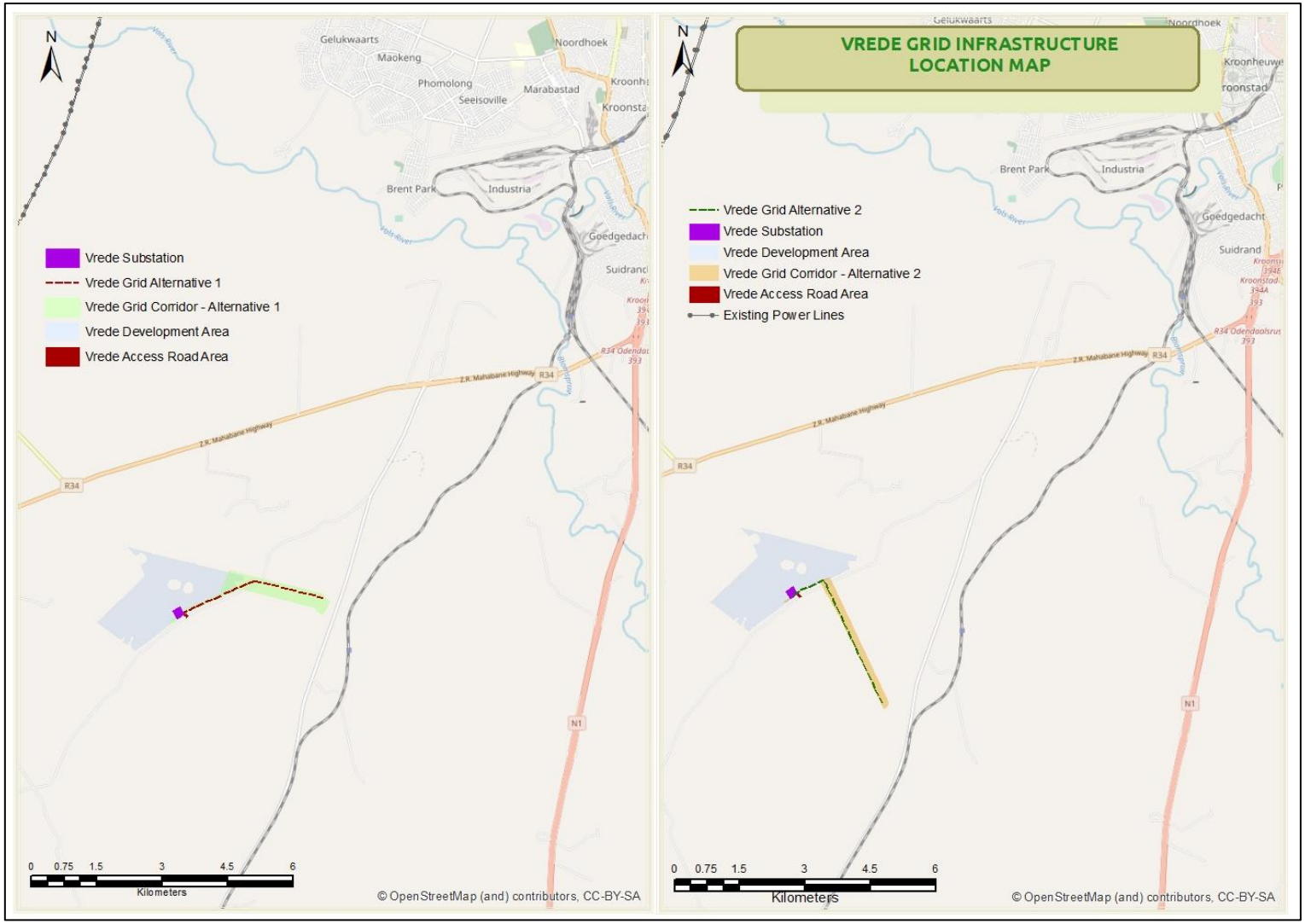

Figure 1: Proposed location of the Vrede Grid Infrastructure.

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.

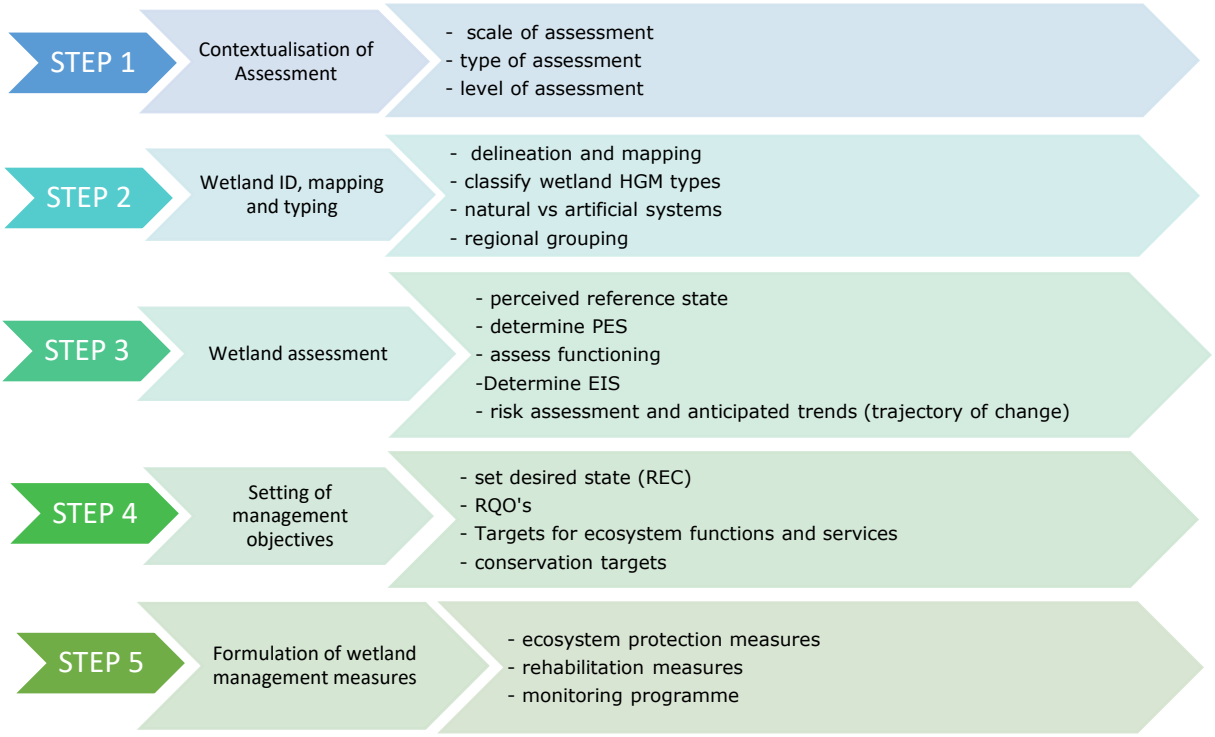

Figure 2: Proposed decision support framework for wetland assessment in South Africa (after Ollis et al., 2014)

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.
» Kooij, M.S., Scheepers, J.C., Bredenkamp, G.J. & Theron, G.K. (1991). The Vegetation of the Kroonstad Area, Orange Free State I: Vlei and Bottomland Communities. *S.Afr.J.Bot*. **57(4)**: 213-219.
» 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 (Figure 3). 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 provides 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 55% of the entire development area is located on cultivated fields (dryland), whist approximately 30% of the project site can be regarded as a natural form of grassland. Furthermore, approximately 4% of the project site is covered by wetlands.

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 a spatial analysis, which were also confirmed during the field work, 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.

The affected properties are predominantly used for agricultural purposes, in the past mainly for dryland cultivation, and to a lesser extent for livestock farming (predominantly cattle). However, cultivation practices have been abandoned within the project area for a relative long period of time. Game farming have also become much more prominent within the region over the last decade (wide variety of game species including rare antelope and big game such as buffalo).

Currently (and for a long period of time), no cultivation activities are taking place. Approximately 60% of the development area appears to be fallow lands, most recently abandoned (<20 years) and is now used as pastures for cattle. Historically cultivated land (> 30 years), covers an area of approximately 18% (of the development area) 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 (Figure 2). These areas are also now likely being utilised as grazing. Subsequently, approximately 78% of the development area has been, at some point in time, subjected to ploughing (soil and vegetation disturbance) and cultivation. Only approximately 20% natural veld remain comprising of grasslands with varying coverage/density of shrubs.

Furthermore, natural wetland features cover approximately 2% of the project area, comprising mostly of valley-bottom and depression wetlands. Small earth dam structures have been created within some of the wetlands, in an attempt to concentrate and store surface water for longer periods of time within these wetland features.

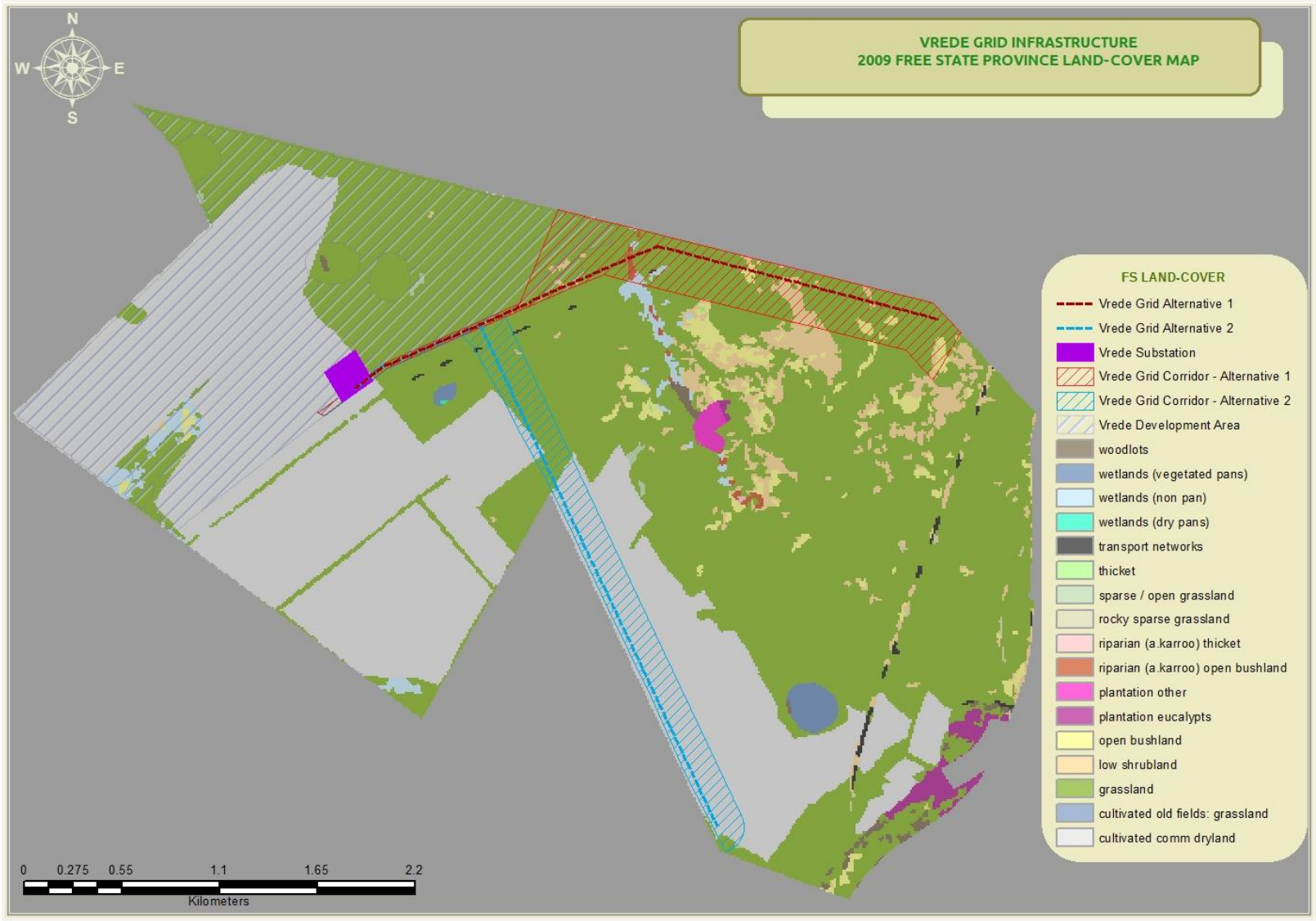

Figure 3: 2009 Free State Province Land-Cover Map (note: cultivated land illustrated here has since been abandoned and is now utilised as pastures for cattle farming, as was confirmed during the site visit).

Regional/Local Biophysical Setting

The development footprint is located on Portion 1 of the farm Uitval No. 1104 and the Remaining Extent of the farm Vrede No. 1152, situated approximately 18.3km (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 an existing gravel road (P99/1 route) which provides access to the properties off of the secondary road (S172 route) which is located east of the project site linking Kroonstad with Hennenman.

Land use within the project site is mostly for farming. Farming practices consist of livestock farming (cattle) farming with some "free" roaming small game. Due to moderate to moderate-low land capability of the dominant soil forms within the project site, crop production has been systematically abandoned over the past 30-20years, with the historically cultivated areas converted to grazing field (pastures). Small, fractured patches of natural vegetation have remained in areas that have never been ploughed. In terms of the surrounding landscape, most farmers have followed a similar route, where unproductive lands have been converted to grazing field. However, rainfed annual crop production is still a common practice within some of the properties to the west, and especially to the south. Pivot irrigation is a less common land use practice within the area. Most "natural" vegetation within the surrounding properties are used for cattle farming, however the breeding of scarce and large game has become increasingly popular within the area, especially to the north and east of the affected properties. The neighbouring property to the south has a relative intensive lion breeding programme.

Prominent anthropogenic features within the region include the P99/1 gravel road, S172 secondary route, 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, game and cultivation 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 C60H whilst a portion of the northern half of the development site falls within Quaternary Catchment C60G (Middle Vaal Management Area), which is drained by the Vals River and associated tributaries including the Diepstruit stream traversing the north eastern corner of the development site, flowing mostly in a northern direction and feeding directly into the Vals River (Figure 4). Other prominent watercourses draining the region include the Blomesprui and Otterspruit.

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 Vrede 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.

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 SEF footprint.

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

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

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			
DWA Ecoregions	Level 1	Level 2	DWA, 2005
	Highveld	11.08	
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	Vaal-Vet Sandy Grassland: Plains-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. Central Free State Grassland: 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, & 2018)
BODATSA Data	Regional: Total Species Observed 491 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	2020-08-02_231620030-BRAHMSOnlineData

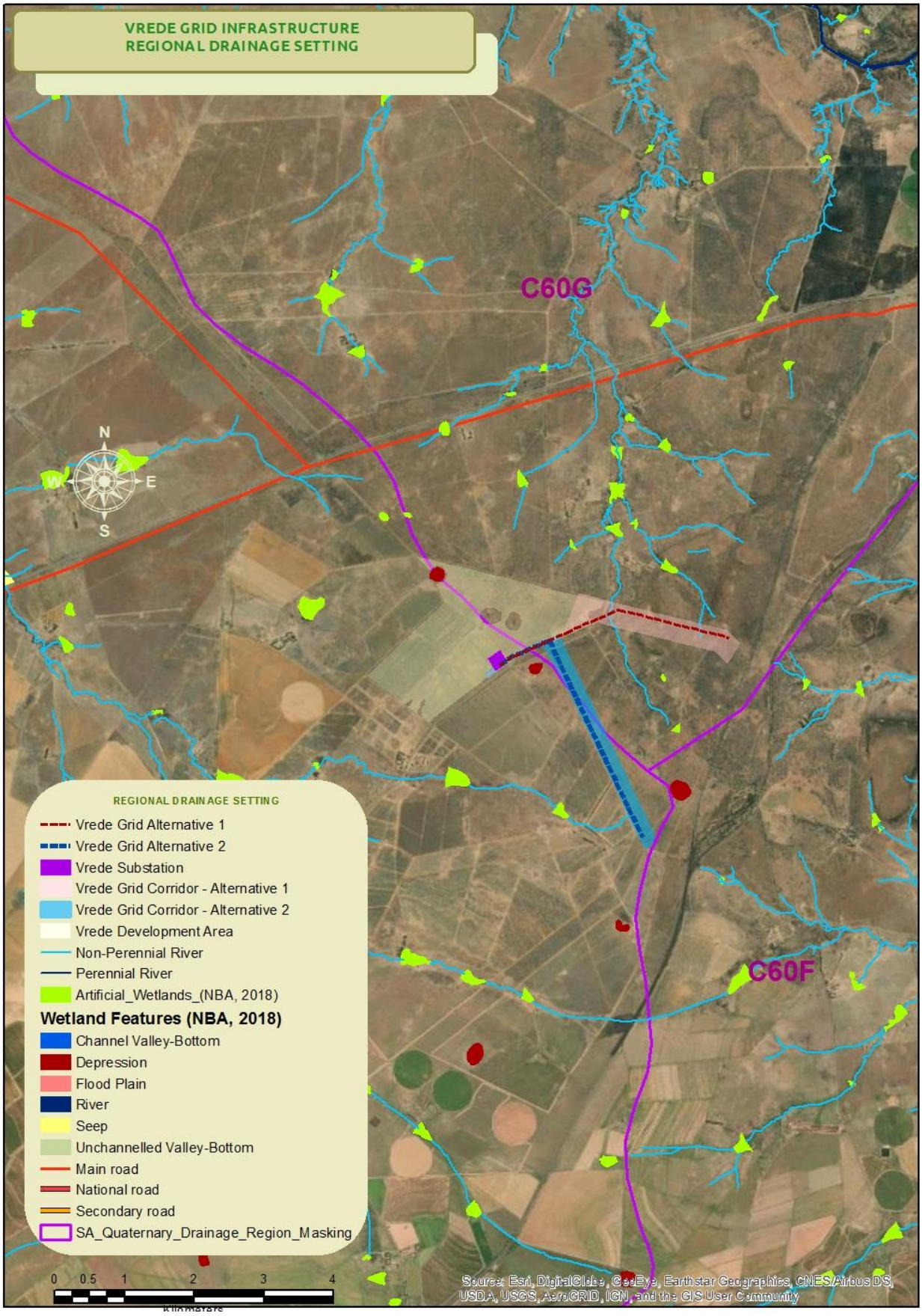

Figure 4: Regional drainage setting.

