Terrestrial Ecological and Avifauna Assessment
Proposed Bloemsmond 4 PV
Between Keimoes and Upington
Northern Cape Province

June 2019

APPLICANT

Bloemsmond Solar 4 (Pty) Ltd

ENVIRONMENTAL ASSESSMENT PRACTITIONER

Cape EAPrac
Dale Holder
082 448 9225
dale@cape-eaprac.co.za

PREPARED BY

Enviro-Insight CC
Corné Niemandt *(Pr. Sci. Nat.)*
corne@enviro-insight.co.za
Samuel Laurence *(Pr. Sci. Nat.)*
sam@enviro-insight.co.za
Alex Rebelo (M.Sc.)

Table of contents

List of Figures

List of Tables

1 INTRODUCTION

1.1 PROJECT DETAILS AND BACKGROUND

Enviro-Insight CC was commissioned by Bloemsmond Solar 4 (Pty) Ltd to perform a Terrestrial Ecological Assessment for the proposed Bloemsmond 4 project located near Keimoes in the Northern Cape Province, South Africa. This report was developed to conform to the requirements of an Appendix 6 level specialist assessment (NEMA 2014, as amended on 7 April 2017).

The PV energy facility is to consist of solar photovoltaic (PV) technology, fixed-tilt-, single-axis tracking- or dual-axis tracking-mounting structures, with a net generating capacity of 100 MW as well as associated infrastructure, which will include:

- On-site switching-station / substation;
- Auxiliary buildings (gate-house and security, control centre, office, warehouse, canteen & visitors centre, staff lockers etc.);
- Inverter-stations, transformers and internal electrical reticulation (underground cabling);
- Access and internal road network;
- Laydown area;
- Upington MTS (400/132 kV), via the 132kV Bloemsmond Collector Substation (either of, or a combination of, the approved Bloemsmond 1 and 2 Substations).
- Rainwater tanks; and
- Perimeter fencing and security infrastructure

The projects intend connecting to the National Grid via the Upington Main Transmission Substation (MTS). Bloemsmond 3 will connect at 132kV to the Upington MTS, via the 132kV Bloemsmond Collector Substation.

A typical PV tracker, tracks from -55° to 55° as per the cross section indicated in Figure 1-1. Infrastructure in the ground is limited to steel H beams that are rammed into the ground. These H beams are 150mm x 100mm and are placed about 10m apart. The torque tube which moves the panels is about 1m above the ground as indicated in Figure 1-2. The higher vegetation is slashed so that it does not impede the tracker, but otherwise no earthworks or removal of topsoil takes place.

1.2 STUDY AREA

The study area of approximately 270ha is located on Portion 5 and Portion 14 of the Farm Bloemsmond 455 in the Northern Cape Province. The proposed development is located south west of Upington and north east of Keimoes in the Kai !Garib Municipality in the ZF Mgcawu District Municipality in the Northern Cape (Figure 1-3; Figure 2-1).

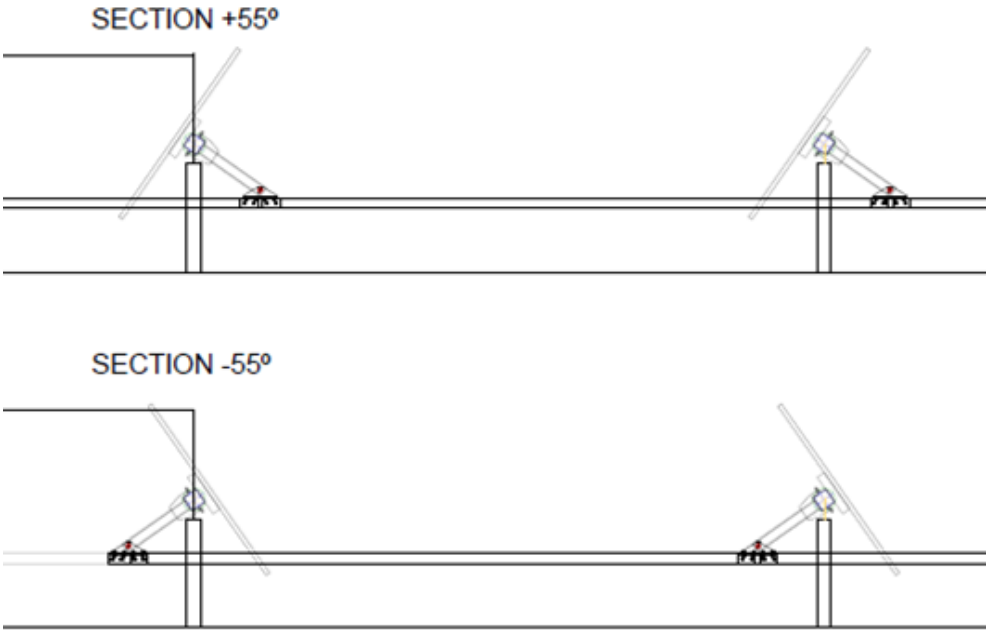


Figure 1-1: Cross section of a typical PV tracker ranging from -55° to 55°.

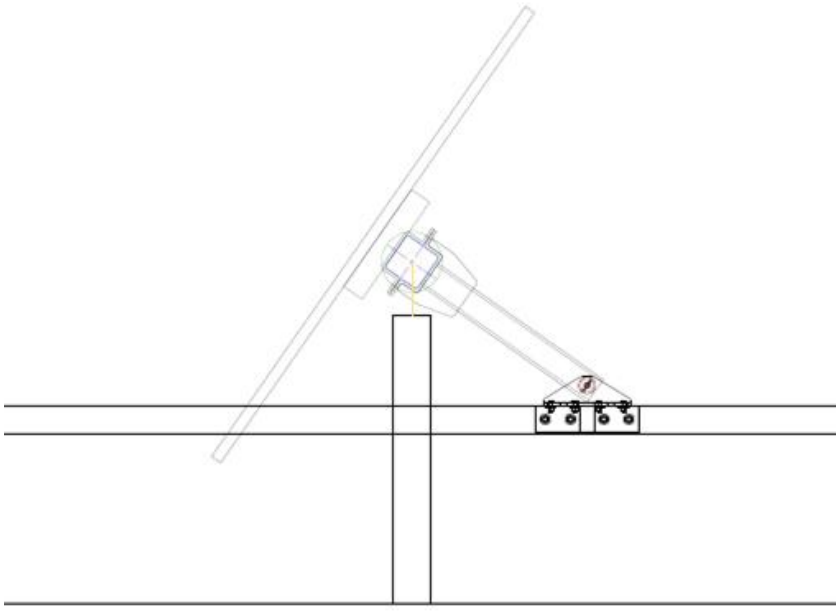


Figure 1-2: Steel H beams are rammed into the ground. The torque tube which moves the panels is about 1m above the ground.

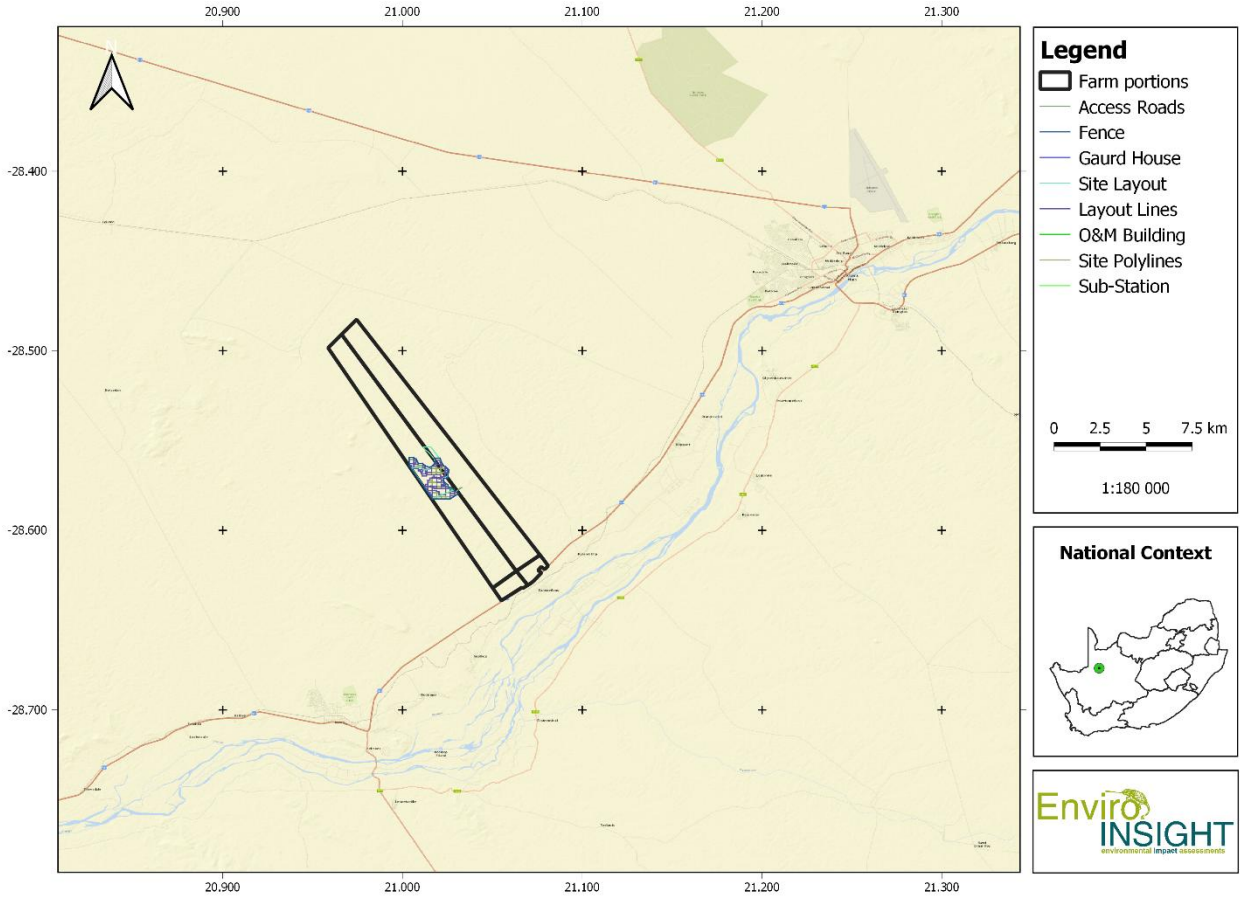


Figure 1-3: Locality of the study area of the proposed project.

1.3 STUDY LIMITATIONS

- It is assumed that all third party information acquired is correct (e.g. GIS data and scope of work);
- Due to the nature of most biophysical studies, it is not always possible to cover every square metre of a given study area. Due to the large study area, it is possible that small individual plant species of conservation concern (SCC) may have been overlooked even though care has been taken to search for specific SCC;
- Even though the site visit occurred at the end of the wet season (end of April), site conditions were dry as the region has experienced a drought since 2017 (pers. comm. from farmer). This impact together with overgrazing and browsing by cattle and antelope made identifying flora species difficult as leaves, flowers and/or fruit were not visible on plants. The number of annuals, forbs and graminoids recorded is relatively low and more species would be present in wetter years.
- A major potential limitation associated with sampling is the narrow temporal window. Ideally, a site should be visited during both the dry and wet season to ensure that the full complement of flora and fauna species present on site is

represented. However, this is rarely possible due to time and cost constraints and therefore, the species list compiled during sampling for this study is not a comprehensive list.

- The late-wet season timing had significant limitations regarding avifaunal migrants, many of which have left the region.
- The fauna lists for the site are based on those observed during the site visit as well as those expected to occur in the area based on their distribution and habitat preferences. Several site visits have also been conducted on the property and adjacent; accordingly information on the presence of fauna on the study area is well known. This represents a conventional and cautious approach with high confidence which takes the study limitations into account.
- The exact position of the concession area was not finalised until after the field investigation was complete. In addition, two other concessions were surveyed simultaneously during the study period. Therefore, the study is subject to some data extrapolation and interpretation from accompanying surveys.
- It is felt that individually, the concessions will have an Impact Analysis that is not representative (in their Scale, Magnitude and overall Severity) of the Cumulative Impact Assessment that may be applied to the Project Area of Influence which will show increased development of solar facilities.
- It is currently unknown where exactly supporting infrastructure (such as supporting roads and fences) will be placed within the study area which in turn may affect the Impact Analysis accuracy.

2 METHODS

2.1 DESKTOP SURVEY

2.1.1 GIS

Existing data layers were incorporated into a GIS to establish how the proposed study areas and associated activities interact with important terrestrial entities. Emphasis was placed on the following spatial datasets:

- Vegetation Map of South Africa, Lesotho and Swaziland (Mucina & Rutherford, 2018);
- Northern Cape Critical Biodiversity Areas (Northern Cape Department of Environment and Nature Conservation, 2016);
- Important Bird Areas (BirdLife South Africa, 2015);
- Protected and Conservation areas of South Africa (South Africa Protected Areas Database-SAPAD; South Africa Conservation Areas Database-SACAD)[1]; and
- National List of Threatened Ecosystems (SANBI, 2011).

All mapping was performed using open source GIS software (QGIS[2]).

[1] http://dea.maps.arcgis.com/apps/MapTools/index.html?appid=2367540dd75148e8b6eaeab178a19d3a
2 http://qgis.osgeo.org/en/site/

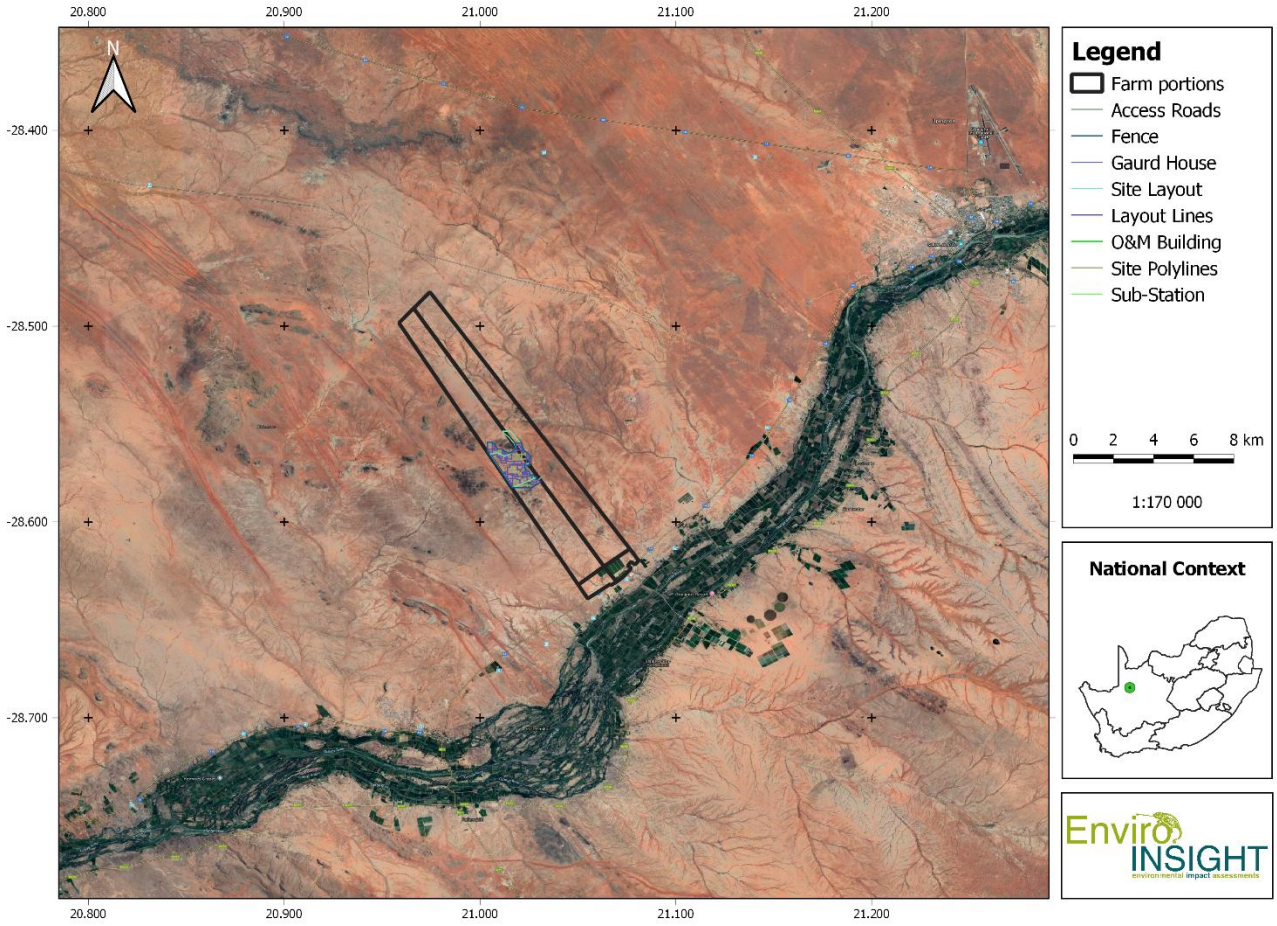


Figure 2-1: Locality of the study area indicating farm portions.

2.1.2 Flora Assessment

A literature review was conducted as part of the desktop study to identify the potential habitats and flora species of conservation concern (SCC) present within the study area. The South African National Biodiversity Institute (SANBI) provides an electronic database system, namely the Botanical Database of Southern Africa (BODATSA) (SANBI, 2016[3]), to access distribution records on southern African plants[4]. This is a new database which replaces the old Plants of Southern Africa (POSA) database. The POSA database provided distribution data of flora at the quarter degree grid cell (QDGC) resolution; however, the BODATSA database provides distribution data as point coordinates. The literature study therefore, focussed on querying the database to generate species lists for the xMin, yMin 20.20°,-29.20° : xMax, yMax 21.4°,-28.20° extent (WGS84 datum) in order to increase the likelihood of obtaining a representative species list for the proposed study area. A total of 86 species were recorded for the mentioned location.

3 http://newposa.sanbi.org/
4 Data are obtained from the National Herbarium in Pretoria (PRE), the Compton Herbarium in Cape Town (NBG & SAM) and the KwaZulu-Natal Herbarium in Durban (NH)

The Red List of South African Plants website (SANBI, 2019)[5] was utilized to provide the most current account of the national status of flora. Relevant field guides and texts consulted for identification purposes in the field during the surveys included the following:

- Guide to grasses of southern Africa (Van Oudtshoorn, 2014);
- Field guide to trees of southern Africa (Van Wyk & Van Wyk, 2013);
- Field guide to succulents of southern Africa (Smith *et al*. 2017);
- Field guide to wild flowers of South Africa (Manning, 2019);
- Problem plants and alien weeds of South Africa (Bromilow, 2019); and
- Identification guide to southern African grasses: An identification manual with keys, descriptions and distributions (Fish, Mashau, Moeaha, & Nembudani, 2015).

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

- The Vegetation of South Africa, Lesotho and Swaziland (Mucina & Rutherford, 2010); and
- Red List of South African Plants (Raimondo *et al*., 2009; SANBI, 2019).

2.1.3 Avifauna Assessment

A desktop study was undertaken in which bird species that could potentially occur in the vicinity of the Welgedacht C study area were identified using data from the second South African Bird Atlas Project (SABAP 2; [SABAP2, 2019]). SABAP 2 records were developed based on records per pentad (i.e., 5' X 5'). To account for the high mobility of birds (inherent to linked habitats such as linear drainage lines), and the fact that atlas efforts are generally lower in remote areas, particularly away from public roads, a list of species potentially occurring within the study area was developed from SABAP 2 data for the pentads within the quarter degree grid cells (QDGCs) 2820DB and 2821CA within which the study are falls, as well as all adjacent QDGCs pentads. This species list is therefore based on an area much larger than the actual study area. This approach was adopted to ensure that all species potentially occurring within the study area, whether resident, nomadic, or migratory, are identified.

5 http://redlist.sanbi.org/

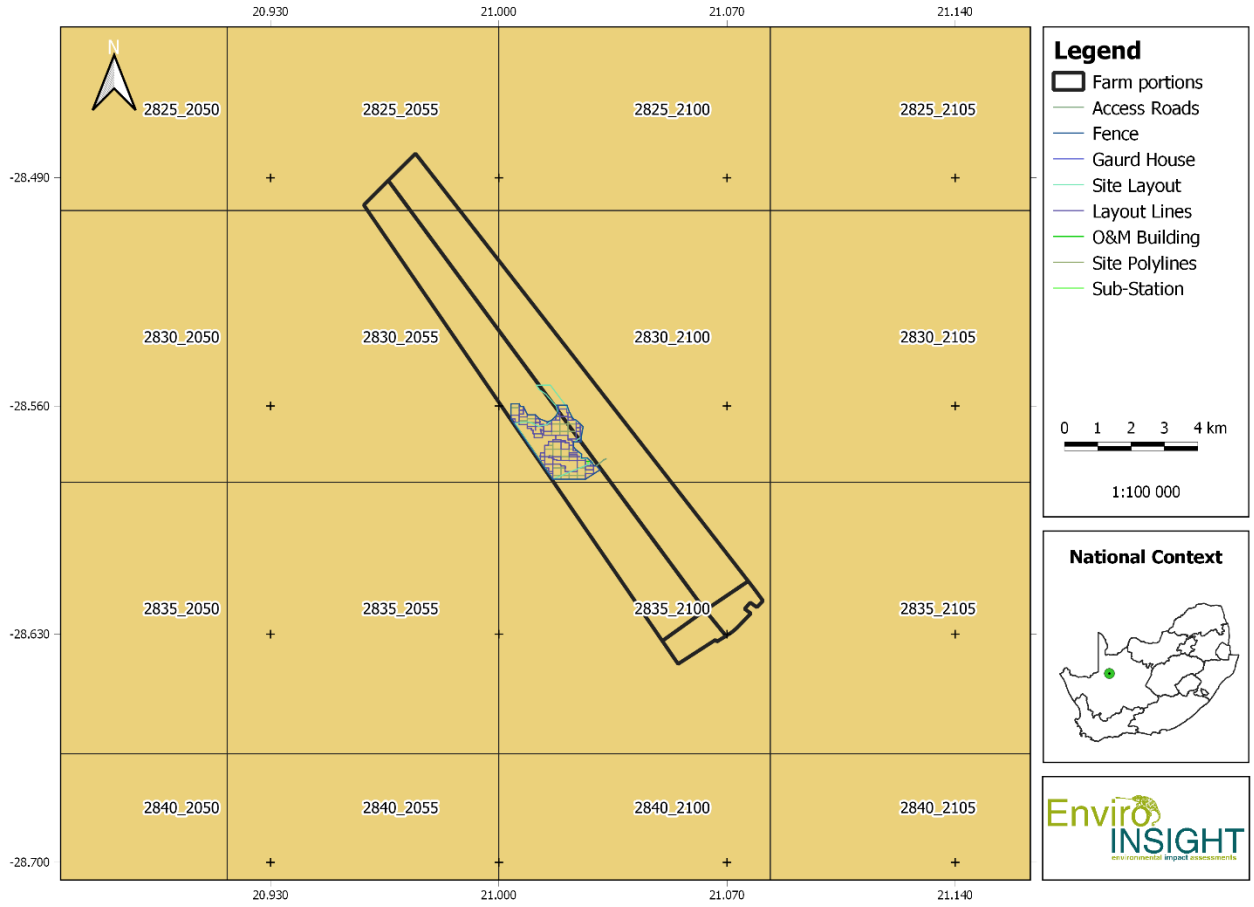


Figure 2-2: The study area in relation to the SABAP2 pentads.

The following main literature sources have been consulted for the avifauna study:

- Information relating to avifauna species of conservation concern (SCC) was obtained from the Southern Africa Bird Atlas Project (SABAP 2, 2019), Hockey *et al.* (2005) and Taylor *et al.* (2015);
- Hockey *et al.* (2005) were consulted for general information on the life history attributes of relevant bird species; and
- The conservation status of bird species is categorised according to Taylor *et al.* (2015) the IUCN Red List of threatened species (IUCN, 2019); and
- Avifaunal Impact Assessment: Proposed construction of the AEP Bloemsmond Solar 2 Photovoltaic (PV) facility and associated infrastructure, Kai !Garib Local Municipality (Widdows 2015).

2.1.4 Mammal Assessment

The list of mammal species predicted to occur in the region and their respective likelihood of occurrence within the study area was generated based on known distributions and habitat suitability, sourced from online and literature sources such as MammalMap (2019), Skinner & Chimimba (2005) and Stuart & Stuart (1998). The literature study focussed on querying the

MammalMap database to generate species lists for the 2820DB and 2821CA QDGCs (Figure 2-3). The predicted list is heavily influenced by factors other than just distribution or biome type. Factors such as habitat suitability, current land use, current levels of disturbance and structural integrity of the habitats all influence the potential for a species to occur in the vicinity of study area. The key literature sources used during the mammal literature review included:

- MammalMAP (2019) - The online Virtual Museum (VM) facility of the Animal Demography Unit (ADU) of the University of Cape Town (http://vmus.adu.org.za);
- Mammal SCC information was obtained from Child *et al.* (2017);
- Lists of nationally protected species according to NEMBA (2004, as amended);
- Liebenberg (2005) and Stuart & Stuart (1998) were consulted to aid with identification of tracks and signs;
- Geographic distribution and general data were acquired from MammalMap (2019) and from Skinner & Chimimba (2007); and
- Minimum standards regarding the sampling of mammals were acquired from (Sutherland, 2006).

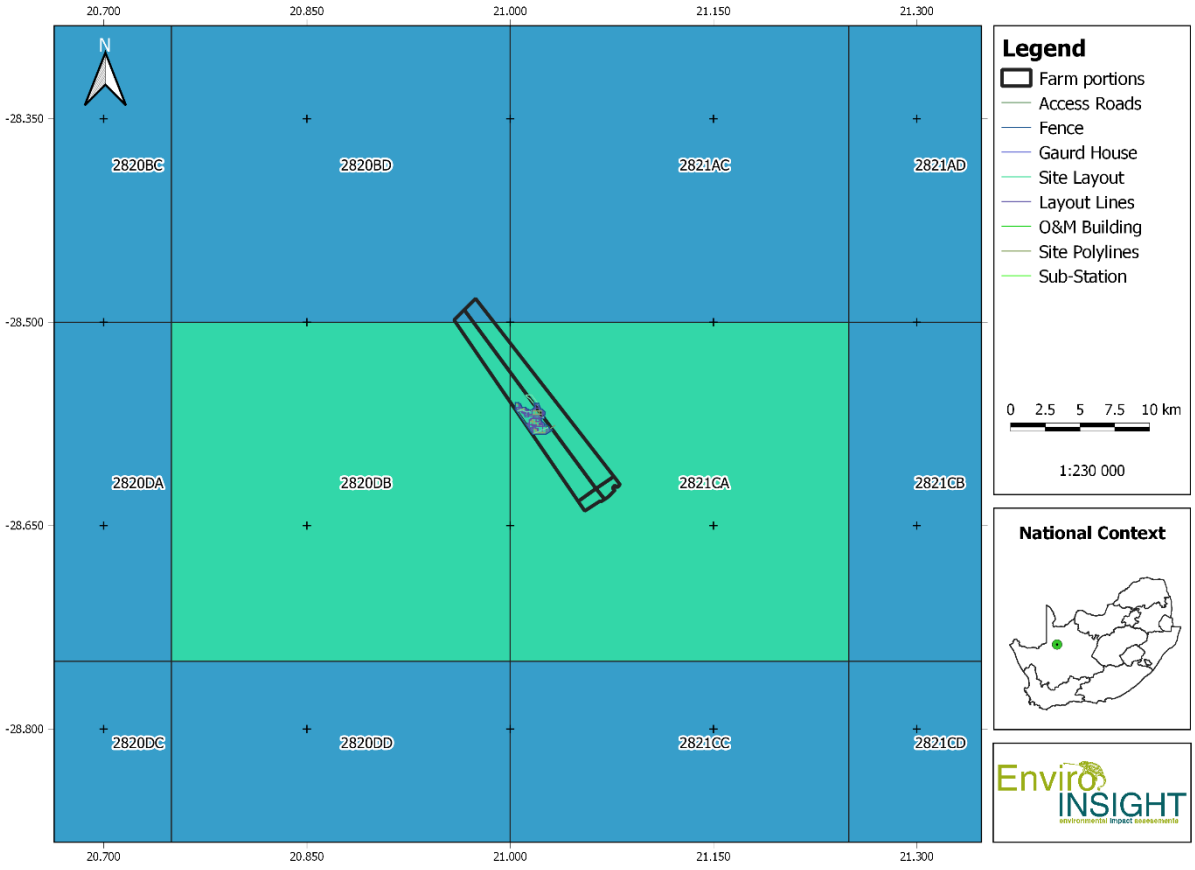


Figure 2-3: Quarter degree grid cell relevant to the study area.

Finally, the very nature of mammals is that they occupy several different niches and are represented by a vast diversity of body size/ types that perhaps exceed other vertebrate types (birds, reptiles etc). For example, rodents will occupy entirely different niches to apex predators (leopard/ caracals) and must therefore be evaluated in different ways. In addition, there is a high likelihood that not all mammal species known to occur within the study area and surrounding areas will be located during a particular survey. The relevant species of special consideration were addressed separately based on the data collected during the wet season fieldwork studies, in context with the proposed development and the potential effects on the species.

2.1.5 Herpetofauna Assessment

Relevant databases, field guides and texts were consulted for the desktop and literature study included the following:

- The online Virtual Museum (VM) facility of the Animal Demography Unit (ADU) of the University of Cape Town (http://vmus.adu.org.za) and iNaturalist (https://inaturalist.org) were queried for the presence of reptile (ReptileMAP, 2019) and amphibian (FrogMAP, 2019) species within the QDGC in which the proposed development is situated (2821CA), the nearby QDGC (2820DB), as well as the ten surrounding QDGC's (2820BC, 2820BD, 2821AC, 2821AD, 2821CB, 2821CD, 2821CC, 2820DD, 2820DB; see Figure 2-3; due to the low sampling effort in the area, these additional QDGC's are justified);
- Reptile SCC information was obtained from Bates *et al.* (2014); and
- Amphibian SCC information was obtained from Du Preez & Carruthers (2017). Minter *et al.* (2004) has been the official reference used to provide the local conservation status of amphibians but because this reference is outdated, Du Preez & Carruthers (2017) was preferentially referenced.

Reptile species nomenclature follows ReptileMAP (2019) as new distribution data and taxonomic changes have already occurred since publication of Bates *et al.* (2014). Similarly, the Frog Atlas of Southern Africa (FrogMAP, 2019) provides information on the geographic distributions of amphibians and keeps current with the latest taxonomic changes. The use of these online facilities is justified as it not only includes the latest verified publicly contributed data but also a complete record of the museum material in South Africa. Drawing expected species lists for the surrounding QDGC's decreases the likelihood of underestimating the number of species present within the focal QDGC but also artificially inflates the total number of species likely to occur within the focal QDGC (some habitats may be present in adjacent QDGC's that are not present in the focal QDGC). Therefore, the resulting species list drawn from the twelve QDGC's was heavily refined to exclude those species unlikely to occur within the project area, based on habitat availability and knowledge of habitat selection by particular species. As a precautionary measure, species with a low probability of occurrence within the project area were included in the predicted list.

2.2 FIELD SURVEYS

A site visit was performed in April 2019 (representing the late wet season) by a botanist and zoologist where the floral and the faunal aspects of the survey area were rapidly evaluated. The timing of the surveys represented late wet season conditions which were suboptimal. It should be noted that poor rainfall in the last couple of years made conditions less optimal for botanical work. Accordingly, many species were not in flower and have lost their vegetative parts which made species identification difficult.

During the field surveys performed, the habitats were evaluated on foot and a series of georeferenced photographs were taken of the habitat attributes. The field surveys focused on a classification of the observed fauna and flora, habitats as well as the actual and potential presence of species of conservation concern (either classified as Threatened by the IUCN (2019), protected by NEMBA (2014) or indeed other legislations applicable provincially or nationally). An analysis of the diversity and ecological integrity of the habitats present on site was also performed.

2.3 SPECIES OF CONSERVATION CONCERN

The Red List of threatened species generated by the IUCN (http://www.iucnredlist.org/) provided the global conservation status of terrestrial fauna and flora. However, regional conservation status assessments performed following the IUCN criteria were considered to be the most relevant and sourced for each group as follows:

- Plants: Red List of South African plants version 2017.16 and Raimondo *et al*. (2009);
- Reptiles: Bates *et al.* (2014);
- Amphibians: Du Preez & Carruthers (2017);
- Mammals: Child *et al.* (2016); and
- Avifauna: Taylor *et al*. (2015).

The conservation status categories defined by the IUCN (Figure 2-4), which are considered here to represent species of conservation concern, are the "threatened" categories defined as follows:

- **Critically Endangered (CR)** - Critically Endangered refers to species facing immediate threat of extinction in the wild.
- **Endangered (EN)** - Endangered species are those facing a very high risk of extinction in the wild within the foreseeable future.
- **Vulnerable (VU)** - Vulnerable species are those facing a high risk of extinction in the wild in the medium-term.

6 http://redlist.sanbi.org/index.php

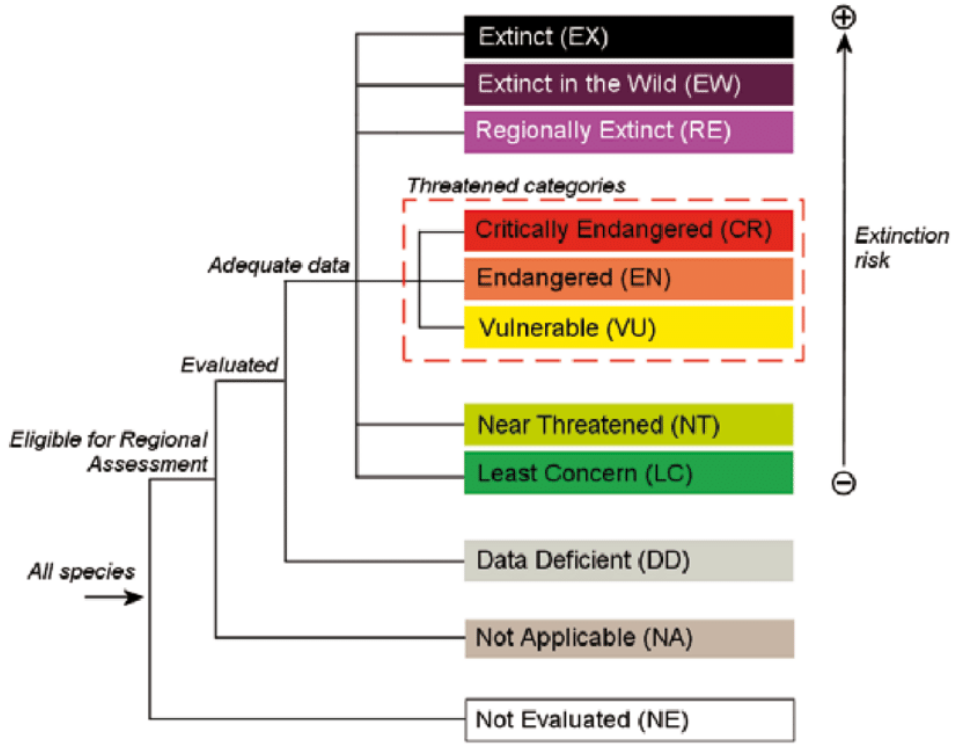


Figure 2-4: Schematic representation of the structure of the IUCN Red List Categories (IUCN 2012).

Other measures of conservation status include species listed under the following:

- Trade in Protected Species (TOPS; National)
- Convention on International Trade in Endangered Species (CITES; International)

2.4 IMPACT ASSESSMENT

The following lists of impacts were evaluated against the data captured during the fieldwork to identify relevance to the study area. The relevant impacts were then subjected to a prescribed Impact Analysis methodology which is also described below. Mitigation measures were only developed for impacts deemed relevant on the basis of the Impact Analysis.

2.4.1 Potential Flora Impacts

1. Loss, destruction and/or eradication of critically endangered/endangered plant species;
2. Impact on plant communities of particular scientific, conservation or education value;
3. Impact on sensitive plant ecological systems;
4. Decrease in diversity of natural plant communities;
5. Possibility to enhance the spread of invasive and/or alien plants and declared weeds;
6. Threat to the ecological functioning of natural plant communities due to:
    - Isolation of plant communities by destruction of habitat;

- Reduction in the effective size of habitat/community; and
- Physical destruction of the habitat.

7. Degradation of plant habitat through:
   - Compaction of the topsoil through trampling, vehicles, machinery etc.;
   - Introduction and/or spread of invasive alien species - creation of dispersal sites; and
   - Potential for bush encroachment through disturbance of topsoil.

2.4.2 Potential Fauna Impacts

1. Loss and/or displacement of critically endangered/endangered animal species;
2. Impact on natural communities of particular scientific, conservation or education value;
3. Impact on natural movement of species (flight pathways etc.);
4. Disturbance of non-resident or migrant species (birds over-wintering, breeding);
5. Decrease in diversity of natural animal communities;
6. Decrease in availability and reliability of food sources for animal communities;
7. Possibility to introduce and/or enhance the spread of alien animal species;
8. Threat to the ecological functioning of natural terrestrial communities due to:
   - Isolation of animal communities by destruction of habitat; and
   - Physical destruction of the habitat.
   - Construction of barriers to animal movement or migration.

2.4.3 Impact Analysis

Direct, indirect and cumulative impacts of the issues identified during the specialist investigations were assessed in terms of these six standard rating scales to determine their significance. The rating system used for assessing impacts (or when specific impacts cannot be identified, the broader term issue should apply) is based on five criteria, namely:

- **Status of impacts** (Table 2-1) – determines whether the potential impact is positive (positive gain to the environment), negative (negative impact on the environment), or neutral (i.e. no perceived cost or benefit to the environment). Take note that a positive impact will have a low score value as the impact is considered favourable to the environment;
- **Extent of impacts** (Table 2-2) – determines the spatial scale of the impact on a scale of localised to global effect. Potential impact is expressed numerically on a scale of 1 (site-specific) to 5 (global);
- **Duration of impacts** (
- Table 2-3) – determines the extent of the impact in terms of timescale and longevity. Potential impact is expressed numerically on a scale of 1 (project duration) to 5 (permanent);

Magnitude of impacts (

- Table 2-4) – quantifies the impact in terms of the magnitude of effect on environment (receptor) and is derived by consideration of points 1, 2 and 3 above. For this particular study, a conservative approach is adopted for severity (e.g.

where spatial impact was considered to be 2 and temporal impact was considered to be 3, a value of 3 would be adopted as a conservative estimate for severity of impact); and

- **Probability of impacts** (Table 2-5) – quantifies the impact in terms of the likelihood of the impact occurring on a percentage scale of <5% (improbable) to >95% (definite).

Table 2-1: Status of Impacts

Rating	Description	Quantitative Rating
Positive	A benefit to the receiving environment (positive impact)	+
Neutral	No determined cost or benefit to the receiving environment	N
Negative	At cost to the receiving environment (negative impact)	-

Table 2-2: Extent of Impacts

Rating	Description	Quantitative Rating
Very Low	**Site Specific** – impacts confined within the project site boundary	1
Low	**Proximal** – impacts extend to within 1 km of the project site boundary	2
Medium	**Local** – impacts extend beyond to within 5 km of the project site boundary	3
High	**Regional** – impacts extend beyond the site boundary and have a widespread effect - i.e. > 5 km from project site boundary	4
Very High	**Global** – impacts extend beyond the site boundary and have a national or global effect	5

Table 2-3: Duration of Impacts

Rating	Description	Quantitative Rating
Very Low	**Project duration** – impacts expected only for the duration of the project or not greater than 1 year	1
Low	**Short term** – impacts expected on a duration timescale of 1 to 2 years	2
Medium	**Medium term** – impacts expected on a duration timescale of 2-5 years	3
High	**Long term** – impacts expected on a duration timescale of 5-15 years	4
Very High	**Permanent** – impacts expected on a duration timescale exceeding 15 years	5

Table 2-4: Severity of Impacts

Rating	Description	Quantitative Rating
Very Low	Negligible – zero or very low impact	1
Low	Site specific and short term impacts	2
Medium	Local scale and / or short term impacts	3
High	Regional and / or long term impacts	4
Very High	Global scale and / or permanent environmental change	5

Table 2-5: Probability of Impacts

Rating	Description	Quantitative Rating

Highly Improbable	Likelihood of the impact arising is estimated to be negligible; <5%.	1
Improbable	Likelihood of the impact arising is estimated to be 5-35%.	2
Possible	Likelihood of the impact arising is estimated to be 35-65%	3
Probable	Likelihood of the impact arising is estimated to be 65-95%.	4
Highly Probable	Likelihood of the impact arising is estimated to be > 95%.	5

These five criteria are combined to describe the overall significance rating (Table 2-6). Calculated significance of impact – determines the overall impact on (or risk to) a specified receptor and is calculated as: the product of the probability (P) of the impact occurring and the severity (S) of the impact if it were to occur (Impact = P × S). This is a widely accepted methodology for for calculating risk and results in an overall impact rating of Low (L), Low/Medium (LM), Medium (M), Medium/High (MH) or High High (H). The significance of a particular impact is depicted in

Table 2-7 and assigned a particular colour code in relation to its severity.

Table 2-6: Significance of Impacts

Rating	Description		Quantitative Rating
Low	P x S = 1-3	(low impact significance)	**L**
Low/Medium	P x S = 4-5	(low/medium impact significance)	**LM**
Medium	P x S = 6-9	(medium impact significance)	**M**
Medium/High	P x S = 10-14	(medium/high impact significance)	**MH**
High	P x S = 15-25	(High impact significance)	**H**

Table 2-7: Perceived Significance of Impacts

Probability (P)	Severity (S)				
	1	2	3	4	5
1	L	L	L	LM	LM
2	L	LM	M	M	MH
3	L	M	M	MH	H
4	LM	M	MH	H	H
5	LM	MH	H	H	H

The impact significance rating should be considered by authorities in their decision-making process based on the implications of ratings ascribed below:

- **Insignificant**: the potential impact is negligible and will not have an influence on the decision regarding the proposed development;
- **Low**: the potential impact is very small and should not have any meaningful influence on the decision regarding the proposed development;

- **Low/Medium**: the potential impact may not have any meaningful influence on the decision regarding the proposed activity/development;
- **Medium**: the potential impact should influence the decision regarding the proposed activity/development;
- **Medium/High**: the potential impact will affect the decision regarding the proposed activity/development; and
- **High**: the proposed activity should only be approved under special circumstances.

Practicable mitigation and optimisation measures are recommended and impacts are rated in the prescribed way both without and with the assumed effective implementation of the recommended mitigation (and/or optimisation) measures. Mitigation and optimisation measures are either:

- Essential: measures that must be implemented and are non-negotiable; or
- Best Practice: recommended to comply with best practice, with adoption dependent on the proponent's risk profile and commitment to adhere to best practice, and which must be shown to have been considered and sound reasons provided by the proponent if not implemented.

3 RESULTS

3.1 REGIONAL VEGETATION

The study area is located in the Kalahari Karroid Shrubland (Least threatened) and Bushmanland Arid Grassland (Least threatened) vegetation types (Figure 3-1). The study area is not located in a threatened ecosystem (Figure 3-2). The Lower Gariep Alluvial Vegetation threatened ecosystem is located south of the study area.

Kalahari Karroid Shrubland vegetation type is endemic to the Northern Cape Province (**Error! Reference source not found.**). The vegetation type is characteristic of forming belts alternating with belts of Gordonia Duneveld on plains northwest of Upington through Lutzputs and Noenieput to the Rietfontein/Mier area in the north. Other patches occur around Kakamas and north of Groblershoop. The unit is also found in the neighbouring Namibia. The vegetation can be described as low karroid shrubland on flat, gravel plains. Karoo-related and northern floristic elements such as shrubs meet here, indicating a transition to the Kalahari region and sandy soils. Altitude varies mostly from 700 - 1100 m.

The conservation target is set at 21% with very little statutorily conserved in the Augrabies Falls National Park. Although only a small area has been transformed many of the belts of this type were preferred routes for early roads, thus promoting the introduction of alien plants (about a quarter of the unit has scattered *Prosopis* species). Erosion is very low (94%) (Mucina & Rutherford, 2010).

Table 3-1: Attributes of the Kalahari Karroid Shrubland vegetation type.

Name of vegetation type	Kalahari Karroid Shrubland
Code as used in the Book - contains space	NKb5
Conservation Target (percent of area) from NSBA	21%
Protected (percent of area) from NSBA	0.1%
Remaining (percent of area) from NSBA	99.2%

Description of conservation status from NSBA	Least threatened
Description of the Protection Status from NSBA	Hardly protected
Area (km^2) of the full extent of the Vegetation Type	8283.90
Name of the Biome	Nama-Karoo

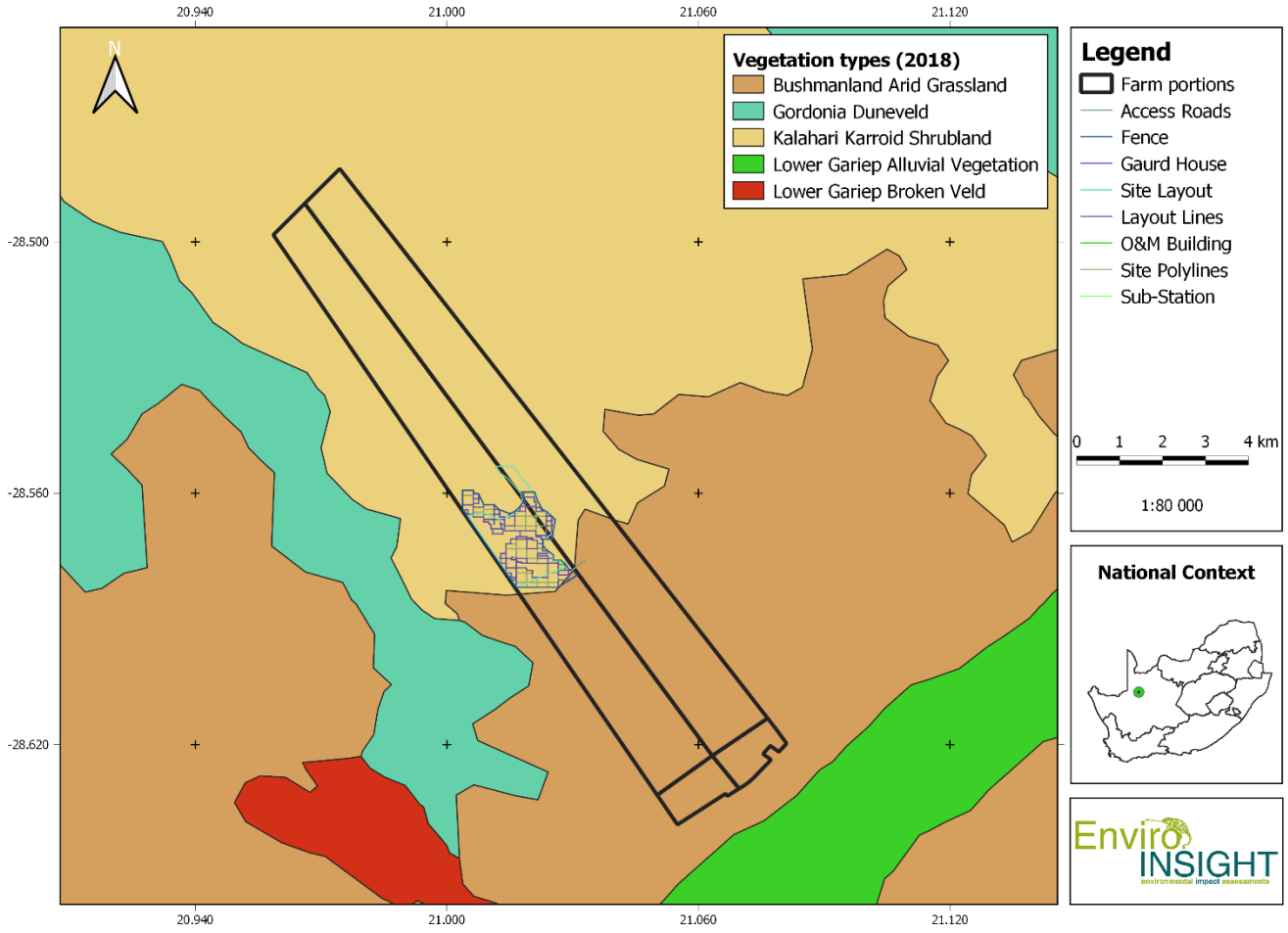


Figure 3-1: Regional vegetation types in relation to the study area (Mucina & Rutherford, 2018).

The Bushmanland Arid Grassland vegetation type occurs only in the Northern Cape Province (Table 3 2). It spans about one degree of latitude from around Aggeneys in the west to Prieska in the east. The southern border of the unit is formed by edges of the Bushmanland Basin while in the northwest this vegetation unit borders on desert vegetation (northwest of Aggeneys and Pofadder). The northern border (in the vicinity of Upington) and the eastern border (between Upington and Prieska) are formed with often intermingling units of Lower Gariep Broken Veld, Kalahari Karroid Shrubland and Gordonia Duneveld. Most of the western border is formed by the edge of the Namaqualand hills. Altitude varies mostly from 600–1 200 m. The

conservation target is set at 21% with only small patches statutorily conserved in Augrabies Falls National Park and Goegab Nature Reserve. Very little of the area has been transformed. Erosion is very low (60%) and low (33%) (Mucina & Rutherford, 2010).

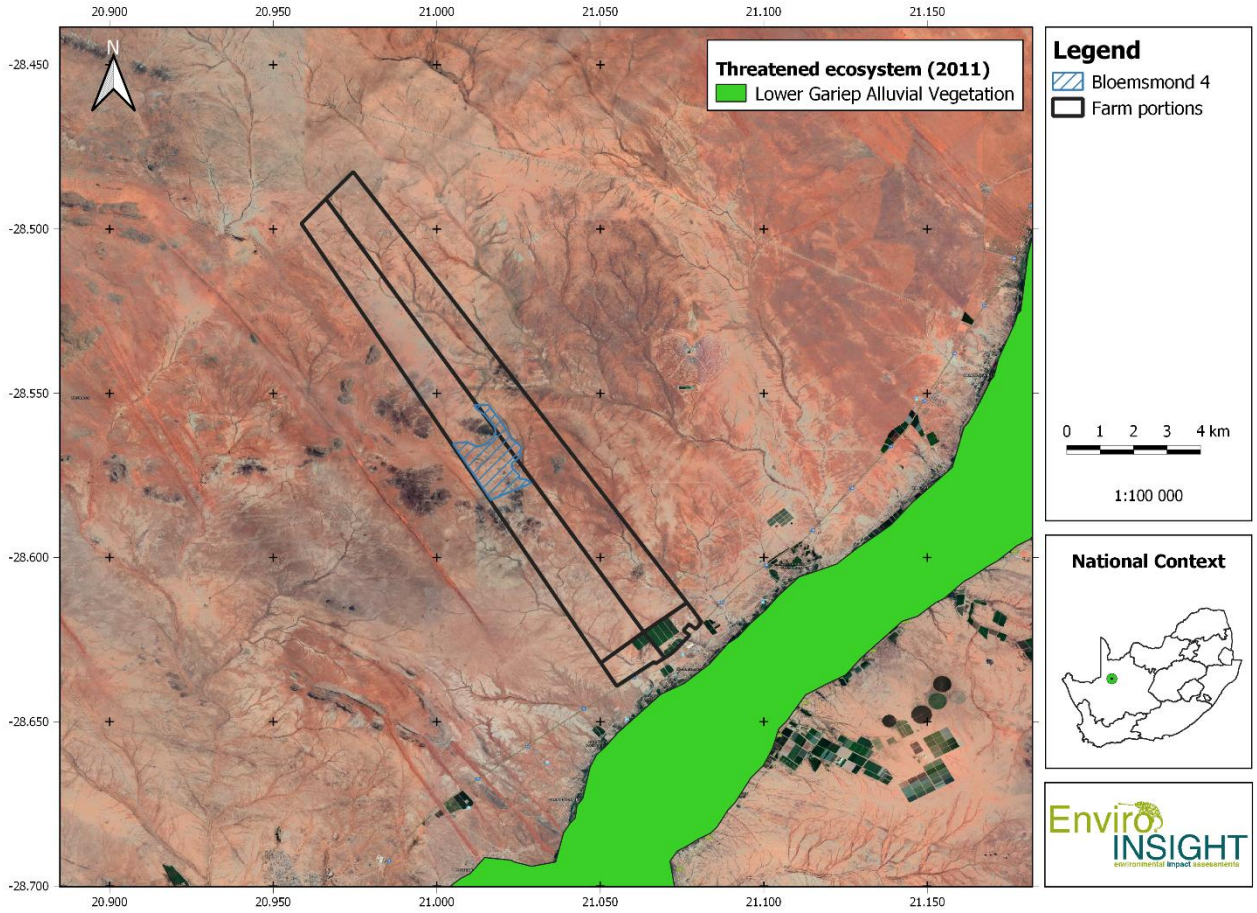


Figure 3-2: The study area in relation to threatened ecosystems.

Table 3-2: Attributes of the Bushmanland Arid Grassland vegetation type.

Name of vegetation type	
Code as used in the Book - contains space	NKb3
Conservation Target (percent of area) from NSBA	21%
Protected (percent of area) from NSBA	0.4%
Remaining (percent of area) from NSBA	99.4%
Description of conservation status from NSBA	Least threatened
Description of the Protection Status from NSBA	Hardly protected

Area (km²) of the full extent of the Vegetation Type	45478.96
Name of the Biome	Nama-Karoo

3.2 NORTHERN CAPE CRITICAL BIODIVERSITY AREAS

The Northern Cape CBA Map (2016) identifies biodiversity priority areas, called Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs), which, together with protected areas, are important for the persistence of a viable representative sample of all ecosystem types and species as well as the long-term ecological functioning of e landscape as a whole.

The Northern Cape Critical Biodiversity Area (CBA) Map updates, revises and replaces all older systematic biodiversity plans and associated products for the province. According to the CBA Map, the study area is located in the category "Other Natural Areas" (Figure 3-3).

