**APPENDIX D**

**SPECIALISTS' REPORTS**

**APPENDIX D1 - Terrestrial Ecology Assessment**

**APPENDIX D2 - Avifaunal Assessment**

**APPENDIX D3 - Desktop Paleontological Assessment**

**APPENDIX D4 - Visual Impact Assessment**

**APPENDIX D5 - Soil and Agricultural Study**

**APPENDIX D6 - Heritage Impact Assessment**

**APPENDIX D7 - Declarations**

# APPENDIX D

# SPECIALISTS' REPORTS

## APPENDIX D1 - Terrestrial Ecology Assessment

# THE TERRESTRIAL ECOLOGY BASELINE & IMPACT ASSESSMENT FOR THE PROPOSED SERE PHOTOVOLTAIC DEVELOPMENT

## Koekenaap, Western Cape Province

July 2022

**CLIENT**


**Prepared by:**

**The Biodiversity Company**

Cell: +27 81 319 1225

Fax: +27 86 527 1965

info@thebiodiversitycompany.com

www.thebiodiversitycompany.com

## Executive Summary

The hybridisation of the existing Sere Wind Farm with the installation of photovoltaic (PV) capacity was identified as one of the Renewable initiatives in the Eskom Corporate Plan. Sere Wind Farm is a 105.8 MW wind facility located near Vredendal in the Western Cape, which entered into commercial operation on 31 March 2015. In order to address the urgent need for additional generating capacity, it has been proposed that PV technology be installed at the Sere Wind Farm site in phases.

Two layouts – one for the fixed technology (Option A) and the other for tracking technology (Option B) have been considered for two site alternatives. The two site alternatives comprise the two project alternatives being considered. These two site alternatives were assessed during two separate assessments.

The current layout of site 1 overlaps within sensitive habitats and other areas of high biodiversity potential and is expected to have a significant and high negative impact as it would directly affect the habitat of threatened/protected plant species and expected listed faunal species that use these ecosystems.

The habitat existence and importance of these habitats is regarded as crucial, due to the species recorded as well as the role of this intact unique habitat to biodiversity within the local landscape, not to mention the sensitivity according to various ecological datasets.

The high sensitivity terrestrial areas found in Site 1 still:

- Serve as and represent CBA 1 and ESA as per the Conservation Plan;
- Forms part of NPAES and SKEP;
- Supports and protects fauna and flora (including protected species); and
- Support various organisms and may play a more important role in the ecosystem if left to recover from the superficial impacts.

Any development on the high sensitivity areas will lead the direct destruction and loss of portions of functional CBA, and also the floral and faunal species that are expected to utilise this habitat. Thus, if these areas are not maintained in a natural or near natural state, destroyed or fragmented, then meeting targets for biodiversity features will not be achieved.

Both sites considered for the project were similar in species composition when compared with the surrounding vegetation. The interaction with CBA 1 area is considerably less in Site 2, and therefore the development of Site 2 is more favourable. Further to this, the location of the CBA 1 is in proximity to the SERE Wind Farm and Skaapvlei substation, and disturbances (albeit limited) to the CBA 1 area are evident. Thus, it can be said that Site 2 is the preferred option.

The mitigations, management and associated monitoring regarding these operational impacts will be the most important factor of this project and must be considered by the issuing authority.

## Table of Contents

## List of Tables

## List of Figures

# 1 Introduction

## 1.1 Background

The Biodiversity Company was appointed to undertake a fauna and flora baseline assessment for the proposed Sere Solar Photovoltaic (PV) facility near Koekenaap, Western Cape (Figure 1-2).

The hybridisation of the existing Sere Wind Farm with the installation of PV capacity was identified as one of the Renewable initiatives in the Eskom Corporate Plan. Sere Wind Farm is a 105.8 MW wind facility located near Vredendal in the Western Cape, which entered into commercial operation on 31 March 2015. In order to address the urgent need for additional generating capacity, it has been proposed that PV technology be installed at the Sere Wind Farm site in phases.

Two layouts – one for the fixed technology (Option A) and the other for tracking technology (Option B) have been considered for two site alternatives (Figure 1-1). The two site alternatives comprise the two project alternatives being considered. These two site alternatives were assessed during two separate assessments. Collectively these two areas have been referred to as the ‘project area’ from hereon.

**Alternatives that will be considered are outlined below:**

1) Site 1 / First Project Area (Figure 1-3); and
2) Site 2 / Second Project Area (Figure 1-4).

The technology and project area updates were received on 11 July 2022, requiring an update to a report submitted in May 2022. Due to time constraints, the update herein pertains to the habitat and associated sensitivities, and final impact assessment. A project area of influence (PAOI) was demarcated for the sites.

This assessment was conducted in accordance with the amendments to the Environmental Impact Assessment Regulations. 2014 (GNR 326, 7 April 2017) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA). The approach has taken cognisance of the recently published Government Notices (GN) 320 (20 March 2020): “Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998, when applying for Environmental Authorisation” (Reporting Criteria). The National Web based Environmental Screening Tool has characterised the terrestrial sensitivity as “Very High”.

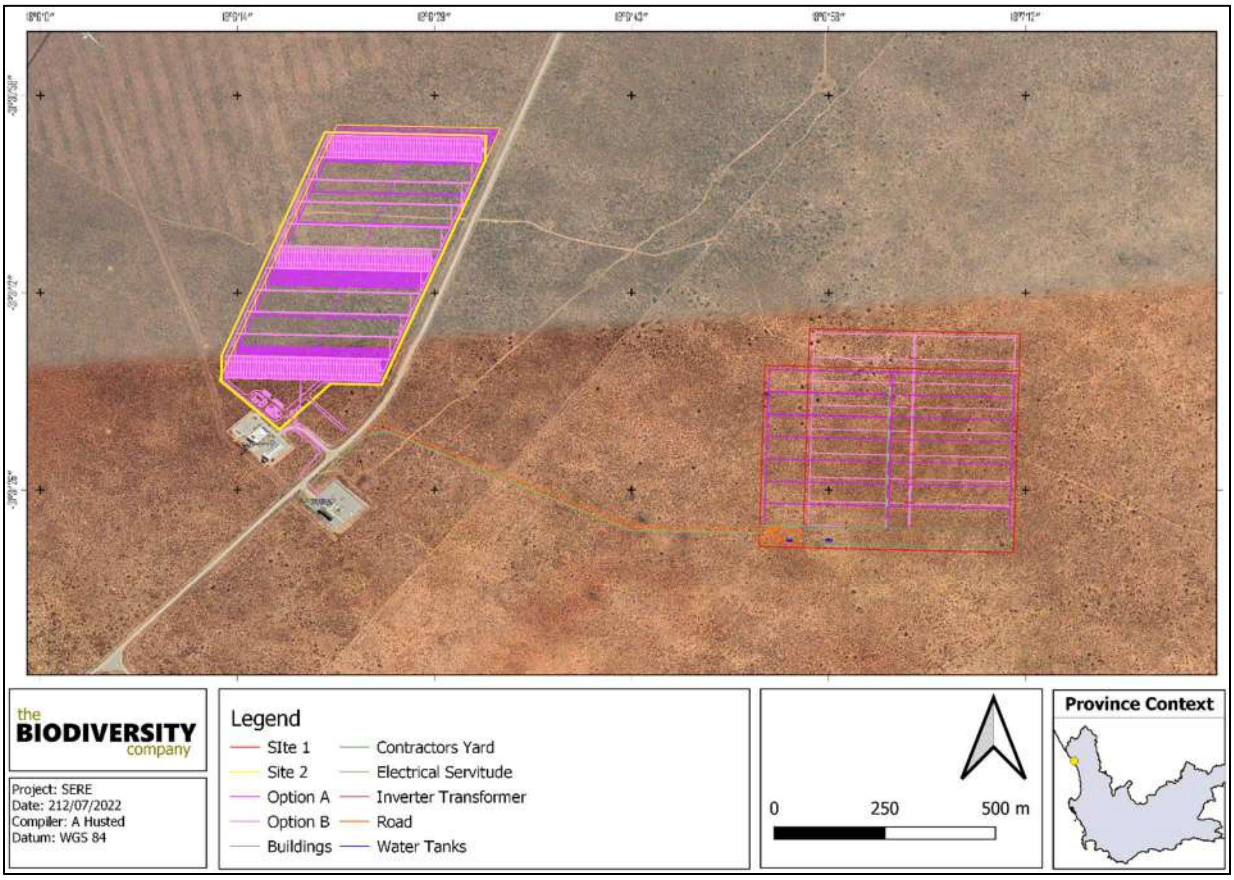



*Figure 1-1 Proposed project site and technology alternatives*

## 1.2 Project Specifications

This project is applicable for the first phase (Phase 1A) of the Sere PV project. Phase 1A aims to address Eskom's urgent need for additional generating capacity.

The facility proposed for Sere PV Phase 1A will include a total site area less than 20 hectares to allow for the construction of a PV facility up to 19.9 MW capacity and associated infrastructure:

- Solar PV modules, up to a total of 120,000 m$^2$, that convert solar radiation directly into electricity. The solar PV modules will be elevated off the ground and will be mounted on either fixed tilt systems or tracking systems. The Solar PV modules will be placed in rows in such a way that there is allowance for a perimeter road and security fencing along the site boundary, and access roads in between each PV module row. There will be underground cabling connecting Solar PV modules to the Inverter stations;

- Inverter stations, each occupying a footprint up to approximately 30 m$^2$, with up to 20 Inverter stations installed on the site. Each Inverter station will contain an inverter, step-up transformer, and switchgear. The Inverter stations will be distributed on the site, located alongside its associated Solar PV module arrays. The Inverter station will perform conversion of DC (direct current) to AC (alternating current), and step-up the LV voltage of the inverter to 33kV, to allow the electricity to be fed into the Skaapvlei substation. Inverter stations will connect several arrays of Solar PV modules and will be placed along the internal roads for easy accessibility and maintenance;

- Adequately designed foundations and mounting structures that will support the Solar PV modules and Inverter stations;

- Existing roads that provide access to Sere Wind Farm will be used and extended where necessary (estimated up to 1 km long) to provide access to the PV site;
- A perimeter road around the site, approximately 5 m wide and 1.8 km in length;
- Internal roads for access to the Inverter stations, approximately 5 m wide and 3.4 km total length;
- Internal roads/paths between the Solar PV module rows, approximately 2.5 m wide, to allow access to the Solar PV modules for operations and maintenance activities;
- Laydown area, occupying a footprint up to 4,000 $m^2$, located adjacent to the substation. The laydown area will also accommodate water storage tanks (estimated 32 kl for the first 4 months and 20 kl for the remaining 20 months, until construction is completed). This area will also accommodate the offices for construction contractors;
- Batching plant, occupying a footprint up to 7,675 $m^2$, for the mixing ingredients for concrete;
- The infrastructure required for the operation and maintenance of the Sere PV Plant – Phase 1a installation will be optimised to consider common usage of the existing Sere Wind Farm infrastructure;
- The Solar PV plant facility security cabin, occupying a footprint up to 10 $m^2$, including ablution facilities;
- Perimeter fencing of the Solar PV site, with access gates. Detailed requirements will be determined following the security risk assessment;
- Construction and installation of underground electrical interconnection cables, with trenching up to 1 km long, connecting the Solar PV facility to the 33/132 kV Skaapvlei substation;
- The solar PV plant has a design life of a minimum of 25 years. The extension of the life of the plant will be considered when assessing the plant's economic viability to remain operational after its end of life; and
- Total area of the Solar PV modules themselves will be 16 – 18 ha within the approximate 19.6 ha site boundary. Either fixed/static or tracking technology will be used, this has not been finalised by Eskom both options are provided in this report, it is however not seen as alternatives for this assessment.

The technologies will be at different heights but will have the same 1.5 m deep foundations.

- Fixed or static PV – fixed mounted PV up to 3.5 m above ground level. Fixed or static PV – at 30º, north facing slope; and
- Tracking – single or double axis tracking up to 6 m above ground level. Tracking – PV module rows will track the sun path from east to west daily.

The purpose of the specialist studies is to provide relevant input into the basic assessment process and provide a report for the proposed activities associated with the project. This report, after taking into consideration the findings and recommendations provided by the specialist herein, should inform and guide the Environmental Assessment Practitioner (EAP) and regulatory authorities, enabling informed decision making, as to the ecological viability of the proposed project.

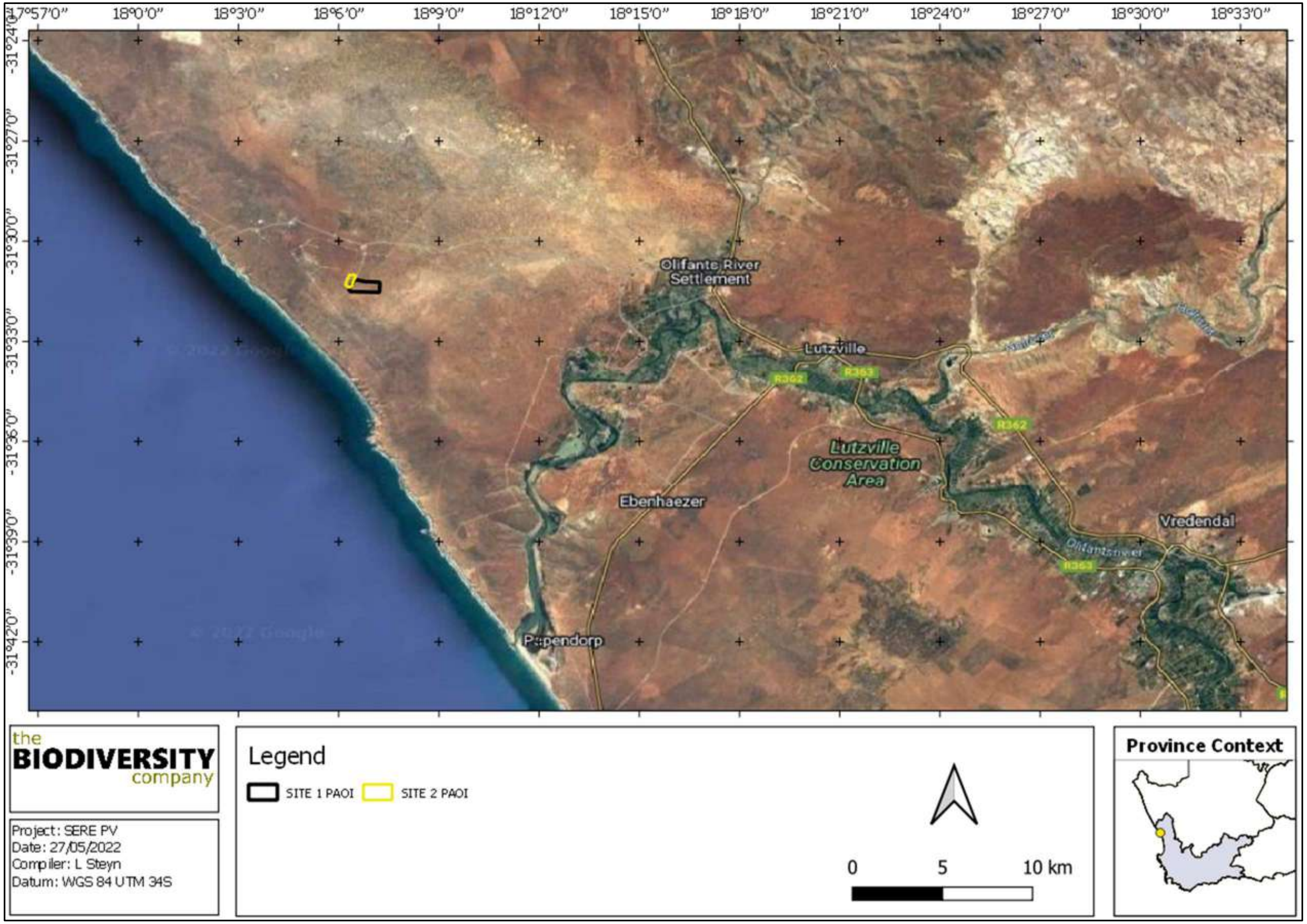



***Figure 1-2*** ***Proposed location of the project areas in relation to the nearby towns.***

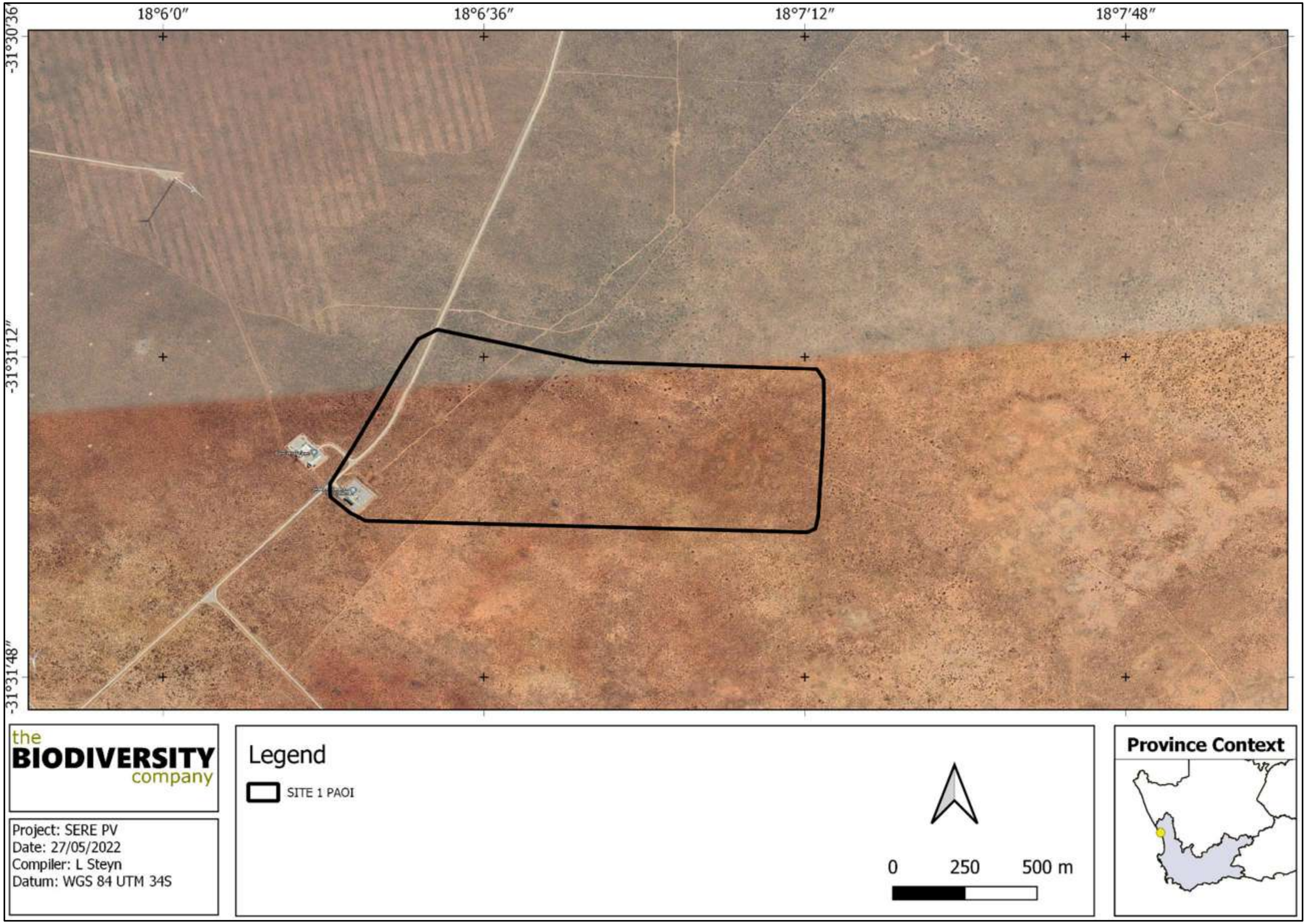



***Figure 1-3 Proposed first project area***

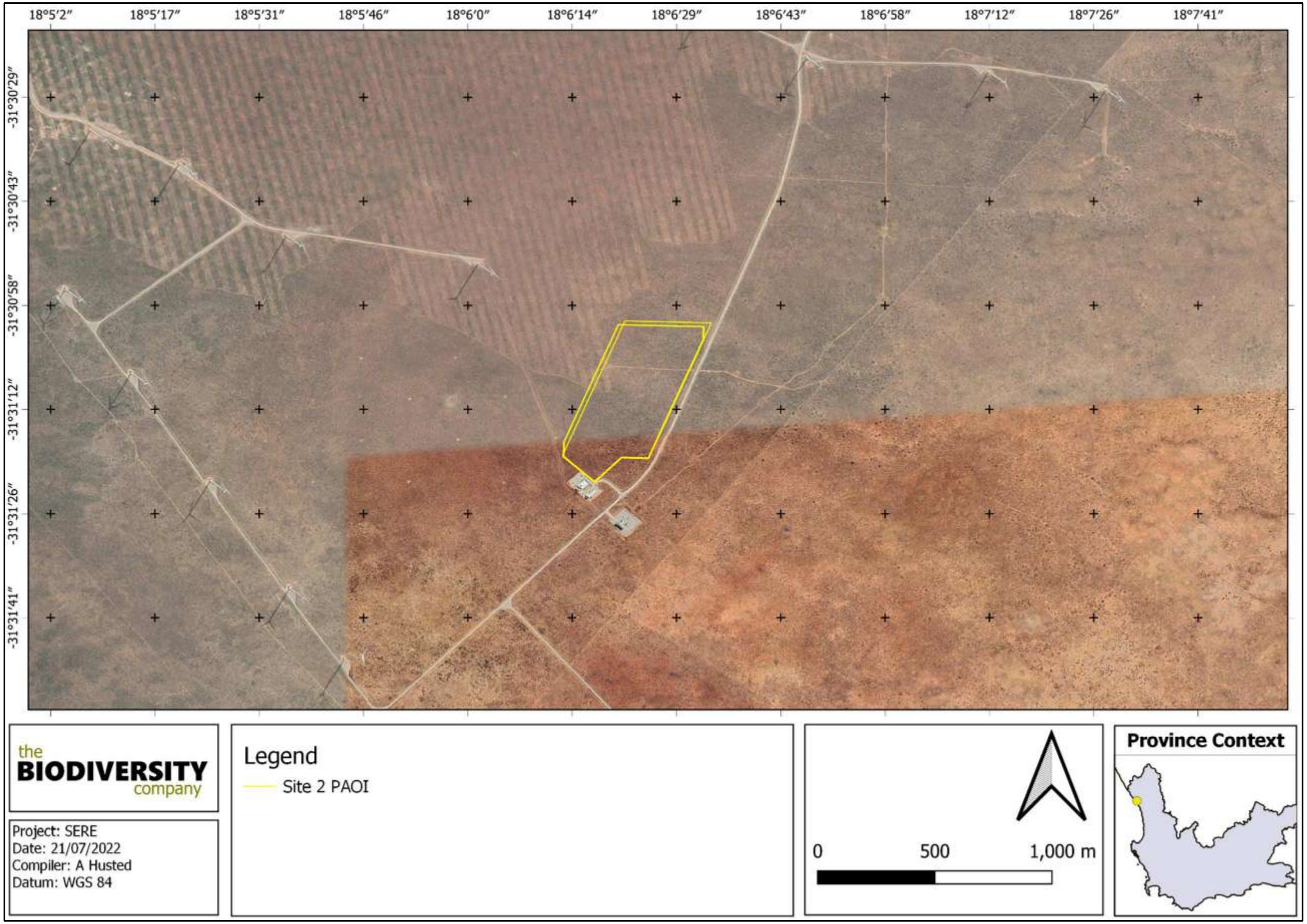



*Figure 1-4 Proposed second project area*

## 1.3 Specialist Details

| | |
|---|---|
| Report Name | **THE TERRESTRIAL ECOLOGY BASELINE & IMPACT ASSESSMENT FOR THE PROPOSED SERE PHOTOVOLTAIC DEVELOPMENT** |
| Reference | **SERE PV** |
| Submitted to | NEMAI CONSULTING |
| Report Writer (Desktop) | **Lindi Steyn**<br>Dr Lindi Steyn has completed her PhD in Biodiversity and Conservation from the University of Johannesburg. Lindi is a terrestrial ecologist with a special interest in ornithology. She has completed numerous studies ranging from basic Assessments to Environmental Impact Assessments following IFC standards. |
| Report Writer (Fauna and Flora) Site 1 | **Martinus Erasmus**<br>Martinus Erasmus obtained his B-Tech degree in Nature Conservation in 2016 at the Tshwane University of Technology. Martinus has been conducting EIAs, basic assessments and assisting specialists in field during his studies since 2015. Martinus is Cand. Sci. Nat. registered (118630) is a specialist terrestrial ecologist and botanist which conducts floral surveys faunal surveys which include mammals, birds, amphibians and reptiles. |
| Report Writer (Fauna and Flora) Site 2 | **Rudolph Greffrath**<br>Rudolph is a terrestrial ecology specialist with 14 years of experience in biodiversity baseline assessments, biodiversity action planning design and development, biodiversity off-set design and implementation, biodiversity strategy design, conservation management planning and implementation, IFC performance standards best practice, ecological restoration, ecosystems services and environmental impact assessments, across Africa. He is Pr Sci Nat registered (400018/17) in Conservation Science field of practice. |
| Reviewer | **Andrew Husted**<br>Andrew Husted is Pr Sci Nat registered (400213/11) in the following fields of practice: Ecological Science, Environmental Science and Aquatic Science. Andrew is an Aquatic, Wetland and Biodiversity Specialist with more than 12 years' experience in the environmental consulting field. Andrew has completed numerous wetland training courses, and is an accredited wetland practitioner, recognised by the DWS, and also the Mondi Wetlands programme as a competent wetland consultant. |
| Declaration | The Biodiversity Company and its associates operate as independent consultants under the auspice of the South African Council for Natural Scientific Professions. We declare that we have no affiliation with or vested financial interests in the proponent, other than for work performed under the Environmental Impact Assessment Regulations, 2017. We have no conflicting interests in the undertaking of this activity and have no interests in secondary developments resulting from the authorisation of this project. We have no vested interest in the project, other than to provide a professional service within the constraints of the project (timing, time and budget) based on the principals of science. |

## 2 Scope of Work

The principle aim of the assessments were to provide information to guide the risk of the proposed activity to the flora and fauna communities of the associated ecosystems within the project area/corridor. This was achieved through the following:

- Desktop assessment to identify the relevant ecologically important geographical features within the project areas;
- Desktop assessment to compile an expected species list and possible threatened flora and fauna species that occur within the project areas;
- Field survey to ascertain the species composition of the present flora and fauna community within the project areas;
- Delineate and map the habitats and their respective sensitivities that occur within the project areas;
- Identify the manner that the proposed project impacts the flora and fauna community and evaluate the level of risk of these potential impacts; and
- The prescription of mitigation measures and recommendations for identified risks.