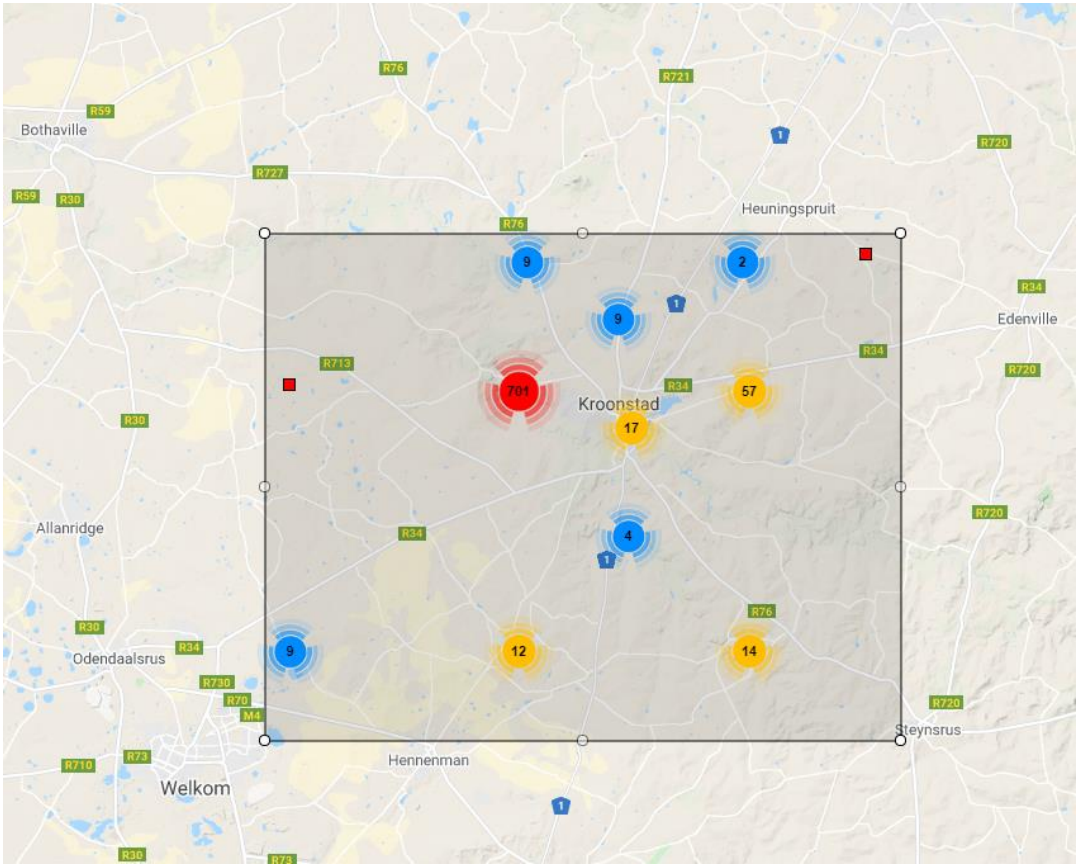

Figure 5: Extracted area and sample locations from POSA. Extracted data was used to compile a plant species list of species that may potentially occur within the project site and provide an indication of potential conservation important species that may be found within the area.

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 5).

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	National Protected Areas Expansion Strategy	Focus Area	Outside of Focus Area: ± 2km south of a Free State Highveld Focus Area	Not Classified
	Protected Areas and Conservation	South African Conservation Area (SACA)	Well outside of any SACA:	Not Classified

	Areas (PACA) Database	South African Protected Area (SAPA)	Located adjacent, south of Boslaagte Private Nature Reserve	Boslaagte Private Nature Reserve
	Vegetation Types	Vaal-Vet Sandy Grassland	Vegetation of Study Area	Endangered
		Central Free State Grassland	Vegetation of Study Area	Least Threatened
	Threatened Ecosystems	Vaal-Vet Sandy Grassland Ecosystem	Ecosystems of Study Area	Endangered
	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
	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.
PROVINCIAL AND REGIONAL LEVEL CONSERVATION PLANNING CONTEXT	NCBSP: Critical Biodiversity Areas	Ecological Support Areas ESA1	Corridors/linkages between the upland (terrestrial) areas and important water resource features such as the Vals and Blomspruit Rivers. No ESA1 located within the SEF development area.	ESA
		Critical Biodiversity Areas CBA1	Natural areas of Vaal-Vet Sandy Grassland which are regarded as irreplaceable and essential in meeting the biodiversity conservation targets as set out for the Free State Province North-eastern and north-western portions of SEF development area falls within CBAs	CBA1

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 6).

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 outside of any Focus Area (Figure 7) with the closest focus area located approximately 2km to the north (Free State Highveld Focus Area). Subsequently, no NPAES Focus Areas will be impacted by the development.

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 adjacent to the north of the proposed SEF footprint (Figure 7). Such nature reserves are typically well cordoned off with game fences, often with some electrified wires, 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. Some disturbance of the nature reserves' fauna may however occur along the boundary fence during the construction phase and periods of maintenance during the operational phase. Most animals will likely merely move away from the area near the disturbance and will likely move back as the movement and noise declines. This potential impact was assessed in this report and recommendations and mitigation measures provided as required, in order to reduce the impact of noise and human movement on the fauna of the nature reserve.

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)
Vaal-Vet Sandy Grassland	24%	0.3%	65.2%	Endangered	Endangered
Central Free State Grassland	24%	0.8%	23.5%	Least Concerned	Not Listed

According to current layout the bulk of the footprint is located within the endangered Vaal-Vet Sandy Grassland (Figure 8), with only a small portion falling within the Central Free State Grassland. However, as described earlier (Land cover and Land Use Section), approximately 78% of the development footprint is located within transformed areas whist only 20% of the footprint is located in what appears to be grassland largely consistent to that of Vaal-Vet Sandy Grassland. Furthermore, during the field survey it was found that only approximately 10% of the project area resembles a slightly impacted form of Vaal-Vet Sandy Grassland

During the survey and assessment, it was determined that most of these areas identified as Natural Vaal-Vet Sandy Grassland have been historically subjected to cultivation and vegetation transformation, with small patches of remaining natural vegetation, resembling natural, untransformed Vaal-Vet Sandy Grassland. These patches of natural grassland, collectively, only cover an area of less than 15% of the proposed projects site, furthermore, most of these patches of natural Vaal-Vet Sandy Grassland along the northern boundary will be avoided, according the development layout. Although the development will impact at a small, local scale it is highly unlikely that this development will impact on the status of

this vegetation type (impact on a regional scale) as the majority of the development will occur, as mentioned, within mostly transformed habitats.

At species level:

No Plant SCC have been historically observed within the development site, according to available plant species lists of the area; however, a few provincially protected species have been observed namely;

- *Aloe davyana* (a single species, just outside of the development footprint),
- *Boophone disticha,*
- *Schizocarpus nervosus,*
- *Amorcharis conranica* (the plants observed were associated with the wetland habitats and as these habitats will be avoided, these species will not be impacted).

Such species are especially vulnerable to infrastructure development due to the fact that they cannot move out of the path of the construction activities, but are also affected by overall loss of habitat.

The nature and extent of impacts on vegetation can be evaluated, and the impacts can be largely mitigated through avoidance of identified sensitive areas and listed species, by allowing a minimum clearance of vegetation (restricted to the absolute necessary areas), or allowing for search and rescue of individuals where this is viable.

Due to the small extent of natural grassland remaining within the SEF footprint, as well as the fractured nature of these patches of natural grassland, it is unlikely that the development will have a significant impact on this vegetation/ecosystem type.

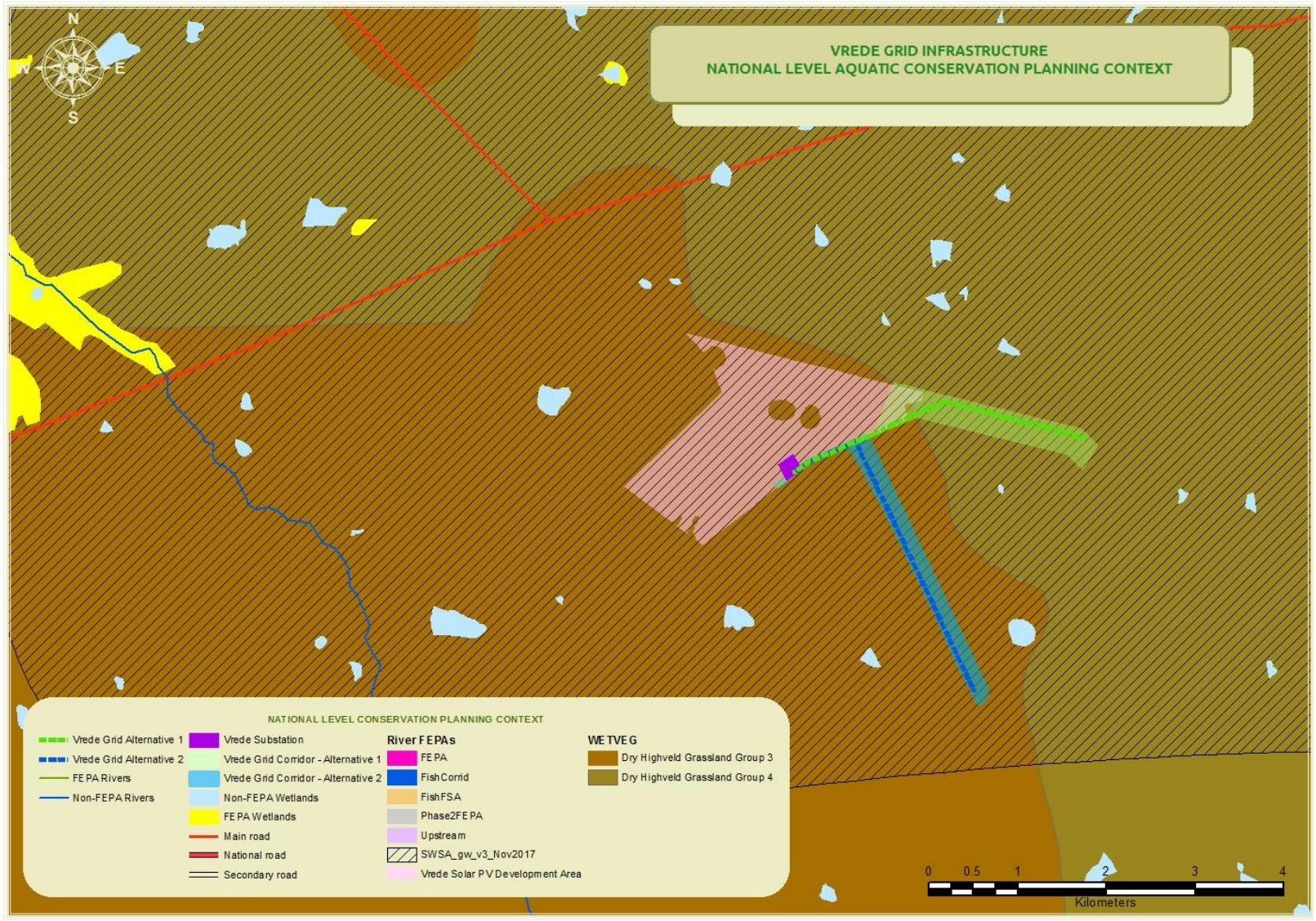

Figure 6: National Level Aquatic Conservation Planning Context.

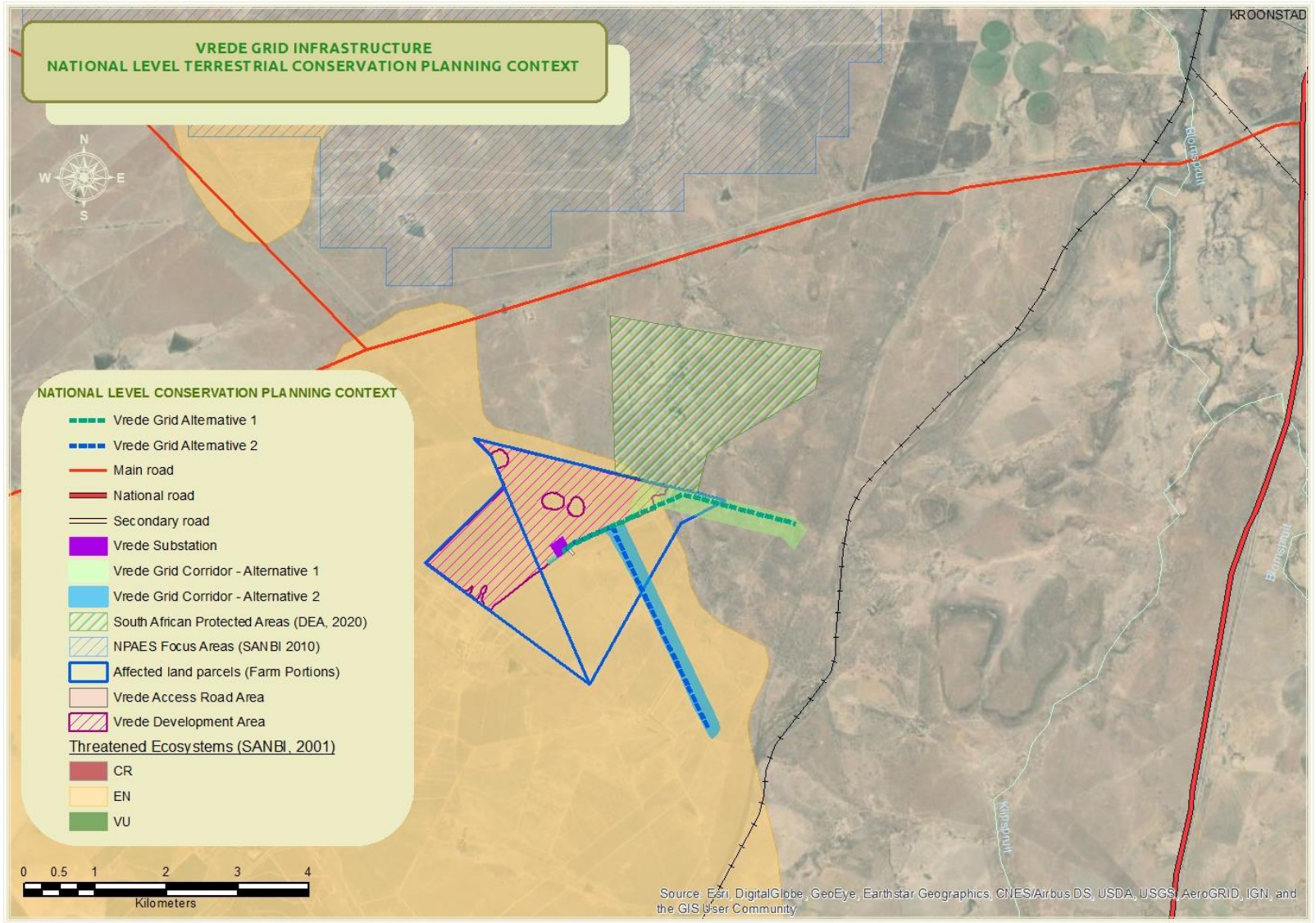

Figure 7: National Level Terrestrial Conservation Planning Context

Critical Biodiversity Areas and Broad Scale Ecological Processes

The development area occurs 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 majority of the development area occurs within degraded areas whilst the north-eastern and north-western portions of the footprint is located within CBA1 (Figure 8). No ESA1 or 2 sites occur within the development footprint.

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).

Critical Biodiversity Areas 1

The CBAs located within the development area, have been classified as such due to fact that these areas are regarded as irreplaceable as they are potentially essential in meeting the targets set for the conservation of the endangered Vaal-Vet Sandy Grassland. However, during the field survey, it was found that large portions that have been classified as CBAs were in fact historical cultivated areas that have been left fallow for an extensive period of time allowing for succession to take place to a stage where these areas are now covered with a relative stable grass and shrub cover. Subsequently, natural/original Vaal-Vet Sandy Grassland are only confined to a few isolated patches. Due to the small extent and patchy distribution of this endangered vegetation type within the SEF footprint, it is unlikely that this development will have an impact on the status of the remaining natural Vaal-Vet Sandy Grassland.

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 development area revealed that no River FEPAs are located within the development area of the project. Furthermore, the NFEPA coverage for the development area shows no Wetland FEPAs contained therein.

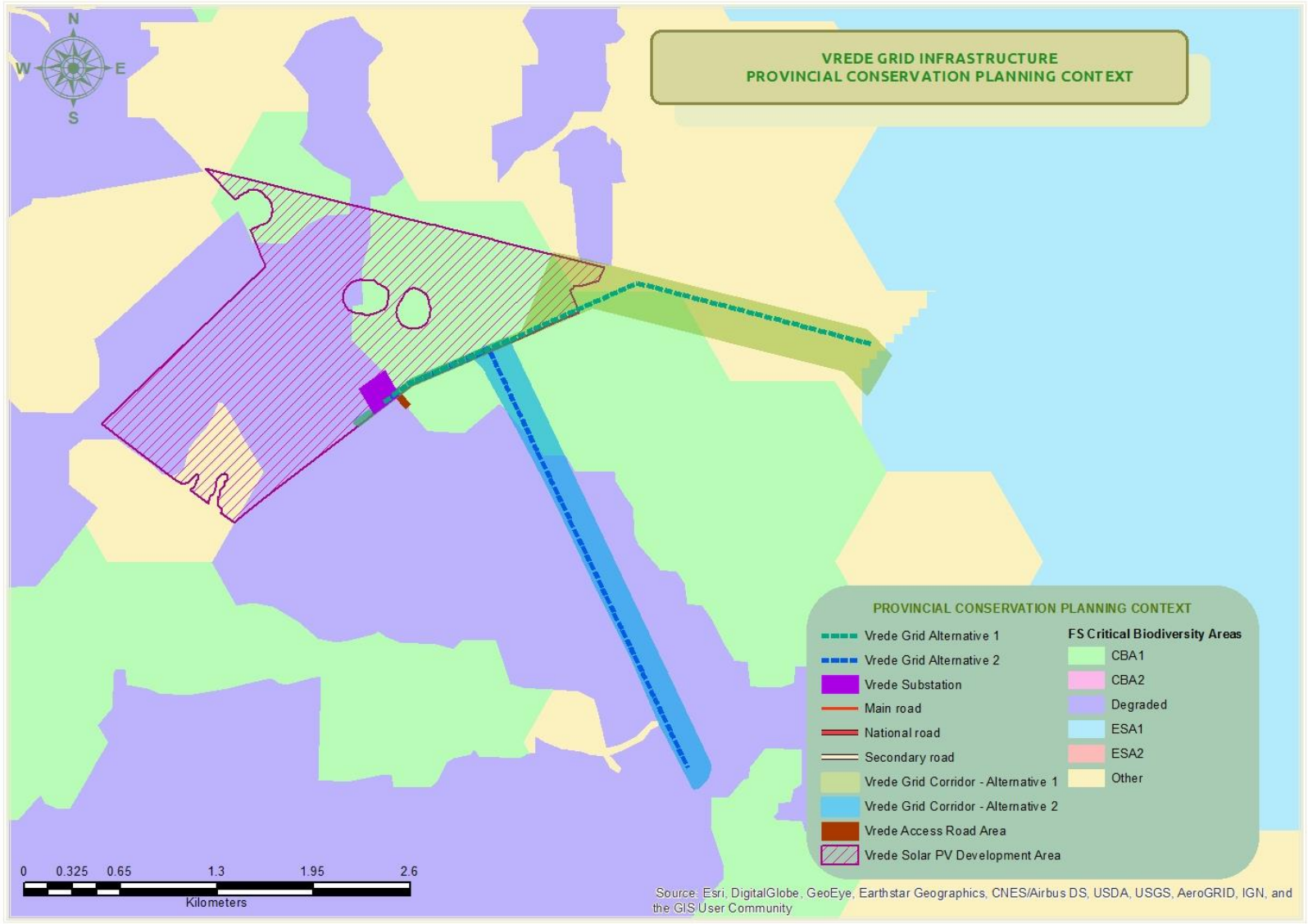

Figure 8: Provincial Level Conservation Planning Context – CBA Map (Free State Province Biodiversity Conservation Assessment).

6. FINDINGS OF THE FRESHWATER RESOURCE BASELINE ASSESSMENT

The baseline habitat assessment, informed by on-site data collection, focused on wetland units that are regarded as being at High to Moderate 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 7th to the 10th of April 2021.

On the project site, there are three depression wetland features, and a channelled valley-bottom wetland running across the north-eastern corner of the site and which terminates into the Vals River to the north. A seepage wetland feeds into the valley-bottom wetland (within the project area).

All of the freshwater resource features on and around the site are mostly, naturally, ephemeral, however artificial (anthropogenically) modifications to the morphology of most of the wetlands has resulted in portions of these wetland resource features becoming seasonally inundated (for an extended period of time).

A dominant feature of the channelled valley bottom wetland is the patches of woody riparian habitats interrupted with grassy riparian fringes lining the outer edges of these valley bottom wetlands. The height and density of the forb and tree/shrub layer is highly variable throughout the extent of the valley-bottom wetland. The depression wetlands as well as the seepage wetland comprise of a large temporarily saturated zone with a small seasonally saturated zone and an artificially created permanent saturated zone (only in the case of the depression wetlands, this zone is absent within the seepage wetland) and is dominated by a dense, moderate to tall graminoid cover (obligate and facultative wetland grasses and sedges).

Ultimately, five (5) freshwater resource features were identified and delineated within the development area and include; <u>three</u> depression wetland, <u>one</u> seepage wetland and one channelled valley-bottom wetland (Figures 9).

Classification, Delineation and Description of Surface Water Resource Features

Surface Water Resource Delineation

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

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.

Depression Wetlands:

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.

Wetland ecosystems are in general the dominant drainage features in this landscape and comprise predominantly of ephemeral depressions (endorheic) hydrogeomorphic (HGM) units. Depression wetlands, also known as pans, form within shallowed-out basins within the flatter landscape areas and are generally closed systems that are inward draining (endorheic).

Three such depression wetlands were identified and delineated within the development footprint. Such depression wetlands make up the majority of the lentic (non-flowing) systems of the greater landscape. These depression wetlands are, as mentioned endorheic, i.e. isolated from other surface water ecosystems, usually with inflowing surface water but no outflow. There is generally little or no direct connection with groundwater, and these depressions tend to be fed by unchanneled overland flow and interflow following rainfall events. Interflow is the lateral movement of water, usually derived from precipitation, that occurs in the upper part of the unsaturated zone between the ground surface and the water table. This water generally enters directly into a wetland or other aquatic ecosystem, without having occurred first as surface runoff, or it returns to the surface at some point down-slope from its point of infiltration.

Endorheic pans are the most common wetland type in arid and semi-arid environments (Allan *et al.*, 1995), and are generally thought to form as a result of the synergy of a number of factors and processes, including low rainfall, sparse vegetation, flat to gently sloping topography, disrupted drainage, geology (e.g. dolerite sills and dykes) grazing and deflation.

Naturally, inundation periods for these wetlands, would have been short-lived (few weeks up to about two months) following sufficient precipitation. However, in an attempt to store

surface water for longer periods (water source for livestock), portions of these depression wetlands have been artificially deepened. These portions are now seasonally inundated and may stay inundated for extended periods of time. This modification to the morphology and hydrology of the wetland have resulted in an alteration in the local vegetation cover as well. The depression wetland is covered by moderate to tall graminoid and forb layer, with graminoids, especially moisture loving (hydrophytic and mesophytic), grasses being the most prominent.

Seepage Wetland:

A single seepage wetland has been identified within the project area. Seepage wetlands tend to be located on gently (as in the case of this delineated seep) to steeply sloping land and is dominated by colluvial (gravity driven), unidirectional movement of water and material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically extend onto a valley-floor. This specific seepage wetland is located on a fairly gently slope, just above the valley-floor, which contains a channelled valley-bottom wetland and into which this seepage wetland feeds into.

Seepage wetlands are characterized by their association with geological formations (litologies) and topographic positions that either cause groundwater to discharge to the land surface or rain-derived water to seep down-slope as subsurface interflow. In the case of this seepage wetland, the wetland owes its presence to the fact that the water table intersects the land surface along the slope, resulting in groundwater discharge directly to the land surface as well as presence of a relatively impervious subsoil layer (clay) which impedes the infiltration of rain-derived water into the ground.

Thus, water inputs are primarily via subsurface flows from an up-slope direction. Water movement through the seep is mainly in the form of interflow, with diffuse overland flow often being significant during and after rainfall events. Furthermore, the seep is connected to a valley-bottom wetland and water tends to seep into the valley-bottom wetland through a combination of diffuse surface flow and interflow.

Inundation periods for this wetland is very short-lived (a matter of days) following sufficient precipitation. Furthermore, soil saturation is mainly temporary with a small portion being seasonally saturated. The seep is covered by an overall moderate tall grass and forb layer, especially moisture loving (mesophytic), grasses dominating the wetland.

Channelled Valley-bottom Wetland (CVB)

A single channelled valley-bottom wetland has been identified within the north-eastern portion of the project area. 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 define channel. In terms of this CVB wetland the channel within the upper reaches is predominantly relative narrow and shallow, however trampling, overgrazing and erosion have locally scoured the channels, deepening sections of these channels and in some areas have created deeper pools. The effect of channel deepening and widening becomes much more pronounced downstream, especially north of the R34 route where erosion has had a significant impact on the morphology of this wetland

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.

Inundation periods for this wetland is highly variable (laterally and longitudinally). In terms of the impacted portion of the wetland, inundation of the channel is typically fairly short-lived (few weeks) following sufficient precipitation. However, inundation within the eroded channels and pools may be seasonally. Inundation of the wetland areas adjacent to the channel is very seldom and erratic.

The channel and deeper pools tend to be more sparsely covered by a short to medium vegetation cover, comprising of a mixture of hydrophytic sedges and forbs. The terrace sections (seasonal and mostly temporary saturated zones) of the CVB wetland is however densely covered by medium to tall grasses and some forbs. Patches of woody riparian trees and shrubs can be found occasionally along lining the outer boundary of the CVB wetland, and in some areas these woody elements may encroach into the CVB wetland. Tree/shrub and forb density and height is highly variable along this CVB wetland.

Table 9: Summary of delineated freshwater resource features.

HGM Unit	Summary		
Depression Wetlands	Size	Wetland 3	1.695 ha
		Wetland 4	3.926 ha
		Wetland 5	2.310 ha
	Slope	Wetland 3	1.5% (Max: 2.8%)
		Wetland 4	1.1% (Max: 2.6%)
		Wetland 5	1.6% (Max: 3.2%)
	Elevation	Wetland 3	1430 - 1433m (Av. 1432m)
		Wetland 4	1432 – 1345m (Av. 1434m)
		Wetland 5	1429 – 1432m (Av. 1431m)
	Landscape Unit	Valley Floor	
	Outflow Drainage	No outflow (Endorheic)	
	Inflow Drainage	Unchanneled overland flow and interflow	
	Hydroperiod	All tree hydro-geomorphic zones are present: » Permanent saturated zone (smallest portion of the wetland) » Seasonal saturated zone » Temporary saturated zone (largest portion of wetland) Inundation: » Was naturally intermittent » Artificial deepening of a portion of these wetlands have resulted in these deeper areas being seasonally intermittent.	
	Drainage Direction	Various directions	
	Sediment	<u>Permanent Saturated Zone:</u> Katspruit » Orthic A Horizon: Dark greyish brown horizon with greyish brown to grey coloured clay fractions and greyish coatings on sand particles. Bleached horizon reflects reducing soil conditions and a greater degree of saturation with water in this horizon. » Gley Horizon: Diffuse transition from Grey to light grey. A result of continuous duration of saturation with stagnant and reduced water. Marked accumulation of clay within the horizon due to illuviation from upslope areas. Form in terrain positions subjected to vertical, and especially lateral in-flow of water and where subsurface water permeability to adjacent soil is low, limiting out-flow of water. <u>Seasonal Saturated Zone:</u> Sepane	

		» Orthic A Horizon: Greyish Brown horizon with greyish brown to grey coloured clay fractions and greyish coatings on sand particles. Bleached horizon along with an abundance (40%) of fairly large red to dark orange mottles reflect reducing soil conditions and a greater degree of seasonal saturation with water in this horizon. » Pedocutanic Horizon: Moderately structured soils with distinct cutans on the ped surface and a sandy clay loam texture. Cutanic character is the result of the illuviation of fine material manifested as prominent clay cutans on most ped surfaces. Fairly abundant (25%) red and dark orange mottles. » Gley Horizon: Diffuse transition from light brownish grey to light grey). Few mottles (10%), mainly small light orange to yellow. <u>Temporary Saturated Zone:</u> Sepane » Orthic A Horizon: Greyish Brown horizon with very little few mottles (1%) » Pedocutanic Horizon: Light yellowsh brown to brownish grey moderately structured soils with distinct cutans on the ped surface and a sandy clay loam texture. Moderately low abundance (5%) of small red mottles. Fairly abundant red and dark orange mottles. » Gley Horizon: Diffuse transition from light brownish grey to light grey. Few mottles (7%), mainly small light orange to yellow.
	Key Plant Species	Permanent Saturated and Seasonally Inundated Zone	*Eleocharis limosa, Aponogeton rehmannii, Utricularia stellaris, Potamogeton crispus, Persicaria decipiens, Paspalum distichum*
		Permanent Saturated and Temporary Inundated Zone	*Paspalum distichum, Leptochloa fusca, Persicaria decipeins, Eleocharis limosa*
		Seasonal Saturated Zone	*Echinochloa holubii, Eragrostis planiculmis, Helichrysum aureonitens, Cyperus denudatus, Leptochloa fusca, Gnaphalium filagopsis, Verbena bonariensis, V. officinalis, Setaria incrassata*
		Temporary Saturated Zone	*Eragrostis plana, Eragrostis chloromelas, Themeda triandra, Helichrysum aureonitens, Verbena officinalis, Cynodon dactylon, Eragrostis curvula, Panicum coloratum, Gomphocarpus fruticosus, Arctotis arctoides, Conyza bonariensis, Eragrostis gummiflua*
Seepage Wetland	Size	1.6868 ha	
	Slope Elevation Landscape Unit	1.8% (Max: 3.2%) 1397 - 1403m (Av. 1400m) Footslope	
	Outflow Drainage	Unchanneled overland- and interflow into channeled valley-bottom wetland	
	Inflow Drainage	Via subsurface flows from an up-slope direction	
	Hydroperiod	Saturation Period: Intermittently Inundation Period: Very seldomly inundated	
	Drainage Direction	Eastward towards the CVB wetland.	
	Sediment	<u>Seasonal Saturated Zone:</u> Sepane	

		» Orthic A Horizon: Greyish Brown horizon with greyish brown to grey coloured clay fractions and greyish coatings on sand particles. Bleached horizon along with an abundance (40%) of fairly large red to dark orange mottles reflect reducing soil conditions and a greater degree of seasonal saturation with water in this horizon. » Pedocutanic Horizon: Moderately structured soils with distinct cutans on the ped surface and a sandy clay loam texture. Cutanic character is the result of the illuviation of fine material manifested as prominent clay cutans on most ped surfaces. Fairly abundant (25%) red and dark orange mottles. » Gley Horizon: Diffuse transition from light brownish grey to light grey). Few mottles (10%), mainly small light orange to yellow. <u>Temporary Saturated Zone:</u> Tukulu » Orthic A Horizon: Brown horizon with very little few mottles (2%) » Neocutanic Horizon: Overall pale brown (variegated soil colours) weakly structured subsoil. Associated with materials of colluvial origin located in footslopes that have been subjected to an intermediate stage of pedogenic alteration. Colour variegations in neocutanic horizons are usually the result of illuvial material that coats weak structural units. Moderately low abundance (4%) of small red mottles. Gley Horizon: Diffuse transition from light brownish grey to light grey. Few mottles (7%), mainly small light orange to yellow.	
	Key plant species	Seasonal Saturated Zone	*Eragrostis planiculmis, Pennisetum spacelatum, Setaria incrassata, Senecio inornatus, Eragrostis plana, Paspalum dilatatum, Themeda triandra, Setaria pallide-fusca, Sporobolus africanus*
		Temporary Saturated Zone	*Eragrostis plana, Eragrostis planiculmis, Themeda triandra, Cynodon dactylon, Eragrostis chloromelas*
Channeled Valley-Bottom Wetland	Size (Potential area of impact)	10 ha	
	Slope (Potential area of impact)	0.6% (Max: 3.3%)	
	Elevation	1394 - 1409m (Av. 1400m)	
	Landscape Unit	Valley floor	
	Outflow Drainage	Mainly channeled surface flow.	
	Inflow Drainage	Surface flow and interflow	
	Hydroperiod	Saturation Period: Permanent saturated pools, Seasonally Saturated channels and terraces fringe channels, Temporary Saturated terraces. Inundation Period: Intermittently within channels and seasonally within deeper pools.	
	Drainage Direction	Northwards towards the Vals River	
	Sediment	<u>Permanent Saturated Zone:</u> Rensburg <u>Seasonal Saturated Zone:</u> Katspruit (Vertic horizon overlying a Gley subsurface); Idutywa (Orthic A horizon overlying a Prismacutanic and then Gleyic horizon) <u>Temporary Saturated Zone:</u> Sepane (Orthic A horizon overlying a Peducutanic and then Gleyic Horizon)	

	Key plant species	Permanent Saturated and Seasonally Inundated pools/depression within channels	*Marsilea macrocarpa, Schonoplectus muricinux, Leersia hexandra, Persicaria decipeins, Paspalum distichum, Echinchloa holubii*
		Seasonally Saturated Channels	*Verbena officinalis, Paspalum dilatatum, Cynodon dactylon, Haplocarpa scaposa, Cypersus eragrostis,*
		Permanent Saturated and Seasonally Inundated pools/depression within channels	
		Temporary Saturated Zone	Paspalum dilatatum, Echinochloa holubii, Verbena officinalis, Eragrostis plana, Setaria incrassata, Seatria pallide-fusca, Eragrostis planiculmis, Pennisetum sphacelatum, Sporobolus africanus
		Riparian Zone	*Celtis africana, Searsia pyrioides, Sida dregei, Pavonia senegalensis, Pentharrhinum insipidum, Gleditsia triacanthos, Ziziphus mucronata, Acacia karoo, Asparagus laricinus, Setaria verticillata, Cynodon dactylon, Bidens bipinnata, Achyranthes aspera*

Present Ecological State

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 10.

» The depression wetlands (W3-5) as well as the channelled valley bottom wetland (W1) (W6) have 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 wetland (W6) has been assessed as being largely natural with few modifications ('B' PES) which implies *that a slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.*

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

» Depression wetland:
    - Alteration to a portion of the wetlands morphology: Portions have been artificially (anthropogenically) deepened in order to store water for longer periods of time (water source for cattle). The overburden material has been stockpiled within the boundaries of the wetlands and has also contributed to the modification of the morphology;
    - These deepened areas have led to a slight local change in the inundation period extent of the hydro-morphological zones as well as the plant species cover within the inundated area.
    - Especially the permanent and seasonally saturated zones have been subjected to trampling.
    - All of these wetlands are exposed frequent grazing with some local signs of overgrazing.
    - Disturbed areas are subjected to the invasion of numerous weedy and herbaceous invasive alien plants such as *Salsola kali, Alternanthera pungens,*

Tribulus terrestris, Cirsium vulgare, Schkuria pinnata, Tagetes minuta, Xanthium spinosum, Datura stramonium and Verbena aristigera,

- Outside of these disturbed areas, the "natural" areas also contain some invasive alien plants such as Verbena bonariensis and especially *V. officinalis*. Other alien and weedy plants frequently observed include; *Conyza bonariensis, Tagetes minuta, Verbena aristigera and Paspalum dilatatum,*
- Historically ploughing/cultivation activities have encroached slightly into portions of the temporary zones; however, these practices have been abandoned, and a plagioclimax grassland has since established within these areas.

» Seepage Wetland:

- Long term selective grazing and occasional overgrazing have impacted the grass composition slightly.
- A power line spans across this wetland with a few pylons located within the wetland.
- Alien invasive plants such as Verbena bonariensis and especially V. officinalis have established within this area although the current level of invasion is regarded as low.
- Indigenous shrubs such *as Acacia (Vachellia karoo)* and *Asparagus laricinus* have become slightly encroaching although level is regarded as low.

» Channelled Valley-Bottom Wetland:

- Trampling and erosion have impacted the channel morphology and resulted in the formation of small depression where water tend to be collected and stored for period of time.
- Trampling by livestock and erosion have also resulted in a modification of the vegetation composition and structure of the channels.
- Infilling associated with the gravel road have also impacted the local wetland morphology as well as the distribution and retention of waterflow upstream and downstream of the road, however the significance of this impact is regarded as moderate-low.
- The establishment of alien invasive plants is regarded as a significant, especially *Gleditsia triacanthos* which is locally abundant. Other invasive alien plant species recorded within this wetland include; *Verbena bonariensis* and *V. offincialis.*

Table 10: Summary of the Present Ecological Scores (PES) of the affected Hydrogeomorphic units.

Hydro-geomorphic Unit	Hydrology	Geomorphology	Vegetation	Overall PES
Depression Wetlands (W3-5)	C: Moderately Modified (PES Score: 2.7)	C: Moderately Modified (PES Score: 2.4)	B: Largely Natural (PES Score 1.8)	C: Moderately Modified (PES Score: 2.3)
Seepage Wetland (W6)	A: Natural (PES Score: 0.8)	B: Largely Natural (PES Score: 1.3)	B: Largely Natural (PES Score 1.7)	B: Largely Natural (PES Score: 1.2)
Channelled Valley-Bottom Wetland	C: Moderately Modified	C: Moderately Modified	D: Largely Modified (PES Score: 4.6)	C: Moderately Modified

(W1)	(PES Score: 2.9)	(PES Score: 3.7)		(PES Score: 3.7)

Ecological Importance and Sensitivity (EIA) Assessment

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

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 11 below and indicates the following:

» The channelled Valley-Bottom (W1) 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 (primary and secondary) grasslands. Furthermore, water quality enhancement and maintenance are vital for functionality and services provided by important downstream ecosystems.
» The depression wetlands (W2-4) is also considered to be of 'High' EIS, primarily due to their association with the endangered Vaal-Vet Sandy Grassland as well as their sensitivity to external impacts as well as their low to moderate importance in providing biodiversity maintenance.
» The seepage wetland (W5) is considered to be of 'Moderate' EIS, linked with its high sensitivity to external impacts as well as its high importance in terms of water quality enhancement services. Due to this wetland's association (hydrological connection) with the lower lying channelled valley-bottom wetland which is regarded as a high EIS system, this wetland features have been upgraded to High sensitive and importance.
» No red listed, CITES or nationally protected species were recorded within any of the wetlands.
» However, the following provincially protected species were recorded: *Crinum bulbispermum* (W1), *Boophone disticha* (W2-4), *Ammocharis caronica* (W1, W2-4) and *Schizocarphus nervosus* (W2 – 5).
» *Hypoxis hemerocallidea* (W1, W2-4) was also recorded within some of the wetlands and even though this species is neither provincially nor nationally protected this species is

prone to illegal collection and harvesting and populations may subsequently be vulnerable to such activities. Subsequently local populations of this species are regarded as locally important.

» The depression wetlands as well as the seasonally saturated zones of the channelled valley bottom wetland are regarded as suitable habitat for Giant Bullfrog - *Pyxicephalus adspersus* (Vulnerable) with a moderate likelihood of occurrence.
» Dense grass covered wetland areas (all wetlands delineated) and the fringing natural terrestrial vegetation is also furthermore regarded as suitable habitat for Serval – *Leptailurus serval* (Near Threatened) with a high likelihood of occurrence.
» All three depression wetlands are located within T-CBA1, according to the terrestrial critical biodiversity areas for the Free State (2015)
» All wetland units occurring within Critical Biodiversity Areas (CBA), were rated as 'High' with regards to protected status.

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

DETERMINANT		IMPORTANCE SCORES (0-4) AND RATINGS		
		Depression Wetlands (W2-4)	**Seepage Wetland (W5)**	**Channelled Valley-Bottom Wetland (W1)**
PRIMARY DETERMINANTS	Rare & Endangered Species	3	1	3
	Populations of Unique Species	1	1	1
	Species/taxon Richness	3	2	3
	Diversity of Habitat Types or Features	2	2	4
	Migration route/breeding and feeding site for wetland species	2	2	2
	Sensitivity to Changes in the Natural Hydrological Regime	4	4	3
	Sensitivity to Water Quality Changes	3	4	3
	Flood Storage, Energy Dissipation & Particulate/Element Removal	1	3	1
MODIFYING DETERMINANTS	Protected Status	4	4	4
	Ecological Integrity	3	3	2
TOTAL		26	26	26
MEDIAN		3	2.5	3
OVERALL ECOLOGICAL SENSITIVITY & IMPORTANCE		**B High**	**C Moderate**	**B High**

Wetland Buffer Zones and No-Go 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 overall project area is situated within two vegetation types, namely the Vaal-Vet Sandy Grassland (Gh10) and Central Free State Grassland (Gh6) according to Mucina & Rutherford (2006) (Figure 9). The proposed SEF footprint is however almost solely situated within one vegetation type, the Vaal-Vet Sandy Grassland with only a small portion extending into the Central Free State Grassland.

C. Vaal Vet Sandy Grassland

The Vaal Vet Sandy Grassland vegetation type is found in North-West and Free State Provinces. This vegetation type typically comprises of plains-dominated landscape with some scattered, slightly irregular undulating plains and hills. Mainly low-tussock grasslands

with an 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 and/or erratic rainfall (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 Vaal Vet Sandy Grassland.

Graminoids: *Anthephora pubescens* (d), *Aristida congesta* (d), *Chloris virgata* (d), *Cymbopogon caesius* (d), *Cynodon dactylon* (d), *Digitaria argyrograpta* (d), *Elionurus muticus* (d), *Eragrostis chloromelas* (d), *E. lehmanniana* (d), *E. plana* (d*), E. trichophora* (d), *Heteropogon contortus* (d), *Panicum gilvum* (d), *Setaria sphacelata* (d), *Themeda triandra* (d), *Tragus berteronianus* (d), *Brachiaria serrata*, *Cymbopogon pospischilii, Digitaria eriantha, Eragrostis curvula, E. obtusa, E. superba, Panicum coloratum, Pogonarthria squarrosa, Trichoneura grandiglumis, Triraphis andropogonoides* (Mucina & Rutherford, 2006).

Herbs**:** *Stachys spathulata* (d), *Barleria macrostegia*, *Berkheya onopordifolia* var. *onopordifolia*, *Chamaesyce inaequilatera*, *Geigeria aspera* var. *aspera*, *Helichrysum caespititium*, *Hermannia depressa, Hibiscus pusillus, Monsonia burkeana, Rhynchosia adenodes, Selago densiflora, Vernonia oligocephala* (Mucina & Rutherford, 2006).

Geophytic Herbs: *Bulbine narcissifolia, Ledebouria marginata*.

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

Low Shrubs: *Felicia muricata* (d), *Pentzia globosa* (d), *Anthospermum rigidum* subsp. *pumilum, Helichrysum dregeanum*, *H. paronychioides, Ziziphus zeyheriana* (Mucina & Rutherford, 2006).

Endemic Taxon Herb: *Lessertia phillipsiana*.

D. 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).

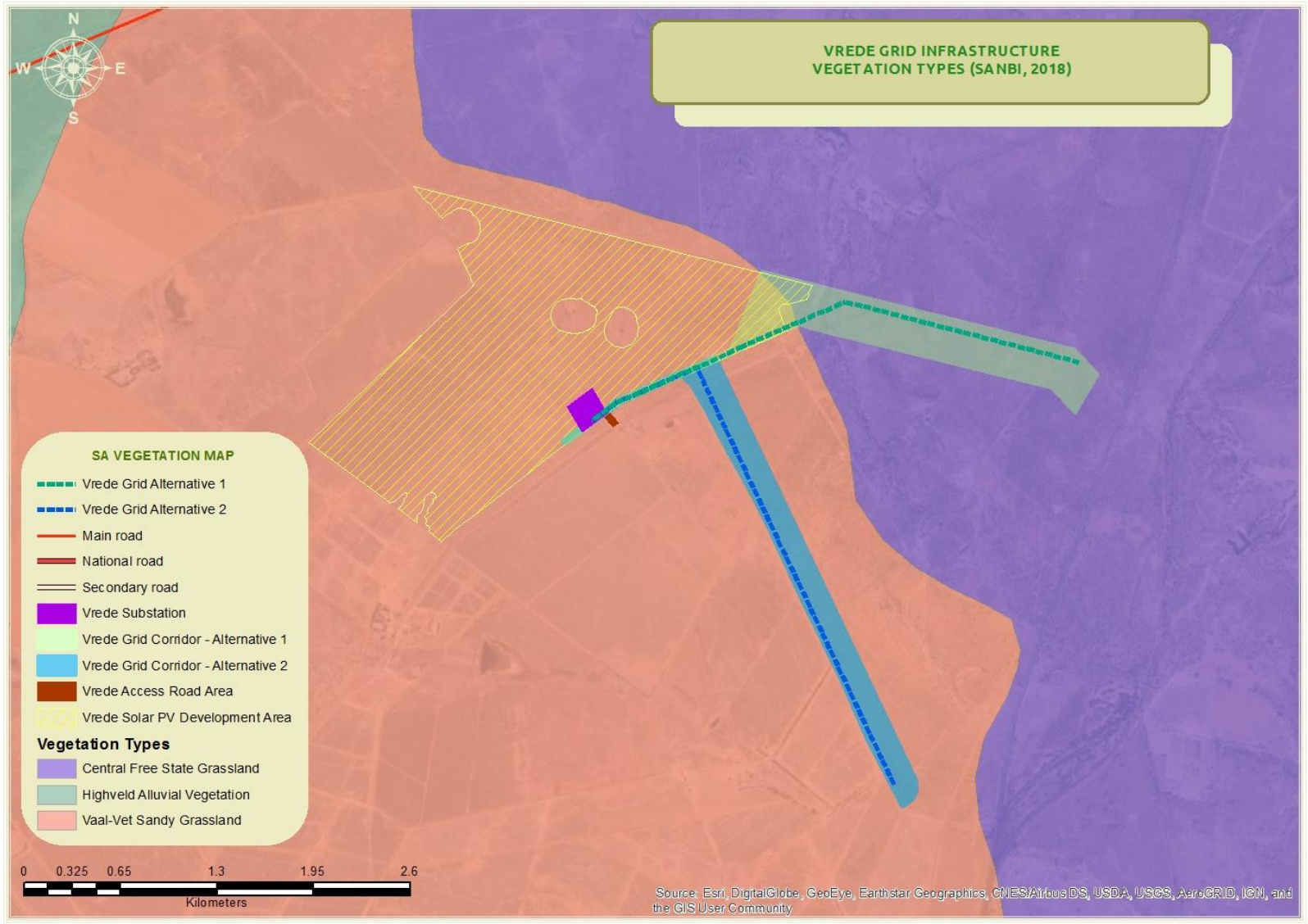

Figure 9: Vegetation Types (SANBI, 2018)

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 region that includes the project area (relevant quarter degree grid). 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 2). 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 development area 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 8).

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 12: 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	Unlikely
Atelerix frontalis	South African Hedgehog	NT	LC	High
Felis nigripes	Black-footed Cat	VU	VU	Low
Hydrictis maculicollis	Spotted-necked Otter	VU	NT	Unlikely
Leptailurus serval	Serval	NT	LC	High
Lycaon pectus	African Wild Dog	EN	EN	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	Moderate

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. Based on the absence of any perennial rivers or wetlands within the project area the likelihood of occurrence of this species occurring in the project area is considered to be unlikely.

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 development area and therefore the likelihood of occurrence is rated as 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 development 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). No suitable habitat is available in the development area for this species and therefore the likelihood of occurrence is Unlikely.

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 grassland areas, the likelihood of occurrence for this species is rated as 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 development 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 development 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 development 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 development area and the likelihood of occurrence of this species is therefore considered to be Moderate.

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 likelihood of finding the species in the development area is High.

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 development 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 (20) 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 9).

The Giant Bull Frog (*Pyxicephalus adspersus*) is a species of conservation concern that may possibly occur in the development 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 development area and therefore the likelihood of occurrence is regarded as Moderate.

Table 13: 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	High
Chamaesaura aenea	Coppery Grass Lizard	NT	LC	Moderate

Fine Scale Vegetation Patterns (Habitats)

In this section, the different habitats and vegetation patterns observed within the study site are described. 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 development area (including the proposed development footprint) is provided in Figure 10.

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

Within the moist bottomlands, three habitat types were identified namely, depression wetlands, valley bottom wetland with riparian fringe and the seepage wetland feeding into the valley bottom wetland. Furthermore, vegetation units within these habitat types are associated with the different hydro-geomorphological zones.

In terms of the grassland habitats, three habitat types can be distinguished namely, severely disturbed/transformed grassland, thornveld grassland, and pure grassland. Within the thornveld grassland two vegetation units were identified namely dense bottomland thornveld and secondary sparse woody grassland, whilst the pure grassland can be divided into secondary grassland and primary grassland.

A. Depression Wetland Habitat:

This unit is associated with temporary saturated zone and is covered by a relative dense, medium tall vegetation cover, dominated by moisture loving (mostly facultative wetland plants) graminoids and forbs. In some areas historical cultivation have encroached into these areas. Grazing by livestock is also a significant impact.

Three depression wetlands have been identified within the development area (within the north-western half), with two depression wetlands, surrounded by the development footprint. These wetland features are fairly similar in terms of hydrology, geomorphology and vegetation coverage.

a) *Utricularia stellaris – Eleocharis limosa* Permanent Saturated and Seasonally Inundated Vegetation Unit

This unit is associated with an area artificially/anthropogenically deepened within the depression wetland features in an attempt to store surface water for longer periods of time (water resource for cattle). Consequently, these areas are normally inundated with water for extended periods through the wet season into late autumn early winter. The water level may be as deep as 1.1 m. These "pools" comprise mostly of floating and submerged hydrophytic sedges and forbs. Trampling by cattle along the edges of these "pools" are a significant impact.

b) *Paspalum distichum – Leptochloa fusca* Permanent Saturated and Temporary Inundated Vegetation Unit

This unit is associated with an area of the depression wetlands which is permanently inundated, but will only be inundated following sufficient rainfall events, with inundation being short lived afterwards. This vegetation unit comprise mostly of submerged grasses and sedges. Trampling by cattle within this zone/vegetation unit is regarded as the most significant impact.

c) *Cyperus denudatus – Echinochloa holubii* Permanent Saturated and Seasonally Saturated Vegetation Unit

This unit is typically only seasonally saturated and comprise a dense, relative tall, moisture loving grass and forb cover. Again, trampling by cattle, within this zone/vegetation unit is regarded as the most significant impact.

d) *Eragrostis chloromelas – Eragrostis plana* Temporary Saturated Vegetation Unit

This unit is associated with temporary saturated zone and is covered by a relative dense, medium tall vegetation cover, dominated by moisture loving (mostly facultative wetland plants) graminoids and forbs. In some areas historical cultivation have encroached into these areas. Grazing by livestock is also a significant impact to the function and ecological contribution of this unit.

B. Valley Bottom Wetland and associated Riparian Fringe:

This habitat is located outside of the development footprint, however due to the close proximity to the development footprint, and the fact that a portion of the wetland's catchment falls within the development footprint, it was deemed worth of inclusion in this assessment/study.

a) *Marsilea macrocarpa – Leersia hexandra* Permanent Saturated Pools

These small localised pools occur within the channel of the valley bottom wetland and is a result of a combination of trampling and soil erosion. These micro-

depressions collect and store water during the wet season and is dominated by a combination of floating and submerged (obligate) hydrophytic forbs, grasses and sedges.

b) *Haplocarpa scaposa – Cynodon dactylon Seasonally Saturated Channels*

The channel of the valley-bottom wetland is seasonally saturated and dominated by moderate to low growing obligate and facultative wetland grasses. Erosion and trampling are a frequent found within these channels.

c) *Senecio inornatus – Paspalum diladatum* Temporary Saturated Grassland

This vegetation unit is associated with the overbank spill areas and grassy riparian fringes and is normally only saturated for a short period of time following sufficient precipitation events. This vegetation unit is characterized by a dense, moderate to tall grass cover. The alien plant, *Paspalum dilatatum* is a prominent species within this habitat unit.

d) *Gleditsia triacanthos – Searsia pyriodes* Riparian Woodland Fringe

The vegetation unit has a patchy distribution along the peripheries of the valley-bottom wetland. The density, height and composition of the woody and herb layer varies immensely. Within the affected property and the adjacent property to the north, the riparian fringe is characterized by a fairly tall riparian fringe dominated by the Category 1b Invasive Alien Plant, *Gleditsia triacanthos*. Under natural conditions *Searsia pyrioides* and *Acacia (Vachellia) karroo* will be the dominating woody species.

C. Seepage Wetland:

This habitat is also located outside of the development footprint, however due to the close proximity to the development footprint, and the fact that a portion of the wetland's catchment falls within the development footprint, it was deemed worth of inclusion in this assessment/study.

This seepage wetland is located to the west of the valley-bottom wetland and feed into the downslope valley-bottom wetland. This seepage wetland is largely ground fed due to a change in topography and underlying, shallow geology.

a) *Pennisetum sphacelatum – Eragrostis planiculmis* Seasonally Saturated Grassland

This vegetation unit is characterised by a relative tall moisture loving grass cover and is seasonally saturated. Disturbances within this unit includes an existing

telephone line that traverses this vegetation unit with some pylons constructed within the boundaries of this habitat unit.

b) *Themeda triandra – Eragrostis plana* Temporary Saturated Grassland

This vegetation unit is characterised by a medium tall grass cover (mainly facultative wetland grasses) and is only saturated for a short period of time following sufficient precipitation events. Disturbances within this unit includes an existing telephone line that traverses this vegetation unit with some pylons constructed within the boundaries of this habitat unit.

D. Disturbed Grassland:

a) *Verbena aristigera – Cynodon dactylon* 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.

E. Thornveld:

a) *Asparagus laricinus – Acacia (Vachellia) karroo* Bottomland Thornveld

This is a primary vegetation unit and is situated in the lower lying terrestrial lands along the valley flats, fringing the seepage and valley-bottom wetlands. Overgrazing has resulted in the encroachment of *Asparagus laricinus* as well as shrubby forms of *A. karroo*.

b) *Helichrysum dregeanum – Acacia (Vachellia) karroo* Secondary Sparse Woody Grassland

This vegetation unit can also be regarded as a plagioclimax unit that has established and stabilised on old cultivated areas (>30years). This unit can be characterized by a fairly open grassland comprising of Increase II, Climax grasses. Trees and shrubs are typically clustered together and are highly varying in terms of density, and height.

F. Pure Grassland:

Even though, the term pure has been given to this habitat type, forbs and shrubs are still present within this habitat, however grasses dominate the overall coverage.

a) *Helichrysum rugulosum – Digitaria eriantha* Secondary Grassland (Pasture)

This vegetation unit can also be regarded as a plagioclimax unit that has established (seeded) and stabilised on old cultivated areas (<30years).

b) *Vernonia oligocephala – Eragrostis chloromelas* Primary Grassland

This vegetation unit resemble a natural form of Vaal-Vet Sandy Grassland and patches of these grasslands have remained due to the fact that these areas are not suitable for cultivation. Even though, *Themeda triandra* is till relative prominent, some retrogression has occurred from *T. triandra*, to *P. coloratum* and *E. chloromelas*, indicating that these areas have been subjected to long term grazing, with periodical overgrazing.

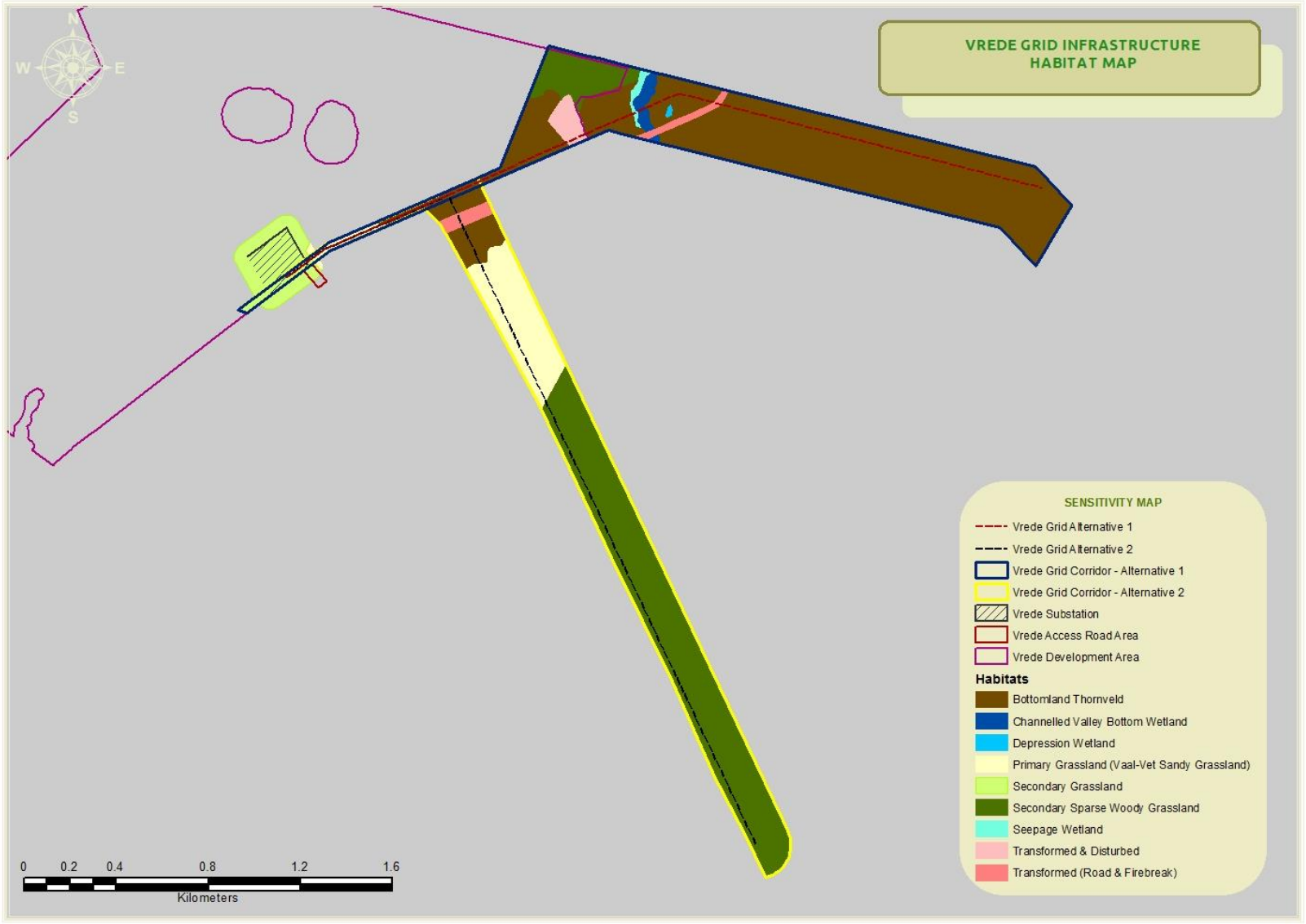

Figure 10: Delineated habitat units.

Depression Wetlands

Habitat and Land use			
Substrate	Greyish clay to clayey loam soils, Soils tend to moderately in depth. These depression wetlands are primarily surface water fed with some subsurface water input. All three hydro-morphological zones are present with the temporary saturated zone being the largest in extent. As mentioned, portions of the depressions have been, artificially, made deeper in an attempt to store water for longer periods of time. These areas are now inundated for extended periods of time during the wet season	**Disturbance**	Trampling and grazing through cattle. May become excessive in portions of these habitats and may lead to soil compaction and a loss in vegetation cover. Artificial deepening of a section of the depression wetlands and the stockpiling of the removed soil. Establishment of Invasive Alien Plants: *Verbena bonariensis, V. offincialis*
Species Richness	70 species of which 13 are alien plants and 7 are indigenous weeds	**Conservation value:**	High Mostly natural moist grassland. Provide valuable ecosystem functions and services.
Ecosystem function	Accumulation and filtering of runoff before water seeps into ground water Seasonal surface water » Seasonal availability of associated biota (most notably invertebrates) that serve as important food sources for especially reptiles and birds Seasonal grazing on peripheries of depressions during periods of higher moisture Below-ground storage and channelling of water	**Sensitivity:**	Very High – No-Go Area
Need for rehabilitation	Manage grazing within these depression wetlands		

Vegetation structure		
Layer	**Height (m)**	**Cover (%)**
High shrubs and trees	1.5 - 4	0
Low Shrubs	0.2 – 1	0 - 3

Graminoids	0.3 –1.4	80 - 90
Forbs	0.1 – 1.2	10 - 20
Permanent Saturated & Seasonally Inundated Zone		
Diagnostic Species	*Eleocharis limosa, Aponogeton rehmannii, Utricularia stellaris, Potamogeton crispus*	
Dominant Species	*Persicaria decipiens, Paspalum distichum*	
Permanent Saturated & Temporary Inundated Zone		
Diagnostic Species	*Paspalum distichum, Leptochloa fusca*	
Dominant Species	*Persicaria decipeins, Eleocharis limosa*	
Seasonal Saturated Zone		
Diagnostic Species	*Echinochloa holubii, Eragrostis planiculmis, Helichrysum aureonitens, Cyperus denudatus*	
Dominant Species	*Leptochloa fusca, Gnaphalium filagopsis, Verbena bonariensis, V. officinalis, Setaria incrassata*	
Temporary Saturated Zone		
Diagnostic Species	*Eragrostis plana, Eragrostis chloromelas, Themeda triandra*	
Dominant Species	*Helichrysum aureonitens, Verbena officinalis, Cynodon dactylon, Eragrostis curvula, Panicum coloratum, Gomphocarpus fruticosus, Arctotis arctoides, Conyza bonariensis, Eragrostis gummiflua*	

Growth Form	Family	Species	Status	Depression Wetland			
				Permanent Saturated & Seasonally Inundated	Permanent Saturated & Temporarily Inundated	Seasonal Saturated	Temporary Saturated
Creeping Forb	Fabaceae	*Rhynchosia minima*					X
Creeping Forb	Fabaceae	*Rhynchosia totta var. totta*					X
Darf Shrub	Asteraceae	*Felicia muricata*	Potential Encroacher				X
Dwarf Shrub	Asteraceae	*Seriphium plumosum*	Potential Encroacher				X
Forb	Apocynaceae	*Gomphocarpus fruticosus subsp. Fruticosus*	Weed				X
Forb	Aponogetonaceae	*Aponogeton rehmannii*		X			

Forb	Asteraceae	*Arctotis arctoides*					X
Forb	Asteraceae	*Aster squamatus*	Alien Plant				X
Forb	Asteraceae	*Berkheya onopordifolia*					X
Forb	Asteraceae	*Berkheya radula*				X	
Forb	Asteraceae	*Cirsium vulgare*	Category 1b Invasive Alien Plant				X
Forb	Asteraceae	*Conyza bonariensis*	Alien Plant				X
Forb	Asteraceae	*Gnaphalium filagopsis*				X	X
Forb	Asteraceae	*Helichrysum aureonitens*				X	X
Forb	Asteraceae	*Helichrysum rugulosum*	Weed		X		X
Forb	Asteraceae	*Pseudognaphalium luteo-album*	Alien Plant			X	
Forb	Asteraceae	*Schkuhria pinnata*	Alien Plant				X
Forb	Asteraceae	*Senecio inornatus*				X	
Forb	Asteraceae	*Tagetes minuta*	Alien Plant				X
Forb	Asteraceae	*Zinnia peruviana*	Alien Plant				X
Forb	Campanulaceae	*Wahlenbergia denticulata*					X
Forb	Caryophyllaceae	*Pollichia campestris*					X
Forb	Fabaceae	*Crotalaria distans subsp. Distans*					X
Forb	Geraniaceae	*Monsonia burkeana*					X
Forb	Lentibulariaceae	*Utricularia stellaris*		X			
Forb	Malvaceae	*Hermannia coccocarpa*					X
Forb	Malvaceae	*Hibiscus pusillus*					X
Forb	Malvaceae	*Hibiscus trionum*	Alien Plant				X
Forb	Malvaceae	*Sida cordifolia*	Weed				X
Forb	Oxalidaceae	*Oxalis obliquifolia*	Weed			X	X
Forb	Polygonaceae	*Persicaria amphibia*	Alien Plant	X			
Forb	Polygonaceae	*Persicaria decipiens*		X	X	X	
Forb	Potamogetonaceae	*Potamogeton crispus*		X			
Forb	Rubiaceae	*Kohautia caespitosa*	Weed				X
Forb	Verbenaceae	*Lippia javanica*					X
Forb	Verbenaceae	*Verbena aristigera*	Alien Plant				X
Forb	Verbenaceae	*Verbena bonariensis*	Category 1b Invasive Alien Plant			X	X
Forb	Verbenaceae	*Verbena officinalis*	Category 1b Invasive Alien Plant			X	X
Geophyte	Amaryllidaceae	*Ammocharis coranica*	Protected				X
Geophyte	Hyacinthaceae	*Albuca spp.*				X	X
Geophyte	Hyacinthaceae	*Schizocarphus nervosus*	Protected				X
Geophyte	Hypoxidaceae	*Hypoxis hemerocallidea*					X
Graminoid	Cyperaceae	*Cyperus denudatus var. denudatus*				X	X
Graminoid	Cyperaceae	*Eleocharis limosa*		X	X	X	
Graminoid	Cyperaceae	*Kylinga erecta var. erecta*				X	

Graminoid	Cyperaceae	*Schoenoplectus muricinux*				X	
Graminoid	Poaceae	*Aristida junciformis*					X
Graminoid	Poaceae	*Cymbopogon pospischilii*					X
Graminoid	Poaceae	*Cynodon dactylon*	Weed			X	X
Graminoid	Poaceae	*Echinochloa holubii*			X	X	X
Graminoid	Poaceae	*Eragrostis chloromelas*					X
Graminoid	Poaceae	*Eragrostis curvula*				X	X
Graminoid	Poaceae	*Eragrostis gummiflua*					X
Graminoid	Poaceae	*Eragrostis micrantha*			X		
Graminoid	Poaceae	*Eragrostis plana*				X	X
Graminoid	Poaceae	*Eragrostis planiculmis*			X	X	X
Graminoid	Poaceae	*Leersia hexandra*		X			
Graminoid	Poaceae	*Leptochloa fusca*			X	X	
Graminoid	Poaceae	*Panicum coloratum*				X	X
Graminoid	Poaceae	*Panicum maximum*					X
Graminoid	Poaceae	*Paspalum dilatatum*	Alien Plant			X	
Graminoid	Poaceae	*Paspalum distichum*		X	X		
Graminoid	Poaceae	*Setaria incrassata*				X	X
Graminoid	Poaceae	*Setaria pallide-fusca*				X	X
Graminoid	Poaceae	*Sporobolus africanus*			X		X
Graminoid	Poaceae	*Themeda triandra*				X	X
Graminoid	Poaceae	*Urochloa panicoides*	Weed				X
Shrub	Asparagaceae	*Asparagus laricinus*	Potential Encroacher				X
Shrub	Fabaceae	*Acacia (Vachellia) karroo*	Potential Encroacher				X
Succulent Dwarf Shrub	Aizoaceae	*Delosperma floribundum*					X

Valley-bottom Wetland

Habitat and Land use			
Substrate	Dark to lighter grey, vertic soils Valley-bottom wetlands predominantly surface water fed. Input from runoff (diffuse flow from the slopes as well as contained flow within the higher lying drainage channels) and precipitation. Water input also from the seepage wetland.	**Disturbance**	Trampling and grazing through cattle. May become excessive in portions of these habitats and may lead to channel and gully erosion. Moderate to high levels of Alien plant and weed invasion Establishment of Invasive Alien Plants: *Verbena bonariensis, V. offincialis, Gleditsia triacanthos*

Species Richness	57 species of which 12 are alien plants and 6 are indigenous weeds	**Conservation value:**	High Mostly natural moist grassland. Provide valuable ecosystem functions and services.
Ecosystem function	Vegetation as grazing and stabilisation of soils, accumulated and slows down runoff from higher lying areas, maximises infiltration of runoff into soils and filtering of runoff before it seeps further into lower-lying river systems, creates unique habitat for flora and fauna	**Sensitivity:**	Very High – No-Go Area
Need for rehabilitation	Manage grazing within these wetland habitats. Rehabilitation of eroded areas. Management of IAPs		

Vegetation structure		
Layer	**Height (m)**	**Cover (%)**
High shrubs and trees	1.8 - 4	2
Low Shrubs	0.2 – 1.7	8
Grass	0.1 – 0.9	70 - 80
Forbs	0.01 – 1.5	10 - 20
Permanent Saturated Pools		
Diagnostic Species	*Marsilea macrocarpa, Schonoplectus muricinux, Leersia hexandra*	
Dominant Species	*Persicaria decipeins, Paspalum distichum, Echinchloa holubii*	
Seasonally Saturated Channels		
Diagnostic Species	*Verbena officinalis, Paspalum dilatatum, Cynodon dactylon, Haplocarpa scaposa*	
Dominant Species	*Cypersus eragrostis,*	
Temporary Saturated Zone		
Diagnostic Species	*Paspalum dilatatum, Echinochloa holubii*	
Dominant Species	*Verbena officinalis, Eragrostis plana, Setaria incrassata, Seatria pallide-fusca, Eragrostis planiculmis, Pennisetum sphacelatum, Sporobolus africanus*	

Growth Form	Family	Species	Status	Permanent Saturated Pools	Seasonally Saturated Channels	Temporary Saturated Grassland

Forb	Verbenaceae	*Verbena officinalis*	Category 1b Invasive Alien Plant	X	X	X
Graminoid	Poaceae	*Paspalum dilatatum*	Alien Plant	X	X	X
Forb	Polygonaceae	*Persicaria decipiens*		X	X	
Graminoid	Cyperaceae	*Cyperus eragrostis*	Alien Plant	X	X	
Graminoid	Poaceae	*Cynodon dactylon*	Weed	X	X	
Graminoid	Poaceae	*Paspalum distichum*		X	X	
Forb	Verbenaceae	*Verbena bonariensis*	Category 1b Invasive Alien Plant	X		X
Graminoid	Poaceae	*Echinochloa holubii*		X		X
Fern	Marsileaceae	*Marsilea macrocarpa*		X		
Graminoid	Cyperaceae	*Schoenoplectus muricinux*		X		
Graminoid	Poaceae	*Leersia hexandra*		X		
Forb	Asteraceae	*Berkheya radula*			X	X
Forb	Asteraceae	*Conyza bonariensis*	Alien Plant		X	X
Forb	Dipsacaceae	*Scabiosa columbaria*			X	X
Graminoid	Poaceae	*Eragrostis micrantha*			X	X
Graminoid	Poaceae	*Eragrostis plana*			X	X
Graminoid	Poaceae	*Setaria incrassata*			X	X
Graminoid	Poaceae	*Setaria pallide-fusca*			X	X
Shrub	Asparagaceae	*Asparagus laricinus*	Potential Encroacher		X	X
Creeping Forb	Convolvulaceae	*Dichondra micrantha*	Weed		X	
Forb	Apiaceae	*Ciclospermum leptophyllum*	Alien Plant		X	
Forb	Asteraceae	*Haplocarpha scaposa*			X	
Forb	Malvaceae	*Sida dregei*			X	
Forb	Onagraceae	*Oenothera rosea*	Alien Plant		X	
Forb	Orobanchaceae	*Buchnera reducta*			X	
Forb	Ranunculaceae	*Ranunculus multifidus*			X	
Forb	Scrophulariaceae	*Mimulus gracilis*			X	
Forb	Verbenaceae	*Verbena aristigera*	Alien Plant		X	
Geophyte	Amaryllidaceae	*Ammocharis coranica*	Protected		X	
Graminoid	Cyperaceae	*Cyperus congestus*	Weed		X	
Graminoid	Cyperaceae	*Cyperus longus var. longus*			X	
Graminoid	Poaceae	*Sporobolus fimbriatus*			X	
Shrub	Anacardiaceae	*Searsia pyroides*			X	
Tree	Fabaceae	*Gleditsia triacanthos*	Category 1b Invasive Alien Plant		X	
Forb	Apocynaceae	*Gomphocarpus fruticosus subsp. Fruticosus*	Weed			X
Forb	Apocynaceae	*Xysmalobium undulatum*				X

Forb	Asteraceae	*Aster squamatus*	Alien Plant			X
Forb	Asteraceae	*Berkheya onopordifolia*				X
Forb	Asteraceae	*Cirsium vulgare*	Category 1b Invasive Alien Plant			X
Forb	Asteraceae	*Cotula anthemoides*				X
Forb	Asteraceae	*Senecio inornatus*				X
Forb	Asteraceae	*Tagetes minuta*	Alien Plant			X
Forb	Convolvulaceae	*Cuscuta australis*	Outside of range			X
Forb	Malvaceae	*Sida cordifolia*	Weed			X
Forb	Oxalidaceae	*Oxalis obliquifolia*	Weed			X
Graminoid	Poaceae	*Digitaria eriantha*				X
Graminoid	Poaceae	*Eragrostis chloromelas*				X
Graminoid	Poaceae	*Eragrostis curvula*				X
Graminoid	Poaceae	*Eragrostis obtusa*				X
Graminoid	Poaceae	*Eragrostis planiculmis*				X
Graminoid	Poaceae	*Hyparrhenia hirta*				X
Graminoid	Poaceae	*Panicum coloratum*				X
Graminoid	Poaceae	*Pennisetum sphacelatum*				X
Graminoid	Poaceae	*Setaria verticillata*				X
Graminoid	Poaceae	*Sporobolus africanus*				X
Graminoid	Poaceae	*Themeda triandra*				X
Shrub	Fabaceae	*Acacia (Vachellia) karroo*	Potential Encroacher			X

Woody Riparian Fringe

Habitat and Land use			
Substrate	Dark, vertic soils	**Disturbance**	High levels of Alien plant and weed invasion Establishment of Invasive Alien Plants: *Gleditsia triacanthos*
Species Richness	40 species of which 10 are alien plants and 7 are indigenous weeds	**Conservation value:**	High Relative high diversity, Unique habitat.
Ecosystem function	Grazing and Browsing, Unique habitat, niche and source of food for animals, Provides some stabilization of wetland fringes.	**Sensitivity:**	Very High – No-Go Area
Need for rehabilitation	Rehabilitation of eroded areas. Management of IAPs		

Vegetation structure		
Layer	**Height (m)**	**Cover (%)**
High shrubs and trees	1.8 - 4	60
Low Shrubs	0.2 – 1.7	35
Grass	0.1 – 0.9	15-25
Forbs	0.01 – 1.5	25 - 55
Diagnostic Species	*Celtis africana, Searsia pyrioides, Sida dregei, Pavonia senegalensis, Pentharrhinum insipidum, Gleditsia triacanthos*	
Dominant Species	*Ziziphus mucronata, Acacia karoo, Asparagus laricinus, Setaria verticillata, Cynodon dactylon, Bidens bipinnata, Achyranthes aspera*	

Growth Form	Family	Species	Status	Riparian Fringe
Climbing Forb	Apocynaceae	*Pentharrhinum insipidum*		X
Climbing Shrub	Ranunculaceae	*Clematis brachiata*		X
Creeping Forb	Convolvulaceae	*Dichondra micrantha*	Weed	X
Forb	Amaranthaceae	*Achyranthes aspera*	Weed	X
Forb	Amaranthaceae	*Amaranthus viridus*	Alien Plant	X
Forb	Amaranthaceae	*Atriplex semibacata*	Weed	X
Forb	Apiaceae	*Ciclospermum leptophyllum*	Alien Plant	X
Forb	Asteraceae	*Bidens bipinnata*	Alien Plant	X
Forb	Asteraceae	*Conyza bonariensis*	Alien Plant	X
Forb	Asteraceae	*Haplocarpha scaposa*		X
Forb	Asteraceae	*Tagetes minuta*	Alien Plant	X
Forb	Asteraceae	*Zinnia peruviana*	Alien Plant	X
Forb	Chenopodiaceae	*Chenopodium album*	Weed	X
Forb	Lamiaceae	*Stachys hyssopoides*		X
Forb	Lamiaceae	*Teucrium trifidum*		X
Forb	Malvaceae	*Pavonia senegalensis*		X
Forb	Malvaceae	*Sida cordifolia*	Weed	X
Forb	Malvaceae	*Sida dregei*		X
Forb	Solanaceae	*Solanum nigrum*		X
Forb	Verbenaceae	*Verbena aristigera*	Alien Plant	X
Graminoid	Cyperaceae	*Cyperus congestus*	Weed	X
Graminoid	Poaceae	*Cynodon dactylon*	Weed	X
Graminoid	Poaceae	*Panicum maximum*		X
Graminoid	Poaceae	*Paspalum dilatatum*	Alien Plant	X
Graminoid	Poaceae	*Setaria incrassata*		X
Graminoid	Poaceae	*Setaria pallide-fusca*		X
Graminoid	Poaceae	*Setaria verticillata*		X
Graminoid	Poaceae	*Sporobolus fimbriatus*		X
Shrub	Anacardiaceae	*Searsia pyroides*		X
Shrub	Asparagaceae	*Asparagus laricinus*	Potential Encroacher	X
Shrub	Asparagaceae	*Asparagus setaceus*		X
Shrub	Boraginaceae	*Ehretia rigida*		X
Shrub	Celastraceae	*Gymnosporia heterophylla*		X
Shrub	Ebenaceae	*Diospyros lycioides*		X

Shrub	Rosaceae	*Cotoneaster franchettii*	Category 1b Invasive Alien Plant	X
Tree	Anacardiaceae	*Searsia lancea*		X
Tree	Fabaceae	*Acacia (Vachellia) karroo*		X
Tree	Fabaceae	*Gleditsia triacanthos*	Category 1b Invasive Alien Plant	X
Tree	Rhamnaceae	*Ziziphus mucronata*		X
Tree	Ulmaceae	*Celtis africana*		X

Seepage Wetland

Habitat and Land use			
Substrate	Dark to lighter grey, clay to clay loam soils Seepage contain a lower permeability layer underlain by impermeable strata (bed rock). Subsequently input is from groundwater seepage, precipitation and surface runoff. Groundwater may be restricted by lower permeability layer.	**Disturbance**	Trampling and grazing through cattle. May become excessive in portions of these habitats and may lead to channel and gully erosion. Moderate levels of overgrazing and trampling. Presence powerline pylons within wetland. Moderate levels of Alien plant and weed invasion Establishment of Invasive Alien Plants: *Verbena bonariensis, V. offincialis, V. bonariensis*
Species Richness	74 species of which 12 are alien plants and 6 are indigenous weeds	**Conservation value:**	High Mostly natural moist grassland. Provide valuable ecosystem functions and services.
Ecosystem function	Vegetation as grazing and stabilisation of soils, accumulated and slows down runoff from higher lying areas, maximises infiltration of runoff into soils and filtering of runoff before it seeps further into lower-lying river systems, creates unique habitat for flora and fauna	**Sensitivity:**	Very High – No-Go Area
Need for rehabilitation	Manage grazing within these wetland habitats. Management of IAPs		

Vegetation structure		
Layer	**Height (m)**	**Cover (%)**
High shrubs and trees	1.8 - 4	1
Low Shrubs	0.2 – 1.7	8
Grass	0.1 – 0.9	70 - 80
Forbs	0.01 – 1.5	10 - 20

Seasonally Saturated Grassland	
Diagnostic Species	*Eragrostis planiculmis, Pennisetum spacelatum, Setaria incrassata*
Dominant Species	*Senecio inornatus, Eragrostis plana, Paspalum dilatatum, Themeda triandra, Setaria pallide-fusca, Sporobolus africanus*
Temporary Saturated Grassland	
Diagnostic Species	*Themeda triandra*
Dominant Species	*Cypersus eragrostis,*
Temporary Saturated Zone	
Diagnostic Species	*Paspalum dilatatum, Echinochloa holubii*
Dominant Species	*Verbena officinalis, Eragrostis plana, Setaria incrassata, Seatria pallide-fusca, Eragrostis planiculmis, Pennisetum sphacelatum, Sporobolus africanus*

Growth Form	Family	Species	Status	Seasonally Saturated Grassland	Temporary Saturated Grassland
Forb	Asteraceae	*Berkheya radula*		X	X
Forb	Asteraceae	*Senecio inornatus*		X	X
Forb	Asteraceae	*Senecio pentactinus*		X	X
Graminoid	Poaceae	*Eragrostis plana*		X	X
Graminoid	Poaceae	*Eragrostis planiculmis*		X	X
Graminoid	Poaceae	*Paspalum dilatatum*	Alien Plant	X	X
Graminoid	Poaceae	*Pennisetum sphacelatum*		X	X
Graminoid	Poaceae	*Themeda triandra*		X	X
Shrub	Asparagaceae	*Asparagus laricinus*	Potential Encroacher	X	X
Forb	Apocynaceae	*Xysmalobium undulatum*		X	
Forb	Asteraceae	*Cotula anthemoides*		X	
Forb	Asteraceae	*Haplocarpha scaposa*		X	
Forb	Dipsacaceae	*Scabiosa columbaria*		X	
Forb	Malvaceae	*Hibiscus trionum*	Alien Plant	X	
Forb	Onagraceae	*Oenothera rosea*	Alien Plant	X	
Forb	Ranunculaceae	*Ranunculus multifidus*		X	
Forb	Solanaceae	*Datura stramonium*	Category 1b Invasive Alien Plant	X	

Forb	Verbenaceae	*Verbena bonariensis*	Category 1b Invasive Alien Plant	X	
Forb	Verbenaceae	*Verbena officinalis*	Category 1b Invasive Alien Plant	X	
Graminoid	Poaceae	*Echinochloa holubii*		X	
Graminoid	Poaceae	*Setaria incrassata*		X	
Graminoid	Poaceae	*Setaria pallide-fusca*		X	
Graminoid	Poaceae	*Sporobolus africanus*		X	
Dwarf Shrub	Asteraceae	*Felicia muricata*	Potential Encroacher		X
Forb	Asteraceae	*Aster squamatus*	Alien Plant		X
Forb	Asteraceae	*Berkheya pinnatifida*			X
Forb	Asteraceae	*Bidens bipinnata*	Alien Plant		X
Forb	Asteraceae	*Cirsium vulgare*	Category 1b Invasive Alien Plant		X
Forb	Asteraceae	*Conyza bonariensis*	Alien Plant		X
Forb	Asteraceae	*Gazania krebsiana*			X
Forb	Asteraceae	*Helichrysum aureonitens*			X
Forb	Asteraceae	*Schkuhria pinnata*	Alien Plant		X
Forb	Oxalidaceae	*Oxalis obliquifolia*	Weed		X
Forb	Solanaceae	*Solanum nigrum*			X
Forb	Verbenaceae	*Verbena aristigera*	Alien Plant		X
Graminoid	Poaceae	*Chloris virgata*	Weed		X
Graminoid	Poaceae	*Cynodon dactylon*	Weed		X
Graminoid	Poaceae	*Eragrostis chloromelas*			X
Graminoid	Poaceae	*Eragrostis lehmanniana*			X
Graminoid	Poaceae	*Eragrostis micrantha*			X
Graminoid	Poaceae	*Eragrostis obtusa*			X
Graminoid	Poaceae	*Panicum coloratum*			X
Graminoid	Poaceae	*Tragus berteronianus*	Weed		X
Shrub	Anacardiaceae	*Searsia pyroides*			X
Shrub	Fabaceae	*Acacia (Vachellia) karroo*	Potential Encroacher		X
Succulent Shrub	Cactaceae	*Opuntia ficus-indica*	Category 1b Invasive Alien Plant		X
Tree	Anacardiaceae	*Searsia lancea*			X

Highly disturbed/transformed Grassland

Habitat and Land use			
Substrate	Loam to loamy-clay soils of varying depths, mostly moderately deep. Some fine gravel and grit may be present in some areas	**Disturbance**	Severely trampled areas, Mowed areas (fire breaks) Kraals Water and feeding points High abundance of weeds and alien plants
Species Richness	57 species of which 14 are alien plants and 15 are indigenous weeds	**Conservation value:**	Low

Ecosystem function	Permanent vegetation cover for stabilising, maintaining and nourishing soil as well as for slowing down runoff to increase infiltration into the soil. Vegetation as grazing (low potential due to moderate to low palatability of dominant grasses and weeds).	**Sensitivity:**	Low
Need for rehabilitation	Clearing of weeds and alien invasive species		

Vegetation structure		
Layer	**Height (m)**	**Cover (%)**
High shrubs and trees	1.8 - 4	0
Low Shrubs	0.2 – 1.5	0-6
Grass	0.1 – 0.7	60-80
Forbs	0.01 – 1.5	30-20
Diagnostic Species	*Celtis africana, Searsia pyrioides, Sida dregei, Pavonia senegalensis, Pentharrhinum insipidum, Gleditsia triacanthos*	
Dominant Species	*Ziziphus mucronata, Acacia karoo, Asparagus laricinus, Setaria verticillata, Cynodon dactylon, Bidens bipinnata, Achyranthes aspera*	

Growth Form	Family	Species	Status	Disturbed Grassland
Creeping Forb	Amaranthaceae	Alternanthera pungens	Weed	X
Creeping Forb	Convolvulaceae	Dichondra micrantha	Weed	X
Creeping Forb	Nyctaginaceae	Boerhavia diffusa	Weed	X
Creeping Forb	Zygophyllaceae	Tribulus terrestris	Weed	X
Dwarf Shrub	Asteraceae	Felicia muricata	Potential Encroacher	X
Dwarf Shrub	Chenopodiaceae	Salsola kali	Category 1b Alien Invasive Plant	X
Dwarf Shrub	Fabaceae	Indigofera cryptantha		X
Dwarf Shrub	Scrophulariaceae	Selago densiflora		X
Forb	Amaranthaceae	Amaranthus thunbergii	Weed	X
Forb	Amaranthaceae	Amaranthus viridus	Alien Plant	X
Forb	Amaranthaceae	Atriplex semibacata	Weed	X
Forb	Asteraceae	Arctotis arctoides		X
Forb	Asteraceae	Berkheya onopordifolia		X
Forb	Asteraceae	Berkheya pinnatifida		X
Forb	Asteraceae	Bidens bipinnata	Alien Plant	X
Forb	Asteraceae	Cirsium vulgare	Category 1b Invasive Alien Plant	X
Forb	Asteraceae	Conyza bonariensis	Alien Plant	X
Forb	Asteraceae	Cotula podocephala		X
Forb	Asteraceae	Helichrysum rugulosum	Weed	X
Forb	Asteraceae	Nidorela residifolia		X
Forb	Asteraceae	Schkuhria pinnata	Alien Plant	X
Forb	Asteraceae	Tagetes minuta	Alien Plant	X
Forb	Asteraceae	Tripteris aghillana	Weed	X

Forb	Asteraceae	Xanthium spinosum	Category 1b Invasive Alien Plant	X
Forb	Campanulaceae	Wahlenbergia denticulata		X
Forb	Commelinaceae	Commelina africana		X
Forb	Geraniaceae	Monsonia burkeana		X
Forb	Lamiaceae	Stachys hyssopoides		X
Forb	Malvaceae	Hermannia depressa		X
Forb	Malvaceae	Sida cordifolia	Weed	X
Forb	Rubiaceae	Kohautia caespitosa	Weed	X
Forb	Scrophulariaceae	Aptosimum procumbens		X
Forb	Solanaceae	Datura stramonium	Category 1b Invasive Alien Plant	X
Forb	Verbenaceae	Verbena aristigera	Alien Plant	X
Forb	Verbenaceae	Verbena officinalis	Category 1b Invasive Alien Plant	X
Graminoid	Poaceae	Aristida adscensionis		X
Graminoid	Poaceae	Aristida congesta	Weed	X
Graminoid	Poaceae	Brachiaria eruciformis		X
Graminoid	Poaceae	Chloris virgata	Weed	X
Graminoid	Poaceae	Cynodon dactylon	Weed	X
Graminoid	Poaceae	Digitaria eriantha		X
Graminoid	Poaceae	Eragrostis chloromelas		X
Graminoid	Poaceae	Eragrostis curvula		X
Graminoid	Poaceae	Eragrostis gummiflua		X
Graminoid	Poaceae	Eragrostis lehmanniana		X
Graminoid	Poaceae	Eragrostis trichophora		X
Graminoid	Poaceae	Hyparrhenia hirta		X
Graminoid	Poaceae	Paspalum dilatatum	Alien Plant	X
Graminoid	Poaceae	Pogonarthria squarrosa		X
Graminoid	Poaceae	Setaria pallide-fusca		X
Graminoid	Poaceae	Themeda triandra		X
Graminoid	Poaceae	Tragus berteronianus	Weed	X
Graminoid	Poaceae	Urochloa panicoides	Weed	X
Shrub	Asparagaceae	Asparagus laricinus	Potential Encroacher	X
Shrub	Fabaceae	Acacia (Vachellia) karroo	Potential Encroacher	X
Succulent Forb	Portulacaceae	Portulaca quadrifida	Alien Plant	X
Tree	Oleaceae	Fraxinus spp.	Alien Plant	X

Bottomland Thornveld

Habitat and Land use			
Substrate	Moderately-shallow, greyish Clay to clay-loam soils	**Disturbance**	Overgrazing over a long period of time which has led to the encroachment of *Acacia karroo* shrubs and *Asparagus laricinus*. Establishment of IAPs: *Opuntia ficus-indica*
Species Richness	75 species of which 11 are alien plants and 5 are indigenous weeds	**Conservation value:**	Moderate

Ecosystem function	Grazing, maintenance of pollinator populations, vegetation cover necessary for soil conservation, stabilisation of soils, accumulates and slows down runoff, maximises infiltration of runoff into soils and filtering of runoff before it seeps further into lower-lying wetland systems, habitat for flora and fauna limited to high typographical positions.	**Sensitivity:**	Medium
Need for rehabilitation	Clearing of weeds and alien invasive species		

Vegetation structure		
Layer	**Height (m)**	**Cover (%)**
High shrubs and trees	1.8 - 4	15-20
Low Shrubs	0.2 – 1.5	50-70
Grass	0.1 – 1	80
Forbs	0.01 – 1.5	5-10
Diagnostic Species	*Cymbopogon pospischilii, Eragrostis gummiflua, Asparagus laricinus, Ehretia rigida, Gymnosporia heterophylla, Acacia karroo (Shrub), Delosperma floribundum, Acacia karroo (tree)*	
Dominant Species	*Opuntia ficus-indica, Themeda triandra, Eragrostis obtusa, Eragrostis lehmanniana, Eragrostis chloromelas, Clematis brachiata, Pentharrhinum insipidum*	

Growth Form	Family	Species	Status	Bottomland Thornveld
Climbing Forb	Apocynaceae	*Pentharrhinum insipidum*		X
Climbing Shrub	Ranunculaceae	*Clematis brachiata*		X
Creeping Forb	Fabaceae	*Rhynchosia minima*		X
Dwarf Shrub	Asteraceae	*Pentzia incana*	Potential Encroacher	X
Dwarf Shrub	Asteraceae	*Seriphium plumosum*	Potential Encroacher	X
Forb	Acanthaceae	*Blepharis integrifolia*		X
Forb	Acanthaceae	*Crabbea acaulis*		X
Forb	Amaranthaceae	*Atriplex semibacata*	Weed	X
Forb	Asteraceae	*Arctotis arctoides*		X
Forb	Asteraceae	*Berkheya onopordifolia*		X
Forb	Asteraceae	*Berkheya pinnatifida*		X
Forb	Asteraceae	*Bidens bipinnata*	Alien Plant	X
Forb	Asteraceae	*Conyza bonariensis*	Alien Plant	X
Forb	Asteraceae	*Gazania krebsiana*		X
Forb	Asteraceae	*Schkuhria pinnata*	Alien Plant	X
Forb	Asteraceae	*Tagetes minuta*	Alien Plant	X
Forb	Asteraceae	*Tripteris aghillana*	Weed	X
Forb	Asteraceae	*Vernonia olgiocephala*		X
Forb	Asteraceae	*Zinnia peruviana*	Alien Plant	X

Forb	Campanulaceae	*Wahlenbergia virgata*		X
Forb	Convolvulaceae	*Cuscuta australis*	Outside of range	X
Forb	Fabaceae	*Indigofera deleoides*		X
Forb	Geraniaceae	*Monsonia burkeana*		X
Geophyte	Hypoxidaceae	*Hypoxis argentea*		X
Forb	Lamiaceae	*Teucrium trifidum*		X
Forb	Malvaceae	*Corchorus aspelnifolius*		X
Forb	Malvaceae	*Hermannia coccocarpa*		X
Forb	Malvaceae	*Hermannia depressa*		X
Forb	Malvaceae	*Hibiscus aethipicus*		X
Forb	Malvaceae	*Hibiscus pusillus*		X
Forb	Malvaceae	*Hibiscus trionum*	Alien Plant	X
Forb	Malvaceae	*Sida cordifolia*	Weed	X
Forb	Malvaceae	*Sida dregei*		X
Forb	Verbenaceae	*Lippia javanica*		X
Forb	Verbenaceae	*Verbena aristigera*	Alien Plant	X
Forb	Verbenaceae	*Verbena officinalis*	Category 1b Invasive Alien Plant	X
Geophyte	Hypoxidaceae	*Hypoxis hemerocallidea*		X
Geoxylic Suffrutex	Rhamnaceae	*Ziziphus zeyheriana*		X
Graminoid	Poaceae	*Aristida congesta*	Weed	X
Graminoid	Poaceae	*Cymbopogon pospischilii*		X
Graminoid	Poaceae	*Cynodon dactylon*	Weed	X
Graminoid	Poaceae	*Digitaria eriantha*		X
Graminoid	Poaceae	*Elionurus muticus*		X
Graminoid	Poaceae	*Eragrostis biflora*		X
Graminoid	Poaceae	*Eragrostis chloromelas*		X
Graminoid	Poaceae	*Eragrostis gummiflua*		X
Graminoid	Poaceae	*Eragrostis lehmanniana*		X
Graminoid	Poaceae	*Eragrostis obtusa*		X
Graminoid	Poaceae	*Eragrostis superba*		X
Graminoid	Poaceae	*Eragrostis trichophora*		X
Graminoid	Poaceae	*Panicum coloratum*		X
Graminoid	Poaceae	*Panicum maximum*		X
Graminoid	Poaceae	*Setaria pallide-fusca*		X
Graminoid	Poaceae	*Setaria verticillata*		X
Graminoid	Poaceae	*Themeda triandra*		X
Graminoid	Poaceae	*Trichoneura grandiglumis*		X
Shrub	Asparagaceae	*Asparagus laricinus*	Potential Encroacher	X
Shrub	Asparagaceae	*Asparagus setaceus*		X
Shrub	Boraginaceae	*Ehretia rigida*		X
Shrub	Celastraceae	*Gymnosporia heterophylla*		X
Shrub	Ebenaceae	*Diospyros lycioides*		X
Shrub	Fabaceae	*Acacia (Vachellia) karroo*	Potential Encroacher	X
Shrub	Malvaceae	*Grewia flava*		X
Succulent Dwarf Shrub	Aizoaceae	*Delosperma cooperi*		X
Succulent Dwarf Shrub	Aizoaceae	*Delosperma floribundum*		X
Succulent Forb	Asphodelaceae	*Bulbine capitata*		X
Succulent Shrub	Agavaceae	*Agave americana*	Category 2 Alien Invasive Plant	X
Succulent Shrub	Cactaceae	*Opuntia ficus-indica*	Category 1b Invasive Alien Plant	X
Succulent Shrub	Cactaceae	*Opuntia humifusa*	Category 1b Alien Invasive Plant	X
Tree	Anacardiaceae	*Searsia lancea*		X
Tree	Fabaceae	*Acacia (Vachellia) karroo*		X
Tree	Rhamnaceae	*Ziziphus mucronata*		X
Shrub	Solanaceae	*Lycium ferocissimum*		X
Graminoid	Poaceae	*Setaria spp.*		X

Forb	Asteraceae	*Helichrysum dregeanum*		X

Secondary Sparse Woody Grassland

Habitat and Land use			
Substrate	Greyish to brown clay-loam soil	**Disturbance**	Historical cultivated area. Overgrazing. Establishment of IAPs: *Opuntia ficus-indica* and *Verbena officinalis*
Species Richness	82 species of which 7 are alien plants and 7 are indigenous weeds	**Conservation value:**	Low
Ecosystem function	Grazing, maintenance of pollinator populations, vegetation cover necessary for soil conservation, stabilisation of soils, accumulates and slows down runoff, maximises infiltration of runoff into soils, habitat for flora and fauna	**Sensitivity:**	Low
Need for rehabilitation	Clearing of weeds and alien invasive species		

Vegetation structure		
Layer	**Height (m)**	**Cover (%)**
High shrubs and trees	1.8 - 4	0.5-10
Low Shrubs	0.2 – 1.5	10-15
Grass	0.1 – 1	80
Forbs	0.01 – 1.5	10-20
Diagnostic Species	*Cynodon dactylon, Digitaria eriantha, Eragrostis chloromelas, Panicum coloratum, Acacia karroo (Shrub)*	
Dominant Species	*Acacia karoo (Tree), Themeda triandra, Heteropogon contortus, Eragrostis lehmanniana, Eragrostis gummiflua, Aristida congesta, Monsonia burkeana, Nidorela residifolia, Helichrysum rugulosum, Arctotis arctoides,*	

Growth Form	Family	Species	Status	Secondary (Plagioclimax) Sparse Woody Grassland
Climbing Forb	Apocynaceae	*Pentharrhinum insipidum*		X

Climbing Shrub	Ranunculaceae	*Clematis brachiata*		X
Creeping Forb	Fabaceae	*Rhynchosia minima*		X
Creeping Forb	Fabaceae	*Rhynchosia totta var. totta*		X
Dwarf Shrub	Asteraceae	*Felicia muricata*	Potential Encroacher	X
Dwarf Shrub	Asteraceae	*Pentzia incana*	Potential Encroacher	X
Forb	Acanthaceae	*Crabbea acaulis*		X
Forb	Amaranthaceae	*Achyranthes aspera*	Weed	X
Forb	Asteraceae	*Arctotis arctoides*		X
Forb	Asteraceae	*Berkheya onopordifolia*		X
Forb	Asteraceae	*Berkheya pinnatifida*		X
Forb	Asteraceae	*Bidens bipinnata*	Alien Plant	X
Forb	Asteraceae	*Conyza bonariensis*	Alien Plant	X
Forb	Asteraceae	*Dicoma anomala subsp. Circioides*		X
Forb	Asteraceae	*Gazania krebsiana*		X
Forb	Asteraceae	*Helichrysum nudifolium*		X
Forb	Asteraceae	*Helichrysum rugulosum*	Weed	X
Forb	Asteraceae	*Nidorela residifolia*		X
Forb	Asteraceae	*Tagetes minuta*	Alien Plant	X
Forb	Asteraceae	*Tripteris aghillana*	Weed	X
Forb	Asteraceae	*Zinnia peruviana*	Alien Plant	X
Forb	Campanulaceae	*Wahlenbergia denticulata*		X
Forb	Campanulaceae	*Wahlenbergia virgata*		X
Forb	Caryophyllaceae	*Pollichia campestris*		X
Forb	Commelinaceae	*Commelina africana*		X
Forb	Convolvulaceae	*Convolvulus sagittatus*		X
Forb	Convolvulaceae	*Cuscuta australis*	Outside of range	X
Forb	Fabaceae	*Chamaecrista comosa*		X
Forb	Fabaceae	*Indigofera deleoides*		X
Forb	Geraniaceae	*Monsonia burkeana*		X
Geophyte	Hypoxidaceae	*Hypoxis argentea*		X
Forb	Lamiaceae	*Stachys hyssopoides*		X
Forb	Lamiaceae	*Teucrium trifidum*		X
Forb	Malvaceae	*Hermannia coccocarpa*		X
Forb	Malvaceae	*Hermannia depressa*		X
Forb	Malvaceae	*Hibiscus pusillus*		X
Forb	Malvaceae	*Pavonia senegalensis*		X
Forb	Malvaceae	*Sida cordifolia*	Weed	X
Forb	Malvaceae	*Sida dregei*		X
Forb	Pedaliaceae	*Sesamum triphyllum*	Weed	X
Forb	Scrophulariaceae	*Aptosimum procumbens*		X
Forb	Scrophulariaceae	*Jamesbrittenia aurantiaca*		X
Forb	Verbenaceae	*Lippia javanica*		X
Forb	Verbenaceae	*Verbena aristigera*	Alien Plant	X
Forb	Verbenaceae	*Verbena officinalis*	Category 1b Invasive Alien Plant	X
Geophyte	Agavaceae	*Chlorophytum fasciculatum*		X
Geophyte	Amaryllidaceae	*Boophone disticha*	Protected	X
Geophyte	Hyacinthaceae	*Schizocarphus nervosus*	Protected	X
Geophyte	Hypoxidaceae	*Hypoxis hemerocallidea*		X
Geophyte	Hypoxidaceae	*Hypoxis rigidula*		X
Geoxylic Suffrutex	Rhamnaceae	*Ziziphus zeyheriana*		X
Graminoid	Poaceae	*Aristida adscensionis*		X
Graminoid	Poaceae	*Aristida congesta*	Weed	X
Graminoid	Poaceae	*Cynodon dactylon*	Weed	X
Graminoid	Poaceae	*Digitaria eriantha*		X
Graminoid	Poaceae	*Elionurus muticus*		X

Graminoid	Poaceae	*Eragrostis chloromelas*		X
Graminoid	Poaceae	*Eragrostis curvula*		X
Graminoid	Poaceae	*Eragrostis gummiflua*		X
Graminoid	Poaceae	*Eragrostis lehmanniana*		X
Graminoid	Poaceae	*Eragrostis obtusa*		X
Graminoid	Poaceae	*Eragrostis plana*		X
Graminoid	Poaceae	*Eragrostis superba*		X
Graminoid	Poaceae	*Eragrostis trichophora*		X
Graminoid	Poaceae	*Heteropogon contortus*		X
Graminoid	Poaceae	*Panicum coloratum*		X
Graminoid	Poaceae	*Setaria pallide-fusca*		X
Graminoid	Poaceae	*Sporobolus fimbriatus*		X
Graminoid	Poaceae	*Themeda triandra*		X
Shrub	Asparagaceae	*Asparagus laricinus*	Potential Encroacher	X
Shrub	Asparagaceae	*Asparagus setaceus*		X
Shrub	Celastraceae	*Gymnosporia heterophylla*		X
Shrub	Ebenaceae	*Diospyros lycioides*		X
Shrub	Fabaceae	*Acacia (Vachellia) karroo*	Potential Encroacher	X
Succulent Forb	Asphodelaceae	*Bulbine capitata*		X
Succulent Forb	Asphodelaceae	*Bulbine narcissifolia*		X
Succulent Shrub	Cactaceae	*Opuntia ficus-indica*	Category 1b Invasive Alien Plant	X
Tree	Anacardiaceae	*Searsia lancea*		X
Tree	Fabaceae	*Acacia (Vachellia) karroo*		X
Tree	Rhamnaceae	*Ziziphus mucronata*		X
Graminoid	Poaceae	*Setaria spp.*		X
Forb	Asteraceae	*Helichrysum dregeanum*		X

Secondary Grassland

Habitat and Land use			
Substrate	Orange to light brown, loamy-sand. Moderate soil depth	**Disturbance**	Historical cultivated area. Pasture Establishment of IAPs: *Verbena officinalis*
Species Richness	62 species of which 9 are alien plants and 10 are indigenous weeds	**Conservation value:**	Low
Ecosystem function	Grazing, vegetation cover necessary for soil conservation, stabilisation of soils, accumulates and slows down runoff, maximises infiltration of runoff into soils, habitat for flora and fauna.	**Sensitivity:**	Low
Need for rehabilitation	Clearing of weeds and alien invasive species		

Vegetation structure		
Layer	**Height (m)**	**Cover (%)**
High shrubs and trees	1.8 - 4	3
Low Shrubs	0.2 – 1.5	5-10
Grass	0.1 – 1	80
Forbs	0.01 – 1.5	10-20
Diagnostic Species	*Helechrysum rugulosum, Digitaria eriantha, Eragrostis chloromelas, Eragrostis curvula*	
Dominant Species	*Verbena officinalis, Conyza bonariensis, Berkheya onopordifolia, Seriphium plumosum, Felicia muricata, Cynodon dactylon, Eragrostis lehmanniana, Panicum coloratum, Helichrysum dregeanum*	

Growth Form	Family	Species	Status	Secondary (Plagioclimax) Grassland
Creeping Forb	Amaranthaceae	*Alternanthera pungens*	Weed	X
Creeping Forb	Fabaceae	*Rhynchosia minima*		X
Dwarf Shrub	Asteraceae	*Felicia muricata*	Potential Encroacher	X
Dwarf Shrub	Asteraceae	*Pentzia incana*	Potential Encroacher	X
Dwarf Shrub	Asteraceae	*Seriphium plumosum*	Potential Encroacher	X
Dwarf Shrub	Scrophulariaceae	*Selago densiflora*		X
Forb	Amaranthaceae	*Achyranthes aspera*	Weed	X
Forb	Amaranthaceae	*Amaranthus thunbergii*	Weed	X
Forb	Asteraceae	*Arctotis arctoides*		X
Forb	Asteraceae	*Berkheya onopordifolia*		X
Forb	Asteraceae	*Berkheya pinnatifida*		X
Forb	Asteraceae	*Bidens bipinnata*	Alien Plant	X
Forb	Asteraceae	*Conyza bonariensis*	Alien Plant	X
Forb	Asteraceae	*Cotula podocephala*		X
Forb	Asteraceae	*Helichrysum rugulosum*	Weed	X
Forb	Asteraceae	*Nidorela residifolia*		X
Forb	Asteraceae	*Pseudognaphalium luteo-album*	Alien Plant	X
Forb	Asteraceae	*Schkuhria pinnata*	Alien Plant	X
Forb	Asteraceae	*Tagetes minuta*	Alien Plant	X
Forb	Asteraceae	*Tripteris aghillana*	Weed	X
Forb	Campanulaceae	*Wahlenbergia undulata*		X
Forb	Campanulaceae	*Wahlenbergia virgata*		X
Forb	Caryophyllaceae	*Pollichia campestris*		X
Forb	Chenopodiaceae	*Chenopodium album*	Weed	X
Forb	Fabaceae	*Indigofera deleoides*		X
Forb	Geraniaceae	*Monsonia burkeana*		X
Forb	Malvaceae	*Hermannia depressa*		X
Forb	Malvaceae	*Hibiscus aethipicus*		X
Forb	Malvaceae	*Hibiscus trionum*	Alien Plant	X
Forb	Malvaceae	*Sida cordifolia*	Weed	X
Forb	Scrophulariaceae	*Aptosimum procumbens*		X
Forb	Scrophulariaceae	*Jamesbrittenia aurantiaca*		X
Forb	Solanaceae	*Solanum nigrum*		X
Forb	Verbenaceae	*Lippia javanica*		X
Forb	Verbenaceae	*Verbena aristigera*	Alien Plant	X

Forb	Verbenaceae	*Verbena officinalis*	Category 1b Invasive Alien Plant	X
Geophyte	Amaryllidaceae	*Boophone disticha*	Protected	X
Geophyte	Hypoxidaceae	*Hypoxis hemerocallidea*		X
Graminoid	Cyperaceae	*Cyperus usitatus*	Weed	X
Graminoid	Poaceae	*Aristida congesta*	Weed	X
Graminoid	Poaceae	*Cynodon dactylon*	Weed	X
Graminoid	Poaceae	*Digitaria eriantha*		X
Graminoid	Poaceae	*Eragrostis chloromelas*		X
Graminoid	Poaceae	*Eragrostis curvula*		X
Graminoid	Poaceae	*Eragrostis gummiflua*		X
Graminoid	Poaceae	*Eragrostis lehmanniana*		X
Graminoid	Poaceae	*Eragrostis plana*		X
Graminoid	Poaceae	*Eragrostis racemosa*		X
Graminoid	Poaceae	*Eragrostis superba*		X
Graminoid	Poaceae	*Eragrostis trichophora*		X
Graminoid	Poaceae	*Heteropogon contortus*		X
Graminoid	Poaceae	*Hyparrhenia hirta*		X
Graminoid	Poaceae	*Panicum coloratum*		X
Graminoid	Poaceae	*Themeda triandra*		X
Shrub	Asparagaceae	*Asparagus setaceus*		X
Shrub	Boraginaceae	*Ehretia rigida*		X
Shrub	Fabaceae	*Acacia (Vachellia) karroo*	Potential Encroacher	X
Succulent Dwarf Shrub	Aizoaceae	*Delosperma floribundum*		X
Succulent Forb	Portulacaceae	*Portulaca quadrifida*	Alien Plant	X
Tree	Fabaceae	*Acacia (Vachellia) karroo*		X
Graminoid	Poaceae	*Setaria spp.*		X
Forb	Asteraceae	*Helichrysum dregeanum*		X

Primary Grassland

Habitat and Land use			
Substrate	Light brown, loamy-sand to loamy-clay. Moderate to shallow soil depth	**Disturbance**	Habitat fracturing, Long term grazing with periods of overgrazing. Establishment of IAPs: *Verbena officinalis*
Species Richness	44 species of which 3 are alien plants and 4 are indigenous weeds	**Conservation value:**	High: Natural patches of grassland resembling Vaal-Vet Sandy Grassland
Ecosystem function	Grazing, vegetation cover necessary for soil conservation, stabilisation of soils, accumulates and slows down runoff, maximises infiltration of runoff into soils, habitat for flora and fauna.	**Sensitivity:**	High: Natural patches of grassland resembling Vaal-Vet Sandy Grassland
Need for rehabilitation	Clearing of weeds and alien invasive species		

Vegetation structure		
Layer	**Height (m)**	**Cover (%)**
High shrubs and trees	1.8 - 4	3
Low Shrubs	0.2 – 1.5	5-10
Grass	0.1 – 1	80
Forbs	0.01 – 1.5	10-20
Diagnostic Species	*Vernonia oligocephala, Eragrostis chloromelas. Themeda triandra, Panicum coloratum*	
Dominant Species	*Heteropogon contortus, Hermannia depressa, Teucrium trifidum, Berkheya onopordifolia, Arctotis arctoides, Felicia muricata, Lippia javanica,*	

Growth Form	Family	Species	Status	Primary Grassland
Climbing Forb	Apocynaceae	*Pentharrhinum insipidum*		X
Creeping Forb	Fabaceae	*Rhynchosia minima*		X
Dwarf Shrub	Asteraceae	*Felicia muricata*	Potential Encroacher	X
Dwarf Shrub	Fabaceae	*Indigofera cryptantha*		X
Forb	Acanthaceae	*Crabbea acaulis*		X
Forb	Amaranthaceae	*Achyranthes aspera*	Weed	X
Forb	Asteraceae	*Arctotis arctoides*		X
Forb	Asteraceae	*Berkheya onopordifolia*		X
Forb	Asteraceae	*Conyza bonariensis*	Alien Plant	X
Forb	Asteraceae	*Dicoma zeyheri*		X
Forb	Asteraceae	*Helichrysum rugulosum*	Weed	X
Forb	Asteraceae	*Tagetes minuta*	Alien Plant	X
Forb	Asteraceae	*Vernonia olgiocephala*		X
Forb	Campanulaceae	*Wahlenbergia virgata*		X
Forb	Fabaceae	*Chamaecrista comosa*		X
Forb	Fabaceae	*Indigofera deleoides*		X
Forb	Geraniaceae	*Monsonia burkeana*		X
Forb	Lamiaceae	*Stachys hyssopoides*		X
Forb	Lamiaceae	*Teucrium trifidum*		X
Forb	Malvaceae	*Hermannia depressa*		X
Forb	Malvaceae	*Hibiscus aethipicus*		X
Forb	Malvaceae	*Pavonia senegalensis*		X
Forb	Scrophulariaceae	*Aptosimum procumbens*		X
Forb	Scrophulariaceae	*Jamesbrittenia aurantiaca*		X
Forb	Scrophulariaceae	*Striga asiatica*		X
Forb	Verbenaceae	*Lippia javanica*		X
Forb	Verbenaceae	*Verbena officinalis*	Category 1b Invasive Alien Plant	X
Geophyte	Amaryllidaceae	*Boophone disticha*	Protected	X
Geophyte	Hyacinthaceae	*Schizocarphus nervosus*	Protected	X
Geophyte	Hypoxidaceae	*Hypoxis hemerocallidea*		X
Graminoid	Poaceae	*Aristida congesta*	Weed	X
Graminoid	Poaceae	*Cynodon dactylon*	Weed	X
Graminoid	Poaceae	*Elionurus muticus*		X
Graminoid	Poaceae	*Eragrostis chloromelas*		X
Graminoid	Poaceae	*Eragrostis curvula*		X
Graminoid	Poaceae	*Heteropogon contortus*		X

Graminoid	Poaceae	*Panicum coloratum*		X
Graminoid	Poaceae	*Themeda triandra*		X
Shrub	Asparagaceae	*Asparagus laricinus*	Potential Encroacher	X
Shrub	Fabaceae	*Acacia (Vachellia) karroo*	Potential Encroacher	X
Succulent Dwarf Shrub	Aizoaceae	*Delosperma floribundum*		X
Succulent Forb	Asphodelaceae	*Aloe davyana*	Protected	X
Tree	Fabaceae	*Acacia (Vachellia) karroo*		X
Dwarf Shrub	Solanaceae	*Lycium horridum*		X

Plant Species of Conservation Concern (SCC)

During the survey no plant SCC was recorded. However, three provincially protected species were recorded, as listed within the Free State Nature Conservation Bill (2007), namely; Aloe *davyana, Boophone disticha, Schizocarpus nervosus and Ammocharis coranica*. 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 6th – 10th of April 2020 (end of wet season).

Overall, mammal diversity in the project area was moderate, with eleven (11) mammal species being physically recorded based on direct observations, camera trap photographs, Sherman traps, and/or the presence of visual tracks & signs. These 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 (as mentioned by the landowner).

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
Gerbilliscus brantsii	Highveld Gerbil	LC	LC
Rhabdomys pumilio	Four-Striped Grass Mouse	LC	LC
Mastomys coucha	Southern Multimammate Mouse	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

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. However, what was surprising, was that only one species of *Mastomys coucha* (Southern Multimammate Mouse) was caught whilst *Rhabdomys pumilio* (Four Striped-Grass Mouse) was fairly regularly trapped. It is feasible, that due to very high rainfall leading up to the sample period (and thus very high productivity of vegetation, insects and seeds), it is possible that the abundance of resources prohibited trapping success, although this does not dimmish the reliability of the data gathered.

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. Primary Grassland and Secondary (Plagioclimax) Sparse Woody Grassland

These habitats provide excellent 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. Within the development site, these habitats represent, combined, the second largest mammalian habitat. The grasses in these habitats are very dense and of fair forage value. Moderate-high structural complexity (habitat and niche diversity) and strong foraging potential allows for a moderate species diversity for these areas, with species from most trophic levels present. However, it must be reiterated that the poor and unusually low trapping success has likely deprived the habitat of its predicted total diversity. Overall diversity, connectivity and sensitivity of these areas can be regarded as Moderate.

B. Secondary Grassland (Pastures)

These are old cultivated lands that have been anthropogenically re-seed to serve as forage (pastures) for livestock. These "planted" grasslands are the prevailing land use. Although

the grass layer was excellent, the fairly species poor nature of the habitat reduces habitat and foraging potential in comparison with the above described habitats. The softer substrate is however more optimal for fossorial or burrowing species such as mole rats, mongooses, Suids (pig species) and porcupines. The overall diversity, connectivity and sensitivity of these areas were Low.

C. 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. The overall diversity, connectivity and sensitivity of these areas were Low.

D. Wetland Habitats

Wetlands occur naturally or have been somewhat modified throughout the study area and support surrounding agricultural practices. The vegetation around these habitats is wetland associated and include dense long grasses. This provides structural complexity and potential breeding/foraging habitat for mammal species. The overall diversity, connectivity and sensitivity of these areas were Moderate to High.

E. Bottomland Thornveld

This habitat also provides good refugia and forage for small mammal species, which in turn form the basis for the trophic food chain. This habitat is also regarded as a fairly important breeding and foraging sites for mammal species. The grasses in these habitats are 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 fairy strong foraging potential and overall, the species diversity for these areas was moderate-low, with species from most trophic levels present. Overall diversity, connectivity and sensitivity of these areas can be regarded as Moderate.

Herpetofauna

This section represents the results from the field survey conducted from the 6th – 10th of April 2020 (end of wet season).

Herpetofauna diversity was considered to be moderate-low with three (3) reptile species and one (1) 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

8. COMBINED HABITAT SENSITIVITY

The following sensitivity map (Figure 11) has been compiled combining the results obtained from the field survey as well as available geo-spatial information.

Very High Sensitivity

» All Wetland Features: Wetland features that feed into important downstream watercourses, are associated with natural grassland resembling Vaal-Vet Sandy Grassland and hens worth being classified as CBA1, provide various unique habitats and niches (contribute to habitat and species diversity), are a potential suitable habitat for *Pyxicephalus adspersus* – Giant Bullfrog (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).

- General Development Recommendations:
  This part of the Vaal-Vet Sandy Grassland, apart from being part of a listed threatened ecosystem and containing a few protected species, fulfils a relatively important role in the wider ecosystem. It accumulates and significantly reduces the speed of all runoff coming from higher-lying areas. The vegetation filters this water, retaining nutrients, detritus, and possible pollutants that could leach out of higher-lying cultivation areas. The discharge of these substances into lower-lying river systems could lead to eutrophication and a rise in aquatic weeds, and thus to cumulative impacts of the development should this portion of the vegetation be destroyed.

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.

High Sensitivity

» Primary Grassland: Primary grassland features that are representative of slightly degraded (overgrazed) form of Vaal-Vet Sandy Grassland (Endangered), and which are located within the CBA1 areas as delineated by DESTEA. These remaining "CBA1" areas were however, during the site visit, confirmed to be slightly degraded (as a result of longer grazing with periods of overgrazing), and mostly small, fractured, patches surrounded by historically cultivated areas. Subsequently these patches of primary grassland can rather be regarded as Ecological Support Areas.

- General Development Recommendations:
  Due to the patchiness and fractured/isolated nature of these primary grasslands, development within these areas are regarded as acceptable. However, care should be taken to keep the impacted area as small as possible. Existing access routes should be used as far as possible

» 30m buffer areas around wetland features: This buffer area is recommended around the identified wetland features and have already be discussed above.

Medium Sensitivity

» Primary Grassland resembling natural Central Free State Grassland, and Bottom Thornveld: All natural primary vegetation features located outside of CBAs or which represent Central Free State Grassland have also been classified as medium sensitive.

- 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.

» 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.

- General Development Recommendations:
  Development within these habitats are acceptable.

  To prevent the onset of accelerated erosion, it is recommended that where possible vegetation clearing be limited to footprints of the pylons, furthermore all invasive trees and other alien invasives recorded along the route should be eradicated. 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.

Low Sensitivity

» All transformed and disturbed area: 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.

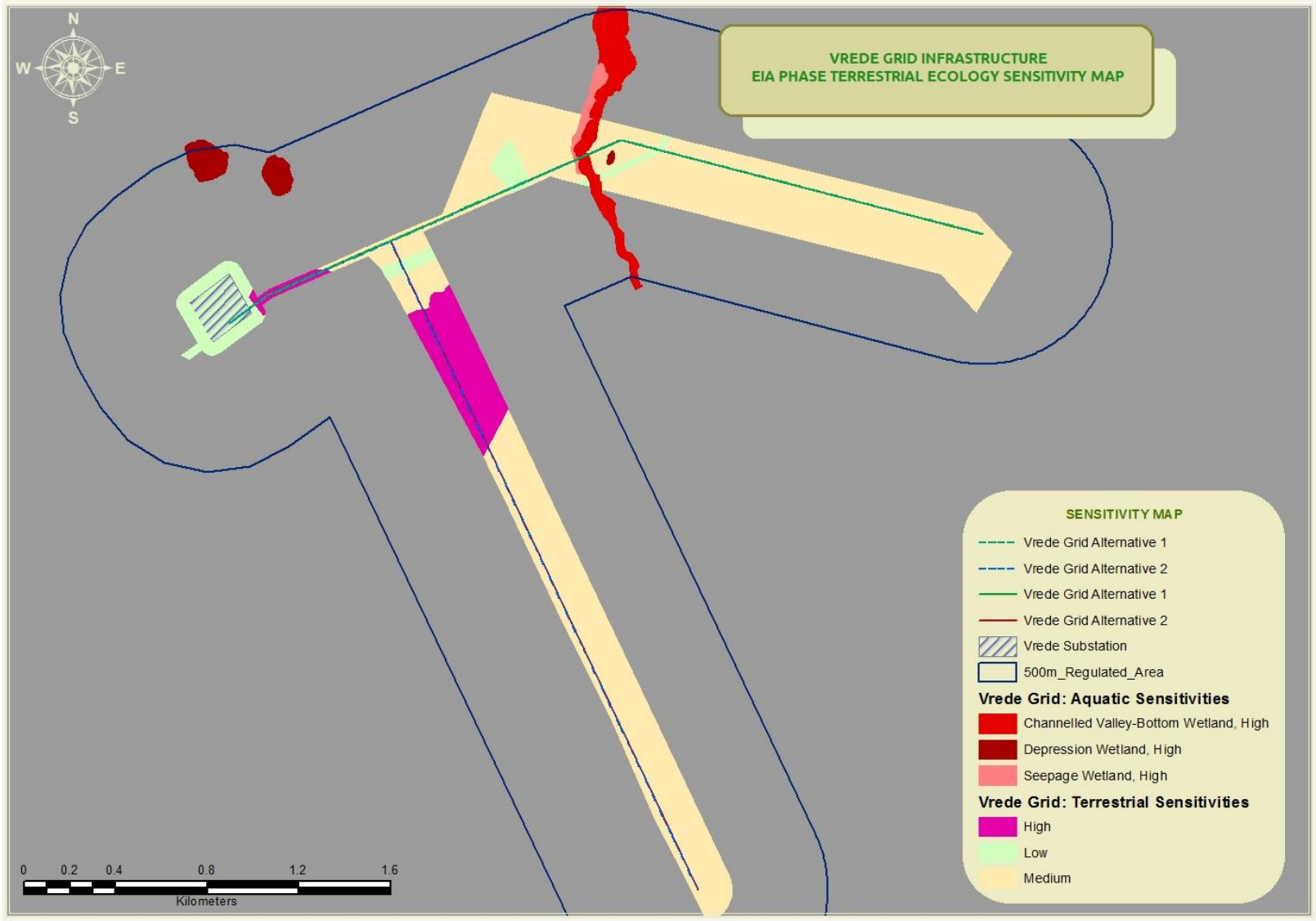

Figure 11: Combined Sensitivity Map.

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

- » The proposed location for the on-site substation is, as mentioned an area that has been historically cultivated, artificial re-seeding has also been done within the area to improve the grazing of the area. Subsequently, even though this area has been mapped as part of the Endangered Vaal-Vet Sandy Grassland Vegetation Type, this area provides very little value in terms of the conservation of this vegetation type, and any impacts within this area will not result or influence the status of this vegetation type. As such this aspect (impact on an endangered vegetation type) was not considered during the

assessment of potential impact arising from construction and operation of the on-site substation.

» Due to the fact that the proposed on-site substation is located a fair distance away from any freshwater resource features (outside of any important micro-catchment areas) and due the relative flat to very low gradient of the area, impacts on freshwater resource features are highly unlikely and as such impacts relating to such features were not assessed for the on-site substation.

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	Minor (2)	Small (1)
Probability	Probable (3)	Improbable (2)
Significance	**Low (21)**	**Low (12)**
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 (1)	Local (1)
Duration	Medium-term (3)	Short-term (1)
Magnitude	Minor (2)	Small (1)
Probability	Probable (3)	Improbable (2)
Significance	**Low (18)**	**Low (6)**
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 PV panel 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.

Vrede Grid Connection

» For both grid options, the impacts relating to terrestrial ecology are very similar and as such the impact assessment conducted below, relating to terrestrial ecology, is applicable to both gridline alternatives.
» In terms of impacts on freshwater resource/aquatic features; gridline alternative 2 is located a fair distance away from any freshwater resource features (outside of any important micro-catchment areas) and due the relative flat to very low gradient of the area, impacts on freshwater resource features are highly unlikely. However, gridline alternative 1 will cross a channelled valley-bottom wetland and its associated seepage wetland as well as a small drainage line to the east (feeds into a valley-bottom wetland) and as such will likely have some impact on freshwater resource features. Subsequently no impact assessment relating to freshwater/aquatic resource features will be necessary for gridline alternative 2, but for gridline alternative 1, potential impacts on such aquatic resources' features will be assessed.

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	
	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Minor (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	
	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Short-term (2)	Short-term (2)
Magnitude	Low (4)	Minor (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 (1)	Local (1)
Duration	Medium-term (3)	Short-term (1)
Magnitude	Low (4)	Minor (2)
Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (32)**	**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 (1)	Local (1)
Duration	Permanent (5)	Short-term (1)
Magnitude	Low (4)	Small (1)
Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (40)**	**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 (Freshwater/Aquatic): *Loss/disturbance of wetlands, watercourses and/or riparian systems during the construction, operation and decommissioning phases.*

Impact Nature: The physical removal and disturbance of narrow strips of wetland/riparian zones 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.

	ALTERNATIVE 1	
	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	Minor (4)
Probability	Definite (5)	Highly Probable (4)
Significance	**Medium (55)**	**Medium (36)**

Status	Negative	Negative
Reversibility	Low	Low to Medium
Irreplaceable loss of resources	Slight potential for the loss of local resources	Very low potential for the loss of local resources
Can impacts be mitigated?	Direct impacts on the vegetation of the wetland and/or riparian areas can be avoided by spanning the powerline across these freshwater resource features and avoiding the placement of pylons or any permanent infrastructure within these features and through the use of existing road crossings.	
Mitigation	» No pylons must be placed within the delineated wetland/riparian habitats; however, the pylon 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 (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 via the ephemeral systems.

Appropriate ablution facilities should be provided for construction workers during construction of the power line.

	ALTERNATIVE 1	
	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.

This may furthermore, influence water quality.

	ALTERNATIVE 1	
	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	» 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.

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 (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)	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 CBAs 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 (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)	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 the Vaal-Vet Sandy Grassland, 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 two gridline alternatives.

A summary of the assessment of impacts done for the Vrede 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>Reasons (incl. potential issues)</th></tr>
<tr><td rowspan="6">Vrede PV Solar Facility</td><td colspan="2">Overall Impact Significance in terms Freshwater/Aquatic Resource Features</td><td rowspan="6">» Both gridline alternatives/options will traverse a small portion classified as CBA1, however this will be for only a relative short distance (less than 700m for both options), and will mostly be along the existing gravel road. Subsequently, both options will not have a significant impact on the CBA1 status and its associated conservation targets.
» Even though alternative gridline 2 is slightly longer and is furthermore located within the boundaries of the Endangered Vaal-Vet Sandy Grassland Vegetation Type (SANBI, 2018), this gridline alternative is still regarded as slightly more favorable. The reason for this being the fact that the majority of the route will traverse historically disturbed/transformed areas (historically cultivated areas) which is now covered by a secondary grassland, and as such will not have a significant impact on natural Vaal-Vet Sandy Grassland and as such will not compromise the status of functionality of this vegetation within the area. Gridline Alternative 1 will for most part traverse natural to near-natural shrubby form of Central Free State Grassland. As such it can be concluded that Gridline Alternative 2 will have a lower impact on natural to near-natural habitats.
» From a freshwater/aquatic resource perspective, Gridline Alternative 2 is by far the preferred options as this alternative will not impact any freshwater resource features, whereas Gridline Alternative 1 will cross three wetland features.</td></tr>
<tr><td>Mainly Medium prior to Mitigation and Low with Mitigation considered</td><td>No Impact</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 Medium prior to Mitigation and Low with Mitigation considered</td></tr>
<tr><td colspan="2">Preference</td></tr>
<tr><td>Favorable</td><td>Not Preferred</td></tr>
</table>

10. CONCLUSION AND RECOMMENDATIONS

The development area falls within two vegetation types namely; Vaal-Vet Sandy Grassland and Central Free State Grassland. However, the proposed development footprint is located mostly within the Vaal-Vet Sandy Grassland with a small portion extending into the Central Free State Grassland. Vaal-Vet Sandy Grassland is listed as an endangered ecosystem whilst the Central Free State Grassland 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.

The proposed on-site substation is located a fair distance away from any freshwater resource features (outside of any important micro-catchment areas) and due the relative flat to very low gradient of the area, impacts on freshwater resource features are highly unlikely

In terms of the preferred grid route option:

» Grid Rout Option 1 is the most favourable and preferred route choice from a terrestrial and freshwater resource perspective based on the following:
  - Both gridline alternatives/options will traverse a small portion classified as CBA1, however this will be for only a relative short distance (less than 700m for both options), and will mostly be along the existing gravel road. Subsequently, both options will not have a significant impact on the CBA1 status and its associated conservation targets.

- Even though alternative gridline 2 is slightly longer and is furthermore located within the boundaries of the Endangered Vaal-Vet Sandy Grassland Vegetation Type (SANBI, 2018), this gridline alternative is still regarded as slightly more favourable. The reason for this being the fact that the majority of the route will traverse historically disturbed/transformed areas (historically cultivated areas) which is now covered by a secondary grassland, and as such will not have a significant impact on natural Vaal-Vet Sandy Grassland and as such will not compromise the status of functionality of this vegetation within the area. Gridline Alternative 1 will for most part traverse natural to near-natural shrubby form of Central Free State Grassland. As such it can be concluded that Gridline Alternative 2 will have a lower impact on natural to near-natural habitats.
- From a freshwater/aquatic resource perspective, Gridline Alternative 2 is by far the preferred options as this alternative will not impact any freshwater resource features, whereas Gridline Alternative 1 will cross three wetland features.

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

The sensitive areas identified, are as follow:

Very High Sensitivity

» All Wetland Features: Wetland features that feed into important downstream watercourses, are associated with natural grassland resembling Vaal-Vet Sandy Grassland and hens worth being classified as CBA1, provide various unique habitats and niches (contribute to habitat and species diversity), are a potential suitable habitat for *Pyxicephalus adspersus* – Giant Bullfrog (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 Vrede Solar Energy Facility project site, there are three depression wetland features, and a channelled valley-bottom wetland running across the north-eastern corner of the site and which terminates into the Vals River to the north. A seepage wetland feeds into the valley-bottom wetland (within the project area).

All of the freshwater resource features on and around the site are mostly, naturally, ephemeral, however artificial (anthropogenically) modifications to the morphology of most of the wetlands has resulted in portions of these wetland resource features becoming seasonally inundated (for an extended period of time).

A dominant feature of the channelled valley bottom wetland is the patches of woody riparian habitats interrupted with grassy riparian fringes lining the outer edges of these valley bottom wetlands. The height and density of the forb and tree/shrub layer is highly variable throughout the extent of the valley-bottom wetland. The depression wetlands as well as the seepage wetland comprise of a large temporarily saturated zone with a small seasonally saturated zone and an artificially created permanent saturated zone (only in the case of the depression wetlands, this zone is absent within the seepage wetland) and is dominated by a dense, moderate to tall graminoid cover (obligate and facultative wetland grasses and sedges).

» The findings of the baseline wetland assessment suggest the following Present Ecological Status' for the delineated wetland features:
  - All tree depression wetlands: C (Moderately Modified)
  - Seepage wetland: B (Largely Natural)
  - Channelled Valley Bottom Wetland: C (Moderately Modified)

» Following the Ecological Importance and Sensitivity (EIS) assessment, it was found that the depression wetlands as well as the channelled valley-bottom wetland are considered to ecologically important and sensitive (Class B: High EI&S). The seepage wetland was found to be of moderate ecological importance and sensitivity (Class C: Moderate EI&S). However, due to this wetland's association (hydrological connection) with the lower lying channelled valley-bottom wetland which is regarded as a high EIS system, this wetland features have been upgraded to High sensitive and importance.

» Natural Primary Grassland: Natural grassland features that are representative of Vaal-Vet Sandy Grassland (Endangered), are located within CBA1, and provide potential habitat for species of conservation concern, especially *Smaug gigantius* – Sungazer (Vulnerable).

High Sensitivity

» Natural Primary Grassland: Primary grassland features that are representative of slightly degraded (overgrazed) form of Vaal-Vet Sandy Grassland (Endangered), and which are located within the CBA1 areas as delineated by DESTEA. These remaining "CBA1" areas were however, during the site visit, confirmed to be slightly degraded (as a result of longer grazing with periods of overgrazing), and mostly small, fractured, patches surrounded by historically cultivated areas. Subsequently these patches of primary grassland can rather be regarded as Ecological Support Areas. Furthermore, these areas provide potential habitat for species of conservation concern, especially *Smaug gigantius* – Sungazer (Vulnerable). Development within these primary grassland patches, located within the proposed development area, is regarded as acceptable, with the strict implementation of the provided mitigation measures.

» 30m buffer areas around wetland features: This buffer area is 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 wetland features.

Medium Sensitivity

» Primary Grassland resembling natural Central Free State Grassland, and Bottom Thornveld: All natural primary vegetation features located outside of CBAs or which represent Central Free State Grassland have been classified as medium sensitive. Development within these habitats are acceptable.

» 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.

Low Sensitivity

» All transformed and disturbed area: 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.

Overall, no significant terrestrial ecological flaws that could pose a problem to the proposed PV Facility development were identified during the EIA phase 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 Vrede SEF are:

» 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.

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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 14).

Table 14: 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 15, below.

Table 15: 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 16: 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 17: 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 18: 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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Level 1:
System » Connectivity to open ocean

WETLAND/AQUATIC ECOSYSTEM CONTEXT	
LEVEL 2: REGIONAL SETTING	LEVEL 3: LANDSCAPE UNIT
DWA Level 1 Ecoregions or NFEPA WetVeg Groups or Other spatial frameworks	Valley floor
	Slope
	Plain
	Bench (Hilltop/Saddle/Shelf)

FUNCTIONAL UNIT	
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT	LEVEL 5: HYDROLOGICAL REGIME
River	Perenniality
Floodplain wetland	Period and depth of inundation and Period of saturation
Channelled valley-bottom wetland	
Unchannelled valley-bottom wetland	
Depression	
Seep	
Wetland flat	

WETLAND/AQUATIC ECOSYSTEM CHARACTERISTICS
LEVEL 6: DESCRIPTORS
Natural vs. Artificial Salinity pH Substratum type Vegetation type Geology

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 19). 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 19: 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 20, below. This classification is consistent with DWAF categories used to evaluate the present ecological state of aquatic ecosystems.

Table 20: 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

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References

Gerhard Botha

ECOLOGICAL RELATED STUDIES AND SURVEYS

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

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).