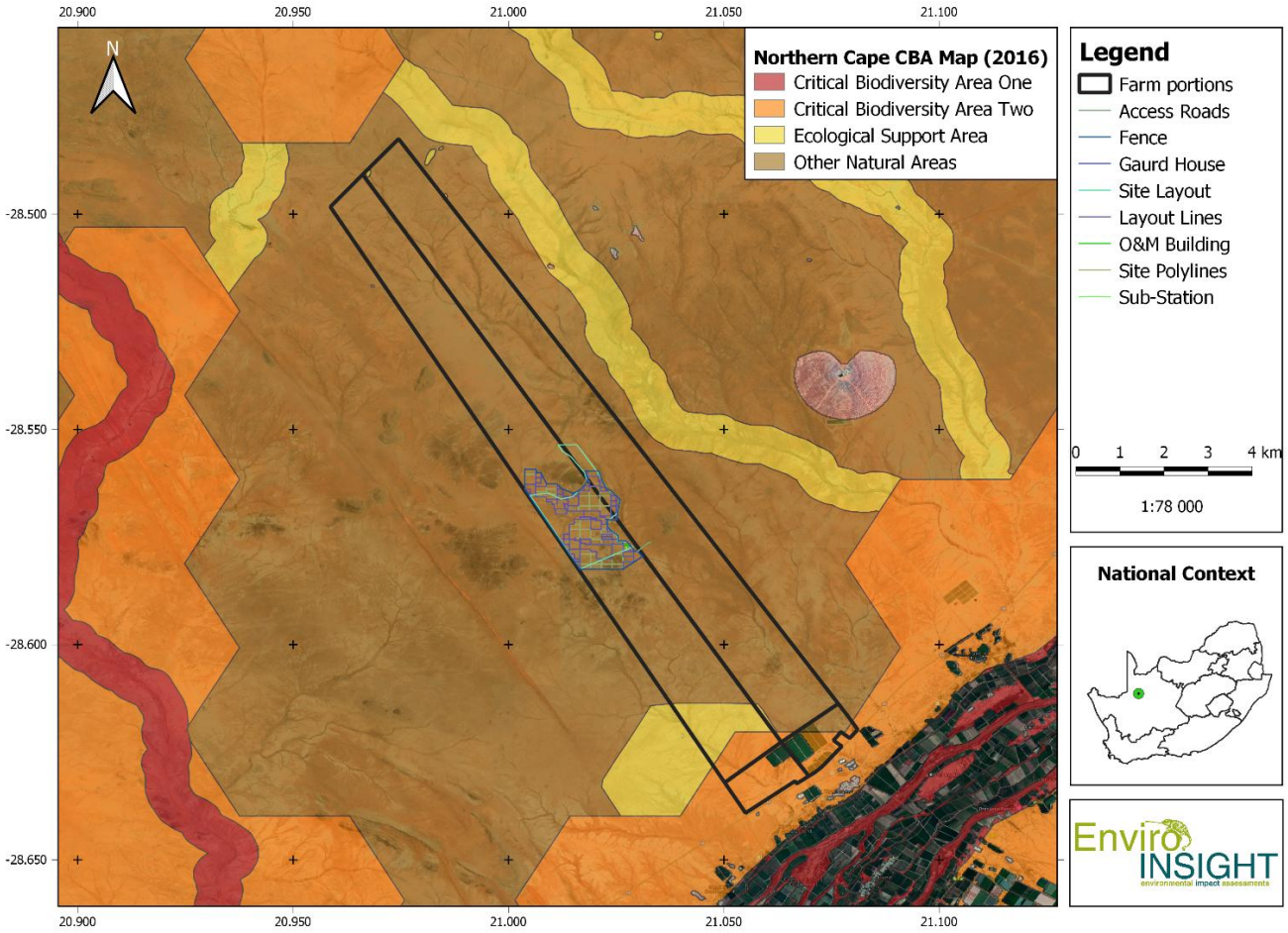


Figure 3-3: The study area in relation to the Northern Cape Critical Biodiversity Areas (2016).

3.3 OVERVIEW AND CURRENT IMPACTS

Two natural macro habitats were identified and some areas were disturbed due to cattle and game farming activities (Figure 3-4). The specialist GPS tracks as well as the location of the georeferenced photos taken during the field survey are shown in Figure 3-5. The georeferenced photographs (Appendix 1) serve to assist in both the site characterisation as well as the sensitivity analysis and provide lasting evidence for future queries. The specialist coverage was considered to be semi-optimal considering the large study area. Furthermore, all areas of the study area were clearly visible and accessible.

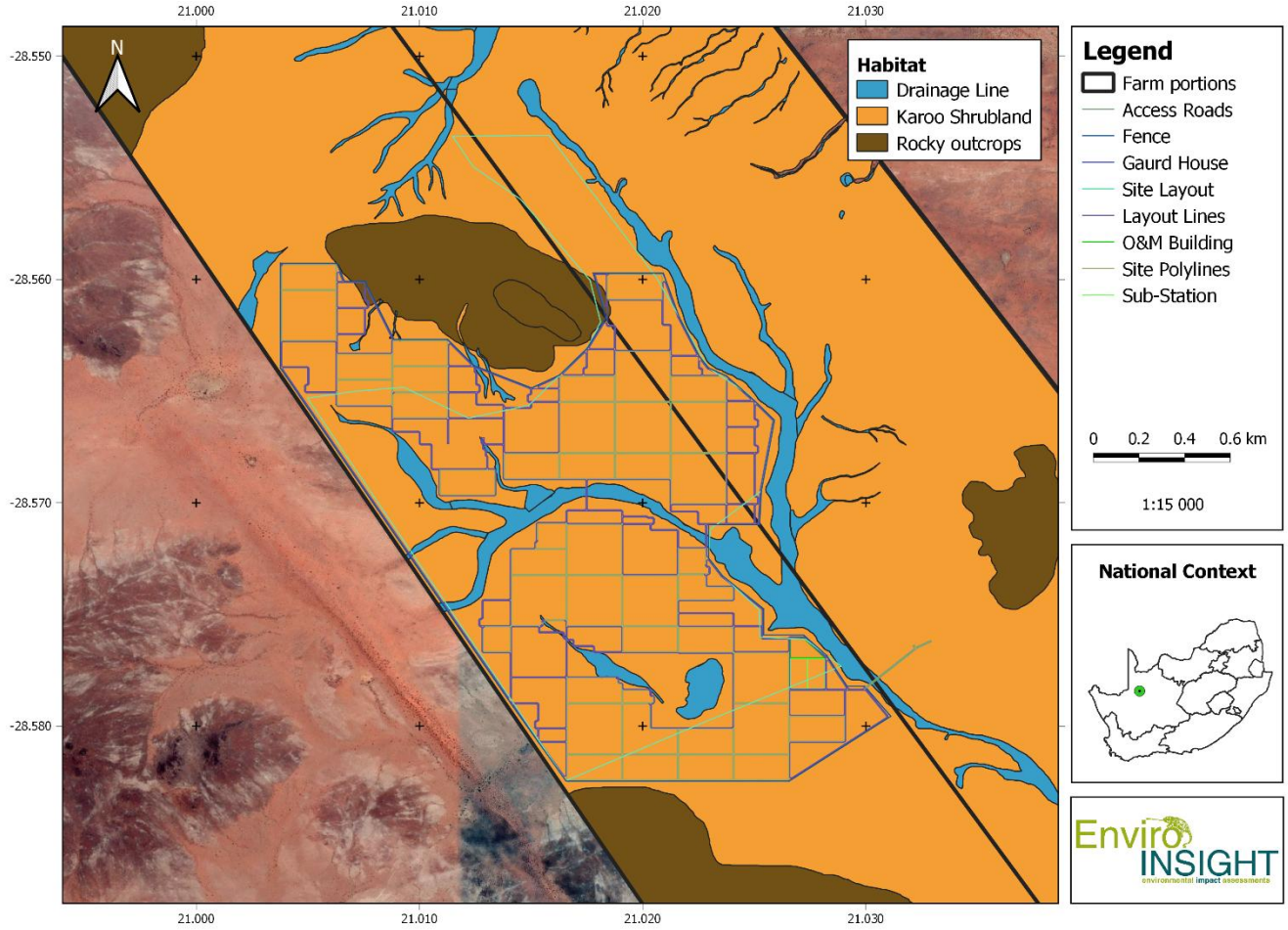


Figure 3-4: Habitats identified for the study area.

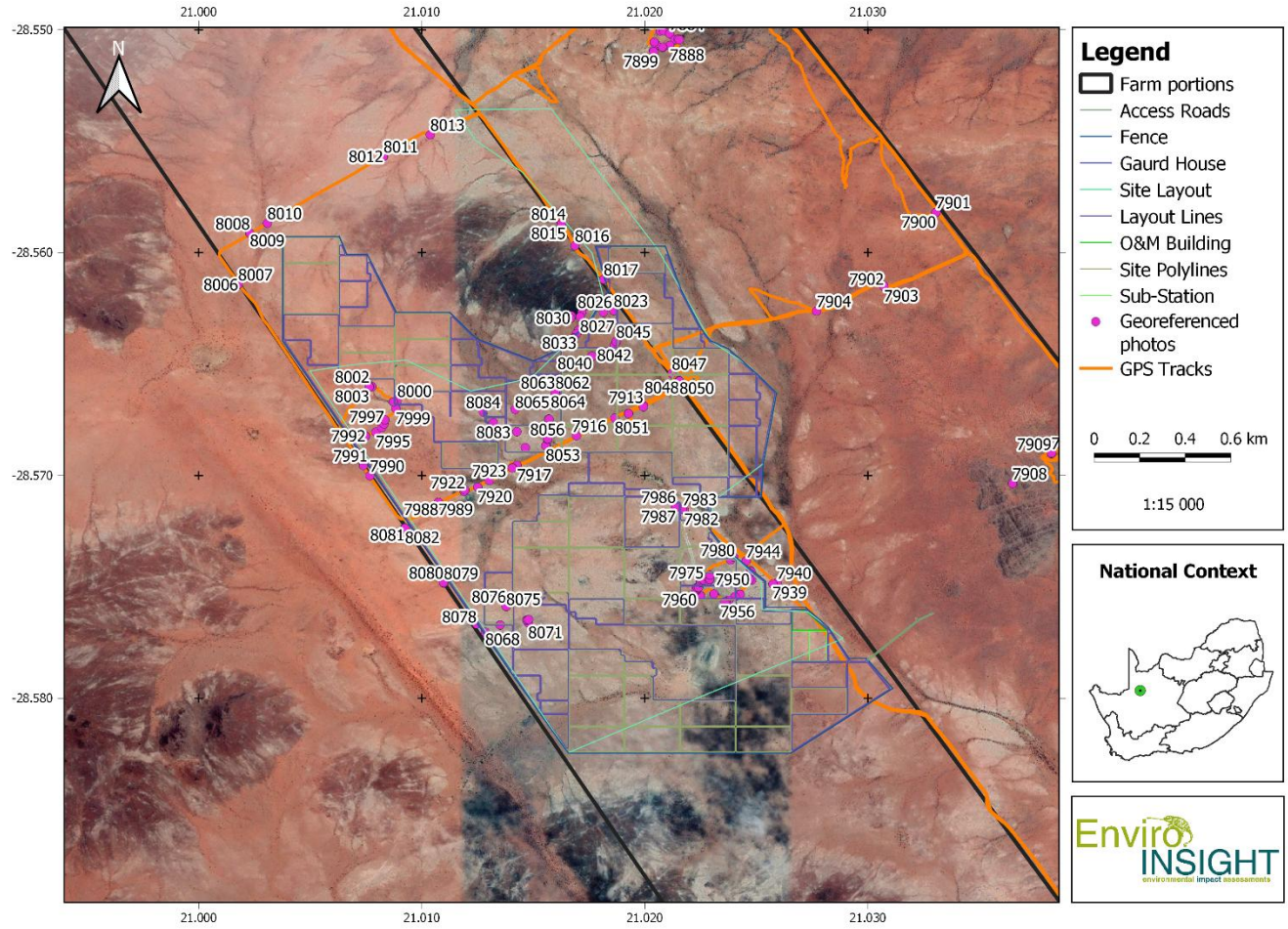


Figure 3-5: Specialist coverage (GPS tracks) and location of georeferenced photographs taken during the field surveys.

3.3.1 Shrubland

This dwarf shrubland is found on the plains between the drainage lines on site. (Figure 3-6) The Shrubland habitat is characterised by shrubs, forbs and succulents characteristic of the Kalahari and sandy soils. A list of species recorded in this habitat is provided in **Error! Reference source not found.**.

Protected species (for which a permit for removal will be required) include: *Aloe claviflora, Avonia albissima, Boscia albitrunca, Boscia foetida subsp. foetida, Euphorbia gariepina subsp. gariepina, Mesembryanthemum sp., Vachellia erioloba*

The grass layer is poorly recorded due to a combination of overgrazing and late season sampling.

Figure 3-6: Vegetation and landscape features of the shrubland.

Table 3-3: Plant species recorded in the shrubland during the site visit.

Growth form	*Species*
Trees and shrubs	*Boscia albitrunca, Boscia foetida* subsp. *foetida, Leucosphaera bainesii, Monechma genistifolium* subsp. *australe, Parkinsonia africana,* ***Prosopis sp.****, Rhigozum trichotomum, Searsia pendulina, Senegalia mellifera subsp. detinens, Seriphium plumosum, Vachellia erioloba, Zygophyllum dregeanum*
Graminoids	*Enneapogon sp., Oropetium capense*
Succulents	*Aloe claviflora, Euphorbia gariepina* subsp. *gariepina, Kleinia longiflora, Mesembryanthemum sp., Sansevieria aethiopica, Tylecodon sp.*
Herbs and creepers	*Acanthopsis hoffmannseggiana, Aptosimum albomarginatum, Aptosimum spinescens, Asparagus cf. pearsonii, Avonia albissima, Barleria lichtensteiniana, Barleria rigida, Blepharis mitrata, Blepharis sp., Cucumis zeyheri, Harpagophytum procumbens, Tapinanthus oleifolius*

*Medicinal plants; Species indicated in bold are alien invasive species.

3.3.2 Drainage Lines

This dwarf shrubland is found along the small and narrow ephemeral drainage lines flowing in the landscape (Figure 3-7). The drainage lines on the footslopes and plains are covered by sandy to sandy loam soils, while higher up it becomes rockier. Typical species are indicated in Table 3-4. *Protected species (for which a permit for removal will be required) include: Boscia albitrunca, Boscia foetida* subsp. *foetida, Euphorbia gariepina subsp. gariepina* and *Vachellia erioloba.*

Figure 3-7: Vegetation and landscape features of the drainage lines.

Table 3-4: Plant species recorded in the drainage lines during the site visit.

Growth form	*Species*
Trees and shrubs	*Boscia albitrunca, Boscia foetida* subsp. *foetida, Leucosphaera bainesii, Monechma genistifolium* subsp. *australe, Parkinsonia africana, Rhigozum trichotomum, Searsia pendulina, Senegalia mellifera subsp. detinens, Vachellia erioloba, Zygophyllum dregeanum*
Graminoids	*Stipagrostis namaquensis*
Succulents	*Euphorbia gariepina* subsp. *gariepina, Kleinia longiflora*
Herbs and creepers	*Acanthopsis hoffmannseggiana, Aptosimum albomarginatum, Aptosimum spinescens, Asparagus cf. pearsonii, Avonia albissima, Barleria lichtensteiniana, Barleria rigida, Blepharis mitrata, Blepharis sp., Cucumis zeyheri, Harpagophytum procumbens, Tapinanthus oleifolius*

*Medicinal plants; Species indicated in bold are alien invasive species.

3.4 OBSERVED AND EXPECTED FAUNA

The previous biodiversity impact assessments for the proposed Bloemsmond 2 (Todd 2015; Widdows 2015) were consulted. Both reports contained significant errors in regards to SCC status, for example, Honey Badger being listed as Endangered when in actual fact it was listed as NT at the time [(it is now listed as LC as significant changes have been made to South African assessments of SCC e.g. Child *et al*., (2016); Taylor *et al*., (2015) which is reflected in the current report]. These status classifications have both legal and management ramifications within the current report.

3.4.1 Mammals

The study area resides in the 2820DB and 2821CA quarter degree grid cells (QDGCs). These QDGCs along with adjacent cells were considered to represent similar habitats and therefore the predicted species list was derived from observation records from these QDGCs.

The level of time and terms of reference for the survey did not allow for highly intensive mammal surveying. However, accurate results are shown in

The mammal species list derived from records collected for the QDGCs is presented in Appendix 3: Mammal species list. Three species of conservation concern could be expected to occur within the study area and are discussed in detail in section 3.9: Felicia deserti: Known from two highly disjunct areas, last collected in 1925. The population status, distribution and habitat of this species are too poorly known to determine its status.

Boscia albitrunca and *Vachellia erioloba* were recorded within the farm portion and is protected under the National Forest Act (Act No 84 of 1998). Should any of these species be harmed or damaged by the proposed development or removal is required a permit application should be submitted to the relevant authority prior to construction activities taking place.

Faunal Species of Conservation Concern.

3.4.1.1 Small herbivores

Small herbivores are located throughout the study areas and were sighted frequently during the survey period. Steenbok (*Raphicerus campestris*) were sighted on numerous occasions with frequent records of spoor and scat recorded from all habitats. Rock hyrax (*Procavia* capensis) and porcupines (*Hystrix africaeaustralis*) were recorded frequently via spoor/signs and direct sightings. As a taxonomic group, small herbivores are far more resilient than their larger counterparts, primarily due to their ability to take refuge in a wider range of habitats. In addition, springhares (*Pedetes capensis*), Smith's red rock rabbits and Cape hares (*Lepus capensis*) were very common throughout the study areas and surrounding habitats, albeit showing some habitat specific requirements. Small herbivores are often amongst the last of the mammalian taxonomic groups to be eliminated in heavily disturbed or heavily utilised areas.

Table 3-5 and allowed for the survey which records the mammalian species inventory as 42 species in total. Of these species, many, including Endangered Roan Antelope and Vulnerable Sable Antelope are classified as ranched and other ungulates such as springbok and blesbok may be classified as being semi-ranched. Therefore, the status of ranched species, or the relatively inflated mammal diversity provided by other semi-ranched species cannot impact the results of the Environmental Impact Assessment/ Analysis. Overall, the study area shows a medium/ high rich mammal diversity (in comparison with other national studies carried out by the author [SL]) which is expected given the varied karroid, drainage line/ ridge and arid environment. The detailed field survey provided invaluable information regarding mammals within the study area and the mammal inventory within the study areas shows all the relevant mammal species, likelihood of occurrence, EWT status, IUCN status and NEMBA status (Table 3-5). Due to the inherently large variations in the mammalian taxa, each group must be assessed separately in the context of the study areas. Mammalian groups are defined and discussed below.

The mammal species list derived from records collected for the QDGCs is presented in Appendix 3: Mammal species list. Three species of conservation concern could be expected to occur within the study area and are discussed in detail in section 3.9: Felicia deserti: Known from two highly disjunct areas, last collected in 1925. The population status, distribution and habitat of this species are too poorly known to determine its status.

Boscia albitrunca and *Vachellia erioloba* were recorded within the farm portion and is protected under the National Forest Act (Act No 84 of 1998). Should any of these species be harmed or damaged by the proposed development or removal is required a permit application should be submitted to the relevant authority prior to construction activities taking place.

Faunal Species of Conservation Concern.

3.4.1.2 Small herbivores

Small herbivores are located throughout the study areas and were sighted frequently during the survey period. Steenbok (*Raphicerus campestris*) were sighted on numerous occasions with frequent records of spoor and scat recorded from all habitats. Rock hyrax (*Procavia* capensis) and porcupines (*Hystrix africaeaustralis*) were recorded frequently via spoor/signs and direct sightings. As a taxonomic group, small herbivores are far more resilient than their larger counterparts, primarily due to their ability to take refuge in a wider range of habitats. In addition, springhares (*Pedetes capensis*), Smith's red rock rabbits and Cape hares (*Lepus capensis*) were very common throughout the study areas and surrounding habitats, albeit showing some habitat specific requirements. Small herbivores are often amongst the last of the mammalian taxonomic groups to be eliminated in heavily disturbed or heavily utilised areas.

Table 3-5: Mammal list of sightings and from previous data which covers the larger project area of influence.

Scientific name	Common name	Mammal Type (Free Roaming=FR, Ranched=R)	Red List	Likelihood	Method of Acquisition	Notes
Antidorcas marsupialis	Springbok	Medium Ungulate (R)	LC	Confirmed	Sighting	Common resident/ ranched
Alcelaphus buselaphus	Red Hartebeest	Large Ungulate (R)	LC	Confirmed	Sighting	Ranched resident
Aonyx capensis	African Clawless	Meso Carnivore (FR)	NT	Confirmed	Previous Survey in area	Uncommon visitor
Atilax paludinosus	Marsh mongoose	Meso Carnivore (FR)	LC	Confirmed	Previous Survey in area	Uncommon visitor
Canis mesomelas	Black-backed Jackal	Meso Carnivore (FR)	LC	Confirmed	Sighting	Common resident
Caracal caracal	Caracal	Meso Carnivore (FR)	LC	Confirmed	Spoor	Common resident
Cynictis penicillata	Yellow Mongoose	Small Carnivore (FR)	LC	Confirmed	Sighting	Common resident
Elephantulus intufi	Bushveld Elephant-shrew	Small Mammal (FR)	LC	Confirmed	Sighting	Common resident
Equus burchellii	Plains Zebra	Large Ungulate (R)	LC	Confirmed	Sighting	Common resident
Felis silvestris lybica	African Wild Cat	Small Carnivore (FR)	LC	Confirmed	Dead specimen	Common resident
Galerella sanguinea	Slender Mongoose	Small Carnivore (FR)	LC	Confirmed	Sighting	Common resident
Genetta genetta	Small-spotted Genet	Small Carnivore (FR)	LC	Confirmed	Spoor	Common resident
Genetta tigrina	Large-spotted Genet	Small Carnivore (FR)	LC	Confirmed	Spoor	Common resident
Helogale parvula	Dwarf Mongoose	Small Carnivore (FR)	LC	Confirmed	Spoor	Common resident
Hippotragus equinus	Roan Antelope	Large Ungulate (R)	EN	Confirmed	Sighting	Ranched resident
Hippotragus niger	Sable Antelope	Large Ungulate (R)	VU	Confirmed	Sighting	Ranched resident
Hystrix africaeaustralis	Porcupine	Small Herbivore (FR)	LC	Confirmed	Quills/ spoor	Common resident
Ichneumia albicauda	White-tailed Mongoose	Small Carnivore (FR)	LC	High	Spoor	Common resident
Ictonyx striatus	Striped Polecat	Small Carnivore (FR)	LC	Confirmed	Spoor	Common resident
Lepus capensis	Cape Hare	Small Herbivore (FR)	LC	Confirmed	Sighting	Common resident
Lepus saxatilis	Scrub Hare	Small Herbivore (FR)	LC	Confirmed	Sighting	Common resident
Manis temmincki	Pangolin	Large Insectivore (FR)	VU	Confirmed	Previous survey in area	Low density resident
Mellivora capensis	Honey Badger	Meso Carnivore (FR)	LC	Confirmed	Spoor	Low density resident
Mungos mungo	Banded Mongoose	Small Carnivore (FR)	LC	Confirmed	Sighting	Common resident
Orycteropus afer	Aardvark	Large Insectivore (FR)	LC	Confirmed	Dead specimen	Common resident
Oryx gazella	Gemsbok	Large Ungulate (R)	LC	Confirmed	Sighting	Common resident
Otocyon megalotis	Bat-eared Fox	Meso Carnivore (FR)	LC	Confirmed	Camera trap	Common resident

Parahyaena brunnea	Brown Hyaena	Large Carnivore (FR)	NT	Confirmed	Camera trap	Common resident
Paraxerus cepapi	Tree Squirrel	Small Mammal (FR)	LC	Confirmed	Sighting	Common resident
Pedetes capensis	Springhare	Small Mammal (FR)	LC	Confirmed	Spoor	Common resident
Procavia capensis	Rock Hyrax	Small Herbivore (FR)	LC	Confirmed	Droppings/ prey remains	Habitat specific resident
Pronolagus rupestris	Smith's Red Rock Rabbit	Small Herbivore (FR)	LC	Confirmed	Droppings	Habitat specific resident
Proteles cristatus	Aardwolf	Meso Carnivore (FR)	LC	Confirmed	Roadkill	Habitat specific resident
Raphicerus campestris	Steenbok	Small Herbivore (FR)	LC	Confirmed	Sighting	Common resident
Suricata suricata	Meerkat	Small Carnivore (FR)	LC	Confirmed	Sighting/ camera trap	Common resident
Sylvicapra grimmia	Common Duiker	Small Herbivore (FR)	LC	Confirmed	Sighting	Common resident
Tatera leucogaster	Bushveld Gerbil	Small Mammal (FR)	DD	Confirmed	Sighting	Common resident
Thallomys paedulcus	Tree Rat	Small Mammal (FR)	LC	Confirmed	Droppings	Common resident
Tragelaphus oryx	Eland	Large Ungulate (R)	LC	Confirmed	Sighting	Common ranched resident
Tragelaphus strepsiceros	Kudu	Large Ungulate (FR)	LC	Confirmed	Sighting	Common resident
Vulpes chama	Cape Fox	Meso Carnivore (FR)	LC	Confirmed	Camera trap	Common resident

3.4.1.3 Large and medium herbivores

Larger herbivores that are found within the study area must be divided into naturally occurring or free-roaming and "game farmed" or ranched. There may be some overlap for a given species which may be farmed on one property within the study areas, yet free roaming on another. Species that fall into this category include Sable antelope (*Hippotragus niger*), Roan antelope (*Hippotragus equinus*), blesbok (*Damaliscus pygargus phillipsi*), kudu (*Tragelaphus strepsiceros*) and springbok (*Antidorcas marsupialis*). Overall, the study areas show only a moderate large herbivore habitat potential which is why the study area is heavily subsidised through supplementary feeding. All of the above mentioned herbivores such as kudu and springbok were sighted frequently during the study period and appeared to be in excellent condition. Although the densities of this mammalian group were high, the diversity of the group is moderate. Overall, the study areas show evidence of a functional herbivore system which indicates that the trophic level of the food chain is being adequately represented. However, it is clear from the veld condition that some areas are overstocked, possibly due to the localised high densities of sheep and to a lesser extent, cattle.

3.4.1.4 Meso-carnivores

It appears that larger carnivores exhibit an insignificant presence throughout the study area and are considered to be largely absent. Meso-carnivores, however were significantly represented within the study areas. Relevant species include honey badger (*Mellivora capensis*), black-backed jackal (*Canis mesomelas*), water mongoose (*Atilax* paludinosus), bat-eared fox (*Otocyon megalotis*), African wild-cat (*Felis silvestris lybica*), Caracal (*Caracal* caracal) and Cape fox (*Vulpes chama*). The significant presence of the species could be explained by a number of factors. Firstly, and most importantly, the food supply (especially within the feeding spectrum of meso-predators) is still highly functional with small mammals, birds, insects, reptiles and amphibians available in high densities and high diversity. The wetland areas may exhibit a sporadic high density of amphibians, whilst the vegetated areas, ridges and even human residential areas showed large densities of small mammals, nesting birds and reptiles, all of which are utilised (albeit in different ratios) by the above mentioned species. Insectivorous species such as aardwolf and bat-eared fox (and to a lesser extent Cape fox and black-backed jackal) have access to a large resource base which is typical of such arid environments. Aardwolf and bat-eared fox however is addressed in a separate category, despite its status as member of the Order Carnivora. Finally, meso-predators often react positively to the presence of humans (in the absence of large densities of African dogs and intensive persecution) and will readily forage on anthropogenic food sources. The primary reason for the low observed densities of caracals and black-backed jackal however is due to the significant influence of predator extermination programs taking place within the study area.

3.4.1.5 Small carnivores

This group includes smaller carnivores below 5 kg in mass. Relevant species include smaller species of mongoose, suricates (*Suricata suricata*) small-spotted cat (*Felis nigripes* is addressed in the Red-List section below), genets and polecats (*Ictonyx striatus*). Of these listed species, slender mongooses (*Galerella sanguinea*), yellow mongooses (*Cynictis penicillata)*, small-grey mongoose (*Galerella pulverulenta)*, and spotted genets (*Genetta genetta)* were recorded frequently throughout the study area and region. These species are usually highly resilient and respond positively to human presence, as they readily utilise

anthropogenic food sources or the rodents that are attracted to human settlements. They are also highly catholic in their habitat requirements, meaning that most habitat types are suitable to meet the ecological requirements of the species. Dietary requirements are equally broad, which increases the adaptability of the group and therefore their overall resilience. These species may be considered to be essential in controlling the spread of synanthropic[7] or alien rodents.

3.4.1.6 Primates

Relevant species from this taxonomic group are limited to vervet monkeys (*Cercopithecus pygerythrus*) (baboons were not observed during the current study) which were frequently sighted, both within the riverine portions adjacent to the study area and the region as a whole. They are primarily limited to areas linked to available surface water and/or trees (drainage).

3.4.1.7 Large insectivores

Aardvarks (*Orycteropus afer*) are specialist insectivores that are very common within the study areas. They are a "keystone" species whose burrows are utilised as refugia by numerous other animals. Although regionally common, areas showing high aardvark density (similar to that observed for the study areas) should show due consideration and earthworks may seriously impact on local populations. Aardwolf (*Proteles cristatus*) and bat-eared fox (*Otocyon megalotis*) can be counted as specialist insectivore species for the purposes of ecology, despite their status as carnivores. Aardwolf were particularly common throughout the study area, with numerous individuals observed per night drive. The species is also particularly prone to collisions with vehicles and many individuals were observed along the roads between the study areas. A dead specimen was recorded during the survey.

Photographic evidence of the some of the mammals recorded within the study area is shown in **Error! Reference source not found.**Figure 3-8.

[7] Associated with humans and their infrastructure

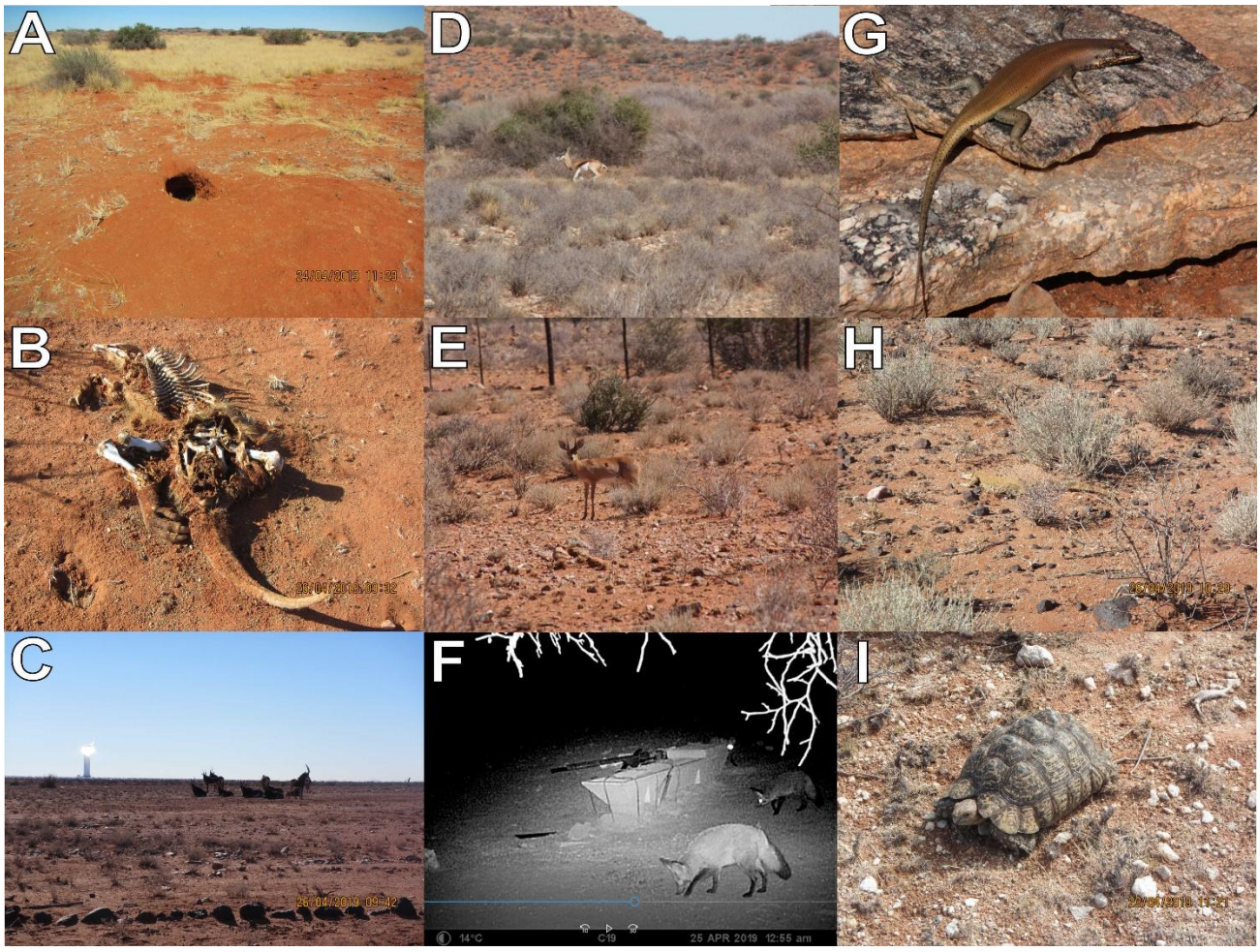


Figure 3-8: Photographic evidence of the some of the fauna recorded within the study area.[8]

3.4.2 Herpetofauna

The study area resides on the 2821CA and 2820DB QDGC's. These QDGC's along with ten adjacent cells (2820BC, 2820BD, 2821AC, 2821AD, 2821CB, 2821CD, 2821CC, 2820DD, 2820DB) were considered to represent similar habitats and therefore the predicted species list was derived from observation records from these QDGCs. Expected species lists derived in this manner may therefore represent an overestimation of the diversity expected as very specific habitat types may be required by a species which may be present in a QDGC but not necessarily on the study site within the QDGC. Conversely, many large areas in South Africa are poorly sampled for herpetofauna and expected species lists derived from a single QDGC may therefore underestimate the species diversity. Drawing expected species from surrounding QDGCs therefore increases the

[8] (A) Burrow of an Aardvark; (B) *Orycteropus afer* carcass; (C) Sable antelope (*Hippotragus niger*); (D) Springbok (*Antidorcas marsupialis*); (E) Steenbok (*Raphicerus campestris*); (F) Foraging Cape fox (*Vulpes chama*); (G) Western Rock Skink (*Trachylepis sulcata sulcata*); (H) Rock Monitor (*Varanus albigularis*); (I) Leopard tortoise (*Stigmochelys pardalis*).

likelihood of obtaining a species list that suffers less from poor sampling in the area but it also artificially inflates the expected number of species because many different habitats in the surrounding QDGCs may not be present on the study site. To counteract this, all possible attempts were made to refine the expected species list based on species-specific habitat requirements and a good understanding of the habitat types and quality of the study site.

The QDGC's near the project area are poorly sampled, and are characterised by moderate diversity and low endemicity for reptiles and low diversity and endemicity for amphibians (FrogMAP, 2019; ReptileMAP, 2019).

The herpetofauna species list derived from records collected for the QDGCs is presented in

Family	Scientific name	Common name	Conservation status Child *et al*., (2016)
Bovidae	*Antidorcas marsupialis*	Springbok	Least Concern
Bovidae	*Connochaetes taurinus taurinus*	Blue wildebeest	Least Concern
Bovidae	*Oryx gazella*	Gemsbok	Least Concern
Canidae	*Otocyon megalotis*	Bat-eared Fox	Least Concern
Erinaceidae	*Atelerix frontalis*	Southern African Hedgehog	Near Threatened
Felidae	*Felis nigripes*	Black-footed Cat	Vulnerable
Felidae	*Panthera pardus*	Leopard	Vulnerable
Herpestidae	*Cynictis penicillata*	Yellow Mongoose	Least Concern
Leporidae	*Lepus capensis*	Cape Hare	Least Concern
Leporidae	*Lepus saxatilis*	Scrub Hare	Least Concern
Macroscelididae	*Macroscelides proboscideus*	Short-eared Elephant Shrew	Least Concern
Muridae	*Desmodillus auricularis*	Cape Short-tailed Gerbil	Least Concern
Muridae	*Otomys unisulcatus*	Karoo Bush Rat	Least Concern
Mustelidae	*Ictonyx striatus*	Striped Polecat	Least Concern
Mustelidae	*Mellivora capensis*	Honey Badger	Least Concern
Pedetidae	*Pedetes capensis*	South African Spring Hare	Least Concern
Procaviidae	*Procavia capensis*	Cape Rock Hyrax	Least Concern
Sciuridae	*Xerus inauris*	South African Ground Squirrel	Least Concern

Appendix 4: Herpetofauna species list. Five amphibian species have previously been recorded within and surrounding the project area. A total of 59 reptile species could potentially occur within and surrounding the project area although only twelve have previously been recorded from within 2821CA QDGC.

The site intersects multiple habitat features, such as boulders, gravel plains and dry river beds and arid living rupicolous and some arenicolous reptile species are therefore expected to be present in the project area. However, the project area is situated adjacent to the Orange River, which is suitable habitat for mesic herpetofauna assemblages, but the habitat is unsuitable for such species, which may temporarily persist or pass through the project area.

No threatened (CR, EN or VU) herpetofauna are expected to occur within the project area and no other SCC are expected to be resident or breeding within the project area. However, there are two NT species that may occur within and surrounding the project area. These species are discussed in detail in section 3.9: Felicia deserti: Known from two highly disjunct areas, last collected in 1925. The population status, distribution and habitat of this species are too poorly known to determine its status.

Boscia albitrunca and *Vachellia erioloba* were recorded within the farm portion and is protected under the National Forest Act (Act No 84 of 1998). Should any of these species be harmed or damaged by the proposed development or removal is required a permit application should be submitted to the relevant authority prior to construction activities taking place.

Faunal Species of Conservation Concern.

3.4.3 Avifauna

The study area is located in the 2830_2055, 2830_2100, 2830_2105 and 2835_2100 pentads (Figure 2-2). From Widdows (2015), 40 bird species were observed. The current study recorded 75 species in relatively suboptimal conditions. Many of the bird species expected and observed in the study areas (most of them non passerines) are dependent upon local availability of suitable habitat or food and their presence is not directly determined by the surrounding indigenous vegetation. In addition, many of the recorded birds were represented by highly mobile species, able to move around to areas where rain has fallen. These include several of the lark species, finchlarks, canaries and buntings. Several of these mobile species form flocks. This is another key conclusion that has shown that the avifaunal assemblages are dictated by optimal conditions, rather than prevailing habitat types. However, distinct groupings of bird species were observed in some more “unique” habitat types such as the rocky ridges and large drainage lines. For the purposes of this study, the discussion will focus on SCC.

As mentioned a total of 75 avifauna species were recorded in the current study. As mentioned previously, the study period was relatively short and the data gathered was not powerful enough in order to formulate guild profiles. The most important change from the previous study was the very frequent sightings of IUCN Endangered Ludwig’s Bustard (*Neotis ludwigii*).

Species of Conservation Concern are discussed in section 3.6: Felicia deserti: Known from two highly disjunct areas, last collected in 1925. The population status, distribution and habitat of this species are too poorly known to determine its status.

Boscia albitrunca and *Vachellia erioloba* were recorded within the farm portion and is protected under the National Forest Act (Act No 84 of 1998). Should any of these species be harmed or damaged by the proposed development or removal is required a permit application should be submitted to the relevant authority prior to construction activities taking place.

Faunal Species of Conservation Concern. The avifauna species list derived from SABAP2 records is presented in Appendix 5: Avifauna Expected species list.

3.5 FLORAL SPECIES OF CONSERVATION CONCERN

According to the Botanical Database of Southern Africa (BODATSA)[9] for the xMin, yMin 20.20°,-29.20°: xMax, yMax 21.4°, -28.20° extent (WGS84 datum) four Red List species are present. In addition, six species are protected under the Northern Cape Nature Conservation Act (Act No 9 of 2009) of which two species are protected under the National Forest Act (Act No 84 of 1998). All potential Red and Orange Listed plant species are indicated in Table 3-6.

The SANBI Red Listed species *Aloidendron dichotomum* was recorded on site. Climate change models project a 36% decline in range in 100 years, assuming dispersal into newly suitable areas. Patterns of modelled declines have been supported by field and repeat photo studies. However no colonization of newly suitable areas has yet happened. Without dispersal, the models predict a 73% decline in 100 years, qualifying the species as Endangered. This is a vital flagship species for climate change impacts on biodiversity. It is also likely to be a keystone and umbrella species. This species is not likely to be more sensitive to climate change than others. Foden's study has shown that this species is a useful indicator of climate change and that, because modelled and actual mortality are shown to be relatively similar, the modelled future range shifts need to be seriously considered (Foden 2002, Foden et al. 2007). We have assessed this species based on the modelled future range shifts. Main threats include climate change, harvesting and trampling by livestock. Damage by baboons, scale insects and fungus has been observed, but none of these seem to cause mortality. There is a large amount of morphological variation between populations. Genetic studies show that there is much genetic variation between populations. Degree of interbreeding between populations is unknown, but large dispersal distance and bird pollinators make genetic exchange seem likely. The population is declining due to mortality of individuals in northern subpopulations.

Acanthopsis hoffmannseggiana is taxonomically problematic and is classified as data deficient. As per SANBI Red List of South African Plants: "*A widespread and variable species that possibly contains several taxa, some of which may be of conservation concern. More study is needed to find reliable distinguishing characters to separate individual taxa."* This species

[9] http://posa.sanbi.org/sanbi/Explore

occurs in sandy plains, stony hillsides and ridges, usually associated with weathered quartzite and granite, but also occur on mudstone (in Prince Albert area) and limestone (Asbestos Mountains), usually at an elevation between 650 and 1000 m (Von Staden & Steyn 2015).

Table 3-6: Potential plant species of conservation concern.

Species	Common Name	SANBI National Red List[10]	Northern Cape Protected[11]	National Forest Act (1998)[12]	Habitat Description	Present on site
Acanthopsis hoffmannseggiana		Data deficient - Taxonomically Problematic			Sandy plains, stony hillsides and ridges, usually associated with weathered quartzite and granite, but also occurs on mudstone (in Prince Albert area) and limestone (Asbestos Mountains), usually at an elevation between 650 and 1000 m.	Yes
Aloe claviflora	Aanteelaalwyn	Least Concern	Yes		Well drained areas on rocky slopes or flat stony areas at the margins of Kalahari Thornveld. Usually, but not always, on calcrete	Yes
Aloidendron dichotomum	Quiver tree	Vulnerable			On north-facing rocky slopes (particularly dolomite) in the south of its	Yes

[10] http://redlist.sanbi.org/
[11] Northern Cape Nature Conservation Act (Act No 9 of 2009)
[12] Notice of the list of protected tree species under the National Forests Act 84 of 1998 published in GN 182 in GG 41100 of 8 September 2017

Species	Common Name	SANBI National Red List[10]	Northern Cape Protected[11]	National Forest Act (1998)[12]	Habitat Description	Present on site
					range. Any slopes and sandy flats in the central and northern parts of range.	
Avonia (Anacampseros) albissima		Least Concern	Yes		Rock outcrops and quartz flats. Southern Angola through Namibia to the Richtersveld, and eastwards through Bushmanland to Griqualand West.	Yes
Boscia albitrunca	Shepherd's tree	Least Concern	Yes	Yes	Terrestrial – including seven provinces excluding Western and Eastern Cape	Within farm portion
Boscia foetida		Least Concern	Yes		Terrestrial – Northern Cape	Within farm portion
Dinteranthus wilmotianus		Near Threatened			Alluvial gravel soils – desert, Nama Karoo	Within farm portion. High likelihood to occur in study area
Euphorbia gariepina subsp. *gariepina*		Least Concern	Yes		Terrestrial – Northern Cape endemic	Yes – occurs throughout study area
Felicia deserti		Data deficient			Terrestrial – Nama Karoo, Succulent Karoo	Possible

Species	Common Name	SANBI National Red List[10]	Northern Cape Protected[11]	National Forest Act (1998)[12]	Habitat Description	Present on site
Hoodia gordonii	Bitterghaap, Bobbejaanghaap	Least Concern	Yes		Occurs in a wide variety of arid habitats from coastal to mountainous, also on gentle to steep shale ridges, found from dry, rocky places to sandy spots in riverbeds – Desert, Nama Karoo, Savanna, Succulent Karoo.	Within farm portion. High likelihood to occur in study area
Mesembryanthemum (all species)			Yes - All species are listed			Yes - Recorded throughout study area
Vachellia erioloba	Camel thorn	Least Concern	Yes	Yes	Widespread in the arid northern provinces of South Africa, also Namibia, Botswana, Zimbabwe, southern Angola and south-western Zambia	Within farm portion

Felicia deserti: Known from two highly disjunct areas, last collected in 1925. The population status, distribution and habitat of this species are too poorly known to determine its status.

Boscia albitrunca and *Vachellia erioloba* were recorded within the farm portion and is protected under the National Forest Act (Act No 84 of 1998). Should any of these species be harmed or damaged by the proposed development or removal is required a permit application should be submitted to the relevant authority prior to construction activities taking place.

3.6 FAUNAL SPECIES OF CONSERVATION CONCERN

3.6.1 Mammals

Of the observed and expected mammal species, the black-footed cat *Felis nigripes* (expected) is listed as Vulnerable while the honey badger *Mellivora capensis* (observed in the current study) was listed as Near Threatened (IUCN 2015) but as of 2016, has been downgraded to Least Concern; it is however still NEMBA protected. The Cape fox (*Vulpes chama*) (observed during the current survey) is also protected by the NEMBA.

Three of the observed mammal species within the study areas are Red-Listed in South Africa and two species are protected by NEMBA. These species are discussed below and the probability of occurrence for selected threatened and near threatened mammal species on the respective study areas is shown in Table 3-7.

Table 3-7: The probability of occurrence[13] for selected threatened and near threatened mammal taxa by study area

Species	Bloemsmond 3	Bloemsmond 4	Bloemsmond 5	Powerline
Felis nigripes (Small-spotted/black footed cat)	Low	Low	Low	Low
Vulpes chama (Cape fox)	Confirmed	Confirmed	Confirmed	Confirmed
Mellivora capensis (Honey Badger)	Low	Low	Low	Moderate

3.6.1.1 Honey Badger (*Mellivora capensis*)

Honey badgers were recorded once through spoor tracking within the drainage line habitat of the study area. Their presence is unusual even though the study area does not represent a stronghold for the species. This species is often associated with more savanna type habitats encountered in the Kalahari and Bushveld which is represented in the drainage line habitat (and not the more karroid habitats to the north). It is often subject to snaring and persecution due to its penchant for raiding commercial honey farms and chicken breeding facilities. The presence of honey badgers on the study area should be considered as a healthy ecological indicator and the NEMBA protection warrants due consideration.

3.6.1.2 Small-spotted cat (*Felis nigripes*)

[13]High: regular, expected to be present daily/weekly, Moderate: uncommon but expected to be present at least once a month Low: irregular or occasional to very rare

This cat species is a relatively uncommon resident that is nationally protected. It was not observed during the survey period but is predicted to be resident within suitable habitats within the surrounding study areas, mostly associated with termitaria. Termitaria represent one of the most important micro habitat types within the greater study area and should form the cornerstone of the mitigation measures to ensure protection for this species.

3.6.1.3 Cape fox (*Vulpes chama*)

This canid species is a relatively uncommon resident that is nationally protected. The stronghold of this species is centered around more arid savanna systems and the Mpumalanga grassland habitats. It was not sighted during the survey period although road kill was seen within the greater study area. Despite widespread and intensive persecution by farmers, it is a relatively common species throughout its range and can be considered to be relatively resilient to impacts.

3.6.2 Mammalian Importance

Mammalian importance relates to species diversity, endemism and the presence of topographical features or primary habitat units with the intrinsic ability to sustain mammal species of conservation importance. It is clear that throughout the study areas most of the habitats are generic in their ability to support the prevailing mammal population, including species of conservation concern. With the exception of inselberg ridges, no unique geographical or topographical features exist which would cause the areas targeted for solar farms to be classified as a "No Go" area. Therefore, the region as a whole is considered to be an area of medium mammalian importance although the study areas should still be managed in a holistic manner at a policy level, prioritising general best practice (not fatal flaw or high sensitivity related) mitigation and monitoring of mammal species, both general and of conservation concern.

Areas with elevated mammal sensitivities include inselberg ridges, seasonal drainage lines, artificial impoundments and windmills. The seasonal drainage lines act as linear dispersal corridors for mammal species. Greater species diversity (as well as a unique composition) was observed in this habitat and therefore, these systems are earmarked as being of high mammal importance. It must be noted that this elevated diversity could also be attributed to the highly trackable substrate within the drainage line making the detection of mammal species through spoor tracking easier. However, the probability is high that the corridor potential of the habitat type acts as a factor increasing the presence of mammal species. Intermittent impoundments and water sources throughout a region that is inherently arid is an obvious cause for increased mammal diversity, density and therefore sensitivity within these habitat types, due to the inherent water dependence of the taxonomic group as well as the increased foraging potential of the ecosystem. The presence of impenetrable fences also limits migration and dispersal making enclosed populations totally dependent on these water points. Finally, the ridge systems (connected or otherwise) may not provide habitat for mammal SCC but are a crucial source of food for avifaunal SCC which rely on small to medium mammals as the cornerstone of their prey base. Therefore, these systems are unique in the landscape and must be subject to appropriate buffering.

3.6.3 Herpetofauna

Giant Bullfrog (*Pyxicephalus adspersus*)

The Giant Bullfrog is listed by Minter *et al*. (2004) as Near Threatened. However, the IUCN (2019) considers this species to be of Least Concern across its global distribution. This species may undergo an escalation in conservation status soon and must pre-emptively be considered to be of conservation importance. This species has not been recorded in 2821CA in which the project area is situated, but has been observed in adjacent QDGCs (FrogMAP, 2019). In arid regions Giant Bullfrogs utilise small pans that are difficult to detect without heavy rainfall, it is likely that suitable breeding habitat occurs within the project area.

Verrox's Tent Tortoise (*Psammobates tentorius verroxii*)

Although Verrox's Tent Tortoise is listed by Bates et al. (2014) as Least Concern, the IUCN (2019) considers the species to be Near Threatened. This small, scarce tortoise species is rarely seen. It is active in early mornings and evenings during the wet season when it feeds on succulents and perennial plants, but burrow beneath the base of shrubs during dry spells. This tortoise species has been recorded in the 2821CA QDGC on which the project area is situated (ReptileMAP, 2019). It is likely to be a permanent resident within the project area.

3.6.4 Avifauna

The Widdows (2015) study recorded a number of SCC that were not recognised and/ or discussed in detail in accordance to Taylor *et al.* (2015) and the regulations. Therefore, the entire SCC and mitigation application has been reviewed and updated in the current study.

According to the literature, 12 Red-Listed species are known to occur in the region with 6 species confirmed during the respective surveys, representing a very high success rate given the short study period. Of the nine highly likely or confirmed species and according to Taylor *et al.* (2015), two of the species are Endangered, four of the species are Vulnerable species and three are Near-Threatened. These species are discussed below and the probability of occurrence for selected threatened and near threatened avifauna on the respective study areas is shown in Table 3-8. According to this, 8 species can be expected regularly in the study areas. *A. paradisaea* and *N. ludwigii* are particularly widespread in the area.

Table 3-8: The probability of occurrence[14] for selected threatened and near threatened avifauna by study area.

Species	3	4	5	Powerline
Aquila verreauxii(Verreaux's Eagle)	Confirmed	High	High	High
Polemaetus bellicosus (Martial Eagle)	High	High	High	High
Circus maurus(Black Harrier)	Low	Low	Low	Low
Ciconia nigra (Black Stork)	Low	Low	Low	Low

[14]High: regular, expected to be present daily/weekly, Moderate: uncommon but expected to be present at least once a month Low: irregular or occasional to very rare. Confirmed species per study area not indicated

Ardeotis kori (Kori Bustard)	High	High	High	Confirmed
Eupodotis vigorsii (Karoo Korhaan)	Confirmed	Confirmed	Confirmed	Confirmed
Neotis ludwigii (Ludwig's Bustard)	Confirmed	High	High	High
Falco biarmicus (Lanner Falcon)	Confirmed	High	High	High
Circus macrourus (Pallid Harrier)	Medium	Medium	Medium	Medium
Sagittarius serpentarius (Secretary Bird)	High	High	High	High
Rhinoptilus africanus (Double banded courser)	Confirmed	Confirmed	High	Confirmed
Spizocorys sclateri (Sclater's Lark)	High	High	High	Confirmed
Total (High-Confirmed)	**9**	**9**	**9**	**9**

Table 3-9 represents a summary explanation of the Red-Listed species identified by SABAP 1 and SABAP 2 within the AOI and relates to the detailed discussion provided below. The table illustrates the long term habitat suitability for the observed and high likelihood Red-Listed species. The remaining taxa are either (1) irregular to rare foraging visitors or (2) unlikely to be present on the study area due to the poor availability (surface cover) of suitable habitat on the study areas. According to Table 3-8 (which describes the likelihood of occurrence of Red-Listed species per study area) it is evident that most of the connected (therefore cumulative) study areas exhibit similar likelihoods of occurrence. However, the areas showing large associations with ridges and/ drainage lines are characterised by some moderately unique habitat attributes and are thus likely to provide refuge and foraging habitat for large terrestrial bird species (e.g. cranes, bustards, secretary bird and storks) and/ or wetland associates/ foraging migratory raptors, therefore, elevating the sensitivity.

In regards to the current study, it was deemed unnecessary that all species should be discussed in detail. Species such as Lanner Falcon as migrants incur pressures outside of the borders of South Africa and do not warrant intensive discussion. Therefore, the selected relevant species that are possibly susceptible to the proposed development have been discussed in detail below. Photographic evidence of Red-Listed species observed during the current study is provided in Figure 3-9.

Table 3-9: Avifauna species of conservation concern previously recorded in the study area pentads

Species	Global Conservation Status (IUCN 2019)	National Conservation Status (Taylor et al. 2015)	Preferred Habitat	Potential likelihood of occurrence on study area
Anthropoides paradiseus (Blue Crane)	Vulnerable	Near threatened	Prefers open grasslands. Also forages in wetlands, pastures and agricultural land.	Moderately Likely: An uncommon foraging visitor to most of the study areas. Low densities expected with breeding pairs recorded in adjacent areas and potentially susceptible to development activities.
Aquila verreauxii	-	Vulnerable	Mountainous areas or areas	Confirmed: Infrequent foraging resident

Species	Global Conservation Status (IUCN 2019)	National Conservation Status (Taylor et al. 2015)	Preferred Habitat	Potential likelihood of occurrence on study area
(Verreaux's' Eagle)			with prominent outcrops with a high prey base (e.g. hyrax)	throughout the study areas, susceptible to poisoning events. Confirmed from previous records and one sighting during the study. Low risk from proposed activities.
Polemaetus bellicosus (Martial Eagle)	Endangered	Endangered	Open bushveld with adequate roosting and foraging potential.	Likely: A highly irregular to rare foraging visitor dependent on adequate food supply and roosts. Moderately vulnerable to the proposed development activities
Ciconia nigra (Black Stork)	-	Vulnerable	Breeds on steep cliffs within mountain ranges; forages on ephemeral wetlands.	Likely: A highly irregular to rare foraging visitor dependent on the wetland systems located throughout the study area and potentially very vulnerable to the proposed development activities.
Falco biarmicus (Lanner Falcon)	-	Vulnerable	Varied, but prefers to breed in mountainous areas.	Confirmed: A fairly common foraging migrant not recorded in the current study but expected periodically to occur. Not vulnerable to the proposed activities.
Neotis ludwigii (Ludwig's Bustard)	Endangered	Endangered	Primary upland grassland, particularly on hilly terrain.	Confirmed in high densities throughout the study areas. Large bodied species, highly susceptible to development activities.
Oxyura maccoa (Maccoa Duck)	Near threatened	Near threatened	Large saline pans and shallow impoundments.	Unlikely: Rare visitor occurring in inundated water impoundments. Individually susceptible to development activities but as a species, low risk.
Sagittarius serpentarius (Secretarybird)	Vulnerable	Vulnerable	Prefers open grassland or lightly wooded habitat although forages extensively in open karroid savannah.	Confirmed: Regular low density resident which is most likely of lower risk to the proposed development activities.
Eupodotis vigorsii (Karoo Korhaan)	Near threatened	Near threatened	Large saline pans and shallow impoundments.	Confirmed: Common resident occurring near areas with open water. Individually susceptible to development activities but as a species, low risk.
Afrotis afra (Southern Black	Vulnerable	Vulnerable	Prefers open grassland or lightly wooded habitat	Confirmed: Regular low density resident which is most likely of lower risk to the proposed

Species	Global Conservation Status (IUCN 2019)	National Conservation Status (Taylor et al. 2015)	Preferred Habitat	Potential likelihood of occurrence on study area
Korhaan			although forages extensively in open karroid savannah.	development activities.
Red-footed falcon (Lesser Kestrel)	Near Threatened	Near Threatened	Prefers open grassland or lightly wooded habitat although forages extensively in open karroid savannah.	Highly Likely: Regular migrant of fluctuating seasonal density which is most likely of lower risk to the proposed development activities due to most pressures occurring with breeding grounds and migration routes.
Circus maurus (Black Harrier)	Vulnerable	Endangered	Prefers open wetland and moist grasslands. Uncommon in open karroid savannah.	Low probability: Low density uncommon migrant which is most likely of lower risk to the proposed development activities.
Circus ranivorus (Marsh Harrier)	Least Concern	Endangered	Prefers open wetland and moist grasslands. Uncommon in open karroid savannah.	Likely: Regular albeit low density uncommon migrant which is most likely of lower risk to the proposed development activities.

3.6.4.1 Kori Bustard (*Ardeotis kori*)

Kori Bustards are globally and regionally listed as Near-Threatened (Taylor *et al.*, 2015). This large terrestrial bird exhibits a preference for lightly wooded savanna as well as arid open systems, which are very abundant within the study areas. Camera trapping and anecdotal community interview information suggest that breeding pairs may persist on site and young sub-adults were encountered within the study area. The species is resident and at risk to the creation of large, non-marked powerlines which may cause collision of birds. In addition, large-scale increases in fencing (entanglement) combined with a high volume of large construction and/or maintenance trucks or vehicles may cause localised drastic declines in bustard numbers.

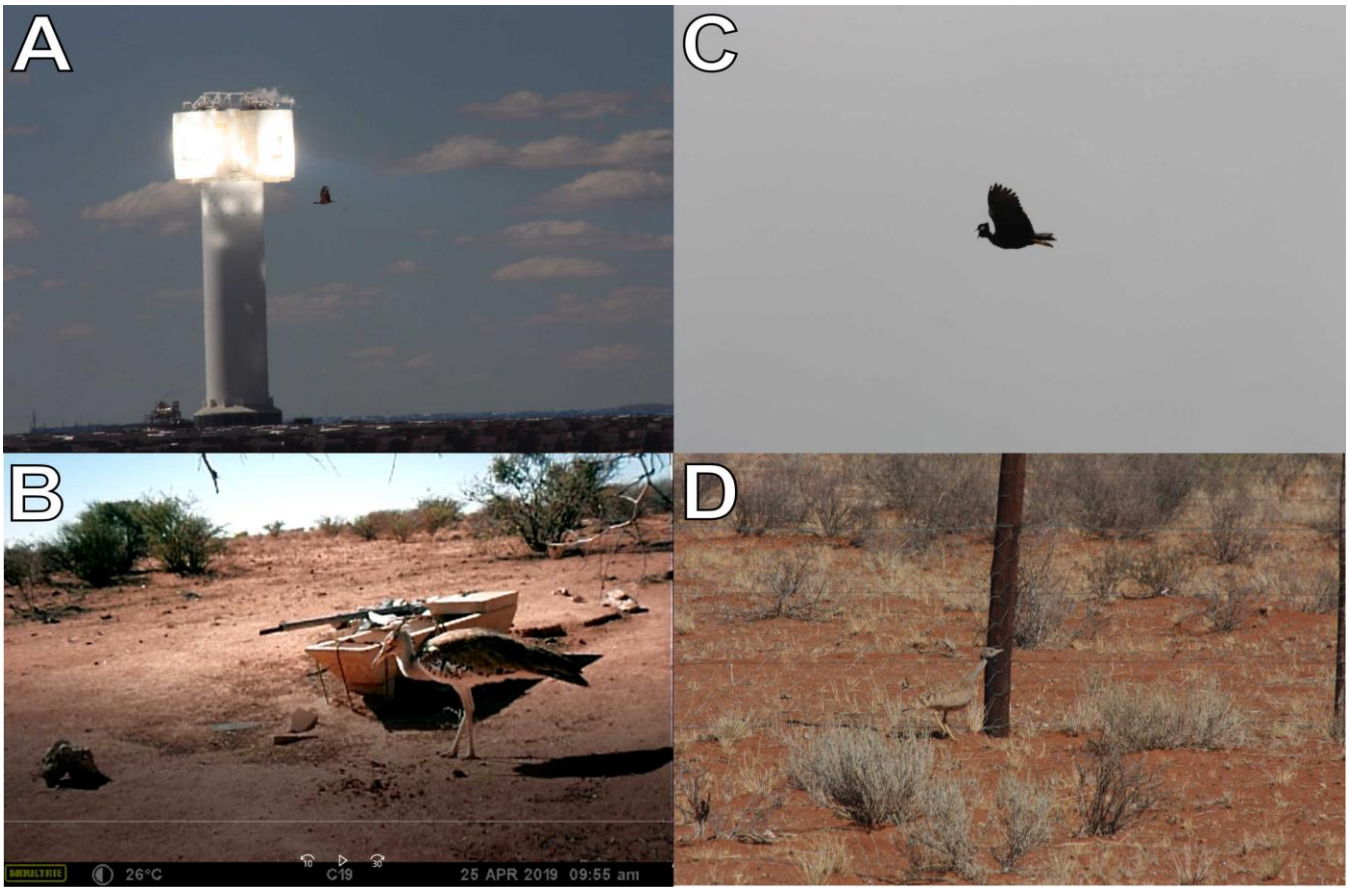


Figure 3-9: Photographic evidence of avifauna SCC observed during the current study.[15]

3.6.4.2 Ludwig's Bustard (*Neotis ludwigii*)

Ludwig's Bustards are globally and regionally listed as Endangered (Taylor *et al.* 2015) which is cause for a significant evaluation of the species in relation to the proposed development. Actual counts were not carried out (time limitations) although community interview data suggest that breeding pairs persist for prolonged periods within the study area and two separate sightings (total number of five individuals including a sub-adult) were recorded. The species is highly migratory and localised development may not represent a fatal flaw. However, the fact that sub-adults and juveniles are encountered in the study area provides strong anecdotal evidence of residential breeding behaviour which may have significance ramifications for the Cumulative Impact Assessment. The species was not recorded at any time from the previous study in 2015 and it is a significant oversight that no landowner interviews were carried out given the intricate long-term knowledge shown by interview subjects, including diagnostic distinctions between bustard species. The landowner stated that Ludwig's bustards have

[15] (A) *Neotis ludwigii* (Ludwig's Bustard); (B) *Ardeotis kori* (Kori Bustard); (C) *Afrotis afra* (Southern Black Korhaan); (D) *Eupodotis vigorsii* (Karoo Korhaan).

increased in density over the last five years. There are a number of possible explanations for the observed increase in density over time:

- It is possible that predator poisoning programs designed to eliminate jackals and black eagles (both of which prey on Ludwig's bustard and both of which are heavily targeted by sheep farmers) have allowed for a local population recovery/ increase;
- The lack of powerlines within much of the study area allowing for localised lower mortality rates; and
- This species, as a nomad, may show localised and temporal increases as part of natural population dynamics.

This species is almost certainly resident and at risk to the creation of large, non-marked powerlines which may cause collision of birds. In addition, large-scale increases in fencing combined with a high volume of large maintenance trucks may cause drastic declines in bustard numbers due to displacement, collisions and entanglements. The presence of this species must form a significant focal point of the mitigation measures of the project which is addressed below.

On a final note concerning monitoring of the species (and possible mitigations), it is vital to highlight that fact that as an Endangered species, Ludwig's bustard demands higher degrees of auditing and monitoring attention than other Red-Listed birds (a fact supported by multiple publications including Visser *et al.* 2018 and Scott *et al.* 2012). It is also vital to highlight that presence or absence over time for a nomadic species is difficult to predict and spatial/ temporal population reductions may or may not be development-induced. For example, the cessation of predator poisoning activities within mine boundaries may in fact cause a localised increase in jackal populations, thereby reducing the population of Bustards through good practice. Although it is highly feasible that the development may be directly responsible for local population reductions, comprehensive and continuous data collection is required to monitor the situation on site and apply appropriate mitigation measures and far more significant weighting and value should be applied to the Cumulative Impact Assessment.

3.6.4.3 Black Stork (*Ciconia nigra*)

The IUCN Vulnerable Black Stork (*Ciconia nigra*) is not expected to occur within the study areas in significant densities. Due to lack of standing water and sub-optimal time of year, this species was not sighted during the current survey. The species is an uncommon albeit regular migrant and is seasonally associated with water bodies and pans throughout the region.

3.6.4.4 Verreaux's Eagle (*Aquila verreaux*) and Martial Eagle (*Polemaetus bellicosus*)

As a rule, all nesting raptors should be protected within the study area. Although seen infrequently, Verreaux's eagle is most likely classified as a regular foraging visitor on the study areas. The IUCN Vulnerable Verreaux's Eagles and IUCN Endangered Martial Eagle provide a typical scenario where the foraging population (and possible breeding pairs) of a Red List species are under constant pressure from development due to modifications and alterations of their preferred foraging habitat and dispersal networks.

Generally, Verreaux's Eagles occupy a home range size of approximately 20-35 km^2 (Van der Lecq 2012) or 35 - 65 km^2 in the Magaliesberg (Allan 1988; Anderson 2002) in areas where their preferred prey, the Rock Hyrax (*Procavia capensis*) is abundant (Gargett & Mundy 1990; Simmons 2005). Within the larger study area, not only were rock hyrax and Smith's red

rock rabbit observed in high densities, but a Verreaux's Eagle was observed actively foraging within Bloemsmond 4. Finally, the local landowner confidently stated that Verreaux's Eagle was a regular foraging visitor within the project area of influence, regularly scavenging (and sometimes "hunting") young livestock. In areas of high disturbance, the species can increase their home range to an area of 150 - 200 km^2. This observed expansion of their home range size is probably explained by the lack of sufficient densities of prey and subsequent habitat loss within the landscape.

These data reveal a number of risks in regard to the current study. Increased stress to obtain food in the area will almost certainly modify the eagles' behaviour within the national population. Breeding adults become more aggressive towards each other leading to increased post-hatchling mortalities (Anon 2012). This is especially relevant in regards to the loss of habitat for the cumulative effects due to much reduced available prey as well as the increased disturbance levels.

It is an undisputed fact that the fitness of Verreaux's Eagle (e.g. breeding success) is closely tied with the availability of its preferred prey. The proposed future development can likely threaten the long-term viability of suitable prey populations, the Verreaux's Eagle can be expected to suffer equivalent population declines (Allan 1988).

Impacts

Disturbance applies to the disruption of a foraging, breeding or roosting bird caused by human-induced activities. Since development and construction go hand in hand with high ambient noise levels and habitat loss, it is possible for bird species and bird individuals to be displaced from the surrounding environment. It is essentially true for large species that require extensive home ranges, and those species that are inherently shy or unobtrusive by nature (e.g. raptors).

Displacement will be the response of eagles to the disturbance activity, for example when a bird changes its behaviour or takes flight by aborting its activity prior to the disturbance, or being unsuccessful in completing its current activity (Ruddock & Whitfield 2007). Reactions are likely to differ between species and between individuals of the same species (Rogers & Smith 1995; Rogers & Schwikert 2002). Reactions are also positively correlated to the magnitude and frequency of a particular disturbance event. For the proposed solar farm application as well as the cumulative applications, it is currently unknown to what degree these activities will affect the eagles and their prey (due to absence of approvals, long-term studies and detailed list of activities), but reactions can be estimated to be similar due to the surrounding development activities. It must be stated that many bird species will become accustomed, or have the ability to learn and adapt, to constant occurring disturbance events of low magnitude (e.g. vehicle noise), unless they are not directly affected (e.g. their physical habitat is left intact). However, reduced poisoning of large SCC raptors may in fact have a positive effect on the population.

Reaction to disturbance events causes behavioural disruption which is likely to result in an increased energy expenditure (e.g. if a disturbed bird takes flight) and physical stress. In the case of breeding birds, disturbances could lead to the loss of eggs or nestlings, thereby affecting the breeding success of the population (Stillman *et al*. 2007). In addition, sustained disturbances could eventually result in less time for individuals to invest in breeding activities due to high energy demands compromising their survival. Displacement and disturbances are further aggravated by an increased loss of suitable foraging, breeding and roosting habitat.

Mitigation measures

Set-back areas or buffer zones are allocated to sensitive or important habitat features to alleviate the effect of foraging habitat in particular. The choice of an appropriate set-back distance is complex since different species and even different taxon groups demand different habitat types or home ranges to maintain a viable population in the long term.

The distance from an individual when it ceases normal behaviour (so-called alert distance) or before an individual engages in flight (so-called flight initiation distance) when approached by a potential disturbance entity (e.g. human intrusion) varies between individuals and species (Ruddock & Whitfield 2007). GDARD Biodiversity Guidelines is used in this case due to the higher proportion of studies conducted in Gauteng but can be applied to all populations. This is a dated policy document (GDARD 2014) which specifies buffer areas for certain Red List avifauna species. The Guidelines proposed a buffer of 800 m around the breeding colony or vulture restaurant for the Cape Vulture (*Gyps coprotheres*). Other buffers of 650 metres or more have been recommended for large bodied raptors of a similar niche to Verreaux's Eagle.

Given that the study area has been confirmed as a foraging site and not (as of yet) a breeding site, the following recommendation is proposed in order to preserve the ecological function of the ridge habitats, and to maintain foraging corridors for large SCC raptor species in the form of a set-back area of natural vegetation. The study area is therefore best zoned as a wildlife support area, where development should take into account foraging habitat without compromising the National economic value of sustainable energy generation. For the proposed development activities, the presence of Verreaux's and Martial Eagles and their preferred prey does not represent a fatal flaw, as the temporary nature and relatively small ecological impact footprint of the activities are unlikely to translate into permanent negative impacts on the regional populations. It is recommended that the entire ridge habitat areas should be interpreted as ecologically sensitive and declared as "no-go" areas for future development activities and their associated impacts.

3.6.4.5 All small Bustard, Korhaan species and especially Karoo Korhaan (*Eupodotis vigorsii*)

Due to the similar life histories and susceptibility to impacts, all Korhaan species are to be dealt with together. Karoo Korhaans are listed as Near-Threatened and were also observed with great frequency, totalling more than 15 sightings across the study period. All species are highly susceptible to entanglement in jackal fences and as an endemic species, range reductions (possibly between 30 to 50% loss between SABAP 1 and SABAP 2) are considered to be of significant concern. Therefore, and like many medium to large-bodied species, large-scale increases in fencing combined with a high volume of maintenance vehicles may cause drastic declines in Korhaan numbers.

3.6.4.6 Secretarybird (Sagittarius serpentarius)

This species was recently upgraded from regionally Near-Threatened to Vulnerable (Taylor *et al.*, 2015) as evidence suggests large-scale rapid population declines across its entire range. The species was not observed during the study but local landowners have testified that significant populations exist within the region. The cause of the declines is mainly due to habitat loss through intensive agricultural practices as well as accidental persecution and poisoning. Within the study area, they appeared to be a species of unknown density. The species prefers open areas, in particular open savanna and grassland and it is considered as a regular foraging visitor in the region owing to its preference for snakes and reptiles. It is predicted to share

habitats in common with the Kori Bustards. Due to the nomadic habits of this bird as well as the observed low densities, the potential impacts on the species are considered to be Moderate to unknown.

3.7 CURRENT IMPACT DESCRIPTION

Several current ecological impacts were identified for the study areas. It is vital to adequately describe these current impacts as they serve to illustrate the *status quo* of the study areas and provide context to the impacts and mitigations section. The most obvious current impacts observed were:

- Fences causing direct mortalities of fauna;
- Powerline infrastructure causing avifauna mortality;
- Fencing inhibiting free movement of fauna;
- Livestock grazing;
- Wildlife-vehicle collisions (WVC's);
- Hunting (both legal and illegal);
- Dust effects and contamination; and
- Rock collection to pack against fence bottoms.

Photographic evidence of a selection of current impacts are shown in Figure 3-10.

3.7.1 The influence of fences on direct mortalities for faunal species

Fencing is very prevalent in the Karoo due to the livestock farming practices that persist throughout the region. Fencing varies between simple properties boundaries to "jackal proof" fences which are used to control access by these potential sheep predators. This infrastructure causes the direct mortality of fauna through collision entanglement, especially for large and medium bodied birds, small ungulates and tortoises, the mortalities of which were observed on several occasions during the field surveys.

3.7.2 Powerline infrastructure causing avifaunal mortality

Existing and future distribution and transmission electrical line infrastructure is present throughout some of the study areas but increases significantly in the areas adjacent to the exiting Khi One Solar facility and will increase cumulatively with the establishment of significant powerline infrastructure. Large bodied birds such as bustards, cranes and korhaans are particularly susceptible to mortalities arising from collisions with these electrical lines, which has caused large population declines for these species.

3.7.3 Fencing inhibiting free movement of fauna

As discussed above, large-scale fencing is prevalent throughout the Karoo landscape which prevents free movement of many fauna. Species unable to jump high enough or burrow (e.g. tortoises, smaller antelope) are particularly susceptible to such fencing which effectively results in habitat fragmentation. In areas with intensely managed fencing, this habitat fragmentation

can result in populations of certain species that are completely isolated from one another (e.g. Aardwolf) leading to inbreeding and population decline. Furthermore, during unfavourable environmental conditions such as drought, these animals cannot disperse to seek more suitable conditions and face localised extinctions. This is however somewhat offset by the fact that most of these intensely managed fenced camps have water sources in the forms of windmills which raises the ecological importance of these man-made structures considerably.

3.7.4 Extensive livestock and ranched antelope grazing

Livestock farming is the primary land use observed within the study areas. The intensity of grazing by ranched wildlife species, livestock, particularly sheep and cattle, varies both seasonally (rotational grazing) and in density throughout each of the study areas. Livestock presence causes numerous impacts in the landscape including selective eradication of vegetation through grazing, displacement of native species, large scale erosion through the clearing of vegetation, spread of disease and alien invasive species. Poor husbandry and grazing practices have caused damage to several areas that may not be able to recover without active rehabilitation.

3.7.5 Wildlife-vehicle collisions (WVC's)

The direct mortality of fauna through collisions with vehicles represents one of the most significant and detectible impacts throughout the Karoo. Susceptible species include slow moving reptiles such as tortoises, large lizards and snakes, ungulates of all sizes and predators trapped on the roads between impenetrable fences and large bodied birds. Despite the fact that the current traffic volumes on these roads are relatively low, numerous road mortalities were encountered during the field surveys (especially on highways servicing the area). The anticipated increased traffic volume from the proposed development is expected to significantly exacerbate this impact if direct mitigation is not implemented.

3.7.6 Hunting (both legal and illegal)

Livestock agriculture represents one of the most important commercial and subsistence income/ food streams for the Karoo region. As a result, large predator eradication campaigns (poisoning, trapping and shooting) have been implemented throughout the study areas in order to limit livestock losses. Targeted species include all predators, regardless of their actual impact on livestock (examples being black-backed jackal, caracal, bat-eared fox, cape fox and aardwolf) as well as large raptors such as Verreaux's Eagle. In addition, several farmers regularly kill large leopard tortoises as they often interfere with the infrastructure at sheep watering points and windmills and compete with sheep for grazing. The presence of controlled concession areas by the proposed development (and subsequent control of such activities) may in fact show positive results in regards to reducing the significance of this impact.

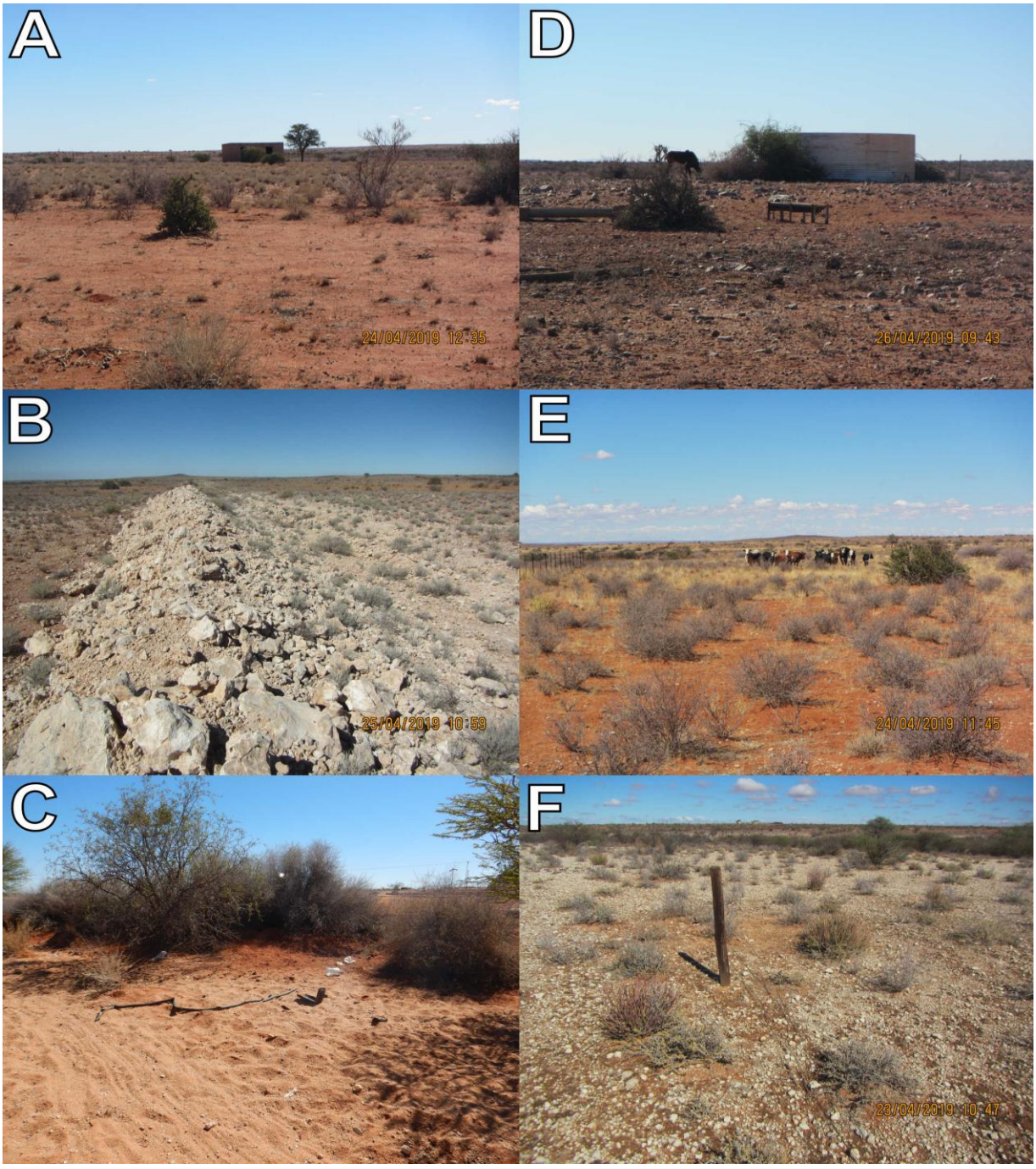


Figure 3-10: A selection of current impacts recorded within the study area and surroundings[16].

[16] Top to bottom, left to right: Farm buildings; Historical dam wall; Rubbish pollution within riverbeds; Reservoirs; Cattle grazing; Fences.

3.8 HABITAT SENSITIVITY

Based on the fauna and flora observations during the fieldwork as well as the current impacts described above, ecological sensitivity of each habitat type was identified. This sensitivity is rated as either low, medium or high, where low sensitivity is considered ideal for prospecting activities and high sensitivity areas are to be avoided (Figure 3-11). A 100 m "No-Go" area has been indicated and a further 200 m buffer around all sensitive ridges that have suitable foraging and breeding habitat for SCC where ideally minimum activities should occur by the proposed development. For *Aloidendron dichotomum,* a 200 m buffer is proposed for this species protection. [For the purpose of interpretation, it must be stated that a buffer is a recommended minimum area of "avoidance" for infrastructure based upon identified impacts while a "no go" area is a non-negotiable area that exist in order to avoid the impact]

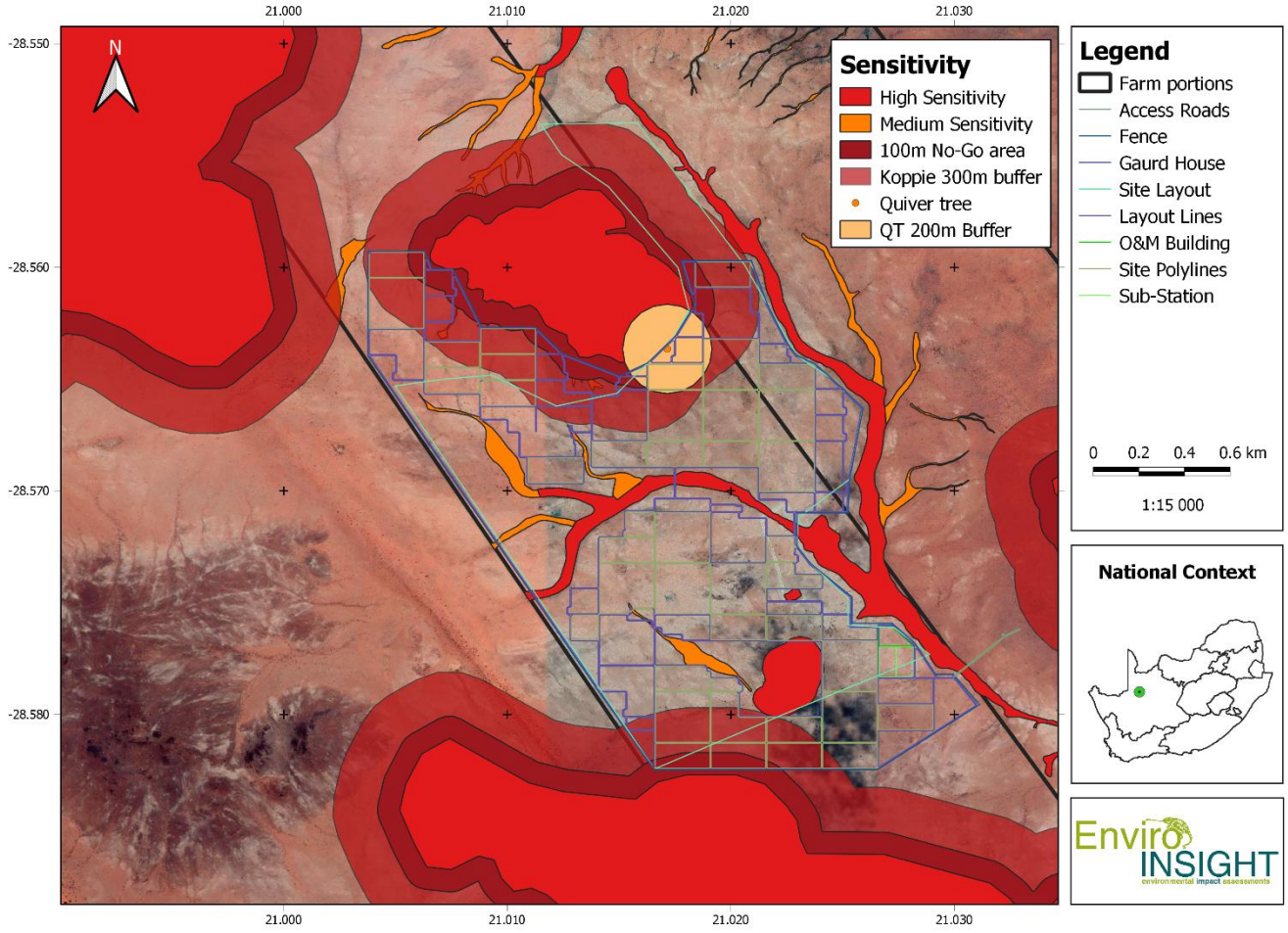


Figure 3-11: Habitat sensitivity of the study area.

3.8.1 Flora: Aloidendron dichotomum

A. dichotomum is classified as Vulnerable with the possibility of being upgraded to Endangered unless colonisation of newly suitable areas takes place. Without dispersal, climate change models predict a 73% decline in 100 years (Foden 2005). For this reason, suitable habitat of this species needs to be protected in order to ensure when colonisation takes place [estimated recruitment frequency of 15 years (Foden et al., 2007)] there is sufficient and optimal habitat for this species; hence the 200m proposed buffer for this species (provincial or national guidelines do not make suggestions for suitable buffer for this species, however GDARD Biodiversity Guidelines (GDARD 2014) states a minimum buffer of 200m for SCC, and in reality suggest a 400m buffer for species listed under the A3 criteria. Accordingly, a conservative approach was taken here in order to protect this species suitable habitat). Van der Merwe & Geldenhuys (2017) stated the importance that no additional pressure is to be placed on *A. dichotomum* populations. Although the impacts of renewable energy projects such as this one was not assessed by them, current impacts including trampling, theft of seedlings and juveniles and fungal diseases already place strain on *A. dichotomum* populations in the region. The cumulative impacts on *A. dichotomum* for the region will be higher compared to the direct impacts of this project on one individual within the development footprint.

A. dichotomum seems to be responding to climate change by shifting its distribution range towards higher latitudes (closer to the poles) and higher altitudes (tops of mountains), where conditions are typically cooler and moister. To keep up with a rapidly shifting climate, *A. dichotomum* must, in time, colonise new pole-ward or mountainous areas that are increasingly becoming more suitable. Up to date, limited new populations have yet been found as colonisation rates to suitable habitats are too slow in keeping up with a shifting climate. Nurse plants seem to play an important role in providing the necessary traps for the collection of windblown seeds; in addition, rocks and rock crevices seem to be highly important as they act as safe sites (Foden 2002; Van der Merwe & Geldenhuys 2017). For these reasons, the 100m "No-Go" area for all sensitive ridges are not only applicable to avifauna, but for the protection of this species preferred habitat. Several individuals have been observed on the surrounding koppies and ridges, which indicate that this species is currently still thriving in the project area of influence.

3.8.2 Avifaunal Importance

Avifaunal importance relates to species diversity, endemism and the presence of topographical features or primary habitat units with the intrinsic ability to sustain avifaunal assemblages, their food supply as well as SCC. It is clear that throughout the study area that most of the habitats are generic in their ability to support a high diversity of general avifaunal species, Red-Listed species and SCC. However, unique geographical or topographical features exist which would cause the areas targeted for mining to be classified as a "No Go" area in regards to avifauna. Due to the high diversity and density of the above mentioned Red-Listed species recorded during the survey, (including regionally and globally listed Endangered and Vulnerable birds), the region as a whole is considered to be an area of very high avifaunal importance and activities should be managed in a holistic manner at a policy level, prioritising mitigation and monitoring of avifaunal species of conservation concern.

Habitats with high avifauna sensitivities include the seasonal drainage lines and water sources:

- The seasonal drainage lines and accompanying riparian trees are linear dispersal corridors for terrestrial bird species. Much higher species diversity (as well as a unique composition) was observed in this habitat and therefore, these systems are earmarked with high avifaunal importance. The drainage lines act as important flight corridors for passerines and raptors between foraging and roosting sites.
- The surface water habitats (artificial dams) are vital in the landscape, primarily due to the very arid conditions prevailing within the region. Avifaunal species depend on an interconnected system of water features (artificial or otherwise) and, based on seasonality and prevailing climatic conditions, it is anticipated that these systems experience a frequent turnover of species over time (seasonally and long term). They often provide essential breeding habitat, foraging habitat and water resources for avifaunal species including large bodied species of conservation concern such as cranes, storks and bustards. When water is present, the impoundments and pan habitats provide ephemeral foraging habitat for regionally and national Vulnerable and Near-Threatened storks.
- The stony and rocky ridges act as prominent landmarks and foraging habitat for diurnal birds of prey. It also provides potential hunting habitat for the all SCC eagles which hunts rock hyrax (common in these habitats) and rock rabbits as a staple of their dietary requirements. The localised high population densities of rock hyrax and rock rabbits within the study areas as well as the regional linkage to the koppie habitats, elevates the importance of this habitat for avifauna.

Areas with medium avifaunal sensitivities include rocky and open habitats:

- The rocky habitats provide structural complexity not available in the open karoo vegetation which provides for an increase in species diversity and often higher densities of avifauna due to the prey species that are found in this habitats; and
- The open karoo habitats (including old cultivated lands and grassland areas) that provide suitable foraging habitat for the Ludwig's Bustard (*Neotis ludwigii*), Kori Bustard (*Ardeotis kori*) and Secretary bird (*Sagittarius serpentarius*).

In summary, the following key findings include:

- A high richness of Red-Listed and species of conservation concern occur within the study areas;
- A total of six Red-Listed bird species were confirmed to be present in the study areas out of 12 possible species with nine being highly likely in total; and
- High frequency of observations for the Near-Threatened Kori Bustard, the Endangered Ludwig's Bustard.

4 IMPACT ASSESSMENT

1. **Impact on vegetation and loss of flora species of conservation concern**

    a. Physical disturbance of vegetation
        i. Slashing of vegetation [Construction & Operation] – *Higher vegetation such as shrubs and trees will be slashed or removed where the solar panels will be erected. No earthworks or removal of topsoil will take place. Smaller species will initially be disturbed during the construction phase, but limited maintenance will take place during the operational phase which will severely harm, damage or destroy vegetation that has regrown underneath the panels. Available habitat for terrestrial fauna species might be reduced. Vegetation regrowth should be encouraged*;
        ii. Rammed in H beams [Construction & Operation] – *Physical damage caused to vegetation by equipment, ramming in of the H beams and erection of the solar panels is inevitable.*
        iii. Direct loss of flora species of conservation concern and flora species endemic to the region [Construction & Operation] - *The vegetation type has a unique floral species composition and the potential destruction of natural vegetation could lead to a significant loss of biodiversity. Removal of species of conservation concern is possible, and where necessary permits have to be submitted to the competent authority for their removal, destruction or damaged caused to them.*
        iv. *Aloidendron dichotomum physical disturbance and habitat destruction [Construction] - Only one individual was recorded in Bloemsmond 4 (another application), but numerous individuals occur on the surrounding ridges. This species should be protected in situ where possible; however, if the layout cannot be amended to accommodate this species, a permit application for its removal is required by the competent authority. A 100m No-Go area for ridges have been indicated in order to protect this species suitable habitat.*
        v. Site camps and laydown areas [Construction] - *The proposed activities require temporary erection of machinery and site camps, and consequently increase the impact on the vegetation. Available habitat for terrestrial fauna species will also be reduced.*
        vi. Stochastic events such as fire (e.g. cooking fires or cigarettes of workers) [Construction & Operation] - *careless discarding of lit cigarette butts and/or glowing embers from cooking fires being blown into surrounding vegetation may cause runaway fires to remove habitat for terrestrial fauna species that would otherwise have been available. Also a human risk if out of control.*
    b. Secondary impacts associated with the removal/destruction of vegetation and loss of SCC
        i. Displacement/loss of flora & fauna (including rare or endangered species and important habitats) - *the removal of habitat, in particular vegetation, will directly result in the loss of flora species, and indirectly affect fauna reliant on this vegetation for foraging and/or refugia;*
        ii. Habitat fragmentation & disruption of habitat corridors – *removal of vegetation leading to fauna habitat loss and fragmentation preventing migration and dispersal.*
        iii. Establishment of alien and invasive vegetation – *alien and invasive flora are usually pioneer species capable of establishing and spreading across the sites where the natural vegetation has been disturbed. This further reduces available natural habitat and habitat quality for flora and fauna.*
    c. Impact Assessment (Pre-mitigation) – Refer to Table 4-1.
    d. Mitigation and Enhancement Measures
        i. Clearings associated with ramming and movement of equipment across the site should occur in as small a footprint as possible. The layout design needs to specify the areas where disturbances will take place, including roads that will be utilised and the location of the site camp. The surrounding natural area that is not part of the layout design may not be disturbed or damaged;

ii. The site camps and laydown areas should be located in low sensitivity areas and should be demarcated. No unauthorised activities may take place outside of the demarcated fenced areas. Alternatively, existing storerooms and landowners yards can be utilised for storing of equipment and machinery. This can be organised with landowners directly;
iii. Alternatives should be planned in order to avoid loss of or damage to SCC as well as primary habitat such as the ridge towards the south. Appropriate buffers should be maintained in order to prohibit loss of habitat for SCC and breeding and foraging sites for fauna SCC;
iv. No vehicles may drive off existing roads and create new roads in natural vegetation unless authorised;
v. Buffer zones are allocated to sensitive or important habitat features to alleviate the effect of habitat loss, habitat fragmentation, disturbances, increased isolation and edge effects. It is suggested that a 200m buffer for flora SCC and a 100 m "no-go" buffer should be applied from the base of all ridges for fauna. A total 300 m buffer zone for all ridges for fauna must be implemented where activities should be limited where possible;
vi. Temporary erosion control measures during the construction phase should be implemented to limit erosion where applicable, especially close to drainage lines;
vii. Re-vegetation where required after clearance should commence immediately after removal of camp site;
viii. Alien vegetation control should take place during all phases of the proposed development to limit the likelihood of dispersal and establishment of new areas;
ix. An environmental induction for all staff members must be mandatory in which all matters regarding SCC and specific issues related to the potential of fire are addressed e.g. only smoking in designated areas, no open cooking fires etc.
x. Where natural vegetation is kept intact, it can act as an effective natural dust suppressor between the solar panels and roads.

e. Impact Assessment (Post-mitigation) – Refer to Table 4-2.
f. Residual impacts
   i. The spread of alien species is likely to occur and should be continuously controlled.
   ii. Habitat loss will result from the development, equivalent to the operational footprint of the facility
g. Uncertainty – The location of the site camp has not been determined as yet.

2. Direct mortality of fauna

a. Project components that can cause direct mortality of fauna
   i. Staff or construction workers poaching and hunting [Construction & Operation] - *Several fauna species could be hunted and consumed by staff during the prospecting activities*;
   ii. Direct mortality due to collisions with vehicles and machinery (roadkill) [Construction & Operational phase] - *Vehicles are defined as support vehicles (e.g. bakkies / pickups), staff vehicles (light passenger vehicles), large and slow moving construction vehicles (such as earth moving equipment/trucks, drill) that will be either self-propelled or towed (construction phase). As this is a restricted area with low traffic volumes vehicle presence throughout the project is expected to be low and consequently collisions would be minimal. Reptiles, amphibians, small mammals and avifauna are particularly prone to collisions with fast moving vehicles as they do not move out of the way upon approach by a vehicle. Furthermore, vehicle drivers rarely see small fauna on the road surface or avifauna flying across, and cannot avoid collisions with these animals while travelling at high speed;*

iii. Intentional killing of fauna [Construction & Operation] - *In general people are either superstitious or extremely fearful of snakes which usually results in the death of the snake when it is encountered. Despite the beneficial ecological functions of snakes such as rodent control, snakes are usually considered to be dangerous (despite the many non-venomous species) and are therefore killed;*

iv. Loss of Species of Conservation Concern [Construction & Operation] – *Several avifauna SCC are present on site. Destruction of their foraging and/or breeding habitat is possible. For this reason a 100 m "no-go" buffer zone and a total (including "no-go" buffer) 300 m buffer zone for all ridges must be implemented where activity should be avoided if possible in order to protect habitat but also to allow for minimal direct impacts with infrastructure such as fences and powerlines. Displacement of SCC will occur with placement of solar panels*;

v. Direct mortality due to ground preparation for construction [Construction] - *The machinery used and the method of installation can result in the direct mortality of fauna, especially for burrowing fauna.*

vi. Fences - *Development fences are designed to separate land portions, especially along different property boundaries as well as along road boundaries. These fences often are relatively impenetrable (with the exception of burrows, weak points and breakages) and approximately 1.5 metres high. Without adequate road servitude space (effectively allowing escape or buffer space for animals), animals may run to avoid vehicles and collide with fences, causing death. In addition, these fence systems funnel slow moving fauna such as chelonians onto roads which concentrate on the open surfaces, often exacerbated by roadside water accumulations and green flush vegetation. Therefore, fence systems cause both direct mortality as well as indirect mortality due to the negative association with vehicles.*

b. Secondary impacts associated with direct mortality of fauna

i. Changes in fauna population dynamics (e.g. rodent population explosion) – *for example, prolonged mortality of predacious species such as snakes could significantly reduce the population density of these predators and allow prey species to undergo localised population explosions. This in turn can have major negative impacts on the surrounding ecology*.

ii. Species mortalities due to collision with fences – *Due to the obvious increase in vehicle presence through the project, it is unavoidable that collision related mortality including flushing of species into fences, causing deaths will increase significantly*. *There are a plethora of susceptible faunal species throughout the region, namely chelonians (tortoises and terrapins), small to medium sized nocturnal mammals and medium to large walking/flying bird species. All these species are highly characteristic of the Karoo biome system where the open habitats with harsh climatic conditions are conducive to the ecology of the species. Chelonians: There are a low density of terrapins (which are associated with temporary water systems) and especially tortoises which exhibit seasonal booms linked to early spring related mating and foraging behaviour. Much of the movement of these species are linked to roads due to easy movement as well as the barrier effects of fences (described below) and they are extremely susceptible to mostly diurnal moving traffic of all speeds above 40 km ph. Small to medium nocturnal mammals: Species such as meso-carnivores (bat-earred fox, striped polecat, aardwolf, cape fox, black-backed jackal and hares) were all observed dead on the roads (both tar and dirt) road and are highly susceptible to bright lights and high speed vehicles. Medium to large walking/ flying bird species: These species include cranes, korhaans, bustards and guineafowl. The susceptibility of these species to collision varies in accordance to the species and they are especially prone to high speed collisions.*

c. Impact Assessment (Pre-mitigation) – Refer to Table 4-1.

d. Mitigation and Enhancement Measures

i. All vehicle speeds associated with the project should be monitored and should be limited to 40 km/h (maximum) during the construction and operation phases;
ii. Speed humps need to be placed at pre-determined locations to force project vehicles to reduce speed;
iii. Road mortalities should be monitored by both vehicle operators (for personal incidents only) and the ECO (all road and fence kill on periodic monitoring basis as well as specific incidents) with trends being monitored and subject to review as part of the monthly reporting. Monitoring should occur via a logbook system where staff takes note of the date, time and location of the sighting/ incident. This will allow determination of the locations where the greatest likelihood exists of causing a road mortality and mitigate against it through both the embedded measures mentioned above (reducing vehicle speeds in sensitive areas) and below (e.g. fauna underpasses, fence removals and seasonal speed reductions). Finally, mitigation should be adaptable to the onsite situation which may vary over time;
iv. Reduce direct mortalities either by removing fences in identified sensitive areas or indeed, increasing the buffer area either side of the road by 50 metres either side, in order to allow fauna to have an escape area away from impenetrable fences;
v. Reduce direct mortalities by allowing for fauna to cross the roads, particularly where the roads cross a sensitive natural habitat (e.g. wetlands or artificial water points). This can be achieved by constructing fauna underpasses under the roads (large culverts or large open-ended concrete pipes laid into the raised roads). These underpasses should be used in conjunction with "fauna barriers" which prevent the most susceptible small fauna from crossing the roads on the surface by directing them towards the underpasses where they can cross under the roads safely. It is important to note that utilization of underpasses is strongly dependent on animal body size (larger culverts are more successful) and the surrounding habitat (Mata *et al*. 2005); and
vi. All staff operating motor vehicles must undergo an environmental induction training courses that includes instruction on the need to comply with speed limits, to respect all forms of wildlife (especially reptiles and amphibians) and, wherever possible, prevent accidental road kills of fauna. Dead mammals should never be handled due to the risk of rabies and snakes should only be handled after inductions have taken place due to the risks of post-mortem envenomation. Drivers not complying with speed limits should be subject to penalties;
vii. Should large holes or burrows be located at the sites, and where avoidance of these areas is not possible, a zoological specialist should be contacted to investigate and possibly remove any species located within them.

e. Impact Assessment (Post-mitigation) – Refer to Table 4-2.
f. Residual impacts
   - It is not possible to avoid all faunal deaths but proper mitigation will reduce the residual impacts to acceptable levels.
g. Uncertainty – None.

3. Disruption/alteration of ecological life cycles (breeding, migration, feeding) due to noise, dust and lighting [Construction & Operation]

a. Project components that can result in noise, dust and lighting
   i. Access roads and construction works [Construction & Operation] – *Noise, dust and lighting generated from moving vehicles operating on roads and from machinery on site can disrupt fauna populations by interfering with their movements and/or breeding activities. In particular, lighting at*

night is expected to attract insects which will attract geckos and amphibians which in turn can attract snakes (which might be venomous). Lighting at night may also disrupt flight paths of migrating birds and bats foraging at night which could cause collisions.

b. Secondary impacts associated with disruption/alteration of ecological lifecycles.

i. Increased probability of interaction with reptiles – *As described above, snakes may be attracted to potential prey due to lights and represent a potential health and safety threat. In addition, reptiles attracted to site such as snakes could be killed by staff on site.*
ii. Birds nesting in power plant infrastructure – *Birds can nest within the infrastructure which makes them susceptible to be harmed or killed during the operational phase of the project.*
iii. Supporting infrastructure, especially, roads, fences and powerlines will cause ecological disruptions and possible mortality.

c. Impact Assessment (Pre-mitigation) – Refer to Table 4-1.

d. Mitigation and Enhancement Measures

i. Equipment with low noise emissions must be used or silencers should be fitted on all engines;
ii. A dust monitoring system should be implemented during the construction and operational phase;
iii. Reduce exterior lighting to that necessary for safe operation, and implement operational strategies to reduce spill light. Use down-lighting from non-UV lights where possible, as light emitted at one wavelength has a low level of attraction to insects. This will reduce the likelihood of attracting insects and their predators at night;
iv. Keep noise levels suppressed as per the local municipality or national standards. Do not unnecessarily disturb faunal species, especially during the breeding season and those with juveniles;
v. A 100 m "no-go" buffer and a 300 m total buffer zone for all ridges must be implemented where activity should not take place if possible in order to protect habitat but also to allow for minimal direct impacts of birds with solar infrastructure;
vi. All staff should be subjected to an induction training program where appropriate conservation principles, safety procedures, snake bite avoidance and first aid treatment are taught. Several staff members should complete a snake handling course in order to safely remove snakes from construction areas.

e. Impact Assessment (Post-mitigation) – Refer to Table 4-2

f. Residual impacts – None

g. Uncertainty – None.

4. Introduction of alien and/or invasive flora affecting native flora and faunal assemblages

a. Project components that can result in increased densities of alien flora
   i. Vehicles and machinery [Construction & Operation] – *Vehicles and machinery can spread alien plant seeds throughout the study area which could potentially spread into the adjacent natural and agricultural areas. Alien plants can cause alterations to the environment which could affect local flora and fauna, especially since the study area is located within a threatened ecosystem and vegetation type;*
   ii. Soil Disturbance [Construction & Operation] – *Seeds lying dormant for years could germinate when the soil is disturbed;*
b. Secondary impacts associated with increased alien flora and fauna species

i. Displacement of native species due to competition and/or unfavourable habitats due to alien establishment.

c. Impact Assessment (Pre-mitigation) – Refer to Table 4-1.
d. Mitigation and Enhancement Measures
   i. Disturbance of surrounding natural areas should be avoided and the spread of alien flora into natural areas should be controlled.
   ii. Continuous monitoring of the growth and spread of alien flora coupled with an adaptive management approach to identify suitable control mechanisms. No chemical control should take place in close proximity of watercourses unless authorised by the competent authority;
   iii. An Alien and Invasive species eradication action plan should be compiled, in order to ensure that the spread and establishment of Alien and Invasive species are controlled and that disturbances are minimal and mitigated where necessary.
e. Impact Assessment (Post-mitigation) – Refer to Table 4-2.
f. Residual impacts
   - The management of alien flora remains a global issue with the success of control measures highly dependent on the management strategy as well as resources available (e.g. financial and intellectual).
   - Several alien invasive species exist due to current impacts.
g. Uncertainty – The types of alien species that might be dormant within the soils.

5. Increase in erosion reduces habitat quality

a. Project components that can cause increase in erosion
   i. Vegetation clearing [Construction] – *Vegetation clearing and soil compaction throughout the site will lead to increased erosion. Such erosion undermines the stability of the habitat and reduces overall habitat quality for fauna and flora.*
   ii. Roads and other hardened surfaces [Construction] – *Increased runoff could cause erosion.*
b. Secondary impacts associated with increased erosion
   i. Establishment of alien and invasive vegetation – *as alien and invasive flora establish and spread across the site it reduces available natural habitat and habitat quality for fauna*
c. Impact Assessment (Pre-mitigation) – Refer to Table 4-1
d. Mitigation and Enhancement Measures
   i. Vegetation clearing should be done for as short a time as possible. Erosion control methods during the construction phase should be implemented to limit erosion where applicable.
   ii. Revegetation in natural areas after clearance should commence directly where natural areas have been disturbed unnecessarily;
   iii. Heavy vehicles should preferably not operate in the wet season as gravel roads can be disturbed and lead to erosion if not managed.
e. Impact Assessment (Post-mitigation) – Refer to Table 4-2
f. Residual impacts – None.
g. Uncertainty – None.

Table 4-1: The proposed development impacts on fauna and flora pre-mitigation.

Impact	Impacts Status	Spatial scale	Temporal scale	Probability (P)	Severity (S)	Significance value (P × S)	Significance rating
Loss of existing habitat due to loss of vegetation							
Slashing of vegetation	Negative	1	3	5	3	15	High
Rammed in H beams	Negative	1	4	5	4	20	High
Site camps and laydown areas	Negative	1	4	5	3	15	High
Direct loss of flora species of conservation concern and flora species endemic to the region	Negative	1	4	4	4	16	High
Stochastic events such as fire	Negative	4	3	4	4	16	High
Direct mortality of fauna							
Staff or construction workers poaching and hunting	Negative	1	2	4	3	12	Medium/High
Collisions with vehicles	Negative	1	4	4	4	16	High
Intentional killing of fauna	Negative	1	4	4	3	12	Medium/ High
Loss of species of conservation concern	Negative	2	4	4	4	16	High
Vegetation clearing/ construction preparation	Negative	1	2	4	3	12	Medium/ High
Disruption/alteration of ecological life cycles (breeding, migration, feeding) due to noise, dust and lighting							
Access roads and construction works	Negative	2	4	4	3	12	Medium/High
Solar panels (operational)	Negative	2	5	5	4	20	High
Introduction of alien flora affecting native floral and faunal assemblages							
Vehicles and machinery	Negative	3	4	4	4	16	High
Soil Disturbance	Negative	2	3	4	4	16	High
Increase in erosion reduces habitat quality							
Vegetation clearing	Negative	1	3	3	3	9	Medium
Roads and hardened surfaces	Negative	1	4	4	3	12	Medium/High

Table 4-2: The proposed development impacts on fauna and flora post-mitigation.

Impact	Impacts Status	Spatial scale	Temporal scale	Probability (P)	Severity (S)	Significance value (P × S)	Significance rating
Loss of existing habitat due to loss of vegetation							
Slashing of vegetation	Negative	1	3	3	2	6	Medium
Rammed in H beams	Negative	1	4	3	3	9	Medium
Site camps and laydown areas	Negative	1	4	3	2	6	Medium
Direct loss of flora species of conservation concern and flora species endemic to the region	Negative	1	4	3	2	6	Medium
Stochastic events such as fire	Negative	4	3	2	2	4	Low/Medium
Direct mortality of fauna							
Staff or construction workers poaching and hunting	Negative	1	2	1	2	2	Low
Collisions with vehicles	Negative	1	4	2	2	4	Low/Medium
Intentional killing of fauna	Negative	1	4	1	2	2	Low
Loss of species of conservation concern	Negative	2	4	3	3	9	Medium
Vegetation clearing/ construction preparation	Negative	1	2	2	2	4	Low/Medium
Disruption/alteration of ecological life cycles (breeding, migration, feeding) due to noise, dust and lighting							
Access roads and construction works	Negative	1	1	2	2	4	Low/Medium
Solar panels (operational)	Negative	1	1	2	2	4	Low/Medium
Introduction of alien flora affecting native faunal assemblages							
Vehicles and machinery	Negative	2	4	3	2	6	Medium
Soil disturbance	Negative	2	3	2	2	4	Low/Medium
Increase in erosion reduces habitat quality							
Vegetation clearing	Negative	1	3	2	2	4	Low/Medium
Roads and hardened surfaces	Negative	1	4	3	2	6	Medium

4.1 CUMULATIVE IMPACTS

There is a large amount of solar development within the area, which raises the possibility of significant cumulative impacts. As the proposed development occurs in a Renewable Energy Development Zone (REDZ), the large number of renewable energy projects especially solar farms is expected within the region. This includes several approved, preferred-bidder PV projects immediately adjacent to the site on Dyason's Klip as well as the Abengoa Khi Solar One CSP facility north-east of the site as well as several mixed CSP/PV developments north of Dyason's Klip (Figure 4-1). The current project would contribute about 334ha of the total 1184ha transformed area for the Bloemsmond project. This equates to around 28.2% of the total transformed area for Bloemsmond (this excludes all other surrounding PV and CSP developments).

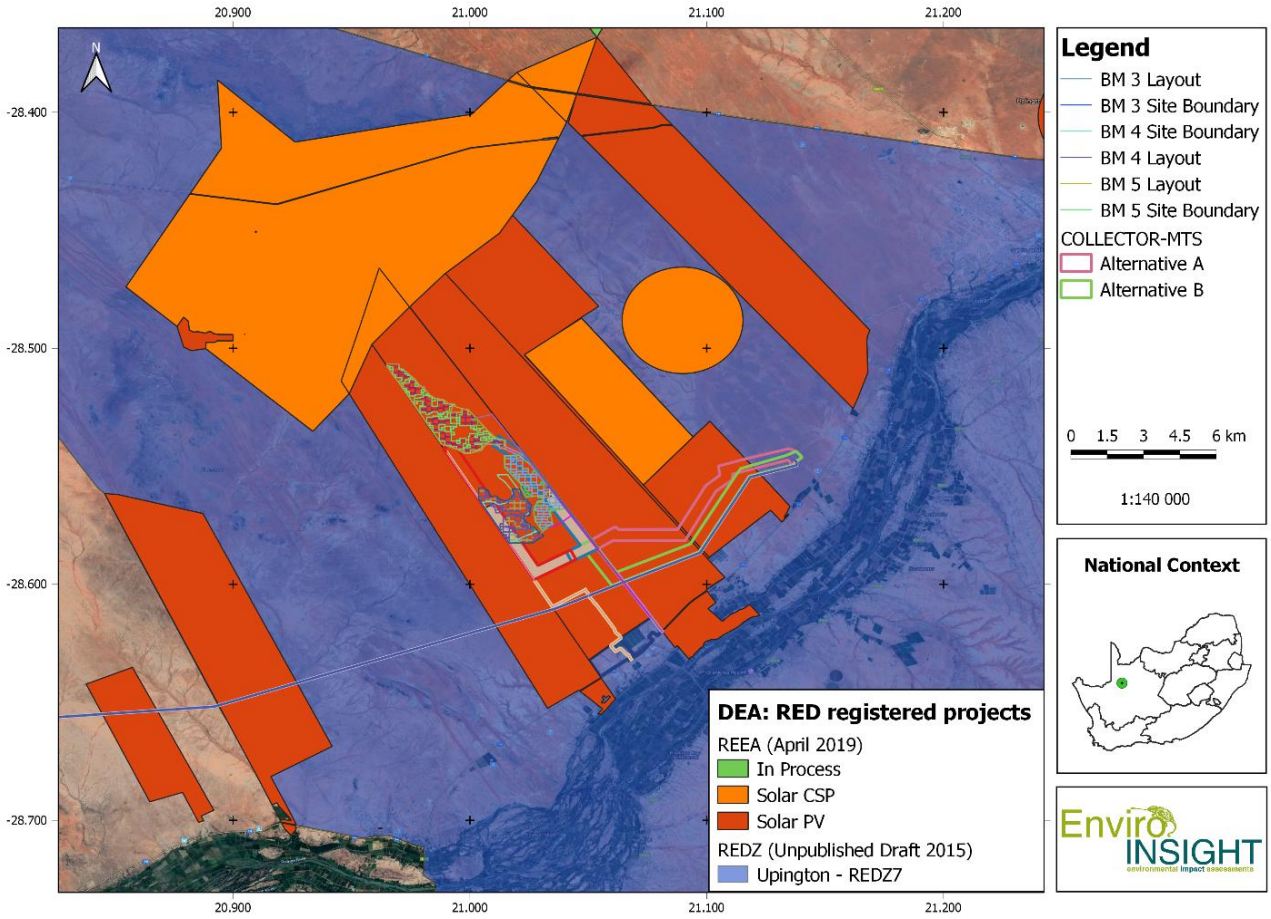


Figure 4-1: DEA Renewable Energy Development (RED) registered projects for the area as at April 2019. The proposed Bloemsmond 3-5 developments are located between either existing or proposed PV or CSP projects.

Accordingly, the biggest concern regarding solar developments at present in this region is not necessarily the direct impacts caused by the individual developments, but rather the cumulative impacts of several developments adjacent to one another (this entails the three Bloemsmond projects which can be regarded as one project as well as the additional PV and CSP projects occurring around the Bloemsmond projects). Currently, all projects are assessed in isolation which may limit the overall accuracy of the Impact Analysis (there are currently three separate applications for solar development within a 4.5 km radius). Some of the main cumulative impacts of renewable energy developments in the region will include:

- Vegetation and habitat loss
- Increased habitat fragmentation
- Reduced landscape connectivity for fauna species
- Loss of critical habitat for SCC
- Loss of provincially protected species and nationally protected tree species
- Loss of avifauna species due to incineration, electrocution and collision with infrastructure
- Surface water impacts
- Increased erosion
- Loss of vegetation cover will cause increased dust pollution
- Increased alien flora and fauna species

A significant bridging instrument would be to issue an independent and detailed Cumulative Impact Assessment which incorporates all local solar developments within the project area of influence as well as all supporting infrastructure.

5 CONCLUSION AND PROFESSIONAL OPINION

The study area is located within the Kalahari Karroid Shrubland and Bushmanland Arid Grassland vegetation types, both listed as Least Threatened. The project is also located in "Other Natural Areas" according to the Northern Cape CBA Map. The two main habitats that transect the study area are Karoo Shrubland and Drainage Lines. Several important ridges and rocky outcrops occur within the surrounding area which are highly sensitive and should be avoided by the proposed development as they act as important habitat for foraging and breeding fauna SCC, for example *Neotis ludwigii*, as well as important habitat for *Aloidendron dichotomum* (which has been recorded on Bloemsmond 4 and the surrounding koppies) and *Dinteranthus wilmotianus* (recorded at rocky outcrops in previous study on the property). These species are highly dependent on ridges and rocky outcrops for ther survival and a 100m "no-go" area has been suggested for the protection of ther habitat. This entails that **no development should occur within 100m from the identified ridges and rocky outcrops, and a further 200m buffer has been suggested where activities should be limited**. For *A. dichotomum* a conservative 200 m buffer has been suggested. It is preferred that this species is protected *in situ*; however, if this is not possible a permit application should be submitted to the competent authority for its relocation (this decision ultimately lies with the competent authority and not the developer).

The impact assessment indicated that not all impacts can be mitigated to acceptable levels - medium significance post-mitigation should be interpreted that more can be done to avoid this impact. This is mainly because impact assessments regarding solar developments have been poorly understood since their inception (Rudman *et al*., 2017) and the impacts of solar developments on fauna and flora especially in the Kalahari have significant consequences if not implemented correctly. Previous specialist reports hardly assessed cumulative impacts or make suggestions regarding buffer areas for protecting habitat for SCC that do occur within the study area and region. This oversight has cascading ramifications for SCC when decisions are based on small individual projects. When assessing renewable energy projects, each project cannot be considered in isolation, especially since applying for environmental authorisation for large scale wind and solar photovoltaic energy development activities (Gazette Number 41445, 16 February 2018) within Renewable Energy Development Zones (REDZs) only requires a Basic Assessment process to be followed. Caution should be taken by specialist when conducting studies for large scale solar photovoltaic energy developments not to downgrade the level of assessment as the decision to reduce a process in terms of timeframes is the only factor that should be considered, and not the level of study itself. The protection of important habitat for SCC should be assessed as a significant environmental risk. However, it is the opinion of the consultancy that the impacts associated with renewable solar projects are far more preferable to non-renewable alternatives and that, while striving to maintain the highest standards of mitigation and monitoring as well as the commissioning of a highly detailed regional strategic cumulative Impact Assessment, developments such as Bloemsmond 3 should be encouraged within designated areas.

One of the provisions in the Northern Cape Nature Conservation Act (Act No 9 of 2009) is that no person may without a permit, pick, import, export, transport, possess, cultivate or trade in a specimen of a specially protected plant or a protected plant species. Two species (*Hoodia gordonii* and *Aloidendron dichotomum*) are listed as **specially protected plant species** and **five protected plant** species were recorded on site. It should be noted that since a comprehensive list of flora species could not be compiled due to sampling difficulty, all species recorded on the study area that will be affected by the proposed development subjected to the NCNCA (2009) require a permit from the competent authority for the removal, even though most of these species are quite common. The removal of *Aloidendron dichotomum* is not supported and this species and its habitat should be protected *in situ*. Furthermore, protected trees influenced by the proposed development including *Boscia albitrunca* and *Vachellia erioloba* will require permits from the competent authority for their removal according to the National Forest Act (Act No 84 of 1998).

The project can be approved subject to alternative layouts prepared taking into consideration buffer areas according to Figure 3-11, and permit applications are applied for the removal and relocation of protected species listed according to the NCNCA (2009) and NFA (1998).

6 REFERENCES

ANDERSON, M.D. 2002. Black Eagle pair successfully fledges two young. Ostrich 73: 61-62.

ANON. 2012. Black Eagle Project's preliminary comments submission: Provisional list of environmental issues related to the Proposed Protea Dal development (Gaut 002/11-12/E0287)

ALLAN, D.G. 1988. Breeding success, nest spacing and territory size of Black Eagles in the Magaliesberg, South Africa. Gabar 3: 76-81.

BARNES, K. 2000. The Eskom Red Data Book of birds of South Africa, Lesotho and Swaziland. Johannesburg: BirldLife South Africa.

BATES, M.F., BRANCH, W.R., BAUER, A.M., BURGER, M., MARAIS, J., ALEXANDER, G.J. & DE VILLIERS, M.S. (EDS). 2014. Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland. Suricata 1. South African National Biodiversity Institute, Pretoria, South Africa.'

BIRDLIFE INTERNATIONAL. 2012a. " Kori Bustard". IUCN Red List of Threatened Species. Version 2012.1. International Union for Conservation of Nature. Retrieved 14 June 2019.

BRANCH, W.R. 1998. Field guide to snakes and other reptiles of southern Africa. Struik, Cape Town.

CHILD, M.F., Roxburgh, L., Do Linh San, E., Raimondo, D., Davies-Mostert, H.T. (editors). 2016. Red List of Mammals of South Africa, Lesotho and Swaziland. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

DU PREEZ, L.H. & CARRUTHERS, V. 2017. *Frogs of Southern Africa: A Complete Guide*. 2nd Revised edition, Struik Nature.

FODEN, W. 2002. A demographic study of *Aloe dichotoma* in the succulent Karoo: are the effects of climate change already apparent? , University of Cape Town.

FODEN, W. 2005. *Aloidendron dichotomum* (Masson) Klopper & Gideon.F.Sm. National Assessment: Red List of South African Plants version 2017.1.

FODEN, W., MIDGLEY, G.F., HUGHES, G., BOND, W.J., THUILLER, W., HOFFMAN, M.T., KALEME, P., UNDERHILL, L.G., REBELO, A.G. and HANNAH, L. 2007. A changing climate is eroding the geographical range of the Namib Desert tree Aloe through population declines and dispersal lags. Diversity and Distributions 13:645-653.

FROGMAP. 2019. The Southern African Frog Atlas Project (SAFAP, now FrogMAP). http://vmus.adu.org.za/

GARGETT, V. and MUNDY, P.J. 1990. The black eagle: a study. Acorn Books.

GDARD. 2014. Gauteng Department of Agriculture And Rural Development, Directorate of Nature Conservation. GDARD Requirements for Biodiversity Assessments. Version 3.

HOCKEY, P.A.R., DEAN, W.R.J. & RYAN, P.G. (eds.) 2005. Roberts – Birds of Southern Africa, VIIth ed. The Trustees of the John Voelker Bird Book Fund, Cape Town.

IUCN. 2012. IUCN Red List Categories and Criteria: Version 3.1. Second edition. Gland, Switzerland and Cambridge, UK: IUCN. iv + 32pp.

IUCN. 2019. The IUCN red data list website. Available at www.iucnredlist.org

JOHNSON, S.D. & BYTEBIER, B. 2015. Orchids of South Africa: A Field Guide. Struik Nature.

MAMMALMAP. 2019. The Animal Demography Virtual Museum MammalMAP Project. University of Cape Town. http://vmus.adu.org.za.

MARAIS, J. 1999. A Complete Guide to the Snakes of Southern Africa. Struik Nature, Cape Town.

MARNEWICK, M., RETIEF, E., THERON, N., WRIGHT, D., & ANDERSON, T. 2015. *Important Bird and Biodiversity Areas of South Africa.* Johannesburg: BirdLife South Africa.

MATA, C., HERVÁS, I., HERRANZ, J., SUAREZ, F. AND MALO, J.E. 2005. Complementary use by vertebrates of crossing structures along a fenced Spanish motorway. *Biological Conservation*, 124(3), pp.397-405.

MINTER, L.R., BURGER, M., HARRISON, J.A., BRAACK, H.H., BISHOP, P.J. & KLOEPFER, D. 2004. Atlas and Red Data Book of the frogs of South Africa, Lesotho and Swaziland. SI/MAB Series #9. Smithsonian Institution, Washington DC.

MONADJEM, A., TAYLOR, P.J., DENYS, C., COTTERILL, F.P.D. 2015. Rodents of Sub-Saharan Africa: A Biogeographic and Taxonomic Synthesis. De Gruyter, Berlin, Germany.

MUCINA, L. AND RUTHERFORD, M.C. (Eds.) 2010. The vegetation of South Africa, Lesotho and Swaziland. Strelizia 19. South African National Biodiversity Institute, Pretoria

NATIONAL ENVIRONMENTAL MANAGEMENT: BIODIVERSITY ACT. 2004 (act 10 of 2004): Publication of lists of critically endangered, endangered, vulnerable and protected species.

QGIS Development Team, 2016. QGIS Geographic Information System. Open Source Geospatial Foundation. URL http://qgis.osgeo.org.

RAIMONDO, D., VON STADEN, L., FODEN, W., VICTOR, J.E., HELME, N.A., TURNER, R.C., KAMUNDI, D.A. & MAYAMA, P.A. (eds). 2009. Red List of South African plants. Strelitzia 25. South African National Biodiversity Institute, Pretoria.

REPTILEMAP. 2019. The Southern African Reptile Conservation Assessment (SARCA, now ReptileMAP). http://vmus.adu.org.za/

RODGERS, J.A. and SMITH, H.T. 1995. Set-back distances to protect nesting bird colonies from human disturbance in Florida. Conservation Biology, 9, 89–99.

RODGERS, J. and SCHWIKERT, S. 2002. Buffer-zone distances to protect foraging and loafing waterbirds from disturbance by personal watercraft and outboardpowered boats. Conservation Biology, 16, 216-224.

RUDDOCK, M., and WHITFIELD, D.P. 2007. A review of disturbance distances in selected bird species. A report from Natural Research (Projects) Ltd to Scottish Natural Research, Banchory, UK.

RUDMAN, J, GAUCHÉ P, ESLER KJ. 2017. Direct environmental impacts of solar power in two arid biomes: An initial investigation. S Afr J Sci. 2017; 113(11/12). http://dx.doi.org/10.17159/ sajs.2017/20170113

SABAP2 (South African Bird Atlas Project). 2019. http://vmus.adu.org.za/

SANBI. 2019. Botanical Database of Southern Africa (BODATSA) [dataset]. Retrieved from http://newposa.sanbi.org/

SANBI. 2019. *Red List of South African Plants version 2017.1.* Retrieved from http://redlist.sanbi.org/index.php

SKINNER J.D. & CHIMIMBA, C.T. 2005. The Mammals of the Southern African Subregion (New Edition). Cambridge University Press. South Africa.

SIMMONS, R.E. 2005. Verreaux's Eagle. In: HOCKEY, P.A.R., DEAN, W.R.J. & RYAN, P.G. (eds.) 2005. Roberts – Birds of Southern Africa, VIIth ed. The Trustees of the John Voelker Bird Book Fund, Cape Town.

STILLMAN, R.A., WEST, A.D., CALDOW, R.W. and DURELL, S.E.L.V.D. 2007. Predicting the effect of disturbance on coastal birds. Ibis, 149, pp.73-81.

STUART, C. & STUART, T. 1998. *A Field Guide to the Tracks and Signs of Southern and East Africa.* South Africa: Southern Book Publishers.

TAYLOR, M.R., PEACOCK, F. AND WANLESS, R.M., 2015. The Eskom red data book of birds of South Africa, Lesotho and Swaziland. BirdLife South Africa, Johannesburg.

TAYLOR, P., BAXTER, R., CHILD, M.F. 2016. A conservation assessment of *Otomys auratus*. In Child MF, Roxburgh L, Do Linh San E, Raimondo D, Davies-Mostert HT, editors. The Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

TODD, S. 2015. ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED AEP BLOEMSMOND SOLAR 2 FACILITY NEAR UPINGTON, NORTHERN CAPE: FAUNA & FLORA SPECIALIST ECOLOGICAL IMPACT ASSESSMENT.

VAN OUDTSHOORN F. 2014. Guide to grasses of southern Africa. Second Edition. Pretoria. Briza Publications.

VAN WYK, B and MALAN, S. 1998. *Field guide to the wildflowers of the Highveld*. Struik Publishers, Cape Town.

VAN WYK, B and VAN WYK, P. 1997. Field guide to trees of Southern Africa. Cape Town. Struik Publishers.

VISSER, E., PEROLD, V., RALSTON-PATON, S., CARDENAL, A.C and RYAN, P.G. 2018. Assessing the impacts of a utility - scale photovoltaic solar energy facility on birds in the Northern Cape, South Africa. Renewable Energy 133: 1285 – 1294.

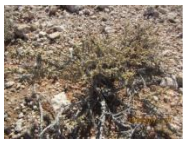
VON STADEN, L. & STEYN, H.M. 2015. *Acanthopsis hoffmannseggiana* (Nees) C.B.Clarke. National Assessment: Red List of South African Plants version 2017.1.

WIDDOWS, C. 2015. AVIFAUNAL IMPACT ASSESSMENT: *PROPOSED CONSTRUCTION OF THE AEP BLOEMSMOND SOLAR 2 PHOTOVOLTAIC (PV) FACILITY AND ASSOCIATED INFRASTRUCTURE, KAI !GARIB LOCAL MUNICIPALITY, NORTHERN CAPE PROVINCE.*

7 APPENDIX

7.1 APPENDIX 1: GEOREFERENCED PHOTOGRAPHS TAKEN DURING THE FIELDWORK SURVEY.

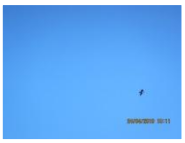
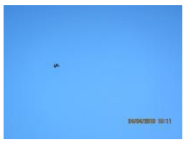
					
7592	7593	7594	7595	7596	7597
					
7598	7599	7600	7601	7602	7603
					
7604	7605	7606	7607	7608	7609
					
7610	7611	7612	7613	7614	7615
					
7616	7617	7618	7619	7620	7621
					
7622	7623	7624	7625	7626	7627

					
7628	7629	7630	7631	7632	7633
					
7634	7635	7636	7637	7638	7639
					
7640	7641	7642	7643	7644	7645
					
7646	7647	7648	7649	7650	7651
					
7652	7653	7654	7655	7656	7657
					
7658	7659	7660	7661	7662	7663

					
7664	7665	7666	7667	7668	7669
					
7670	7671	7672	7673	7674	7675
					
7676	7677	7678	7679	7680	7681
					
7682	7683	7684	7685	7686	7687
					
7688	7689	7690	7691	7692	7693
					
7694	7695	7696	7697	7698	7699

					
7700	7701	7702	7703	7704	7705
					
7706	7707	7708	7709	7710	7711
					
7712	7713	7714	7715	7716	7717
					
7718	7719	7720	7721	7722	7723
					
7724	7725	7726	7727	7728	7729
					
7730	7731	7732	7733	7734	7735

					
7736	7737	7738	7739	7740	7741
					
7742	7743	7744	7745	7746	7747
					
7748	7749	7750	7751	7752	7753
					
7754	7755	7756	7757	7758	7759
					
7760	7761	7762	7763	7764	7765
					
7766	7767	7768	7769	7770	7771

					
7772	7773	7774	7775	7776	7777
					
7778	7779	7780	7781	7782	7783
					
7784	7785	7786	7787	7788	7789
					
7790	7791	7792	7793	7794	7795
					
7796	7797	7798	7799	7800	7801
					
7802	7803	7804	7805	7806	7807

					
7808	7809	7810	7811	7812	7813
					
7814	7815	7816	7817	7818	7819
					
7820	7821	7822	7823	7824	7825
					
7826	7827	7828	7829	7830	7831
					
7832	7833	7834	7835	7836	7837
					
7838	7839	7840	7841	7842	7843

					
7844	7845	7846	7847	7848	7849
					
7850	7851	7852	7853	7854	7855
					
7856	7857	7858	7859	7860	7861
					
7862	7863	7864	7865	7866	7867
					
7868	7869	7870	7871	7872	7873
					
7874	7875	7876	7877	7878	7879

					
7880	7881	7882	7883	7884	7885
					
7886	7887	7888	7889	7890	7891
					
7892	7893	7894	7895	7896	7897
					
7898	7899	7900	7901	7902	7903
					
7904	7905	7906	7907	7908	7909
					
7910	7911	7912	7913	7914	7915

					
7916	7917	7918	7919	7920	7921
					
7922	7923	7924	7925	7926	7927
					
7928	7929	7930	7931	7932	7933
					
7934	7935	7936	7937	7938	7939
					
7940	7941	7942	7943	7944	7945
					
7946	7947	7948	7949	7950	7951

					
7952	7953	7954	7955	7956	7957
					
7958	7959	7960	7961	7962	7963
					
7964	7965	7966	7967	7968	7969
					
7970	7971	7972	7973	7974	7975
					
7976	7977	7978	7979	7980	7981
					
7982	7983	7984	7985	7986	7987

					
7988	7989	7990	7991	7992	7993
					
7994	7995	7996	7997	7998	7999
					
8000	8001	8002	8003	8004	8005
					
8006	8007	8008	8009	8010	8011
					
8012	8013	8014	8015	8016	8017
					
8018	8019	8020	8021	8022	8023

					
8024	8025	8026	8027	8028	8029
					
8030	8031	8032	8033	8034	8035
					
8036	8037	8038	8039	8040	8041
					
8042	8043	8044	8045	8046	8047
					
8048	8049	8050	8051	8052	8053
					
8054	8055	8056	8057	8058	8059

					
8060	8061	8062	8063	8064	8065
					
8066	8067	8068	8069	8070	8071
					
8072	8073	8074	8075	8076	8077
					
8078	8079	8080	8081	8082	8083
					
8084	8085	8086			

7.2 APPENDIX 2: EXPECTED FLORA SPECIES LIST

Plant species recorded on the BODATSA database for the the xMin, yMin 20.20°,-29.20°: xMax, yMax 21.4°,-28.20° extent (WGS84 datum). Species of Conservation Concern are indicated in Red.

Scientific names	IUCN Category[17]	Ecology
Geigeria pectidea	LC	Indigenous; Endemic
Indigastrum argyroides	LC	Indigenous; Endemic
Heliophila sp.		
Peliostomum leucorrhizum	LC	Indigenous; Endemic
Ruschia sp.		
Arctotis leiocarpa	LC	Indigenous; Endemic
Suaeda merxmuelleri	LC	Indigenous
Solanum burchellii	LC	Indigenous; Endemic
Zygophyllum dregeanum	LC	Indigenous
Mesembryanthemum coriarium		Indigenous; Endemic
Tetraena microcarpa		Indigenous; Endemic
Selago paniculata	LC	Indigenous; Endemic
Kohautia cynanchica	LC	Indigenous
Rhigozum trichotomum	LC	Indigenous
Tribulus zeyheri	LC	Indigenous
Searsia pendulina		Indigenous; Endemic
Pteronia mucronata	LC	Indigenous; Endemic
Phalaris canariensis	NE	Not indigenous; Naturalised
Ferraria variabilis	LC	Indigenous; Endemic
Wahlenbergia denticulata	LC	Indigenous
Dimorphotheca pluvialis	LC	Indigenous; Endemic
Felicia muricata	LC	Indigenous
Anacampseros albissima		Indigenous; Endemic
Dyerophytum africanum	LC	Indigenous; Endemic
Tylecodon rubrovenosus		Indigenous; Endemic
Eragrostis procumbens	LC	Indigenous
Tephrosia dregeana	LC	Indigenous
Heliophila minima	LC	Indigenous; Endemic
Eragrostis brizantha	LC	Indigenous; Endemic
Aptosimum lineare		Indigenous
Felicia deserti	DD	Indigenous; Endemic

[17] VU = Vulnerable; NT = Near Threatened; DD = Data Deficient; LC = Least Concern; NE = Not Evaluated;

Pentzia sp.		
Ficus cordata	LC	Indigenous
Cenchrus ciliaris	LC	Indigenous
Melolobium macrocalyx		Indigenous
Cyperus longus	NE	Indigenous
Mesembryanthemum crystallinum	LC	Indigenous
Vachellia erioloba	LC	Indigenous
Ornithoglossum vulgare		Indigenous
Kleinia longiflora	LC	Indigenous
Setaria italica	NE	Not indigenous; Naturalised
Trachyandra sp.		
Cleome angustifolia	LC	Indigenous
Dinteranthus wilmotianus	NT	Indigenous; Endemic
Senecio sisymbriifolius	LC	Indigenous; Endemic
Melinis sp.		
Laggera decurrens	LC	Indigenous
Mesembryanthemum articulatum		Indigenous; Endemic
Setaria pumila	LC	Indigenous
Prosopis velutina	NE	Not indigenous; Naturalised; Invasive
Brachiaria glomerata	LC	Indigenous; Endemic
Crotalaria virgultalis	LC	Indigenous; Endemic
Kedrostis capensis	LC	Indigenous; Endemic
Barleria lichtensteiniana		Indigenous; Endemic
Forsskaolea candida		Indigenous; Endemic
Montinia caryophyllacea	LC	Indigenous
Prosopis chilensis	NE	Not indigenous; Naturalised
Dimorphotheca polyptera	LC	Indigenous; Endemic
Lotononis rabenaviana	LC	Indigenous; Endemic
Eriochloa fatmensis	LC	Indigenous
Bidens bipinnata		Not indigenous; Naturalised
Triraphis ramosissima	LC	Indigenous
Nymania capensis	LC	Indigenous; Endemic
Nerine laticoma	LC	Indigenous
Babiana flabellifolia	LC	Indigenous; Endemic
Tetragonia calycina	LC	Indigenous; Endemic
Crinum sp.		
Aloe claviflora	LC	Indigenous; Endemic
Eriospermum roseum	LC	Indigenous; Endemic
Aristida congesta	LC	Indigenous

Sebaea pentandra	LC	Indigenous; Endemic
Hermannia sp.		
Anthephora pubescens	LC	Indigenous
Azolla filiculoides	NE	Not indigenous; Naturalised; Invasive
Helianthus annuus		Not indigenous; Naturalised; Invasive
Phaeoptilum spinosum	LC	Indigenous; Endemic
Moraea polystachya	LC	Indigenous; Endemic
Echinochloa holubii	LC	Indigenous
Lapeirousia littoralis		Indigenous
Ruschia canonotata	LC	Indigenous; Endemic
Tragus berteronianus	LC	Indigenous
Heliophila trifurca	LC	Indigenous; Endemic
Dipcadi papillatum		Indigenous
Adromischus sp.		
Albuca suaveolens		Indigenous; Endemic
Cyanella lutea		Indigenous; Endemic
Eragrostis biflora	LC	Indigenous
Nolletia annetjieae	LC	Indigenous; Endemic
Monsonia parvifolia	LC	Indigenous; Endemic
Anacampseros baeseckei		Indigenous; Endemic
Echinochloa stagnina	LC	Indigenous
Senegalia mellifera	LC	Indigenous
Lasiosiphon polycephalus	LC	Indigenous; Endemic
Geigeria filifolia	LC	Indigenous
Berkheya spinosissima	LC	Indigenous; Endemic
Prosopis sp.		
Vachellia haematoxylon	LC	Indigenous; Endemic
Ledebouria sp.		
Eragrostis porosa	LC	Indigenous
Stipagrostis amabilis	LC	Indigenous; Endemic
Larryleachia marlothii		Indigenous; Endemic
Eriospermum bakerianum	LC	Indigenous; Endemic
Requienia sphaerosperma	LC	Indigenous
Aptosimum spinescens	LC	Indigenous; Endemic
Salsola tuberculata	LC	Indigenous; Endemic
Justicia spartioides		Indigenous; Endemic
Oxalis lawsonii	LC	Indigenous; Endemic
Salix mucronata	LC	Indigenous
Gorteria corymbosa	LC	Indigenous; Endemic

Geigeria ornativa	LC	Indigenous
Hermannia bicolor	LC	Indigenous; Endemic
Adenolobus garipensis	LC	Indigenous
Hermannia stricta	LC	Indigenous; Endemic
Acanthopsis hoffmannseggiana	DD	Indigenous; Endemic
Berkheya annectens	LC	Indigenous; Endemic
Mesembryanthemum guerichianum	LC	Indigenous; Endemic
Gladiolus saccatus	LC	Indigenous; Endemic
Cyperus marginatus	LC	Indigenous
Mesembryanthemum sp.		
Tetragonia reduplicata	LC	Indigenous
Tetraena simplex		Indigenous
Selago divaricata	LC	Indigenous; Endemic
Oxygonum alatum	LC	Indigenous
Polygala seminuda	LC	Indigenous
Haemanthus humilis	LC	Indigenous; Endemic
Suaeda caespitosa	LC	Indigenous; Endemic
Aristida engleri	LC	Indigenous; Endemic
Anacampseros filamentosa		Indigenous; Endemic
Rogeria longiflora	LC	Indigenous; Endemic
Urochloa panicoides	LC	Indigenous
Centropodia glauca	LC	Indigenous
Orbea sp.		
Lapeirousia plicata	LC	Indigenous; Endemic
Monsonia crassicaulis	LC	Indigenous; Endemic
Portulaca hereroensis		Indigenous
Codon royenii	LC	Indigenous; Endemic
Amellus tridactylus	LC	Indigenous; Endemic
Searsia lancea		Indigenous
Heliophila carnosa	LC	Indigenous
Eragrostis aspera	LC	Indigenous
Ifloga molluginoides	LC	Indigenous; Endemic
Aptosimum sp.		
Spergularia media		Not indigenous; Naturalised
Gymnosporia linearis	LC	Indigenous; Endemic
Parkinsonia africana	LC	Indigenous; Endemic
Crassula muscosa		Indigenous; Endemic
Manulea schaeferi	LC	Indigenous; Endemic
Thesium hystricoides	LC	Indigenous; Endemic

Lithops bromfieldii	LC	Indigenous; Endemic
Salsola kali		Not indigenous; Naturalised; Invasive
Hermannia spinosa	LC	Indigenous; Endemic
Digitaria sp.		
Tribulus pterophorus	LC	Indigenous; Endemic
Diplosoma sp.		
Aloidendron dichotomum	VU	Indigenous; Endemic
Leptochloa fusca	LC	Indigenous
Adenium oleifolium	LC	Indigenous; Endemic
Blepharis mitrata		Indigenous; Endemic
Cenchrus incertus	NE	Not indigenous; Naturalised
Justicia australis		Indigenous; Endemic
Enneapogon scaber	LC	Indigenous
Dipcadi gracillimum		Indigenous
Hermannia minutiflora	LC	Indigenous; Endemic
Prosopis glandulosa	NE	Not indigenous; Naturalised; Invasive
Monsonia luederitziana	LC	Indigenous; Endemic
Senna italica	LC	Indigenous
Anacampseros filamentosa		Indigenous; Endemic
Eragrostis rotifer	LC	Indigenous
Sericocoma avolans	LC	Indigenous; Endemic
Jamesbrittenia integerrima	LC	Indigenous; Endemic
Kissenia capensis	LC	Indigenous
Stipagrostis uniplumis	LC	Indigenous
Indigofera pungens	LC	Indigenous; Endemic
Anacampseros filamentosa		Indigenous; Endemic
Jamesbrittenia aridicola	LC	Indigenous; Endemic
Colchicum melanthoides		Indigenous; Endemic
Helichrysum gariepinum	LC	Indigenous; Endemic
Hirpicium echinus	LC	Indigenous; Endemic
Stipagrostis obtusa	LC	Indigenous
Aristida vestita	LC	Indigenous
Aptosimum procumbens	LC	Indigenous; Endemic
Tapinanthus oleifolius	LC	Indigenous
Commiphora gracilifrondosa	LC	Indigenous; Endemic
Pellaea calomelanos	LC	Indigenous
Prosopis glandulosa	NE	Not indigenous; Naturalised
Asparagus pearsonii	LC	Indigenous; Endemic
Persicaria lapathifolia		Not indigenous; Naturalised

Hermannia abrotanoides	LC	Indigenous; Endemic
Gisekia africana	LC	Indigenous
Osteospermum microcarpum	LC	Indigenous
Heliophila deserticola	LC	Indigenous; Endemic
Cyperus usitatus	LC	Indigenous
Digitaria sanguinalis	NE	Not indigenous; Naturalised
Sida rhombifolia	LC	Indigenous
Gazania lichtensteinii	LC	Indigenous; Endemic
Zygophyllum sp.		
Eragrostis annulata	LC	Indigenous
Stipagrostis ciliata	LC	Indigenous
Hermannia tomentosa	LC	Indigenous
Grielum humifusum	LC	Indigenous; Endemic
Setaria sp.		
Albuca virens		Indigenous; Endemic
Crinum bulbispermum	LC	Indigenous; Endemic
Schmidtia kalahariensis	LC	Indigenous
Felicia namaquana	LC	Indigenous; Endemic
Cotyledon orbiculata		Indigenous; Endemic
Lycium pumilum	LC	Indigenous; Endemic
Melinis repens	LC	Indigenous
Foveolina dichotoma	LC	Indigenous; Endemic
Aizoon canariense	LC	Indigenous
Barleria rigida	LC	Indigenous; Endemic
Dinebra retroflexa		Indigenous
Aloe gariepensis	LC	Indigenous; Endemic
Litogyne gariepina	LC	Indigenous
Setaria verticillata	LC	Indigenous
Rhigozum obovatum	LC	Indigenous
Dicoma capensis	LC	Indigenous
Helichrysum micropoides	LC	Indigenous; Endemic
Enneapogon desvauxii	LC	Indigenous

7.3 APPENDIX 3: MAMMAL SPECIES LIST

Mammals predicted to potentially occur within the study area. Species of conservation concern are highlighted in red.

Family	Scientific name	Common name	Conservation status

			Child *et al*., (2016)
Bovidae	*Antidorcas marsupialis*	Springbok	Least Concern
Bovidae	*Connochaetes taurinus taurinus*	Blue wildebeest	Least Concern
Bovidae	*Oryx gazella*	Gemsbok	Least Concern
Canidae	*Otocyon megalotis*	Bat-eared Fox	Least Concern
Erinaceidae	*Atelerix frontalis*	Southern African Hedgehog	Near Threatened
Felidae	*Felis nigripes*	Black-footed Cat	Vulnerable
Felidae	*Panthera pardus*	Leopard	Vulnerable
Herpestidae	*Cynictis penicillata*	Yellow Mongoose	Least Concern
Leporidae	*Lepus capensis*	Cape Hare	Least Concern
Leporidae	*Lepus saxatilis*	Scrub Hare	Least Concern
Macroscelididae	*Macroscelides proboscideus*	Short-eared Elephant Shrew	Least Concern
Muridae	*Desmodillus auricularis*	Cape Short-tailed Gerbil	Least Concern
Muridae	*Otomys unisulcatus*	Karoo Bush Rat	Least Concern
Mustelidae	*Ictonyx striatus*	Striped Polecat	Least Concern
Mustelidae	*Mellivora capensis*	Honey Badger	Least Concern
Pedetidae	*Pedetes capensis*	South African Spring Hare	Least Concern
Procaviidae	*Procavia capensis*	Cape Rock Hyrax	Least Concern
Sciuridae	*Xerus inauris*	South African Ground Squirrel	Least Concern

7.4 APPENDIX 4: HERPETOFAUNA SPECIES LIST

Herpetofauna predicted to potentially occur within the study area. Species of conservation concern are highlighted in red.

Family	Common name	Scientific name	National Conservation Status	IUCN	Habitat preference	Focal QDGC (2528 CC)	Probability of Occurrence	Justification
				AMPHIBIANS				
Bufonidae	Karoo Toad (subsp. gariepensis)	*Vandijkophrynus gariepensis gariepensis*	LC	LC	Habitat generalist across wide array of arid biomes	X	Moderate	Close to edge of range, but similar habitat
Pipidae	Common Platanna	*Xenopus laevis*	LC	LC	Habitat generalist but requires aquatic habitats that are at least semi-permanently inundated		Low	no water drainage areas in site, but individuals might migrate across it
Pyxicephalidae	Common Caco	*Cacosternum boettgeri*	LC	LC	Endorheic and palustrine systems in a wide variety of biomes		High	
Pyxicephalidae	Giant Bull Frog	*Pyxicephalus adspersus*	LC	LC	Seasonal endorheic and palustrine systems in a wide variety of biomes. Will not breed in permanent water.		High	
Pyxicephalidae	Tremelo Sand Frog	*Tomopterna cryptotis*	LC	LC	Endorheic and palustrine systems in a wide variety of biomes	X	High	
				REPTILES				
Agamidae	Common Ground Agama	*Agama aculeata aculeata*	LC	LC	Habitat generalist across wide array of arid biomes, associated with sandy plains	X	High	
Agamidae	Anchieta's Agama	*Agama anchietae*	LC	LC	Habitat generalist across wide array of arid biomes, associated with rocky habitats		High	
Agamidae	Southern Rock Agama	*Agama atra*	LC	LC	Habitat generalist across wide array of biomes, associated with rocky habitats		High	

Family	Common name	Scientific name	National Conservation Status	IUCN	Habitat preference	Focal QDGC (2528 CC)	Probability of Occurrence	Justification
Amphisbaenidae	Dusky Worm Lizard	*Monopeltis infuscata*	LC	LC	Fossorial, associated with sandy habitats		High	
Amphisbaenidae	Maurice's Worm Lizard	*Monopeltis mauricei*	LC	LC	Fossorial, associated with sparsely vegetated Kalahari sands		Low	The dune systems are not present within the site, which lacks deep sand
Amphisbaenidae	Kalahari Dwarf Worm Lizard	*Zygaspis quadrifrons*	LC	Not Listed	Fossorial, associated with sandy habitats but recorded marginally in karroid habitat		Low	Patchy distribution, but recorded 2 QDGC away
Colubridae	Rhombic Egg-eater	*Dasypeltis scabra*	LC	LC	Habitat generalist across wide array of biomes		High	
Colubridae	Dwarf Beaked Snake	*Dipsina multimaculata*	LC	LC	Habitat generalist across wide array of arid biomes		High	
Colubridae	Beetz's Tiger Snake	*Telescopus beetzii*	LC	LC	Habitat generalist across wide array of arid biomes, associated with rocky habitats		High	
Cordylidae	Karoo Girdled Lizard	*Karusasaurus polyzonus*	LC	LC	Habitat generalist across wide array of biomes, associated with rocky habitat	X	High	
Elapidae	Coral Shield Cobra	*Aspidelaps lubricus lubricus*	LC	LC	Habitat generalist across wide array of biomes	X	High	
Elapidae	Black Spitting Cobra	*Naja nigricincta woodi*	LC	LC	Associated with rocky arid habitats		High	
Elapidae	Cape Cobra	*Naja nivea*	LC	LC	Habitat generalist across wide array of biomes		High	
Gekkonidae	Common Giant Ground Gecko	*Chondrodactylus angulifer angulifer*	LC	LC	Habitat generalist across wide array of arid biomes, associated with sandy soils in which it burrows		Low	Site lacks deep sandy soils
Gekkonidae	Bibron's Gecko	*Chondrodactylus bibronii*	LC	LC	Habitat generalist across wide array of biomes, associated with rocky habitat		High	

Family	Common name	Scientific name	National Conservation Status	IUCN	Habitat preference	Focal QDGC (2528 CC)	Probability of Occurrence	Justification
Gekkonidae	Turner's Gecko	*Chondrodactylus turneri*	LC	LC	Habitat generalist across wide array of arid biomes, associated with rocky habitat	X	Moderate	Records at range margin, possibly misidentified C. bibronii
Gekkonidae	Bradfield's Dwarf Gecko	*Lygodactylus bradfieldi*	LC	LC	Habitat generalist preferring trees and rocks		High	
Gekkonidae	Augrabies Gecko	*Pachydactylus atorquatus*	LC	LC	Rocky specialist in arid habitats		Low	Recorded 2 QDGC away, but site may contain suitable habitat
Gekkonidae	Cape Gecko	*Pachydactylus capensis*	LC	LC	Generalist in grassland and savanna		High	
Gekkonidae	Quartz Gecko	*Pachydactylus latirostris*	LC	LC	Arid sandy habitats, such as dry river beds and plains		High	
Gekkonidae	Namaqua Mountain Gecko	*Pachydactylus montanus*	LC	LC	Generalist in arid rocky habitats		High	
Gekkonidae	Speckled Gecko	*Pachydactylus punctatus*	LC	LC	Generalist in open habitats, such as dry river beds		High	
Gekkonidae	Purcell's Gecko	*Pachydactylus purcelli*	LC	LC	Generalist in arid rocky habitats	X	High	
Gekkonidae	Common Rough Gecko	*Pachydactylus rugosus*	LC	LC	Associated with dry river beds and woody debris		High	
Gekkonidae	Striped Ground Gecko	*Pachydactylus wahlbergii furcifer*	LC	LC	Sandy soils in dune habitats		Low	The dune systems are not present within the site, which lacks deep sand
Gekkonidae	Common Barking Gecko	*Ptenopus garrulus garrulus*	LC	LC	Associated mostly with dunes and sandy karroid habitat	X	Moderate	Site lacks deep sandy soils
Gekkonidae	Spotted Barking Gecko	*Ptenopus garrulus maculatus*	LC	LC	Associated mostly with dunes and sandy karroid habitat		Low	Unlikely to be sympatric with P. g. garrulus, and is more marginally distributed near the site
Gerrhosauridae	Dwarf Plated Lizard	*Cordylosaurus subtessellatus*	LC	LC	Generalist in arid rocky habitats		Moderate	Rocky habitat present but not extensive

Family	Common name	Scientific name	National Conservation Status	IUCN	Habitat preference	Focal QDGC (2528 CC)	Probability of Occurrence	Justification
Lacertidae	Bushveld Lizard	*Heliobolus lugubris*	LC	LC	Generalist in lowland savanna, often associated with Kalahari sands		Low	The dune systems are not present within the site, which lacks deep sand
Lacertidae	Spotted Desert Lizard	*Meroles suborbitalis*	LC	LC	Habitat generalist across wide array of biomes		High	
Lacertidae	Western Sandveld Lizard	*Nucras tessellata*	LC	LC	Generalist associated with arid rocky areas, dry river beds and karroid habitat		Moderate	Sparse but scattered records in site vicinity, habitat suitable
Lacertidae	Plain Sand Lizard	*Pedioplanis inornata*	LC	LC	Generalist associated with open arid rocky areas		High	
Lacertidae	Karoo Sand Lizard	*Pedioplanis laticeps*	LC	LC	Prefers well vegetated karroid habitats and montane grassland		Low	Sparse but scattered records in site vicinity, lack of vegetative cover
Lacertidae	Spotted Sand Lizard	*Pedioplanis lineoocellata lineoocellata*	LC	LC	Habitat generalist across wide array of biomes, prefers open habitats		High	
Lacertidae	Namaqua Sand Lizard	*Pedioplanis namaquensis*	LC	LC	Habitat generalist across wide array of arid biomes, prefers open sandy habitats		High	
Lamprophiidae	Brown House Snake	*Boaedon capensis*	LC	LC	Habitat generalist across wide array of biomes		High	
Lamprophiidae	Cape Wolf Snake	*Lycophidion capense capense*	LC	LC	Habitat generalist across wide array of biomes		High	
Lamprophiidae	Two-striped Shovel-snout	*Prosymna bivittata*	LC	LC	sandveld, karoo scrub and savanah		Moderate	Sparse but scattered records in site vicinity, lack of vegetative cover
Lamprophiidae	Southwestern Shovel-snout	*Prosymna frontalis*	LC	LC	Rocky arid habitats		High	
Lamprophiidae	Karoo Sand Snake	*Psammophis notostictus*	LC	LC	Habitat generalist across wide array of biomes		High	

Family	Common name	Scientific name	National Conservation Status	IUCN	Habitat preference	Focal QDGC (2528 CC)	Probability of Occurrence	Justification
Lamprophiidae	Fork-marked Sand Snake	*Psammophis trinasalis*	LC	LC	Arid savanna and grassland		High	
Lamprophiidae	Mole Snake	*Pseudaspis cana*	LC	LC	Partly fossorial, generalist across wide array of biomes		Moderate	Sparse but scattered records in site vicinity
Lamprophiidae	Bicoloured Quill-snouted Snake	*Xenocalamus bicolor bicolor*	LC	LC	Fossorial, prefering habitats with Kalahari sands		Low	Site lacks deep sandy soils
Scincidae	Striped Blind Legless Skink	*Acontias kgalagadi kgalagadi*	LC	LC	Fossorial, prefering dunes and savanna with Kalahari sands		Low	The dune systems are not present within the site, which lacks deep sand
Scincidae	Striped Dwarf Legless Skink	*Acontias lineatus*	LC	LC	Fossorial generalist, associated with sandy habitats		High	
Scincidae	Cape Skink	*Trachylepis capensis*	LC	LC	Habitat generalist across wide array of biomes, but absent from Nama Karoo biome		Moderate	Marginal habitat with lack of vegetative cover
Scincidae	Western Three-striped Skink	*Trachylepis occidentalis*	LC	LC	Habitat generalist across wide array of arid biomes	X	High	
Scincidae	Karasburg Tree Skink	*Trachylepis sparsa*	LC	LC	Arid savanna and karoo, associated with trees in dry river beds and rocky areas	X	High	
Scincidae	Kalahari Tree Skink	*Trachylepis spilogaster*	LC	LC	Arid savanna and karoo, associated with trees in dry river beds and rocky areas	X	High	
Scincidae	Western Rock Skink	*Trachylepis sulcata sulcata*	LC	LC	Habitat generalist across arid biomes, always associated with rocky habitats	X	High	
Scincidae	Variegated Skink	*Trachylepis variegata*	LC	LC	Habitat generalist across wide array of biomes		High	
Testudinidae	Serrated Tent Tortoise	*Psammobates oculifer*	LC	LC	Prefers high altitude arid habitats, but marginally distributed in Nama Karoo biome		Moderate	Marginally distributed near the site

Family	Common name	Scientific name	National Conservation Status	IUCN	Habitat preference	Focal QDGC (2528 CC)	Probability of Occurrence	Justification
Testudinidae	Verrox's Tent Tortoise	*Psammobates tentorius verroxii*	LC	NT	Habitat generalist across wide array of arid biomes, associated with some karroid vegetation cover	X	High	
Testudinidae	Leopard Tortoise	*Stigmochelys pardalis*	LC	LC	Habitat generalist across wide array of biomes, but absent in most karroid habitats		Moderate	Distribution extends along the Orange River and while the site habitat is unsuitable some individuals might utilise the area temporarily.
Typhlopidae	Schinz's Beaked Blind Snake	*Rhinotyphlops schinzi*	LC	LC	Fossorial, arid habitats	X	High	
Varanidae	Rock Monitor	*Varanus albigularis albigularis*	LC	LC	Habitat generalist across wide array of biomes, associated with rocks or trees		High	
Viperidae	Puff Adder	*Bitis arietans arietans*	LC	LC	Habitat generalist across wide array of biomes		High	
Viperidae	Horned Adder	*Bitis caudalis*	LC	Not Listed	Habitat generalist across wide array of arid biomes		High	
Viperidae	Desert Mountain Adder	*Bitis xeropaga*	LC	Not Listed	Rocky specialist in arid habitats		Low	Edge of distribution, but rocky outcrop on site

7.5 APPENDIX 5: AVIFAUNA EXPECTED SPECIES LIST

Avifauna predicted to potentially occur within the study area according to SABAP1 and SABAP2. Species of conservation concern are highlighted in red.

Scientific name	Common name	Conservation status
Acrocephalus baeticatus	Reed-warbler, African	Least concern
Acrocephalus gracilirostris	Swamp-warbler, Lesser	Least concern
Actitis hypoleucos	Sandpiper, Common	Least concern
Afrotis afraoides	Korhaan, Northern Black	Least concern
Alcedo cristata	Kingfisher, Malachite	Least concern
Alopochen aegyptiacus	Goose, Egyptian	Least concern
Amadina erythrocephala	Finch, Red-headed	Least concern
Amaurornis flavirostris	Crake, Black	Least concern
Anas erythrorhyncha	Teal, Red-billed	Least concern
Anas sparsa	Duck, African Black	Least concern
Anhinga rufa	Darter, African	Least concern
Anthoscopus minutus	Penduline-tit, Cape	Least concern
Anthus cinnamomeus	Pipit, African	Least concern
Apus affinis	Swift, Little	Least concern
Apus apus	Swift, Common	Least concern
Apus caffer	Swift, White-rumped	Least concern
Aquila pennatus	Eagle, Booted	Least concern
Ardea cinerea	Heron, Grey	Least concern
Ardea goliath	Heron, Goliath	Least concern
Ardea melanocephala	Heron, Black-headed	Least concern
Ardea purpurea	Heron, Purple	Least concern
Ardeotis kori	Bustard, Kori	Least concern
Batis pririt	Batis, Pririt	Least concern
Bostrychia hagedash	Ibis, Hadeda	Least concern
Bradornis infuscatus	Flycatcher, Chat	Least concern
Bubulcus ibis	Egret, Cattle	Least concern
Burhinus capensis	Thick-knee, Spotted	Least concern
Calendulauda africanoides	Lark, Fawn-coloured	Least concern
Calendulauda sabota	Lark, Sabota	Least concern
Campethera abingoni	Woodpecker, Golden-tailed	Least concern
Caprimulgus rufigena	Nightjar, Rufous-cheeked	Least concern
Centropus burchellii	Coucal, Burchell's	Least concern

Cercomela familiaris	Chat, Familiar	Least concern
Cercotrichas coryphoeus	Scrub-robin, Karoo	Least concern
Cercotrichas paena	Scrub-robin, Kalahari	Least concern
Certhilauda subcoronata	Lark, Karoo Long-billed	Least concern
Ceryle rudis	Kingfisher, Pied	Least concern
Charadrius tricollaris	Plover, Three-banded	Least concern
Chersomanes albofasciata	Lark, Spike-heeled	Least concern
Chrysococcyx caprius	Cuckoo, Diderick	Least concern
Cinnyris fuscus	Sunbird, Dusky	Least concern
Cinnyris mariquensis	Sunbird, Marico	Least concern
Circus pygargus	Harrier, Montagu's	Least concern
Cisticola aridulus	Cisticola, Desert	Least concern
Cisticola juncidis	Cisticola, Zitting	Least concern
Cisticola tinniens	Cisticola, Levaillant's	Least concern
Clamator jacobinus	Cuckoo, Jacobin	Least concern
Colius colius	Mousebird, White-backed	Least concern
Columba guinea	Pigeon, Speckled	Least concern
Corvus albus	Crow, Pied	Least concern
Cossypha caffra	Robin-chat, Cape	Least concern
Creatophora cinerea	Starling, Wattled	Least concern
Crithagra albogularis	Canary, White-throated	Least concern
Crithagra atrogularis	Canary, Black-throated	Least concern
Crithagra flaviventris	Canary, Yellow	Least concern
Cypsiurus parvus	Palm-swift, African	Least concern
Dendrocygna viduata	Duck, White-faced	Least concern
Dendropicos fuscescens	Woodpecker, Cardinal	Least concern
Egretta garzetta	Egret, Little	Least concern
Elanus caeruleus	Kite, Black-shouldered	Least concern
Emberiza impetuani	Bunting, Lark-like	Least concern
Eremomela icteropygialis	Eremomela, Yellow-bellied	Least concern
Eremopterix verticalis	Sparrowlark, Grey-backed	Least concern
Estrilda astrild	Waxbill, Common	Least concern
Euplectes orix	Bishop, Southern Red	Least concern
Eupodotis vigorsii	Korhaan, Karoo	Least concern
Falco biarmicus	Falcon, Lanner	Vulnerable
Fulica cristata	Coot, Red-knobbed	Least concern
Gallinula chloropus	Moorhen, Common	Least concern

Genus Species	Common_group, Common_species	Least concern
Glaucidium perlatum	Owlet, Pearl-spotted	Least concern
Halcyon albiventris	Kingfisher, Brown-hooded	Least concern
Haliaeetus vocifer	Fish-eagle, African	Least concern
Himantopus himantopus	Stilt, Black-winged	Least concern
Hippolais icterina	Warbler, Icterine	Least concern
Hirundo albigularis	Swallow, White-throated	Least concern
Hirundo cucullata	Swallow, Greater Striped	Least concern
Hirundo fuligula	Martin, Rock	Least concern
Hirundo rustica	Swallow, Barn	Least concern
Hirundo spilodera	Cliff-swallow, South African	Least concern
Indicator minor	Honeyguide, Lesser	Least concern
Ixobrychus minutus	Bittern, Little	Least concern
Lagonosticta senegala	Firefinch, Red-billed	Least concern
Lamprotornis nitens	Starling, Cape Glossy	Least concern
Lanius collaris	Fiscal, Common (Southern)	Least concern
Lanius minor	Shrike, Lesser Grey	Least concern
Malcorus pectoralis	Warbler, Rufous-eared	Least concern
Megaceryle maximus	Kingfisher, Giant	Least concern
Melierax canorus	Goshawk, Southern Pale Chanting	Least concern
Merops apiaster	Bee-eater, European	Least concern
Merops bullockoides	Bee-eater, White-fronted	Least concern
Merops hirundineus	Bee-eater, Swallow-tailed	Least concern
Mirafra fasciolata	Lark, Eastern Clapper	Least concern
Motacilla aguimp	Wagtail, African Pied	Least concern
Motacilla capensis	Wagtail, Cape	Least concern
Muscicapa striata	Flycatcher, Spotted	Least concern
Mycteria ibis	Stork, Yellow-billed	Endangered
Myrmecocichla formicivora	Chat, Anteating	Least concern
Nilaus afer	Brubru, Brubru	Least concern
Numida meleagris	Guineafowl, Helmeted	Least concern
Nycticorax nycticorax	Night-Heron, Black-crowned	Least concern
Oena capensis	Dove, Namaqua	Least concern
Oenanthe monticola	Wheatear, Mountain	Least concern
Oenanthe pileata	Wheatear, Capped	Least concern
Onychognathus nabouroup	Starling, Pale-winged	Least concern
Parisoma layardi	Tit-babbler, Layard's	Least concern

Parisoma subcaeruleum	Tit-babbler, Chestnut-vented	Least concern
Parus cinerascens	Tit, Ashy	Least concern
Passer diffusus	Sparrow, Southern Grey-headed	Least concern
Passer domesticus	Sparrow, House	Least concern
Passer melanurus	Sparrow, Cape	Least concern
Phalacrocorax africanus	Cormorant, Reed	Least concern
Phalacrocorax carbo	Cormorant, White-breasted	Least concern
Philetairus socius	Weaver, Sociable	Least concern
Phragmacia substriata	Warbler, Namaqua	Least concern
Phylloscopus trochilus	Warbler, Willow	Least concern
Plectropterus gambensis	Goose, Spur-winged	Least concern
Plegadis falcinellus	Ibis, Glossy	Least concern
Plocepasser mahali	Sparrow-weaver, White-browed	Least concern
Ploceus velatus	Masked-weaver, Southern	Least concern
Polihierax semitorquatus	Falcon, Pygmy	Least concern
Prinia flavicans	Prinia, Black-chested	Least concern
Pterocles namaqua	Sandgrouse, Namaqua	Least concern
Pycnonotus nigricans	Bulbul, African Red-eyed	Least concern
Quelea quelea	Quelea, Red-billed	Least concern
Rhinopomastus cyanomelas	Scimitarbill, Common	Least concern
Riparia paludicola	Martin, Brown-throated	Least concern
Scopus umbretta	Hamerkop, Hamerkop	Least concern
Sigelus silens	Flycatcher, Fiscal	Least concern
Spizocorys starki	Lark, Stark's	Least concern
Sporopipes squamifrons	Finch, Scaly-feathered	Least concern
Stenostira scita	Flycatcher, Fairy	Least concern
Streptopelia capicola	Turtle-dove, Cape	Least concern
Streptopelia semitorquata	Dove, Red-eyed	Least concern
Streptopelia senegalensis	Dove, Laughing	Least concern
Struthio camelus	Ostrich, Common	Least concern
Sylvietta rufescens	Crombec, Long-billed	Least concern
Tachybaptus ruficollis	Grebe, Little	Least concern
Tadorna cana	Shelduck, South African	Least concern
Telophorus zeylonus	Bokmakierie, Bokmakierie	Least concern
Threskiornis aethiopicus	Ibis, African Sacred	Least concern
Trachyphonus vaillantii	Barbet, Crested	Least concern
Tricholaema leucomelas	Barbet, Acacia Pied	Least concern

Tringa glareola	Sandpiper, Wood	Least concern
Tringa nebularia	Greenshank, Common	Least concern
Turdus smithi	Thrush, Karoo	Least concern
Tyto alba	Owl, Barn	Least concern
Upupa africana	Hoopoe, African	Least concern
Urocolius indicus	Mousebird, Red-faced	Least concern
Vanellus armatus	Lapwing, Blacksmith	Least concern
Vanellus coronatus	Lapwing, Crowned	Least concern
Vidua macroura	Whydah, Pin-tailed	Least concern
Zosterops pallidus	White-eye, Orange River	Least concern

7.6 APPENDIX 6: SPECIALISTS PROOF OF QUALIFICATION

Specialist: Corné Niemandt

SACNASP
South African Council for Natural Scientific Professions

herewith certifies that

Corné Niemandt
Registration number: 116598

is registered as a

Professional Natural Scientist

in terms of section 20(3) of the Natural Scientific Professions Act, 2003
(Act 27 of 2003)
in the following fields(s) of practice (Schedule 1 of the Act)

Ecological Science

Effective 13 December 2018 Expires 31 March 2019

President Executive Director

Disclaimer

I Corné Niemandt *Pr. Sci. Nat. (Ecological Science)* declare that the work presented above is my own and has not been influenced in any way by the client. At no point has the client asked me as a specialist to manipulate my results and the above methods has been carried out to the highest ecological standards.

Corné Niemandt (*Pr. Sci. Nat.*)

Specialist: Samuel Laurence


SACNASP
South African Council for Natural Scientific Professions

herewith certifies that

Samuel David Laurence
Registration number: 400450/13

is registered as a

Professional Natural Scientist

in terms of section 20(3) of the Natural Scientific Professions Act, 2003
(Act 27 of 2003)
in the following field(s) of practice (Schedule I of the Act)

Zoological Science	20 November 2013
Ecological Science	20 November 2013

COPY

20 November 2013
Pretoria

President

Executive Director

Disclaimer

I Samuel Laurence *Pr. Sci. Nat. (Zoology and Ecological Science)* declare that the work presented above is my own and has not been influenced in any way by the client. At no point has the client asked me as a specialist to manipulate my results and the above methods has been carried out to the highest ecological standards.

Samuel Laurence (*Pr. Sci. Nat.*)