## 3 Key Legislative Requirements

The legislation, policies and guidelines listed below in Table 3-1 are applicable to the current project. The list below, although extensive, may not be complete and other legislation, policies and guidelines may apply in addition to those listed below.

***Table 3-1 A list of key legislative requirements relevant to biodiversity and conservation in the Western Cape Province***

| Region | Legislation / Guideline |
|---|---|
| International | Convention on Biological Diversity (CBD, 1993) |
| | The Convention on Wetlands (RAMSAR Convention, 1971) |
| | The United Nations Framework Convention on Climate Change (UNFCC,1994) |
| | The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 1973) |
| | The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention, 1979) |
| National | Constitution of the Republic of South Africa (Act No. 108 of 1996) |
| | The National Environmental Management Act (NEMA) (Act No. 107 of 1998) |
| | The National Environmental Management: Protected Areas Act (Act No. 57 of 2003) |
| | The National Environmental Management: Biodiversity Act (Act No. 10 of 2004), Threatened or Protected Species Regulations |
| | Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998, GNR 320 of Government Gazette 43310 (March 2020) |
| | Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998, GNR 1150 of Government Gazette 43855 (October 2020) |
| | The National Environmental Management: Waste Act, 2008 (Act 59 of 2008); |
| | The Environment Conservation Act (Act No. 73 of 1989) |
| | National Protected Areas Expansion Strategy (NPAES) |
| | Natural Scientific Professions Act (Act No. 27 of 2003) |
| | National Biodiversity Framework (NBF, 2009) |
| | National Forest Act (Act No. 84 of 1998) |
| | National Veld and Forest Fire Act (101 of 1998) |

| | |
|---|---|
| | National Water Act (NWA) (Act No. 36 of 1998) |
| | National Spatial Biodiversity Assessment (NSBA) |
| | World Heritage Convention Act (Act No. 49 of 1999) |
| | Municipal Systems Act (Act No. 32 of 2000) |
| | Alien and Invasive Species Regulations and, Alien and Invasive Species List 20142020, published under NEMBA |
| | South Africa's National Biodiversity Strategy and Action Plan (NBSAP) |
| | Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983) (CARA) |
| | Sustainable Utilisation of Agricultural Resources (Draft Legislation). |
| | White Paper on Biodiversity |
| | Draft Western Cape Biodiversity Bill, 2019 |
| **Provincial** | Nature and environmental conservation ordinance no. 19 of 1974 |
| | Western Cape Biodiversity Sector Plan 2017 |

# 4 Methods

## 4.1 Project Areas

The project areas are situated 15 km west of Koekenaap and 40 km north west of Vredendal in the Western Cape Province. Presently, the project areas are surrounded by portions of the SERE wind farm, an Eskom Skaapvlei substation, the MSR Tormin Mine and the ocean to the west (> 4 km).

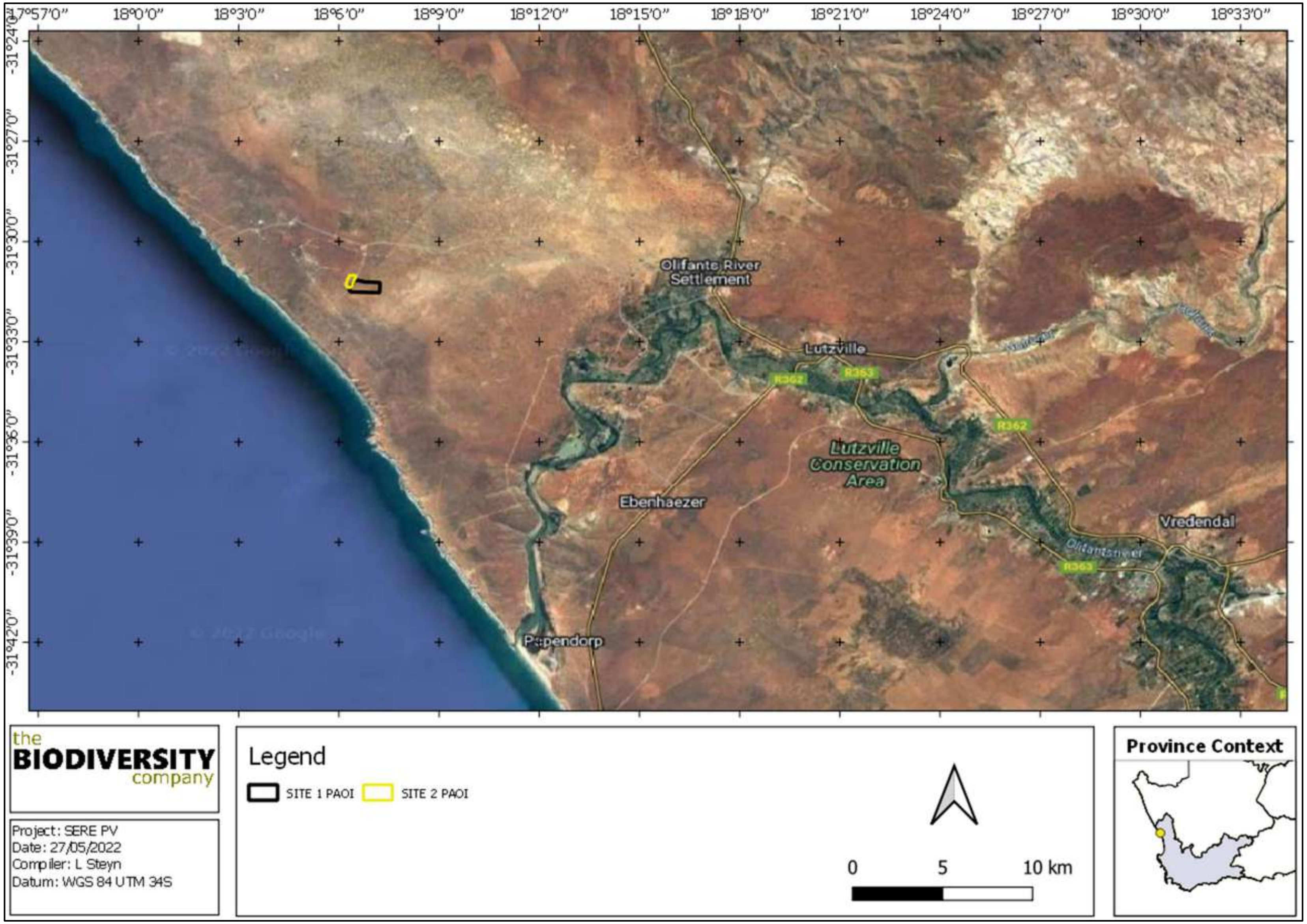



***Figure 4-1 Map illustrating the location of the proposed project areas***

## 4.2 Desktop Assessment

The desktop assessment was principally undertaken using a Geographic Information System (GIS) to access the latest available spatial datasets to develop digital cartographs and species lists. These datasets and their date of publishing are provided below.

### 4.2.1 Ecologically Important Landscape Features

Existing ecologically relevant data layers were incorporated into a GIS to establish how the proposed project might interact with any ecologically important entities. Emphasis was placed around the following spatial datasets:

- *National Biodiversity Assessment 2018 (Skowno et al, 2019) (NBA)*- The purpose of the NBA is to assess the state of South Africa's biodiversity based on best available science, with a view to understanding trends over time and informing policy and decision-making across a range of sectors. The NBA deals with all three components of biodiversity: genes, species and ecosystems; and assesses biodiversity and ecosystems across terrestrial, freshwater, estuarine and marine environments. The two headline indicators assessed in the NBA are:

    - *Ecosystem Threat Status* – indicator of an ecosystem's wellbeing, based on the level of change in structure, function or composition. Ecosystem types are categorised as Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) or Least Concern (LC), based on the proportion of the original extent of each ecosystem type that remains in good ecological condition.

    - *Ecosystem Protection Level* – indicator of the extent to which ecosystems are adequately protected or under-protected. Ecosystem types are categorised as Well Protected (WP), Moderately Protected (MP), Poorly Protected (PP), or Not Protected (NP), based on the proportion of the biodiversity target for each ecosystem type that is included within one or more protected areas. NP, PP or MP ecosystem types are collectively referred to as under-protected ecosystems.

- Protected areas:

    - *South Africa Protected Areas Database (SAPAD) (DEA, 2020)* – The (SAPAD) Database contains spatial data for the conservation of South Africa. It includes spatial and attribute information for both formally protected areas and areas that have less formal protection. SAPAD is updated on a continuous basis and forms the basis for the Register of Protected Areas, which is a legislative requirement under the National Environmental Management: Protected Areas Act, Act 57 of 2003.

    - *National Protected Areas Expansion Strategy (NPAES) (SANBI, 2010)* – The NPAES provides spatial information on areas that are suitable for terrestrial ecosystem protection. These focus areas are large, intact and unfragmented and therefore, of high importance for biodiversity, climate resilience and freshwater protection.

- Western Cape Biodiversity Sector Plan

The Western Cape CBA classified areas within the province on the basis of its contribution to reach the conservation targets within the province. The C-Plan uses the following terms to categorise the various land used types according to their biodiversity and environmental importance:

- Critical Biodiversity Area (CBA);
- Ecological Support Area (ESA);
- Other Natural Area (ONA); and

- Protected Area (PA);

In the spatial datasets a further distinction is made between CBAs that are likely to be in a natural condition (CBA 1) and those that are potentially degraded or represent secondary vegetation (CBA 2). This distinction is based on best available land cover data. Similarly, a distinction is made between ESAs that are likely to be functional (i.e., in a natural, near-natural or moderately degraded condition; ESA 1), and Ecological Support Areas that are likely severely degraded or have no natural cover remaining and therefore require restoration where feasible (ESA 2).

- Important Bird and Biodiversity Areas (IBAs) (BirdLife South Africa, 2015) – IBAs constitute a global network of over 13 500 sites, of which 112 sites are found in South Africa. IBAs are sites of global significance for bird conservation, identified through multi-stakeholder processes using globally standardised, quantitative and scientifically agreed criteria; and

- South African Inventory of Inland Aquatic Ecosystems (SAIIAE) (Van Deventer *et al.,* 2018) – A SAIIAE was established during the NBA of 2018. It is a collection of data layers that represent the extent of river and inland wetland ecosystem types and pressures on these systems.

### 4.2.2 Desktop Flora Assessment

The Vegetation of South Africa, Lesotho and Swaziland (Mucina & Rutherford, 2006) and SANBI (2019) was used to identify the vegetation type that would have occurred under natural or pre-anthropogenically altered conditions. Furthermore, the Plants of Southern Africa (POSA) database was accessed to compile a list of expected flora species within the project area (Figure 4-2). The Red List of South African Plants (Raimondo *et al.,* 2009; SANBI, 2020) was utilized to provide the most current national conservation status of flora species.

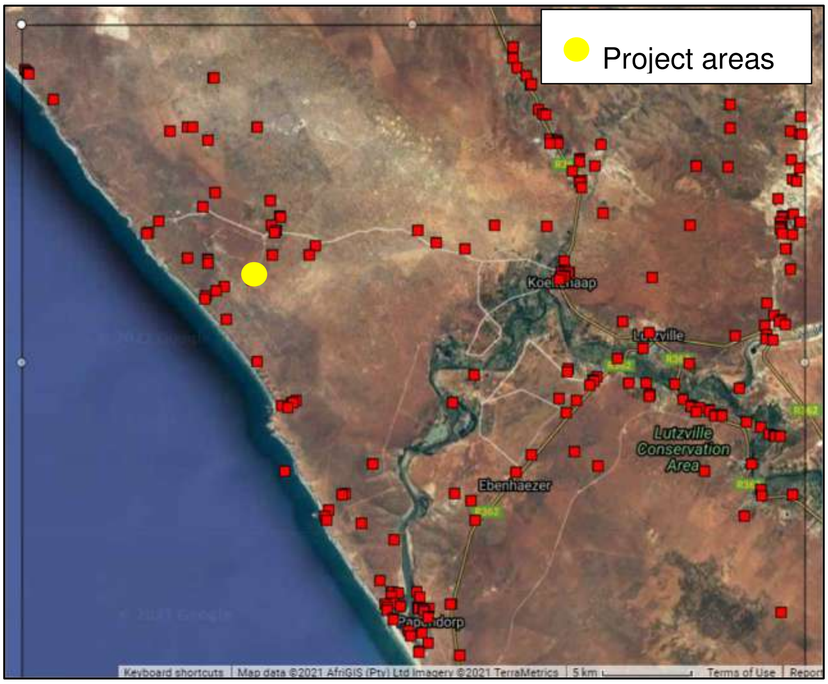



***Figure 4-2 Map illustrating extent of area used to obtain the expected flora species list from the Plants of South Africa (POSA) database. Yellow dot indicates approximate location of the project areas. The red squares are cluster markers of botanical records as per POSA data.***

### 4.2.3 Desktop Faunal Assessment

The faunal desktop assessment comprised of the following, compiling an expected:

- Amphibian list, generated from the IUCN spatial dataset (2017) and ReptileMap database (Fitzpatrick Institute of African Ornithology, 2021a), using the 3118 quarter degree square;
- Reptile list, generated from the IUCN spatial dataset (2017) and AmphibianMap database (Fitzpatrick Institute of African Ornithology, 2021b), using the 3118 quarter degree square; and
- Mammal list from the IUCN spatial dataset (2017).

## 4.3 Biodiversity Field Assessment

A field survey was undertaken in December 2021 for the First Project Area, and in April 2022 for the Second Project Area. Effort was made to cover all the different habitat types, within the limits of time and access.

### 4.3.1 Flora Survey

The fieldwork and sample sites were placed within targeted areas (i.e., target sites) perceived as ecologically sensitive based on the preliminary interpretation of satellite imagery (Google Corporation) and GIS analysis (which included the latest applicable biodiversity datasets) available prior to the fieldwork. The focus of the fieldwork was therefore to maximise coverage and navigate to each target site in the field, to perform a rapid vegetation and ecological assessment at each sample site. Emphasis was placed on sensitive habitats, especially those overlapping with the proposed project area.

Homogenous vegetation units were subjectively identified using satellite imagery and existing land cover maps. The floristic diversity and search for flora SCC were conducted through timed meanders within representative habitat units delineated during the scoping fieldwork. Emphasis was placed mostly on sensitive habitats overlapping with the proposed project areas.

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

At each sample site notes were made regarding current impacts (e.g., livestock grazing, erosion etc.), subjective recording of dominant vegetation species and any sensitive features (e.g., wetlands, outcrops etc.). In addition, opportunistic observations were made while navigating through the project area.

### 4.3.2 Fauna Survey

The faunal assessment within this report pertains to herpetofauna (amphibians and reptiles) and mammals. A separate avifauna assessment was conducted. The faunal field survey comprised of the following techniques:

- *Visual and auditory searches* - This typically comprised of meandering and using binoculars to view species from a distance without them being disturbed; and listening to species calls;
- Active hand-searches - are used for species that shelter in or under particular micro-habitats (typically rocks, exfoliating rock outcrops, fallen trees, leaf litter, bark etc.); and
- Utilization of local knowledge.

Relevant field guides and texts consulted for identification purposes included the following:

- Field Guide to Snakes and other Reptiles of Southern Africa (Branch, 1998);
- A Complete Guide to the Snakes of Southern Africa (Marais, 2004);
- Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland (Bates *et al,* 2014);
- A Complete Guide to the Frogs of Southern Africa (du Preez and Carruthers, 2009);
- Smithers' Mammals of Southern Africa (Apps, 2000);

- A Field Guide to the Tracks and Signs of Southern and East African Wildlife (Stuart and Stuart, 2000);

## 4.4 Terrestrial Site Ecological Importance

The different habitat types within the project area were delineated and identified based on observations during the field assessment, and available satellite imagery. These habitat types were assigned Ecological Importance (EI) categories based on their ecological integrity, conservation value, the presence of species of conservation concern and their ecosystem processes.

Site Ecological Importance (SEI) is a function of the Biodiversity Importance (BI) of the receptor (e.g., SCC, the vegetation/fauna community or habitat type present on the site) and Receptor Resilience (RR) (its resilience to impacts) as follows.

BI is a function of Conservation Importance (CI) and the Functional Integrity (FI) of the receptor as follows. The criteria for the CI and FI ratings are provided in Table 4-1 and Table 4-2, respectively.

***Table 4-1 Summary of Conservation Importance (CI) criteria***

| Conservation Importance | Fulfilling Criteria |
|---|---|
| **Very High** | Confirmed or highly likely occurrence of Critically Endangered (CR), Endangered (EN), Vulnerable (VU) or Extremely Rare or CR species that have a global extent of occurrence (EOO) of < 10 $km^2$.<br>Any area of natural habitat of a CR ecosystem type or large area (> 0.1% of the total ecosystem type extent) of natural habitat of an EN ecosystem type.<br>Globally significant populations of congregatory species (> 10% of global population). |
| **High** | Confirmed or highly likely occurrence of CR, EN, VU species that have a global EOO of > 10 $km^2$. IUCN threatened species (CR, EN, VU) must be listed under any criterion other than A.<br>If listed as threatened only under Criterion A, include if there are less than 10 locations or < 10 000 mature individuals remaining.<br>Small area (> 0.01% but < 0.1% of the total ecosystem type extent) of natural habitat of EN ecosystem type or large area (> 0.1%) of natural habitat of VU ecosystem type.<br>Presence of Rare species.<br>Globally significant populations of congregatory species (> 1% but < 10% of global population). |
| **Medium** | Confirmed or highly likely occurrence of populations of Near Threatened (NT) species, threatened species (CR, EN, VU) listed under Criterion A only and which have more than 10 locations or more than 10 000 mature individuals.<br>Any area of natural habitat of threatened ecosystem type with status of VU.<br>Presence of range-restricted species.<br>> 50% of receptor contains natural habitat with potential to support SCC. |
| **Low** | No confirmed or highly likely populations of SCC.<br>No confirmed or highly likely populations of range-restricted species.<br>< 50% of receptor contains natural habitat with limited potential to support SCC. |
| **Very Low** | No confirmed and highly unlikely populations of SCC.<br>No confirmed and highly unlikely populations of range-restricted species.<br>No natural habitat remaining. |

***Table 4-2 Summary of Functional Integrity (FI) criteria***

| Functional Integrity | Fulfilling Criteria |
|---|---|
| **Very High** | Very large (> 100 ha) intact area for any conservation status of ecosystem type or > 5 ha for CR ecosystem types.<br>High habitat connectivity serving as functional ecological corridors, limited road network between intact habitat patches.<br>No or minimal current negative ecological impacts, with no signs of major past disturbance. |
| **High** | Large (> 20 ha but < 100 ha) intact area for any conservation status of ecosystem type or > 10 ha for EN ecosystem types.<br>Good habitat connectivity, with potentially functional ecological corridors and a regularly used road network between intact habitat patches.<br>Only minor current negative ecological impacts, with no signs of major past disturbance and good rehabilitation potential. |
| **Medium** | Medium (> 5 ha but < 20 ha) semi-intact area for any conservation status of ecosystem type or > 20 ha for VU ecosystem types.<br>Only narrow corridors of good habitat connectivity or larger areas of poor habitat connectivity and a busy used road network between intact habitat patches.<br>Mostly minor current negative ecological impacts, with some major impacts and a few signs of minor past disturbance. Moderate rehabilitation potential. |

| | |
|---|---|
| **Low** | Small (> 1 ha but < 5 ha) area.<br>Almost no habitat connectivity but migrations still possible across some modified or degraded natural habitat and a very busy used road network surrounds the area.<br>Low rehabilitation potential.<br>Several minor and major current negative ecological impacts. |
| **Very Low** | Very small (< 1 ha) area.<br>No habitat connectivity except for flying species or flora with wind-dispersed seeds.<br>Several major current negative ecological impacts. |

BI can be derived from a simple matrix of CI and FI as provided in Table 4-3.

***Table 4-3 Matrix used to derive Biodiversity Importance (BI) from Functional Integrity (FI) and Conservation Importance (CI)***

| Biodiversity Importance (BI) | | Conservation Importance (CI) | | | | |
|---|---|---|---|---|---|---|
| | | **Very high** | **High** | **Medium** | **Low** | **Very low** |
| **Functional Integrity (FI)** | **Very high** | Very high | Very high | High | Medium | Low |
| | **High** | Very high | High | Medium | Medium | Low |
| | **Medium** | High | Medium | Medium | Low | Very low |
| | **Low** | Medium | Medium | Low | Low | Very low |
| | **Very low** | Medium | Low | Very low | Very low | Very low |

The fulfilling criteria to evaluate RR are based on the estimated recovery time required to restore an appreciable portion of functionality to the receptor, as summarised in Table 4-4.

***Table 4-4 Summary of Resource Resilience (RR) criteria***

| Resilience | Fulfilling Criteria |
|---|---|
| **Very High** | Habitat that can recover rapidly (~ less than 5 years) to restore > 75% of the original species composition and functionality of the receptor functionality, or species that have a very high likelihood of: (i) remaining at a site even when a disturbance or impact is occurring, or (ii) returning to a site once the disturbance or impact has been removed. |
| **High** | Habitat that can recover relatively quickly (~ 5–10 years) to restore > 75% of the original species composition and functionality of the receptor functionality, or species that have a high likelihood of: (i) remaining at a site even when a disturbance or impact is occurring, or (ii) returning to a site once the disturbance or impact has been removed. |
| **Medium** | Will recover slowly (~ more than 10 years) to restore > 75% of the original species composition and functionality of the receptor functionality, or species that have a moderate likelihood of: (i) remaining at a site even when a disturbance or impact is occurring, or (ii) returning to a site once the disturbance or impact has been removed. |
| **Low** | Habitat that is unlikely to be able to recover fully after a relatively long period: > 15 years required to restore ~ less than 50% of the original species composition and functionality of the receptor functionality, or species that have a low likelihood of: (i) remaining at a site even when a disturbance or impact is occurring, or (ii) returning to a site once the disturbance or impact has been removed. |
| **Very Low** | Habitat that is unable to recover from major impacts, or species that are unlikely to: (i) remain at a site even when a disturbance or impact is occurring, or (ii) return to a site once the disturbance or impact has been removed. |

Subsequent to the determination of the BI and RR, the SEI can be ascertained using the matrix as provided in Table 4-5.

***Table 4-5 Matrix used to derive Site Ecological Importance from Receptor Resilience (RR) and Biodiversity Importance (BI)***

| Site Ecological Importance | | Biodiversity Importance (BI) | | | | |
|---|---|---|---|---|---|---|
| | | **Very high** | **High** | **Medium** | **Low** | **Very low** |
| **Receptor Resilience (RR)** | Very Low | Very high | Very high | High | Medium | Low |
| | Low | Very high | Very high | High | Medium | Very low |
| | Medium | Very high | High | Medium | Low | Very low |
| | High | High | Medium | Low | Very low | Very low |
| | Very High | Medium | Low | Very low | Very low | Very low |

Interpretation of the SEI in the context of the proposed project is provided in Table 4-6.

***Table 4-6 Guidelines for interpreting Site Ecological Importance in the context of the proposed development activities***

| Site Ecological Importance | Interpretation in relation to proposed development activities |
|---|---|
| Very High | Avoidance mitigation – no destructive development activities should be considered. Offset mitigation not acceptable/not possible (i.e., last remaining populations of species, last remaining good condition patches of ecosystems/unique species assemblages). Destructive impacts for species/ecosystems where persistence target remains. |
| High | Avoidance mitigation wherever possible. Minimisation mitigation – changes to project infrastructure design to limit the amount of habitat impacted, limited development activities of low impact acceptable. Offset mitigation may be required for high impact activities. |
| Medium | Minimisation and restoration mitigation – development activities of medium impact acceptable followed by appropriate restoration activities. |
| Low | Minimisation and restoration mitigation – development activities of medium to high impact acceptable followed by appropriate restoration activities. |
| Very Low | Minimisation mitigation – development activities of medium to high impact acceptable and restoration activities may not be required. |

The SEI evaluated for each taxon can be combined into a single multi-taxon evaluation of SEI for the assessment area. Either a combination of the maximum SEI for each receptor should be applied, or the SEI may be evaluated only once per receptor but for all necessary taxa simultaneously. For the latter, justification of the SEI for each receptor is based on the criteria that conforms to the highest CI and FI, and the lowest RR across all taxa.

# 5 Assumptions and Limitations

The following assumptions and limitations are applicable for this assessment:

- The assessment area was based on the area provided by the client and any alterations to the route and/or missing GIS information pertaining to the assessment area would have affected the area surveyed;
- Even though the two sites were assessed on two separate occasions, the assessment areas did not overlap and therefore it can be said that temporal trends were not considered;
- The surveys conducted for the respective studies, constituted a dry season survey with its limitations;
    - Flora identification is limited due to the lack of aboveground plant parts used to determine species, especially in regard to bulbous plants, the vegetation was dry, and most plants had already lost the green flush;
    - It must be noted that during the survey, only a fraction of the expected geophytes were visible due to their variable emergence patterns.
- Whilst every effort is made to cover as much of the site as possible, representative sampling is completed and by its nature, it is possible that some plant and animal species that are present on site were not recorded during the field investigations.

# 6 Results & Discussion

## 6.1 Desktop Assessment

### 6.1.1 Ecologically Important Landscape Features

The GIS analysis pertaining to the relevance of the proposed project to ecologically important landscape features are summarised in Table 6-1.

***Table 6-1 Summary of relevance of the proposed project to ecologically important landscape features.***

| Desktop Information Considered | Relevant/Irrelevant | Section |
|---|---|---|

| | | |
|---|---|---|
| Ecosystem Threat Status | Relevant – Overlaps with a Least Concern ecosystem | 6.1.1.1 |
| Ecosystem Protection Level | Relevant – Overlaps with a Poorly Protected Ecosystem | 6.1.1.2 |
| Protected Areas | Irrelevant – 11.7 km from the closest Protected Area | - |
| Renewable Energy Development Zones | Irrelevant – 156 km from the closest REDZ | - |
| Powerline Corridor | Relevant- the project area falls within a corridor | - |
| National Protected Areas Expansion Strategy | Relevant – Site 1 overlaps with a NPAES focus area, while Site 2 falls just outside the NPAES area | 6.1.1.4 |
| Critical Biodiversity Area | Relevant – The project area overlaps with a CBA1, ESA, ESA1, ESA2 and ONA area. | 6.1.1.3 |
| Succulent Karoo Ecosystem Programme | Relevant- The project area overlaps with a mammal near endemic habitat | 6.1.1.5 |
| Important Bird and Biodiversity Areas | Relevant – Located 9.6 km from the Olifants River Estuary IBA | - |
| South African Inventory of Inland Aquatic Ecosystems | Relevant - The project area is more than 500 m away from NBA wetlands and rivers | 6.1.1.6 |
| National Freshwater Priority Area | Relevant – The project area does not overlap with a FEPA river nor a FEPA wetland. | 6.1.1.7 |
| Strategic Water Source Areas | Irrelevant- The project area is approximately 96 km from the closest SWSA | - |

#### 6.1.1.1 Ecosystem Threat Status

The Ecosystem Threat Status is an indicator of an ecosystem's wellbeing, based on the level of change in structure, function or composition. Ecosystem types are categorised as Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) or Least Concern (LC), based on the proportion of the original extent of each ecosystem type that remains in good ecological condition. According to the spatial dataset the proposed project areas overlap with a LC ecosystem (Figure 6-1).

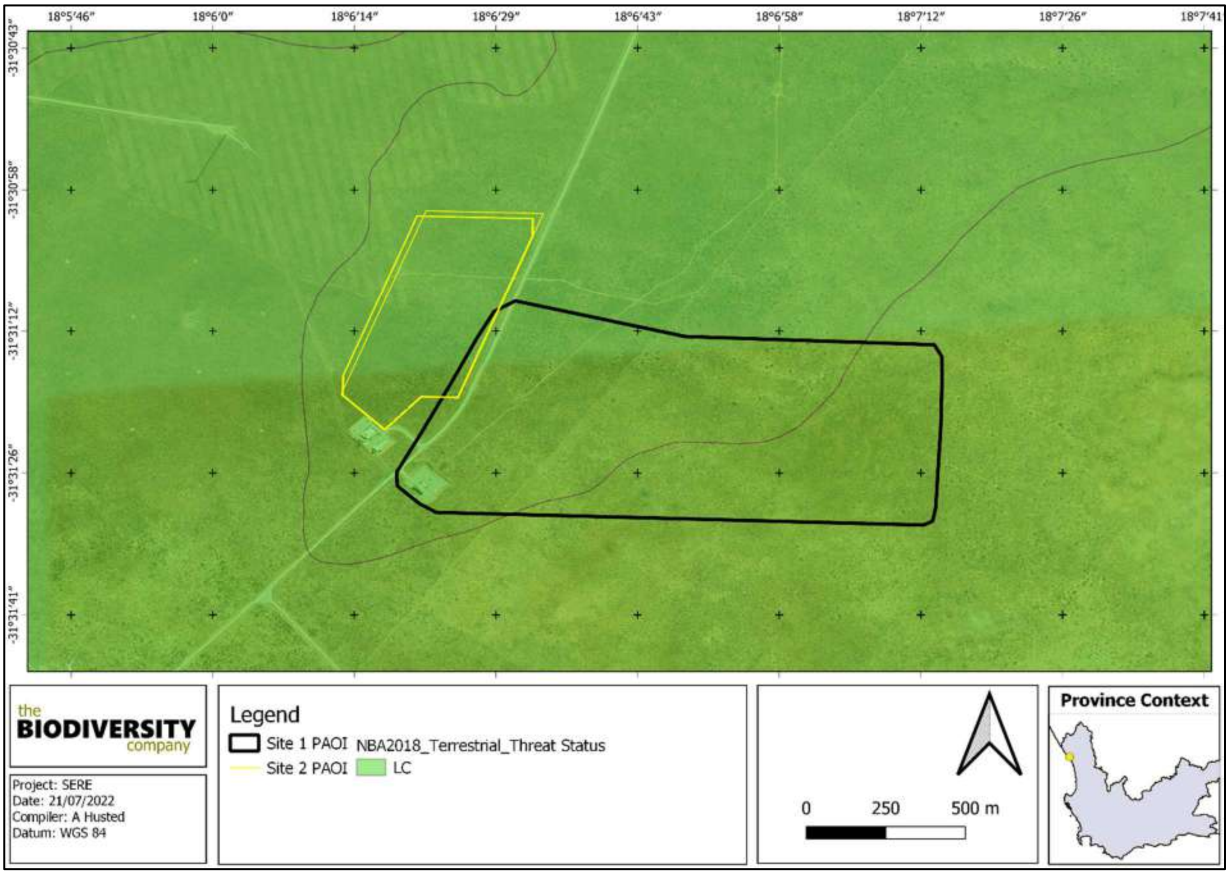



*Figure 6-1 Map illustrating the ecosystem threat status associated with the project areas.*

#### 6.1.1.2 Ecosystem Protection Level

This is an indicator of the extent to which ecosystems are adequately protected or under-protected. Ecosystem types are categorised as Well Protected (WP), Moderately Protected (MP), Poorly Protected (PP), or Not Protected (NP), based on the proportion of the biodiversity target for each ecosystem type that is included within one or more protected areas. NP, PP or MP ecosystem types are collectively referred to as under-protected ecosystems. The proposed project overlaps with a PP ecosystem (Figure 6-2).

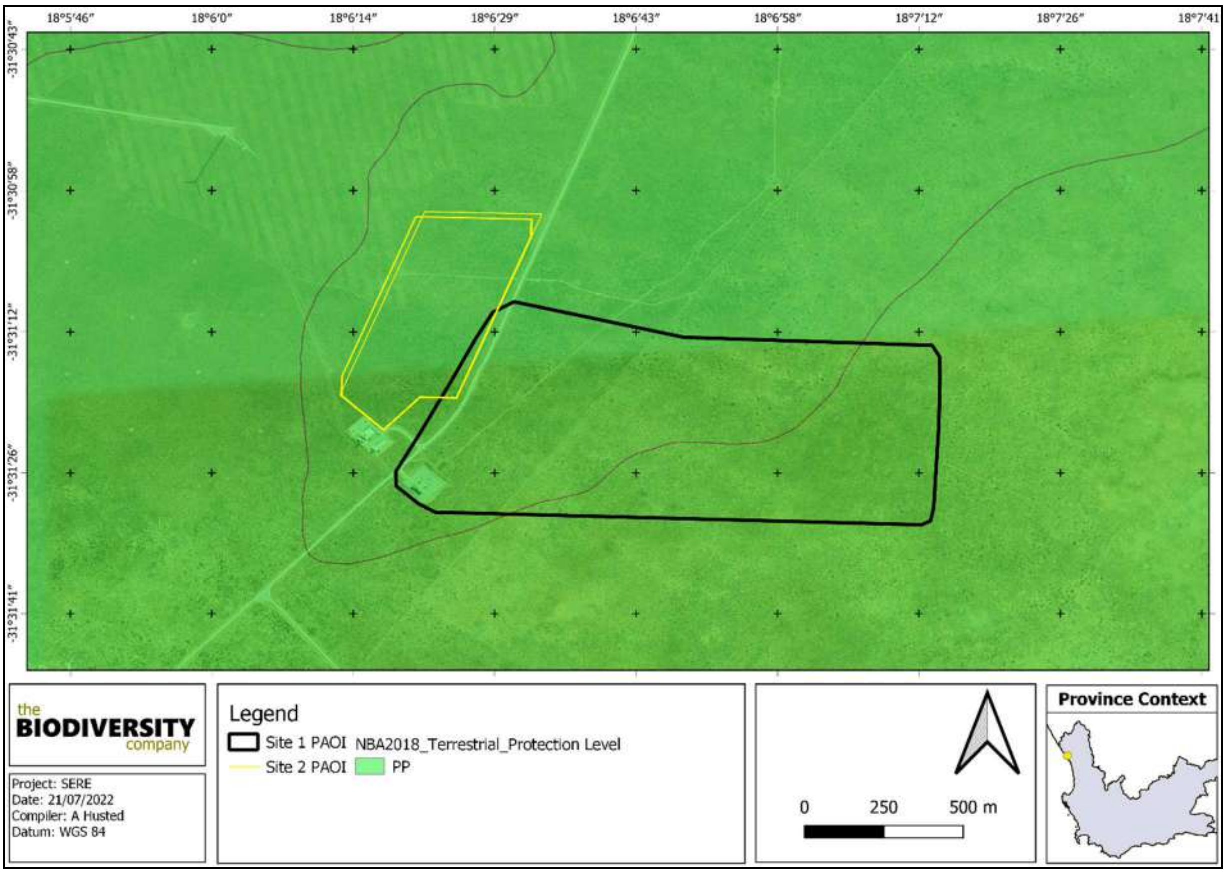



***Figure 6-2 Map illustrating the ecosystem protection level associated with the project areas***

#### 6.1.1.3 Critical Biodiversity Areas and Ecological Support Areas

The key output of a systematic biodiversity plan is a map of biodiversity priority areas. The CBA map delineates Critical Biodiversity Areas (CBAs), Ecological Support Areas (ESAs), Other Natural Areas (ONAs), Protected Areas (PAs), and areas that have been irreversibly modified from their natural state.

**Critical Biodiversity Areas (CBAs)** are terrestrial and aquatic areas of the landscape that need to be maintained in a natural or near-natural state to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services. CBAs are areas of high biodiversity value and need to be kept in a natural state, with no further loss of habitat or species. Thus, if these areas are not maintained in a natural or near natural state then biodiversity targets cannot be met. Maintaining an area in a natural state can include a variety of biodiversity compatible land uses and resource uses (SANBI-BGIS, 2017).

**Ecological Support Areas (ESAs)** are not essential for meeting biodiversity targets but play an important role in supporting the ecological functioning of Critical Biodiversity Areas and/or in delivering ecosystem services. Critical Biodiversity Areas and Ecological Support Areas may be terrestrial or aquatic (SANBI-BGIS, 2017).

**Other Natural Areas (ONAs)** consist of all those areas in good or fair ecological condition that fall outside the protected area network and have not been identified as CBAs or ESAs. A biodiversity sector plan or bioregional plan must not specify the desired state/management objectives for ONAs or provide land-use guidelines for ONAs (SANBI-BGIS, 2017).

Figure 6-3 shows the project area superimposed on the Terrestrial CBA map. The project areas overlaps with a CBA1, ESA1, ESA2 and ON area.

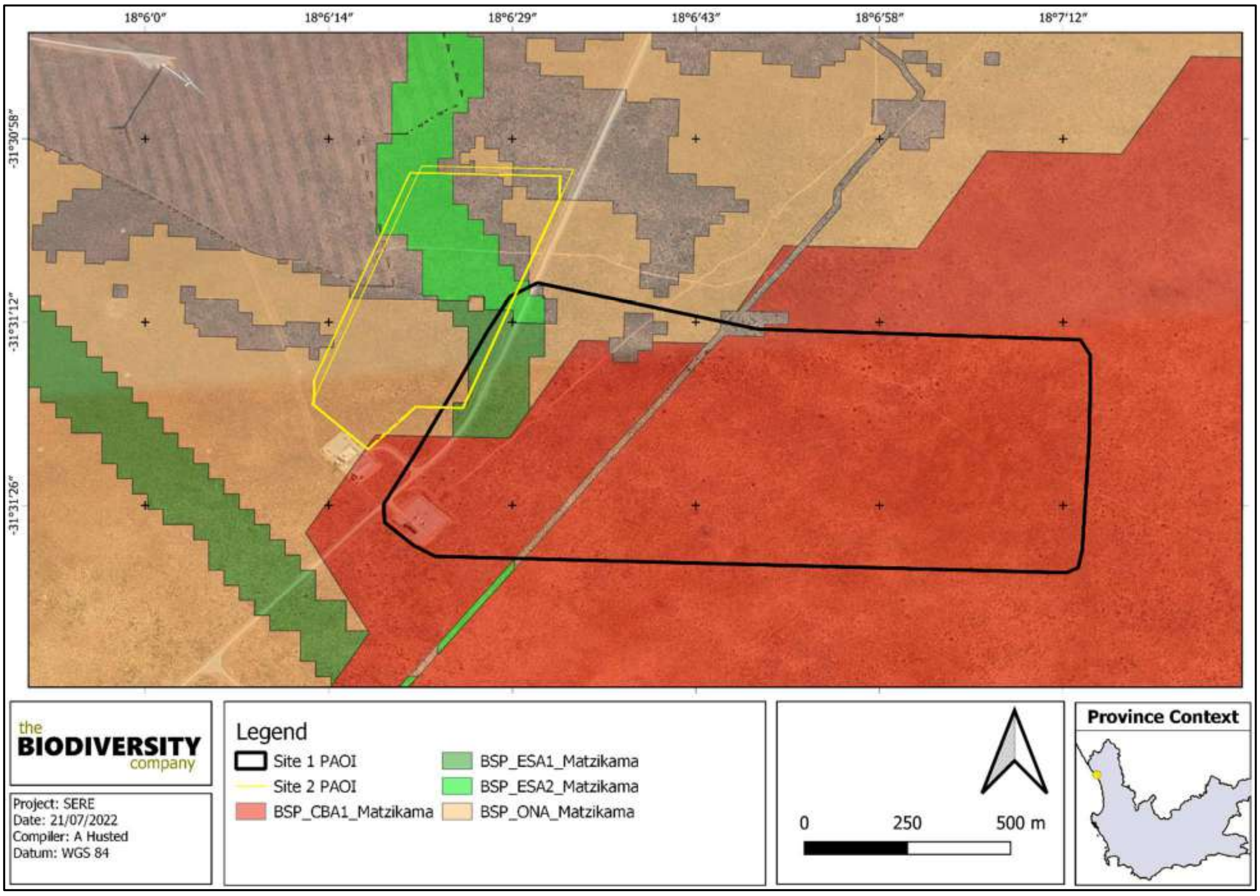



***Figure 6-3 Map illustrating the locations of CBAs in the project areas***

#### 6.1.1.4 National Protected Area Expansion Strategy

National Protected Area Expansion Strategy 2017 (NPAES) were identified through a systematic biodiversity planning process. They present the best opportunities for meeting the ecosystem-specific protected area targets set in the NPAES and were designed with strong emphasis on climate change resilience and requirements for protecting freshwater ecosystems. These areas should not be seen as future boundaries of protected areas, as in many cases only a portion of a particular focus area would be required to meet the protected area targets set in the NPAES. They are also not a replacement for finescale planning which may identify a range of different priority sites based on local requirements, constraints and opportunities (NPAES, 2017). The project area overlaps with a Priority Focus Area, while Site 2 falls just outside of the NPAES as can be seen in Figure 6-4.

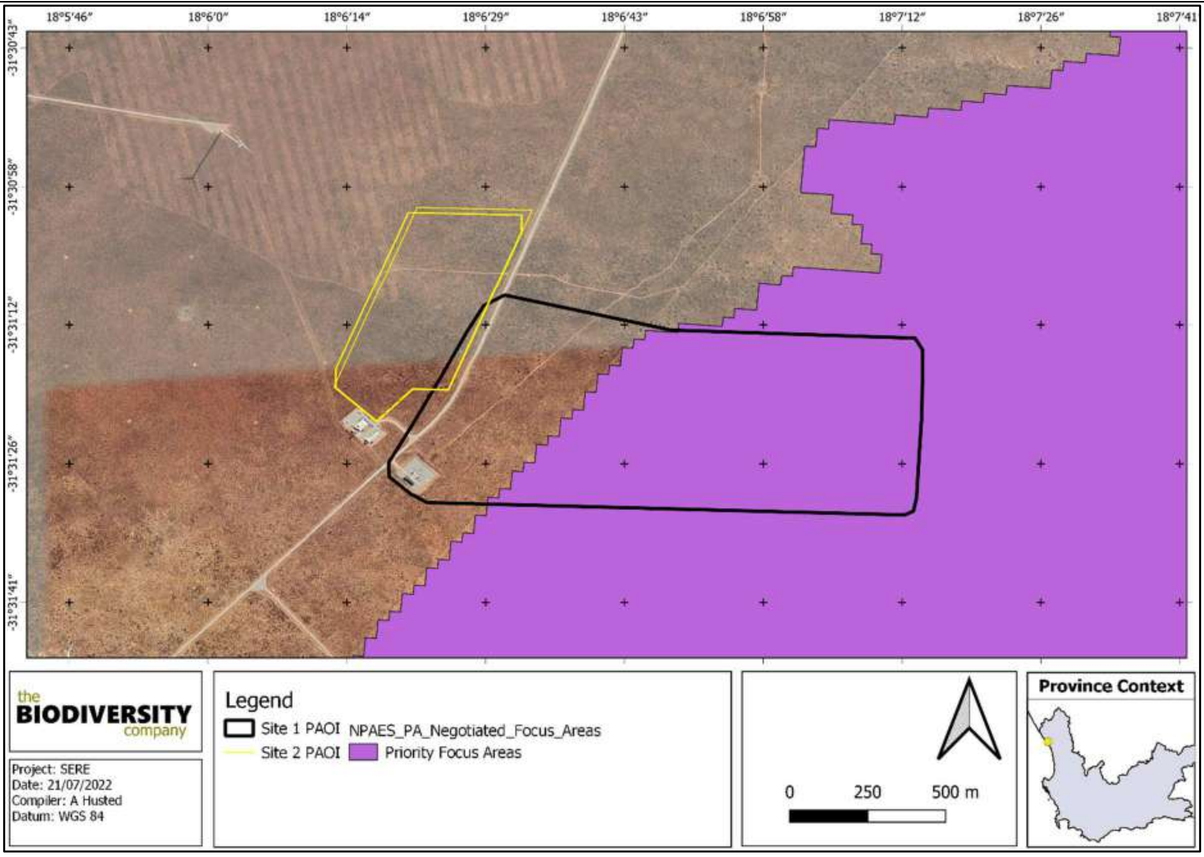



***Figure 6-4 The project areas in relation to the National Protected Area Expansion Strategy***

#### 6.1.1.5 Succulent Karoo Ecosystem Programme

Succulent Karoo Ecosystem Programme (SKEP) is a long term bioregional conservation programme, with the aim to conserve ecosystems and to develop conservation as a land-use rather than instead of land-use (SANBI, 2021). Their focal areas are:

- Increasing local, national and international awareness of the unique biodiversity of the Succulent Karoo;
- Expanding protected areas and improving conservation management, particularly through the expansion of public-private-communal-corporate partnerships;
- Support the creation of a matrix of harmonious land uses; and
- Improve institutional co-ordination to generate momentum and focus on priorities, maximise opportunities for partnerships, and ensure sustainability.

The areas of SKEP endemism for mammals, amphibians, reptiles and birds were assessed in relation to the project areas, it was found that the project areas overlap with a mammal near endemic habitat (Figure 6-5).

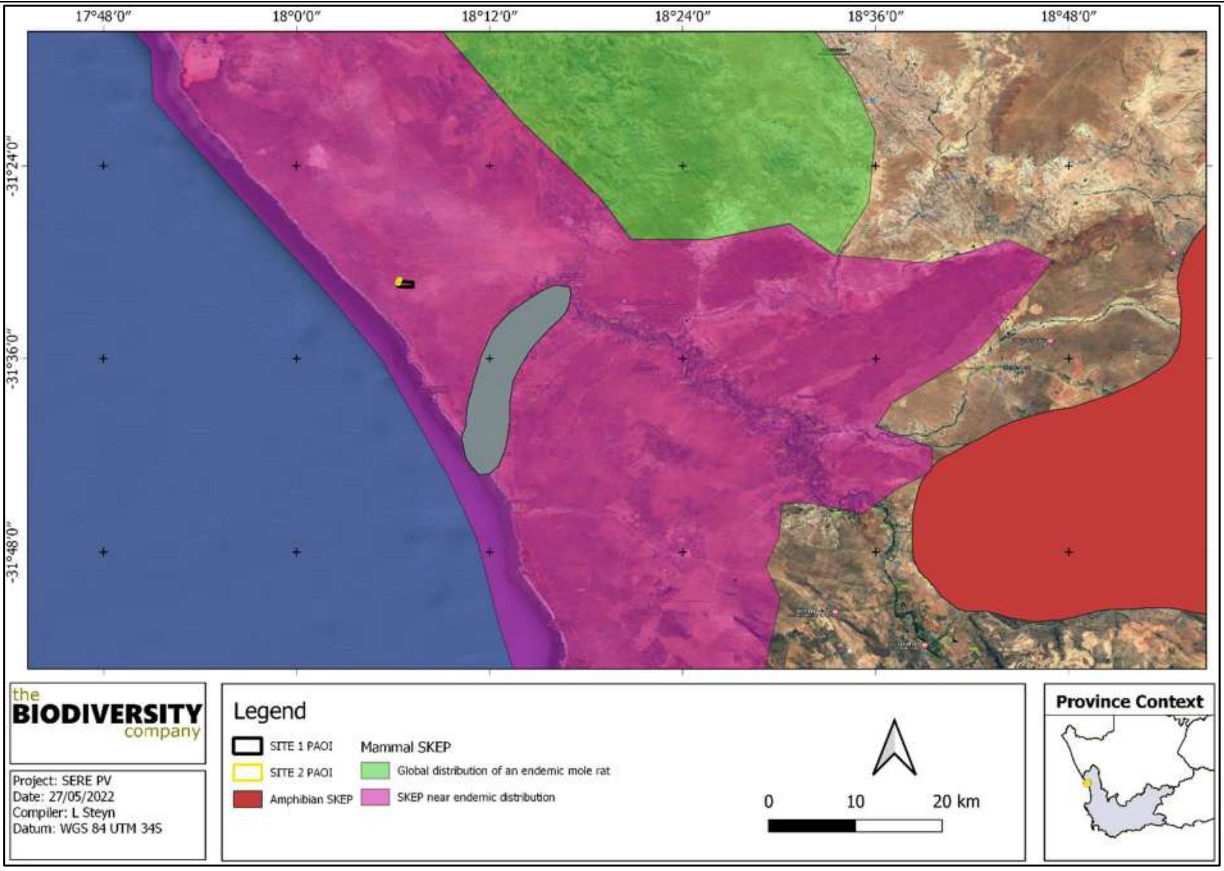



***Figure 6-5 The project areas in relation to the Succulent Karoo Ecosystem Programme***

#### 6.1.1.6 Hydrological Setting

The South African Inventory of Inland Aquatic Ecosystems (SAIIAE) was released with the NBA 2018. Ecosystem threat status (ETS) of river and wetland ecosystem types are based on the extent to which each river ecosystem type had been altered from its natural condition. Ecosystem types are categorised as CR, EN, VU or LT, with CR, EN and VU ecosystem types collectively referred to as 'threatened' (Van Deventer *et al.,* 2019; Skowno *et al.,* 2019). The project areas are found just more than 500 m from a CR wetland and is 10 km from the Olifants river and 3 km from the coastline (Figure 6-6).

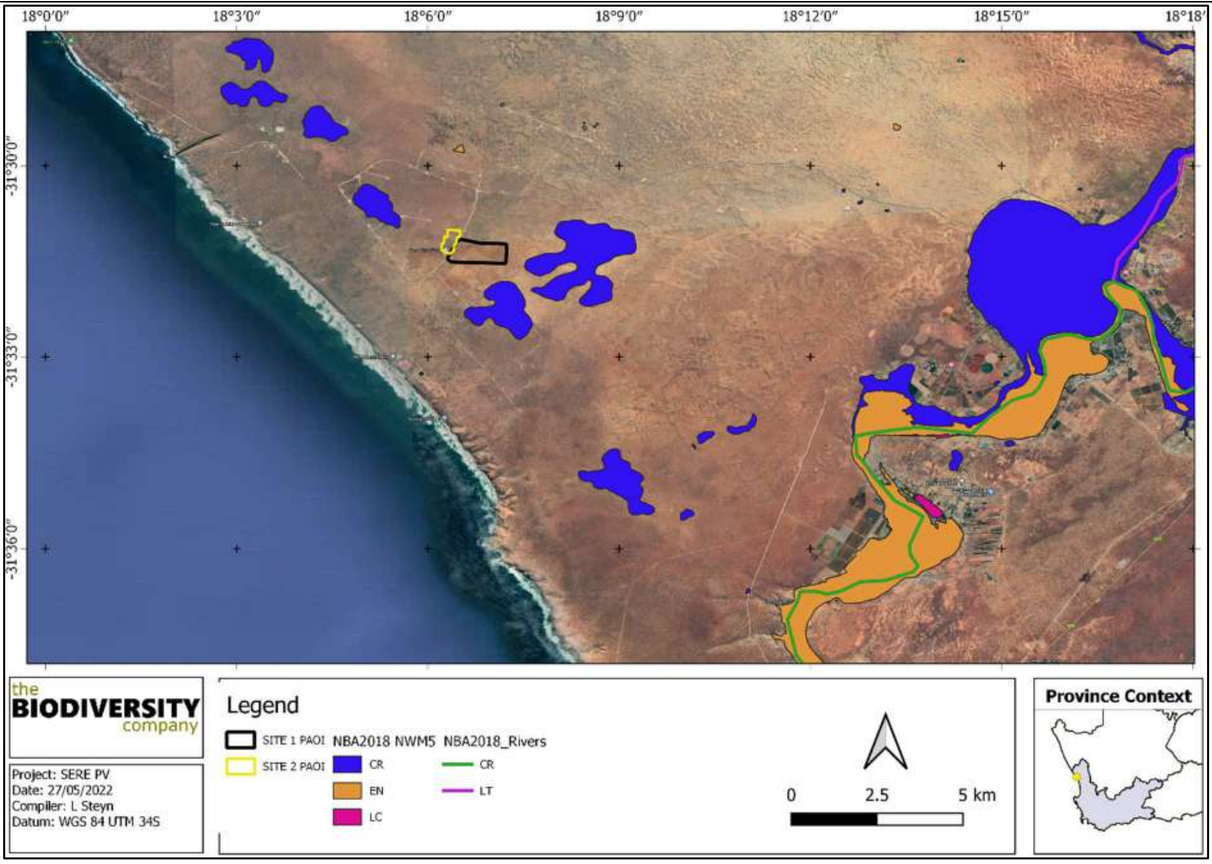



***Figure 6-6*** ***Map illustrating ecosystem threat status of rivers and protection level of wetland ecosystems in the project areas***

#### 6.1.1.7 National Freshwater Ecosystem Priority Area Status

In an attempt to better conserve aquatic ecosystems, South Africa has categorised its river systems according to set ecological criteria (i.e., ecosystem representation, water yield, connectivity, unique features, and threatened taxa) to identify Freshwater Ecosystem Priority Areas (FEPAs) (Driver *et al.,* 2011). The FEPAs are intended to be conservation support tools and envisioned to guide the effective implementation of measures to achieve the National Environment Management Biodiversity Act's (NEM:BA) biodiversity goals (Nel *et al.,* 2011). Figure 6-7 shows the project areas does not overlap with FEPA wetlands nor FEPA rivers.

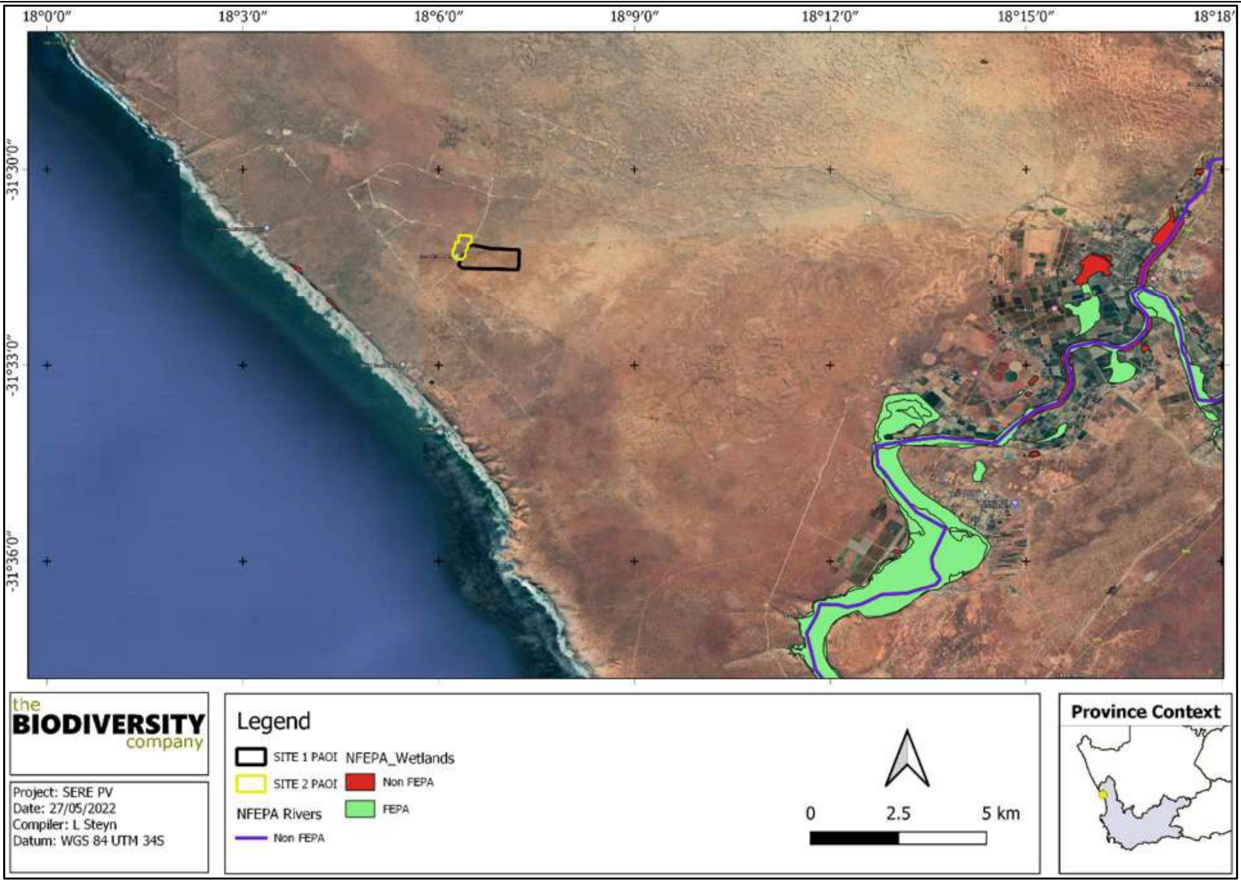



***Figure 6-7*** ***The project area in relation to the National Freshwater Ecosystem Priority Areas, River lines and Inland water areas***

#### 6.1.1.8 Renewable Energy Projects

A number of existing and planned applications for PV, CSP and CPV solar developments are found around the project areas. The data used to determine the number of applications in the nearby area were obtained from SA Renewable Energy EIA Application Database (REEA) (https://egis.environment.gov.za/) and were accurate as per 31 August 2021. The cumulative impact of all these projects would be high, especially in an area where a large number of highly endemic species are found (Figure 6-8).

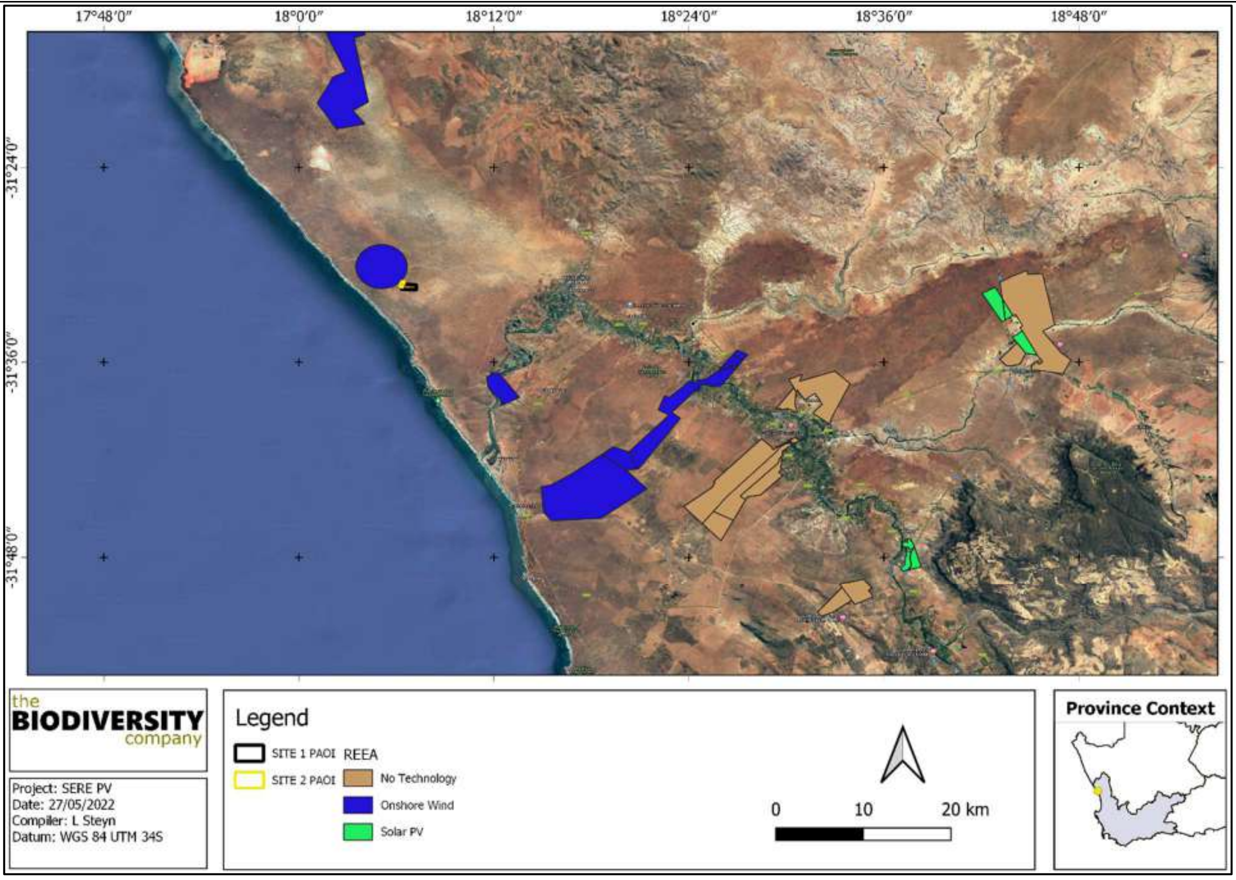



*Figure 6-8 Renewable energy applications and projects close to the project areas*

### 6.1.2 Flora Assessment

This section is divided into a description of the vegetation type expected under natural conditions and the expected flora species.

#### 6.1.2.1 Vegetation Type

The project area is situated within the Fynbos and the Succulent Karoo biomes.

**Fynbos biome**

The fynbos biome comprises of three naturally fragmented vegetation type, they are; fynbos, renosterveld and sandveld (Mucina & Rutherford, 2006). This evergreen, fire-prone shrubland is characterised by the presence of restios, high cover of ericoid shrubs and the common occurrence of proteoid shrubs (Mucina & Rutherford, 2006).

The fynbos occurs mainly on nutrient poor sandy soils and less frequently on limestone, leached clay soils derived from shale and granite, and gravelly soils derived from duricrust outcrops and alluvial sediments (Mucina & Rutherford, 2006).

**Succulent Karoo biome.**

Most of the biome covers a flat to gently undulating plain, with some hilly and "broken" veld, mostly situated to the west and south of the escarpment, and north of the Cape Fold Belt. The altitude is mostly below 800 m, but in the east, it may reach 1 500 m (SANBI, 2019).

The Succulent Karoo Biome is primarily determined by the presence of low winter rainfall and extreme summer aridity. Rainfall varies between 20 and 290 mm per year. Because the rains are cyclonic, and not due to thunderstorms, the erosive power is far less than of the summer rainfall biomes. During summer, temperatures in excess of 40°C are common, while fog is common nearer to the coast (SANBI, 2019).

The vegetation is dominated by dwarf, succulent shrubs, of which the Vygies (Mesembryanthemaceae) and Stonecrops (Crassulaceae) are particularly prominent. Mass flowering displays of annuals (mainly Daisies Asteraceae) occur in spring, often on degraded or fallow lands. Grasses are rare, except in some sandy areas, and are of the C3 type. The number of plant species mostly succulents - is very high and unparalleled elsewhere in the world for an arid area of this size (SANBI, 2019).

On a fine-scale vegetation type, Site 1 overlaps with two vegetation type: the Namaqualand Inland Duneveld and the Namaqualand Sand Fynbos, while Site 2 only falls across the latter vegetation type (Figure 6-9).

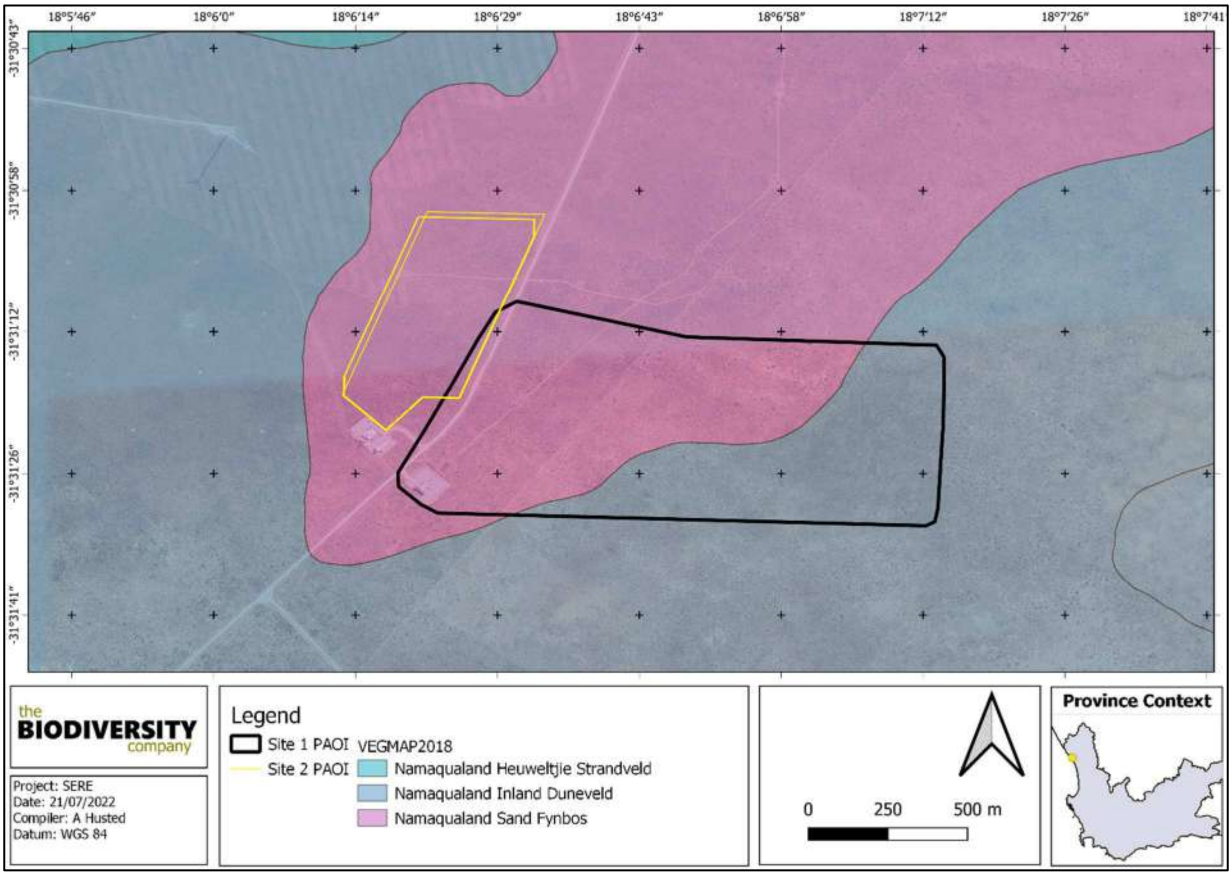



***Figure 6-9 Map illustrating the vegetation type associated with the project areas***

#### 6.1.2.1.1 Namaqualand Sand Fynbos

This vegetation is made up of slightly undulating plains comprising both isolated streets and dune fields of aeolian sand. Scattered 1–1.5 m tall shrubs 1–3 m in diameter but dominated by Restionaceae in between. This vegetation type if found in the Western and Northern Cape Provinces at altitudes of 60-300m.

**Important Taxa (d= dominant)**

Tall Shrubs: *Leucospermum praemorsum* (d), *L. rodolentum* (d), *Wiborgia obcordata* (d), *Gymnosporia buxifolia*.

Low Shrubs: *Elytropappus rhinocerotis* (d), *Stoebe nervigera* (d), *Trichogyne repens* (d), *Chrysanthemoides incana*, *Clutia daphnoides*, *Diospyros austro-africana*, *Eriocephalus africanus* var. *africanus*, *Justicia cuneata*, *Leucadendron brunioides* var. *brunioides*, *Macrostylis decipiens*, *Metalasia adunca*, *Nenax arenicola*, *Salvia lanceolata*.

Succulent Shrubs: *Othonna protecta*, *Ruschia caroli*, *R. extensa*, *R. subpaniculata*.

Herbs: *Grielum grandiflorum*, *Limeum fenestratum*, *Wahlenbergia asparagoides*.

Geophytic Herb: *Watsonia meriana*.

Graminoids: *Ehrharta villosa* var. *villosa* (d), *Thamnochortus bachmannii* (d), *Willdenowia incurvata* (d), *Ehrharta calycina*, *Ficinia capitella*, *Ischyrolepis macer*, *I. monanthos*, *Stipagrostis zeyheri* subsp. *macropus*.

**Biogeographically Important Taxa** (Namaqualand endemics)

Herb: *Helichrysum marmarolepis*.

Succulent Herb: *Quaqua armata* subsp. *maritima*.

**Endemic Taxa** Succulent Shrub: *Lampranthus procumbens*.

Geophytic Herbs: *Albuca decipiens*, *Babiana brachystachys*.

**Conservation Status**

This vegetation is classified as LC, with a conservation target of 29 % (SANBI, 2018).

#### 6.1.2.1.2 Namaqualand Inland Duneveld

This vegetation type occurs in two patches one between Kotzesrus northwards to Groen River while another is located between Wallekraal and Hondeklipbaai. The vegetation is tall shrubland dominated by nonsucculent shrubs such as *Berkheya sp, Eriocephalus sp, Euclea sp, Gloveria sp, Lycium sp, Searsia sp, Tetragonia sp, Tripteris sp and Zygophyllum sp* as well as some grasses (*Ehrharta sp*) and restioids (*Willdenowia sp*).

**Important Taxa (d=dominant)**

Succulent Shrubs: *Othonna cylindrica* (d), *Tetragonia fruticosa*, *Zygophyllum morgsana*.

Tall Shrubs: *Diospyros ramulosa*, *Euclea racemosa*, *Nylandtia spinosa*, *Searsia longispina*, *S. undulata*.

Low Shrubs: *Eriocephalus racemosus* var. *affinis* (d), *Helichrysum hebelepis* (d), *Berkheya fruticosa*, *Gloveria integrifolia*, *Hermannia trifurca*, *Lebeckia sericea*, *Monechma spartioides*, *Pharnaceum incanum*, *Pteronia paniculata*, *Salvia lanceolata*, *Selago pinguicula*, *Trichogyne ambigua*, *Tripteris oppositifolia*.

Graminoids: *Willdenowia incurvata* (d), *Ehrharta barbinodis*, *E. calycina*, *Ficinia argyropa*.

**Conservation Status**

This vegetation type is listed as LC, with the national conservation target being set at 26%. This vegetation type is sensitive to overgrazing and animal trampling mainly because of the sandy substrate on which it is found.

### 6.1.2.2 Expected Flora Species

The POSA database indicates that 537 species of indigenous plants are expected to occur within the project areas. Appendix A provides the list of species and their respective conservation status and endemism. Fourty-one (41) SCC based on their conservation status could be expected to occur within the project area and are provided in Table 6-2 below.

***Table 6-2 Threatened flora species that may occur within the project area***

| Family | Taxon | Author | IUCN | Ecology |
|---|---|---|---|---|
| **Iridaceae** | *Romulea lutea* | J.C.Manning & Goldblatt | CR | Indigenous; Endemic |
| **Iridaceae** | *Babiana teretifolia* | Goldblatt & J.C.Manning | CR | Indigenous; Endemic |
| **Scrophulariaceae** | *Selago heterotricha* | Hilliard | EN | Indigenous; Endemic |
| **Geraniaceae** | *Pelargonium appendiculatum* | (L.f.) Willd. | EN | Indigenous; Endemic |
| **Hyacinthaceae** | *Ornithogalum hallii* | Oberm. | EN | Indigenous; Endemic |

| | | | | |
|---|---|---|---|---|
| **Geraniaceae** | *Pelargonium crassipes* | Harv. | EN | Indigenous; Endemic |
| **Aizoaceae** | *Monilaria pisiformis* | (Haw.) Schwantes | EN | Indigenous; Endemic |
| **Iridaceae** | *Romulea sinispinosensis* | M.P.de Vos | EN | Indigenous; Endemic |
| **Apocynaceae** | *Quaqua pulchra* | (Bruyns) Plowes | EN | Indigenous; Endemic |
| **Fabaceae** | *Otholobium incanum* | C.H.Stirt. | EN | Indigenous; Endemic |
| **Crassulaceae** | *Tylecodon fragilis* | (R.A.Dyer) Toelken | EN | Indigenous; Endemic |
| **Aizoaceae** | *Leipoldtia klaverensis* | L.Bolus | EN | Indigenous; Endemic |
| **Campanulaceae** | *Wahlenbergia asparagoides* | (Adamson) Lammers | NT | Indigenous; Endemic |
| **Iridaceae** | *Babiana virescens* | Goldblatt & J.C.Manning | NT | Indigenous; Endemic |
| **Iridaceae** | *Babiana confusa* | (G.J.Lewis) Goldblatt & J.C.Manning | NT | Indigenous; Endemic |
| **Apocynaceae** | *Ceropegia occidentalis* | R.A.Dyer | NT | Indigenous |
| **Asteraceae** | *Helichrysum marmarolepis* | S.Moore | NT | Indigenous; Endemic |
| **Aizoaceae** | *Jordaaniella uniflora* | (L.Bolus) H.E.K.Hartmann | NT | Indigenous; Endemic |
| **Iridaceae** | *Babiana hirsuta* | (Lam.) Goldblatt & J.C.Manning | NT | Indigenous; Endemic |
| **Aizoaceae** | *Drosanthemum marinum* | L.Bolus | NT | Indigenous; Endemic |
| **Iridaceae** | *Ferraria foliosa* | G.J.Lewis | NT | Indigenous; Endemic |
| **Crassulaceae** | *Crassula ammophila* | Toelken | NT | Indigenous; Endemic |
| **Apiaceae** | *Arctopus dregei* | Sond. | NT | Indigenous; Endemic |
| **Asteraceae** | *Othonna intermedia* | Compton | NT | Indigenous; Endemic |
| **Asteraceae** | *Othonna hallii* | B.Nord. | VU | Indigenous; Endemic |
| **Aizoaceae** | *Lampranthus procumbens* | Klak | VU | Indigenous; Endemic |
| **Aizoaceae** | *Ruschia langebaanensis* | L.Bolus | VU | Indigenous; Endemic |
| **Aizoaceae** | *Ruschia bipapillata* | L.Bolus | VU | Indigenous; Endemic |
| **Asphodelaceae** | *Bulbine melanovaginata* | G.Will. | VU | Indigenous; Endemic |
| **Iridaceae** | *Lapeirousia simulans* | Goldblatt & J.C.Manning | VU | Indigenous; Endemic |
| **Polygalaceae** | *Muraltia obovata* | DC. | VU | Indigenous; Endemic |
| **Asteraceae** | *Leucoptera nodosa* | (Thunb.) B.Nord. | VU | Indigenous; Endemic |
| **Aizoaceae** | *Diplosoma luckhoffii* | (L.Bolus) Schwantes ex Ihlenf. | VU | Indigenous; Endemic |
| **Asteraceae** | *Helichrysum dunense* | Hilliard | VU | Indigenous; Endemic |
| **Iridaceae** | *Moraea quartzicola* | Goldblatt & J.C.Manning | VU | Indigenous |
| **Asteraceae** | *Othonna cakilefolia* | DC. | VU | Indigenous; Endemic |
| **Iridaceae** | *Babiana lewisiana* | B.Nord. | VU | Indigenous; Endemic |
| **Asteraceae** | *Oedera silicicola* | (K.Bremer) Anderb. & K.Bremer | VU | Indigenous; Endemic |
| **Hyacinthaceae** | *Ornithogalum naviculum* | W.F.Barker | VU | Indigenous; Endemic |
| **Proteaceae** | *Leucospermum rodolentum* | (Salisb. ex Knight) Rourke | VU | Indigenous; Endemic |
| **Asphodelaceae** | *Bulbine haworthioides* | B.Nord. | VU | Indigenous; Endemic |

### 6.1.3 Faunal Assessment

#### 6.1.3.1 Amphibians

Based on the IUCN Red List Spatial Data and AmphibianMap, 13 amphibian species are expected to occur within the area (Appendix B). None are regarded as threatened.

#### 6.1.3.2 Reptiles

Based on the IUCN Red List Spatial Data and the ReptileMAP database, 68 reptile species are expected to occur within the area (Appendix C). Four (4) are regarded as threatened (Table 6-3).

***Table 6-3 Threatened reptile species that are expected to occur within the project area***

| Species | Common Name | Conservation Status | | Likelihood of Occurrence |
|---|---|---|---|---|
| | | Regional (SANBI, 2016) | IUCN (2021) | |
| ***Chersobius signatus*** | Speckled Dwarf Tortoise | EN | EN | High |
| ***Goggia matzikamaensis*** | Matzikama Gecko | NT | LC | High |
| ***Psammophis leightoni*** | Cape Sand Snake | VU | VU | High |
| ***Scelotes gronovii*** | Gronovi's Dwarf Burrowing Skink | NT | NT | High |

*Chersobius signatus* (Speckled Dwarf Tortoise) is naturally restricted to a small area in the Little Namaqualand, where it normally lives on rocky outcrops and forages among the rocks on succulent plants. Based on the suitable habitat and food sources found in the project areas, a high likelihood of occurrence was appointed to the species.

*Goggia matzikamaensis* (Matzikama Gecko) is NT on a regional scale. This species rock cracks in Succulent Karoo**.** Suitable habitat can be found in the project areas, as such the species were given a high likelihood of occurrence.

*Psammophis leightoni* (Cape Sand Snake) is categorised as VU internationally and locally. Endemic to the western regions of the Western Cape, South Africa. Threatened primarily by habitat loss associated with agriculture and development of human settlements throughout its range. The likelihood of finding the species in the project areas are high, this was based on another snake species with similar habitat requirements being present.

*Scelotes gronovii (Gronovi's Dwarf Burrowing Skink)* is NT on both a regional and global scale. They inhabit sparsely-vegetated coastal dunes and strandveld, chiefly at elevations below 100 m. As their ideal habitat is found in the project areas this species were given a high likelihood of occurrence.

#### 6.1.3.3 Mammals

The IUCN Red List Spatial Data lists 58 mammal species that could be expected to occur within the area (Appendix D). This list excludes large mammal species that are limited to protected areas. Seven (7) of these expected species are regarded as threatened (Table 6-4), three of these have a low likelihood of occurrence based on the lack of suitable habitat and the level of disturbance nearby to the project areas.

***Table 6-4 Threatened mammal species that are expected to occur within the project area.***

| Species | Common Name | Conservation Status | | Likelihood of occurrence |
|---|---|---|---|---|
| | | Regional (SANBI, 2016) | IUCN (2021) | |
| ***Eremitalpa granti*** | Grant's Golden Mole | VU | Unlisted | Moderate |
| ***Felis nigripes*** | Black-footed Cat | VU | VU | Low |
| ***Graphiurus ocularis*** | Spectacular Dormouse | NT | LC | Moderate |
| ***Leptailurus serval*** | Serval | NT | LC | Moderate |
| ***Mystromys albicaudatus*** | White-tailed Rat | VU | EN | Low |
| ***Panthera pardus*** | Leopard | VU | VU | Low |
| ***Parotomys littledalei*** | Littledale's Whistling Rat | NT | LC | Moderate |

*Eremitalpa granti* (Grant's Golden Mole) is categorised as VU on a regional scale. This species prefers soft, shifting sands of dune crests but also present in inter-dune swales with quite dense vegetation as long as sand is not too consolidated. Areas containing scattered clumps of the dune grass (*Aristida sabulicola*), Ostrich Grass (*Cladoraphis spinosa*) and Long Bushman Grass (*Stipagrostis ciliata*), are the preferred habitats for this species. Much of the range of this species coincides with coastal desert where human influence on habitats is not substantial, so the overall population is probably not in decline. The likelihood of occurrence in the project areas are rated as moderate.

*Graphiurus ocularis (*Spectacular Dormouse) is categorised as NT on a regional scale. This species is endemic to South Africa, where it occurs widely in Northern Cape, Eastern Cape, and Western Cape provinces, with a single record from the North West province. The species is associated with the sandstone formations of the Cape, which have many vertical and horizontal cracks and crevices in which to shelter and nest. The likelihood of occurrence is rated as moderate

*Leptailurus serval* (Serval) occurs widely through sub-Saharan Africa and is commonly recorded from most major national parks and reserves (IUCN, 2017). The Serval's status outside reserves is not certain, but they are inconspicuous and may be common in suitable habitat as they are tolerant of farming practices provided there is cover and food available. In sub-Saharan Africa, they are found in habitat with well-watered savanna long-grass environments and are particularly associated with reedbeds and other riparian vegetation types. The project areas provide some areas of suitable habitat and were given a moderate likelihood.

*Parotomys littledalei* (Littledale's Whistling Rat) is listed as NT on a regional scale. This diurnal species occurs in shrubland and is dependent on ground cover. Littledale's Whistling Rat is herbivorous only, feeding on fresh plant material, including annuals, succulent perennials, non-succulent perennials, and grasses. The presence of ground cover increases their likelihood of occurrence in the project areas. Suitable but not ideal habitat is found in the project areas, therefore the likelihood of occurrence was rated as moderate.

#### 6.1.4 Literature Review

Nick Helme prepared a botanical survey for the Eskom Wind energy facility on the cape west coast (Helme, 2007). In the study he found *Leucoptera nodosa* which is a red list species, along with this species he also recommended the translocation of *Trachyandra involucrate*, *Boophone haemanthoides, Brunsvigia orientalis*, *Lebeckia lotononoides,* all *Ferraria* species, all *Lachenalia* species, all *Babiana* species and *Eriospermum arenosum.* In this study it was also recommended that the wind turbines be placed on the existing mining areas.

Nemai consulting conducted a botanical survey for The Eskom Skaapvlei Substation and BESS (Nemai, 2019). In this study they found *Babiana virescens* which is a nationally Near Threatened plant. They also make mention of the likelihood of *Leucoptera nodosa* occurring on site. Two provincially protected plants *Brunsvigia orientalis* and *Boophone haemanthoides* were also recorded in the project area and must be relocated during a search and rescue operation. The loss of ESA and CBA were regarded as the greatest impact during this survey.

In 2008 P le F.N Mouton performed a fauna assessment for the proposed Wind energy facility and associated infrastructure. No species of conservation concern is listed that were found in the area, he did however ptovide a list of species that could likely be present, these included: *Typhlosaurus lomii* (Lomi's Blind Legless Skink), *Cordylus cataphractus* (Armadillo Girdled lizard), *Bitis schneideri* (Namaqua Dwarf Adder), *Eremitalpa granti* (Grants Golden Mole), *Bathyergus janetta* (Namaqua Dune Mole Rat). On the fauna this study found the greatest impact would be on burrowing lizards and burrowing mammals in the form of habitat loss and physical death, while the bats are expected to be influenced by collisions with the wind turbine blades.

## 6.2 Field Assessment for Site 1

The following sections provide the results from the field survey for the proposed development that was undertaken during the 1st to the 2nd of December 2021.

### 6.2.1 Flora Assessment

This section is divided into two sections:

- Indigenous flora; and
- Invasive Alien Plants (IAPs).

#### 6.2.1.1 Indigenous Flora

The species composition of the assessment area was consistent with typical Namaqualand Sand Fynbos and Namaqualand Inland Duneveld vegetation types. Distinctive vegetation communities were observed within these vegetation types and can be classified into Sand Shrubland which contained rocky outcrops. The plant species recorded is by no means comprehensive, and repeated surveys during different phenological periods were not covered, additional surveys may likely yield up to 40% additional flora species for the project area. However, floristic analysis conducted to date is however regarded as a sound representation of the local flora for the project area.

The sand shrubland habitat occurred throughout most of the project area and consisted of short and tall shrubland with succulent and non-succulent plants. Rocky outcrops occurred sporadically throughout the habitat. This habitat generally consisted of species such as *Boophone haemanthoides, Brunsvigia orientalis, Wiborgia obcordata, Gymnosporia buxifolia, Leucadendron brunioides, Salvia lanceolata, Ruschia caroli, R. extensa, R. subpaniculata, Tetragonia fruticosa, Zygophyllum morgsana, Limonium sp, Willdenowia incurvata, Ehrharta sp, Gethyllis sp, Babiana sp, Mesembryanthemum guerichianum and Euphorbia stapelioides.*

Succulents were ubiquitous throughout the assessment area and occurred within the community described above. Geophytes were particularly lacking due to the timing of the survey however are expected to occur. However, the *most* species will not be feasible to geotag due to the extent of the number. Moreover, further surveys are likely to reveal additional protected species, especially when undertaken during different seasons and climatic conditions. It can be assumed that the species recorded by Helme, in 2007 and Nemai, 2019 occurred throughout.

It is important to note that many of these growth forms, and their non-succulent relatives, are protected under the Western Cape Legislation.


***Figure 6-10 Photographs illustrating some of the flora recorded within the assessment area. A) Boophone haemanthoides (protected), B) Gethyllis sp, C) Limonium sp and D) Brunsvigia orientalis (protected).***

#### 6.2.1.2 Invasive Alien Plants

Invasive Alien Plants (IAPs) tend to dominate or replace indigenous flora, thereby transforming the structure, composition and functioning of ecosystems. Therefore, it is important that these plants are controlled by means of an eradication and monitoring programme. Some invader plants may also degrade ecosystems through superior competitive capabilities to exclude native plant species.

NEMBA is the most recent legislation pertaining to alien invasive plant species. In August 2014, the list of Alien Invasive Species was published in terms of the NEMBA. The Alien and Invasive Species Regulations were published in the Government Gazette No. 44182, 24th of February 2021. The legislation calls for the removal and / or control of IAP species (Category 1 species). In addition, unless authorised thereto in terms of the NWA, no land user shall allow Category 2 plants to occur within 30 meters of the 1:50 year flood line of a river, stream, spring, natural channel in which water flows regularly or intermittently, lake, dam or wetland. Category 3 plants are also prohibited from occurring within proximity to a watercourse. Below is a brief explanation of the three categories in terms of the NEMBA:

- *Category 1a*: Invasive species requiring compulsory control. Remove and destroy. Any specimens of Category 1a listed species need, by law, to be eradicated from the environment. No permits will be issued.
- *Category 1b*: Invasive species requiring compulsory control as part of an invasive species control programme. Remove and destroy. These plants are deemed to have such a high invasive potential that infestations can qualify to be placed under a government sponsored invasive species management programme. No permits will be issued.
- *Category 2*: Invasive species regulated by area. A demarcation permit is required to import, possess, grow, breed, move, sell, buy or accept as a gift any plants listed as Category 2 plants. No permits will be issued for Category 2 plants to exist in riparian zones.
- *Category 3*: Invasive species regulated by activity. An individual plant permit is required to undertake any of the following restricted activities (import, possess, grow, breed, move, sell, buy or accept as a gift) involving a Category 3 species. No permits will be issued for Category 3 plants to exist in riparian zones.

Note that according to the Alien and Invasive Species Regulations, a person who has under his or her control a category 1b listed invasive species must immediately:

- Notify the competent authority in writing
- Take steps to manage the listed invasive species in compliance with:
    - Section 75 of the NEMBA;
    - The relevant invasive species management programme developed in terms of regulation 4; and
    - Any directive issued in terms of section 73(3) of the NEMBA.

No NEMBA IAP species were recorded within the project area.

### 6.2.2 Faunal Assessment

Herpetofauna and mammal observations and recordings fall under this section. A separate avifauna assessment was conducted.

#### 6.2.2.1 Amphibians and Reptiles

Three (3) species of reptiles were recorded in the project area during survey period (Table 6-5) (Figure 6-11). However, there is the possibility of more species being present, as certain reptile species are secretive and require long-term surveys to ensure capture. No amphibian species were recorded during the survey period, this was largely due to the season in which the field survey was carried out as well as the fact that no pitfall trapping was done, surveys relied on opportunistic sightings as opposed to intensive and appropriate sampling methods. The only other method utilised was refuge examinations using visual scanning of terrains to record smaller herpetofauna species that often conceal themselves under rocks, in fallen logs, rotten tree stumps, in leaf litter, rodent burrows, ponds, old termite mounds, this method was also not intensively applied in the field. None of the herpetofauna species recorded are regarded as threatened, albeit 2 are protected under provincial legislation.

The use of the rocky areas by these species on the fine-scale habitats is important to consider for mitigation actions when an area is cleared for placement of the infrastructure.

***Table 6-5 Summary of herpetofauna species recorded within the project area.***

| Family | Species | Common Name | Conservation Status | | Western Cape Nature Conservation Laws Amendment Act, 2000[1] |
|---|---|---|---|---|---|
| | | | Regional (SANBI, 2016) | IUCN (2021) | |
| **Testudinidae** | *Chersina angulata* | Angulate Tortoise | LC | LC | Schedule 2 |
| **Lamprophiidae** | *Homoroselaps lacteus* | Spotted Harlequin Snake | LC | LC | |
| **Cordylidae** | *Karusasaurus polyzonus* | Southern Karusa Lizard | LC | LC | Schedule 2 |

[1] This Act amends the Nature and Environmental Conservation Ordinance, 1974, the Western Cape Nature Conservation Board Act, 1998 in relation with matters of administration. It redefines the Department of Environmental and Cultural Affairs and Sport and provides for some matters relative to the Western Cape Nature Conservation Board Act


***Figure 6-11 Photographs illustrating some of the reptiles recorded within the assessment area. A) Spotted Harlequin Snake (Homoroselaps lacteus) B) Angulate Tortoise (Chersina angulata) (protected), C) Southern Karusa Lizard (Karusasaurus polyzonus) (protected).***

#### 6.2.2.2 Mammals

Three (3) mammal species were observed during the survey of the project area (Table 6-6) based on either direct observation or the presence of visual tracks and signs (Table 6-6). None of the species recorded are regarded as a SCC, one mammal species are additionally protected provincially.

***Table 6-6 Summary of mammal species recorded within the project area***

| Species | Common Name | Conservation Status | | Western Cape Nature Conservation Laws Amendment Act, 2000 |
|---|---|---|---|---|
| | | Regional (SANBI, 2016) | IUCN (2021) | |
| ***Cryptomys hottentotus*** | Common Mole-rat | LC | LC | |
| ***Raphicerus campestris*** | Steenbok | LC | LC | Schedule 2 |
| ***Hystrix africaeaustralis*** | Cape Porcupine | LC | LC | |


***Figure 6-12*** ***Photographs illustrating some of the mammals recorded within the assessment area. A) Common Mole-rat (Cryptomys hottentotus), B and C) Cape Porcupine (Hystrix africaeaustralis), D) Steenbok (Raphicerus campestris) (protected).***

### 6.3 Field Assessment for Site 2

The following sections provide the results from the field survey for the proposed development that was undertaken during the 21st to the 22nd of April 2022.

#### 6.3.1 Flora Assessment

This section is divided into two sections:

- Indigenous flora; and
- Invasive Alien Plants (IAPs).

##### 6.3.1.1 Indigenous Flora

The species composition of the assessment area was consistent with typical Namaqualand Sand Fynbos vegetation type. Distinctive vegetation communities were observed within these vegetation types and can be classified into Sand Shrubland which contained rocky outcrops. The plant species recorded is by no means comprehensive, and repeated surveys during different phenological periods were not covered, additional surveys may likely yield up to 20% additional flora species for the project area. However, floristic analysis conducted to date is however regarded as a sound representation of the local flora for the project area.

The sand shrubland habitat occurred throughout most of the project area and consisted of short and tall shrubland with succulent and non-succulent plants. Rocky outcrops occurred sporadically throughout the habitat. This habitat generally consisted of species such as *Boophone haemanthoides, Brunsvigia orientalis, Wiborgia obcordata, Gymnosporia buxifolia, Leucadendron brunioides, Salvia lanceolata, Ruschia caroli, R. extensa, R. subpaniculata, Tetragonia fruticosa, Zygophyllum morgsana, Limonium sp, Willdenowia incurvata, Ehrharta sp, Gethyllis sp, Babiana sp, Mesembryanthemum guerichianum and Euphorbia stapelioides.*

Succulents were ubiquitous throughout the assessment area and occurred within the community described above. Geophytes were particularly lacking due to the timing of the survey however are expected to occur. However, the *most* species will not be feasible to geotag due to the extent of the number. Moreover, further surveys are likely to reveal additional protected species, especially when undertaken during different seasons and climatic conditions. It can be assumed that the species recorded by Helme, in 2007 and Nemai, 2019 occurred throughout.

It is important to note that many of these growth forms, and their non-succulent relatives, are protected under the Western Cape Legislation, and a permit may be required for the destruction or relocation of these species.

***Figure 6-13 Photographs illustrating some of the flora recorded within the assessment area. A) Asparagus capensis, B) Conicosia elongate, (C) Boophone haemanthoides (protected), Euphorbia decepta).***

#### 6.3.1.2 Invasive Alien Plants

Invasive Alien Plants (IAPs) tend to dominate or replace indigenous flora, thereby transforming the structure, composition and functioning of ecosystems. Therefore, it is important that these plants are controlled by means of an eradication and monitoring programme. Some invader plants may also degrade ecosystems through superior competitive capabilities to exclude native plant species.

NEMBA is the most recent legislation pertaining to alien invasive plant species. In August 2014, the list of Alien Invasive Species was published in terms of the NEMBA. The Alien and Invasive Species Regulations were published in the Government Gazette No. 44182, 24th of February 2021. The legislation calls for the removal and / or control of IAP species (Category 1 species). In addition, unless authorised thereto in terms of the NWA, no land user shall allow Category 2 plants to occur within 30 meters of the 1:50 year flood line of a river, stream, spring, natural channel in which water flows regularly or intermittently, lake, dam or wetland. Category 3 plants are also prohibited from occurring within proximity to a watercourse. Below is a brief explanation of the three categories in terms of the NEMBA:

- *Category 1a*: Invasive species requiring compulsory control. Remove and destroy. Any specimens of Category 1a listed species need, by law, to be eradicated from the environment. No permits will be issued.
- *Category 1b*: Invasive species requiring compulsory control as part of an invasive species control programme. Remove and destroy. These plants are deemed to have such a high invasive potential that infestations can qualify to be placed under a government sponsored invasive species management programme. No permits will be issued.
- *Category 2*: Invasive species regulated by area. A demarcation permit is required to import, possess, grow, breed, move, sell, buy or accept as a gift any plants listed as Category 2 plants. No permits will be issued for Category 2 plants to exist in riparian zones.
- *Category 3*: Invasive species regulated by activity. An individual plant permit is required to undertake any of the following restricted activities (import, possess, grow, breed, move, sell, buy or accept as a gift) involving a Category 3 species. No permits will be issued for Category 3 plants to exist in riparian zones.

Note that according to the Alien and Invasive Species Regulations, a person who has under his or her control a category 1b listed invasive species must immediately:

- Notify the competent authority in writing
- Take steps to manage the listed invasive species in compliance with:
    - Section 75 of the NEMBA;
    - The relevant invasive species management programme developed in terms of regulation 4; and
    - Any directive issued in terms of section 73(3) of the NEMBA.

No NEMBA IAP species were recorded within the project area.

### 6.3.2 Faunal Assessment

Herpetofauna and mammal observations and recordings fall under this section.

#### 6.3.2.1 Amphibians and Reptiles

Three (3) species of reptiles were previously recorded in the vicinity of the project area (Table 6-5) (Figure 6-11). However, there is the possibility of more species being present, as certain reptile species are secretive and require long-term surveys to ensure capture. No amphibian species were recorded during the survey period, this was largely due to the season in which the field survey was carried out as well as the fact that no pitfall trapping was done, surveys relied on opportunistic sightings as opposed to intensive and appropriate sampling methods. The only other method utilised was refuge examinations using visual scanning of terrains to record smaller herpetofauna species that often conceal themselves under rocks, in fallen logs, rotten tree stumps, in leaf litter, rodent burrows, ponds, old termite mounds, this method was also not intensively applied in the field. None of the herpetofauna species recorded are regarded as threatened, albeit 2 are protected under provincial legislation.

The use of the rocky areas by these species on the fine-scale habitats is important to consider for mitigation actions when an area is cleared for placement of the infrastructure.

***Table 6-7 Summary of herpetofauna species recorded within the project area.***

| Family | Species | Common Name | Conservation Status | | Western Cape Nature Conservation Laws Amendment Act, 2000 |
|---|---|---|---|---|---|
| | | | Regional (SANBI, 2016) | IUCN (2021) | |
| **Testudinidae** | *Chersina angulata* | Angulate Tortoise | LC | LC | Schedule 2 |
| **Lamprophiidae** | *Homoroselaps lacteus* | Spotted Harlequin Snake | LC | LC | |
| **Cordylidae** | *Karusasaurus polyzonus* | Southern Karusa Lizard | LC | LC | Schedule 2 |

*Figure 6-14* ***Photograph illustrating a reptiles species recorded within the assessment area. Angulate Tortoise (Chersina angulata) (protected).***

#### 6.3.2.2 Mammals

Two (2) mammal species were observed during this survey of the project area (Table 6-6) based on either direct observation or the presence of visual tracks and signs (Table 6-6). None of the species recorded are regarded as a SCC.

***Table 6-8*** ***Summary of mammal species recorded within the project area***

| Species | Common Name | Conservation Status | | Western Cape Nature Conservation Laws Amendment Act, 2000 |
|---|---|---|---|---|
| | | Regional (SANBI, 2016) | IUCN (2021) | |
| *Cryptomys hottentotus* | Common Mole-rat | LC | LC | |
| *Hystrix africaeaustralis* | Cape Porcupine | LC | LC | |

# 7 Habitat Assessment and Site Ecological Importance

## 7.1 Habitat Assessment

The main habitat types identified across the project areas were identical. They were initially identified largely based on aerial imagery. These main habitat types were refined based on the field coverage and data collected during the surveys; the delineated habitats can be seen in Figure 7-1. Emphasis was placed on limiting timed meander searches along the proposed project area within the natural habitats and therefore habitats with a higher potential of hosting SCC. The habitats observed, coincide with the vegetation types as described by Mucina & Rutherford in 2006 and SANBI (2019) due to the lack of large-scale transformation, these are discussed in detail in the sections that follow.

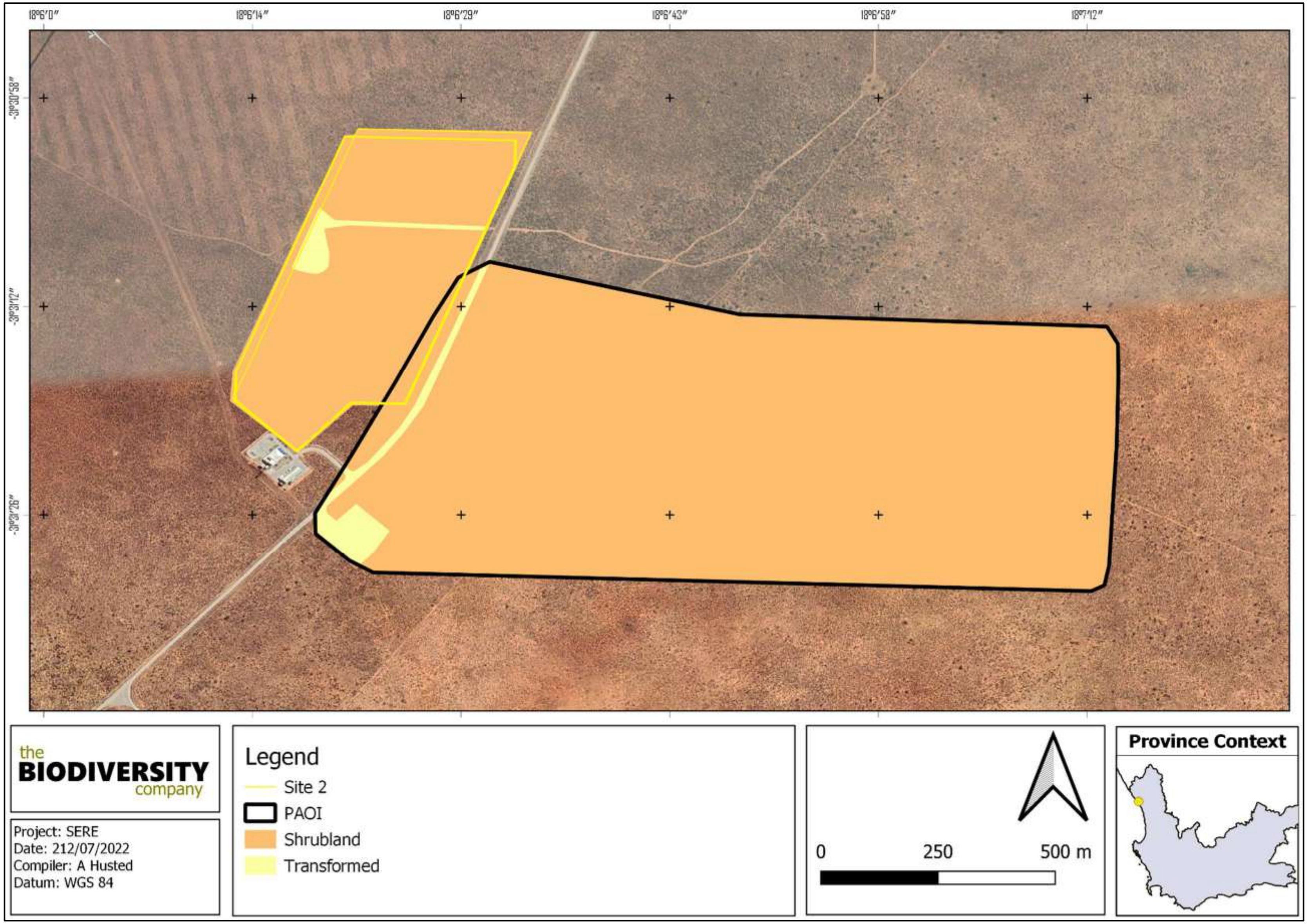



***Figure 7-1 Habitats identified in the project areas.***

### 7.1.1 Namaqua Shrubland

Areas of Namaqualand Sand Fynbos and Namaqualand Inland Duneveld which is intact and with low degree of impacts, has been impacted by some secondary roads, grazing , mismanagement and certain areas have been overgrazed. Even though this habitat is partly disturbed, it supports largely intact vegetation and has a rehabilitation potential. Acts as Corridor for fauna dispersion within the landscape. Acts as buffer for high sensitivity areas. Acts as degraded CBA 1, will recover if left undisturbed (Figure 7-2 and Figure 7-3). The current ecological condition of this habitat with regard to the main driving forces, are intact, which is evident in the amount of, and importance of the species recorded in the flora and faunal assessment, and also to the type of plant species recorded corresponding to the vegetation type as described by Mucina (2006).

This habitat includes areas that are rocky outcrops that occur within the shrubland habitat (Figure 7-4). The habitat is used by faunal species as fine-scale habitats and is important to consider for mitigation actions, especially when an area is potentially cleared for placement of the infrastructure. These habitats can be considered as ecological hotspots being an important habitat for fauna and flora, especially plants as well as reptiles.

These habitats, jointly, is important as a movement corridor as it creates a link between the system and its surrounding terrestrial landscape for several faunal species, especially birds and mammals, and plays a vital role as an ecosystem for biodiversity. These units act as greenlands which supports viable plant species populations and is also used for foraging by fauna. This habitat unit can be regarded as highly important, not only within the local landscape, but also regionally.

***Figure 7-2 Namaqua shrubland***

*Figure 7-3 Namaqua shrubland*

*Figure 7-4 Rocky Outcrop within the Namaqua shrubland*

#### 7.1.2 Transformed

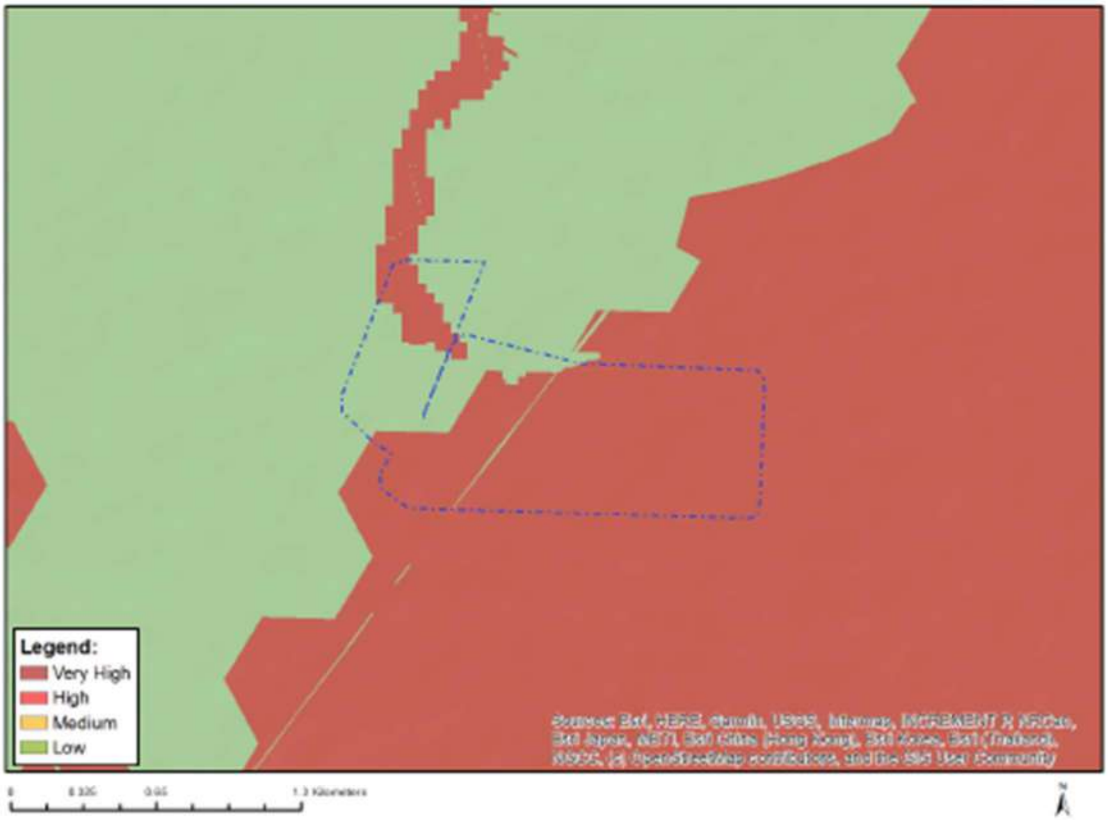
This is the area that has already been altered from their natural state. Transformed areas includes the existing access road that divides the project area and the existing power station.

### 7.2 Site Ecological Importance

The biodiversity theme sensitivity, as indicated in the screening report, was derived to be Very High, mainly due to the project area being within a CBA 1 and an ESA (Figure 7-5). Site 2 was derived to be Very High, mainly due to the southern end of the project area being within a CBA 1 and a central portion being an ESA 2. Both sites considered for the project were similar in species composition when compared with the surrounding vegetation. The interaction with CBA 1 area is considerably less in Site

2, and therefore more favourable. Further to this, the location of the CBA 1 is in proximity to the SERE Wind Farm and Skaapvlei substation, and disturbances (albeit limited) to the CBA 1 area are evident.

**MAP OF RELATIVE TERRESTRIAL BIODIVERSITY THEME SENSITIVITY**




| Very High sensitivity | High sensitivity | Medium sensitivity | Low sensitivity |
|---|---|---|---|
| X | | | |

**Sensitivity Features:**

| Sensitivity | Feature(s) |
|---|---|
| Low | Low Sensitivity |
| Very High | Critical biodiveristy area 1 |
| Very High | Ecological support area 2 |
| Very High | Protected Areas Expansion Strategy |

***Figure 7-5 Terrestrial Biodiversity Theme Sensitivity for both alternatives, National Web based Environmental Screening Tool.***

The location and extent of these habitats are illustrated in Figure 7-1. Based on the criteria provided in Section 4.4 of this report, all habitats within the assessment area of the proposed Site 1 were allocated a sensitivity category. The sensitivities of the habitat types delineated are illustrated in Figure 7-6. 'High Sensitivity' areas are due to the following and the guidelines can be seen in Table 7-1:

- Functional CBA1, NPAES and SKEP.
- Unique, important and low resilience habitats; and
- Protected flora and fauna species were abundant and ubiquitous within the assessment area.

Site 2 was assigned a "Medium Sensitivity" due to the same reasons as above with the exception of the CBA area being in a less intact state (Table 7-2).

***Table 7-1 SEI Summary of habitat types delineated within field assessment area of site 1***

| Habitat | Conservation Importance | Functional Integrity | Biodiversity Importance | Receptor Resilience | Site Ecological Importance |
|---|---|---|---|---|---|
| Namaqua Shrubland | Medium | High | Medium | Low | High |
| Transformed | Low | Very Low | Very Low | Low | Very Low |

***Table 7-2 SEI Summary of habitat types delineated within field assessment area of site 2***

| Habitat | Conservation Importance | Functional Integrity | Biodiversity Importance | Receptor Resilience | Site Ecological Importance |
|---|---|---|---|---|---|
| Namaqua Shrubland | Medium | High | Medium | Medium | Medium |
| Transformed | Low | Very Low | Very Low | Low | Very Low |

***Table 7-3 Guidelines for interpreting Site Ecological Importance in the context of the proposed development activities***

| Site Ecological Importance | Interpretation in relation to proposed development activities |
|---|---|
| High | Avoidance mitigation wherever possible. Minimisation mitigation – changes to project infrastructure design to limit the amount of habitat impacted, limited development activities of low impact acceptable. Offset mitigation may be required for high impact activities. |
| Medium | Minimisation and restoration mitigation – development activities of medium impact acceptable followed by appropriate restoration activities. |
| Very Low | Minimisation mitigation – development activities of medium to high impact acceptable and restoration activities may not be required. |

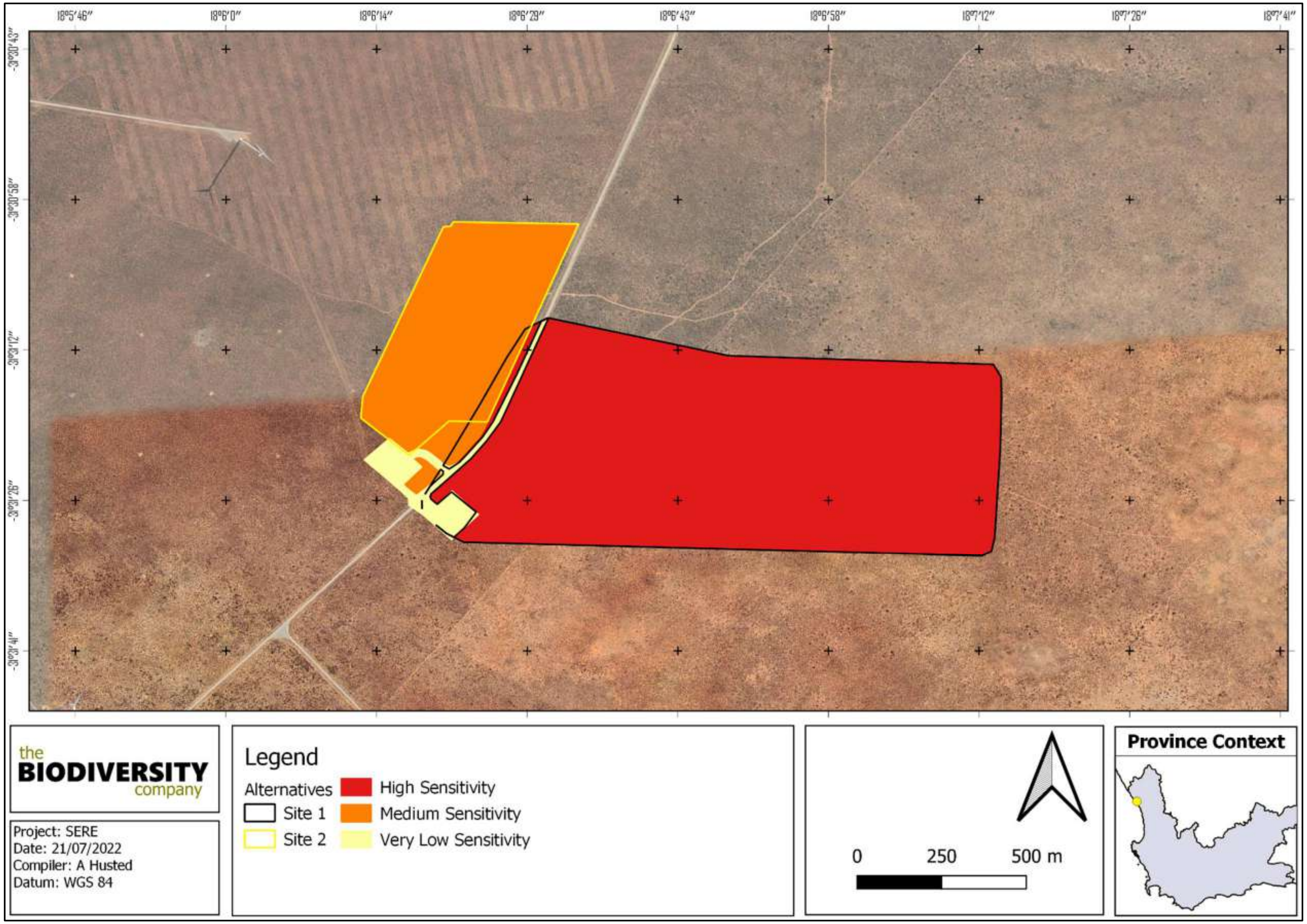



***Figure 7-6*** ***Sensitivity of the project area***

# 8 Impact Risk Assessment

The section below and associated tables serve to indicate and summarise the significance of perceived impacts on the terrestrial ecology of the project area. Potential impacts were evaluated against the data captured during the desktop and field assessment to identify relevance to the project area. The relevant impacts associated with the proposed construction of the development were then subjected to a prescribed impact assessment methodology and is available on request.

## 8.1 Biodiversity Risk Assessment

### 8.1.1 Present Impacts to Biodiversity

Considering the anthropogenic activities and influences within the landscape, very limiting direct negative impacts to biodiversity were observed within the project area. These include:

- Historic mismanagement;
- Farm roads and main roads (and associated traffic and wildlife road mortalities);
- Grazing and trampling of natural vegetation by livestock in certain areas;
- Alien and/or Invasive Plants (IAP); and
- Fences and associated maintenance.

### 8.1.2 Terrestrial Impact Assessment

Potential impacts were evaluated against the data captured during the desktop and field assessments to identify relevance to the project area. The relevant impacts associated with the proposed development were then subjected to a prescribed impact assessment methodology which is available on request.

Anthropogenic activities drive habitat destruction causing displacement of fauna and flora and possibly direct mortality. Land clearing destroys local wildlife habitat and can lead to the loss of local breeding grounds, nesting sites and wildlife movement corridors such as rivers, streams and drainage lines, or other locally important features. The removal of natural vegetation may reduce the habitat available for fauna species and may reduce animal populations and species compositions within the area.

### 8.1.3 Alternatives Considered.

Two project areas were considered.

### 8.1.4 Loss of Irreplaceable Resources

- CBA 1 will be lost, limited encroachment for temporary access road by Site 2. Considerable encroachment into a designated CBA 1 area for Site 1.

### 8.1.5 Anticipated Impacts

The impacts anticipated for the proposed activities are considered in order to predict and quantify these impacts and assess & evaluate the magnitude on the identified terrestrial biodiversity (Table 8-1).

***Table 8-1 Anticipated impacts for the proposed activities on terrestrial biodiversity***

| Main Impact | Project activities that can cause loss/impacts to habitat (especially with regard to the proposed infrastructure areas): | Secondary impacts anticipated |
|---|---|---|
| **1. Destruction, fragmentation and degradation of habitats and ecosystems** | Physical removal of vegetation, including protected species. | Displacement/loss of flora & fauna (including possible SCC) |
| | Access roads and servitudes | Increased potential for soil erosion |

| | | |
|---|---|---|
| | Soil dust precipitation | Habitat fragmentation |
| | Dumping of waste products | Increased potential for establishment of alien & invasive vegetation |
| | Random events such as fire (cooking fires or cigarettes) | Erosion |
| **Main Impact** | **Project activities that can cause the spread and/or establishment of alien and/or invasive species** | **Secondary impacts anticipated** |
| **2. Spread and/or establishment of alien and/or invasive species** | Vegetation removal | Habitat loss for native flora & fauna (including SCC) |
| | Vehicles potentially spreading seed | Spreading of potentially dangerous diseases due to invasive and pest species |
| | Unsanitary conditions surrounding infrastructure promoting the establishment of alien and/or invasive rodents | Alteration of fauna assemblages due to habitat modification |
| | Creation of infrastructure suitable for breeding activities of alien and/or invasive birds | |
| **Main Impact** | **Project activities that can cause direct mortality of fauna** | **Secondary impacts anticipated** |
| **3. Direct mortality of fauna** | Clearing of vegetation | Loss of habitat<br>Loss of ecosystem services |
| | Roadkill due to vehicle collision | Increase in rodent populations and associated disease risk |
| | Pollution of water resources due to dust effects, chemical spills, etc. | |
| | Intentional killing of fauna for food (hunting) | |
| **Main Impact** | **Project activities that can cause reduced dispersal/migration of fauna** | **Secondary impacts anticipated** |
| **4. Reduced dispersal/migration of fauna** | Loss of landscape used as corridor | Reduced dispersal/migration of fauna<br>Loss of ecosystem services |
| | Compacted roads | Reduced plant seed dispersal |
| | Removal of vegetation | |
| **Main Impact** | **Project activities that can cause pollution in watercourses and the surrounding environment** | **Secondary impacts anticipated** |
| **5. Environmental pollution due to water runoff, spills from vehicles and erosion** | Chemical (organic/inorganic) spills | Pollution in watercourses and the surrounding environment |
| | Erosion | Faunal mortality (direct and indirectly)<br>Groundwater pollution<br>Loss of ecosystem services |
| **Main Impact** | **Project activities that can cause disruption/alteration of ecological life cycles due to sensory disturbance.** | **Secondary impacts anticipated** |
| **6.Disruption/alteration of ecological life cycles (breeding, migration, feeding) due to noise, dust and light pollution.** | Operation of machinery (Large earth moving machinery, vehicles) | Disruption/alteration of ecological life cycles due to noise<br>Loss of ecosystem services |
| | Project activities that can cause disruption/alteration of ecological life cycles due to dust | Secondary impacts associated with disruption/alteration of ecological life cycles due to dust |
| | Vehicles | Loss of ecosystem services |
| **Main Impact** | **Project activities that can cause staff to interact directly with potentially dangerous fauna** | **Secondary impacts anticipated** |
| **8. Staff and others interacting directly with fauna (potentially dangerous) or poaching of animals** | All unregulated/supervised activities outdoors | Loss of SCCs |

### 8.1.6 Unplanned Events

The planned activities will have anticipated impacts as discussed; however, unplanned events may occur on any project and may have potential impacts which will need management.

Table 8-2 is a summary of the findings of an unplanned event assessment from a terrestrial ecology perspective. Note, not all potential unplanned events may be captured herein, and this must therefore be managed throughout all phases according to recorded events.

***Table 8-2 Summary of unplanned events for terrestrial biodiversity***

| Unplanned Event | Potential Impact | Mitigation |
|---|---|---|
| **Spills into the surrounding environment** | Contamination of habitat as well as water resources associated with a spillage. | A spill response kit must be available at all times. The incident must be reported on and if necessary, a biodiversity specialist must investigate the extent of the impact and provide rehabilitation recommendations. |
| **Fire** | Uncontrolled/unmanaged fire that spreads to the surrounding natural Bushveld and ridge. | Appropriate/Adequate fire management plan need to be implemented. |
| **Erosion caused by water runoff from the surface** | Erosion on the side of the road | Storm water management plan must be compiled and implemented. |

### 8.1.7 Identification of Additional Potential Impacts of Site 1

#### 8.1.7.1 Assessment of Impact Significance

The assessment of impact significance considers pre-mitigation as well as implemented of post-mitigation scenarios. The mitigation actions required to lower the risk of the impact are provided in Section 8.1.8 of this report.

Photovoltaic panels (PV) are a form of renewable energy that has a lower effect on wildlife as it does not have mechanically moving parts, is quiet and does not result in ground water pollution. The installation of PV sites requires the removal of all vegetation in order to reduce the risk of fire.

#### 8.1.7.2 Construction Phase

The following potential main impacts on the biodiversity (based on the framework above) were considered for the construction phase of the proposed development. This phase refers to the period during construction when the proposed features are constructed; and is considered to have the largest direct impact on biodiversity. The main anticipated impact includes the clearing of vegetation, thus will ultimately lead to the loss of CBA 1, proliferation of alien plant species along the roads and cleared areas as well as the severing of movement corridors for fauna, loss of fauna and flora SCCs and the fragmentation of habitat. The following potential impacts to terrestrial biodiversity were considered:

- Destruction, further loss and fragmentation of the of habitats, ecosystems and vegetation community;
- Introduction of alien species, especially plants;
- Destruction of protected plant species;
- Displacement of faunal community due to habitat loss, direct mortalities and disturbance (road collisions, noise, dust, vibration and poaching); and
- Chemical pollution associated with dust suppressants (if used).

#### 8.1.7.3 Operation Phase

The operational phase of the impact of daily activities is anticipated to further spread the IAP, as well as the deterioration of the habitats due to the increase of dust and edge effect impacts. Dust reduces the ability of plants to photosynthesize and thus leads to degradation/retrogression of the veld. Moving maintenance and mining vehicles do not only cause sensory disturbances to fauna, affecting their life cycles and movement, but will lead to direct mortalities due to collisions. The use of non-environmentally friendly chemical for the cleaning of the PV panels can lead to the pollution of water sources and ultimately death of fauna and flora.

The following potential impacts were considered:

- Continued fragmentation and degradation of habitats and ecosystems ;
- Spread of alien and/or invasive species; and
- Ongoing displacement and direct mortalities of faunal community due to disturbance (road collisions, collisions with substation, noise, light, dust, vibration).
- Chemical pollution associated with measures to keep PV clean.

##### 8.1.7.3.1 Assessment of Significance

The assessment of impact significance considers pre-mitigation as well as implemented of post-mitigation scenarios.

###### 8.1.7.3.1.1 Construction Phase

Table 8-3 summarises the significance of potential impacts associated project on fauna and flora before and after implementation of mitigation measures. The loss of habitat and the degradation of habitat were rated as ‘High’ prior to mitigations. Through the implementation of mitigations such as the restriction and demarcation of the project footprint this can only be lowered to ‘Moderately High’, it can however not be mitigated completely as habitat will still be lost.

###### 8.1.7.3.1.2 Operational Phase

Table 8-4 summarises the significance of the operational phase impacts on biodiversity before and after implementation of mitigation measures. The continued loss of habitat and the degradation of habitats within the area were rated as ‘High’ prior to mitigations. Through the implementation of mitigations such as dust control this can only be lowered to ‘Moderately High’, it can however not be mitigated completely as habitats surrounding the area is inherently sensitive. The impact significance of displacement and direct mortalities of fauna were rated as ‘Moderately High’ prior to mitigation for the project. Implementation of mitigation measures reduced the significance of the impact to a ‘Low’ level.

*Table 8-3 Assessment of significance of potential impacts on the terrestrial fauna and flora associated with the construction phase*

| Impact | Prior to mitigation | | | | | | Post mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance |
| | 5 | 3 | 4 | 4 | 5 | | 4 | 2 | 3 | 4 | 4 | |
| **Destruction, fragmentation and degradation of habitats, and ecosystems** | Permanent | Local area/ within 1 km of the site boundary / < 5000ha impacted / | Great / harmful/ ecosystem structure and function largely altered | Ecology highly sensitive /important | Definite | **High** | Life of operation or less than 20 years: Long Term | Development specific/ within the site boundary / < 100 ha impacted / | Significant / ecosystem structure and function moderately altered | Ecology highly sensitive /important | Highly likely | **Moderately High** |
| | 4 | 3 | 3 | 4 | 4 | | 3 | 2 | 2 | 2 | 3 | |
| **Spread and/or establishment of alien and/or invasive species** | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted | Significant / ecosystem structure and function moderately altered | Ecology highly sensitive /important | Highly likely | **Moderately High** | One year to five years: Medium Term | Development specific/ within the site boundary / < 100 ha impacted | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |
| | 5 | 3 | 3 | 3 | 4 | | 2 | 2 | 2 | 2 | 3 | |
| **Destruction of protected plant species** | Permanent | Local area/ within 1 km of the site boundary / < 5000ha impacted | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Highly likely | **Moderately High** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |
| | 4 | 3 | 3 | 4 | 4 | | 2 | 2 | 2 | 4 | 3 | |
| **Displacement of faunal community (Including several SCC) due to habitat loss, direct mortalities and disturbance (road collisions, noise, light, dust, vibration);** | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted | Significant / ecosystem structure and function moderately altered | Ecology highly sensitive /important | Highly likely | **Moderately High** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / | Small / ecosystem structure and function largely unchanged | Ecology highly sensitive /important | Likely | **Low** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4 | 4 | 4 | 3 | 4 | | 2 | 2 | 2 | 2 | 1 | |
| **Chemical pollution associated with dust suppressants** | Life of operation or less than 20 years: Long Term | Regional within 5 km of the site boundary / < 2000ha impacted | Great / harmful/ ecosystem structure and function largely altered | Ecology moderately sensitive/ /important | Highly likely | **Moderately High** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Highly unlikely | **Absent** |

*Table 8-4 Assessment of significance of potential impacts on terrestrial fauna and flora associated with the operational phase*

| | Prior to mitigation | | | | | | Post mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Impact** | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance |
| | 5 | 3 | 4 | 4 | 4 | | 4 | 3 | 3 | 3 | 3 | |
| **Continued fragmentation and degradation of habitats and ecosystems** | Permanent | Local area/ within 1 km of the site boundary / < 5000ha impacted / | Great / harmful/ ecosystem structure and function largely altered | Ecology highly sensitive /important | Highly likely | **Moderately High** | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Likely | **Moderate** |
| | 4 | 3 | 3 | 4 | 3 | | 2 | 2 | 2 | 2 | 3 | |
| **Spread and/or establishment of alien and/or invasive species** | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / | Significant / ecosystem structure and function moderately altered | Ecology highly sensitive /important | Likely | **Moderate** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |
| | 4 | 3 | 3 | 4 | 3 | | 3 | 2 | 2 | 2 | 2 | |
| **Displacement and direct mortalities of faunal community (including SCC) due to disturbance (road collisions, collisions with substation, noise, light, dust, vibration)** | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / | Significant / ecosystem structure and function moderately altered | Ecology highly sensitive /important | Likely | **Moderate** | One year to five years: Medium Term | Development specific/ within the site boundary / < 100 ha impacted | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Possible | **Low** |
| | 4 | 3 | 3 | 4 | 3 | | 2 | 2 | 2 | 2 | 3 | |
| **Chemical pollution associated with measures to keep PV clean** | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / | Significant / ecosystem structure and function moderately altered | Ecology highly sensitive /important | Likely | **Moderate** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |

### 8.1.8 Identification of Additional Potential Impacts of Site 2

#### 8.1.8.1 Assessment of Impact Significance

The assessment of impact significance considers pre-mitigation as well as implemented of post-mitigation scenarios. The mitigation actions required to lower the risk of the impact are provided in Section 8.1.8 of this report.

#### 8.1.8.2 Construction Phase

The following potential main impacts on the biodiversity (based on the framework above) were considered for the construction phase of the proposed development. This phase refers to the period during construction when the proposed features are constructed; and is considered to have the largest direct impact on biodiversity. The main anticipated impact includes the clearing of vegetation, thus will ultimately lead to the loss of CBA 1, proliferation of alien plant species along the roads and cleared areas as well as the severing of movement corridors for fauna, loss of fauna and flora SCCs and the fragmentation of habitat. The following potential impacts to terrestrial biodiversity were considered:

- Destruction, further loss and fragmentation of the of habitats, ecosystems and vegetation community;
- Introduction of alien species, especially plants;
- Destruction of protected plant species;
- Displacement of faunal community due to habitat loss, direct mortalities, and disturbance (road collisions, noise, dust, vibration and poaching); and
- Chemical pollution associated with dust suppressants.

#### 8.1.8.3 Operation Phase

The operational phase of the impact of daily activities is anticipated to further spread the IAP, as well as the deterioration of the habitats due to the increase of dust and edge effect impacts. Dust reduces the ability of plants to photosynthesize and thus leads to degradation/retrogression of the veld. Moving maintenance and mining vehicles do not only cause sensory disturbances to fauna, affecting their life cycles and movement, but will lead to direct mortalities due to collisions. The use of non-environmentally friendly chemical for the cleaning of the PV panels can lead to the pollution of water sources and ultimately death of fauna and flora.

The following potential impacts were considered:

- Continued fragmentation and degradation of habitats and ecosystems ;
- Spread of alien and/or invasive species; and
- Ongoing displacement and direct mortalities of faunal community due to disturbance (road collisions, collisions with substation, noise, light, dust, vibration).
- Chemical pollution associated with measures to keep PV clean.

##### 8.1.8.3.1 Assessment of Significance

The assessment of impact significance considers pre-mitigation as well as implemented of post-mitigation scenarios.

#### 8.1.8.3.1.1 Construction Phase

Table 8-3 summarises the significance of potential impacts associated project on fauna and flora before and after implementation of mitigation measures. The loss of habitat and the degradation of habitat were rated as 'Moderately High' prior to mitigations. Through the implementation of mitigations such as the restriction and demarcation of the project footprint this can only be lowered to 'Moderately', it can however not be mitigated completely as habitat will still be lost. The habitat and vegetation type recorded are not restricted or endangered and is well represented in the general area.

#### 8.1.8.3.1.2 Operational Phase

Table 8-4 summarises the significance of the operational phase impacts on biodiversity before and after implementation of mitigation measures. The continued loss of habitat and the degradation of habitats within the area were rated as 'Moderately High' prior to mitigations. Through the implementation of mitigations such as dust control this can only be lowered to 'Moderately', it can however not be mitigated completely as habitats surrounding the area is inherently sensitive. The impact significance of displacement and direct mortalities of fauna were rated as 'Moderately' prior to mitigation for the project. Implementation of mitigation measures reduced the significance of the impact to a 'Low' level.

***Table 8-5 Assessment of significance of potential impacts on the terrestrial fauna and flora associated with the construction phase***

| Impact | Prior to mitigation | | | | | | Post mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance |
| Destruction, fragmentation and degradation of habitats, and ecosystems | 5 | 3 | 4 | 3 | 5 | | 4 | 2 | 3 | 4 | 4 | |
| | Permanent | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Great / harmful/ ecosystem structure and function largely altered | Ecology moderately sensitive/ /important | Definite | **Moderately High** | Life of operation or less than 20 years: Long Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Significant / ecosystem structure and function moderately altered | Ecology highly sensitive /important | Highly likely | **Moderate** |
| Spread and/or establishment of alien and/or invasive species | 4 | 3 | 3 | 4 | 4 | | 3 | 2 | 2 | 2 | 3 | |
| | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology highly sensitive /important | Highly likely | **Moderately High** | One year to five years: Medium Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |
| Displacement of faunal community (Including possible SCC) due to habitat loss, direct mortalities and | 3 | 3 | 3 | 5 | 5 | | 2 | 2 | 2 | 5 | 3 | |
| | One year to five years: Medium Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / | Significant / ecosystem structure and function moderately altered | Ecology critically sensitive /important | Definite | **Moderately High** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha | Small / ecosystem structure and function | Ecology critically sensitive /important | Likely | **Low** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| disturbance (road collisions, noise, light, dust, vibration); | | Linear features affected < 1000m | | | | | | impacted / Linear features affected < 100m | largely unchanged | | | |
| Mortalities and displacements of fauna and flora SCCs. | 5 | 3 | 3 | 3 | 4 | | 2 | 2 | 2 | 2 | 3 | |
| | Permanent | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Highly likely | **Moderately High** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |
| Chemical pollution associated with dust suppressants | 4 | 4 | 4 | 3 | 4 | | 2 | 2 | 2 | 2 | 2 | |
| | Life of operation or less than 20 years: Long Term | Regional within 5 km of the site boundary / < 2000ha impacted / Linear features affected < 3000m | Great / harmful/ ecosystem structure and function largely altered | Ecology moderately sensitive/ /important | Highly likely | **Moderately High** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Possible | **Absent** |

***Table 8-6 Assessment of significance of potential impacts on terrestrial fauna and flora associated with the operational phase***

| Impact | Prior to mitigation | | | | | | Post mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance |
| Continued fragmentation and degradation of habitats and ecosystems | 5 | 3 | 4 | 4 | 4 | | 4 | 3 | 3 | 4 | 3 | |
| | Permanent | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Great / harmful/ ecosystem structure and function largely altered | Ecology highly sensitive /important | Highly likely | **Moderately High** | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology highly sensitive /important | Likely | **Moderate** |
| Spread and/or establishment of alien and/or invasive species | 4 | 3 | 3 | 4 | 3 | | 2 | 2 | 2 | 4 | 3 | |
| | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology highly sensitive /important | Likely | **Moderate** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology highly sensitive /important | Likely | **Low** |
| Displacement and direct mortalities of faunal community (including SCC) due to disturbance (road collisions, collisions with | 4 | 3 | 3 | 4 | 3 | | 3 | 2 | 2 | 3 | 2 | |
| | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features | Significant / ecosystem structure and function moderately altered | Ecology highly sensitive /important | Likely | **Moderate** | One year to five years: Medium Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features | Small / ecosystem structure and function largely unchanged | Ecology moderately sensitive/ /important | Possible | **Low** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| substation, noise, light, dust, vibration) | | affected < 1000m | | | | | | affected < 100m | | | | |
| Reduced dispersal of fauna | 4 | 3 | 3 | 4 | 3 | | 2 | 2 | 2 | 2 | 3 | |
| | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology highly sensitive /important | Likely | **Moderate** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |
| Chemical pollution associated with measures to keep PV clean | 4 | 3 | 3 | 4 | 3 | | 2 | 2 | 2 | 2 | 3 | |
| | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology highly sensitive /important | Likely | **Moderate** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |
| Fencing of PV site | 4 | 3 | 3 | 4 | 3 | | 2 | 2 | 2 | 2 | 3 | |
| | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology highly sensitive /important | Likely | **Moderate** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |

#### 8.1.8.4 Cumulative Impacts

Cumulative impacts are assessed in context of the extent of the proposed project area; other developments in the area; and general habitat loss and transformation resulting from other activities in the area.

The impacts of projects are often assessed by comparing the post-project situation to a pre-existing baseline. Where projects can be considered in isolation this provides a good method of assessing a project's impact. However, in areas where baselines have already been affected, or where future development will continue to add to the impacts in an area or region, it is appropriate to consider the cumulative effects of development. This is similar to the concept of shifting baselines, which describes how the environmental baseline at a point in time may represent a significant change from the original state of the system. This section describes the potential impacts of the project that are cumulative for fauna and flora.

Localised cumulative impacts include the cumulative effects from operations that are close enough to potentially cause additive effects on the environment or sensitive receivers (such as nearby renewable energy or PV activities within the area). These include dust deposition, noise and vibration, disruption of corridors or habitat, groundwater drawdown, groundwater and surface water quality, and transport.

Long-term cumulative impacts due to extensive solar farm footprint, powerlines and substations can lead to the loss of endemic species and threatened species, loss of habitat and vegetation types and even degradation of well conserved areas. The PV panels and associated infrastructure are expected to have a moderate cumulative impact, due to the wind farm and existing substations in the area. Cumulatively these developments will be responsible for the destruction of a large portion of shrubland in the area.

#### 8.1.9 Biodiversity Management Plan

The aim of the management outcomes is to present the mitigations in such a way that the can be incorporated into the Environmental Management Programme (EMPr), allowing for more successful implementation and auditing of the mitigations and monitoring guidelines Table 8-7 presents the recommended mitigation measures and the respective timeframes, targets and performance indicators for the terrestrial study. The management plan is relevant to both areas, with the exception of the highly sensitive area that must be seen as no go areas which is only relevant to Site 1.

The focus of mitigation measures is to reduce the significance of potential impacts associated with the development and thereby to:

- Prevent the further loss and fragmentation of vegetation communities and the CBA areas in the vicinity of the project area;
- As far as possible, reduce the negative fragmentation effects of the development and enable safe movement of faunal species;
- Prevent the direct and indirect loss and disturbance of faunal species and community (including occurring and potentially occurring species of conservation concern); and
- Follow the guidelines for interpreting Site Ecological Importance (SEI).

***Table 8-7 Mitigation measures including requirements for timeframes, roles and responsibilities for the terrestrial study***

| Impact Management Actions | Implementation | | Monitoring | |
|---|---|---|---|---|
| | Phase | Responsible Party | Aspect | Frequency |
| **Management outcome: Vegetation and Habitats** | | | | |
| Areas rated as High sensitivity within Site 1, should be declared as 'no-go' areas. | Construction Phase | Project manager, Environmental Officer | Development footprint | Ongoing |
| Areas of indigenous vegetation, even secondary communities outside of the direct project footprint, should under no circumstances be fragmented or disturbed further. Clearing of vegetation should be minimized and avoided where possible. All activities must be restricted too within the low/medium sensitivity areas. No further loss of very high/high sensitivity areas should be permitted. It is recommended that areas to be developed be specifically demarcated so that during the construction phase, only the demarcated areas be impacted upon. | Life of operation | Project manager, Environmental Officer | Areas of indigenous vegetation | Ongoing |
| Existing access routes, especially roads must be made use of. | Construction/Operational Phase | Environmental Officer & Design Engineer | Roads and paths used | Ongoing |
| All laydown, chemical toilets etc. should be restricted to medium sensitivity areas. Any materials may not be stored for extended periods of time and must be removed from the project area once the construction phase has been concluded. No permanent construction phase structures should be permitted. Construction buildings should preferably be prefabricated or constructed of re-usable/recyclable materials. No storage of vehicles or equipment will be allowed outside of the designated project areas. | Construction/Operational Phase | Environmental Officer & Design Engineer | Laydown areas | Ongoing |
| Areas that are denuded during construction need to be re-vegetated with indigenous vegetation to prevent erosion during flood and wind events. This will also reduce the likelihood of encroachment by alien invasive plant species. All livestock must always be kept out of the project area, especially areas that have been recently re-planted | Operational phase | Environmental Officer & Contractor | Assess the state of rehabilitation and encroachment of alien vegetation | Quarterly for up to two years after the closure |
| A hydrocarbon spill management plan must be put in place to ensure that should there be any chemical spill out or over that it does not run into the surrounding areas. The Contractor shall be in possession of an emergency spill kit that must always be complete and available on site. Drip trays or any form of oil absorbent material must be placed underneath vehicles/machinery and equipment when not in use. No servicing of equipment on site unless necessary. All contaminated soil / yard stone shall be treated in situ or removed and be placed in containers. Appropriately contain any generator diesel storage tanks, machinery spills (e.g. accidental spills of hydrocarbons oils, diesel etc.) in such a way as to prevent them leaking and entering the environment. Construction activities and vehicles could cause spillages of lubricants, fuels and waste material potentially | Life of operation | Environmental Officer & Contractor | Spill events, Vehicles dripping. | Ongoing |

| | | | | |
|---|---|---|---|---|
| negatively affecting the functioning of the ecosystem. All vehicles and equipment must be maintained, and all re-fuelling and servicing of equipment is to take place in demarcated areas outside of the project area. | | | | |
| It should be made an offence for any staff to take/ bring any plant species into/out of any portion of the project area. No plant species whether indigenous or exotic should be brought into/taken from the project area, to prevent the spread of exotic or invasive species or the illegal collection of plants. | Life of operation | Project manager, Environmental Officer | Any instances | Ongoing |
| A fire management plan needs to be complied and implemented to restrict the impact fire might have on the surrounding areas. | Life of operation | Environmental Officer & Contractor | Fire Management | During Phase |
| Any individual of the protected plants that are present needs a relocation or destruction permit in order for any individual that may be removed or destroyed due to the development. Hi visibility flags must be placed near any threatened/protected plants in order to avoid any damage or destruction of the species. If left undisturbed the sensitivity and importance of these species needs to be part of the environmental awareness program. Infrastructure, development areas and routes where protected plants cannot be avoided, these plants many being geophytes or small succulents should be removed from the soil and relocated/ re-planted in similar habitats where they should be able to resprout and flourish again. All protected and red-data plants should be relocated, and as many other geophytic species as possible. | Life of operation | Project manager, Environmental Officer | Protected Tree/Plant species | Ongoing |
| A pre-construction survey in the flowering season (July-September) should be conducted in order to ensure that a more comprehensive floral presence confirmation. For the threatened species that may not be destroyed, it is recommended that professional service providers that deal with plant search and rescue be used to remove such plants and use them either for later rehabilitation work other conservation projects. | Planning Phase, Pre-Construction | Project manager, Environmental Officer & Contractor | Flora species | During Phase |

| **Management outcome: Fauna** | | | | |
|---|---|---|---|---|
| **Impact Management Actions** | **Implementation** | | **Monitoring** | |
| | Phase | Responsible Party | Aspect | Frequency |
| A qualified environmental control officer must be on site when construction begins. A site walk through is recommended by a suitably qualified ecologist prior to any construction activities, preferably during the wet season and any SSC should be noted. In situations where the threatened and protected plants must be removed, the proponent may only do so after the required permission/permits have been obtained in accordance with national and provincial legislation. In the abovementioned situation the development of a search, rescue and recovery program is suggested for the protection of these species. Should animals not move out of the area on their own relevant specialists must be contacted to advise on how the species can be relocated | Construction Phase | Environmental Officer, Contractor | Presence of any floral or faunal species. | During phase |

| | | | | |
|---|---|---|---|---|
| The areas to be developed must be specifically demarcated to prevent movement of staff or any individual into the surrounding environments,<br>• Signs must be put up to enforce this | Construction/Operational Phase | Project manager, Environmental Officer | Infringement into these areas | Ongoing |
| The duration of the construction should be minimized to as short term as possible, to reduce the period of disturbance on fauna. | Construction | Project manager, Environmental Officer & Design Engineer | Construction/Closure Phase | Ongoing |
| Noise must be kept to an absolute minimum during the evenings and at night to minimize all possible disturbances to amphibian species and nocturnal mammals | Construction/Operational Phase | Environmental Officer | Noise levels | Ongoing |
| No trapping, killing, or poisoning of any wildlife is to be allowed<br>• Signs must be put up to enforce this; | Life of operation | Environmental Officer | Evidence of trapping etc | Ongoing |
| Outside lighting should be designed and limited to minimize impacts on fauna. All outside lighting should be directed away from highly sensitive areas. Fluorescent and mercury vapor lighting should be avoided and sodium vapor (green/red) lights should be used wherever possible. | Construction/Operational Phase | Project manager, Environmental Officer & Design Engineer | Light pollution and period of light. | Ongoing |
| Try incorporating motion detection lights as much as possible to reduce the duration of illumination. Heights of light columns to be minimised to reduce light spill. Baffles, hoods or louvres to also be used to reduce light spill | Construction Phase | Environmental Officer & Design Engineer | Light pollution | Ongoing |
| All construction and maintenance motor vehicle operators should undergo an environmental induction that includes instruction on the need to comply with speed limits, to respect all forms of wildlife. Speed limits must still be enforced to ensure that road killings and erosion is limited. | Life of operation | Health and Safety Officer | Compliance to the training. | Ongoing |
| Schedule activities and operations during least sensitive periods, to avoid migration, nesting and breeding seasons. | Life of operation | Project manager, Environmental Officer & Design Engineer | Activities should take place during the day in the case. | Ongoing |
| All areas to be developed must be walked through prior to any activity to ensure no nests or fauna species are found in the area. Should any Species of Conservation Concern not move out of the area or their nest be found in the area a suitably qualified specialist must be consulted to advise on the correct actions to be taken. | Construction and Operational phase | Project manager, Environmental Officer | Presence of Nests and faunal species | Planning, Construction and Rehabilitation |
| Any holes/deep excavations must be dug and planted in a progressive manner and shouldn't be left open overnight;<br>• Should the holes overnight they must be covered temporarily to ensure no small fauna species fall in. | Planning and Construction | Environmental Officer & Contractor, Engineer | Presence of trapped animals and open holes | Ongoing |
| Ensure that cables and connections are insulated successfully to reduce electrocution risk. | Life of project | Environmental Officer & Contractor, Engineer | Presence of electrocuted fauna | Ongoing |
| Any exposed parts must be covered (insulated) to reduce electrocution risk. | Life of project | Environmental Officer & Contractor, Engineer | Presence of electrocuted fauna | Ongoing |
| Heat generated from the substations must be monitored to ensure it does not negatively affect the local fauna | Life of operation | Environmental Officer & Contractor | Heat generated by substations | Ongoing |
| Use environmentally friendly cleaning and dust suppressant products | Construction and operation | Environmental Officer & Contractor, Engineer | Presence of chemicals in and around the project area | Ongoing |

| | | | | |
|---|---|---|---|---|
| Fencing mitigations:<br>• Top 2 strands must be smooth wire<br>• Routinely retention loose wires<br>• Minimum 30cm between wires<br>• Place markers on fences | Planning, construction and operation | Environmental Officer & Contractor, Engineer | Monitor fences for slack wires | Ongoing |
| **Management outcome: Alien species** | | | | |
| **Impact Management Actions** | **Implementation** | | **Monitoring** | |
| | Phase | Responsible Party | Aspect | Frequency |
| Compilation of and implementation of an alien vegetation management plan. | Life of operation | Project manager, Environmental Officer & Contractor | Assess presence and encroachment of alien vegetation | Twice a year |
| The footprint area of the construction should be kept to a minimum. The footprint area must be clearly demarcated to avoid unnecessary disturbances to adjacent areas. Footprint of the roads must be kept to prescribed widths. | Construction/Operational Phase | Project manager, Environmental Officer & Contractor | Footprint Area | Life of operation |
| Waste management must be a priority and all waste must be collected and stored adequately. It is recommended that all waste be removed from site on a weekly basis to prevent rodents and pests entering the site | Life of operation | Environmental Officer & Health and Safety Officer | Presence of waste | Life of operation |
| A pest control plan must be put in place and implemented; it is imperative that poisons not be used due to the likely presence of SCCs | Life of operation | Environmental Officer & Health and Safety Officer | Evidence or presence of pests | Life of operation |
| **Management outcome: Dust** | | | | |
| **Impact Management Actions** | **Implementation** | | **Monitoring** | |
| | Phase | Responsible Party | Aspect | Frequency |
| Dust-reducing mitigation measures must be put in place and must be strictly adhered to. This includes wetting of exposed soft soil surfaces.<br>• No non environmentally friendly suppressants may be used as this could result in pollution of water sources | Life of operation | Contractor | Dustfall | Dust monitoring program. |
| **Management outcome: Waste management** | | | | |
| **Impact Management Actions** | **Implementation** | | **Monitoring** | |
| | Phase | Responsible Party | Aspect | Frequency |
| Waste management must be a priority and all waste must be collected and stored effectively. | Life of operation | Environmental Officer & Contractor | Waste Removal | Weekly |
| Litter, spills, fuels, chemicals and human waste in and around the project area. | Construction/Closure Phase | Environmental Officer & Health and Safety Officer | Presence of Waste | Daily |

| | | | | |
|---|---|---|---|---|
| A minimum of one toilet must be provided per 10 persons. Portable toilets must be pumped dry to ensure the system does not degrade over time and spill into the surrounding area. | Life of operation | Environmental Officer & Health and Safety Officer | Number of toilets per staff member. Waste levels | Daily |
| The Contractor should supply sealable and properly marked domestic waste collection bins and all solid waste collected shall be disposed of at a licensed disposal facility | Life of operation | Environmental Officer & Health and Safety Officer | Availability of bins and the collection of the waste. | Ongoing |
| Where a registered disposal facility is not available close to the project area, the Contractor shall provide a method statement with regard to waste management. Under no circumstances may domestic waste be burned on site | Life of operation | Environmental Officer, Contractor & Health and Safety Officer | Collection/handling of the waste. | Ongoing |
| Refuse bins will be emptied and secured Temporary storage of domestic waste shall be in covered waste skips. Maximum domestic waste storage period will be 10 days. | Life of operation | Environmental Officer, Contractor & Health and Safety Officer | Management of bins and collection of waste | Ongoing, every 10 days |

**Management outcome: Environmental awareness training**

| Impact Management Actions | Implementation | | Monitoring | |
|---|---|---|---|---|
| | Phase | Responsible Party | Aspect | Frequency |
| All personnel and contractors to undergo Environmental Awareness Training. A signed register of attendance must be kept for proof. Discussions are required on sensitive environmental receptors within the project area to inform contractors and site staff of the presence of Red / Orange List species, their identification, conservation status and importance, biology, habitat requirements and management requirements the Environmental Authorisation and within the EMPr. The avoidance and protection of the wetland areas must be included into a site induction. Contractors and employees must all undergo the induction and made aware of the "no-go" to be avoided. | Life of operation | Health and Safety Officer | Compliance to the training. | Ongoing |

**Management outcome: Erosion**

| Impact Management Actions | Implementation | | Monitoring | |
|---|---|---|---|---|
| | Phase | Responsible Party | Aspect | Frequency |
| Speed limits must be put in place to reduce erosion.<br>• Reducing the dust generated by the listed activities above, especially the earth moving machinery, through wetting the soil surface and putting up signs to enforce speed limit as well as speed bumps built to force slow speeds;<br>• Signs must be put up to enforce this. | Life of operation | Project manager, Environmental Officer | Water Runoff from road surfaces | Ongoing |
| Where possible, existing access routes and walking paths must be made use of. | Life of operation | Project manager, Environmental Officer | Routes used within the area | Ongoing |

| | | | | |
|---|---|---|---|---|
| Areas that are denuded during construction need to be re-vegetated with indigenous vegetation to prevent erosion during flood events and strong winds. | Life of operation | Project manager, Environmental Officer | Re-establishment of indigenous vegetation | Progressively |
| A stormwater management plan must be compiled and implemented. | Life of operation | Project manager, Environmental Officer | Management plan | Before construction phase: Ongoing |

# 9 Conclusion and Impact Statement

## 9.1 Conclusion

The completion of a comprehensive desktop study, in conjunction with the results from the field survey, suggest there is a good confidence in the information provided. The surveys ensured that there were suitable groundtruth coverage of the assessment areas and most habitats and ecosystems were assessed to obtain a general species (fauna and flora) overview and the major current impacts were observed. The conservation status is classified as Least Concern albeit the protection level is regarded as 'Poorly Protected' Ecosystem. Moreover, the proposed activity overlaps with a CBA1, ESA, NPAES and SKEP.

The current layout of site 1 overlaps within sensitive habitats and other areas of high biodiversity potential and is expected to have a significant and high negative impact as it would directly affect the habitat of threatened/protected plant species and expected listed faunal species that use these ecosystems.

The habitat existence and importance of these habitats is regarded as crucial, due to the species recorded as well as the role of this intact unique habitat to biodiversity within the local landscape, not to mention the sensitivity according to various ecological datasets.

The high sensitivity terrestrial areas found in Site 1 still:

- Serve as and represent CBA 1 and ESA as per the Conservation Plan;
- Forms part of NPAES and SKEP;
- Supports and protects fauna and flora (including protected species); and
- Support various organisms and may play a more important role in the ecosystem if left to recover from the superficial impacts.

Any development on the high sensitivity areas will lead the direct destruction and loss of portions of functional CBA, and also the floral and faunal species that are expected to utilise this habitat. Thus, if these areas are not maintained in a natural or near natural state, destroyed or fragmented, then meeting targets for biodiversity features will not be achieved.

Both sites considered for the project were similar in species composition when compared with the surrounding vegetation. The interaction with CBA 1 area is considerably less in Site 2, and therefore the development of Site 2 is more favourable. Further to this, the location of the CBA 1 is in proximity to the SERE Wind Farm and Skaapvlei substation, and disturbances (albeit limited) to the CBA 1 area are evident. Thus it can be said that Site 2 is the preferred option.

The mitigations, management and associated monitoring regarding these operational impacts will be the most important factor of this project and must be considered by the issuing authority.

## 9.2 Impact Statement

The main expected impacts of the proposed infrastructure will include the following:

- habitat loss and fragmentation;
- degradation of surrounding habitat;
- disturbance and displacement caused during the construction and maintenance phases; and
- direct mortality during the construction phase.

Mitigation measures as described in this report can be implemented to achieve an average moderately-low residual impact. CBA 1 areas are found within both the project areas. The portion of CBA 1 area within Site 2 does display signs of disturbance due to the adjacent infrastructure. Development in this area is considered acceptable, however, because of the intact state of the CBA in Site 1 the area must remain undeveloped and managed accordingly.

Considering the above-mentioned information, no fatal flaws are evident for the proposed project. It is the opinion of the specialists that the project location (Site 2), may be favourably considered on condition that all prescribed mitigation measures and supporting recommendations are implemented.

## 10 References

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 Reptiles of South Africa, Lesotho and Swaziland. Suricata 1. South African Biodiversity Institute, Pretoria.

BGIS (Biodiversity GIS). (2017). http://bgis.sanbi.org/

BODATSA-POSA. (2021). Plants of South Africa - an online checklist. POSA ver. 3.0. http://newposa.sanbi.org/.

Boycott, R. and Bourquin, R. 2000. The Southern African Tortoise Book – A Guide to Southern African Tortoises, Terrapins and Turtles. Revised Edition. Hilton. 228 pages.

Branch, W.R. (1998). Field Guide to Snakes and Other Reptiles of Southern Africa. Struik, Cape Town.

Du Preez, L. & Carruthers, V. (2009) A Complete Guide to the Frogs of Southern Africa. Struik Nature, Cape Town.

EWT. (2016). Mammal Red List 2016. www.ewt.org.za

Fish, L., Mashau, A.C., Moeaha, M.J. & Nembudani, M.T. (2015). Identification Guide to Southern African Grasses: An Identification Manual with Keys, Descriptions, and Distributions. SANBI, Pretoria.

IUCN. (2021). The IUCN Red List of Threatened Species. www.iucnredlist.org

Johnson, S. & Bytebier, B. (2015). Orchids of South Africa: A Field Guide. Struik publishers, Cape Town.

Mouton, P. Le F. N (2008). Proposed Wind energy facility and associated infrastructure: Terrestrial Fauna. Eskom

Mucina, L. & Rutherford, M.C. (Eds.). 2006. The vegetation of South Africa, Lesotho and Swaziland. Strelizia 19. South African National Biodiversity Institute, Pretoria, South African.

Mucina, L., Rutherford, M.C. & Powrie, L.W. (Eds.). 2007. Vegetation map of South Africa, Lesotho and Swaziland. 1:1 000 000 scale sheet maps. 2nd ed. South African National Biodiversity Institute, Pretoria.

Nemai (2019). Botanical survey at ESKOM Skaapvlei substation included in the west coast group of battery energy storage system (BESS) project, Western Cape Province.

Nick Holme Botanical Surveys (2007). Specialist Impact Assessment for proposed ESKOM wind facility on the cape west coast: terrestrial vegetation component.

Nel JL, Murray KM, Maherry AM, Petersen CP, Roux DJ, Driver A, Hill L, Van Deventer H, Funke N, Swartz ER, Smith-Adao LB, Mbona N, Downsborough L and Nienaber S. 2011. Technical Report for the National Freshwater Ecosystem Priority Areas project. WRC Report No. K5/1801.

Raimonde, D. (2009). Red list of South African Plants. SANBI, Pretoria.

SADAP (South Africa Protected Areas Database) and SACAD (South Africa Conservation Areas Database) (2021). http://egis.environment.gov.za

SANBI-BGIS. 2017. Technical guidelines for CBA Maps: Guidelines for developing a map of Critical Biodiversity Areas & Ecological Support Areas using systematic biodiversity planning.

Skowno, A.L., Raimondo, D.C., Poole, C.J., Fizzotti, B. & Slingsby, J.A. (eds.). 2019. South African National Biodiversity Assessment 2018 Technical Report Volume 1: Terrestrial Realm. South African National Biodiversity Institute, Pretoria.

Van Deventer, H., Smith-Adao, L., Collins, N.B., Grenfell, M., Grundling, A., Grundling, P-L., Impson, D., Job, N., Lötter, M., Ollis, D., Petersen, C., Scherman, P., Sieben, E., Snaddon, K., Tererai, F. and Van der Colff D. 2019. *South African National Biodiversity Assessment 2018: Technical Report.* Volume 2b: Inland Aquatic (Freshwater) Realm. CSIR report number CSIR/NRE/ECOS/IR/2019/0004/A. South African National Biodiversity Institute, Pretoria. http://hdl.handle.net/20.500.12143/6230.

Van Deventer, H., Smith-Adao, L., Mbona, N., Petersen, C., Skowno, A., Collins, N.B., Grenfell, M., Job, N., Lötter, M., Ollis, D., Scherman, P., Sieben, E. & Snaddon, K. 2018. South African National Biodiversity Assessment 2018: Technical Report. Volume 2a: South African Inventory of Inland Aquatic Ecosystems (SAIIAE). Version 3, final released on 3 October 2019. Council for Scientific and Industrial Research (CSIR) and South African National Biodiversity Institute (SANBI): Pretoria, South Africa.

# 11 Appendix Items

## 11.1 Appendix A – Flora species expected to occur in the project area.

| Family | Taxon | Author | IUCN | Ecology |
|---|---|---|---|---|
| **Crassulaceae** | *Adromischus marianiae var. immaculatus* | (Marloth) A.Berger | NE | Indigenous; Endemic |
| **Crassulaceae** | *Adromischus sp.* | | | |
| **Hyacinthaceae** | *Albuca ciliaris* | U.Mull.-Doblies | LC | Indigenous; Endemic |
| **Hyacinthaceae** | *Albuca glandulifera* | J.C.Manning & Goldblatt | LC | Indigenous |
| **Hyacinthaceae** | *Albuca paradoxa* | Dinter | LC | Indigenous |
| **Hyacinthaceae** | *Albuca secunda* | (Jacq.) J.C.Manning & Goldblatt | LC | Indigenous; Endemic |
| **Hyacinthaceae** | *Albuca unifolia* | (Retz.) J.C.Manning & Goldblatt | LC | Indigenous |
| **Hyacinthaceae** | *Albuca viscosa* | L.f. | LC | Indigenous |
| **Asteraceae** | *Amellus microglossus* | DC. | LC | Indigenous; Endemic |
| **Asteraceae** | *Amellus sp.* | | | |
| **Aizoaceae** | *Amphibolia laevis* | (Aiton) H.E.K.Hartmann | LC | Indigenous; Endemic |
| **Aizoaceae** | *Amphibolia rupis-arcuatae* | (Dinter) H.E.K.Hartmann | LC | Indigenous |
| **Boraginaceae** | *Amsinckia calycina* | (Moris) Chater | | Not indigenous; Naturalised |
| **Anacampserotaceae** | *Anacampseros retusa* | Poelln. | LC | Indigenous |
| **Rubiaceae** | *Anthospermum spathulatum subsp. spathulatum* | Spreng. | LC | Indigenous |
| **Aizoaceae** | *Antimima amoena* | (Schwantes) H.E.K.Hartmann | LC | Indigenous; Endemic |
| **Aizoaceae** | *Antimima klaverensis* | (L.Bolus) H.E.K.Hartmann | LC | Indigenous; Endemic |
| **Aizoaceae** | *Antimima solida* | (L.Bolus) H.E.K.Hartmann | LC | Indigenous; Endemic |
| **Aizoaceae** | *Antimima sp.* | | | |
| **Aizoaceae** | *Antimima ventricosa* | (L.Bolus) H.E.K.Hartmann | LC | Indigenous; Endemic |
| **Aizoaceae** | *Antimima watermeyeri* | (L.Bolus) H.E.K.Hartmann | LC | Indigenous; Endemic |
| **Apiaceae** | *Arctopus dregei* | Sond. | NT | Indigenous; Endemic |
| **Asteraceae** | *Arctotheca populifolia* | (P.J.Bergius) Norl. | LC | Indigenous |
| **Asteraceae** | *Arctotis breviscapa* | Thunb. | LC | Indigenous; Endemic |
| **Asteraceae** | *Arctotis fastuosa* | Jacq. | LC | Indigenous |
| **Asteraceae** | *Arctotis flaccida* | Jacq. | LC | Indigenous; Endemic |
| **Asteraceae** | *Arctotis hirsuta* | (Harv.) Beauverd | LC | Indigenous; Endemic |
| **Asteraceae** | *Arctotis sp.* | | | |
| **Aizoaceae** | *Argyroderma congregatum* | L.Bolus | LC | Indigenous; Endemic |
| **Aizoaceae** | *Argyroderma fissum* | (Haw.) L.Bolus | LC | Indigenous; Endemic |
| **Aizoaceae** | *Argyroderma framesii subsp. hallii* | L.Bolus | LC | Indigenous; Endemic |
| **Aizoaceae** | *Argyroderma subalbum* | (N.E.Br.) N.E.Br. | LC | Indigenous; Endemic |
| **Poaceae** | *Aristida congesta subsp. congesta* | Roem. & Schult. | LC | Indigenous |

| | | | | |
|---|---|---|---|---|
| **Fabaceae** | *Aspalathus spinescens subsp. lepida* | Thunb. | LC | Indigenous; Endemic |
| **Asparagaceae** | *Asparagus capensis var. capensis* | L. | LC | Indigenous |
| **Asparagaceae** | *Asparagus capensis var. litoralis* | L. | LC | Indigenous |
| **Asparagaceae** | *Asparagus declinatus* | L. | LC | Indigenous |
| **Asparagaceae** | *Asparagus exuvialis forma exuvialis* | Burch. | NE | Indigenous |
| **Asparagaceae** | *Asparagus fasciculatus* | Thunb. | LC | Indigenous |
| **Asparagaceae** | *Asparagus retrofractus* | L. | LC | Indigenous |
| **Asparagaceae** | *Asparagus undulatus* | (L.f.) Thunb. | LC | Indigenous |
| **Asteraceae** | *Athanasia pubescens* | (L.) L. | LC | Indigenous; Endemic |
| **Amaranthaceae** | *Atriplex cinerea* | Poir. | | Indigenous |
| **Amaranthaceae** | *Atriplex cinerea subsp. bolusii* | Poir. | | Indigenous |
| **Amaranthaceae** | *Atriplex cinerea subsp. bolusii* | Poir. | | Indigenous |
| **Amaranthaceae** | *Atriplex eardleyae* | Aellen | | Not indigenous; Naturalised |
| **Amaranthaceae** | *Atriplex lindleyi subsp. inflata* | Moq. | | Not indigenous; Naturalised; Invasive |
| **Amaranthaceae** | *Atriplex semibaccata* | R.Br. | | Not indigenous; Naturalised; Invasive |
| **Amaranthaceae** | *Atriplex sp.* | I.Verd. | | |
| **Amaranthaceae** | *Atriplex vestita var. appendiculata* | (Thunb.) Aellen | LC | Indigenous |
| **Amaranthaceae** | *Atriplex vestita var. inappendiculata* | (Thunb.) Aellen | LC | Indigenous; Endemic |
| **Iridaceae** | *Babiana brachystachys* | (Baker) G.J.Lewis | LC | Indigenous; Endemic |
| **Iridaceae** | *Babiana cinnamomea* | J.C.Manning & Goldblatt | LC | Indigenous; Endemic |
| **Iridaceae** | *Babiana confusa* | (G.J.Lewis) Goldblatt & J.C.Manning | NT | Indigenous; Endemic |
| **Iridaceae** | *Babiana grandiflora* | Goldblatt & J.C.Manning | LC | Indigenous; Endemic |
| **Iridaceae** | *Babiana hirsuta* | (Lam.) Goldblatt & J.C.Manning | NT | Indigenous; Endemic |
| **Iridaceae** | *Babiana lewisiana* | B.Nord. | VU | Indigenous; Endemic |
| **Iridaceae** | *Babiana sinuata* | G.J.Lewis | LC | Indigenous; Endemic |
| **Iridaceae** | *Babiana teretifolia* | Goldblatt & J.C.Manning | CR | Indigenous; Endemic |
| **Iridaceae** | *Babiana virescens* | Goldblatt & J.C.Manning | NT | Indigenous; Endemic |
| **Lamiaceae** | *Ballota africana* | (L.) Benth. | LC | Indigenous |
| **Asteraceae** | *Berkheya fruticosa* | (L.) Ehrh. | LC | Indigenous; Endemic |
| **Bruniaceae** | *Berzelia abrotanoides* | (L.) Brongn. | LC | Indigenous; Endemic |
| **Brassicaceae** | *Brassica tournefortii* | Gouan | | Not indigenous; Naturalised; Invasive |
| **Poaceae** | *Bromus catharticus* | Vahl | NE | Not indigenous; Naturalised; Invasive |
| **Poaceae** | *Bromus leptoclados* | Nees | LC | Indigenous |
| **Poaceae** | *Bromus pectinatus* | Thunb. | LC | Indigenous |
| **Amaryllidaceae** | *Brunsvigia bosmaniae* | F.M.Leight. | LC | Indigenous |
| **Bryaceae** | *Bryum torquescens* | Bruch ex De Not. | | Indigenous |
| **Asphodelaceae** | *Bulbine dactylopsoides* | G.Will. | LC | Indigenous; Endemic |

| | | | | |
|---|---|---|---|---|
| **Asphodelaceae** | *Bulbine diphylla* | Schltr. ex Poelln. | LC | Indigenous; Endemic |
| **Asphodelaceae** | *Bulbine haworthioides* | B.Nord. | VU | Indigenous; Endemic |
| **Asphodelaceae** | *Bulbine melanovaginata* | G.Will. | VU | Indigenous; Endemic |
| **Asphodelaceae** | *Bulbine mesembryanthoides subsp. mesembryanthoides* | Haw. | LC | Indigenous; Endemic |
| **Asphodelaceae** | *Bulbine praemorsa* | (Jacq.) Spreng. | LC | Indigenous |
| **Asphodelaceae** | *Bulbine sp.* | | | |
| **Asphodelaceae** | *Bulbinella nutans subsp. nutans* | (Thunb.) T.Durand & Schinz | LC | Indigenous; Endemic |
| **Fabaceae** | *Calobota angustifolia* | (E.Mey.) Boatwr. & B.-E.van Wyk | LC | Indigenous |
| **Fabaceae** | *Calobota cinerea* | (E.Mey.) Boatwr. & B.-E.van Wyk | LC | Indigenous |
| **Fabaceae** | *Calobota sericea* | (Thunb.) Boatwr. & B.-E.van Wyk | LC | Indigenous; Endemic |
| **Aizoaceae** | *Carpobrotus quadrifidus* | L.Bolus | LC | Indigenous; Endemic |
| **Celastraceae** | *Cassine peragua subsp. peragua* | L. | LC | Indigenous |
| **Aizoaceae** | *Cephalophyllum caespitosum* | H.E.K.Hartmann | LC | Indigenous; Endemic |
| **Aizoaceae** | *Cephalophyllum framesii* | L.Bolus | LC | Indigenous; Endemic |
| **Aizoaceae** | *Cephalophyllum loreum* | (L.) Schwantes | LC | Indigenous; Endemic |
| **Aizoaceae** | *Cephalophyllum rigidum* | L.Bolus | LC | Indigenous; Endemic |
| **Aizoaceae** | *Cephalophyllum sp.* | | | |
| **Aizoaceae** | *Cephalophyllum tricolorum* | (Haw.) N.E.Br. | LC | Indigenous; Endemic |
| **Apocynaceae** | *Ceropegia occidentalis* | R.A.Dyer | NT | Indigenous |
| **Scrophulariaceae** | *Chaenostoma caeruleum* | (L.f.) Kornhall | LC | Indigenous; Endemic |
| **Poaceae** | *Chaetobromus involucratus subsp. dregeanus* | (Schrad.) Nees | LC | Indigenous; Endemic |
| **Gigaspermaceae** | *Chamaebryum pottioides* | Ther. & Dixon | | Indigenous |
| **Iridaceae** | *Chasmanthe floribunda* | (Salisb.) N.E.Br. | LC | Indigenous; Endemic |
| **Pteridaceae** | *Cheilanthes contracta* | (Kunze) Mett. ex Kuhn | LC | Indigenous; Endemic |
| **Aizoaceae** | *Cheiridopsis derenbergiana* | Schwantes | LC | Indigenous; Endemic |
| **Amaranthaceae** | *Chenolea diffusa* | Thunb. | | Indigenous |
| **Agavaceae** | *Chlorophytum graminifolium* | (Willd.) Kunth | | Indigenous; Endemic |
| **Asteraceae** | *Chrysocoma oblongifolia* | DC. | LC | Indigenous; Endemic |
| **Asteraceae** | *Chrysocoma sp.* | | | |
| **Poaceae** | *Cladoraphis cyperoides* | (Thunb.) S.M.Phillips | LC | Indigenous |
| **Poaceae** | *Cladoraphis spinosa* | (L.f.) S.M.Phillips | LC | Indigenous |
| **Aizoaceae** | *Cleretum bellidiforme* | (Burm.f.) G.D.Rowley | LC | Indigenous; Endemic |
| **Aizoaceae** | *Cleretum papulosum subsp. papulosum* | (L.f.) L.Bolus | LC | Indigenous; Endemic |
| **Rosaceae** | *Cliffortia polygonifolia var. polygonifolia* | L. | LC | Indigenous; Endemic |

| | | | | |
|---|---|---|---|---|
| **Molluginaceae** | *Coelanthum grandiflorum* | E.Mey. ex Fenzl | LC | Indigenous |
| **Aizoaceae** | *Conicosia pugioniformis subsp. pugioniformis* | (L.) N.E.Br. | LC | Indigenous; Endemic |
| **Aizoaceae** | *Conophytum calculus* | (A.Berger) N.E.Br. | | Indigenous; Endemic |
| **Aizoaceae** | *Conophytum minutum* | (Haw.) N.E.Br. | NE | Indigenous; Endemic |
| **Aizoaceae** | *Conophytum minutum var. nudum* | (Haw.) N.E.Br. | NE | Indigenous; Endemic |
| **Aizoaceae** | *Conophytum pageae* | (N.E.Br.) N.E.Br. | LC | Indigenous |
| **Aizoaceae** | *Conophytum uviforme subsp. uviforme* | (Haw.) N.E.Br. | LC | Indigenous; Endemic |
| **Asteraceae** | *Cotula microglossa* | (DC.) O.Hoffm. & Kuntze ex Kuntze | LC | Indigenous; Endemic |
| **Crassulaceae** | *Cotyledon papillaris* | L.f. | LC | Indigenous |
| **Asteraceae** | *Crassothonna cylindrica* | (Lam.) B.Nord. | LC | Indigenous |
| **Asteraceae** | *Crassothonna floribunda* | (Schltr.) B.Nord. | LC | Indigenous; Endemic |
| **Crassulaceae** | *Crassula ammophila* | Toelken | NT | Indigenous; Endemic |
| **Crassulaceae** | *Crassula brevifolia subsp. brevifolia* | Harv. | LC | Indigenous |
| **Crassulaceae** | *Crassula elegans subsp. elegans* | Schonland & Baker f. | LC | Indigenous |
| **Crassulaceae** | *Crassula expansa subsp. pyrifolia* | Aiton | LC | Indigenous |
| **Crassulaceae** | *Crassula macowaniana* | Schonland & Baker f. | LC | Indigenous |
| **Crassulaceae** | *Crassula muscosa var. muscosa* | L. | NE | Indigenous |
| **Crassulaceae** | *Crassula nudicaulis* | L. | | Indigenous |
| **Crassulaceae** | *Crassula nudicaulis var. herrei* | L. | LC | Indigenous; Endemic |
| **Crassulaceae** | *Crassula sp.* | | | |
| **Crassulaceae** | *Crassula tomentosa var. tomentosa* | Thunb. | LC | Indigenous |
| **Crassulaceae** | *Crassula umbellata* | Thunb. | LC | Indigenous; Endemic |
| **Lauraceae** | *Cryptocarya angustifolia* | E.Mey. ex Meisn. | LC | Indigenous; Endemic |
| **Asteraceae** | *Curio corymbifer* | (DC.) Eggli | | Indigenous |
| **Asteraceae** | *Curio radicans* | (L.f.) P.V.Heath | LC | Indigenous |
| **Poaceae** | *Cynodon dactylon* | (L.) Pers. | LC | Indigenous |
| **Cyperaceae** | *Cyperus textilis* | Thunb. | LC | Indigenous; Endemic |
| **Apiaceae** | *Dasispermum hispidum* | (Thunb.) Magee & B.-E.van Wyk | LC | Indigenous; Endemic |
| **Apiaceae** | *Dasispermum suffruticosum* | (P.J.Bergius) B.L.Burtt | LC | Indigenous; Endemic |
| **Aizoaceae** | *Delosperma crassum* | L.Bolus | LC | Indigenous; Endemic |
| **Aizoaceae** | *Delosperma sp.* | L.Bolus | | |
| **Scrophulariaceae** | *Diascia pachyceras* | E.Mey. ex Benth. | LC | Indigenous; Endemic |
| **Scrophulariaceae** | *Diascia rudolphii* | Hiern | LC | Indigenous; Endemic |
| **Scrophulariaceae** | *Diascia sp.* | | | |
| **Scrophulariaceae** | *Diascia veronicoides* | Schltr. | LC | Indigenous; Endemic |
| **Aizoaceae** | *Dicrocaulon grandiflorum* | Ihlenf. | LC | Indigenous; Endemic |

| | | | | |
|---|---|---|---|---|
| **Aizoaceae** | *Dicrocaulon nodosum* | (A.Berger) N.E.Br. | LC | Indigenous; Endemic |
| **Asteraceae** | *Didelta carnosa var. carnosa* | (L.f.) Aiton | LC | Indigenous |
| **Asteraceae** | *Didelta carnosa var. tomentosa* | (L.f.) Aiton | LC | Indigenous |
| **Asteraceae** | *Didelta spinosa* | (L.f.) Aiton | LC | Indigenous |
| **Asteraceae** | *Dimorphotheca pinnata* | (Thunb.) Harv. | | Indigenous |
| **Asteraceae** | *Dimorphotheca pinnata var. pinnata* | (Thunb.) Harv. | | Indigenous |
| **Asteraceae** | *Dimorphotheca pluvialis* | (L.) Moench | LC | Indigenous |
| **Asteraceae** | *Dimorphotheca sinuata* | DC. | LC | Indigenous |
| **Ebenaceae** | *Diospyros austroafricana var. rugosa* | De Winter | LC | Indigenous; Endemic |
| **Ebenaceae** | *Diospyros ramulosa* | (E.Mey. ex A.DC.) De Winter | LC | Indigenous |
| **Aizoaceae** | *Diplosoma luckhoffii* | (L.Bolus) Schwantes ex Ihlenf. | VU | Indigenous; Endemic |
| **Scrophulariaceae** | *Dischisma clandestinum* | E.Mey. | LC | Indigenous; Endemic |
| **Scrophulariaceae** | *Dischisma spicatum* | (Thunb.) Choisy | LC | Indigenous |
| **Aizoaceae** | *Dorotheanthus sp.* | | | |
| **Hyacinthaceae** | *Drimia stenocarpa* | J.C.Manning & J.M.J.Deacon | | Indigenous; Endemic |
| **Aizoaceae** | *Drosanthemopsis diversifolia* | (L.Bolus) Klak | | Indigenous; Endemic |
| **Aizoaceae** | *Drosanthemum curtophyllum* | L.Bolus | LC | Indigenous |
| **Aizoaceae** | *Drosanthemum deciduum* | H.E.K.Hartmann & Bruckm. | LC | Indigenous; Endemic |
| **Aizoaceae** | *Drosanthemum inornatum* | (L.Bolus) L.Bolus | LC | Indigenous |
| **Aizoaceae** | *Drosanthemum luederitzii* | (Engl.) Schwantes | LC | Indigenous |
| **Aizoaceae** | *Drosanthemum marinum* | L.Bolus | NT | Indigenous; Endemic |
| **Aizoaceae** | *Drosanthemum oculatum* | L.Bolus | LC | Indigenous; Endemic |
| **Aizoaceae** | *Drosanthemum pulverulentum* | (Haw.) Schwantes | LC | Indigenous; Endemic |
| **Aizoaceae** | *Drosanthemum salicola* | L.Bolus | LC | Indigenous; Endemic |
| **Aizoaceae** | *Drosanthemum sp.* | | | |
| **Poaceae** | *Ehrharta brevifolia var. brevifolia* | Schrad. | LC | Indigenous |
| **Poaceae** | *Ehrharta brevifolia var. cuspidata* | Schrad. | LC | Indigenous |
| **Poaceae** | *Ehrharta calycina* | Sm. | LC | Indigenous |
| **Poaceae** | *Ehrharta rupestris subsp. rupestris* | Nees ex Trin. | LC | Indigenous; Endemic |
| **Poaceae** | *Ehrharta thunbergii* | Gibbs Russ. | LC | Indigenous |
| **Poaceae** | *Eleusine coracana subsp. africana* | (L.) Gaertn. | LC | Indigenous |
| **Polygonaceae** | *Emex australis* | Steinh. | LC | Indigenous |
| **Hypoxidaceae** | *Empodium namaquensis* | (Baker) M.F.Thomps. | LC | Indigenous; Endemic |
| **Poaceae** | *Eragrostis curvula* | (Schrad.) Nees | LC | Indigenous |
| **Poaceae** | *Eragrostis sp.* | | | |

| | | | | |
|---|---|---|---|---|
| **Poaceae** | *Eragrostis trichophora* | Coss. & Durieu | LC | Indigenous |
| **Asteraceae** | *Eriocephalus racemosus var. affinis* | L. | LC | Indigenous; Endemic |
| **Geraniaceae** | *Erodium cicutarium* | (L.) L'Her. | | Not indigenous; Naturalised; Invasive |
| **Fabaceae** | *Euchlora hirsuta* | (Thunb.) Druce | LC | Indigenous; Endemic |
| **Ebenaceae** | *Euclea linearis* | Zeyh. ex Hiern | LC | Indigenous |
| **Ebenaceae** | *Euclea racemosa subsp. racemosa* | L. | LC | Indigenous; Endemic |
| **Euphorbiaceae** | *Euphorbia exilis* | L.C.Leach | LC | Indigenous; Endemic |
| **Euphorbiaceae** | *Euphorbia muricata* | Thunb. | LC | Indigenous; Endemic |
| **Euphorbiaceae** | *Euphorbia rhombifolia* | Boiss. | LC | Indigenous |
| **Euphorbiaceae** | *Euphorbia stapelioides* | Boiss. | LC | Indigenous |
| **Asteraceae** | *Euryops dregeanus* | Sch.Bip. | LC | