Nkurenkuru
ECOLOGY & BIODIVERSITY
SACNASP REG: 400502/14

ECOLOGICAL AND SURFACE HYDROLOGY ASSESSMENT:

BASIC ASSESSMENT

PROPOSED MOEDING SOLAR PV FACILITY, VRYBURG, NORTH-WEST PROVINCE

November 2018

Prepared by:

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TABLE OF CONTENTS

FIGURES

DECLARATION OF CONSULTANT'S INDEPENDENCE

I, Gerhard Botha, as the appointed specialist hereby declare that I:

- » 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 no vested interest in the proposed activity proceeding;
- » have disclosed, to the applicant, EAP and competent authority, any material information that have 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 offence in terms of regulation 48 of GN No. R. 326.

Gerhard Botha Pr.Sci.Nat 400502/14 (Botanical and Ecological Science)
November 2018

MOEDING SOLAR PV FACILITY, NEAR VRYBURG, NORTH WEST PROVINCE
ECOLOGICAL AND SURFACE HYDROLOGY ASSESSMENT REPORT

1 INTRODUCTION

1.1 Applicant

Moeding Solar (Pty) Ltd.

1.2 Project

The project will be known as the Moeding Solar PV Facility.

1.3 Proposed Activity

The facility is proposed to include multiple arrays (static or tracking) of photovoltaic (PV) solar panels with a generating capacity of up to 100MW. The development footprint for the facility is anticipated to be approximately 300ha in extent.

Infrastructure associated with the solar energy facility will include:

» Arrays of PV panels (either a static or tracking PV system) with a capacity of up to 100MW.
» Mounting structures to support the PV panels.
» On-site inverters to convert the power from a direct current to an alternating current.
» An onsite substation to facilitate the connection between the solar energy facility and the Eskom electricity grid.
» A new 132kV power line between the on-site substation and the Eskom grid connection point.
» Battery storage with up to 6hours of storage capacity.
» Cabling between the project components, to be laid underground where practical.
» Offices and workshop areas for maintenance and storage.
» Temporary laydown areas.
» Permanent laydown area.
» Internal access roads and fencing.

Two power line alternatives are being considered:

» Direct connection to the existing Mookodi Substation located approximately 4km north of the project site.
» A turn-in turn-out connection into the Mookodi - Magopela 132kV power line (proposed along the eastern boundary of the project site). A new turn-in and out 132kV power line will be constructed over a distance of ~335m

1.4 Terms of reference

To conduct an ecological and surface hydrology study for a basic 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 ecological and surface hydrological issues pertaining to the target area and potential mitigation and measures to aid in future decisions regarding the proposed project and to minimalize the significance of identified impacts.

1.5 Conditions of this report

Findings, recommendations and conclusions provided in this report are based on the authors' best scientific and professional knowledge and information available at the time of compilation. No form of this report may be amended or extended without the prior written consent of the author. Any recommendations, statements or conclusions drawn from or based on this report must clearly cite or 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.

1.6 Relevant legislation

Legislation pertaining to general ecology:

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

Provincial

» The Transvaal Nature Conservation Ordinance (No. 12 of 1983) in its entirety, with special reference to:
- Schedule 2: Protected Game
- Schedule 3: Specially Protected Game
- Schedule 4: Protected Wild Animals
- Schedule 5: Wild Animals
- Schedule 7: Invertebrates
- Schedule 11: Protected Plants
- Schedule 12: Specially Protected Plants

» The Bophuthatswana Nature Conservation Act (Act 3 of 1973) in its entirety, with special reference to:
- Schedule 1: Protected Game
- Schedule 1A: Specially Protected Game
- Schedule 2: Ordinary Game
- Schedule 3: Wild Animals In Respect Of Which The Provision Of Section 3 (a) (ii) Apply
- Schedule 4: Wild Animals To Which The Provisions Of Section 4 (1) (b) Do Not Apply

- Schedule 7: Protected Plants
- Schedule 7: Specially Protected Plants

The above mentioned Nature Conservation Ordinances accompanied by all amendments is regarded by the North West Department of Rural, Environment and Agricultural Development (READ) 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 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
» National Forest Act 1998 / NFA (No 84 of 1998)
» National Veld and Forest Fire Act (Act No. 101 of 1998)
» 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)

Legislation pertaining to wetlands:

In response to the importance of wetland systems, protection of wetlands has been campaigned at national and international levels. This has led to the development of various policies and promulgation of a range of legislation to help protect wetland systems.

International level

» At an international level wetland protection is emphasized through the following conventions and agreements:

The RAMSAR Convention	Emphasis is placed on protecting wetlands and implementing initiatives to maintain or improve the state of wetland resources.
Convention on Biological Diversity	Countries are to rehabilitate or restore degraded ecosystem through the formulation of appropriate strategies and plans.
United Nations Convention to Combat Desertification	South Africa has responded to the UN Convention to Combat Desertification by developing a National Action Plan. The aim of the NAP is to implement at current and future policies that affect natural resource management and rural development, and establish partnerships between government departments, overseas development agencies, the private sector and NGOs.
The Partnership for Africa's Development (NEPAD)	Wetland conservation and sustainable use is one of the eight themes under the environment initiative.

The World Summit on Sustainable Development (WSSD)	The Implementation Plan highlights actions that reduce the risk of flooding in drought-vulnerable countries by promoting the restoration and protection of wetlands and watersheds.

National

» South African Constitution Act 108 of 1996
» National Environmental Management Act 107 of 1998
» 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.
» Conservation of Agricultural Resources Act / CARA (Act No. 43 of 1983) and amendments

Provincial Level

» The Transvaal Nature Conservation Ordinance (No. 12 of 1983)
» Convention on Biological Diversity, 1995

2 METHODOLOGY

2.1 Ecology (Terrestrial Fauna and Flora): Data scouring and review

Data sources from the literature were consulted and used where necessary in the study and include the following:

Vegetation:

» Vegetation types and their conservation status were extracted from the South African National Vegetation Map (Mucina and Rutherford 2012) as well as the National List of Threatened Ecosystems (2011), where relevant.
» Critical Biodiversity Areas for the site and surroundings were extracted (CBA Map for North West Province obtained from http://bgis.sanbi.org/fsp/project.asp).
» Information on plant and animal species recorded for the surrounding was extracted from the SABIF/SIBIS database hosted by SANBI. This is a considerably larger area than the study area, but is necessary to ensure a conservative approach as well as counter the fact that the site itself has probably not been well sampled in the past.
» 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 (2013).
» Freshwater and wetland information was extracted from the National Freshwater Ecosystem Priority Areas assessment, NFEPA (Nel et al. 2011). This includes rivers, wetlands and catchments defined under the study.

Fauna

- Lists of mammals, reptiles and amphibians which are likely to occur in the project site were derived based on distribution records from the literature and various spatial databases (SANBI's SIBIS and BGIS databases).
- Literature consulted includes Branch (1988) and Alexander and Marais (2007) for reptiles, Du Preez and Carruthers (2009) for amphibians, Friedmann and Daly (2004) and Skinner and Chimimba (2005) for mammals.
- Apart from the literature sources, additional information on reptiles were extracted from the SARCA web portal, hosted by the ADU, http://vmus.adu.org.za.
- The conservation status of each species is also listed, based on the IUCN Red List Categories and Criteria 2014 and where species have not been assessed under these criteria, the CITES status is reported where possible. These lists are adequate for mammals and amphibians, the majority of which have been assessed, however the majority of reptiles have not been assessed and therefore, it is not adequate to assess the potential impact of the development on reptiles, based on those with a listed conservation status alone. In order to address this shortcoming, the distribution of reptiles was also taken into account such that any narrow endemics or species with highly specialised habitat requirements occurring at the site were noted.
- Information on avifaunal species recorded for Quarter Degree Squares (QDS) 2626CD and 2726BA during both SABAP 1 and 2 (South African Bird Atlas Project) was extracted from the SABAP database.

2.2 Ecology (Terrestrial Fauna and Flora): Methods followed for in-field data sampling and interpretation

As part of the BA process, a detailed field survey of the vegetation has been undertaken (from 12th to 15st of May 2018 (Autumn)) and the results includes:

- A phytosociological classification of the vegetation found in the project site according to vegetation survey data and its TWINSPAN / PC ORD analysis.
- A corresponding description of all defined plant communities and their typical habitats, including a full species list for each plant community and a representative photographic record taken on site of each community.
- A map of all plant communities within the boundaries of the project site.
- A description of the sensitivity of each plant community, based on sensitivity criteria outlined in section 2.5.
- A full assessment of impacts according to section 2.6.

2.3 Hydrology (Wetlands and Watercourses): Data scouring and review

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.

Wetlands and watercourse areas were then delineated using the following available literature (these delineated hydrological features have been confirmed and assessed):

Table 1: Information and data coverage's 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 site location.	Shows location of the proposed PV Solar Facility 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 watersources	Shows the present ecological state of the affected non-perennial watercourses	Kleynhans (1999)

2.4 Hydrology (Wetlands and Watercourses): Methods followed for in-field data sampling and interpretation

2.4.1 Wetland and riparian areas delineation

The outer boundary of wetlands occurring within the proposed development boundary has been identified and delineated according to the Department of Water Affairs wetland delineation manual: 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005a). Available wetland indicators have been investigated including hydromorphic features, presence of hydrophytic plant species, and terrain unit features (e.g.

valley bottom settings and "key points"). The broader wetland systems were delineated using aerial photography and contour information at a desktop level.

2.4.2 Classification and assessment of conservation context

Wetlands have been classified according to HGM (hydro geomorphic) type using the National Wetland Classification System which was developed for the South African National Biodiversity Institute (SANBI, 2009). The HGM classification system is based on three key parameters pertaining to the wetland: the geomorphic setting of the wetland, the source of water inputs into the wetland, and its hydrodynamics (how does water move through the wetland), (Brinson 1993; Kotze *et al.* 2005). Additionally, wetland types have furthermore been identified based on the NFEPA (CSIR, 2011) wetland vegetation group in which wetlands are located. The conservation context and associated conservation significance of the project site have been described using available spatial datasets including the National Freshwater Ecosystem Priority Areas or NFEPA Project (CSIR, 2011) and the Aquatic Critical Biodiversity Areas Spatial Information (2008).

2.5 Criteria used to assess sites (Ecology and Hydrology)

The broad-scale scoping phase ecological sensitivity map of the site was produced by integrating information acquired during the desktop survey including available ecological and biodiversity information available in the literature and various spatial databases (SIBIS, BGIS), as well as the North West Provinces' Critical Biodiversity Areas (CBA). The ecological sensitivity of the different units identified in the mapping procedure was rated according to the following scale:

Table 2: Explanation of sensitivity rating

Sensitivity	Factors contributing to sensitivity	Examples of qualifying features
VERY HIGH	Indigenous natural areas that are highly positive for any of the following: ▪ Presence of threatened species (Critically Endangered, Endangered, Vulnerable) and/or habitat critical for the survival of populations of threatened species. ▪ 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). 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,	▪ CBA 1 areas ▪ Remaining areas of vegetation type listed in the Draft Ecosystem List of NEM:BA as Critically Endangered, Endangered or Vulnerable. ▪ Protected forest patches. ▪ Confirmed presence of populations of threatened species.

Sensitivity	Factors contributing to sensitivity	Examples of qualifying features
	carbon storage, pollination, refugia, food production, raw materials, genetic resources, cultural value). ▪ Low ability to respond to disturbance (low resilience, dominant species very old).	
HIGH	Indigenous natural areas that are positive for any of the following: ▪ High intrinsic biodiversity value (moderate/high species richness and/or turnover). ▪ Presence of habitat highly suitable for threatened species (Critically Endangered, Endangered Vulnerable species). ▪ 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). May also be positive for 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).	▪ CBA 2 "critical biodiversity areas". ▪ Habitat where a threatened species could potentially occur (habitat is suitable, but no confirmed records). ▪ Confirmed habitat for species of lower threat status (near threatened, rare). ▪ Habitat containing individuals of extreme age. ▪ 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	Indigenous natural areas that are positive for one or two of the factors listed above, but not a combination of factors.	▪ CBA 2 "corridor areas". ▪ Habitat with high diversity (richness or turnover). ▪ Habitat where a species of lower threat status (e.g. near threatened, rare) could occur (habitat is suitable but no confirmed records).
MEDIUM-LOW	Degraded or disturbed indigenous natural vegetation.	
LOW	No natural habitat remaining	

Any natural vegetation within which there are features of conservation concern has been classified into one of the high sensitivity classes (MEDIUM-HIGH, HIGH or VERY HIGH). The difference between these three high classes is based on a combination of factors and can be summarised as follows:

» Areas classified into the VERY HIGH class are vital for the survival of species or ecosystems. They are either known sites for threatened species or are ecosystems that have been

identified as being remaining areas of vegetation of critical conservation importance. CBA1 areas would qualify for inclusion into this class.

» Areas classified into the HIGH class are of high biodiversity value, but do not necessarily contain features that would put them into the VERY HIGH class. For example, a site that is known to contain a population of a threatened species would be in the VERY HIGH sensitivity class, but a site where a threatened species could potentially occur (habitat is suitable), but it is not known whether it does occur, is classified into the HIGH sensitivity class. The class also includes any areas that are not specifically identified as having high conservation status but, have high local species richness, unique species composition, low resilience or provide very important inclusion into this class, if there were no other factors that would put them into the highest class.

2.6 Assessment of impacts (Ecology and Hydrology)

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 are 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, and a value between 1 and 5 is assigned as appropriate (with 1 being low and 5 being high).
» The **duration**, wherein it was indicated whether:
  - the lifetime of the impact will be of a very short duration (0 – 1 years) – assigned a score of 1;
  - the lifetime of the impact will be of a short duration (2 – 5 years) – assigned a score of 2;
  - medium-term (5 -15 years) – assigned a score of 3;
  - long term (> 15 years) – assigned a score of 4; or
  - permanent – assigned a score of 5.
» The **magnitude**, quantified on a scale from 0 – 10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
» The **probability** of occurrence, which describes the likelihood of the impact actually occurring. Probability is estimated on a scale of 1 -5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct

possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).

» The **significance**, is determined through a synthesis of the characteristics described above and can be assessed as **LOW**, **MEDIUM** or **HIGH**; and
» 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; and
» 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;

» < 30 points: **LOW** (i.e. where the impact would not have a direct influence on the decision to develop in the area),
» 30 – 60 points: **MEDIUM** (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
» > 60 points: **HIGH** (i.e. where the impact must have an influence on the decision process to develop in the area).

3 STUDY AREA

3.1 Locality

The project site is 642ha in extent and is located approximately 8 km south of the town of Vryburg which is situated within the Naledi Local Municipality and Dr Ruth Segomotsi Mompati District Municipality. Furthermore, the project site falls within the 2724BA quarter degree square (QDGS). The following properties form part of the project site and power line corridor:

» Portion 1 of the farm Champions Kloof 731,
» Portion 4 of the farm Waterloo 730,
» Remaining Extent of Portion 3 of the farm Waterloo 730'
» Farm Rosendal 673/RE (does not form part of the project site for the proposed solar development but a section of the proposed power line corridor traverse this property).

The project site is located within Zone 6 of the Renewable Energy Development Zones (REDZ), which is otherwise known as the Vryburg REDZ.

The surrounding landscape is predominantly utilized for agricultural purposes, mainly grazing land for livestock (mostly cattle and to a lesser extent sheep). In some areas game have been re-introduced and should also be seen as part of the agricultural environment. Most of the grazing is unimproved vegetation with some small, scattered patches of secondary grassland, which was historically cultivated. Currently very little of the surrounding environment is under cultivation, with relative small, isolated areas scattered throughout the receiving environment. Access to the project site can be obtained via the N18 which runs in a north to south direction, adjacent-east of the projects site. The closest built-up areas are the agricultural town of Vryburg, which is located some 8km north of the project site and the Huhudi informal/semi-formal settlement which is located approximately 6.3 km north of the project site and adjacent to the N18. Within this part of the receiving environment, anthropogenic influence is also visible in the form of the N18 national route and a railway line which both traverse the project site in a north-south direction as well as electricity transmission infrastructure comprising a 400kV power line and the Mookodi Transmission substation. In addition, there are some small quarries in the area as well as the Arthington Memorial Church and the Tiger Kloof Educational Institution along the N18.

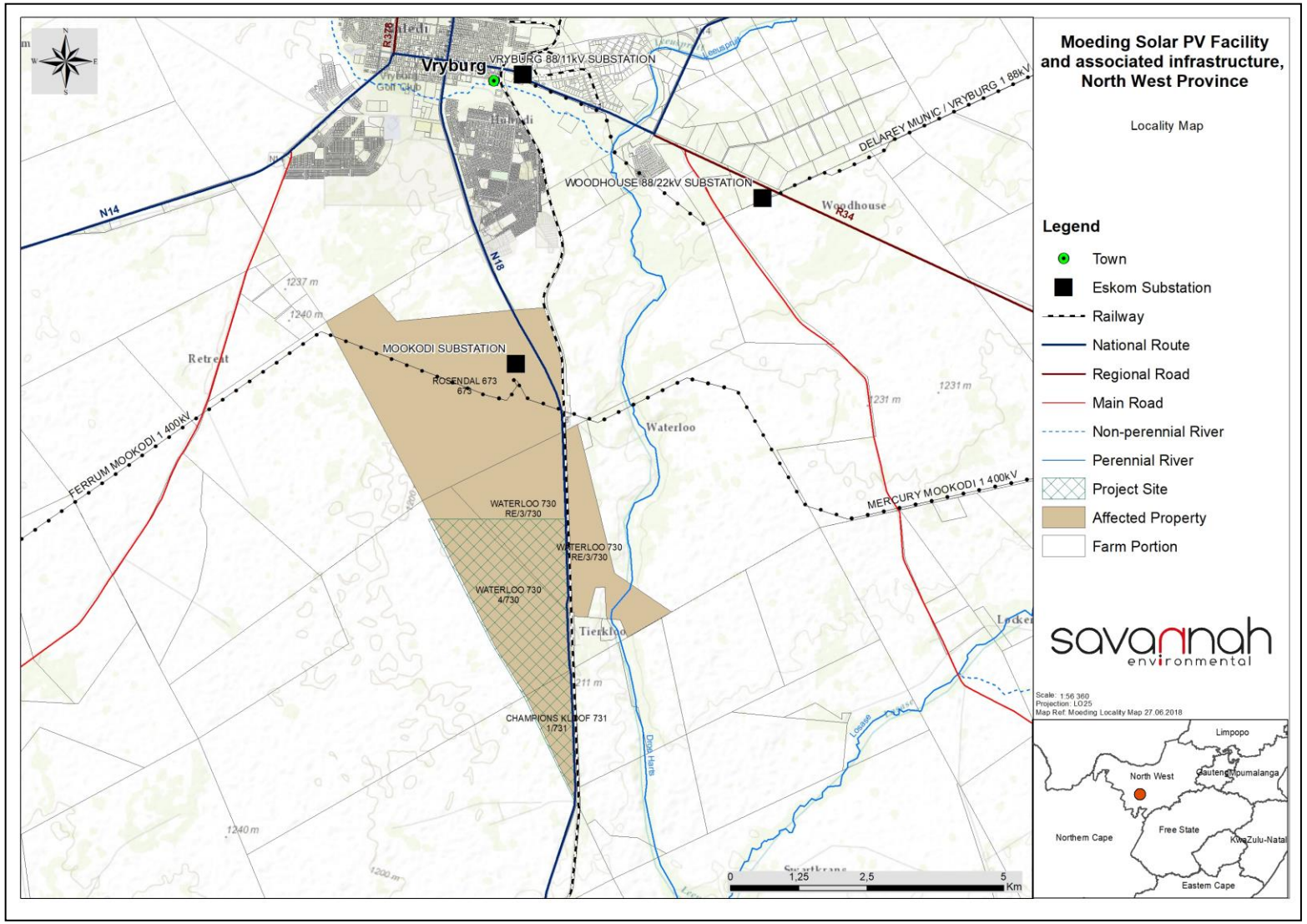

Figure 1: Locality map of the proposed Moeding Solar PV Facility, North-West Province (map provided by Savannah Environmental).

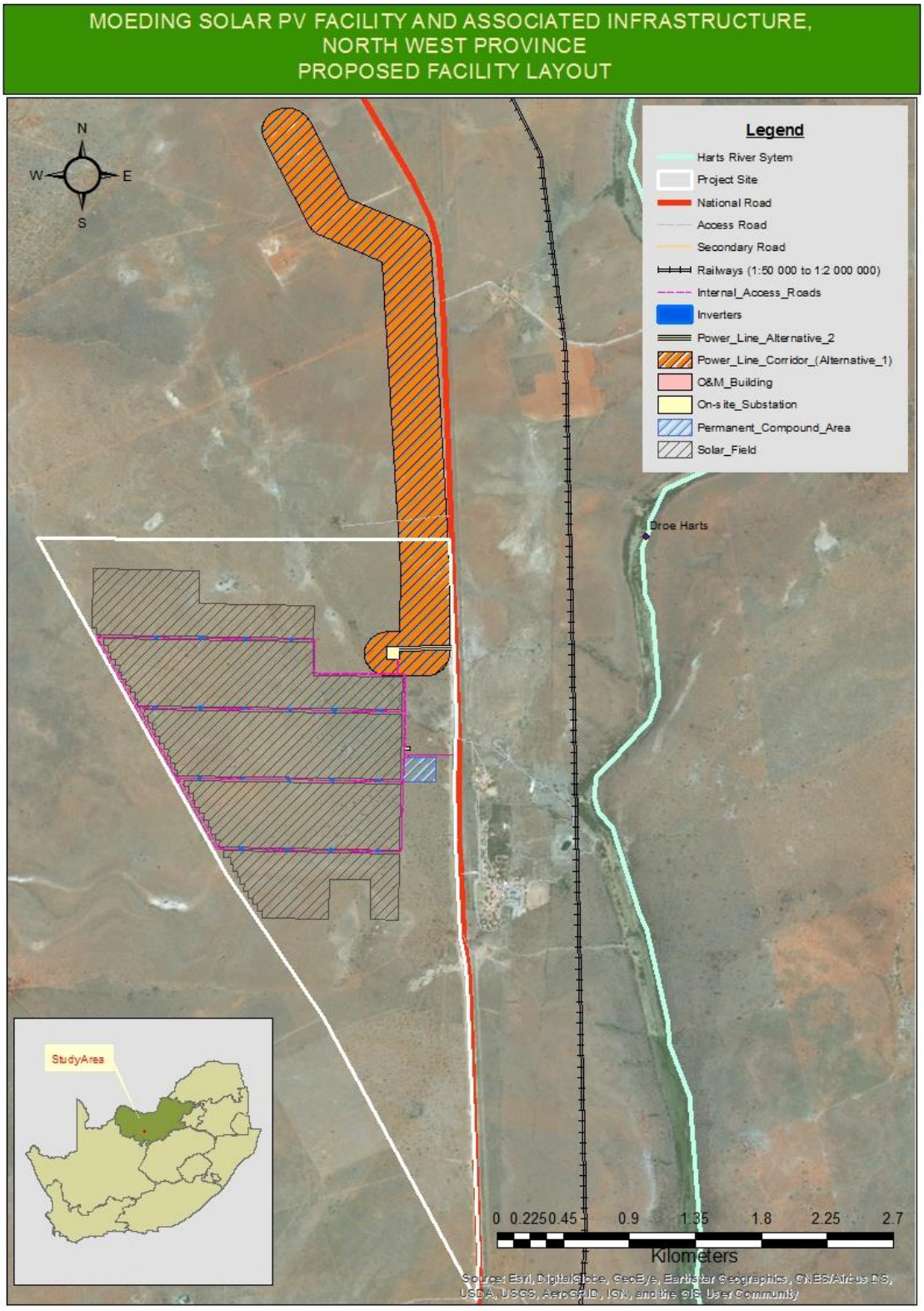

Figure 2: Proposed Moeding Solar PV Facility Layout near Vryburg, North West Province.

3.2 Climate and rainfall

The climate associated with the study area has been derived from recorded and extrapolated climatic data (http://en.climate-data.org/location/10658/) for Vryburg (Figures 3 & 4). Rainfall occurs mainly in summer and autumn with very dry winters. Mean annual rainfall is approximately 477mm with January being the wettest month, averaging about 89mm, and July being the driest, with an average of only 4mm. The average annual temperature in Vryburg is 17.9°C with January being the warmest (Ave. 24.8°C) and July being the coldest (Ave 9.3°C). Frost is frequent to very frequent in winter (mean frost days: 40).

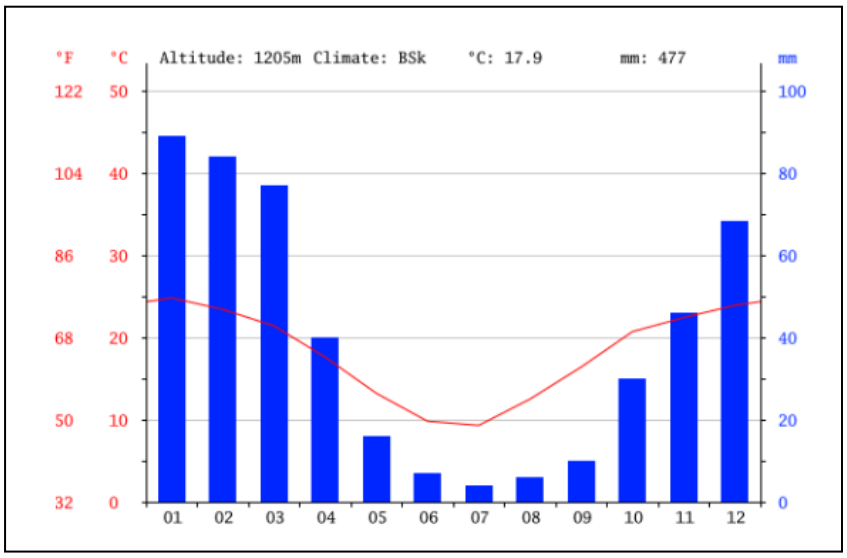

Figure 3: Climate graph of Vryburg (http://en.climate-data.org/location/10658/).

month	1	2	3	4	5	6	7	8	9	10	11	12
mm	89	84	77	40	16	7	4	6	10	30	46	68
°C	24.8	23.4	21.4	17.6	13.2	9.8	9.3	12.5	16.4	20.7	22.4	23.9
°C (min)	17.2	16.3	14.3	9.8	4.4	0.4	-0.3	2.6	7.0	12.0	14.3	16.1
°C (max)	32.4	30.5	28.5	25.5	22.1	19.3	19.0	22.5	25.9	29.5	30.5	31.8
°F	76.6	74.1	70.5	63.7	55.8	49.6	48.7	54.5	61.5	69.3	72.3	75.0
°F (min)	63.0	61.3	57.7	49.6	39.9	32.7	31.5	36.7	44.6	53.6	57.7	61.0
°F (max)	90.3	86.9	83.3	77.9	71.8	66.7	66.2	72.5	78.6	85.1	86.9	89.2

Figure 4: Climate table of Vryburg (http://en.climate-data.org/location/10658/).

3.3 Physiography and soils

Landscape Features

According to Mucina and Rutherford (2006) the region can be described as a flat plateau with a well-developed shrub layer, predominantly *Tarchonanthus camphoratus* and *Acacia karroo*. This description is furthermore consistent with the land type classification (AGIS 2007) which classifies the landscape as Class A2 with

an average slope of between 0% and 2%. Land types represent areas that are uniform with respect to climate, terrain form, geology and soil. According to AGIS (2014), the project site is situated with two land types, Ae36 and Ag10 (Figure 10). Across a landscape, usually five terrain units can be identified. Wetlands occur most frequently in valley bottoms (unit 5), but can also occur on crests, mid slopes and foot slopes (units 1, 3 and 4) (Figure 5). The catena within land type Ag10 incorporate all of the four terrain units 1, 3, 4 and 5, as shown in Figure 4. The catena within land type Ae36 incorporates only the lower lying terrain units 4 and 5, with 5 being slight depression features such as pans.

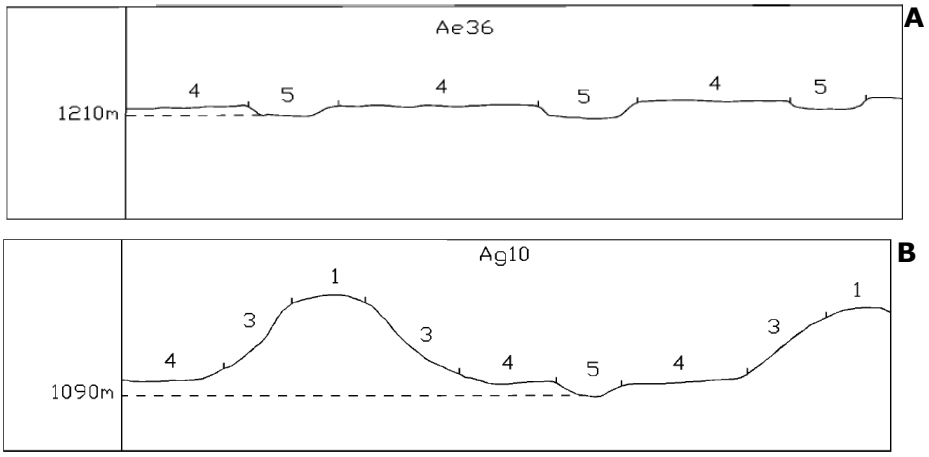

Figure 5: Terrain units occurring within land types Ae36 and Ag10.

At a finer scale using a Google elevation profile for the project site, as well as other spatial resources, the project site can be described as largely flat to slightly undulating with an average slope of only 0.2% and a maximum slope of 0.8%). The position of the project site within the greater landscape can be described as a relative flat (gradual westward sloping) bench or isolated plain, within a footslope region of a mostly concave landscape. This area furthermore, is situated right at the edge of the valley rim of the Droë Harts River valley which is characterised by steep, narrow inner slopes and a relative narrow valley floor. According to Partridge *et al*. (2010) this region is situated right in the north-western corner of the Ghaap Plateau, which transitions into the Lower Vaal and Orange Valley Region. This northern portion of the Ghaap Plateau is characterised by sinkholes and sub-surface drainage. Much of the Ghaap Plateau Province coincide with surviving areas of the African surface on which relief is extremely low. There is little surface drainage, partly as a consequence of the aridity of the area, and partly because of the presence of a well-developed karst system which has favoured vertical infiltration and groundwater recharge. Remnants of palaeo-river channels dating to the late Cretaceous indicate that, in the more humid past, large rivers were able to maintain their flow across the dolomite. The northern section of this province is characterised by steeper slopes and narrower cross-sectional profiles which is

evident from the Korobela and Droë Harts River Valleys which are characterized by concave longitudinal profiles.

The topography of the project site itself can be described as a plain with a slight east to south-eastern inclination with the north-western portion forming the highest lying section and the south-eastern corner the lowest lying section of the project site (Figures 7 – 9). Furthermore, the entire project site is characterised by small micro-topographical variations, mostly due to small geological variations (e.g. low scattered bedrock exposures, depression features (pan wetlands), overlying calcretes) (Figure 8).

The project site is situated at elevations of between 1 220 m and 1 191 m above sea level, with an elevation gain/loss of only 19 m. The average elevation of the project site is 1 209 m above sea level.

A unique feature of the project site is the palaeo-valley (fossil river) running in a West to East direction within the central portion of the project site (i.e. Portion 4 of the Farm Waterloo 730) and is fringed along the southern bank by a very low, cherty-dolomite ridge line (Figure 6). This palaeo channel is approximately 5.9 km in length and originally runs in a North-West to South-East direction (±3.17 km) after which the channel runs in a West to East direction. The palaeo-channel is mostly flat or very gradual sloping. Although there is still a very slight incision of the channel, it is mostly filled with a moderately thin layer of sand and/ or silt and clay. For most part of this channel surface drainage functionality has been lost. Some moisture within the soil may however be retained for longer periods of time, following rainfall events (higher than the surrounding area), but most of these areas seldom exhibit saturated soil conditions. These areas of higher moisture content will likely be characterized by a plant species composition different from the surrounding dryer areas. Shallowed out basins along this channel form a suitable physical template for endorheic (inward-draining) depression wetlands. The larger depression/pan wetland within the project site form such a feature within the distal portion of the palaeo-channel. Other similar depression wetlands are present within this palaeo-channel outside of the project site's boundaries. Subterranean flow may occur below the palaeo-channel and is evident from the natural spring present approximately 1.65 km west of the project site (within the palaeo-channel). This natural spring occurs when the water table intercepts the earth's surface as a natural flow of water. Even though this spring is connected to some of the other depression wetlands outside of the project site, there is no indication of surface connection with any features inside of the project site and thus ecological and surface-hydrology connectivity between the spring and portions of the palaeo-channel is not regarded as important.

Another important landscape feature within the project site is the calcareous bed or mantle, located in the north-western corner and south of the larger pan wetland, which is slightly elevated above the lower lying dolomitic dominated areas.

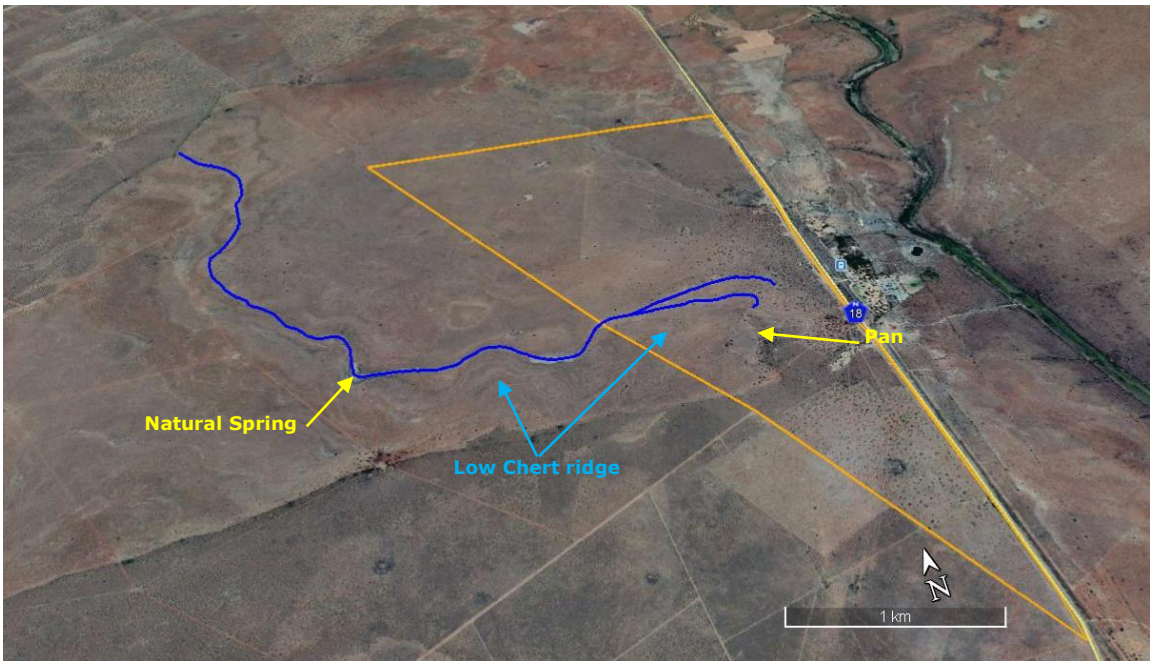

Figure 6: The palaeo-channel (dark blue line) associated with the project site (orange polygon).

Geology

The bulk of the project site is underlain by carbonate rocks of the Boomplaas Formation (Schmidtsdrif Subgroup; Ghaap Group), whilst the north-eastern corner is underlain by mafic and ultramafic rock of the Vryburg Formation (Schmidtsdrif Subgroup; Ghaap Group) and the southern corner with siliciclastic rock (permocarboniferous glacial sediments) of the Dwyka Group (Karoo Supergroup). Small strips between the Boomplaas Formation and Dwyka Group as well as between the Boomplaas and Vryburg Formations is overlain by a mantle of late Caenozoic calcretes (pedogenic limestones).

The Schmidtsdrif Subgroup, which cover the bulk of the project site, has in these areas been exposed due to the erosion of the Dwyka surface. These rocks belong to the basal subdivision of the Late Archaean to Early Proterozoic Ghaap Group (Transvaal Supergroup) which mainly own its origins to 200 Ma of chemical sedimentation, primarily in the form of iron and manganese ores, cherts and carbonates with subordinate siliciclastic rocks.

The rocks of the Schmidtsdrif Subgroup, within the project site, comprise of two Geological Formations. The Vryburg Formation, found in the north-eastern corner

of the project site is underlain by siliclastic fluvial and shallow marine / lagoonal sediments as well as volcanic rocks. This formation is approximately 140 m thick in this area and unconformably overlies lavas of the Ventersdorp Supergroup (Allanridge Formation). The top portion of the Vryburg Formation's stratigraphy typically comprise of interbedded pyroclastic sediments and thin lenticular limestones. This top layer / bed is followed by the carbonate-dominated facies of the Boomplaas Formation, which form the second formation of the Schmidtsdrif Subgroup within the project site. The Boomplaas formation underlies the bulk of the project site and comprise of hallow marine carbonates (predominantly dolomites) and subordinate siliclastic sediments. This formation is dominated by grey dolomites (reddish-brown when weathered) with subordinate interbeds of limestone (weathered blue-grey), quartzite, flaggy sandstone and shale. Packages of oolitic and stromatolitic dolomite alternate with intervals of carbonaceous mudrock containing interbeds of calcareous sandstone and mudclast breccias. Nearshore oolitic and stromatolitic facies with cherty layers and inclusions predominate in the northern outcrop area of the Boomplaas Formation, while offshore mudrock facies are found towards the south.

The southern portion of the project site is underlain by the Dwyka Group (Permocarbonifeorus glacial sediments) and mostly consists of glacial tillite and interglacial shale. Exposure levels are normally very poor, as these mudrocks are readily eroded and weathered, resulting in a scattered distribution.

As mentioned small strips between the Boomplaas Formation and Dwyka Group as well as between the Boomplaas and Vryburg Formations is overlain by a mantle of late Caenozoic calcretes (pedogenic limestones). These rocks represent recent surface deposits.

Table 3: Stratigraphy found within the project (Red Font) area as well as the surrounding environment.

Epoch /Series	Supergroup	Group	Subgroup	Formation	Lithology
Vaalian	Transvaal	Postmasburg		Ongeluk	Lava
				Makganyene	Diamictite
		Ghaap	Asbestos Hills	Danielskuil	Iron-formation
				Kuruman	Iron-formation
				Kliphuis	Iron-formation
			Campbellrand	Tsineng	Dolomite, Limestone
				Gamohaan	Dolomite, Limestone
				Kogelbeen	Dolomite, Limestone
				Papkuil	Dolomite, Limestone

				Klipfontein Heuwel	Dolomite, Limestone
				Fairfield	Dolomite, Limestone
				Reivilo	Dolomite, Limestone
				Monteville	Dolomite, Limestone
			Schmidtdrif	Clearwater	Shale
				Boomplaas	Limestone
				Vryburg	Quartzite (Dolomite)

Soil and Landtypes

Detailed soil information is not available for broad areas of the country. As a surrogate landtype data was used to provide a general description of soil in the project site (landtypes are areas with largely uniform soils, typography and climate). The project site is, as already mentioned situated with the land types Ae36 and Ag10 (Land Type Survey Staff, 1987). Most of the western half of the project site is located within the Ae36 land type whilst the eastern half is located within the Ag10 land type (refer to Figure 10). The power line corridor will traverse the AG10 land type.

- The Ae group of landtypes refer to red-yellow apedal, freely drained soils. These soils are moderately deep (ave. 500mm – 1200mm) red, freely drained and apedal (structureless). These soils generally occur in areas associated with low to moderate rainfall (300mm – 700mm per annum) in the interior of South Africa and have a high fertility status. A wide range of texture occurs (usually sandy loam to sandy clay loam). Common soil forms are Mispah and Hutton and to a lesser extent, Clovely, Stertkspruit and Rensburg.
- The Ag group of landtypes refer to red-yellow apedal, freely drained soils. These soils are shallow (less than 300mm), red, freely-drained, apedal soils that occur in arid to semi-arid areas associated with low rainfall (less than 500mm per annum), as well as areas underlain by hard to weathered rock. Red soils typically have a high base status. Ag10 soils are generally soils with minimal development and occur on hard or weathered rock. A wide range of textures may occur (usually loamy sand to sandy loam). Stones or rocks are often present on the soil surface. Common soil forms are Mispah, Hutton and rock whilst soil forms such as Glenrosa and Shortlands are sparsely present.

Table 4: Soil forms and coverage per terrain unit (%) for the Ag10 land type (soils that are typically associated with wetlands are in blue font).

Soil Form	% Cover per Terrain Unit				Depth (mm)	Clay Content (%)	
	1	3	4	5			
Slope (%)	2-4	12-40	1-2	0-2		A	E
Soil-rock complex							
Rock	30	50	5	2			
Mispah Ms10, Kalkbank Ms22, Loskop Ms12	55	30	10	2	100-150	10-25	
Williamson Gs16, Kanonkop Gs13	15	20	5	1	100-300	15-35	
Shorrocks Hu36, Mangano Hu33			28		300-600	10-25	
Shorrocks Hu36			25		300-600	25-35	
Glendale Sd21, Kinross Sd20			12		300-600	35-45	
Milkwood Mw11, Graythorne Mw21, Bonheim Bo41			5	10	300-600	35-45	
Swaerskloof Ss16			5		200-300	35-45	
Limpopo Oa46, Leeufontein Oa16			2	30	900-1200+	15-35	
Gelykvlakte Ar20, Rensburg Rg20			3	10	450-700	35-50	
Dundee (Du10)				35	>1200	10-15	
Stream beds				10		20-40	

Table 5: Soil forms and coverage per terrain unit (%) for the Ae36 land type (soils that are typically associated with wetlands are in blue font).

Soil Form	% Cover per Terrain Unit		Depth (mm)	Clay Content (%)	
	4	5			
Slope (%)	0-2	0-1		A	E
Soil-rock complex					
Rock	14	19			
Loskop Ms12, Kalkbank Ms22, Mispah Ms10	19	1	100-200	6-20	
Williamson Gs16, Kanonkop Gs13, Trevanian Gs17	3		150-250	10-20	
Shorrocks Hu36	27		300-400	8-15	
Blinkklip Cv36, Dudfield Cv46,	11		350-450	7-15	
Sterkspruit Ss26, Swaerskloof Ss16, Stanford Ss23, Hartbees Ss24	8	10	50-150	10-20	
Rensburg Rg20		40	600-800	50-60	
Limpopo Oa46	2	10	850-950	10-15	
Manango Hu33, Zwartfontein Hu34	3		300-400	6-10	
Rietvlei We12, Sibasa We13, Devon We22	3		450-550	15-25	
Gelykvlakte Ar20	2	5	550-650	45-60	
Lindley Va41, Valsrivier Va40	2	5	150-250	15-20	
Soetmelk Av36	2		550-650	8-15	
Kinross Sd20, Glendale Sd21, Sunvalley Sd31, Makatini Hu37	2		550-650	15-20	
Killarney Ka20		10	250-350	15-20	
Annandale Cv33, Leslie Gc36, Makuya Cv34	1		350-450	6-15	

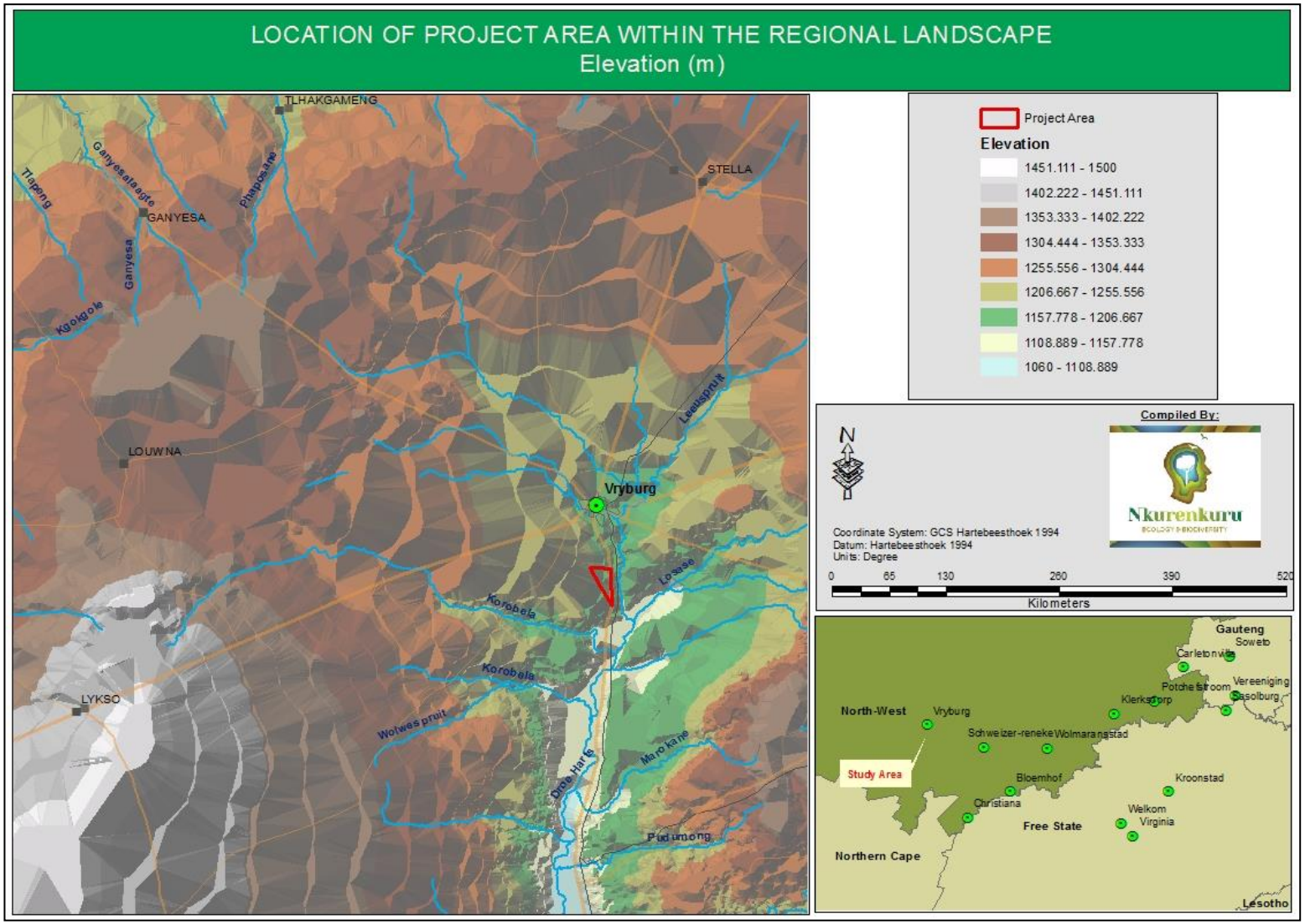

Figure 7: Typographical nature and features of the regional area.

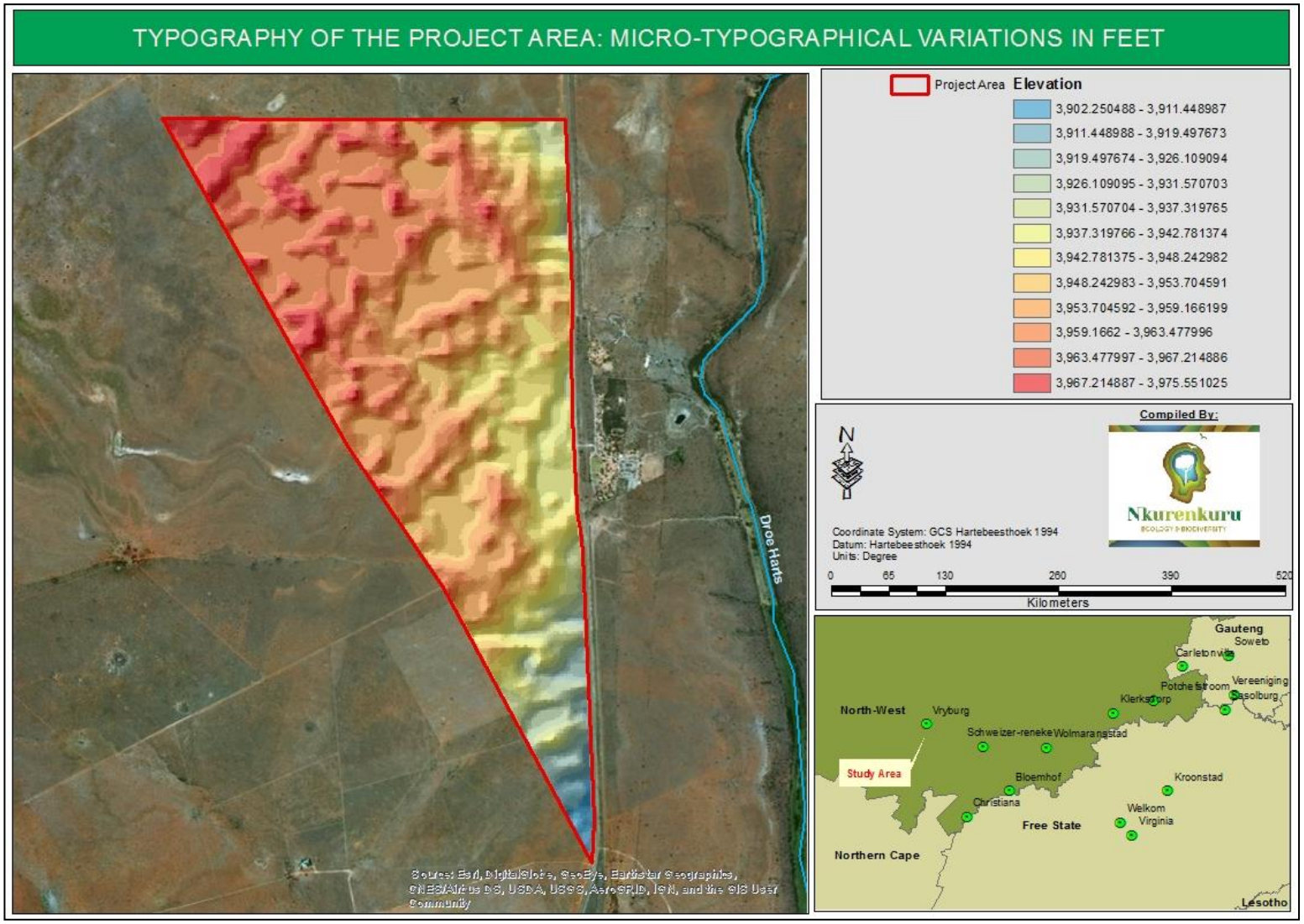

Figure 8: Map illustrating various micro-variations within the project site.

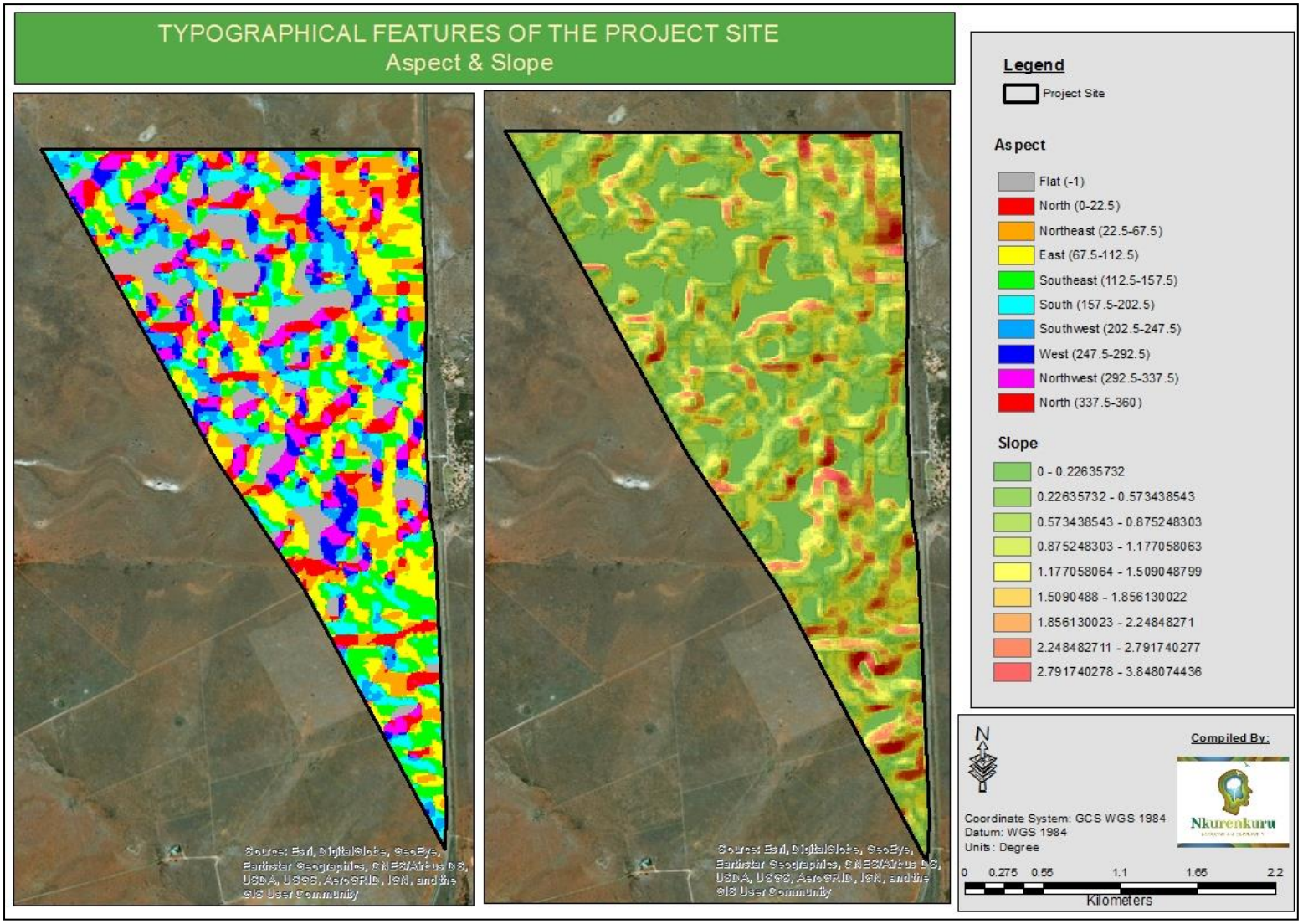

Figure 9: Map illustrating the various aspects and slope gradients within the project site.

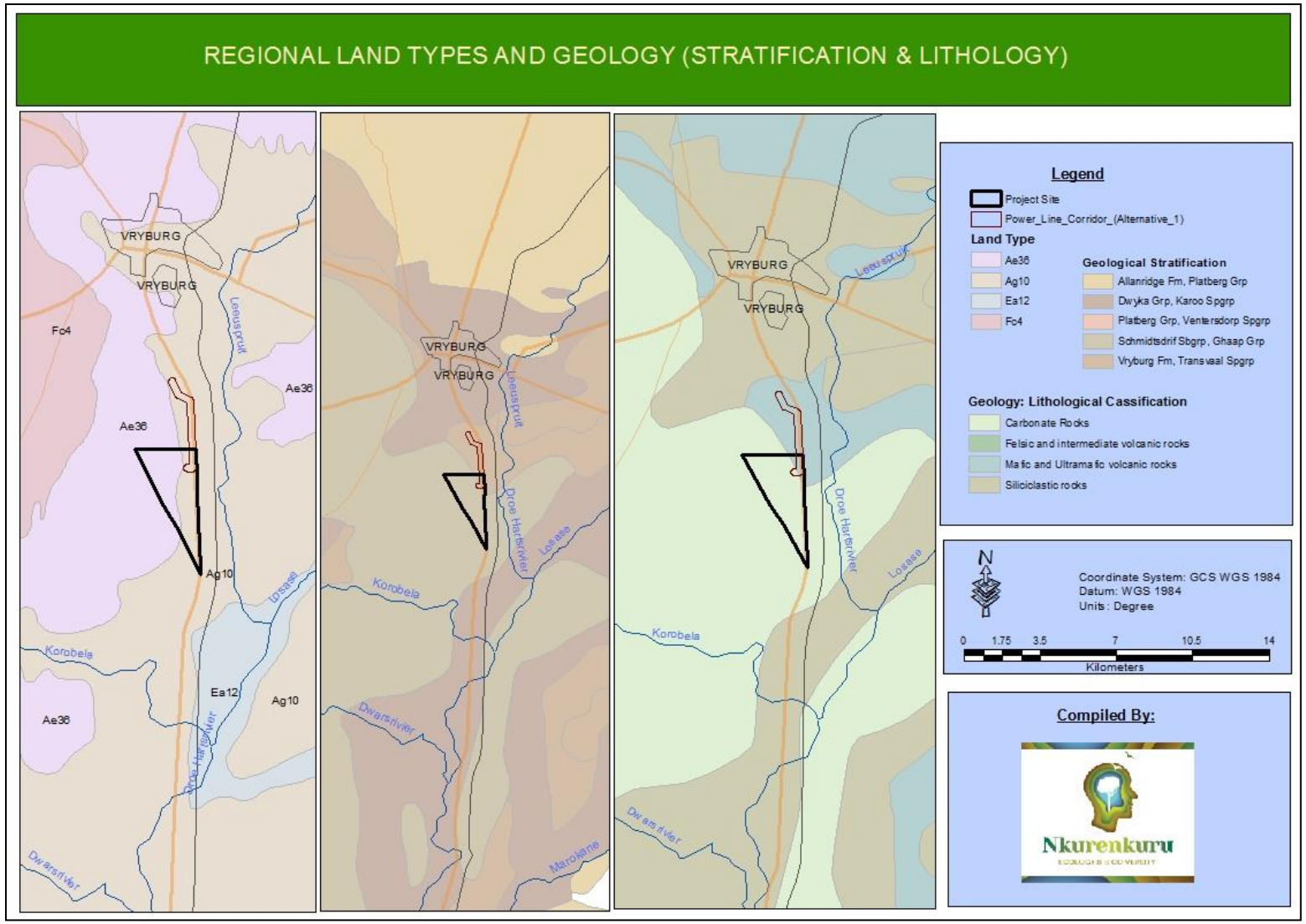

Figure 10: Regional geology and land types of the project site.

Hydrology and Geohydrology

The project site is situated within the Lower Vaal Water Management Area (WMA) 10, Quaternary Catchment C32B (Dry Harts River Catchment) and Ecoregion 29.02 (Southern Kalahari Ecoregion) (Figures 12 &13). The Lower Vaal WMA is located downstream of Bloemhof Dam and upstream of Douglas Weir. It extends to the headwaters of the Harts, Molopo and Kuruman River in the north and the Vaal River Downstream of Bloemhof Dam in the south. It covers a catchment area of 51 543km^2. It lies in the North West and Northern Cape Provinces, with the south-eastern corner in the Free State, and borders on Botswana in the north, as well as on the Crocodile (West) and Marico, Middle Vaal, Upper Orange and Lower Orange water management areas. Major rivers in this WMA include the Molopo, Harts, Dry Harts, Kuruman and Vaal River. As a result of the low rainfall, flat topography and sandy soils over much of the WMA, little usable surface runoff is generated in the WMA.

The project site is situated within the C32B Quaternary Catchment which form part of the upper reaches of the Dry Harts River (Figure 13). The project site is situated approximately 0.8 km west of the Dry Harts River and approximately 3.8 km north-east of the Korobela River. These two watercourses along with the Losase River form the most important surface hydrological features of the region. The Dry Harts River flows mostly in a South-South-West direction, mostly through gradual to flat areas, for approximately 89.1 km, before terminating into the Harts River (approximately 100 km above the confluence of the Vaal- and Orange Rivers). Major tributaries of the Dry Harts River include the Leeuspruit-, Losase-, Korobela-, Dwarsrivier- Morokane and Pudumong Rivers. The only lake and wetland of note is at Baberspan in the upper Harts River catchment which has been given Ramsar status as a wildlife conservation area.

Table 6: Natural Mean Annual Runoff (MAR) and Ecological Reserve (million m^3/a) of the major sub-catchments of the Lower Vaal Water Management Area (DWA, 2012).

Sub-catchment	Natural MAR	Ecological Reserve
Harts	138	15
Vaal downstream of Bloemhof	43	5
Molopo	197	29
Total	**181**	**49**

Major impacts within the C32B Quaternary Catchment include agricultural return flows, flow regulation for irrigation use, and water quality related problems due to urbanization, and agriculture (DWA, 2012). Water use within the Harts River Catchment is dominated by irrigation, which represent 84% of the local requirements for water. Approximately 4% of the requirements is for urban and

industrial use, 3.5% for rural domestic supplies and stock watering, with only 8.3% being transferred out of the catchment. The quality of surface water in the Harts and Vaal Rivers is highly impacted upon by irrigation return flows as well as by water use in the Upper and Middle Vaal Water Management Areas, which limits the usability of water in the lower reaches of these rivers. Water in the Harts River downstream of the Vaalharts irrigation scheme is of exceptional high salinity as a result of saline leachate from the irrigation fields (± 1100 mg/l salinity).

Table 7: Water Requirement (million m^3/a) of the sub-catchments of the Lower Vaal Management Area (DWA, 2012).

Sub-catchment	Irrigation	Urban	Rural	Mining & Bulk Industrial	Total local requirements	Transfers Out	Grand Total
Harts	452	23	19	0	494	45	539
Vaal downstream of Bloemhof	25	32	8	0	65	423	488
Molopo	0	13	17	6	36	0	36
Total	**477**	**68**	**44**	**6**	**595**	**0**	**595**

A summary of the Present Ecological State (PES), Ecological Importance (EI), Ecological Sensitivity (ES) and current impacts on the affected Sub-Quaternary Reach (SQR) as well as immediate surrounding SQRs is presented in Table 8 (also refer to Figure 12) (DWS,2014). The Desktop PES of the relevant SQR (C32B-01953: section of the Dry Harts River) is Moderately Modified (C Category) and a loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged (loss of between 60 - 79%). According to the DWS (2014), the water quality (WQ), potential flow characteristics as well as instream and riparian habitats are seriously impacted on by agriculture, roads, weirs and a fairly large gravel quarry. The EI of C32B-01953 is Moderate due to the presence of only 26 species (riparian, wetland and aquatic species) in this sub-quaternary catchment with no conservation important species. The main habitats for these species include seasonal / ephemeral grassy edges, pools in incised channel, riparian trees and shrubs and floodplains. The size of stream, morphology and geomorphic habitat units determine the ES. The watercourse of C32B-01953 has a Moderate ES Mean Class Rating and a High sensitivity to modified flow conditions and water level changes (DWS, 2014). The degree of flow change will elicit a particular level of response and the smaller streams are usually more sensitive i.e. rapid loss of useable habitats as flows decrease.

Table 8: Summary of the affected Sub-Quaternary Reach (SQR) Ecostatus and impacts as well as the Ecostatus and impacts for the surrounding SQRs.

Sub-Quaternary Reach	SQR Name[1]	PES[2]	EI[3]	ES[4]	Sensitivity to Modified Flow/Water Level Changes	Current Impacts
C32B-01953	Dry Harts	C Moderately Modified	Moderate	Moderate	High	Roads, quarry, weirs, agriculture
C32B-01924	Unnamed	E Serious Modified	Low	Moderate	High	Urban (Vryburg), Waste water treatment works, Rural effluent, Trampling, Weirs, Roads, Instream dams
C32B-02059	Dry Harts	B Largely Natural	Moderate	Moderate	High	Road, upstream road forms a dam, agriculture, trampling, instream dams, lack of ephemeral flow

According to RSA Wetlands Types inventory (2010) as well as the National Freshwater Ecosystem Priority Areas (NFEPA) database (2011), wetlands within the greater region is mostly depressions (pans) and wetland flats within the relative 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 and wetland flats are endorheic. Sections along the Dry Harts River contain some wetland features, mostly in the form of channelled valley-bottom wetlands. According to the above-mentioned inventory and database, no wetlands and hydrological features have been identified within the project site. A closed wetland, and an unchanneled valley-bottom wetland where however identified outside of the boundaries of the study site (located approximately 0.63 km east of the project site) (Figure 14).

[1] SQR: Sub-Quaternary Reach
[2] PES: Present Ecological Status
[3] EI: Ecological Importance
[4] ES: Ecological Sensitivity

Following a thorough desktop and field assessment of the project site, based on the recommended methodology specified by DWAF (2005), four wetland features were identified. The identification and delineation of the wetland features were based on the following indicators:

- Geographical position and terrain unit features (e.g. valley-bottom settings and "key points");
- Hydromorphic features;
- Plant indicators; and
- Soil form and wetness indicators.

The wetlands were furthermore classified into appropriate hydro-geomorphic (HGM) units, according to the classification system of Kotze *et. al*. (2005).

The wetland extent and boundary delineation are based primarily on soil wetness indicators. The field-based soil survey and assessment was conducted by M. Pienaar of TerraAfrica Environmental Consultants in June 2018 and the results obtained was provided to Nkurenkuru Biodiversity and Ecology to incorporate in assessment of the surface hydrological and ecological assessment of the project site. For an area to be considered a wetland, redoximorphic features must be present within the top 50cm of the soil profile (Collins, 2005). Redoximorphic features are the result of the reduction, translocation and oxidation (precipitation) of Fe (iron) and Mn (manganese) oxides that occur when soils alternate between aerobic (oxygenated) and anaerobic (oxygen depleted) conditions. Only once soils within 50cm of the surface display these redoximorphic features, can the soils be considered 'hydric soils'. Redoximorphic features typically occur in three types (Collins, 2005):

- A reduced matrix - i.e. an in situ low chroma (soil colour), resulting from the absence of Fe3+ ions which are characterised by "grey" colours of the soil matrix;
- Redox depletions - the "grey" (low chroma) bodies within the soil where Fe-Mn oxides have been stripped out, or where both Fe-Mn oxides and clay have been stripped. Iron depletions and clay depletions can occur;
- Redox concentrations - Accumulation of iron and manganese oxides (also called mottles).
- These can occur as:
    - Concretions - harder, regular shaped bodies;
    - Mottles - soft bodies of varying size, mostly within the matrix, with variable shape appearing as blotches or spots of high chroma colours;

- Pore linings - zones of accumulation that may be either coatings on a pore surface, or impregnations of the matrix adjacent to the pore. They are recognized as high chroma colours that follow the route of plant roots and are also referred to as oxidised rhizospheres.

The description and classification of the wetland features within the project site are provided in the following sections.

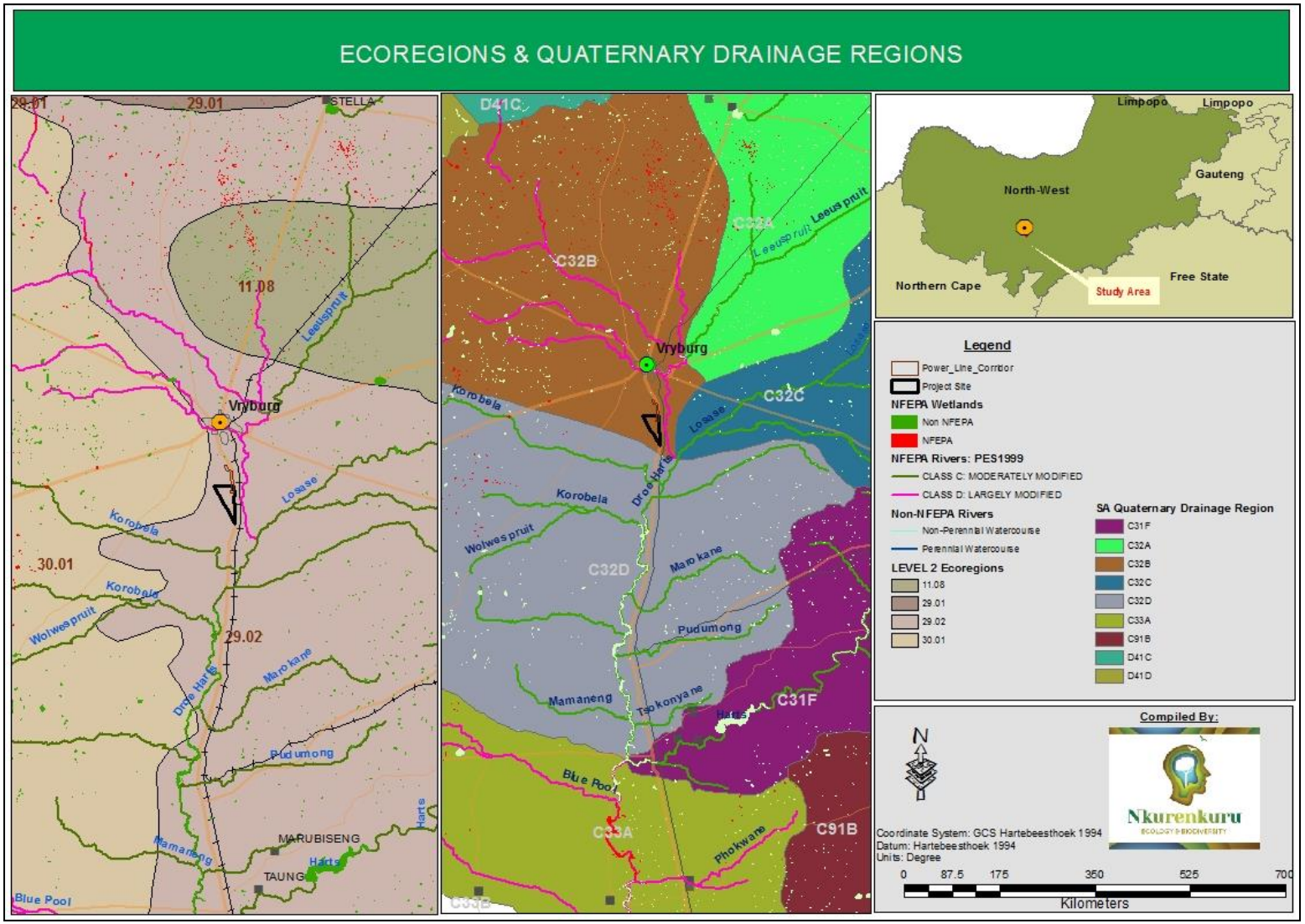

Figure 11: Ecoregions, Quaternary Catchments as well as listed NFEPA wetlands and rivers of the project site and surroundings (PES Classification according to Kleynhans, 2000).

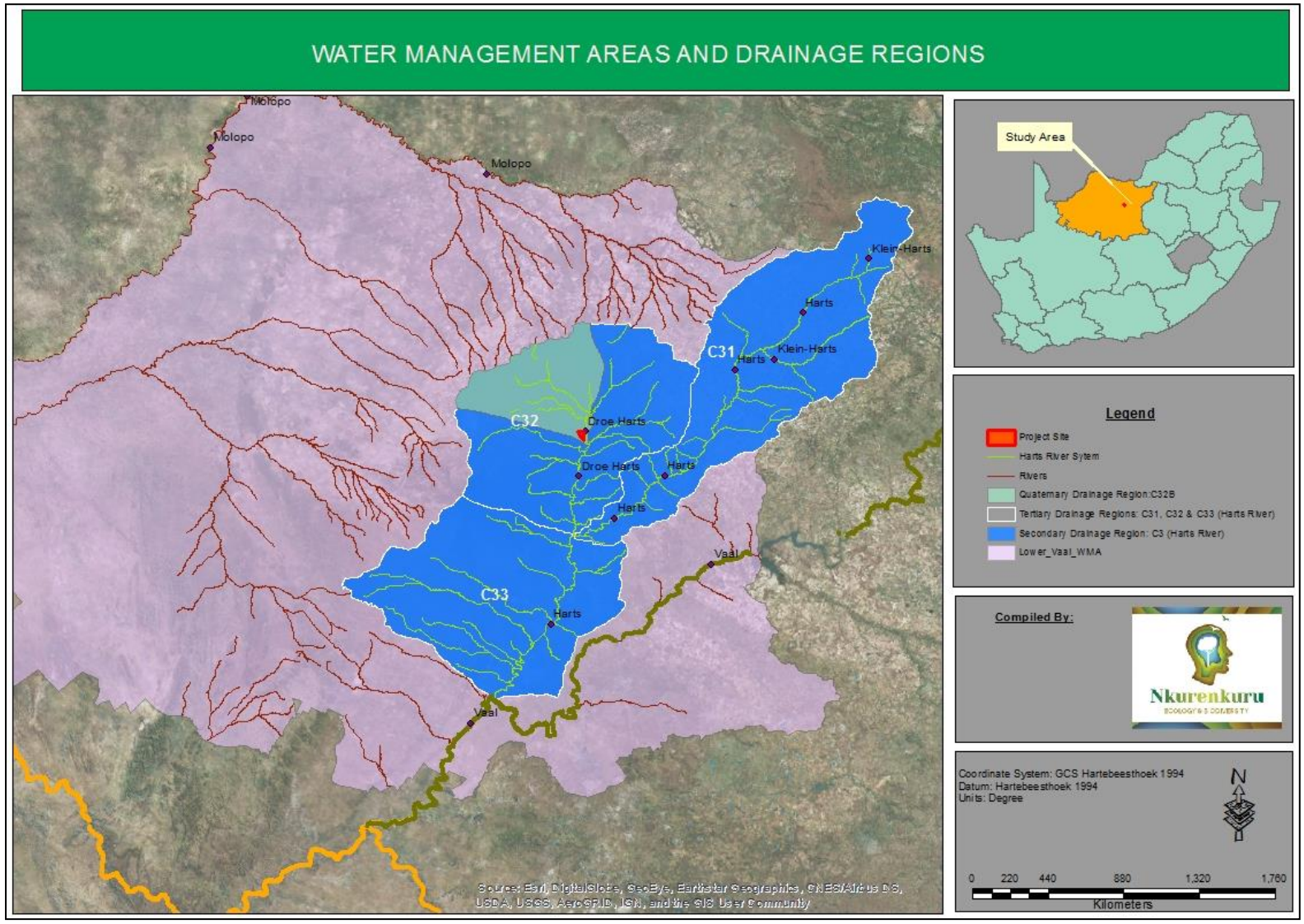

Figure 12: Water Management Areas, Tertiary- and Quaternary Drainage Regions of the project site.

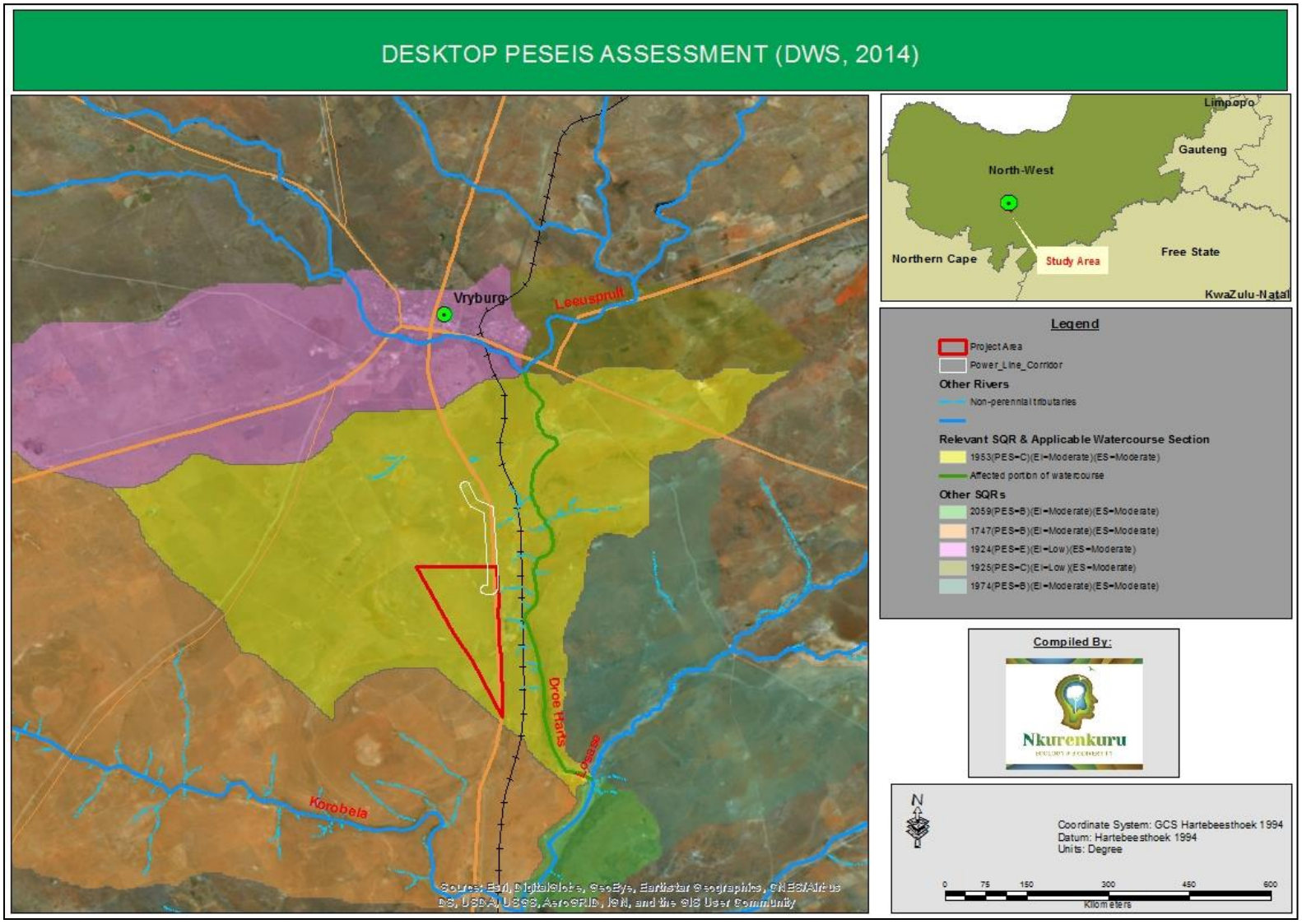

Figure 13: Desktop PESEIS Assessment of the relevant Sub-Quaternary Reach (SQR) as well as surrounding SQRs (Abbreviations: PES=Present Ecological Status; EI=Ecological Importance; ES=Ecological Sensitivity; E=Serious Modified; C=Moderately Modified).

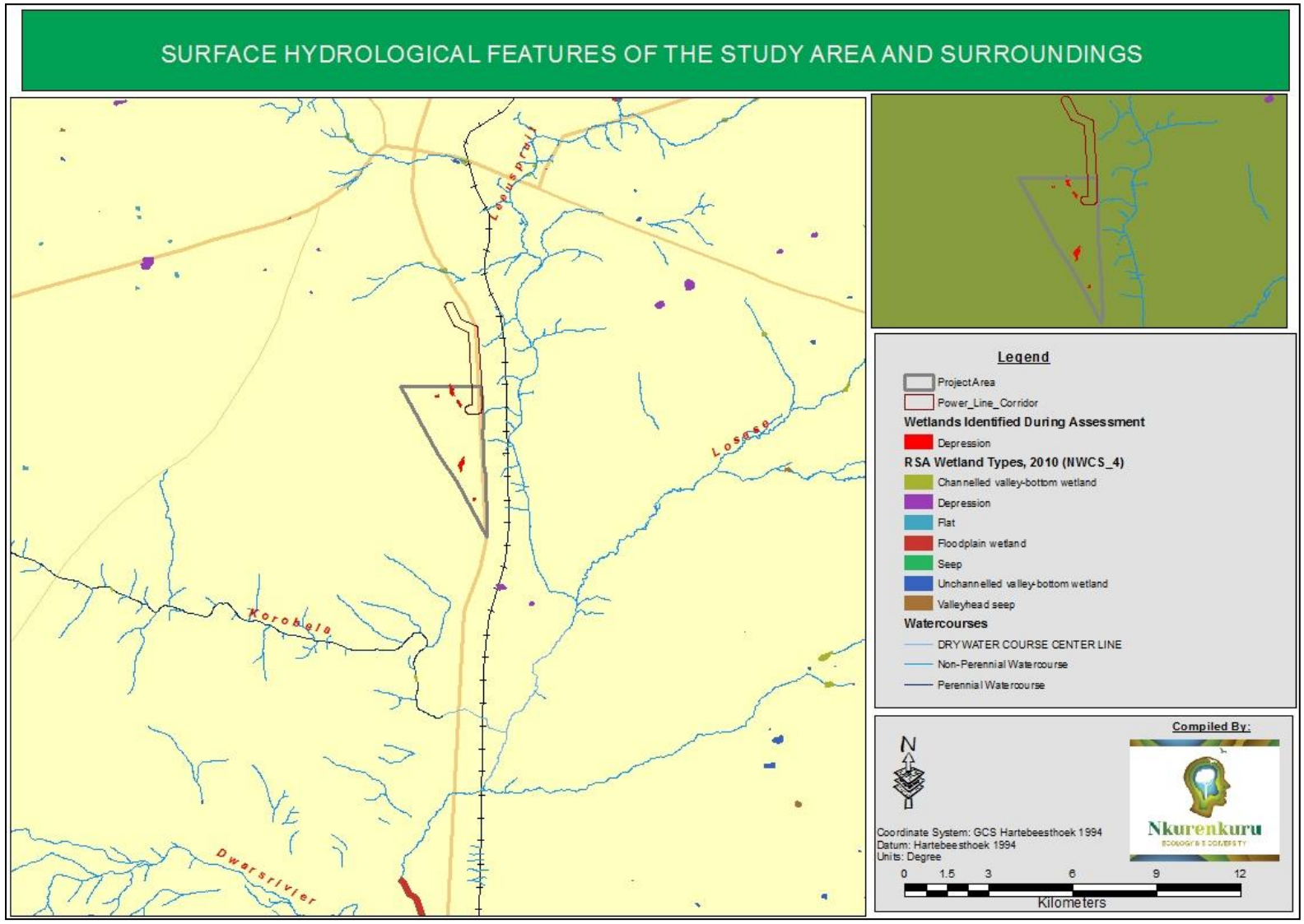

Figure 14: Wetlands and watercourses (perennial and non-perennial water courses) of the project site and surroundings.

3.4 Existing Land Use

The open savanna grassland and shrublands are mostly used as grazing for livestock, especially cattle, with some presence of small game species. Most of the grazing is unimproved vegetation (natural to semi-natural), apart from the southern corner which is covered by a secondary open tree savannah, covering historically cultivated areas.

Built form within the project site, is minimal and mostly restructured to infrastructure associated with the general land use activity (livestock rearing) which include:

- a cattle kraal (pens);
- artificial watering points, windmills and cement dams;
- cattle feeding points;
- fences;
- farmstead;
- gravel access roads;
- ancillary farm buildings;
- remnants of old worker's dwellings.

Other infrastructure includes:

- cell phone mast;
- the N18 road (site access will be gained from this road); and
- 400kV Overhead Power Line (adjacent and parallel with the N18 road).

Other notable infrastructure located in relative close proximity to the project site includes:

- the Mookodi Main Transmission Substation (MTS) (north of the project site);
- the Tierkloof railway station and railway line (running adjacent-east and parallel with the N18); and
- the Tiger Koof Education Institution and Arthington Memorial Church (east of the railway line.

3.5 Strategic Environmental Assessment for wind and solar PV energy in South Africa – Renewable Energy Development Zones (REDZs)

A Strategic Environmental Assessment (SEAs) has been undertaken by the Department of Environmental Affairs (DEA) in order to contribute to the implementation of the National Development Plan and National Infrastructure Plan,

as well as to provide adaptive processes that streamline the regulatory environmental requirements for Strategic Integrated Projects (SIPs) whilst safeguarding the environment. The wind and solar photovoltaic (PV) SEA was accordingly commissioned by the DEA with the objective of facilitating the implementation of sustainable green energy initiatives.

The SEA identifies areas where large scale wind and solar PV energy facilities can be developed in terms of SIP 8 and in a manner that will significantly limit negative impacts on the environment, whilst yielding the highest possible socio-economic benefits to the country. These areas are referred to as Renewable Energy Development Zones (REDZs).

The SEA undertaken in this regard led to the identification of eight proposed REDZs with a combined size of approximately 80 000 km^2 and comprising about 17 000 farm portions.

The solar PV assessment domain was informed by the location of the majority of existing solar PV project applications at the commencement of the SEA and includes the five provinces of the Northern Cape, Western Cape, Eastern Cape, Free State and North West.

The property earmarked for the proposed PV is located within such a REDZ area (REDZ 6: Vryburg) (Figure 14).

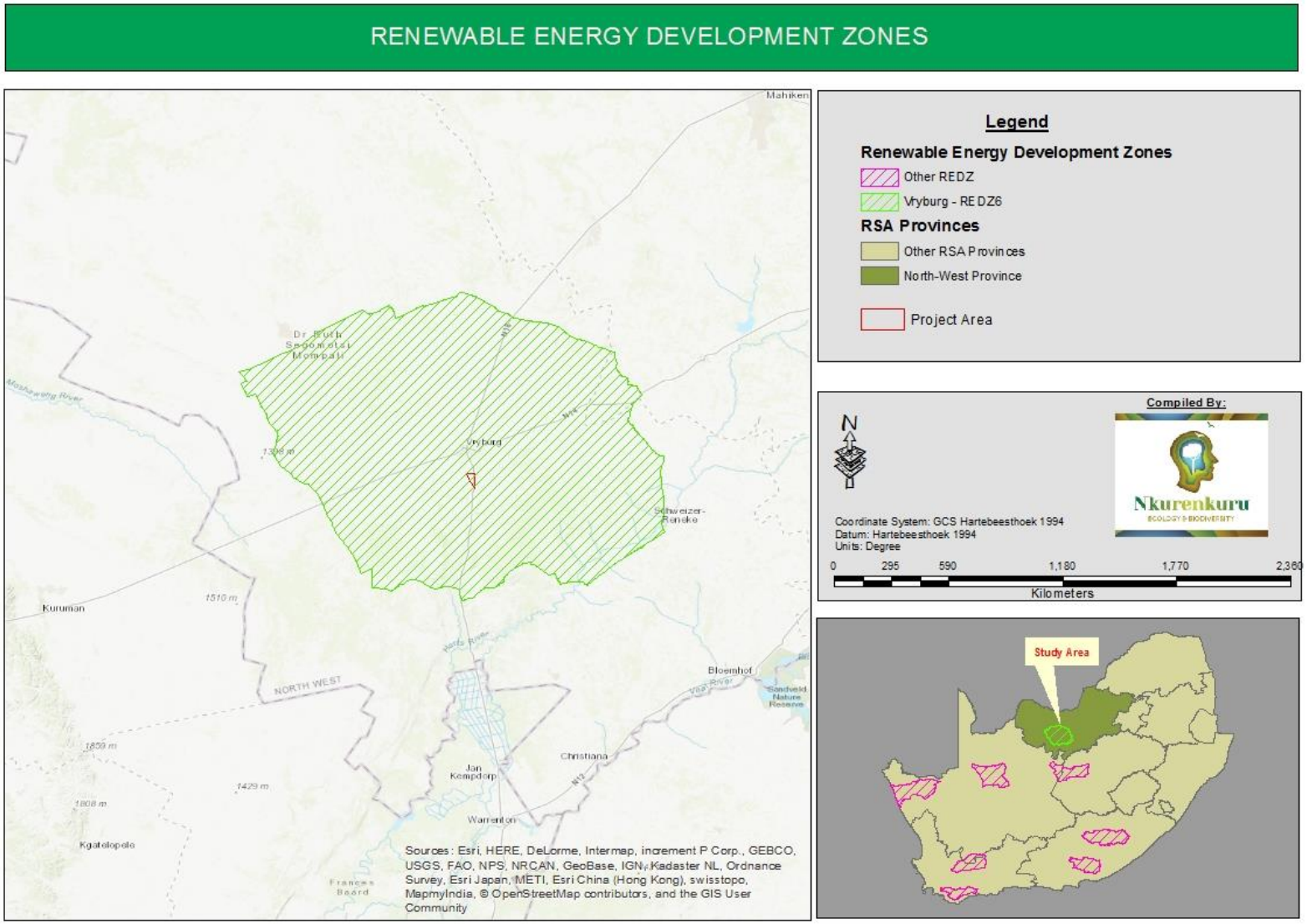

Figure 15: The project site's location within the REDZ6: Vryburg.

3.6 Critical Biodiversity Areas and broad scale ecological processes

Definitions and descriptions of Critical Biodiversity Areas of the North West Province

Critical Biodiversity Areas (CBAs) are terrestrial and aquatic features in the landscape that are critical for retaining biodiversity and supporting continued ecosystem functioning and services. These form the key output of a systematic conservation assessment and are the biodiversity sectors inputs into multi-sectoral planning and decision making tools. The use of CBAs within the North West Province follows the definition laid out in the guideline for publishing bioregional plans (Anon, 2008).

The identification and mapping of CBAs form part of the biodiversity assessment of the North West Province which will be used to inform the development of the Provincial Biodiversity Sector plans, bioregional plans, and also be used to inform Spatial Development Frameworks (SDFs), Environmental Management Frameworks (EMFs), Strategic Environmental Assessments (SEAs) and in the Environmental Impact Assessment (EIA) process in the province. The purpose of the CBA is to spatially indicate the location of critical or important areas for biodiversity in the landscape. The CBA, through the underlying land management objectives that define the CBA, prescribes the desired ecological state in which the province would like to keep this biodiversity. Therefore, the desired ecological state or land management objective determines which land-use activities are compatible with each CBA category based on the perceived impact of each activity on biodiversity pattern and process.

According to the guidelines for bioregional plans, three basic CBA categories can be identified based on three high-level and management objectives (Table 9).

Table 9: Definitions and framework for linking CBAs to land-use planning and decision-making guidelines based on a set of high-level land biodiversity management objectives (Adapted from the guidelines for bioregional plans (Anon 2008).

CBA category	Land Management Objective
Critical Biodiversity Areas (CBAs) Definition: CBAs are areas of the landscape that need to be maintained in a natural or near-natural state in order to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services. In other words, if these areas are not maintained in a natural or near-natural state then biodiversity conservation targets cannon be met. Maintaining an area in a natural state can include a variety of biodiversity-compatible land uses and resource uses.	
Protected Areas (PA) & CBA 1	***Natural landscapes:*** » Ecosystems and species are fully intact and undisturbed.

	» These are areas with high irreplaceability or low flexibility in terms of meeting biodiversity pattern targets. If the biodiversity features targeted in these areas are lost then targets will not be met. » These are landscapes that are at or past their limits of acceptable change.
CBA 2	***Near-natural landscapes:*** » Ecosystems and species largely intact and undisturbed. » Areas with intermediate irreplaceability or some flexibility in terms of the area required to meet biodiversity targets. There are options for loss of some components of biodiversity in these landscapes without compromising the ability to achieve targets. » These are landscapes that are approaching but have not passed their limits of acceptable change.
Ecological Support Areas (ESAs) Definition: ESAs are areas that are not essential for meeting biodiversity representation targets/thresholds but which nevertheless play an important role in supporting the ecological functioning of critical biodiversity areas and/or in delivering ecosystem services that support socio-economic development, such as water provision, food mitigation or carbon sequestration. The degree of restriction on land use and resource use in these areas may be lower than that recommended for critical biodiversity areas.	
ESA	***Functional landscapes:*** » Ecosystem moderately to significantly disturbed but still able to maintain basic functionality. » Individual species or other biodiversity indicators may be severely disturbed or reduced. » These are areas with low irreplaceability with respect to biodiversity pattern targets only.
ONA (Other Natural Areas) and Transformed	Production landscapes: Manage land to optimise sustainable utilisation of natural resources.

The high-level land management objectives (natural, near-natural and functional) can be further unpacked using the three ecosystem integrity indicators namely; ecosystem composition, structure and function. Composition relates to biodiversity pattern, whereas structure and function relate to ecological process and services (Table 10).

Table 10: A summary of the CBA map categories used in relation to the biodiversity-related land management objectives and potential landscape-level biodiversity indicators.

Land Management Objective:	**Land Management Objective Biodiversity Indicators**			
	Component of biodiversity:	Biodiversity Pattern	Ecological Processes and Services	
	Indicator category	Composition	Structure	Functioning
	Specific Indicators	» Habitat types, » Species; » Populations; » Met-populations; » Alien plants	» Transformation; » Fragmentation	» Fire; » Grazing regimes; » Biogeochemical processes;

				» Hydrological functioning; » Soil formation and erosion; » Biotic processes.
	CBA Category	*Limit of Acceptable Change (LAC): Permitted amount or degree of change in biodiversity indicator.*		
Natural	PA / CA	None	None	None
	CBA 1	None	None	None
Near-Natural	CBA 2	Some	Some	None
Functional	ESA 1	Significant	Some	None
	ESA 2	Significant	Some	Some
	ONA	Significant	Significant	Some
	Transformed	Significant	Significant	Significant

Description of Critical Biodiversity Areas within the project site.

Terrestrial Critical Biodiversity Areas (2015): Almost half of the project site is situated with an Ecological Support Area (ESA) (including the power line corridor). No Critical Biodiversity Area is present within the project site as well as the immediate surrounding environment. The largest portion of the ESA has been classified as such, as it is proposed that this area forms part of a corridor for faunal movement along the major watercourse. A small section along the eastern boundary of the project site has been furthermore classified as an ESA due to the presence of a ridge or hill structure.

Major artificial structures, especially linear features, have severely limited the potential of this area to contribute to the proposed function as a corridor for movement and have fractured this portion of the landscape from the Dry Harts River. Such disturbances include:

- the N18 Road;
- the railway line and train station;
- the 400kV Overhead Power Line;
- infrastructure associated with the Tierkloof Educational Institution;
- the gravel quarry, and
- numerous farm and boundary fences.

Some degree of movement is still possible and the area may provide such a function albeit to a limited extent. The proposed development will most likely have a low impact on movement patterns and potential migration routes due to the fact that such movements and routs have already been impacted through the above-mentioned disturbance. However, the potential impact can be mitigated through

the implementation of mitigation measures which may allow some degree of movement between the facility and surrounding environment (will be discussed within the impact assessment section).

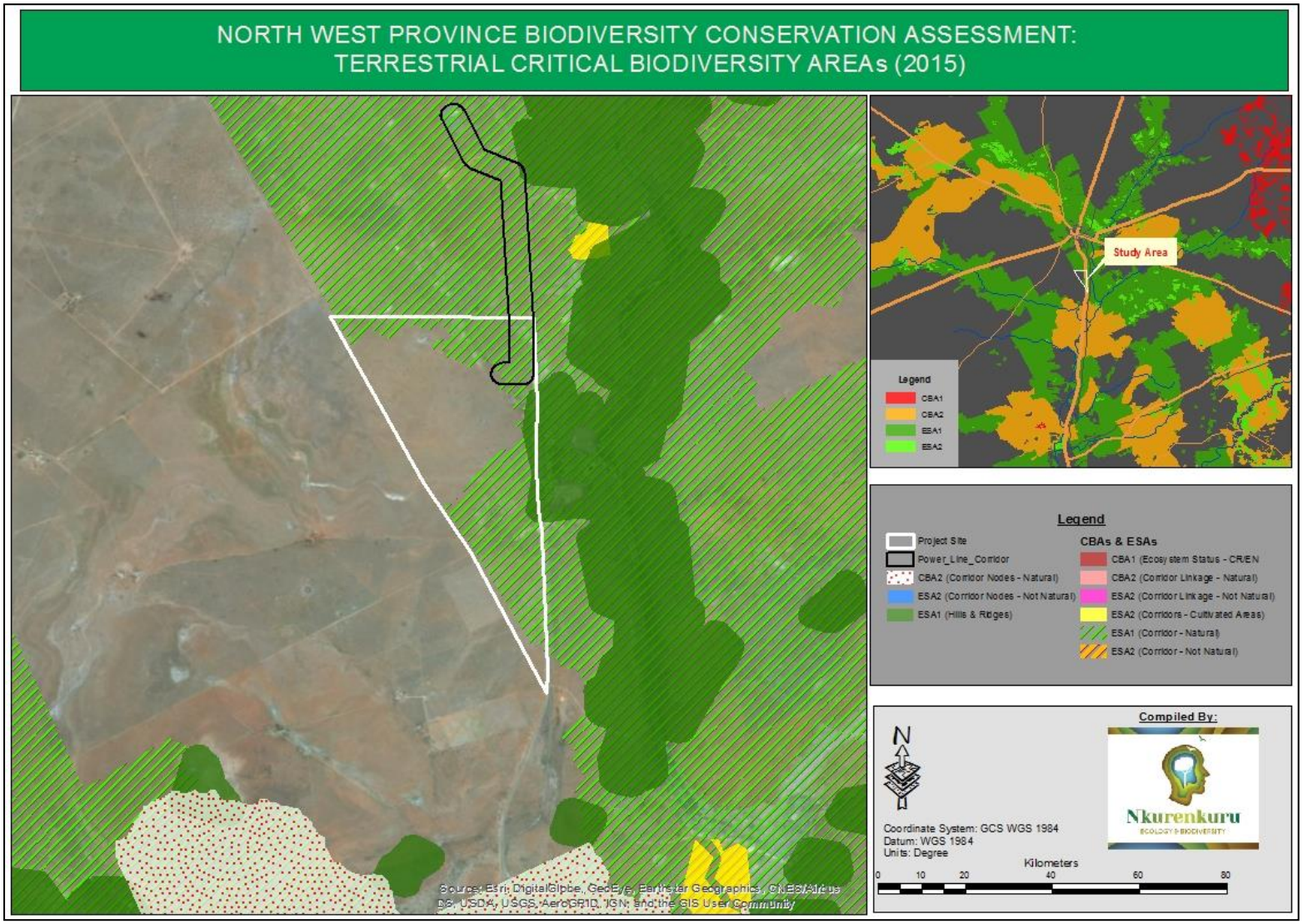

Figure 16: Terrestrial Critical Biodiversity Areas map (North West Province) of the proposed project site and surrounding environment.

4 RESULTS FOR SURFACE HYDROLOGICAL ASSESSMENT

As mentioned earlier, the soil assessment was conducted by TerraAfica Consult cc in June 2018. The results were made available for Nkurenkuru Biodiversity and Ecology who conducted the surface hydrological assessment. Furthermore, Gerhard Botha from Nkurenkuru Biodiversity and Ecology conducted an in-field assessment of the other wetland indicators on the 12th and 13th of May 2018.

The fieldwork verification, ground-truthing and delineation assessment was undertaken to scrutinize the results of the desktop identified features as well as to identify any potentially overlooked wetlands or other surface water resources in the field for the project site.

Ultimately, it was found that there are five pan wetlands, and one small drainage line connecting pan wetland 1 and 2.

Aside from these surface water features, no rivers and other forms of watercourses were identified on site. Although, a short drainage line was identified in-field (between depression wetland 1 and 2).

The physical characteristics of the various indicators for the pan wetlands as well as the drainage lines are provided in more detail below.

4.1 Wetland classification, delineation and description

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

For reference the following definitions are as follows:

» Drainage line: A drainage line is a lower category or order of watercourse that does not have a clearly defined bed or bank. It carries water only during or immediately after periods of heavy rainfall i.e. non-perennial and riparian vegetation may not be present.
» Perennial and non-perennial: Perennial systems contain flow or standing water for all or a large proportion of any given year, while non-perennial systems are episodic or ephemeral and thus contain flows for short periods, such as a few hours or days in the case of drainage lines.
» Riparian: The area of land adjacent to a stream or river that is influenced by stream-induced or related processes. Riparian areas which are saturated or

flooded for prolonged periods would be considered wetlands and could be described as riparian wetlands. However, some riparian areas are not wetlands (e.g. an area where alluvium is periodically deposited by a stream during floods but which is well drained).

» Wetland: 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 under normal circumstances supports or would support vegetation typically adapted to life in saturated soil (Water Act 36 of 1998); land where an excess of water is the dominant factor determining the nature of the soil development and the types of plants and animals living at the soil surface (Cowardin et al., 1979).
» Water course: As per the National Water Act means –
  (a) A river or spring;
  (b) A natural channel in which water flows regularly or intermittently;
  (c) A wetland, lake or dam into which, or from which, water flows; and
  (d) Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

Based on its hydro-geomorphic setting 5 palustrine wetland systems were identified within the project site (refer to Figure 18). The general terrain is mostly flat. There is a very low ridge line in the north-eastern corner as well within a section of the central portion of the western boundary. Shallowed out basins within the flatter landscape areas form a suitable physical template for mostly endorheic (closed systems that are in-ward draining) pan/depression wetlands.

The word 'pan', in ecological wetland studies, is a generic term used in South Africa to describe a wetland type that has a shallow depression or basin and that is usually a closed-system. Overall, pans are principally viewed as ephemeral and sporadic. Pans are also regularly restricted to lowlands or plains and can become very turbid after rainfall events and saline throughout time. In terms of pan wetland formation in South Africa, several conditions contribute to pan formation.
Allan et al. (1995) stresses the role of wind action whereas Goudie and Wells (1995) state the following predisposing conditions:

» Areas must be arid;
» An area should not be one where fluvial processes are fully integrated; and lastly,
» An area should not be one where aeolian accumulation does not result in the infill of any irregularities in the land surface.

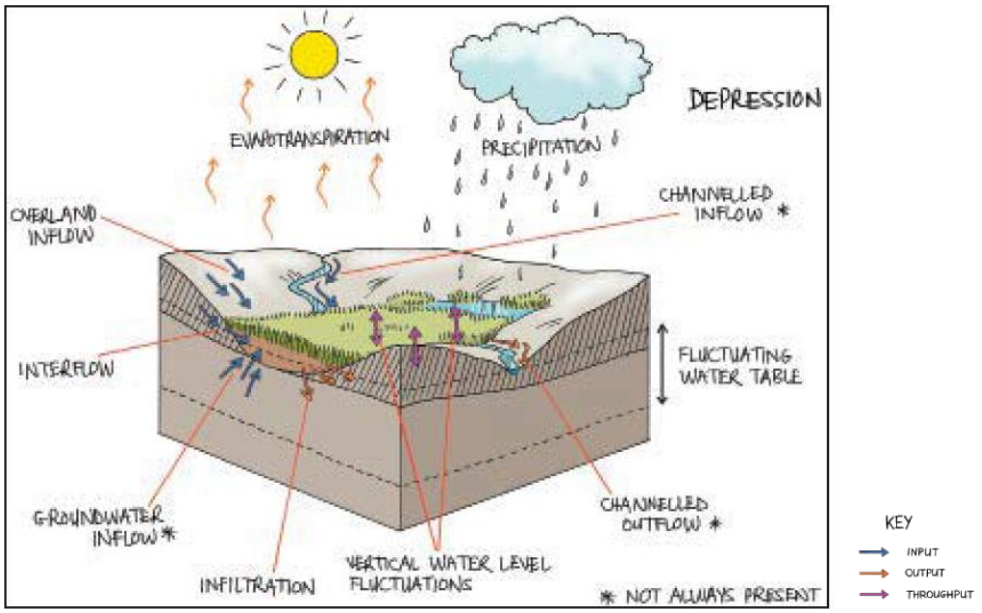

Figure 17: Conceptual illustration of a depression wetland showing the dominant inputs, throughputs and outputs of water (copied from Ollis et al., 2013).

The pan wetlands within the project site are good examples of typical pan wetlands in arid areas.

Furthermore, a short drainage line (±107 m) was identified, connecting pan wetland 1 and 2. The topography is flat but slopes very slightly to the south in which the direction of the drainage line flows. The drainage line is situated at the base of the almost inconspicuous, low ridge line. A similar drainage line appears to be located north of pan wetland 1 (outside of the project site boundaries) and appears to connect this pan with another pan wetland located some 160 m north of pan wetland 1 (outside of the project site boundaries). This drainage line also runs along and at the base of the small ridge line.

Generally, the functions and services (value) of the pan wetland are quite similar but may vary slightly in extent according to the size of the pan, the level of disturbance to which the wetlands have been subjected and the period and size of inundation. The opportunity for attenuating floods is largely limited due to their positions within the landscape, which is generally isolated. However, these pans do capture runoff as a result of their inward draining nature, and thus they reduce the volume of surface water that would otherwise reach the stream system and contribute to storm flows. This inward draining nature, together with their generally impermeable underlying layer, also means, however, that they are highly unlikely to play a role in stream flow augmentation. Temporarily wet pans provide the opportunity for the precipitation of minerals including phosphate minerals because of the concentrating effects of evaporation. Nitrogen cycling is likely to be

important with some losses due to de-nitrification, and volatilisation in the case of high pH. Water quality in pans is influenced by the pedology, geology, and local climate. These factors in turn, also influence the response of these systems to nutrient inputs. Probably the most significant functions these pan wetlands provide is the temporary collection and retention of runoff and associated resources after large rainfall events and seasonal preferential grazing for livestock and other smaller faunal species. Other important functions include the provision of niche habitat, in turn ensuring the persistence of smaller organisms and provides seasonal water and food to migrating fauna. Furthermore, some of the pan wetlands contain patches of larger trees and shrubs on their peripheries, which provide nesting space for birds and shelter/breeding areas for fauna.

The depression wetlands are described as follows:

4.1.1 Pan Wetland 1

This depression wetland is approximately 4.14ha in extent and can be classified as a depression wetland with some channelled inflow and outflow, connecting this wetland with a downstream depression as well as a depression wetland located "upstream". The "upstream" wetland as well as the drainage line connecting the two pan structures, are located outside of the project site's boundaries. This wetland along with pan wetland 2 forms part of a larger wetland and drainage line system and is located at the distal portion of this drainage system. All of the depression wetlands as well as drainage lines of this hydrological system is located at the base of the mentioned small ridge line. Based on outflow and inflow characteristics this pan wetland can be classified as an exoreic depression with channelled inflow. Even though concentrated overland flow is typical of this wetland, interflow also play a vital role with groundwater inflow having a very limited contribution. It appears that this wetland contains a portion which is intermittently inundated with shallow surface water and can be relative clearly divided into hydrogeomorphic zones according to soil form and wetness.

This depression wetland is regarded as largely natural to semi-natural with limited transformation. Disturbances within this depression include trampling and grazing (cattle), dirt road (twin track) and farm fences

Prominent ecosystem functions and services provided by this wetland includes:

» Collection and retention of runoff and associated resources after large rainfall events.
» Seasonal preferential grazing
» Niche habitat ensures persistence of organisms and provides seasonal water and food to migrating fauna.

4.1.2 Pan Wetland 2

This depression wetland is approximately 1.74 ha in extent and can be classified as a depression wetland with some channelled inflow and no clear channelled outflow. As mentioned, this wetland is connected to pan wetland 1 with a short drainage line and forms part of a larger hydrological system (various depression wetlands connected via drainage lines). This pan wetland forms the distal portion of the hydrological system. Based on outflow and inflow characteristics this pan wetland can be classified as an endorheic depression with channelled inflow. Even though concentrated overland flow is typical of this wetland, interflow also play a vital role with groundwater inflow having a very limited contribution. It appears that this wetland contains a portion which is intermittently inundated with shallow surface water and can be relative clearly divided into hydrogeomorphic zones according to soil form and wetness.

This depression wetland is regarded as largely natural to semi-natural with limited transformation. Disturbances within this depression include trampling and grazing (cattle) and a dirt road (twin track).

Prominent ecosystem functions and services provided by this wetland includes:
» Collection and retention of runoff and associated resources after large rainfall events.
» Seasonal preferential grazing.
» Niche habitat ensures persistence of organisms and provides seasonal water and food to migrating fauna.
» Larger shrubs and small trees on the periphery provide nesting space for birds and shelter/breeding areas for fauna.

4.1.3 Pan Wetland 3

This depression wetland is the second smallest of the wetlands identified within the project site and covers an area of only 1.11ha. This small pan contains closed elevation contours, which slightly increase in depth from the perimeter to a central area of greatest depth and within which water typically accumulates. This wetland contains no clear inlet or outlet and can be classified as endorheic with no channelled outflow. The hydrodynamics of this wetland are primarily dominated by vertical water level fluctuations. Water inflow is furthermore fed primarily by surface interflow from the immediate catchment. It appears that this wetland contains a portion which is intermittently inundated with shallow surface water and can be relative clearly divided into hydrogeomorphic zones according to soil form and wetness.

This depression wetland is regarded as mostly natural with very limited disturbance, mostly in the form of trampling and grazing by livestock (cattle).

Prominent ecosystem functions and services provided by this wetland includes:
» Collection and retention of runoff and associated resources after large rainfall events.
» Seasonal preferential grazing.
» Larger shrubs and small trees on the periphery provide nesting space for birds and shelter/breeding areas for fauna.

4.1.4 Pan Wetland 4

This depression wetland is the largest of the pans identified within the project site and covers an area of approximately 6.1ha. This pan wetland contains no indications of channelled inflow and outflow and is subsequently regarded as an endorheic system. This wetland contains no clear inlet or outlet and can be classified as endorheic with no channelled outflow. Furthermore, this pan is situated within a basin area infringing slightly on the elevated ridge line, to the south and the east furthermore contributing to the endorheic nature. This pan depression appears to have been linked to the ephemeral drainage system identified within the project site and which largely runs in a west to east direction. For most part of this palaeo channel surface drainage functionality has been lost. This linear feature runs for a moderately short length (±5.9 km) and then dissipate, for most part, not being linked to the wider drainage network anymore. Shallowed out basins within this palaeo-channel form a suitable physical template for endorheic depression wetlands. This larger depression/pan wetland within the project site form such a feature within the distal portion of the palaeo-channel. Other similar depression wetlands are present within this palaeo-channel outside of the project site's boundaries. Even though, some of the pan wetlands within this palaeo-channel may be linked, there is no indication of surface connection with any features inside of the project site and thus, ecological and surface-hydrology connectivity between the pan wetland within the project site and other depression wetlands within the palaeo-channel (outside of the project site) are regarded as absent. The hydrodynamics of this wetland are primarily dominated by vertical water level fluctuations. Water inflow is furthermore fed primarily by surface interflow from the immediate catchment. It appears that this wetland contains a portion which is intermittently inundated with shallow surface water and can be relative clearly divided into hydrogeomorphic zones according to soil form and wetness.

This depression wetland is probably the most disturbed of the wetlands occuring within the project site but can still be classified as semi-natural. Important,

disturbances within this wetland include; trampling and grazing (cattle), two dirt roads (twin tracks) and some quarrying for rock, sand and also likely lime (small isolated portions along the southern and western boundaries of the wetland).

Prominent ecosystem functions and services provided by this wetland includes:

» Collection and retention of runoff and associated resources after large rainfall events.
» Seasonal preferential grazing.
» Niche habitat ensures persistence of organisms and provides seasonal water and food to migrating fauna.
» Larger shrubs and small trees on the periphery provide nesting space for birds and shelter/breeding areas for fauna.

4.1.5 Pan Wetland 5

This depression wetland is the smallest of the wetlands identified within project site and covers an area approximately 1 ha. This small pan contains closed elevation contours, which slightly increase in depth from the perimeter to a central area of greatest depth and within which water typically accumulates. This wetland contains no clear inlet or outlet and can be classified as endorheic with no channelled outflow. The hydrodynamics of this wetland are primarily dominated by vertical water level fluctuations. Water inflow is furthermore fed primarily by surface interflow from the immediate catchment. It appears that this wetland contains a portion which is intermittently inundated with shallow surface water and can be relative clearly divided into hydrogeomorphic zones according to soil form and wetness.

This depression wetland is regarded as disturbed and transformed especially the catchment area which is a secondary open savanna woodland on historically cultivated areas. Other disturbances include, high levels of trampling and grazing (cattle) and an alteration to the vegetation composition (numerous weeds and alien plants).

Prominent ecosystem functions and services provided by this wetland includes:

» Collection and retention of runoff and associated resources after large rainfall events.

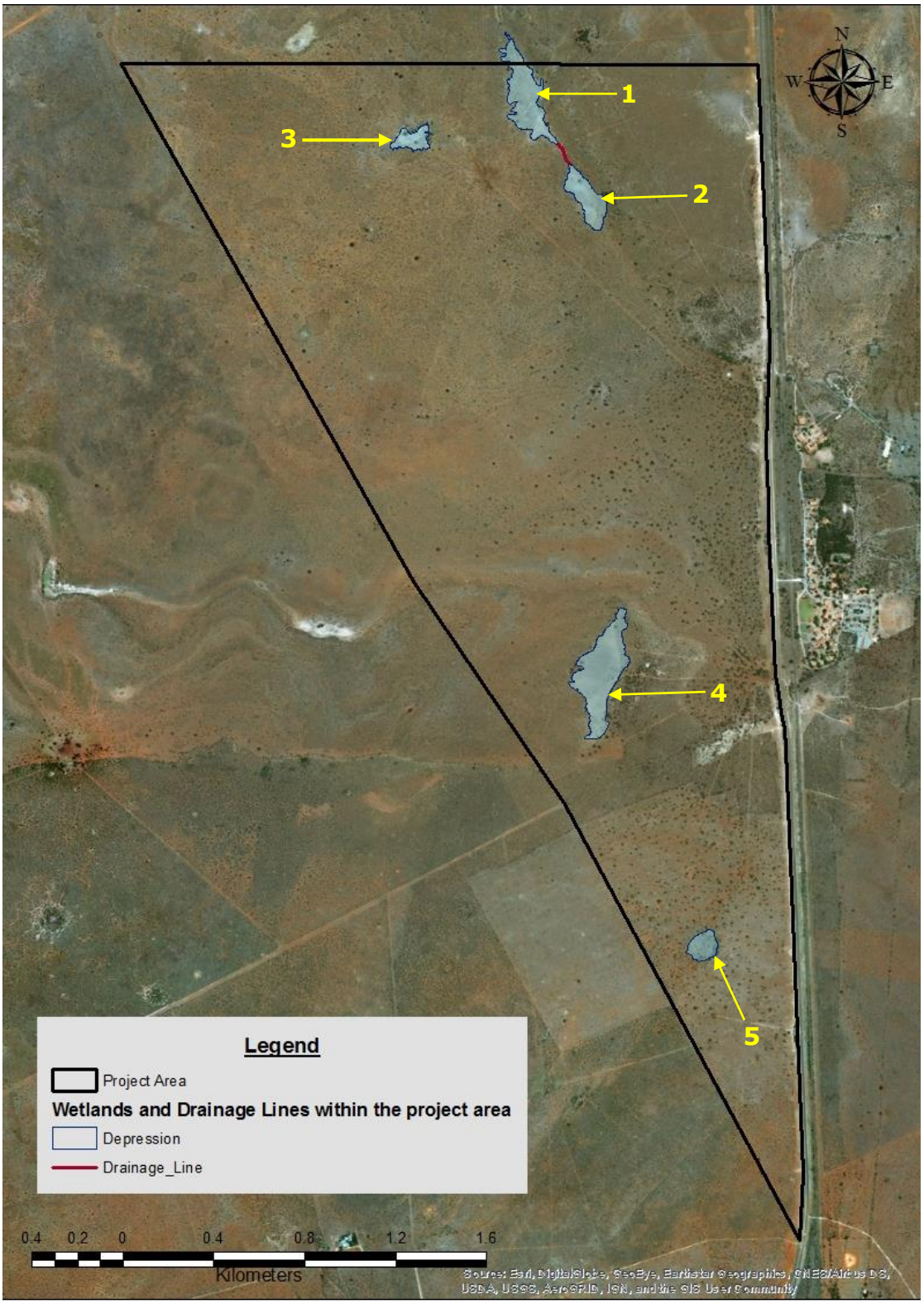

Figure 18: Surface hydrological features identified within the project site.

4.2 Soil Characteristics

The wetland soils encountered during the survey has signs of wetness within 50cm of the surface and both semi-permanent and seasonal wet soils have been identified.

In terms of pan wetland geomorphology, the influx of silt and clay due to inward depositional processes results in the accumulation of sediment. This sediment forms a layer that is relatively impermeable and is found near the surface in the subsoil of a pan basin. The soil composition (for example, degree of sand, silt and clay) however varies between pans. In general, five types of soil forms were identified within the pan wetlands. The first type of soils within the wetlands were predominantly found to contain clays up to the point that the soils were almost vertic in characteristics. Soils were dark in colour with a vertic structure deeper beneath the Orthic A horizon. Soil depth was however limited (up to 60cm) due to the presence of calcrete or bedrock. Small calcretions were evident in the soil samples drawn, before reaching calcrete. These types of soils were mainly found within the permanent saturated zones, which experience intermittent periods of inundation, of Pan Wetlands 2, 3 and 5. The soil forms that could be attributed to these wetlands include that of the Arcadia and Rensburg Soil Form. Mottling at the surface revealed hydric soils.

Typically within these Pan Wetlands (2, 3 and 5) the outer seasonal to temporary zones are characterized by an Orthic A horizon overlying a Hard Plinthic B horizon, typically of the Dresden Soil Form. A plinthic B horizon is usually indicative of a fluctuating water table. Dresden Soil form is also the prominent soil form within Pan Wetland 1.

The larger Pan Wetland 4 is dominated by Katspruit Soil Form within the permanent to seasonal saturated zone, where gleying forms the major pedogenetic process and is driven by long periods of reduction (as a result of extended soil saturation).

As one move to the outer edge of this HGM zone the soils become more loose and friable in character. The Orthic A horizon in these areas was underlain by a grey matrix with a weakly developed structure which has undergone marked in situ net removal of colloidal matter (iron oxides, silicate clay, organic matter) as a result of reduction (extended periods of soil saturation) together with a lateral flow of water. Along with the removal of colouring materials such as oxides and organic matter, clay particles have also been largely removed resulting in a coarser texture. Rusty markings (flecks, streaks, mottles) are common and testify to the temporary saturated conditions within this area. The soil form that could be attributed to this portion of Pan Wetland 4 is the Fernwood Soil Form.

The fifth soil form identified could be attributed to the Mispah Soil Form. The soil profile over some sections of the pans were relatively thin before being interrupted by bedrock. The soils were of an Orthic character and some red iron oxide mottling was observed at the surface in the sandier soils whereas other pans expressed higher clay content with small lime nodules.

4.3 Drainage Line

As earlier explained, the short drainage line connects pan wetland 2 with 1. This drainage line is situated at the base of a low almost inconspicuous ridge line and runs parallel with this ridge line from pan wetland 1 to 2. The topography within the drainage line is flat but slopes very slightly to the south in which the direction of the drainage line flows. The soil profile of the drainage line is very shallow with bedrock extruding for stretches where a soil profile is extremely thin (+-5cm). The soil type varies from the outer HGM zone of Pan wetland 1 where the hard plinthic B horizon is dominant to a Mispah soil form with slight indication of saturation to a Mispah form without any signs of saturations and finally back to a soil form with a hard plinthic B horizon as the drainage line transitions into Pan Wetland 2.

4.4 Wetland Vegetation

Refer to Section 5.2.5.

4.5 Surface Water Buffer Zones

Buffer zones were determined for the identified wetlands since it is only these features that may be potentially directly affected by the proposed development.

For wetlands, the primary threat related to PV developments during the construction phase, is increased run-off and sediment inputs (USEPA, 2005 & 2006), as well as turbidity. This is presumably during vegetation clearing for the PV arrays and excavation of pits for the foundations of the individual PV panels. These areas are left vulnerable to surface run-off, consequent erosion and sedimentation. Given the relatively flat terrain, the size and proximity of the proposed PV field, this is a distinct possibility. However, the aridity of the study area will be a factor in whether there is any run-off at all. Timing of construction is therefore important and should preferably occur outside of the rainy season as far as practically possible in order to limit impacts arising from run-off. Nonetheless, the potential impacts can be easily mitigated with simple management measures

in place. Therefore, the buffer zones can be of limited size in order to address potential impacts.

For the operation phase, run-off from the PV field and adjacent services roads (SANRAL, 2009b; DNREA, 2006; Walker et al., 2000 & Cummings, 1999) can contribute to increased run-off and sediment inputs, as well as turbidity in the wetlands. Again, the terrain and climate factors will have a bearing on potential impacts. However, with the implementation of mitigation measures, potential impacts can be avoided. Based on the above as well as the suggested mitigation measures, construction and operation buffer zones were determined for the identified wetlands. As such, the wetland buffer zones that were determined and are applicable include the following:

» Construction Phase Buffer: 35m
» Operation Phase Buffer: 35m

5 RESULTS FOR ECOLOGICAL ASSESSMENT

5.1 Vegetation overview - Broad Vegetation Description

Broad vegetation types

The project site is situated in the Savanna biome and Eastern Kalahari Bushveld Bioregion. The vegetation in and surrounding the project site is Ghaap Plateau Vaalbosveld (SVk 7) (refer to Figure 19).

The distribution of the vegetation type is spread across the Northern Cape and North West Province, from about Campbell in the south east of Danielskuil through Reivilo to around Vryburg in the north. This vegetation type has been described by Mucina and Rutherford (2006) as a flat plateau with well-developed shrub layer with *Tarchonanthus camphoratus* and *Acacia karroo*. Open tree layer has *Olea europaea* subsp. *africana*, *A. tortilis*, *Ziziphus mucronata* and *Searsia lanceae*. *Olea* is more important in the southern parts of the unit, while *A. tortilis*, *A. hebeclada* and *A. mellifera* are more important in the north and part of the west of the unit. Much of the south-central part of this unit has remarkably low cover of Acacia species for an arid savanna and is dominated by the non-thorny *T. camphoratus, R. lanceae* and *O. europaea* subsp. *africana.*

Table 11: Key species associated with the Ghaap Plateau Vaalbosveld.

DOMINANT SPECIES	
Growth Form	**Key Species**

Low Shrubs	*Anthospermum rigidum subsp. pumilum, Indigofera comosa, Pygmaethamnus zeyheri var. rogersii, Searsia magaliesmontana, Tylosema esculentum, Ziziphus zeyheriana.*
Graminoids	*Aristida congesta, Brachiaria serrata, Cynodon dactylon, Digitaria tricholaenoides, Hiheteropogon ampletens, Eragrostis chloromelas, E. racemosa, Heteropogon contortus, Loudetia simplex, Schizachyrium sanguineum, Setaria sphacelata, Themeda triandra, Alloteropsis semilata subsp. eckloniana, Andropogon schirensis, Aristida canescens, A. diffusa, Bewsia bifola, Bulbostylis burchellii, Cymbopogon caesius, Elinonurus muticus, Eragrostis curvula, E. gummiflua, E. plantana, Eustachys paspaloides, Hyparrhenia hirta, Melinis nerviglumis, M. repens subsp. repens, Monocymbium ceresiiforme, Panicum coloratum, Pogonarthria squarrosa, Trichoneura grandiglumis, Triraphis andropogonoides, Tristachya leucothrix, T. rehmannii.*
Herbs	*Acalypha angustata, Chamaecrista mimosoides, Euphorbia inaequilatera, Crabbea angustifolia, Dianthus mooiensis, Dicoma anomala, Helichrysum caespititium, H. miconiifolium, H. nudifolium var. nudifolium, Ipomoea ommaneyi, Justicia anagalloides, Kohautia amatymbica, Kyphocarpa angustifolia, Ophrestia oblongifolia, Pollichia campestris, Senecio coronatus, Hillardia oligocephala.*
Geophytic Herbs	*Boophane disticha (Declining – Red List), Habenaria mossii.*
Geoxylic suffrutex	*Elephantorrhiza elephantina, Parinari capensis subsp. Capensis.*
ENDEMIC SPECIES	
Growth Form	**Key Species**
Succulent Shrub	*Delosperma davyi.*

A species list from POSA (http://posa.sanbi.org, Grid reference 2624 and 2724) containing the species that have been recorded to date in the Vryburg area was obtained. POSA generated species lists also contain updated Red Data species status according to the Red List of South African Plants published by SANBI in Strelitzia 25 (Raimondo *et al*. 2009, updated 2013). Only protected and red data species that may potentially occur in the project site have been listed under results. The actual field survey will confirm which of the species already recorded will actually occur in the project site, and may reveal the presence of additional species that may not have been recorded in official databases to date.

A total of 369 indigenous species have been recorded in the Vryburg region according to the SANBI database. It is highly unlikely that all of these species will occur within the project site. Alien invasive species (33) have also been recorded within the relevant quarter degree grids.

Conservation status of broad vegetation types

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 12: 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 13: Conservation status of the vegetation type occurring in and around the project site.

Vegetation Type	Target (%)	Conserved (%)	Transformed (%)	Conservation Status	
				Driver *et al*., 2005; Mucina & Rutherford, 2006	National Ecosystem List (NEM:BA)
Ghaap Plateau Vaalbosveld	16%	0%	1%	Least Threatened	Not Listed

According to Mucina and Rutherford (2006) none of the vegetation type is protected within formal conservation areas, but only 1% of this unit has been transformed. The conservation status of this unit is classified as Least Threatened and is not listed under 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) (refer to Figure 18).

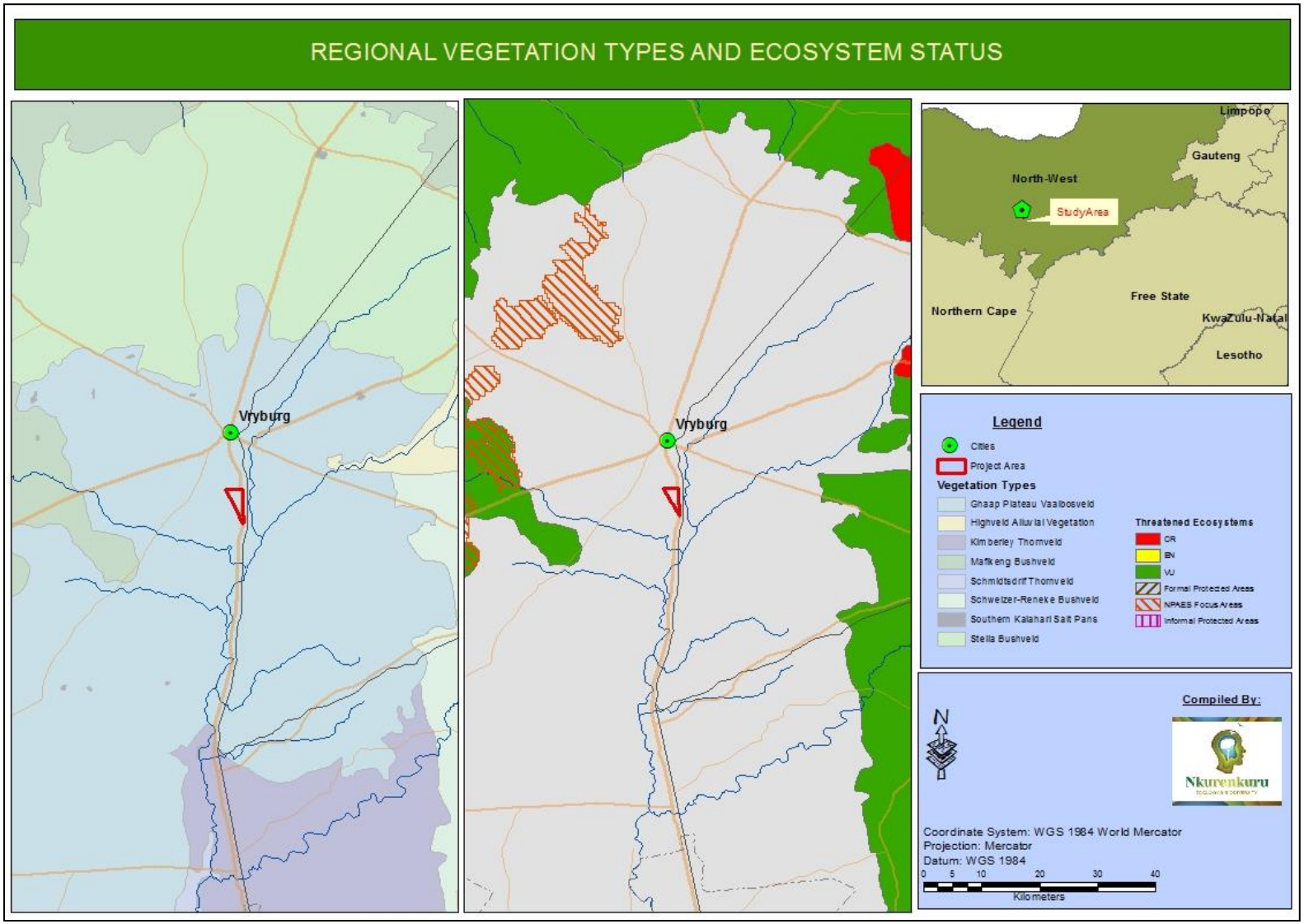

Figure 19: Vegetation types (Mucina & Rutherford, 2006) of the project site as well as the status of Threatened Ecosystems.

Red List and protected plant within the relevant Quarter Degree Grid

As previously mentioned, a species list was obtained from POSA for the relevant degree grids. The species on this list were evaluated to determine the likelihood of any of them occurring in the project site. Of the species that are considered to occur within the geographical area under consideration, there were 19 species which are regarded conservation worthy. Three species recorded in the degree grids are listed on the Red List plant species. According to the South African Red List Categories, one is listed as Rare (*Gnaphalium nesonii*), one Vulnerable (*Rennera stellata*) and one Near Threatened (*Lithops lesliei*). *Boscia albitrunca* is the only tree species protected according to the National Forest Act (NFA) that may potentially occur within the project site. The remaining 16 species are protected within the Transvaal Nature Conservation Ordinance (TNCO) and Bophuthatswana Nature Conservation Act (BNCA).

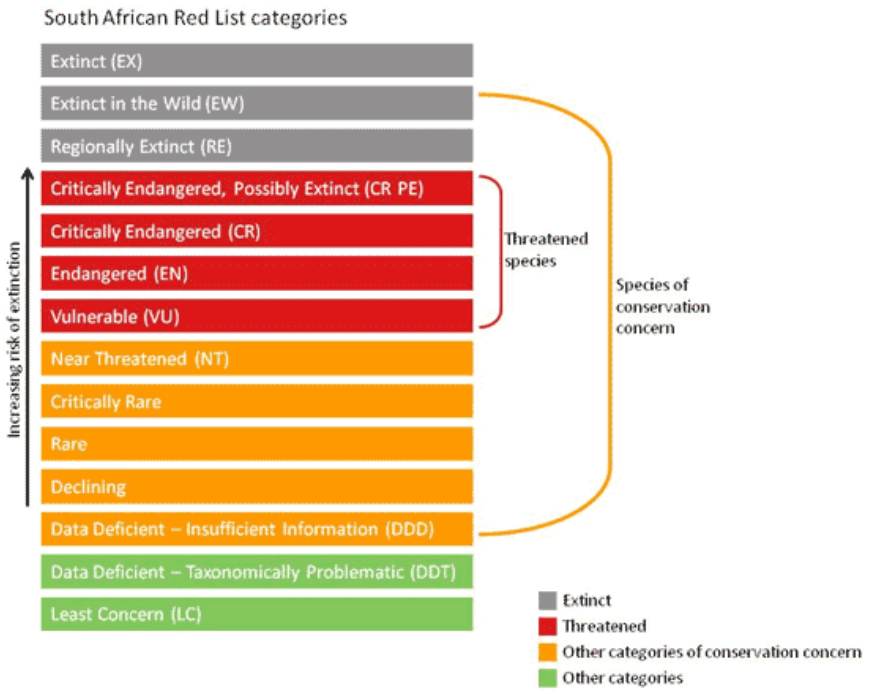

Figure 20: Schematic representation of the South African Red List categories. Taken from http://redlist.sanbi.org/redcat.php

Table 14: Species listed as conservation worthy within the South African Red List, National Forest Act (NFA), Transvaal Nature conservation Ordination (TNCO) and Bophuthatswana Nature Conservation Act (BNCA).

Species	Status
Gnaphalium nesonii	TNCO & BNCA
Rennera stellate	TNCO & BNCA
Lithops lesliei	TNCO & BNCA

Boscia albitrunca	Rare
Ammocharis coranica	Vulnerable
Brunsvigia radulosa	Near Threatened
Crinum crassicaule	TNCO & BNCA
Nerine frithii	TNCO & BNCA
Nerine hesseoides	TNCO & BNCA
Nerine laticoma	TNCO & BNCA
Brachystelma dimorphum subsp. dimorphum	TNCO & BNCA
Brachystelma foetidum	TNCO & BNCA
Ceropegia crassifolia var. crassifolia	TNCO & BNCA
Hoodia pilifera subsp. annulata	TNCO & BNCA
Stapelia grandiflora var. grandiflora	TNCO & BNCA
Aloe grandidentata	TNCO & BNCA
Aloe zebrine	TNCO & BNCA
Chortolirion angolense	TNCO & BNCA
Babiana bainesii	TNCO & BNCA

5.2 Site specific vegetation description – Fine Scale Vegetation Patterns

In this section, the different habitats and vegetation patterns observed within the project 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 is provided in Figure 20.

The project site was relative species diverse with over 170 plant species identified within the boundaries of the project site. Variations in edaphic, geological factors as well as soil moisture content contribute to this diversity. The forb and graminoid was relative well developed and represented by 134 species (88 forb species and 46 graminoid species). Even though the tree and shrub layer are represented by a moderate diversity of species (22 species: 9 tree species and 13 shrub species), these species play an important role in the vegetation structure of the development area. Geophytes and succulents only make up 5.8% of the total species composition. Furthermore, the most dominant plant families within the development area are; Poaceae with 26%, Asteraceae with 12%, Fabaceae with 7% and Malvaceae with 3.5%.

Weeds and invasive alien species are not abundant within the development area and is represented by 24 species of which only 6 species are listed as Invasive Alien Plants (NEM:BA, 2017) namely; *Eucalyptus camaldulensis, E. sederoxylon, Prosopis glandulosa, Opuntia ficus-indica, Datura stamonium* and *Argeomone mexicana.* None of these species occur at high densities within the development area with most species confined to areas around homesteads and where soils are regularly

disturbed (e.g. typically within highly trampled areas around watering and feeding points and kraals). The only species that was recorded to occur within the primary grassland/open savannah was *Opuntia ficus-indica*. Highly trampled areas were regularly invaded with *Argeomone mexicana* and *Datura stramonium* but as mentioned the densities of this species are not regarded as problematic during the time of the survey.

Regarding conservation important species, five species was identified within the development footprint of which two species are Red Listed Species (*Boophone disticha* – Declining and *Acacia erioloba* – Declining) whilst the remaining three species area listed as protected species within the relevant provincial conservation ordinations (*Ammocharis coranica*, *Nerine laticoma* and *Babiana hypogea*).

The project site was confirmed to be consistent with the description for Ghaap Plateau Vaalbosveld with some variations occurring in terms of the herb (grass) tree / shrub layer relationship (different forms of savannah). The main ecological influences determining the vegetation patterns are edaphic and geological factors as well as soil moisture. Generally, the tree/shrub layer decreases along a soil moisture gradient with trees and shrubs almost entirely absent from the depression wetland areas apart from some woody patches at the peripheral fringe of some of the pan wetlands. Furthermore, as the soil layer becomes deeper and sandier in texture, the tree / shrub layer becomes more open. The current and historical grazing regimes also play some part in this tree/shrub and grass relationship, although to a lesser extent. This grazing regimes on the other hand play a more important role in terms of species composition within the grass/forb layer. Key species associated with the project site are provided below in Table 15 below.

Table 15: Key species associated with the project site.

DOMINANT SPECIES	
Growth Form	**Key Species**
Shrubs	*Grewia flava, Trachonanthus camphoratus, Asparagus laricinus, Searsia tridactyla*
Trees	*Searsia lancea, Ziziphus mucronata,*
Graminoids	*Aristida congesta, Digitaria eriantha, Eragrostis lehmanniana, Eragrostis ridgidior, E. superba, Cymbopogon pospischilli, Schmidtia pappophoroides, Centropodia glauca, Kylinga alba*
Forbs	*Geigeria burkei, Salvia disermas, Senna italica, Cleome rubella, Heliotropium ciliatum, Barleria macrostegia, Chascanum pinnatifidum, Pupalia lappaceae,*
Geophytic Herbs	*Boophane disticha (Declining – Red List), Moraea polystachya, Babiana hypogea*
Geoxylic suffrutex	*Elephantorrhiza elephantina*

As mentioned the historical and current grazing regimes is expressed in the species composition of the grass/forb layer. Grass species can be classified according to

their ability to react to different veld management regimes (levels of foliage removal) and are classified as follows:

» Decreaser: A dominant grass in good, well-managed veld that will decrease under any form of mismanagement, such as severe disturbance, untimely burn, overgrazing or under-utilisation.
» Increaser: a grass species that will increase under any type of mismanagement or disturbance.

There are two types of increasers:

- Increaser I: a grass species that will increase under conditions of under-utilisation or understocking or on an area which is selectively under grazed.
- Increaser II: a grass species that is dominant in poor veld or that will increase under any form of overgrazing or disturbance.

According to the grass species composition, it is evident that this area has been exposed to long term overgrazing and cattle stocking rates exceeding the carrying capacity of the veld. This is evident from the dominance of Category II Increaser species within the development area which comprises 70.4% (31 species) of the total grass species recorded within the project site (as well as 7.6% Increaser I species). Decreaser species are represented by only 22% (10 species).

According to Scholes & Archer (1997) savannas occur where trees and grasses interact to create a biome that is neither grassland nor forest. The term savanna has been widely used and variously defined. The prevailing ecological usage denotes communities or landscapes with a continuous grass layer and scattered trees. Savannas have been broadly subdivided based on the stature, canopy cover, and arrangement of woody elements. Within the project site such subdivisions within the Ghaap Plateau Vaalbosveld were visible and are described below along with the plant units that comprise these savanna subdivisions.

5.2.1 Savannah Grassland

This savannah type comprises of a dominant open grassland with some scattered shrubs and trees (mainly *Trachonanthus camphoratus, Grewia flava* and *Searsia tridactyla*). Tall trees are scarse and usually clumped together. These features of circular clumped and/or "mottles" of woody plants is also consistent of a Parkland Savanna type (two-phase mosaic landscape) but due to the fact that such clumps are quite scarse and the grass layer form such a prominent feature within this area, the former savannah type is preferred. Such clumps typically comprise of *Searsia lanceae, Ziziphus mucronata* and *Trachonanthus camphoratus*. Three vegetation units have been identified within this habitat namely:

Open Vaalbos Shrubland: This vegetation type typically occurs on deeper sandy soils and comprise of a moderately tall (1m and taller) grassland with some scattered shrubs (*Trachonanthus camphoratus, Grewia flava* and *Searsia tridactyla*). This vegetation unit comprise of 52 species of which graminoids form 40% of the total species composition with a cover abundance of over 65%. Trees and shrubs form approximately 17% of the project site with a cover abundance of approximately 30%. The remaining 5% comprise of forbs and geophytes. Key species within this vegetation unit includes; *Aristida congesta, Digitaria eriantha, Eragrostis rigidior, Eragrostis superba, Eragrostis lehmanniana, Anthephora pubescens, Centropodia glauca, Schmidtia pappophoroides, Brachiaria nigropedata, Cymbopogon pospischilli, Themeda triandra, Grewia flava, Trachonanthus camphoratus, Geigeria burkei, Asparagus suaveolens, Hertia pallens, Sida chrysanta and Barleria macrostegia*. Species of conservation importance that was observed within this unit were occasional *Boophone disticha* plants whilst *Babiana hypogea* was relatively regularly observed. Other conservation important plants less frequently observed include; *Ammocharis coranica, Aloe greatheadii* and very occasionally, individuals of *Acacia erioloba*.

The power line routes (Alternative 1 and 2) are both located within this vegetation type. However, proposed power line route (Alternative 2) is situated within a variation of this vegetation type with *Acacia mellifera* becoming much more prominent and may even in some areas become encroaching. This variation is similar, interms of edaphic factors, then the primary vegetation type, but is underlaing by a different geological formation (intermediate volcanic and siliciclastic rocks of the Vryburg Formation). The vegetation structure and composition are mostly similar to that of the primary vegetation type, with the exception, as mentioned, of *Aciacia mellifera*. Where *Acacia mellifera* becomes encroaching, however the vegetation structure and composition may become altered. Encroachment with *Acacia mellifera* can be directly corrolated with severe overgrazing within this area.

Short Griekwa Karee Shrubland: Tall trees are mostly absent from this vegetation type and the higher strata is mostly made up with *Searsia tridactyla* whilst shrubs such as *T. camphoratus* and *G. flava* much less prominent than in the other vegetation units. Short Griekwa Karee Shrubland typically occurs on relatively shallow, stony soils, normally dolomite with chert and some calcretes. Most of the central portion of the project site comprise of a low, almost inconspicuous cherty-dolomite ridge intersected by the fossil-channel and forms the main location for this vegetation unit. Within this portion of the project sit, this vegetation unit and its boundaries are relatively well defined. However, some outcroppings and areas with shallower soils scattered within the other vegetation units, comprise of this vegetation unit, but with less defined boundaries. These scattered patches of Short

Griekwa Karee Shrubland occur especially within the Open Vaalbos Shrubland. These patches cannot be clearly defined and subsequently have not been mapped separately from the other vegetation units within which they occur. Where these scattered patches (patches of Short Griekwa Karee Shrubland) occurs within another vegetation unit, there is largely a continuum in vegetation composition between the two vegetation extremes with parts of the transition areas falling variously along a gradient in compositions between the two endpoints. Furthermore, there is little basis on which to differentiate the sensitivity of the two vegetation types and so an attempt to map these patches of Short Griekwa Karee Shrubland within other vegetation units at the site has not been made as there would be little utility in doing so and there is not a clear and natural differentiation of the vegetation units. This unit comprise of 51 species of which graminoids form 45% of the total species composition. The forb diversity which make up 33% of the total species diversity are relative prominent within the project site. The forb/graminoid layer are typically relative short (less than 0.8 m) with taller patches (1m and higher) forming a mosaic within this vegetation stratum. Even though the shrub layer is relatively species poor (11% of total species composition) and is primarily dominated by one species (*Searsia tridactyla*), this species form a key feature within this vegetation unit. Approximately 35% of the unit is covered by shrubs, mostly *S. tridactyla*, whilst graminoid/forb covers approximately 63%. Key graminoid and forb species include; *Aristida congesta, Anthephora pubescens, Eragrostis lehmanniana, Eragrostis rigidior, Microchloa caffra, Eragrostis echinochloidea, Eragrostis nindensis, Enneapogon desvauxii, Geigeria burkei, Oxalis obliquifolia, Cleome rubella, Senna italica, Hermannia* spp. and *Kylinga alba*. The remaining 2% comprises mostly geophytic species such as *Moraea polystachya, Ledebouria revoluta* and *Boophone disticha*. Species of conservation importance that was observed within this unit were occasional *Boophone disticha* plants and a single population of *Nerine laticoma*.

Palaeo-drainages: The palaeo-valley run in a West to East direction within the central portion of the project site and is fringed along the southern bank by a very low, cherty-dolomite ridge line. This feature is no longer considered to be a watercourse, as will be described later in this section. The palaeo-channel is mostly flat or very gradual sloping. Although there is still a very slight incision of the channel, it is mostly filled with a moderately thin layer of sand and/ or silt and clay covering bedrock and stones of dolomite and chert with some isolated calcretes. Pockets of deeper sediment occur within this channel.

This relict drainage feature, is mostly indicated by a linear pattern of greyer (bleached) hydric soils. This linear feature runs for a moderate distance and then dissipate, not appearing to being linked to the wider drainage network (although it is possible that this system was potentially linked to the palaeo Dry Harts River drainage system). This characteristic may reflect the macro-geomorphological

development of the project site over time, in which diminution of surface fluvial activity over time occurred in the wider Kalahari area. Although dunes are not found in the project site, the development of endorheic drainage, as in the Kalahari, has occurred in the project site, with many rivers poorly defined, and 'severed'. The grey colour of the soils as opposed to the surrounding orange soils indicates the presence of hydric soils. The linear distribution of the soils is thought to reflect a relict drainage line that has retained some form of hydromorphic character. Some of these 'severed' drainage systems appear to be linked to pans, with the possibility of pans being the expression of the process of development of this endorheic drainage. Surface drainage functionality of this palaeo-channel within the project site appears to be absent. Some moisture within the soil may however be retained for longer periods of time, following rainfall events (higher than the surrounding area), but seldom exhibit saturated soil conditions within the development area. These areas of higher moisture content are characterized by a plant species composition different from the surrounding dryer areas and is almost entirely covered with graminoids with some forbs. Shrubs are almost absent from this channel with only occasionally the presence of *Grewia flava*. The grass layer is moderately tall (±1 m) with, *Aristida congesta, Digitaria eriantha, Eragrostis lehmanniana, Eragrostis superba* and *Themeda triandra* forming the key species. The palaeo-channel comprises of 46 species with 20 graminoid species and 22 forb species whilst the remaining 4 species are geophytes and shrubs (2 each). Shallow soils are typically covered by shorter grasses such as *Eragrostis x pseudo-obtusa, Chloris virgata, Enneapogon desvauxii, Tragus berteronianus* and *Eragrostis nindensis*. Trampled and severely overgrazed areas are typically covered by *Schkuria pinnata, Geigeria burkei* as well as *Aristida congesta*. Only one conservation important species was observed namely *Nerine laticoma* and was only occasionally observed, normally in small clusters of not more than 6 species per population.

5.2.2 Savannah Shrubland

This savannah type comprises of a dominant and dense shrub layer, primarily *T. camphoratus* and *G. flava*. The forb/ grass layer is also relatively well developed. Taller tree species are occasionally scattered within this shrub dominated area. This savanna type predominantly occupies the slightly elevated calcareous beds or mantles. This savanna type comprises of only one vegetation unit namely the Tall Vaalbos Shrubland which will be described below.

Tall Vaalbos Shrubland: This vegetation unit covers the calcareous beds within the project site and is fairly species poor comprising of only 35 species. *T. camphoratus* and *G. flava* are the most dominant species within this unit and cover approximately 60% - 70% of the project site, creating a fairly dense, medium tall shrub layer. The grass layer below these shrubs comprise of 12 species of which A*nthephora*

pubescens, Eragrostis lehmanniana, Cymbopogon pospischilli, Enneapogon desvauxii and *Themeda triandra* are the most dominant species. The forbs, *Hertia pallens, Barleria macrostegia, Pentzia incanum, Geigeria burkei,* and *Blepharis integrifolia* as well as the dwarf shrub, *Felicia muricata* are also dominant within this unit and are prominent and diagnostic of this unit. It is likely that this shrub layer may have densified and somewhat encroached over this calcareous layer due to overgrazing over a long period of time. Taller shrubs and small trees such as *Acacia karroo* and *Searsia lancea* are occasionally rise above the dominant *T. camphoratus* and *G. flava* cover. The only conservation worthy species recorded within this unit is *Acacia erioloba* which is very sparsely distributed within this unit and very seldom encountered.

5.2.3 Tree Savannah

This savannah type comprises of an open tree savanna characterised by medium size trees and a well-developed and moderate to dense grass layer. This vegetation unit has a relative close resemblance to the Open Vaalbos Shrubland in terms of species composition and diversity, with differences occurring in the form of the structure and relationship between the different plant strata. The tree savannah contains a denser (although still open) tree layer whilst the shrub layer is much more open. As within the Open Vaalbos Shrubland, clustering of trees may occur. Dominant tree species include; *Searsia lancea*, *Acacia karoo, Acacia tortilis* and *Ziziphus mucronata*. *T. camphoratus* and *G. flava*, even though still constant throughout the area, are much lower in density. Within the tree savannah, two vegetation units were identified namely; Tall Karee Woodland covering the central-eastern portion of the project site as well as the Secondary Open Woodland occurring on historically cultivated areas.

Tall Karee Woodland: This vegetation unit covers moderately deep sandy soils with some local shallow soils and exposed dolomites. The tree layer comprises between 15% and 20% of the unit with *S. lancea* and *Z. mucronata* being the prominent tree species. The shrub layer comprising predominantly of T. *camphoratus* cover approximately 20% of the project site. The grass layer is well developed and relative dense comprising of *D. erinatha, A. pubescens, E. lehmanniana, E. rigidior, E. superba, S. pappophoroides* and *A. congesta*. Species diversity within this unit is fairly low comprising of 36 species comprising of 16 graminoid species, 4 shrub species and 4 tree species. Species of conservation importance that was observed within unit were occasional *Aloe greatheadii* plants. Other conservation important plants less frequently observed include; *Ammocharis coranica,* and very occasionally, individuals of *Acacia erioloba*.

Secondary Open Woodland: This vegetation unit occupies historically cultivated areas and can be regarded as a plagio-climatic habitat. This unit occupies a fairly

deep gravelly soil. Other important ecological factors influencing the vegetation composition of this unit are trampling and overgrazing and is evident from the dominance of increasing II grass species, especially *A. congesta, E. echinochloidea, S. pappophoroides* and *E. lehmanniana*. This unit comprise of an open tree layer with some local clustering of tree species. The tree layer constitutes approximately 15% of the total vegetation cover and comprise of an almost equal mixture of broad leave and compound leave species. The shrub layer constitutes approximately 20% of the unit, predominantly *G. flava*. The project site comprises a moderate diversity of species (49 species) with all strata relatively well represented (15 grass species; 6 shrub species, 5 tree species and 18 forb species). Key species includes; *A. congesta, E. lehmanniana, E. superba, S. pappophoroides, E. echinochloidea, G. flava, T. camphoratus, S. lancea, A karroo, Z. mucronata, A. tortilis, Asparagus laricinus, Lantana rugosa, Pentzia incanum, Chascanum pinnatifidum, Nolletia ciliaris* and *Hertia pallens*. Species of conservation importance that was observed within unit were occasional *Aloe greatheadii* plants.

5.2.4 Savannah Woodland

This savannah type comprises a dense tall shrub / tree cover, forming an almost closed canopy in some areas. Open patches and peripheries of these woodlands contain shade loving grasses whilst the deeper shaded areas contain forbs with some possessing the ability to climb. Two types of woodlands were identified namely the small patch of Tall Mixed Woodland and the Tall Woodland Fringe. The Tall Mixed Woodland Patch is located near the central-western portion of the project site, whilst the Tall Woodland Fringe is typically associated with rocky peripheries of some pan wetlands.

Tall Mixed Woodland Patch: This small isolated patch occurs on moderately to deep sandy soils overlying calcrete. Some calcrete gravel is also present on the surface. This patch is dominated by a tall dense tree cover comprising of a mixture of broad- and compound leaved tree species (Acacia karroo, Searsia lancea and Ziziphus mucronata). The lower shrub stratum is characterized by *Diospyros lycioides, Gymnosporia buxifolia* and *Searsia leptidictya.* The lower stratum comprise predominantly of shade tolerating forbs such as *Pergularia daemia, Sida chrysantha* and *Pavonia burchelii*. The nitrogen enriched areas around A. karroo trees are dominated by a dense sward of *Setaria verticilata*. This patch is located near a few informal dwellings and adjacent to a kraal and is subsequently subjected to regular trampling and some wood harvesting. This unit is regarded as moderately disturbed with a highly transformed grass / for layer.

Tall Woodland Fringe: These woody patches are found as small, dense patches at the peripheries of some of the pan wetlands, where the soils are slightly clayey and relatively shallow with surface rock typically present. These patches comprise a

combination of small to moderately sized trees and shrubs with a moderate ground cover, predominantly forbs and shade loving graminoids. Key species include *Searsia lancea, Ziziphus mucronate, Searsia pyroides, Diospyros lycioides, Grewia flava*, *Asparagus laricinus* and *A. suaveolens.* The only conservation worthy species recorded within this unit is *Acacia erioloba* which is very sparsely distributed within this unit.

5.2.5 Depression "Pan" Wetlands

This habitat type does not form part of the Savannah habitat types but rather moisture loving grasslands located in depressions, experiencing various periods of soil saturation with some small areas which may experience short periods of inundation. These areas are also usually characterized by soils with a higher clay content due to the accumulation of such textures in these low-lying areas. The depression wetlands comprises of a low to tall moisture loving grassland which may be replaced by forbs when regularly trampled and grazed. The composition of dominant species typically varies along a moisture gradient.

The zones within these pans that are saturated seasonally to almost temporary are characterized by low growing graminoids such as *Panicum coloratum, Cynodon dactylon, Eragrostis cilianensis, Echinochloa holubii* and *Brachiaria marlothii* as well as *Eragrostis curvula*. Trampled areas may be dominated by *C. dactylon, Tragus berteronianus*, and *Schkuria pinnata*. Areas experiencing periods of inundation (typically temporarily for a few months after sufficient rainfall events) are characterised by *Persicaria serrulata* and *Echinochloa holubii*.

The seasonal to temporary saturated zone are usually characterized by a mixture of short and tall grasses with a stronger forb representation. Key species includes; *Brachiaria marlothii, Panicum coloratum, Cymbogon pospischilii, Cynodon dactylon, Salvia disermas, Gomphrena celosioides, Stachys natalensis* and *Heliotropium ciliatum.* Trampled areas are usually dominated by *Schkuria pinnata, Urochloa panicoides, Cynodon dactylon, Heliotropium ciliatum* and *Gomphrena celosioides*.

The outer edges of the temporary zones are very seldom saturated and comprise of a mixture of the surrounding dry terrestrial species and wetland species, predominantly tall grass species. Key species includes; *Digitaria eriantha, Enneapogon desvauxii, Eragrostis lehmanniana, Eragrostis rigidior, Cymbopogon pospischilii, Panicum coloratum, Sporobolus ioclados, Heliotropium ciliatum* and *Schkuria pinnata.* Very occasionally tall *Acacia erioloba* species may be located within these areas, which is regarded as a conservation important species.

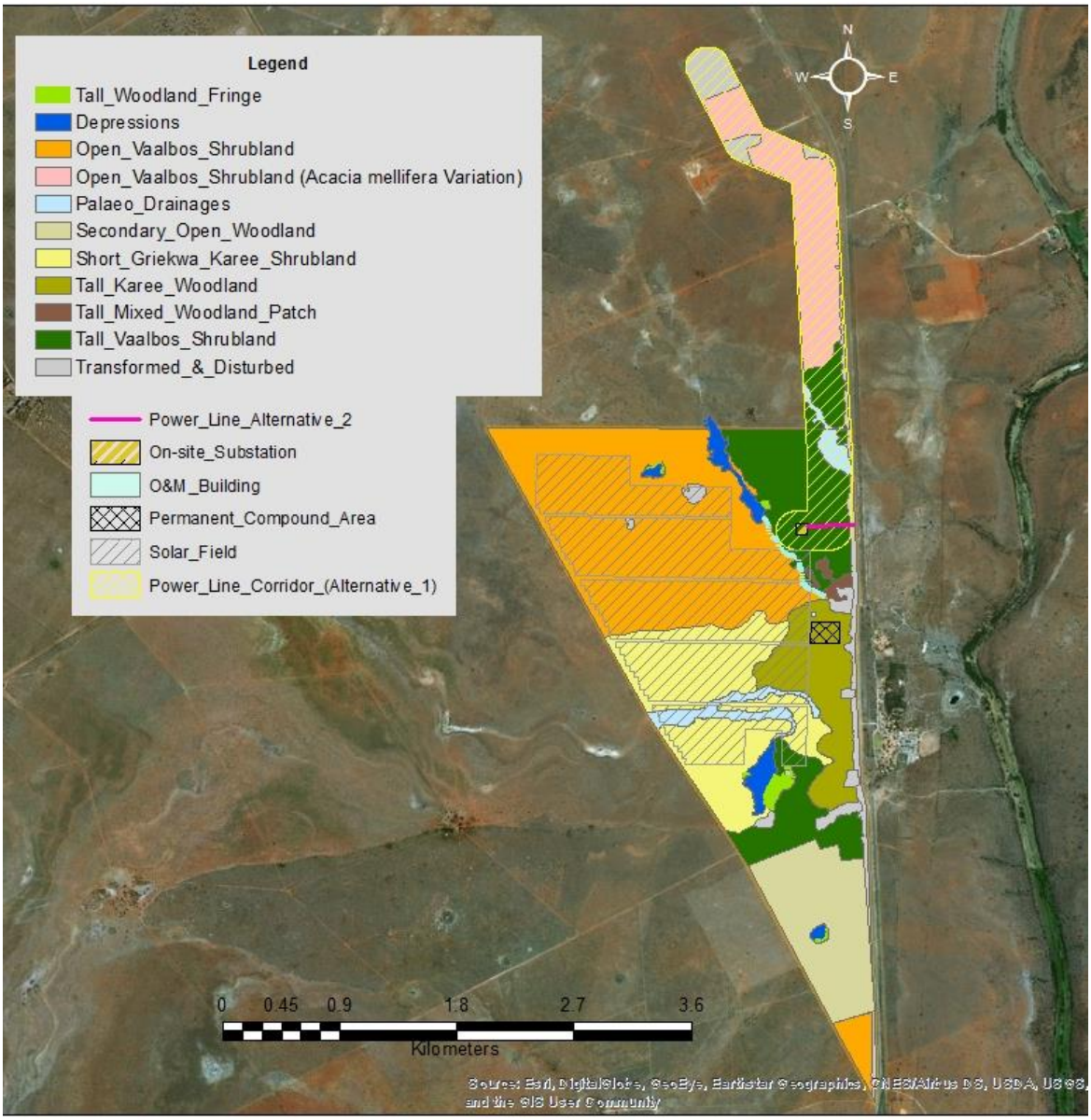

Figure 21: Habitat and feature map of the project site

5.3 Fauna Survey

Mammals

The potential diversity of mammals within the project site is high with as many as 98 terrestrial mammals potentially occurring within the area. Of the 98 mammals that have a distribution that include the project site, only 74 are known to occur in the 2724 Degree Grid with only 11 species from the 2724 QDSs (MammalMap, 2018).

Of the species that have a distribution that include the project site, 41 species are regarded as Conservation Important Species with 21 species either listed as Red

Data species or as a Protected Species within the National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004) (refer to Table 16). Due to the relatively homogenous nature of the project site as well as the high level of disturbances associated with anthropogenic activities (agricultural activities and the major roads), the diversity within the project site itself are low to moderate. Even though suitable habitat is provided for approximately 41 species (Likelihood Rating of 2) and some 25-marginal species (Likelihood: 3), the actual on-site diversity is expected to be much lower.

A number of antelope species have been recorded by the ADU (Animal Demographic Unit) within the 2724 Degree Grid. Most of these antelope species are confined by fences and occur only where farmers have introduced them or allow them to persist and should be considered as part of the farming system rather than as wildlife per se. Some of these South African indigenous antelope species do not have a natural distribution within the specific region but as mentioned have been introduced by farmers. Such antelope species include; Black Wildebeest (*Connochaetes gnou*) Blesbuck (*Damaliscus dorcas* subsp. *phillipsi*), Red Hartebeest (*Alcelaphus buselaphus*), Roan Antelope (*Hippotragus equinus*), African Buffalo (*Sycerus caffer*), Springbok (*Antidorcas marsupialis*) etcetera. Both Duiker (*Sylvicapra grimmia*) and Steenbok (*Raphicerus campestris*) are adaptable species that are able to tolerate high levels of human activity and are not likely to be highly sensitive to the disturbance associated with the development.

During the site visit the following faunal species were confirmed on site:

» Small colony of rodent burrows (most likely Pouched Mouse – *Saccostomus campestris* and/or Bushveld Gerbil – *Gerbilliscus leucogaster* and/or Four-striped Grass Mouse – *Rhabdomys pumilio*).
» Single rodent burrows (most likely Pygmy Hairy-footed Gerbil – *Gerbillurus paeba*).
» Common Mole-rat (*Cryptomys hottentotus*).
» Cape Porcupine (*Hystrix afrecaeaustralis*).
» Slender Mongoose (*Galerella sanguinea*).
» Yellow Mongoose (*Cynictis penicillata*).
» Savanna Hare (Lepus victoriae).
» Sringhare (*Pedetes capensis*).
» Relative large burrows (likely to have been made and utilized by Aardwolf – *Proteles cristatus* and/or Aardvark – *Orycteropus afer*).
» Greater Kudu (*Tragelaphus strepsiceros*).
» Steenbok (*Raphicerus campestris*).

None of these species noted are listed and/or protected species. Furthermore, most of these species are highly mobile and will move away from the construction area

and may move back during operational phase of the project. In general, the impact associated with the development on mammals can be regarded as low.

Table 16: Species listed as conservation worthy within the South African Red Data Base (Regional Red List Status, 2016), IUCN Red List (2015) and National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004); Threatened or Protected Species Regulations. Abbreviations: EN=Endangered, DD=Data Deficient, VU=Vulnerable, NT=Near Threatened, LC=Leas Concerned. Likelihood Rating: 1=Confirmed; 2=Likely; 3=Moderate; 4=Unlikely & 5= May occur as a managed population.

Scientific Name	Common Name	IUCN Status	Regional Status	TOPS (NEM:BA)	Likelihood
Rodentia (Rodents):					
Mystromys albicaudatus	White-tailed Mouse	EN	VU		2
Eulipotyphla (Shrews):					
Crocidura mariquensis	Swamp Musk Shrew	DD	NT		3
Erinaceomorpha (Hedgehog)					
Atelerix frontalis	South African Hedgehog	NT	NT	Protected	2
Philodota (Pangolins)					
Smutsia temminckii	Ground Pangolin	VU	VU	VU	3
Carnivora:					
Proteles cristatus	Aardwolf	LC	LC		2
Crocuta crocuta	Spotted Hyaena	NT	NT	Protected	4
Hyaena brunnea	Brown Hyena	NT	NT	Protected	4
Leptailurus serval	Serval	LC	NT	Protected	3
Felis nigripes	Black-footed cat	VU	VU	Protected	3
Panthera pardus	Leopard	VU	VU	Protected	4
Mellivora capensis	Honey Badger	NT	LC	Protected	3
Vulpes chama	Cape Fox	LC	LC	Protected	3
Aonyx capensis	Cape Clawless Otter	NT	NT	Protected	4
Lutra maculicolis	Spotted-necked Otter	NT	VU	Protected	4
Poecilogale albinucha	African Striped Weasel	DD	NT		3
Rumanantia & Perissodactyla (Ungulates):					
Connochaetes gnou	Black Wildebeest	LC	LC	Protected	5
Redunca fulvorufula	Mountain Reedbuck	LC	EN		5
Redunca arundinum	Southern Reedbuck	LC	LC	Protected	5
Pelea capreolus	Grey Rhebok	LC	NT		5
Chiroptera (Bats)					
Miniopterus natalensis	Natal long-fingered Bat	NT	NT		3
Rhinolophus clivosus	Geoffroy's Horseshoe Bat	LC	NT		3
Rhinolophus darlingi	Darling's Horseshoe Bat	LC	NT		2

Reptiles and Amphibians

The potential diversity of reptilian species within the greater area is moderate with as many as 71 terrestrial reptilian species potentially occurring within the area. The potential diversity of Amphibian species is on the other hand regarded as low with 21 species having distribution that include the project site. As a result of the large absence of suitable habitat, the diversity within the project site itself is regarded as low.

Of the 71 reptilian species that have a distribution that include the project site, only 26 are known to occur in the 2724 Degree Grid with only 3 species within the 2724 QDS (ReptileMap, 2018). Of the species that have a distribution that include the project site, 1 species is regarded as Conservation Important (Southern African Python – *Python natalensis*) whilst 13 species are endemic/ near endemic to South Africa. Due to the relative homogenous nature of the project site, it is expected that the diversity within the project site itself will be moderate, with an expected 29 species likely to inhabit the project site and 22 with a moderate potential to occur within the project site.

Of the 21 amphibian species that have a distribution that include the project site, only 15 are known to occur in the 2724 Degree Gird with only 2 species recorded within the 2724BA QDS (FrogMap, 2018). Of the species that have a distribution that include the project site, 1 species is regarded as Conservation Important (Giant Bullfrog – *Pyxicephalus adspersus*). The Giant Bull Frog is classified as Near Threatened within the Atlas and Red Data book of the frogs of South Africa, Lesotho and Swaziland (2004). These species prefer and breed in the shallows of temporary rain filled depressions in grassland and dry savannah.

It is expected that the diversity within the project site itself will be low, with an expected 5 species likely (Likelihood: 2) to inhabit the project site and 9 with a moderate potential (Likelihood: 3) to occur within the project site. This is mostly due to on-site and surround disturbances and habitat transformation, which include a fractured landscape, surrounding agricultural practices, the presence of large roads and other anthropogenic activities. This was confirmed during the survey with very low diversity observed within the project site.

During the survey only 8 herpetofaunal species was recorded within the projects site namely:

» Cape cobra (*Naja nivea*)
» Western Ground Agama (*Agama aculeata aculeata*)
» Speckled Rock Skink (*Trachylepis punctatissima*)
» Wahlberg's Snake-eyed Skink (*Afroablepharus wahlbergii*)
» Spotted Sandveld Lizard (*Nucras intertexta*)
» Holub's Sandveld Lizard (*Nucras holubi*)

» Savanna Lizard (*Meroles squamulosus*)
» Common Barking Gecko (*Ptenopus garrulus garrulus*)

None of these recorded species are listed as Red Data species.

Regarding the potential of Giant Bullfrog to inhabit the identified pan wetlands, these wetlands identified within the project site has a slight likelihood of containing populations of such species although the potential is reduced due to the nature and extent of the disturbances and transformations that have occurred within these wetland areas.

Table 17: Reptilian and Amphibian species listed as endemic or conservation important within the South African Red Data Base (Regional Red List Status for Reptiles, 2014 & Regional Red List Status for Amphibians, 2004), and National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004); Threatened or Protected Species Regulations (TOPS Species – Highlighted in Yellow). Abbreviations: EN=Endangered, DD=Data Deficient, VU=Vulnerable, NT=Near Threatened, LC=Leas Concerned; E=Endemic; N-E=Near Endemic. Likelihood Rating: 1=Confirmed; 2=Likely; 3=Moderate; 4=Unlikely & 5= May occur as a managed population.

Species	Common Name	Threat Status Regional	Endemism	Likelihood	ADU Database
Testudinidae					
Homopus femoralis	Greater Dwarf Tortoise	LC	E	4	
Amphisbaenidae					
Monopeltis capensis	Cape Worm Lizard	LC	N-E	3	
Cordylidae					
Karusasaurus polyzonus	Southern Karusa Lizard	LC	N-E	4	1
Scincidae					
Acontias gracilicauda	Thin-tailed Legless Skink	LC	E	2	
Agamidae					
Agama atra	Southern Rock Agama	LC	N-E	2	1
Typhlopidae					
Afrotyphlops bibronii	Bibron's Blind Snake	LC	N-E	3	
Pythonidae					
Python natalensis	Southern African Python	LC		4	
Lamprophiidae					
Lamprphis aurora	Aurora Snake	LC	E	3	
Elapidae					
Hemachatus haemachatus	Rinkhals	LC	N-E	4	

PYXICEPHALIDAE (CACOS, RIVER FROGS)					
Pyxicephalus adspersus	Giant Bullfrog	NT		2	X

5.4 Contamination risk

Due to the gradual and low slope of the project site and the nature of the development (Photovoltaic Solar technology) as well as the implementation of appropriate recommended buffers around sensitive areas, the potential for contamination of the groundwater resources as well as downstream watercourses and wetlands can be regarded as low. Accidental spills of oils and other chemicals (during construction and operation) will most likely be localised and can be contained within the spill area, where it can be adequately treated. With appropriate management and maintenance as well as other mitigation measures in place such accidental spills can be avoided.

5.5 Ecological and Surface Hydrological Sensitivity Analysis: Proposed Moeding Solar PV Facility

The relevant sensitivities of the vegetation units and ecological/ surface hydrological features as determined by this study are presented in Figure 16. Furthermore, the proposed development footprint is also indicated within Figure 22 to illustrate the location of the footprint relative to the identified sensitive features. Summaries on the sensitivity issues for every identified ecological and surface hydrological feature is presented thereafter.

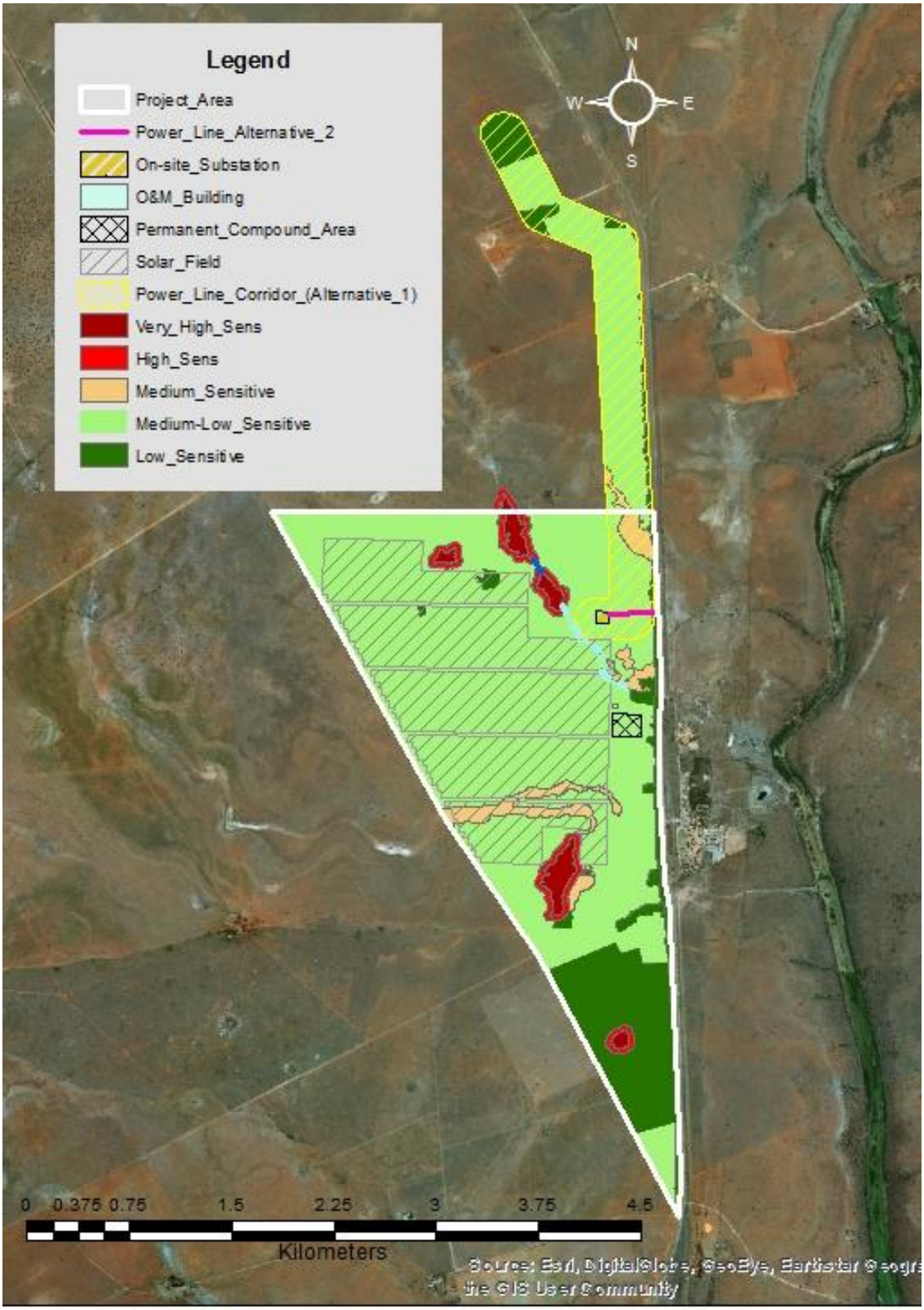

Figure 22: Ecological and Surface Hydrological Sensitivity Map

5.5.1 Very High Sensitivity: Depression "Pan" Wetland.

Conservation status	» High » Niche habitats » Some species restricted to these areas
Ecosystem function	» Corridor for faunal movement between habitat types » Seasonal preferential grazing » Niche habitat ensures persistence of organisms and provides seasonal water and food to migrating fauna. » Larger shrubs and small trees on the periphery provide (Tall Woodland Fringe) nesting space for birds and shelter/breeding areas for fauna.
Red Data Species	» Confirmed: Occasional *Acacia erioloba* (Declining) within the outer boundary of the pan wetlands (Very occasionally observed) » High Potential of Occurrence: Giant Bullfrog (*Pyxicephalus adspersus*) – Near Threatened
Protected Species	» Confirmed: *Acacia erioloba* (Declining)
Stability	» High if habitat is kept intact, despite very variable seasonal herb cover » Loss of functionality will result from clearing this vegetation and altering the surface » Easily invaded by weeds and alien invasive species » Cover may vary significantly from one year to the next » Easily degraded by excessive trampling and overgrazing
Reversibility of degradation	» The rehabilitation of the herb layer will only be possible if the existing micro topography and topsoil characteristics of this and the immediately surrounding environment is maintained
Levels of acceptable Change	» These wetlands are situated outside of the development footprint and subsequently can be maintained intact. Subsequently no change in the morphology and vegetation structure of these depressions and their associated vegetation, including the Tall Woodland periphery of these wetlands, should be allowed.
Rating	» ***Very High Sensitive & No-Go Area***

5.5.2 High Sensitivity: Depression "Pan" Wetland Buffer Zone – 35m.

Conservation status	» High » Niche habitats » Important corridor and buffer for fringing wetland and faunal species associated with pan wetlands
Ecosystem function	» Corridor for movement of faunal species between depression wetland and terrestrial habitat.

	» Food source for faunal species » Soil conservation » Stabilisation of soils » Filtering of runoff » Accumulation and slowing down of runoff; » Buffering of wetlands against potential impacts associated with the proposed development: Increase in intensity and volume of surface water (stormwater) flow resulting in sedimentation, erosion and invasion of weeds and IAPs » Larger shrubs and small trees on the periphery of wetland falling within this buffer zone provide (nesting space for birds and shelter/breeding areas for fauna.
Red Data Species	» Confirmed: Occasional *Acacia erioloba* (Declining) within the outer boundary of the pan wetlands (Very occasionally observed) » High Potential of Occurrence: Giant Bullfrog (Near Threatened) as well as other potential amphibian species tend to forage into portions of terrestrial habitat surrounding wetland habitats
Protected Species	» *Acacia erioloba* (Declining)
Stability	» High if habitat is kept intact, despite very variable seasonal herb cover » Loss of functionality will result from clearing this vegetation and altering the surface » Disturbance and transformation may expose high sensitive wetlands to impacts associated with the proposed development.
Reversibility of degradation	» The rehabilitation of the herb layer will only be possible if the existing micro topography and topsoil characteristics of this environment is maintained
Levels of acceptable Change	» These buffer areas are situated outside the development footprint and subsequently can be maintained intact. Subsequently no change in the morphology and vegetation structure of these buffer areas and their associated vegetation, should be allowed. Linear developments such as overhead power lines may be allowed within these areas although avoidance is regarded as best practice.
Rating	» ***High Sensitive & No-Go Area appart from linear infrastructure***

5.5.3 Medium Sensitivity: Tall Woodland Fringe.

Conservation status	» Medium » Natural to near-natural mostly broad-leaved Woodland, Unique isolated habitat type

Ecosystem function	» Grazing and Browsing; » Unique habitat (Variation from typical Vaalbos Savannah found in the area) » Contribution to habitat, faunal and floral diversity within the affected region » Maintenance of pollinator populations » Niche and source of food for animals » Soil conservation » Stabilisation of soils » Accumulation and slowing down of runoff » Maximising of infiltration of runoff into soils » Filtering of runoff » Corridor for movement of faunal species between depression wetland and terrestrial habitat » Some stabilizing and buffering of pan wetlands
Red Data Species	» Confirmed: Occasional *Acacia erioloba* (Declining) (Very occasionally observed) » High Potential of Occurrence: Suitable habitat for South African Hedgehog (Near Threatened)
Protected Species	» Confirmed: *Acacia erioloba* (Declining)
Stability	» Medium to high if habitat is kept intact » Clearing and monitoring of weeds and invasive species will be necessary » Loss of functionality will result from clearing this vegetation and altering the surface » Disturbance and transformation may expose high sensitive wetlands to impacts associated with the proposed development
Reversibility of degradation	» Habitat will be difficult to recreate after significant modification, rehabilitation of vegetation and ecosystem functionality after disturbance will be problematic and slow
Levels of acceptable Change	» It is recommended that these areas should be excluded from the development footprint as far as possible. » Most of these habitats are located within the recommended wetland buffer zones or outside of buffer zones but also outside the development footprint and subsequently can be maintained intact. Subsequently no change in the morphology and vegetation structure of these depressions and their associated vegetation are likely to occur.
Rating	» ***Medium Sensitive***

5.5.4 Medium Sensitivity: Tall Mixed Woodland Patch.

Conservation status	» Medium

	» Moderately disturbed Mixed (broad- and compound leaved) Woodland, Unique isolated habitat type » Especially the ground stratum (forb and graminoid) have been disturbed and transformed (trampling, overgrazing), with minor disturbance within the higher stratum (trees and shrubs)
Ecosystem function	» Grazing (limited potential) and Browsing » Unique habitat (Variation from typical Vaalbos Savanna found in the area) » Contribution to habitat, faunal and floral diversity within the affected region » Maintenance of pollinator populations » Niche and source of food for animals » Soil conservation » Stabilisation of soils » Maximising of infiltration of runoff into soils » Filtering of runoff » Corridor for movement of faunal species (Very limited)
Red Data Species	» Confirmed: No Red Data Species was confirmed » High Potential of Occurrence: Due to levels of disturbance and location to human presence there is no Red Data faunal species with a high potential to inhabit this vegetation unit
Protected Species	» No protected faunal and/ or floral species was recorded within this vegetation unit.
Stability	» Medium to high if habitat is kept intact » Clearing and monitoring of weeds and invasive species will be necessary. » Loss of functionality (habitat and niche diversity) will result from clearing this vegetation and altering the surface.
Reversibility of degradation	» Habitat will be difficult to recreate after significant modification, rehabilitation of vegetation and ecosystem functionality after disturbance will be problematic and slow
Levels of acceptable Change	» This habitat has already been impacted through trampling, overgrazing and other anthropogenic activities (some wood harvesting etc.) and is in a moderately disturbed state which has altered some of the functions provided by this habitat type. Subsequently this habitat is acceptable for the development of the PV Facility. Only a small area of this vegetation type will be included within the development footprint which is regarded as acceptable.
Rating	» ***Medium Sensitive***

5.5.5 Medium Sensitivity: Palaeo-Drainages within the project site.

Conservation status	» Medium » Create microhabitat » Higher local soil moisture content
Ecosystem function	» Vegetation as grazing and stabilisation of soils » Absorption and reduction of occasional flash floods » Maximises infiltration of runoff into soils, retention of nutrients and filtering of runoff » Creates unique habitat for flora and fauna » Potential corridor for faunal movement and migration » Unique habitat (Variation from typical Vaalbos Savanna found in the area) » Niche and source of food for animals » Soil conservation » Stabilisation of soils
Red Data Species	» Confirmed: No Red Data Species was confirmed » High Potential of Occurrence: o Giant Bullfrog (Near Threatened) may potentially utilize such palaeo channels as migration routes between pan depressions of the region. o Deeper sandy pockets may potentially be suitable habitat for White-tailed Mouse (Endangered) o Suitable habitat for African Striped Weasel (Near Threatened)
Protected Species	» Occasional populations of *Nerine laticoma*. Typically occurred in small populations of not more than 6 – 8 species per population.
Stability	» Medium to high if habitat is kept intact » Loss of functionality (habitat and niche diversity) will result from clearing this vegetation and altering the surface. » Potential erosion
Reversibility of degradation	» Limited and relatively slow and may potentially be subjected to erosion.
Levels of acceptable Change	» This habitat has already been impacted through trampling, overgrazing and is in a moderately disturbed state which has altered some of the functions provided by this habitat type. Subsequently this habitat is acceptable for the development of the PV Facility. This vegetation unit is included witin the development footprint but is however regarded as acceptable.
Rating	» ***Medium Sensitive***

5.5.6 Medium-Low Sensitivity: Short Griekwa Karee Shrubland.

Conservation status	» Medium-Low » Near-natural mixed grassland

	» Moderate species diversity
Ecosystem function	» Vegetation as grazing and stabilisation of soils » Moderate diversity adds to resilience of vegetation to drought and continued availability of resources to fauna » Maximises infiltration of runoff into soils » Prevention of soil degradation » Maintenance of pollinator populations
Red Data Species	» Confirmed: *Boophone disticha* (Declining) » High Potential of Occurrence: o Deeper sandy pockets may potentially be suitable habitat for White-tailed Mouse (Endangered) o Suitable habitat for African Striped Weasel (Near Threatened)
Protected Species	» A single population of *Nerine laticoma* was observed within the project site.
Stability	» Medium to high if habitat is kept intact » Grass layer will fluctuate during season » Low shrub layer remains relatively stable
Reversibility of degradation	» Low where specific bedrock configurations are modified excessively » Slow on rocky and gravel plains due to low moisture retention of soils
Levels of acceptable Change	» This habitat has already been impacted through trampling, overgrazing and is in a moderately disturbed state which has altered some of the functions provided by this habitat type. Subsequently this habitat is acceptable for the development of the PV Facility. This vegetation unit is included witin the development footprint but is however regarded as acceptable.
Rating	» ***Medium-Low Sensitive***

5.5.7 Medium-Low Sensitivity: Open Vaalbos Shrubland.

Conservation status	» Medium-Low » Near-natural mixed grassland » Moderate species diversity
Ecosystem function	» Vegetation for grazing and stabilisation of soils » Denser tree patches provide additional niches and habitats for other plants and faunal species » Maximises infiltration of runoff into soils, » Prevention of soil degradation » Maintenance of pollinator populations

Red Data Species	» Confirmed: *Boophone disticha* (Declining), *Acacia eroloba* (Declining) » High Potential of Occurrence: o Suitable habitat for White-tailed Mouse (Endangered) o Suitable habitat for African Striped Weasel (Near Threatened) o Suitable habitat for South African Hedgehog (Near Threatened) o Suitable habitat for Black-footed cat (Vulnerable)
Protected Species	» Frequently observed species: *Babian hypogea* » Occasionally observed species: *Ammocharis coranica*, *Aloe greatheadii* » Rarely observed: *Acacia erioloba*
Stability	» Medium to high if habitat is kept intact » Slightly higher where the vegetation is moderate to dense (woodland patches) » Low if soil surface is disturbed due to high levels of disturbance (severe overgrazing and trampling)
Reversibility of degradation	» Rehabilitation of vegetation and ecosystem functionality after disturbance will be slow but possible only with the retention of the topsoil » Re-establishment of full original biodiversity will be slow » Disturbance will most likely lead to a rapid invasion by undesirable indigenous and possibly alien invasives
Levels of acceptable Change	» This habitat has already been impacted through trampling, overgrazing and is in a moderately disturbed state which has altered some of the functions provided by this habitat type. Subsequently this habitat is acceptable for the development of the PV Facility. This vegetation unit is included witin the development footprint but is however regarded as acceptable.
Rating	» ***Medium-Low Sensitive***

5.5.8 Medium-Low Sensitivity: Tall Vaalbos Shrubland.

Conservation status	» Medium-Low » Near-natural open shrubland
Ecosystem function	» Vegetation as grazing and stabilisation of soils » Maximises infiltration of runoff into soils » Prevention of soil degradation » Maintenance of pollinator populations

Red Data Species	» Confirmed: *Acacia erioloba* (Declining) » High Potential of Occurrence: o Suitable habitat for African Striped Weasel (Near Threatened) o Suitable habitat for South African Hedgehog (Near Threatened)
Protected Species	» Rarely observed: *Acacia erioloba*
Stability	» Medium where the vegetation is moderate to dense (woodland patches) » Low if soil surface is disturbed due to high levels of disturbance (severe overgrazing and trampling)
Reversibility of degradation	» Rehabilitation of vegetation and ecosystem functionality after disturbance will be slow but possible only with the retention of the topsoil » Re-establishment of full original biodiversity will be slow » Disturbance will most likely lead to a rapid invasion by undesirable indigenous and possibly alien invasives
Levels of acceptable Change	» This habitat has already been impacted through trampling, overgrazing and is in a moderately disturbed state which has altered some of the functions provided by this habitat type. Subsequently this habitat is acceptable for the development of the PV Facility. This vegetation unit is included witin the development footprint but is however regarded as acceptable.
Rating	» ***Medium-Low Sensitive***

5.5.9 Medium-Low Sensitivity: Tall Karee Woodland.

Conservation status	» Medium-Low » Near-natural open savanna » Moderate species diversity
Ecosystem function	» Vegetation as grazing and stabilisation of soils » Denser tree patches provide additional niches and habitats for other plants and faunal species » Maximises infiltration of runoff into soils » Prevention of soil degradation » Maintenance of pollinator populations
Red Data Species	» Confirmed: *Boophone disticha* (Declining), *Acacia eroloba* (Declining) » High Potential of Occurrence: o Suitable habitat for White-tailed Mouse (Endangered) o Suitable habitat for African Striped Weasel (Near Threatened)

	○ Suitable habitat for South African Hedgehog (Near Threatened) ○ Suitable habitat for Black-footed cat (Vulnerable)
Protected Species	» Occasionally observed species: *Ammocharis coranica*, *Aloe greatheadii* » Rarely observed: *Acacia erioloba*
Stability	» Medium to high if habitat is kept intact » Slightly higher where the vegetation is moderate to dense (woodland patches) » Low if soil surface is disturbed due to high levels of disturbance (severe overgrazing and trampling)
Reversibility of degradation	» Rehabilitation of vegetation and ecosystem functionality after disturbance will be slow but possible only with the retention of the topsoil. » Re-establishment of full original biodiversity will be slow » Disturbance will most likely lead to a rapid invasion by undesirable indigenous and possibly alien invasives
Levels of acceptable Change	» This habitat has already been impacted through trampling, overgrazing and is in a moderately disturbed state which has altered some of the functions provided by this habitat type. Subsequently this habitat is acceptable for the development of the PV Facility. This vegetation unit is included witin the development footprint but is however regarded as acceptable.
Rating	» ***Medium-Low Sensitive***

5.5.10 Low Sensitivity: Secondary Open Woodland.

Conservation status	» Low » Secondary open savanna on historically cultivated areas » Moderate species diversity
Ecosystem function	» Impaired functionality especially during the dry season » Limited grazing and stabilisation of soils » Denser tree patches provide additional niches and habitats for faunal species » Maximises infiltration of runoff into soils » Maintenance of pollinator populations
Red Data Species	» Confirmed: No Red Data species was confirmed » High Potential of Occurrence: ○ Suitable habitat for African Striped Weasel (Near Threatened) ○ Suitable habitat for South African Hedgehog (Near Threatened ○ Suitable habitat for Black-footed cat (Vulnerable)

Protected Species	» Occasionally observed species: *Aloe greatheadii*
Stability	» Medium if habitat is kept intact » Slightly higher where the vegetation is moderate to dense (woodland patches) » Low if soil surface is disturbed due to high levels of disturbance (severe overgrazing and trampling)
Reversibility of degradation	» Rehabilitation of vegetation and ecosystem functionality after disturbance will be slow but possible only with the retention of the topsoil » Re-establishment of biodiversity will be slow » Disturbance will most likely lead to a rapid invasion by undesirable indigenous and possibly alien invasives
Levels of acceptable Change	» This habitat has already been severely transformed through historical ploughing and cultivation practices with the grass layer prevented from progressing along the successional gradient due to regular overgrazing and trampling. As a result this area is in a plagio-climatic state. Subsequently this habitat is acceptable for the development of the PV Facility. This vegetation unit falls just outside of the development footprint and subsequently will not be impacted by the proposed development
Rating	» ***Low Sensitive***

5.5.11 Low Sensitivity: Severely transformed and disturbed areas.

The following areas have been classified as Low Sensitive:

» Highly trampled and severely overgrazed areas;
» All areas containing infrastructure such as buildings, cattle kraals, cement dams etc.;
» The existing power line and water pipeline servitude;
» Sand and gravel quarries.

From the described sensitive areas and the location of the proposed development footprint area (according to the proposed facility layout) relative to these areas, it can be concluded that the majority of the proposed development will occur within a **Medium-Low** sensitivity area with minimal encroachment into Medium sensitive areas. The development within these Medium areas are regarded as acceptable as Moeding Solar will not have a significant impact on local biodiversity, habitat diversity (including functionality and services provided) an on conservation important faunal and floral species. Furthermore, no **Very High** and **High Sensitive** areas will be impacted by the proposed development.

Overall, it was concluded that with the necessary mitigation measures implemented this **development will have little impact on the Ecological and Surface Hydrological character of the area with minimal loss due to habitat destruction, disturbance.**

6 ASSESSMENT OF PROPOSED IMPACTS THE PROJECT SITE

6.1 Assumptions

The following is assumed and/or known:

» A thorough ecological walkthrough of all footprint areas (including the power line corridor) will be conducted to detect, and relocate where possible; all plant species of conservation concern by a suitably qualified botanist prior to commencement of construction.
  - Such investigation must be carried out at a time when the maximum amount of species is actively growing and thus visible, (preferably between January and April)

» Prior to development and after construction the development footprint will be routinely cleared of all alien invasive plants if detected.

» The construction phase itself will be associated with clearing of vegetation within the development footprint only.

» Where practically possible, the need for grading is expected to be minimal, limited mostly to contour buffer strips and/or small-scale levelling where necessary.

» All removal of vegetation for construction purposes will be done mechanically, without the use of herbicides for indigenous species and in the case of Invasive Alien Plant only were deemed absolutely necessary and with the authorisation of the ECO and/or EO.

» A continuous vegetation layer is 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.

6.2 Fixed and Tracking PV Panels

Impacts on the environment will be influenced by the types of PV panel array to be used. The most important differences that are envisaged to influence the impact on the ecological environment (Tsoutsos *et al*. 2005, Turney and Fthenakis 2011, Strohbach 2012) can be summarised as follows:

Aspect influenced	Fixed panel	Tracking panel
Size of land needed	Smaller	Larger
Shading and associated change of vegetation	More continuous and intense shading. Less stable and dense vegetation expected, reduced buffering capacity of extreme weather events by vegetation expected.	More variable and less intense overall shading. More stable and denser vegetation cover expected, smaller reduction of buffering capacity of extreme weather events expected.
Effect on runoff and accelerated erosion	Larger continuous panel area, more concentrated runoff, constant runoff edges potentially create more erosion, especially where vegetation is weakened.	Smaller continuous panel areas, runoff more dissipated, moderate variation of runoff edges that are expected to create less erosion where vegetation is weakened.
Mounting height	PV panels may be as low as 50 cm above ground to allow for higher panels, increasing the limits of permissible vegetation due to maintenance and fire risks.	Expected to be more than 1 m off the ground, increasing the possibility of low vegetation establishment and small fauna movement without compromising safety.

6.3 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 species that are rare, 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 a development be kept as close together as possible. Thus, new power lines should follow routes of existing servitudes if such exist, renewable energy facilities should be constructed as close as possible to existing infrastructure or substations, and if several developments are planned within close proximity, these developments should be situated as close together as possible, not scattered throughout the landscape.

6.4 Known and potential cumulative impacts due to nearby developments

» The property earmarked for the proposed PV is located within a REDZ area (REDZ 6: Vryburg).
» Approximately 20 solar facilities are being developed within a radius of 30 km of the proposed Moeding Solar PV Faclity (refer to Figure 22 and Table 18).
» The following facilities are located adjacent or within the project site investigated for the proposed Moeding Solar PV Facility:
    - Subsolar Rosendal (1 X PV): Within the project site;
    - Subsolar Kabi Solar Tiger Kloof (1 X PV): Within the project site;
    - Biotherm Sedawo (3 X PV): Border to the west of the project site;
    - Subsolar Protea (1 X PV): Border to the south-west of the project site;
    - Subsolar Waterloo (1 X PV): Border to the east of the project site; and
    - Subsolar Khubu (1 X PV): Border to the south-east of the project site.
» Further Solar Energy Facility planned in the immediate vicinity include:
    - Genesis Eco-Energy Woodhouse (2 X PV); and
    - Subsolar Gamma (1 X PV)
» Several more solar developments are likely to be planned throughout the Municipality, many on similar habitats.

Conclusion on cumulative impacts due to this and surrounding developments:

» Transformation of intact, sensitive habitats could compromise the ecological functioning of these habitats and may 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.
» Excessive clearing of slow growing trees such as *Acacia erioloba* could significantly impact local and regional population dynamics and microhabitats and resources associated with these species available to other fauna and flora species.

- Clearing of such trees, must be kept to the absolute minimum, and large vigorous specimens should be a priority for conservation and exclusion from development footprints.

» Excessive clearing of vegetation can and will influence runoff and stormwater flow patterns and dynamics, which could cause excessive accelerated erosion of plains, small ephemeral to larger intermittent drainage lines, wetlands, rivers and this could also have detrimental effects on the lower lying Dry Harts River.
  - Rehabilitation and revegetation of all surfaces disturbed or altered during construction is desirable.
  - Runoff from sealed surfaces or surfaces that need to be kept clear of vegetation to facilitate operation of a development needs to be monitored regularly to ensure that erosion control and stormwater management measures are adequate to prevent the degradation of the surrounding environment.

» Large-scale disturbance of indigenous vegetation creates a major opportunity for the establishment of invasive species and the uncontrolled spread of alien invasives into adjacent agricultural land and rangelands.
  - A regular monitoring and eradication protocol must be part of all developments long term management plans.

» The loss of and transformation of intact habitats could compromise the status and ecological functioning of the Ecological Support Areas and may fracture and disrupt the connectivity of these ESAs, impacting the Province's ability to meet its conservation targets.

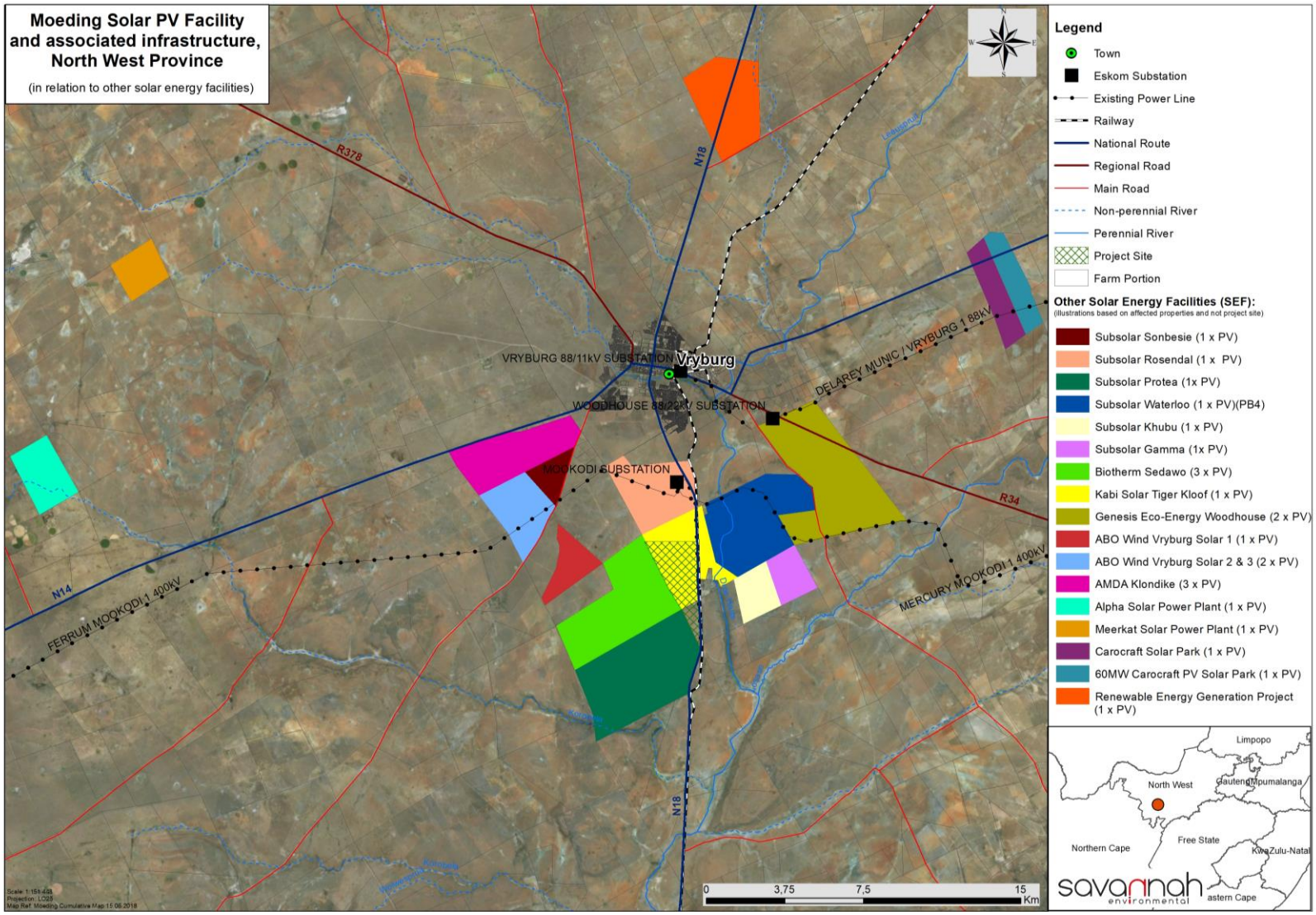

Figure 23: Location Map of the proposed Moeding Solar PV Facility relative to the other Solar facilities planned within a radius of 30 km (Map provided by Savannah Environmental Pty (Ltd)).

Table 18: Table listing the Solar Projects located within a 30 km radius from the proposed Moeding Solar PV Facility

Project Name	Location	Approximate distance from the project site	Project Status
Sonbesie Solar Power Plant	Remaining Extent of the farm Retreat 671	6,2km north west of the site	Authorised
Sediba Solar Energy Facility (Rosendal)	Remaining Extent of the Farm Rosendal 673	Located within the project site	Authorised
Protea Solar Power Plant	Remaining Extent of the farm Hartsboom 734	Located adjacent (west)	Authorised
Waterloo Solar Park	Remaining Extent of Farm Waterloo 992	Located adjacent (east)	Authorisation granted (Preferred Bidder Round 4)
Khubu Solar Power Plant	Portion 5 of Championskloof 731	Located adjacent (south east)	Authorised
Gamma Solar Power Plant	Portion 4 Championskloof	5,9km east of the site	Authorised
Sendawo PV 1 Facility	Portion 1 of Edinburgh 735	Located adjacent (west)	Authorised
Sendawo PV 2 Facility	Portion 1 of Edinburgh 735	Located adjacent (west)	Authorised
Sendawo PV 3 Facility	Portion 1 of Edinburgh 735	Located adjacent (west)	Authorised
Tiger Kloof Solar Energy Facility	Remaining Extent of Portion 3 and Portion 4 of the Farm Waterloo 730	Located within the project site	Authorised
Woodhouse Solar 1 PV Facility	Remaining Extent of the Farm Woodhouse 729	8km east of the site	Authorised
Woodhouse Solar 2 PV Facility	Remaining Extent of the Farm Woodhouse 729	8km east of the site	Authorised
Alpha Solar Power Plant	Remaining Extent of farm Middelpan 605	30km west of the site	Authorised
Klondike PV1 Facility	Remaining Extent of the Farm Klondike 670	8,5km north west of the site	Authorised
Klondike PV2 Facility	Remaining Extent of the Farm Klondike 670	8,5km north west of the site	Authorised
Klondike PV3 Facility	Remaining Extent of the Farm Klondike 670	8,5km north west of the site	Authorised
Meerkat Solar Power Plant	Portion 3 of Vyflings Pan 598	28,5km west of the site	Authorised
Carocraft Solar Park	Remaining Extent of Farm Weltevrede 681	19km north east of the site	Authorised
60MW Carocraft PV Solar Park	Remaining Extent of Farm Weltevrede 681	19km north east of the site	Authorised
Vryburg Solar 1	Portion 2 of Farm Frankfort 672	5km west of the site	Authorised

Vryburg Solar 2	Portion 1 of Farm Retreat 671	7.7km north west of the site	Authorised
Vryburg Solar 3	Portion 1 of Farm Retreat 671	8.3km north west of the site	Authorised
Renewable Energy Generation Project	Remaining Extent of Farm Weltevrede 681	22.5km north of the affected properties	Authorised

6.5 Identification of Potential Ecological Impacts and Associated Activities

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

» 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 purpose.

Construction Phase

» Site clearing and exploration activities for site establishment.
» Vegetation clearing could impact 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 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, wetlands and aquatic habitats, mainly due to an increase of surface water and silt inflow from the surrounding disturbed areas. These potential impacts may result in a reduction in the buffering capacities of the landscape during extreme weather events.
» Movement of construction vehicles and placement of infrastructure within the boundary of the drainage line may lead to the disturbance of these habitats, removal of vegetation cover and a potential increase in erosion which may eventually spread into downstream areas.
» 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. In addition, 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.

» Presence and operation of construction machinery on the project site. This will create a physical impact as well as generate noise, potential pollution and other forms of disturbance at the site.

» Increased human presence can lead to poaching, illegal plant harvesting and other forms of disturbance such as fire.

Operation Phase

» The facility 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.

6.6 Identification of Potential Ecological Impacts and Associated Activities

Construction and operation may lead to potential indirect loss of / or damage to wetlands and drainage lines. This may potentially lead to localised loss of wetland habitat and may lead to downstream impacts that affect a greater extent of wetlands or impact on wetland function and biodiversity. Where these habitats are already stressed due to degradation and transformation, the loss may lead to increased vulnerability (susceptibility to future damage) of the habitat. Physical alteration to wetlands can have an impact on the functioning of those wetlands. Consequences may include:

- increased loss of soil;
- loss of/or disturbance to indigenous wetland vegetation;
- loss of sensitive wetland habitats;
- loss or disturbance to individuals of rare, endangered, endemic and/or protected species that occur in wetlands;
- fragmentation of sensitive habitats;
- impairment of wetland function;
- change in channel morphology in downstream wetlands, potentially leading to further loss of wetland vegetation; and
- reduction in water quality in wetlands downstream.

6.7 Assessment of Impacts

The impacts identified above are assessed below, during the construction and operation phases of the facility as well as before and after mitigation.

6.7.1 For the SOLAR PV FACILITY (Entire project site including the development footprint)

Construction Phase

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

Impact Nature: There are a number of listed and protected species present at the site and it is highly likely that some of these would be impacted by the development. Vegetation clearing during construction will lead to the loss of currently intact habitat within the development footprint and is an inevitable consequence of the development. As this impact is certain to occur it is assessed for the construction phase as this is when clearing will take place.		
	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	Minor (3)
Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (44)**	**Low (24)**
Status	Negative	Negative
Reversibility	Low	Moderate
Irreplaceable loss of resources	Highly Probable	Moderate Probability
Can impacts be mitigated?	Reasonably but with limited full restoration potential.	
Mitigation	» Pre-construction walk-through of the final development footprint, by a suitably qualified botanist, for species of conservation concern that would be affected and that can be translocated. » Since a large proportion of the identified conservation-worthy species at the site are geophytic and succulent species (e.g. *Aloe greatheadii, Nerine laticoma, Babiana hypogea* and *Boophone disticha*), the potential for successful translocation is high. Before construction commences individuals of listed species within the development footprint that would be affected, should be counted and marked and translocated where deemed necessary by the ecologist conducting the pre-construction walk-through survey, and according to the recommended ratios. Permits from the relevant provincial authorities, i.e. the North West Department of Rural, Environment and Agricultural Development (READ), will be required to relocate and/or disturb listed plant species. » Any individuals of protected species affected by and observed within the development footprint during	

	construction should be translocated under the supervision of the ECO and/or Contractor's Environmental Officer (EO). » Pre-construction environmental induction for all construction staff on site must be provided to ensure that basic environmental principles are adhered to. This includes awareness of no littering, appropriate handling of pollution and chemical spills, avoiding fire hazards, minimising wildlife interactions, 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. » ECO and/or Contractor's EO must 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 on demarcated roads 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 plants may be translocated or otherwise uprooted or disturbed for rehabilitation or other purpose without express permission from the ECO and or Contractor's EO, and without the relevant permits. » No fires must be allowed on-site.
Residual Impacts	Some loss of vegetation is inevitable and cannot be avoided.

Construction Impact 2 (Ecology). *Potential Faunal Impacts.*

Impact Nature: Increased levels of noise, pollution, disturbance and human presence during construction will be detrimental to fauna. Sensitive and shy fauna would move away from the area during the construction phase as a result of the noise and human activities present, while some slow-moving species would not be able to avoid the construction activities and might be killed. Some impact on fauna is highly likely to occur during construction. Disturbance could have a negative impact on the breeding activities of various species, particularly if this occurs during a sensitive period in the breeding cycle. Species of

concern are predominantly Kori Bustards. Other small avian species do occur within the development footprint but these species are non-Red Data species.

The proposed site is located within an agricultural habitat close to National and Domestic roads. Therefore, species within this landscape often experience disturbance. As a result, disturbance of birds by the proposed power line construction activities is anticipated to be of low significance as birds will move away from the area temporarily. The relatively small scale of the development (in relation to the large agricultural landscape in the region) is unlikely to have a significant impact on avifauna. However, species are particularly sensitive to disturbance during the breeding season and this must be borne in mind during the construction phase.

	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Short-term (2)	Short-term (2)
Magnitude	Moderate (7)	Minor (3)
Probability	Probable (3)	Probable (3)
Significance	**Medium (30)**	**Low (18)**
Status	Negative	Negative
Reversibility	Moderate	Moderate
Irreplaceable loss of resources	Moderate Probability	Low Probability
Can impacts be mitigated?	Noise and disturbance during the construction phase 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	» Any fauna directly threatened by the construction activities should be removed to a safe location by the ECO or other suitably qualified person, e.g. the Contractor's EO. » All personnel must undergo environmental induction with regards to fauna and in particular awareness about not harming or collecting species such as snakes, tortoises and owls which are often persecuted out of superstition. » All hazardous materials used during construction 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 is recommended) to avoid collisions with susceptible species such as snakes and tortoises.	

	» When possible, no activity should be undertaken at the site between sunset and sunrise, except for security personnel guarding the development. » Any dangerous fauna (snakes, scorpions etc.) that are encountered during construction should not be handled or antagonised by the construction staff and the ECO or other suitably qualified person(s), e.g. the Contractor's EO, should be contacted to remove the animals to safety. » No litter, food or other foreign material must be thrown or left around the site and must be placed in demarcated and fenced rubbish and litter areas that are animal proof. » The collection, hunting or harvesting of any plants or animals at the site must be strictly forbidden. Personnel must not be allowed to wander off the demarcated construction site. » Fires must not be allowed on site.
Residual Impacts	The altered development area will contain a lower diversity of habitat types and niches for faunal species. Faunal diversity is relatively low and subsequently the residual impact will **not be significant**

Construction Impact 3 (Ecology): *Potential increased erosion risk during construction*

Impact Nature: During construction, 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 (2)	Local (1)
Duration	Long-term (4)	Short-term (1)
Magnitude	Moderate (6)	Minor (2)
Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (48)**	**Low (12)**
Status	Negative	Negative
Reversibility	Low – if erosion has reached severe levels the impacts will not be remedied easily	High
Irreplaceable loss of resources	Moderate Probability	Low Probability
Can impacts be mitigated?	Yes, to a large extent	

Mitigation	» Any erosion problems within the development area as a result of the construction activities observed should be rectified immediately and monitored thereafter to ensure that they do not re-occur. » All bare areas resulting fromthe development, should be re-vegetated with locally occurring species, to bind the soil and limit erosion potential. » Roads and other disturbed areas within the development area should be regularly monitored for erosion problems and problem areas should receive follow-up monitoring to assess the success of the remediation. » Silt traps should be used where there is a danger of topsoil or material stockpiles eroding and entering watercourses and other sensitive areas. » Topsoil should be removed from construction areas and stored separately from subsoil. Topsoil should be reapplied where appropriate as soon as possible in order to encourage and facilitate rapid regeneration of the natural vegetation on cleared areas. » Practical phased development and vegetation clearing should be practiced so that cleared areas are not left un-vegetated and vulnerable to erosion for extended periods of time. » Construction of gabions and other stabilisation features must be undertaken to prevent erosion, where deemed necessary. » Activity at the site must be reduced after large rainfall events when the soils are wet. No driving off of hardened roads should occur at any time and particularly immediately following large rainfall events.
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**.

Construction Impact 4 (Surface Hydrology): *Potential loss of wetland vegetation*

All pans (including buffer areas) and drainage lines are located outside of the development footprint and wetland vegetation will not be directly impacted. Vegetation may however be impacted indirectly due to erosion structures (as a result of increase surface runoff – Volume and Velocity) forming within the construction area. Subsequently this impact of wetland vegetation disturbance will be dealt with during the discussion of the potential impacts associated with an increase in sedimentation and erosion

Construction Impact 5 (Surface Hydrology): *Impact on "pan" wetlands through the possible increase in surface water runoff during the Construction Phase*

Impact Nature: For the wetlands, the primary threat related to PV developments during the construction phase, is increased run-off, sediment inputs, as well as turbidity. This is during vegetation clearing for the PV arrays and excavation of pits for the foundations of the individual PV panels. An increase in volume and velocity of surface water flow from the cleared construction areas into the wetlands, may result in the loss of natural wetland vegetation and formation of erosion gullies.

The likelihood of these impacts occurring are however relative low due to the geographical location of the proposed development footprint (within a relative low lying flat to slightly sloping landscape). The potential risk and significance of this impact will furthermore be significantly reduced through the implementation and maintenance of the recommended buffer areas. The potential for these impacts to occur can also furthermore be eluded with diligent and effective mitigation measures in place

	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Short-term (1)
Magnitude	Moderate (6)	Minor (2)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (33)**	**Low (8)**
Status	Negative	Negative
Reversibility	Low – if erosion has reached severe levels the impacts will not be remedied easily.	High
Irreplaceable loss of resources	Moderate Probability	Low Probability
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	» No activities may be allowed outside of the development area, and especially within the identified wetland areas. These areas are regarded as no-go areas. As all identified wetlands are located outside of the development footprint, the most likely potential impacts on the wetlands will be of an indirect nature and as such the following mitigations measures, although not directly associated with the wetlands, are recommended: » Any areas disturbed during the construction phase should be encouraged to rehabilitate as fast and effective as possible and were deemed necessary by the ECO or Contractor's EO, artificial rehabilitation (e.g. re-	

	seeding with collected or commercial indigenous seed mixes) should be applied in order to speed up the rehabilitation process in critical areas (e.g. steep slopes and unstable soils). » No unnecessary vegetation clearance may be allowed and vegetation should be allowed to persist under and around the PV panels once operational. » Apart from the specified linear activities that are allowed, no other activities and infrastructure may be allowed or placed within the recommended wetland buffer areas whose natural vegetation cover should be maintained.
Residual Impacts	By avoiding the identified wetland areas and recommended buffer zones residual impacts are **unlikely to be present**.

Construction Impact 5 (Surface Hydrology): *Increase sedimentation and erosion during the Construction Phase*

Impact Nature: For the wetlands, the primary threat related to PV developments during the construction phase, is increased run-off, sediment inputs, as well as turbidity. This is during vegetation clearing for the PV arrays and excavation of pits for the foundations of the individual PV panels. An increase in volume and velocity of surface water flow from the cleared construction areas into the wetlands, may result in erosion and an increase in sediment inputs into the pan wetlands in the vicinity of the development area.

The likelihood of these impacts occurring are however relatively low due to the geographical location of the proposed development footprint (within a relative low lying flat to slightly sloping landscape). The potential risk and significance of this impact will furthermore be significantly reduced through the implementation and maintenance of the recommended buffer areas. The potential for these impacts to occur can also furthermore be eluded with diligent and effective mitigation measures in place.

	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Short-term (1)
Magnitude	Moderate (6)	Minor (2)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (33)**	**Low (8)**
Status	Negative	Negative
Reversibility	Low – if erosion has reached severe levels the impacts will not be remedied easily.	High
Irreplaceable loss of resources	Moderate Probability	Low Probability

Can impacts be mitigated?	Yes, to a large extent
Mitigation	As all identified wetlands are located outside of the development footprint, most potential impacts on the wetlands will be of an indirect nature and as such the following mitigation measures, although not directly associated with the wetlands, are recommended in order to avoid the encroachment of erosion into these habitats or a reduction in water quality due to an increase in sedimentation into these systems: » Any erosion problems observed as a result of the development 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. » Roads used for project-related activities 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. » Silt traps must be used where there is a danger of topsoil or material stockpiles eroding and entering streams and other sensitive areas. » Topsoil must be removed and stored separately and should be reapplied where appropriate as soon as possible in order to encourage and facilitate 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 of time. » Construction of gabions and other stabilisation features on steep slopes to prevent erosion, if deemed necessary. » Activity at the site must be reduced after large rainfall events when the soils are wet. No driving off of hardened roads should occur at any time, and particularly immediately following large rainfall events. » Apart from the specified linear activities that are allowed, no other activities and infrastructure may be allowed or placed within the recommended wetland buffer areas whose natural vegetation cover should be maintained.

Residual Impacts	By avoiding the identified wetland areas and recommended buffer zones residual impacts are **unlikely to be present**.

Construction Impact 6 (Surface Hydrology): *Potential impact on localised surface water quality*

Impact Nature: During the construction phase, chemical pollutants (hydrocarbons from equipment and vehicles), cleaning fluids, cement and contaminated water could be washed downslope into these pan wetlands and eventually affect water quality.

The likelihood of this impact occurring is however relatively low due to the geographical location of the proposed development footprint (within a relative low lying flat to slightly sloping landscape). The potential risk and significance of this impact will furthermore be significantly reduced through the implementation and maintenance of the recommended buffer areas. The potential for these impacts to occur can also furthermore be eluded with diligent and effective mitigation measures in place.

	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Short-term (1)
Magnitude	High (8)	Moderate (6)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (39)**	**Low (16)**
Status	Negative	Negative
Reversibility	Low – if erosion has reached severe levels the impacts will not be remedied easily.	High
Irreplaceable loss of resources	Moderate Probability	Low Probability
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	» Strict use and management of all hazardous materials used on site must be implemented. » Strict management of potential sources of pollutants (e.g. litter, hydrocarbons from vehicles and machinery, cement during construction etc.). » Containment of all contaminated water by means of careful run-off management on the development area must be undertaken. » Infrastructure may not be placed within the recommended buffer areas whose natural vegetation cover should be maintained in a natural condition. » Due to the low gradient of most of the development footprint any accidental spill or leakage of hazardous or	

	harmful substances can be effectively contained around the source of the spillage. In the case of such an accidental spillage, prompt and effective action is required in order to prevent the spillage form spreading and to successfully rehabilitate the contaminated area.
Residual Impacts	By avoiding the identified wetland areas and recommended buffer zones residual impacts are **unlikely to be present**.

Operation Phase

Operation Impact 1 (Ecology): *Potential increased alien plant invasion during operation*

Impact Nature: Increased alien plant invasion is one of the greatest risk factors associated with this development. 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 during the operation phase 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 - Regional (3)	Local (1)
Duration	Permanent (5)	Short-term (1)
Magnitude	Moderate (6)	Low (4)
Probability	Highly Probable (4)	Highly Probable (4)
Significance	**Moderate (56)**	**Low (24)**
Status	Negative	Negative
Reversibility	Low	Moderate
Irreplaceable loss of resources	Highly Probable	Moderate Probability
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	» Regular monitoring for alien plants at the site should occur and could be conducted simultaneously with erosion monitoring. » When alien plants are detected, these should 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 should aim to keep disturbance to a minimum and must be undertaken in accordance with relevant guidelines.	

	» No planting or importing of any alien species to the site for landscaping, rehabilitation or any other purpose should be allowed.
Residual Impacts	With appropriate mitigation such as regular monitoring and eradication residual impacts will be very low will likely comprise of few alien plants establishing for short periods of time between monitoring and eradication phases.

Operation Impact 2 (Ecology): *Altered runoff patterns due to rainfall interception by PV panel infrastructure and compacted areas resulting in high levels of erosion*

Impact Nature: Disturbance created during construction could take several years to fully stabilise and the presence of hardened surface 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 (2)	Local (1)
Duration	Long-term (4)	Short-term (1)
Magnitude	Moderate (7)	Minor (2)
Probability	Highly Probable (4)	Probable (3)
Significance	**Medium (52)**	**Low (12)**
Status	Negative	Neutral – Slightly Negative
Reversibility	Low – if erosion has reached severe levels the impacts will not be remedied easily.	High
Irreplaceable loss of resources	Potential loss of important resources.	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 (monitoring and inspections done by the Operations and Management Team). » Shading from PV panels may prevent or slow down the re-establishment of some desirable vegetation species, therefore re-establishment should be monitored and species composition adapted if vegetation fails to establish sufficiently. » Alternatively, soil surfaces where no re-vegetation 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 large runoff surfaces of the PV panels, the development area should be adequately landscaped and rehabilitated to contain expected accelerated erosion. » Runoff may have to be specifically channeled or storm water adequately controlled to prevent localised rill and gully erosion. » Any erosion problems observed within the development site should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur. » Roads and other disturbed areas within the development site 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 themselves with a good vegetation cover. With appropriate avoidance and mitigation residual impacts will be **very low**.

Operation Impact 3 (Surface Hydrology): *Altered runoff patterns due to rainfall interception by PV panel infrastructure and compacted areas resulting in high levels of erosion, sedimentation and turbidity within the lower lying "pan" wetland areas.*

Impact Nature:
Disturbance created during construction could take several years to fully stabilise and the presence of hardened surface (roads) will generate a large amount of runoff which will pose a significant erosion risk, if not managed. For wetlands, the primary threat related to PV developments during the operation phase, is such increased run-off, erosion, sediment inputs, as well as turbidity.

The likelihood of these impacts occurring are however relatively low due to the geographical location of the proposed development footprint (within a relative low lying flat to slightly sloping landscape). The potential risk and significance of this impact will furthermore be significantly reduced through the implementation and maintenance of the recommended buffer areas. The potential for these impacts to occur can also furthermore be eluded with diligent and effective mitigation measures in place.

	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)

Duration	Permanent (5)	Short-term (1)
Magnitude	Moderate (6)	Small (0)
Probability	Improbable (2)	Very improbable (1)
Significance	**Low (24)**	**Low (2)**
Status	Negative	Neutral – Slightly Negative
Reversibility	Low	High
Irreplaceable loss of resources	Potential loss of important resources due to the replacement of natural vegetation by invading alien plants.	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 (monitoring and inspections done by the Operations and Management Team). » All mitigation measures pertaining to erosion should be strictly adhered to and promptly executed, which include regular monitoring. » Due to the low gradient of most of the development area any accidental spill or leakage of hazardous or harmful substances can be effectively contained around the source of the spillage and in the case of such an accidental spillage prompt and effective action is required in order to prevent the spillage from spreading and to successfully rehabilitate the contaminated area.	
Residual Impacts	» By avoiding the identified wetland areas and recommended buffer zones residual impacts are **unlikely to be present**.	

Cumulative Impacts

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.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects within the area**
Extent	Local (1)	Regional (3)

Duration	Long Term (4)	Long-Term (4)
Magnitude	Small (1)	Low (4)
Probability	Improbable (2)	Probable (3)
Significance	**Low (12)**	**Medium (33)**
Status	Neutral – Slightly Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources	No	Likely
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	» The development footprints of various facilities in the area must be kept to a minimum and natural vegetation should be encouraged to return to disturbed areas following completion of construction. » An open space management plan should be developed for each individual development which must include management of biodiversity within the fenced area.. » Reduce the footprint of facilities within sensitive habitat types as much as possible.	

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

Impact Nature: Transformation of intact habitat could potentially compromise ecological processes of ESAs as well as ecological functioning of important habitats and would contribute to the fragmentation of the landscape and would potentially disrupt the connectivity of the landscape for fauna and flora and impair their ability to respond to environmental fluctuations.		
	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 (1)	Low (4)
Probability	Improbable (2)	Improbable (2)
Significance	**Low (12)**	**Low (20)**
Status	Neutral – Slightly Negative	Slightly Negative
Reversibility	Low	Low
Irreplaceable loss of resources	No	Likely
Can impacts be mitigated?	Yes, to a large extent	

Mitigation	» The development footprints of the individual facilities should be kept to a minimum and natural vegetation should be encouraged to return to disturbed areas following the completion of construction. » An open space management plan should be developed for the individual developments, which should include management of biodiversity within the fenced area. » Reduce the footprints of the facilities within sensitive habitat types as much as possible.

Cumulative Impact 3: *Cumulative impacts due to nearby renewable energy developments - Large-scale disturbance of indigenous vegetation*

Impact Nature: Cumulative loss of habitats (including sensitive habitats) and further increase in the fractured nature of the landscape may lead to the loss of features responsible for maintaining biodiversity and providing ecosystem goods and services and may potentially lead to;

» A change in the status of the affected vegetation type, subsequently also reducing the ability to meet national conservation obligations and targets;
» A reduction in biodiversity and even the loss of some species from the area;
» Fracturing and isolation of landscapes may cut off important migration routes and prevent genetic variability thus reducing "genetic health" which may in turn lead to weaker species incapable to adapt and react to potential environmental changes and consequently also to a reduction in biodiversity and the extinction of some species from certain areas;
» Large-scale disturbance of indigenous vegetation creates a major opportunity for the establishment of invasive species and the uncontrolled spread of alien invasives into adjacent agricultural land and rangelands.

	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	Minor (2)	Moderate (6)
Probability	Very Improbable (1)	Probable (3)
Significance	**Low (7)**	**Medium (36)**
Status	Neutral	Slightly Negative
Reversibility	Low	Low
Irreplaceable loss of resources	No	Moderate Probability
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	» The development footprints of the individual facilities must be kept to a minimum and natural vegetation should be encouraged to return to disturbed areas	

	following the completion of construction. This must be undertaken by each respective applicant. » An open space management plan should be developed for the individual developments by each respective applicant, which should include management of biodiversity within the fenced area.. » Reduce the footprint of the facilities within sensitive habitat types as far as possible. This must be undertaken by each respective applicant.

Cumulative Impact 4: *Cumulative impacts due to nearby renewable energy developments – Influence on runoff and stormwater flow patterns and dynamics (Due to e*xcessive clearing of vegetation)

Impact Nature:

The interception of rain by the impervious surface of the solar panels produces an "umbrella effect" that delineates a sheltered area. By contrast, its contour receives the collected fluxes, whose intensity or amounts may locally exceed those of the control conditions, depending on the dimensions, height and tilting angle of the panels as well as on wind velocity and direction.

» Cummulatively this alteration could cause excessive accelerated erosion of plains, lower lying small ephemeral to larger intermittent drainage lines, wetlands and river systems and this may ultimately have an effect on the lower lying Dry Harts River

	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects within the area**
Extent	Local (1)	Regional (3)
Duration	Long Term (4)	Long Term (4)
Magnitude	Small (1)	High (7)
Probability	Very Improbable (1)	Improbable (2)
Significance	**Low (6)**	**Low (28)**
Status	Neutral	Negative
Reversibility	Low	Low
Irreplaceable loss of resources	No	Moderate Probability
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	» The development footprints of the individual developments must be kept to a minimum and natural vegetation should be encouraged to return to disturbed areas following the completion of construction. This must be undertaken by each respective applicant.	

	» An open space management plan must be developed for the individual developments by each respective applicant, which should include management of biodiversity within the fenced area. The following on-site mitigation measures are recommended throughout the operational phase in order to minimize the contribution of this development to the described impact: » 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. » The higher level of shading anticipated from PV panels may prevent or slow down the re-establishment of some desirable species, therefore re-establishment should be monitored and species composition adapted if vegetation fails to establish sufficiently. » 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 of the PV panels, the development area should be adequately landscaped and rehabilitated to contain expected accelerated erosion. » Runoff may have to be specifically channeled or storm water adequately controlled to prevent localised rill and gully erosion. » Any erosion problems observed as a result of the project 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.

6.7.2 For the Overhead Power Line

Construction Phase

Construction Impact 1: *Potential Impacts on vegetation and listed protected plant species.*

Impact Nature: There are only a few listed and protected species present at the project site and within the power line corridor and it is highly likely that some of these would be impacted by the development. Vegetation clearing during construction will lead to the loss of currently intact habitat within the development footprint and is an inevitable consequence of the development. As this impact is certain to occur it is assessed for the construction phase as this is when clearing will take place.

	Power Line Alternative 1		**Power Line Alternative 2**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Extent	Local (1)	Local (1)	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Minor (2)	Small (1)	Small (0)
Probability	Probable (3)	Probable (3)	Probable (3)	Probable (3)
Significance	**Low (27)**	**Low (21)**	**Low (18)**	**Low (15)**
Status	Negative	Negative	Negative	Slightly Negative
Reversibility	Moderate	High	Moderate	High
Irreplaceable loss of resources	Limited loss of resources	Very limited loss of resources	Very limited loss of resources	Unlikely
Can impacts be mitigated?	Yes, to a large extent		Yes, to a large extent	
Mitigation	» Pre-construction walk-through of the final power line alignment for species of conservation concern that would be affected and that can be translocated. » Since a large proportion of the identified conservation-worthy species at the site are geophytic and succulent species (e.g. *Aloe greatheadii, Babiana hypogea* and *Boophone disticha*), the potential for successful translocation is high. Before construction commences individuals of listed species within the development footprint that would be affected, should be counted and marked and translocated where deemed necessary by the ecologist conducting the pre-construction walk-through survey, and according to the recommended ratios. Permits from the relevant provincial authorities, i.e. the North West Department of Rural, Environment and Agricultural Development (READ), will be required to relocate and/or disturb listed plant species. » Any individuals of protected species affected by and observed within the development footprint (including the power line corridor) during construction should be translocated under the supervision of the ECO and/or Contractor's Environmental Officer (EO). » Pre-construction environmental induction for all construction staff on site to ensure that basic environmental principles are adhered to. This includes awareness to no littering, appropriate handling of pollution and			

	chemical spills, avoiding fire hazards, minimising wildlife interactions, 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. » ECO and/or 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 on demarcated roads and no unnecessary driving in the veld outside these areas should be allowed. » Regular dust suppression during construction, if deemed necessary, must be undertaken in exposed areas, especially along access roads. » No plants may be translocated or otherwise uprooted or disturbed for rehabilitation or other purpose without express permission from the ECO and or Contractor's EO. • No fires should be allowed on-site.
Cumulative Impacts	Cumulative impacts on vegetation and conservation important species and populations are likely to be very low given the limited footprint area and the fact that power line will be located within a habitat type (vegetation type) which has an extensive and largely uniform distribution.
Residual Impacts	Some loss of vegetation is inevitable and cannot be avoided.

Construction Impact 2: *Faunal Impacts due to construction activities.*

Impact Nature Increased levels of noise, pollution, disturbance and human presence during construction will be detrimental to fauna. Sensitive and shy fauna would move away from the area during the construction phase as a result of the noise and human activities present, while some slow-moving species would not be able to avoid the construction activities and might be killed. Some impact on fauna is highly likely to occur during construction.

Disturbance could have a negative impact on the breeding activities of various species, particularly if this occurs during a sensitive period in the breeding cycle.

Species of concern are predominantly Kori Bustards. Other small avian species do occur within the development footprint but these species are non-Red Data species.

The proposed site is located within an agricultural habitat close to National and Domestic roads. Therefore, species within this landscape often experience disturbance. As a result, disturbance of birds by the proposed power line construction activities is anticipated to be of low significance as birds will move away from the area temporarily. The relatively small scale of the development (in relation to the large agricultural landscape in the region) is unlikely to have a significant impact on avifauna. However, species are particularly sensitive to disturbance during the breeding season and this must be borne in mind during the construction phase.

	Power Line Alternative 1		Power Line Alternative 2	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Extent	Local (1)	Local (1)	Local (1)	Local (1)
Duration	Medium-term (3)	Short-term (2)	Medium-term (3)	Short-term (2)
Magnitude	Low (4)	Minor (2)	Minor (2)	Small (1)
Probability	Probable (3)	Probable (3)	Probable (3)	Probable (3)
Significance	**Low (24)**	**Low (15)**	**Low (18)**	**Low (12)**
Status	Negative	Slightly Negative	Slightly Negative	Slightly Negative
Reversibility	Medium	High	High	High
Irreplaceable loss of resources	Slight loss of resources	Unlikely	Very slight loss of resources	Unlikely
Can impacts be mitigated?	Yes, to a large extent			
Mitigation	» Site access should be controlled and no unauthorised persons should be allowed onto the site. » Any fauna directly threatened by the construction activities should be removed to a safe location by the ECO or other 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 construction 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	Residual impacts would be very low with a very slight loss of natural habitat for faunal species.			

Construction Impact 3: *Potential increased erosion risk during construction.*

Impact Nature During construction, there will be disturbed and loose soil at the site which will render the area vulnerable to erosion.				
	Power Line Alternative 1		**Power Line Alternative 2**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**

Extent	Local (1)	Local (1)	Local (1)	Local (1)
Duration	Medium-term (3)	Short-term (2)	Medium-term (3)	Short-term (2)
Magnitude	Low (4)	Minor (2)	Minor (2)	Small (0)
Probability	Probable (3)	Probable (3)	Probable (3)	Probable (3)
Significance	**Low (24)**	**Low (15)**	**Low (18)**	**Low (9)**
Status	Negative	Slightly Negative	Negative	Slightly Negative
Reversibility	Medium	High	High	High
Irreplaceable loss of resources	Slight loss of resources	Very slight loss of resources	Very slight loss of resources	Unlikely
Can impacts be mitigated?	Yes, to a large extent			
Mitigation	» Any erosion problems observed within the power line servitude or along access roads should be rectified immediately and monitored thereafter to ensure that they do not re-occur. » All bare areas (excluding agricultural land), affected by the development, should be re-vegetated with locally occurring species, to bind the soil and limit erosion potential. » 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). » Roads and other disturbed areas within the power line servitude 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. » Practical phased development and vegetation clearing must be practiced so that cleared areas are not left un-vegetated and vulnerable to erosion for extended periods of time.			
Residual Impacts	With appropriate avoidance and mitigation residual impacts will be very low and may be limited to very limited and local area containing some erosion features with little potential to spread beyond the point of origin.			

Operation Phase

Operation Impact 1: *Increased alien plant invasion during operation*

Impact Nature: The disturbed and bare ground that is likely to be present at the site after construction will leave the site vulnerable to alien plant invasion for some time, and pose a potential threat to surrounding grasslands and wetlands.		
	Power Line Alternative 1	**Power Line Alternative 2**

	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Extent	Local (1)	Local (1)	Local (1)	Local (1)
Duration	Medium-term (3)	Short-term (2)	Medium-term (3)	Short-term (2)
Magnitude	Minor (3)	Minor (2)	Small (1)	Small (0)
Probability	Probable (3)	Probable (3)	Probable (3)	Probable (3)
Significance	**Low (21)**	**Low (15)**	**Low (15)**	**Low (9)**
Status	Negative	Slightly Negative	Slightly Negative	Slightly Negative
Reversibility	Medium	High	High	High
Irreplaceable loss of resources	Slight loss of resources	Very slight loss of resources	Very slight loss of resources	Unlikely
Can impacts be mitigated?	Yes, to a large extent			
Mitigation	» A site-specific eradication and management programme for alien invasive plants must be included in the Environmental Management Programme (EMPr). » 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 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.			

Operation Impact 2: *Increased erosion risk during operation*

Impact Nature Increased erosion risk as a result of soil disturbance and loss of vegetation cover as well as increased runoff generated from hard impenetrable surfaces (i.e. compacted service and access roads and compacted and cleared areas around the pylons).				
	Power Line Alternative 1		**Power Line Alternative 2**	
	Without Mitigation	**With Mitigation**	**Without Mitigation**	**With Mitigation**
Extent	Local (1)	Local (1)	Local (1)	Local (1)
Duration	Medium-term (3)	Short-term (2)	Medium-term (3)	Short-term (2)

Magnitude	Minor (3)	Minor (2)	Minor (2)	Small (0)
Probability	Probable (3)	Probable (3)	Probable (3)	Probable (3)
Significance	**Low (21)**	**Low (15)**	**Low (18)**	**Low (9)**
Status	Negative	Slightly Negative	Negative	Slightly Negative
Reversibility	Medium	High	High	High
Irreplaceable loss of resources	Slight loss of resources	Very slight loss of resources	Very slight loss of resources	Unlikely
Can impacts be mitigated?	Yes, to a large extent			
Mitigation	» All roads and other hardened surfaces within the power line servitude should have runoff control features which redirect water flow and dissipate any energy in the water which may pose an erosion risk. » Regular monitoring for erosion within the power line servitude and along access roads must be undertaken after construction to ensure that no erosion problems have developed as a result of the disturbance. » All erosion problems observed within the power line servitude and along access roads as a result of the development should be rectified as soon as possible, using the appropriate erosion control structures and revegetation techniques. » All cleared areas within the power line servitude should be revegetated, preferably with indigenous perennial grasses (no invasive plants may be used).			
Residual Impacts	If erosion at the site is controlled, then there will be no residual impact.			

6.8 Comparison of Power Line Route Options

In terms of the Overhead Power Line Alternatives, Alternative 2 is, from an Ecological perspective the most preferred option as this option will only extend for a very short distance through near-natural habitat, after which the power line will connect into the Mookodi Magopela line (turn-in-turn-out). This servitude, furthermore, is located in an already transformed and degraded area. Subsequently, minimal additional habitat disturbance and vegetation destruction will occur. Furthermore, by locating the proposed power line near existing power line infrastructure, the total surface area that may contain infrastructure, that may cause faunal disturbance and habitat destruction, will be greatly reduced.

However, Overhead Power Line Alternative 1 is still located mostly within a Medium-Low Sensitive area (follow the alignment of the Mookodi-Magopela line, N18 road and railway line and section of the alignment of the existing Mercury-Mookodi line),

with no High and Very High Sensitive areas, and thus it is expected that if this alternative were to be selected that potential impacts will still be relatively low.

From a Wetland and Surface Hydrological perspective both options are regarded as suitable and are deemed equally preferred as not wetlands and/or surface hydrological features where identified within both alternatives' footprint area.

7 DISCUSSION AND CONCLUSION

» The vegetation of the project site is consistent with Gaap Plateau Vaalbosveld as identified and described by Mucina & Rutherford (2006). Furthermore this vegetation type is not listed as a threatened ecosystem within the national legislation and is classified by Mucina & Rutherford as Least Concerned due to the low level of habitat transformation that has occurred within this vegetation type (only 1%).

» The project site is located within a largely flat to slightly sloping (~0.2%) plain, generally sloping in a south-eastern to eastern direction (towards the Dry Harts River).

» Important or noteworthy geomorphological features within the project site include the following:
  - a west to east palaeo-channel within the central portion of the project site (the part of the channel located within the project site has lost its functionality as a surface drainage region)
  - a very low almost inconspicuous ridge line parallel to the palaeo drainage line as well as within the north-western corner.
  - a slightly elevated calcareous bed or mantle located south of the south of the low ridge as well as within the north-eastern corner.
  - five relative small depression (pan) wetlands of which two are connected with short, almost diffuse drainage lines.
  - elevated N18 Road (most important artificial geomorphological alteration) having a significant impact on surface water drainage towards the Dry Harts River, acting as a barrier.

» The entire project site is located within the Renewable Energy Development Zone (REDZ) 6 (Vryburg Zone) as well as the Great Northern Power Line Corridor.

» The bulk of the project site can be described as near-natural with overgrazing over a very long period of time being the primary impact on the vegetation structure, especially the grass / forb layer. Most of the southern portion of the project site has furthermore been historically cultivated

resulting in this area being covered by a secondary open savanna type with limited grazing potential.

» The project site is predominantly used as grazing for livestock, especially cattle, with some presence of small game species (steenbok, common duiker and migrating greater kudu). Other land use and built infrastructure within the project site is regarded as limited and have had a smaller impact on the project site. The most significant land use and infrastructure present within the project site from top to bottom area:
  - Long term historical overgrazing (predominantly cattle);
  - Less intense current grazing regime (cattle);
  - N18 Road and railway line;
  - Linear infrastructure such as overhead power lines and a water pipeline;
  - Gravel and sand quarry

» From an ecological perspective the following conclusions was drawn following the field assessment and data analysis:
  - The project site is moderately species rich with just over 170 species recorded for the project site.
  - The primary ecological factors driving vegetation and phytosociological patterns are a combination of edaphic (soil texture and moisture), geology (depth of underlying bedrock and type of rock formation; e.g. dolomite, chert and/or calcrete) and biotic (grazing) factors.
  - Weeds and alien plant species were not abundant within the project site but areas where severe grazing and trampling have occurred contained a relative dominant weed and alien plant layer.
  - Five conservation worthy species were identified within the development footprint namely:
    - *Acacia erioloba* (Declining and protected within the National Forest Act as well as within Provincial Nature Conservation Ordinations)
    - *Boophone distica* (Declining)
    - *Babiana hypogea* (Provincial Nature Conservation Ordinations)
    - *Nerine laticoma* (Provincial Nature Conservation Ordinations)
    - *Ammocharis coranica* (Provincial Nature Conservation Ordinations)
    - *Aloe greatheadii* (Provincial Nature Conservation Ordinations)
  - According to tree/shrub – grass interactions four Savanna types were identified with the Savanna grassland habitat being the dominant type and covering the largest extent of the project site.
  - The depression wetlands was typically devoid of shrubs and trees, dominated by grass and forb species.
  - No conservation important faunal species was recorded within the project site and general diversity was mostly low.

- Conservation important fauna species that may inhabit the project site are:
  - White-tailed Mouse (Endangered)
  - South African Hedgehog (Near Threatened)
  - Black-footed Cat (Vulnerable)
  - African Striped Weasel (Near Threatened)

» From a Surface Hydrological perspective the following conclusions was drawn following the field assessment and data analysis:
- The project site is situated within the Lower Vaal Management Area, Quaternary Catchment C32B (Dry Harts River Catchment) and Ecoregion 29.02 (Southern Kalahari Ecoregion).
- Within the project site five surface hydrological features were identified.
- All five hydrological features are classified as 5 palustrine depression wetlands or pans.
- Two of the pan wetlands, located within the northern section of the project site are connected with a short drainage line and are subsequently characterized as exhoreic systems. The remaining three depressions have no clear channeled in- and out flow and are thus endorheic features.
- Due to an influx of silt and clay (inward depositional processes) the sediment forms a layer that is relatively impermeable surface layer.
- Five soil forms were identified which are typically associates with saturated soils of wetland features (seasonal to temporary saturated) namely:
  - Arcadia
  - Rensburg
  - Dresden
  - Katspruit and
  - Fernwood.
- These depression wetlands are in a mostly near-natural condition with some local areas of trampling and soil compaction;
- These wetlands provide important functions including:
  - Collection and retention of runoff and associated resources after large rainfall events,
  - Seasonal preferential grazing,
  - Niche habitat ensures persistence of organisms and provides seasonal water and food to migration fauna,
  - Large shrubs and small trees on the periphery provide nesting space for birds and shelter/breeding areas for fauna.
- The appropriate buffer zones around these pan wetlands were determined to be 35m. A natural vegetation cover should be maintained

within these buffer areas to allow these areas to fulfill its function which includes:

- Corridor for movement of faunal species between depression wetland and terrestrial habitat;
- Food source for faunal species;
- Soil conservation;
- Stabilisation of soils;
- Filtering of runoff;
- Accumulation and slowing down of runoff;
- Buffering of wetlands against potential impacts associated with the proposed development: Increase in intensity and volume of surface water (storm water) flow resulting in sedimentation, erosion and invasion of weeds and IAPs;
- Larger shrubs and small trees on the periphery of wetland falling within this buffer zone provide (nesting space for birds and shelter/breeding areas for fauna.

  - The development footprint excludes these wetlands and their associated buffer areas and subsequently most potential impacts are regarded as unlikely.

» During the study it was found that the majority of the project site can be regarded as Medium-Low to Low Sensitive, with regards to ecology and surface hydrology, with the exception of the wetland habitat types which is regarded as Very-High Sensitive and their associated buffer areas as High Sensitive. Most of the Medium Sensitive areas area associated with unique features such as the palaeo-channel and the Tall Woodland Savannas which contribute to habitat and species diversity. However, these features are not regarded as sensitive features that warrant protection and development within these features are acceptable with the necessary mitigation measures implemented as recommended.

From the provided layout plan for the solar facility as well as the overhead power line alternatives, it can be concluded that the majority of the proposed development will occur within a **Medium-Low** sensitivity area with minimal encroachment into Medium sensitive areas. However, the development within these Medium areas are regarded as acceptable as this will not have a significant impact on local biodiversity, habitat diversity (including functionality and services provided) an on conservation important faunal and floral species. Furthermore, no **Very High** and **High Sensitive** areas will be impacted by the proposed development.

The most significant impacts associate with the development will be vegetation destruction and disturbance, some local habitat loss and potential temporary faunal disturbance. Furthermore, these disturbed areas may become potentially prone to

erosion and invasion with invasive alien plants. However, with the implementation of appropriate mitigation measures the significance of these impacts can be significantly reduced to an acceptable level without impacted the greater, regional ecosystem functioning and services provided by these ecosystems.

» A summary of pre- and post mitigation impact significance ratings for the different impacts and risks factors identified for the proposed development are provided below.

Table 19: Summary of pre and post mitigation impact significance ratings.

PROPOSED SOLAR PV FACILITY			
Construction & Operational Phase			
Phase	**Impact (Ecology & Surface Hydrology)**	**Significance Pre-Mitigation**	**Significance Post Mitigation**
Construction	Potential Impacts on vegetation and Conservation Important Species.	Medium (44)	Low (24)
	Direct faunal impacts during construction	Medium (40)	Low (18)
	Potential erosion risk during construction	Medium (48)	Low (12)
	Impact on "pan" wetlands through the possible increase in surface runoff during construction	Medium (33)	Low (8)
	Increase sedimentation and erosion within "pan" wetlands during construction	Medium (33)	Low (8)
	Impacts on surface water quality of "pan" wetlands during construction	Medium (39)	Low (16)
Operation	Potential increased alien plant invasion during operation	Medium (56)	Low (24)
	Altered runoff patterns due to rainfall interception by PV panel infrastructure and compacted areas resulting in high levels of erosion within the terrestrial environment	Medium (52)	Low (12)
	Altered runoff patterns due to rainfall interception by PV panel infrastructure and compacted areas resulting in high levels of erosion, sedimentation and turbidity within the lower lying "pan" wetland areas.	Low (24)	Low (2)

Cumulative Impacts (*Moeding Solar PV Facility and other Renewable Projects with a 30km radius)*		
Impact	**Over impact of the proposed project considered in isolation**	**Cumulative impact of the project and other projects within the area**
Reduced ability to meet conservation obligation and targets	Low (12)	Medium (33)
Impacts on Ecological Support areas and Broad-Scale Ecological Processes	Low (12)	Low (20)
Cumulative impacts due to nearby renewable energy developments – Influence on runoff and stormwater flow patterns and dynamics (due to excessive clearing of vegetation)	Low (6)	Low (28)
Cumulative impacts due to nearby renewable energy developments – Large-scale disturbance of indigenous vegetation	Low (7)	Medium (36)

PROPOSED OVERHEAD POWER LINE					
Construction & Operational Phase					
		Alternative 1		**Alternative 2**	
Phase	**Impact (Ecology)**	**Significance Pre-Mitigation**	**Significance Post Mitigation**	**Significance Pre-Mitigation**	**Significance Post Mitigation**
Construction	Impacts on vegetation and Conservation Important Species.	Medium (27)	Low (21)	Low (18)	Low (15)
	Faunal impacts	Low (24)	Low (15)	Low (18)	Low (12)
	Potential erosion risk	Low (24)	Low (15)	Low (18)	Low (9)
Operation	*Increased alien plant invasion*	Low (21)	Low (15)	Low (15)	Low (9)
	Increased erosion risk	Low (21)	Low (15)	Low (18)	Low (9)

Based upon the results obtained from the field-work as well as the results from above impact tables the following can be concluded in terms of the different Power Line Alternatives (2 Alternatives):

Overhead Power Line Alternative 2

- Alternative 2 is, from an Ecological perspective the most preferred option as this option will only extend for a very short distance through near-natural habitat, after which the power line will connect into the Mookodi Magopela line (turn-in-turn-out).
- This servitude, is located in an already transformed and degraded area.
- Minimal additional habitat disturbance and vegetation distruction will occur.

» Overhead Power Line Alternative 2 is located within a Medium-Low Sensitive area and it is expected that if this option were to be selected that potential impacts will be relatively low and acceptable.

Overhead Power Line Alternative 1

» Alternative 1 is, from an Ecological perspective the least preferred option as this option will extend, over 3km, through mostly near-natural vegetation.
» However, Overhead Power Line Alternative 1 is still located mostly within a Medium-Low Sensitive area, with no High and Very High Sensitive areas.
» Furthermore, by locating the proposed power line (Alternative 1) near existing power line infrastructure, the total surface area that may contain infrastructure, that may cause faunal disturbance and habitat destruction, will be greatly reduced. This existing servitude, furthermore, is located in an already transformed area.
» Subsequently, if the power line (Alternative 1) is located, as mentioned above, near existing power line infrastructure, minimal additional habitat disturbance will occur and by locating the proposed power line near existing power line infrastructure, the total surface area that may contain infrastructure that may pose collision risk, are greatly reduced.
» Subsequently, it is expected that if this alternative were to be selected that potential impacts will still be relatively low and acceptable.

From a Wetland and Surface Hyrdological perspective both options are regarded as suitable and are deemed equally preferred as no wetlands and/or surface hydrological features where identified within both alternatives' footprint area.

General recommendations:

» All depression wetlands should be regarded as No-Go Areas and be excluded from the development footprint.
» The buffer areas recommended around the pan wetlands should be implentented and maintained in a natural condition to allow efficient functioning of these buffer areas.
» Pre-construction walk-through of the final development footprint and power line alignment for species of conservation concern that would be affected and that can be translocated must be undertaken prior to the commencement of the construction phase.
» Since most of the identified conservation worthy species with the project site are geophytes and succulents with relative shallow rooting systems (e.g *Boophone disticha, Babiana hypogea, Ammocharis coranica, Nerine laticoma and Aloe greatheadii*), the potential for successful translocation is high. Before construction commences individuals of listed species within the development footprint that would be affected, should be counted and marked and translocated, where deemed necessary by the ecologist

conducting the pre-construction walk-through survey, and according to the recommended rations. Permits from the relevant provincial authorities, i.e. the North-West Department of Rural, Environment and Agricultural Development before the individuals are disturbed.

» Any individuals of protected species affected by and observed within the development footprint during construction should be translocated under the supervision of the ECO and/or Contractor's Environmental Officer (EO).

» Few alien invasive plants have been observed on the study site, but several grow in close proximity along major access routes. For all species, there is a very high risk of spread throughout the project site following disturbance. This implies that a detailed Invasive Plant Management Plan will have to be in place prior to commencement of activity and be diligently followed and updated throughout the project cycle up to the decommissioning phase.

The following mitigation measures are recommended:

» Regarding vegetation and protected plant species:

- A pre-construction walk-through of the final development footprint, by a suitably qualified botanist, for species of conservation concern that would be affected and that can be translocated must be undertaken prior to the commencement of the construction phase.
- Vegetation clearing to be kept to a minimum. No unnecessary vegetation to be cleared.
- All construction vehicles should adhere to clearly defined and demarcated roads. No driving outside of the development boundary.
- Rehabilitation of disturbed areas are important: Disturbed areas containing no infrastructure and hard surfaces should be allowed to be rehabilitated with natural vegetation as soon as possible to avoid the potential of erosion and invasion with alien plants. The area should be monitored (responsibility of EO) on a weekly basis throughout the construction phase and on a monthly basis thereafter and to the point where the area has rehabilitated to a satisfactory level.

» Regarding fauna:

- Site access should be controlled and no unauthorized persons should be allowed onto the site.
- Any fauna directly threatened by the construction activities should be removed to a safe location by the ECO or other 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 construction site.
- Fires should not be allowed on site.

- A firebreak should be maintained around the development boundary to avoid potential fires occurring within the facility from spreading into the surrounding grasslands, subsequently posing a threat to faunal species occurring within the surrounding environment.
- 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 to avoid collisions with susceptible species such as snakes and tortoises.
- Any potentially dangerous fauna such as snakes or fauna threatened by the maintenance and operational activities should be removed to a safe location.

» Regarding the potential increased erosion risk
- Any erosion problems observed should be rectified immediately and monitored thereafter to ensure that they do not re-occur.
- All bare areas, affected by the development, should be re-vegetated with locally occurring species, to bind the soil and limit erosion potential.
- 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).
- 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 should be removed and stored separately and should be reapplied where appropriate as soon as possible in order to encourage and facilitate rapid regeneration of the natural vegetation on cleared areas.
- Practical phased development and vegetation clearing should be practiced so that cleared areas are not left un-vegetated and vulnerable to erosion for extended periods of time.
- All roads and other hardened surfaces should have runoff control features which redirect water flow and dissipate any energy in the water which may pose an erosion risk.

» Regarding the potential of invasion by alien plants:
- A site-specific eradication and management program for alien invasive plants should be included in the Operation Environmental Management Program (OEMPr).
- Regular monitoring by the EO for alien plants at the site should occur and could be conducted simultaneously with erosion monitoring.

- When alien plants are detected, these should 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.
- Clearing methods should themselves 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.

From an ecological perspective no objective or motives were identified which would hinder the development of the Moeding Solar PV Facility and associated infrastructure on the affected properties. The development will be appropriate and acceptable from an ecological and surface hydrological perspective and will not cause detrimental impacts to the ecological and surface hydrological features located within the affected and surrounding properties. Therefore, it is the opinion that the development may be authorised, constructed and operated.

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9 APPENDICES:

Appendix 1. Listed Plant Species

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

Colours Relate as follow:
Threatened Status: Critically (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Critically Rare, Rare, Declining and Data Deficient (DDD), Not Evaluated (NE)

» Protected according to National Forest Act 1998 / NFA (No 84 of 1998).

» Protected according to The Transvaal Nature Conservation Ordinance (No. 12 of 1983), and

» Protected according to The Bophuthatswana Nature Conservation Act (Act 3 of 1973).

» Invasive Alien Plant

Family	Species	Threat status
ACANTHACEAE	Barleria irritans	LC
ACANTHACEAE	Barleria macrostegia	LC
ACANTHACEAE	Barleria rigida	LC
ACANTHACEAE	Blepharis integrifolia var. integrifolia	LC
ACANTHACEAE	Crabbea angustifolia	LC
ACANTHACEAE	Dyschoriste pseuderecta	LC
ACANTHACEAE	Dyschoriste transvaalensis	LC
ACANTHACEAE	Monechma divaricatum	LC
ACANTHACEAE	Ruellia patula	LC
ACANTHACEAE	Ruelliopsis setosa	LC
AIZOACEAE	Galenia affinis	LC
AIZOACEAE	Galenia portulacacea	LC
AIZOACEAE	Galenia pubescens	LC
AIZOACEAE	Galenia secunda	LC
AIZOACEAE	Plinthus sericeus	LC
AIZOACEAE	Tetragonia spicata	LC
AIZOACEAE	Trianthema salsoloides var. transvaalensis	LC
AIZOACEAE	Zaleya pentandra	LC
ALLIACEAE	Tulbaghia leucantha	LC
AMARANTHACEAE	Achyranthes aspera var. aspera	NE
AMARANTHACEAE	Aerva leucura	LC
AMARANTHACEAE	Alternanthera nodiflora	NE
AMARANTHACEAE	Alternanthera pungens	NE
AMARANTHACEAE	Amaranthus thunbergii	LC
AMARANTHACEAE	Cyathula lanceolata	LC

AMARANTHACEAE	Gomphrena celosioides	NE
AMARANTHACEAE	Hermbstaedtia fleckii	LC
AMARANTHACEAE	Hermbstaedtia odorata var. albi-rosea	LC
AMARANTHACEAE	Hermbstaedtia odorata var. aurantiaca	LC
AMARANTHACEAE	Hermbstaedtia odorata var. odorata	LC
AMARANTHACEAE	Kyphocarpa angustifolia	LC
AMARANTHACEAE	Pupalia lappacea var. lappacea	LC
AMARANTHACEAE	Sericocoma avolans	LC
AMARANTHACEAE	Sericorema sericea	LC
AMARYLLIDACEAE	**Ammocharis coranica**	LC
AMARYLLIDACEAE	**Brunsvigia radulosa**	LC
AMARYLLIDACEAE	**Crinum crassicaule**	LC
AMARYLLIDACEAE	**Nerine frithii**	LC
AMARYLLIDACEAE	**Nerine hesseoides**	LC
AMARYLLIDACEAE	**Nerine laticoma**	LC
ANACARDIACEAE	Ozoroa paniculosa var. paniculosa	LC
ANACARDIACEAE	Searsia burchellii	LC
ANACARDIACEAE	Searsia lancea	LC
ANACARDIACEAE	Searsia leptodictya	NE
ANACARDIACEAE	Searsia magalismontana subsp. magalismontana	LC
ANACARDIACEAE	Searsia pyroides var. pyroides	LC
ANACARDIACEAE	Searsia tenuinervis	LC
ANACARDIACEAE	Searsia tridactyla	LC
ANTHERICACEAE	Chlorophytum angulicaule	LC
ANTHERICACEAE	Chlorophytum fasciculatum	LC
ANTHERICACEAE	Chlorophytum krauseanum	LC
ANTHERICACEAE	Chlorophytum recurvifolium	LC
APIACEAE	Apium graveolens	NE
APIACEAE	Berula thunbergii	LC
APIACEAE	Centella asiatica	LC
APIACEAE	Cyclospermum leptophyllum	NE
APIACEAE	Deverra burchellii	LC
APOCYNACEAE	Asclepias eminens	LC
APOCYNACEAE	**Brachystelma dimorphum subsp. dimorphum**	LC
APOCYNACEAE	**Brachystelma foetidum**	LC
APOCYNACEAE	**Ceropegia crassifolia var. crassifolia**	LC
APOCYNACEAE	Fockea angustifolia	LC
APOCYNACEAE	Gomphocarpus fruticosus subsp. fruticosus	LC
APOCYNACEAE	Gomphocarpus tomentosus Burch. subsp. tomentosus	LC
APOCYNACEAE	Gomphocarpus tomentosus subsp. tomentosus	LC
APOCYNACEAE	**Hoodia pilifera subsp. annulata**	LC
APOCYNACEAE	Pentarrhinum insipidum	LC
APOCYNACEAE	Pentarrhinum insipidum E.Mey.	LC
APOCYNACEAE	Pergularia daemia subsp. daemia	LC
APOCYNACEAE	Raphionacme hirsuta	LC
APOCYNACEAE	Raphionacme velutina	LC
APOCYNACEAE	**Stapelia grandiflora var. grandiflora**	LC
APOCYNACEAE	Stenostelma capense	LC
APOCYNACEAE	Xysmalobium gomphocarpoides var. gomphocarpoides	LC
APONOGETONACEAE	Aponogeton rehmannii	LC
ASPARAGACEAE	Asparagus bechuanicus	LC

ASPARAGACEAE	Asparagus cooperi	LC
ASPARAGACEAE	Asparagus laricinus	LC
ASPARAGACEAE	Asparagus nodulosus	LC
ASPARAGACEAE	Asparagus retrofractus	LC
ASPARAGACEAE	Asparagus setaceus	LC
ASPARAGACEAE	Asparagus suaveolens	LC
ASPHODELACEAE	**Aloe grandidentata**	LC
ASPHODELACEAE	**Aloe zebrina**	LC
ASPHODELACEAE	Bulbine abyssinica	LC
ASPHODELACEAE	Bulbine narcissifolia	LC
ASPHODELACEAE	**Chortolirion angolense**	LC
ASPHODELACEAE	Haworthia venosa subsp. tessellata	LC
ASPHODELACEAE	Trachyandra burkei	LC
ASPHODELACEAE	Trachyandra laxa var. rigida	LC
ASPHODELACEAE	Trachyandra saltii var. oatesii	LC
ASPHODELACEAE	Trachyandra saltii var. saltii	LC
ASPLENIACEAE	Asplenium phillipsianum	LC
ASTERACEAE	Acanthospermum glabratum	NE
ASTERACEAE	Amphiglossa triflora	LC
ASTERACEAE	Arctotheca calendula	LC
ASTERACEAE	Arctotis arctotoides	LC
ASTERACEAE	Arctotis microcephala	LC
ASTERACEAE	Arctotis venusta	LC
ASTERACEAE	Artemisia afra var. afra	LC
ASTERACEAE	Aster squamatus	NE
ASTERACEAE	Berkheya carlinopsis subsp. magalismontana	LC
ASTERACEAE	Berkheya discolor	LC
ASTERACEAE	Berkheya onopordifolia var. onopordifolia	LC
ASTERACEAE	Berkheya pinnatifida subsp. pinnatifida	LC
ASTERACEAE	Berkheya radula	LC
ASTERACEAE	Bidens bipinnata	NE
ASTERACEAE	Bidens pilosa	NE
ASTERACEAE	Blumea dregeanoides	LC
ASTERACEAE	Chrysocoma ciliata	LC
ASTERACEAE	Chrysocoma obtusata	LC
ASTERACEAE	Cichorium intybus subsp. intybus	NE
ASTERACEAE	Cineraria vallis-pacis	LC
ASTERACEAE	Cirsium vulgare	NE
ASTERACEAE	Conyza bonariensis	NE
ASTERACEAE	Cotula anthemoides	LC
ASTERACEAE	Cotula burchellii	NE
ASTERACEAE	Denekia capensis	LC
ASTERACEAE	Dicoma anomala subsp. anomala	LC
ASTERACEAE	Dicoma anomala subsp. gerrardii	LC
ASTERACEAE	Dicoma capensis	LC
ASTERACEAE	Dicoma macrocephala	LC
ASTERACEAE	Dicoma schinzii	LC
ASTERACEAE	Dimorphotheca cuneata	LC
ASTERACEAE	Dimorphotheca zeyheri	LC
ASTERACEAE	Erlangea misera	LC
ASTERACEAE	Felicia clavipilosa subsp. clavipilosa	LC

ASTERACEAE	Felicia filifolia subsp. filifolia	LC
ASTERACEAE	Felicia hirsuta	LC
ASTERACEAE	Felicia muricata subsp. cinerascens	LC
ASTERACEAE	Felicia muricata subsp. muricata	LC
ASTERACEAE	Flaveria bidentis	NE
ASTERACEAE	Galinsoga parviflora	NE
ASTERACEAE	Gazania krebsiana subsp. serrulata	LC
ASTERACEAE	Geigeria aspera var. aspera	LC
ASTERACEAE	Geigeria brevifolia	LC
ASTERACEAE	Geigeria burkei subsp. burkei var. burkei	LC
ASTERACEAE	Geigeria burkei subsp. burkei var. zeyheri	LC
ASTERACEAE	Geigeria burkei subsp. diffusa	LC
ASTERACEAE	Geigeria burkei subsp. fruticulosa	LC
ASTERACEAE	Geigeria filifolia	LC
ASTERACEAE	Geigeria obtusifolia	LC
ASTERACEAE	Geigeria ornativa subsp. ornativa	LC
ASTERACEAE	Gnaphalium filagopsis	LC
ASTERACEAE	Gnaphalium nelsonii	Rare
ASTERACEAE	Helianthus debilis subsp. cucumerifolius	NE
ASTERACEAE	Helichrysum argyrosphaerum	LC
ASTERACEAE	Helichrysum caespititium	LC
ASTERACEAE	Helichrysum cerastioides var. cerastioides	LC
ASTERACEAE	Helichrysum dregeanum	LC
ASTERACEAE	Helichrysum lineare	LC
ASTERACEAE	Helichrysum nudifolium var. nudifolium	LC
ASTERACEAE	Helichrysum obtusum	LC
ASTERACEAE	Helichrysum paronychioides	LC
ASTERACEAE	Helichrysum tomentosulum subsp. aromaticum	LC
ASTERACEAE	Helichrysum zeyheri	LC
ASTERACEAE	Hertia pallens	LC
ASTERACEAE	Hirpicium bechuanense	LC
ASTERACEAE	Ifloga glomerata	LC
ASTERACEAE	Lactuca inermis	LC
ASTERACEAE	Laggera decurrens	LC
ASTERACEAE	Lasiopogon muscoides	LC
ASTERACEAE	Launaea rarifolia var. rarifolia	LC
ASTERACEAE	Litogyne gariepina	LC
ASTERACEAE	Mikaniopsis cissampelina	LC
ASTERACEAE	Nidorella hottentotica	LC
ASTERACEAE	Nidorella resedifolia subsp. resedifolia	LC
ASTERACEAE	Nolletia ciliaris	LC
ASTERACEAE	Osteospermum muricatum ex subsp. muricatum	LC
ASTERACEAE	Pegolettia retrofracta	LC
ASTERACEAE	Pentzia calcarea	LC
ASTERACEAE	Pentzia calcarea Kies	LC
ASTERACEAE	Pentzia globosa	LC
ASTERACEAE	Pentzia incana	LC
ASTERACEAE	Pentzia lanata	LC
ASTERACEAE	Pentzia quinquefida	LC
ASTERACEAE	Pseudognaphalium luteo-album	
ASTERACEAE	Pseudognaphalium oligandrum	LC

ASTERACEAE	Rennera stellata	VU
ASTERACEAE	Schkuhria pinnata	NE
ASTERACEAE	Senecio arenarius	LC
ASTERACEAE	Senecio burchellii	LC
ASTERACEAE	Senecio inaequidens	LC
ASTERACEAE	Senecio reptans	LC
ASTERACEAE	Sonchus oleraceus	NE
ASTERACEAE	Tagetes minuta	NE
ASTERACEAE	Tarchonanthus camphoratus	LC
ASTERACEAE	Tarchonanthus obovatus	LC
ASTERACEAE	Tripteris aghillana var. aghillana	LC
ASTERACEAE	Ursinia nana subsp. leptophylla	LC
ASTERACEAE	Verbesina encelioides var. encelioides	NE
ASTERACEAE	Vernonia galpinii	LC
ASTERACEAE	Xanthium spinosum	NE
ASTERACEAE	Zinnia peruviana	NE
BIGNONIACEAE	Rhigozum brevispinosum	LC
BORAGINACEAE	Anchusa riparia	LC
BORAGINACEAE	Cynoglossum lanceolatum	LC
BORAGINACEAE	Ehretia alba	LC
BORAGINACEAE	Heliotropium ciliatum	LC
BORAGINACEAE	Heliotropium nelsonii	LC
BORAGINACEAE	Heliotropium ovalifolium	LC
BORAGINACEAE	Heliotropium strigosum	LC
BORAGINACEAE	Heliotropium zeylanicum	LC
BORAGINACEAE	Lithospermum cinereum	LC
BORAGINACEAE	Lithospermum scabrum	LC
BORAGINACEAE	Trichodesma angustifolium subsp. angustifolium	LC
BRASSICACEAE	Capsella bursa-pastoris	NE
BRASSICACEAE	Coronopus integrifolius	NE
BRASSICACEAE	Erucastrum strigosum	LC
BRASSICACEAE	Rorippa fluviatilis var. caledonica	LC
BRASSICACEAE	Sisymbrium capense	LC
BRASSICACEAE	Sisymbrium turczaninowii	LC
BUDDLEJACEAE	Buddleja saligna	LC
BUDDLEJACEAE	Gomphostigma virgatum	LC
BUDDLEJACEAE	Nuxia gracilis	LC
BURSERACEAE	Commiphora glandulosa	LC
BURSERACEAE	Commiphora pyracanthoides	LC
BURSERACEAE	Commiphora pyracanthoides Engl.	LC
CAMPANULACEAE	Wahlenbergia androsacea	LC
CAMPANULACEAE	Wahlenbergia denticulata var. denticulata	LC
CAMPANULACEAE	Wahlenbergia denticulata var. transvaalensis	LC
CAMPANULACEAE	Wahlenbergia paniculata	LC
CAMPANULACEAE	Wahlenbergia undulata	LC
CAPPARACEAE	**Boscia albitrunca**	LC
CAPPARACEAE	Boscia foetida subsp. minima	LC
CAPPARACEAE	Cadaba aphylla	LC
CAPPARACEAE	Cleome angustifolia subsp. diandra	LC
CAPPARACEAE	Cleome angustifolia subsp. petersiana	LC
CAPPARACEAE	Cleome gynandra	LC

CAPPARACEAE	Cleome maculata	LC
CAPPARACEAE	Cleome monophylla	LC
CAPPARACEAE	Cleome rubella	LC
CARYOPHYLLACEAE	Dianthus micropetalus	LC
CARYOPHYLLACEAE	Pollichia campestris	LC
CARYOPHYLLACEAE	Pollichia campestris Aiton	LC
CARYOPHYLLACEAE	Silene undulata	LC
CELASTRACEAE	Gymnosporia buxifolia	LC
CELASTRACEAE	Maytenus acuminata var. acuminata	LC
CELTIDACEAE	Celtis africana	LC
CHENOPODIACEAE	Atriplex semibaccata var. appendiculata	LC
CHENOPODIACEAE	Chenopodium ambrosioides	NE
CHENOPODIACEAE	Chenopodium carinatum	NE
CHENOPODIACEAE	Chenopodium phillipsianum	NE
CHENOPODIACEAE	Salsola atrata	LC
CHENOPODIACEAE	Salsola glabrescens	LC
COLCHICACEAE	Colchicum melanthoides subsp. melanthoides	LC
COLCHICACEAE	Ornithoglossum dinteri	LC
COLCHICACEAE	Ornithoglossum vulgare	LC
COMBRETACEAE	Terminalia sericea	LC
COMMELINACEAE	Commelina africana var. africana	LC
COMMELINACEAE	Commelina africana var. barberae	LC
COMMELINACEAE	Commelina africana var. krebsiana	LC
COMMELINACEAE	Commelina africana var. lancispatha	LC
COMMELINACEAE	Commelina benghalensis	LC
COMMELINACEAE	Commelina livingstonii	LC
COMMELINACEAE	Cyanotis speciosa	LC
CONVOLVULACEAE	Convolvulus multifidus	LC
CONVOLVULACEAE	Convolvulus ocellatus var. ocellatus	LC
CONVOLVULACEAE	Convolvulus sagittatus	LC
CONVOLVULACEAE	Evolvulus alsinoides	LC
CONVOLVULACEAE	Falkia oblonga	LC
CONVOLVULACEAE	Ipomoea bolusiana	LC
CONVOLVULACEAE	Ipomoea obscura var. obscura	LC
CONVOLVULACEAE	Ipomoea oenotheroides	LC
CONVOLVULACEAE	Ipomoea sinensis subsp. blepharosepala	LC
CONVOLVULACEAE	Merremia verecunda	LC
CONVOLVULACEAE	Seddera capensis	LC
CONVOLVULACEAE	Seddera suffruticosa	LC
CONVOLVULACEAE	Xenostegia tridentata subsp. angustifolia	LC
CRASSULACEAE	Crassula lanceolata subsp. transvaalensis	LC
CRASSULACEAE	Kalanchoe paniculata	LC
CUCURBITACEAE	Acanthosicyos naudinianus	LC
CUCURBITACEAE	Coccinia sessilifolia	LC
CUCURBITACEAE	Cucumis africanus	LC
CUCURBITACEAE	Cucumis myriocarpus subsp. myriocarpus	LC
CUCURBITACEAE	Cucumis zeyheri	LC
CUCURBITACEAE	Kedrostis crassirostrata	LC
CUCURBITACEAE	Momordica balsamina	LC
CYPERACEAE	Bulbostylis burchellii	LC
CYPERACEAE	Bulbostylis hispidula subsp. pyriformis	LC

CYPERACEAE	Bulbostylis pusilla	LC
CYPERACEAE	Cyperus atriceps	LC
CYPERACEAE	Cyperus austro-africanus	LC
CYPERACEAE	Cyperus bellus	LC
CYPERACEAE	Cyperus decurvatus	LC
CYPERACEAE	Cyperus difformis	LC
CYPERACEAE	Cyperus esculentus var. esculentus	LC
CYPERACEAE	Cyperus fastigiatus	LC
CYPERACEAE	Cyperus indecorus var. namaquensis	LC
CYPERACEAE	Cyperus longus var. tenuiflorus	LC
CYPERACEAE	Cyperus margaritaceus var. margaritaceus	LC
CYPERACEAE	Cyperus marginatus	LC
CYPERACEAE	Cyperus marlothii	LC
CYPERACEAE	Cyperus obtusiflorus var. obtusiflorus	LC
CYPERACEAE	Cyperus palmatus	LC
CYPERACEAE	Cyperus rubicundus	LC
CYPERACEAE	Cyperus sexangularis	LC
CYPERACEAE	Cyperus sphaerospermus	LC
CYPERACEAE	Cyperus squarrosus	LC
CYPERACEAE	Cyperus usitatus	LC
CYPERACEAE	Kyllinga alba	LC
CYPERACEAE	Kyllinga erecta var. erecta	LC
EUPHORBIACEAE	Acalypha segetalis	LC
EUPHORBIACEAE	Acalypha segetalis Müll.Arg.	LC
EUPHORBIACEAE	Euphorbia inaequilatera var. inaequilatera	LC
FABACEAE	Acacia robusta subsp. robusta	LC
FABACEAE	Gleditsia triacanthos	NE
FABACEAE	Indigastrum costatum subsp. macrum	LC
FABACEAE	Indigofera cryptantha var. cryptantha	LC
FABACEAE	Indigofera heterotricha	LC
FABACEAE	Indigofera sessilifolia	LC
FABACEAE	Otoptera burchellii	LC
FABACEAE	Rhynchosia totta var. totta	LC
FABACEAE	Zornia milneana	LC
HYACINTHACEAE	Dipcadi viride	LC
IRIDACEAE	**Babiana bainesii**	LC
IRIDACEAE	Moraea polystachya	LC
LAMIACEAE	Salvia disermas	LC
LAMIACEAE	Teucrium trifidum	LC
MALVACEAE	Hermannia quartiniana	LC
MALVACEAE	Hibiscus pusillus	LC
MALVACEAE	Hibiscus trionum	
MALVACEAE	Melhania prostrata	LC
MALVACEAE	Sida chrysantha	LC
MESEMBRYANTHEMACEAE	Lithops lesliei subsp. lesliei	NT
MOLLUGINACEAE	Hypertelis salsoloides var. salsoloides	LC
MOLLUGINACEAE	Limeum viscosum subsp. transvaalense	LC
MOLLUGINACEAE	Limeum viscosum subsp. viscosum var. viscosum	LC
NYCTAGINACEAE	Commicarpus pentandrus	LC
PASSIFLORACEAE	Adenia repanda	LC
PHYLLANTHACEAE	Phyllanthus incurvus	LC

PLUMBAGINACEAE	Plumbago zeylanica	NE
POACEAE	Andropogon schirensis	LC
POACEAE	Anthephora pubescens	LC
POACEAE	Aristida bipartita	LC
POACEAE	Aristida canescens subsp. canescens	LC
POACEAE	Aristida congesta subsp. barbicollis	LC
POACEAE	Aristida congesta subsp. congesta	LC
POACEAE	Aristida meridionalis	LC
POACEAE	Aristida spectabilis	LC
POACEAE	Aristida stipitata subsp. graciliflora	LC
POACEAE	Aristida stipitata subsp. spicata	LC
POACEAE	Aristida vestita	LC
POACEAE	Brachiaria brizantha	LC
POACEAE	Brachiaria deflexa	LC
POACEAE	Brachiaria nigropedata	LC
POACEAE	Cymbopogon pospischilii	NE
POACEAE	Diandrochloa pusilla	LC
POACEAE	Digitaria brazzae	LC
POACEAE	Digitaria eriantha	LC
POACEAE	Digitaria sanguinalis	NE
POACEAE	Diheteropogon amplectens var. amplectens	LC
POACEAE	Elionurus muticus	LC
POACEAE	Enneapogon scoparius	LC
POACEAE	Eragrostis barrelieri	NE
POACEAE	Eragrostis bicolor	LC
POACEAE	Eragrostis chloromelas	LC
POACEAE	Eragrostis curvula	LC
POACEAE	Eragrostis echinochloidea	LC
POACEAE	Eragrostis gummiflua	LC
POACEAE	Eragrostis homomalla	LC
POACEAE	Eragrostis lehmanniana var. lehmanniana	LC
POACEAE	Eragrostis nindensis	LC
POACEAE	Eragrostis pallens	LC
POACEAE	Eragrostis rigidior	LC
POACEAE	Eragrostis superba	LC
POACEAE	Eragrostis viscosa	LC
POACEAE	Eragrostis x pseud-obtusa	NE
POACEAE	Fingerhuthia africana	LC
POACEAE	Heteropogon contortus	LC
POACEAE	Hyparrhenia hirta	LC
POACEAE	Leptochloa fusca	LC
POACEAE	Melinis repens subsp. repens	LC
POACEAE	Panicum coloratum var. coloratum	LC
POACEAE	Panicum kalaharense	LC
POACEAE	Panicum maximum	LC
POACEAE	Panicum stapfianum	LC
POACEAE	Pogonarthria squarrosa	LC
POACEAE	Schizachyrium sanguineum	LC
POACEAE	Schmidtia pappophoroides	LC
POACEAE	Sporobolus fimbriatus	LC
POACEAE	Stipagrostis uniplumis var. neesii	LC

POACEAE	Themeda triandra	LC
POACEAE	Tricholaena monachne	LC
POACEAE	Trichoneura grandiglumis	LC
POACEAE	Triraphis andropogonoides	LC
POACEAE	Urochloa panicoides	
POLYGONACEAE	Oxygonum alatum var. alatum	LC
POTTIACEAE	Pseudocrossidium porphyreoneurum	
PTERIDACEAE	Actiniopteris radiata	LC
RICCIACEAE	Riccia albolimbata	
RUBIACEAE	Anthospermum rigidum subsp. rigidum	LC
RUBIACEAE	Kohautia cynanchica	LC
SCROPHULARIACEAE	Aptosimum albomarginatum	LC
SCROPHULARIACEAE	Aptosimum elongatum	LC
SCROPHULARIACEAE	Peliostomum leucorrhizum	LC
SCROPHULARIACEAE	Selago mixta	LC
SCROPHULARIACEAE	Selago mixta Hilliard	LC
SINOPTERIDACEAE	Cheilanthes dolomiticola	LC
SINOPTERIDACEAE	Cheilanthes hirta var. brevipilosa	
SINOPTERIDACEAE	Pellaea calomelanos var. calomelanos	LC
SOLANACEAE	Solanum catombelense	LC
VERBENACEAE	Lantana mearnsii var. latibracteolata	LC
VERBENACEAE	Lantana rugosa	LC
VERBENACEAE	Lippia scaberrima	LC
VERBENACEAE	Verbena officinalis	NE

Appendix 2. List of Mammals

List of Mammals which may potentially occur within the surrounding area. Taxonomy notes are derived from Skinner & Chimimba (2005), while conservation status is according to the IUCN 2010.

Colours Relate as follow:

» Protected according to The Transvaal Nature Conservation Ordinance (No. 12 of 1983); Schedule 2 – Protected Game (Section 15(1)(a)) and Schedule 4 – Protected Wild Animals (Section 15(1)(c)), and

» Protected according to The Bophuthatswana Nature Conservation Act (Act 3 of 1973); Schedule 1 – Protected Game.

» Protected according to The Bophuthatswana Nature Conservation Act (Act 3 of 1973); Schedule 2 – Ordinary Game.

» National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004); Threatened or Protected Species Regulations

- Endangered Species
- Vulnerable Species
- Protected Species

Likelihood Rating: 1=Confirmed; 2=Likely; 3=Moderate; 4=Unlikely & 5= May occur as a managed population

Scientific Name	Common Name	IUCN Status	Regional Status	Likelihood	ADU Database
MACROSCLEDIDEA (ELEPHANT SHREWS): SPECIES: 2 CONSERVATION IMPORTANT SPECIES: 0					
Elephantulus myurus	Eastern Rock Sengi	LC	LC	3	X
Elephantulus brachyrhynchus	Short-snouted Sengi	LC	LC	2	
TUBULENTATA: SPECIES: 1 CONSERVATION IMPORTANT SPECIES: 1					
Orycteropus afer	Aardvark	LC	LC	3	X
HYRACOIDEA (HYRAXES) SPECIES: 1 CONSERVATION IMPORTANT SPECIES: 0					
Procavia capensis	Rock Hyrax	LC	LC	4	
LAGOMORPHA (HARES AND RABBITS): SPECIES: 3 CONSERVATION IMPORTANT SPECIES: 2					
Pronolagus randensis	Jameson's Red Rock Rabbit	LC	LC	4	
Lepus capensis	Cape Hare	LC	LC	3	X
Lepus victoriae	Savanna Hare	LC	LC	2	X
RODENTIA (RODENTS): SPECIES: 29 CONSERVATION IMPORTANT SPECIES: 1					
Cryptomys hottentotus	African Mole Rat	LC	LC	2	X
Hystrix africaeaustralis	Cape Porcupine	LC	LC	2	X
Pedetes capensis	Springhare	LC	LC	2	X
Xerus inauris	South African Ground Squirrel	LC	LC	2	X
Paraxerus cepapi	Tree Squirrel	LC	LC	4	
Graphiurus microtis	Small-eared Dormouse		LC	3	
Graphiurus platyops	Rock Dormouse	DD	LC	2	
Graphiurus murinus	Woodland Dormouse	LC	LC	2	
Thryonomys swinderianus	Greater Cane-rat	LC	LC	4	
Rhabdomys pumilio	Four-striped Grass Mouse	LC	LC	2	X
Rhabdomys dilectus	Mesic Four-striped Grass Mouse	LC	LC	2	X
Lemniscomys rosalia	Single-striped Grass Mouse	DD	LC	2	X
Mus minutoides	Pygmy Mouse	LC	LC	2	

Mus indutus	Desert Pygmy Mouse	LC	LC	3	
Mastomys coucha	Southern Multimammate Mouse	LC	LC	2	X
Mastomys natalensis	Natal Multimammate Mouse	LC	LC	3	
Aethomys ineptus	Tete Veld Rat	LC	LC	2	X
Aethomys chrysophilus	Red Veld Rat	LC	LC	2	
Micaelamys namaquensis	Namaqua Rock Mouse	LC	LC	2	X
Desmodillus auricularis	Cape Short-tailed Gerbil	LC	LC	2	
Gerbilliscus leucogaster	Bushveld Gerbil	DD	LC	2	X
Gerbilliscus brantsii	Highveld Gerbil	LC	LC	3	X
Mystromys albicaudatus	White-tailed Mouse	EN	VU	2	
Saccostamus campestris	Pouched Mouse	LC	LC	2	
Thallomys paedulcus	Acacia Tree Rat	LC	LC	3	x
Malacothrix typica	Large-eared Mouse	LC	LC	2	
Otomys angoniensis	Angoni Vlei Rat	LC	LC	4	
Dendromus melanotis	Grey Climbing Mouse	LC	LC	2	X
Steatomys krebsii	Krebs's Fat Mouse	LC	LC	4	
PRIMATES SPECIES: 3 CONSERVATION IMPORTANT SPECIES: 1					
Papio ursinus	Chacma Baboon	LC	LC	3	
Cercopithecus aethiops	Vervet Monkey	LC	LC	3	X
Galago moholi	Southern Lesser Galago	LC	LC	3	
EULIPOTYPHLA (SHREWS): SPECIES: 5 CONSERVATION IMPORTANT SPECIES: 1					
Myosorex varius	Forest Shrew	DD	LC	3	
Crocidura cyanea	Reddish-Grey Musk Shrew	DD	LC	2	
Crocidura hirta	Lesser Red Musk Shrew	DD	LC	2	
Suncus varilla	Lesser Dwarf Shrew	DD	LC	3	
Crocidura mariquensis	Swamp Musk Shrew	DD	NT	4	X
ERINACEOMORPHA (HEDGEHOG) SPECIES: 1 CONSERVATION IMPORTANT SPECIES: 1					
Atelerix frontalis	South African Hedgehog	NT	NT	2	
PHILODOTA (PANGOLINS) SPECIES: 1 CONSERVATION IMPORTANT SPECIES: 1					

Smutsia temminckii	Ground Pangolin	VU	VU	3	
CARNIVORA: SPECIES: 24 CONSERVATION IMPORTANT SPECIES: 11					
Proteles cristatus	Aardwolf	LC	LC	2	
Crocuta crocuta	Spotted Hyaena	NT	NT	4	
Hyaena brunnea	Brown Hyena	NT	NT	4	
Caracal caracal	Caracal	LC	LC	3	
Leptailurus serval	Serval	LC	NT	3	X
Felis silvestris	African Wild Cat	LC	LC	2	
Felis nigripes	Black-footed cat	VU	VU	3	
Genetta genetta	Small-spotted genet	LC	LC	3	
Genetta maculata	Rusty-spotted genet	LC	LC	4	
Panthera pardus	Leopard	VU	VU	4	
Suricata suricatta	Meerkat	LC	LC	2	X
Mellivora capensis	Honey Badger	NT	LC	3	
Atilax paludinosus	Marsh Mongoose	LC	LC	4	X
Cynictis penicillata	Yellow Mongoose	LC	LC	2	X
Galerella sanguinea	Slender Mongoose	LC	LC	2	X
Ichneumia albicauda	White-tailed Mongoose	LC	LC	4	
Vulpes chama	Cape Fox	LC	LC	3	
Canis mesomelas	Black-backed Jackal	LC	LC	2	X
Otocyon megalotis	Bat-eared Fox	LC	LC	2	
Aonyx capensis	Cape Clawless Otter	NT	NT	4	
Lutra maculicolis	Spotted-necked Otter	NT	VU	4	
Poecilogale albinucha	African Striped Weasel	DD	NT	3	
Ictonyx striatus	Striped Polecat	LC	LC	2	
Mungos mungo	Banded Mongoose	LC	LC	4	
RUMANANTIA & PERISSODACTYLA (UNGULATES): SPECIES: 18 CONSERVATION IMPORTANT SPECIES: 17					
Connochaetes gnou	Black Wildebeest	LC	LC	5	X
Connochaetes taurinus	Blue Wildebeest	LC	LC	5	
Alcelaphus caama	Red Hartebeest	LC	LC	5	
Aepyceros melampus	Impala	LC	LC	5	X

Damaliscus pygargus phillipsi	Blesbok	LC	LC	5	X
Equus quagga	Plains Zebra	LC	LC	5	X
Syncerus caffer	African Savanna Buffalo	LC	LC	5	X
Tragelaphus strepsiceros	Greater Kudu	LC	LC	3	X
Tragelaphus sylvaticus	Bushbuck	LC	LC	5	X
Oryx gazelle	Gemsbok	LC	LC	5	X
Redunca fulvorufula	Mountain Reedbuck	LC	EN	5	X
Redunca arundinum	Southern Reedbuck	LC	LC	5	X
Tragelaphus oryx	Eland	LC	LC	5	X
Pelea capreolus	Grey Rhebok	LC	NT	5	X
Sylvicapra grimmia	Common Duiker	LC	LC	2	X
Antidorcas marsupialis	Springbok	LC	LC	5	X
Raphicerus campestris	Steenbok	LC	LC	2	X
**Elephurus davidianus*	Pere David's Deer	CE	LC	5	X
PIGS & HOGS (SUIDAE) SPECIES: 2 CONSERVATION IMPORTANT SPECIES: 1					
Phacochoerus africanus	Common Warthog	LC	LC	5	X
CHIROPTERA (BATS) SPECIES: 8 CONSERVATION IMPORTANT SPECIES: 3					
Neoromicia capensis	Cape Serotine Bat	LC	LC	2	
Tadarida aegyptiaca	Egyptian Free-tailed Bat	LC	LC	2	
Nycteris thebaica	Egyptian Slit-faced Bat	LC	LC	2	
Miniopterus natalensis	Natal long-fingered Bat	NT	NT	3	
Rhinolophus clivosus	Geoffroy's Horseshoe Bat	LC	NT	3	
Rhinolophus darlingi	Darling's Horseshoe Bat	LC	NT	2	
Pipistrellus rusticus	Rusty Pipestrelle	LC	LC	2	
Scotophilus dinganii	Yellow-bellied House Bat	LC	LC	2	

Appendix 3. List of Reptiles.

List of Reptiles which may potentially occur within the greater area. Taxonomy notes are derived from Branch (1998) and Bates *et al*. (2014), while conservation status is according to Bates *et al*. (2014). List of reptiles which are known from the 2626AA and 2526CC Quarter Degree Squares, according to the SARCA database are also provided.

Colours Relate as follow:

» National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004); Threatened or Protected Species Regulations

- Endangered Species
- Vulnerable Species
- Protected Species

Likelihood Rating: 1=Confirmed; 2=Likely; 3=Moderate; 4=Unlikely & 5= May occur as a managed population

Species	Common Name	Threat Status Regional	Endemism	Likelihood	ADU Database
Pelomedusidae Species:1 Conservation Important Species:0 Endemic & Near Endemic Species:0					
Pelomedusa subrufa	Marsh Terrapin	LC		3	
Testudinidae Species:3 Conservation Important Species:0 Endemic & Near Endemic Species:1					
Homopus femoralis	Greater Dwarf Tortoise	LC	E	4	
Psammobates oculifer	Serrated Tent Tortoise	LC		3	
Stigmochelys pardalis	Leopard Tortoise	LC		2	1
Gekkonidae Species:4 Conservation Important Species:0 Endemic & Near Endemic Species:0					
Hemidactylus mabouia	Common Tropical House Gecko	LC		3	
Lygodactylus capensis capensis	Common Dwarf Gecko	LC		3	1
Pachydactylus capensis	Cape Thick-toed Gecko	LC		2	
Ptenopus garrulus garrulus	Common Barking Gecko	LC		2	
Amphisbaenidae Species:3 Conservation Important Species:0					

Endemic & Near Endemic Species:1					
Monopeltis capensis	Cape Worm Lizard	LC	N-E	3	
Monopeltis infuscata	Dusky Spade-snouted Worm Lizard	LC		4	
Zygaspis quadrifrons	Kalahari Dwarf Worm Lizard	LC		3	
Lacertidae					
Species:6					
Conservation Important Species:0					
Endemic & Near Endemic Species:0					
Meroles squamulosus	Savanna Lizard	LC		2	
Heliobolus lugubris	Bushveld Lizard	LC		2	
Nucras holubi	Holub's Sandveld Lizard	LC		2	
Nucras intertexta	Spotted Sandveld Lizard	LC		3	
Pedioplanis lineoocellata lineoocellata	Spotted Sand Lizard	LC		2	
Pedioplanis namaquensis	Namaqua Sand Lizard	LC		4	
Cordylidae					
Species:1					
Conservation Important Species:0					
Endemic & Near Endemic Species:1					
Karusasaurus polyzonus	Southern Karusa Lizard	LC	N-E	4	1
Gerrhosauridae					
Species:1					
Conservation Important Species:0					
Endemic & Near Endemic Species:0					
Gerrhosaurus flavigularis	Yellow-throated Plated Lizard	LC		2	1
Scincidae					
Species:11					
Conservation Important Species:0					
Endemic & Near Endemic Species:1					
Acontias gracilicauda	Thin-tailed Legless Skink	LC	E	2	
Acontias kgalagadi kgalagadi	Kgalagadi Legless Skink	LC		4	
Acontias occidentalis	Savanna Legless Skink	LC		3	
Afroablepharus wahlbergii	Wahlberg's Snake-eyed Skink	LC		2	
Mochlus sundevallii sundevallii	Sundevall's Writhing Skink	LC		4	
Trachylepis capensis	Cape Skink	LC		2	1
Trachylepis punctatissima	Speckled Rock Skink	LC		1	1
Trachylepis punctulata	Speckled Sand Skink	LC		4	
Trachylepis spilogaster	Kalahari Tree Skink	LC		3	
Trachylepis varia	Variable Skink	LC		2	1
Trachylepis variegata	Variegated Skink	LC		3	
Varanidae					
Species:1					
Conservation Important Species:0					
Endemic & Near Endemic Species:0					
Varanus albigularis albigularis	Southern Rock Monitor	LC		2	
Chamaeleonidae					
Species:2					
Conservation Important Species:0					

Endemic & Near Endemic Species:0					
Chamaeleo dilepis dilepis	Common Flap-neck Chameleon	LC		3	
Chamaeleo namaquensis	Namaqua Chameleon	LC		4	
Agamidae Species:2 Conservation Important Species:0 Endemic & Near Endemic Species:1					
Agama aculeata aculeata	Western Ground Agama	LC		2	
Agama atra	Southern Rock Agama	LC	N-E	2	1
Typhlopidae Species:2 Conservation Important Species:0 Endemic & Near Endemic Species:1					
Afrotyphlops bibronii	Bibron's Blind Snake	LC	N-E	3	
Rhinotyphlops lalandei	Delalande's Beaked Blind Snake	LC		3	
Leptotyphlopidae Species:1 Conservation Important Species:0 Endemic & Near Endemic Species:0					
Leptotyphlops scutifrons	Peter's Thread Snake	LC		2	
Pythonidae Species:1 Conservation Important Species:0 Endemic & Near Endemic Species:0					
Python natalensis	Southern African Python	LC		4	
Viperidae Species:1 Conservation Important Species:0 Endemic & Near Endemic Species:0					
Bitis arietans arietans	Puff Adder	LC		2	
Lamprophiidae Species:12 Conservation Important Species:0 Endemic & Near Endemic Species:2					
Aparallactus capensis	Black-headed Centipede-eater	LC		2	
Atractaspis bibronii	Bibron's Stiletto Snake	LC		3	
Xenocalamus bicolor bicolor	Bicoloured Quill-snouted Snake	LC		3	
Boaedon capensis	Common House Snake	LC		2	1
Lamprphis aurora	Aurora Snake	LC	E	3	
Lycodonomorphus rufulus	Brown Water Snake	LC		4	
Lycophidion capense capense	Cape Wolf Snake	LC		3	
Dipsina multimaculata	Dwarf Beaked Snake	LC		3	
Psammophis brevirostris	Short-snouted Grass Snake	LC		2	1
Psammophis trinasalis	Fork-marked Sand Snake	LC		2	
Psammophylax tritaeniatus	Striped Grass Snake	LC		2	
Pseudaspis cana	Mole Snake	LC		2	

Elapidae Species:4 Conservation Important Species:0 Endemic & Near Endemic Species:1					
Aspidelaps scutatus scutatus	Common Shield Cobra	LC		4	
Hemachatus haemachatus	Rinkhals	LC	N-E	4	
Naja annulifera	Snouted Cobra	LC		2	
Naja nivea	Cape Cobra	LC		2	X
Colubridae Species:5 Conservation Important Species:0 Endemic & Near Endemic Species:0					
Crotaphopeltis hotamboeia	Red-lipped Snake	LC		3	
Dasypeltis scabra	Rhombic Egg-eater	LC		2	X
Dispholidus typus	Boomslang	LC		2	
Philthamnus semivariegatus	Spotted Bush Snake	LC		3	
Telescopus semiannulatus semiannulatus	Eastern Tiger Snake	LC		3	

Appendix 4. List of Amphibians.

List of Amphibians which may potentially occur within the greater area. Taxonomy notes are derived from Du Preez & Carruthers (2009) and Minter *et al*. (2004), while conservation status is according to Minter *et al*. (2004). List of reptiles which are known from the 2626AA and 2526CC Quarter Degree Squares, according to the SARCA database are also provided.

Colours Relate as follow:

» National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004); Threatened or Protected Species Regulations

- Endangered Species
- Vulnerable Species
- Protected Species

Likelihood Rating: 1=Confirmed; 2=Likely; 3=Moderate; 4=Unlikely & 5= May occur as a managed population

Species	Common Name	Threat Status Regional	Likelihood	ADU Database
BREVICIPITIDAE (RAIN FROGS) Species:1 Conservation Important Species:0				
Breviceps adspersus adspersus	Bushveld Rain Frog	LC	3	X
BUFONIDAE (TYPICAL TOADS, PYGMY TOADS & RED TOADS) Species:6 Conservation Important Species:0				
Amietophrynus gutturalis	Guttural Toad	LC	4	
Amietophrynus poweri	Western Olive Toad	LC	2	X
Amietophrynus rangeri	Raucous Toad	LC	4	
Schismaderma carens	Red Toad	LC	3	X
HYPEROLIIDAE (KASSINAS) Species:1 Conservation Important Species:0				
Kassina senegalensis	Bubbling Kassina	LC	2	X
MYCROHYLIDAE (RUBBER FROGS) Species:1 Conservation Important Species:0				
Phrynomantis bifasciatus	Banded Rubber Frog	LC	3	
PHRYNOBATRACHIDAE (PUDDLE FROGS) Species:1 Conservation Important Species:0				
Phrynobatrachus natalensis	Snoring Puddle Frog	LC	4	

PIPIDAE (PLATANNAS) Species:1 Conservation Important Species:0				
Xenopus laevis	Common Platanna	LC	4	
PYXICEPHALIDAE (CACOS, RIVER FROGS) Species:9 Conservation Important Species:1				
Cacosternum boettgeri	Boettger's Caco	LC	2	X
Amietia quecketti	Common River Frog	LC	4	
Amietia fuscigula	Cape River Frog	LC	4	
Pyxicephalus adspersus	Giant Bullfrog	NT	2	X
Tomopterna cryptotis	Tremolo Sand Frog	LC	2	X
Tomopterna krugerensis	Knocking Sand Frog	LC	3	
Tomopterna tandyi	Tandy's Sand Frog	LC	2	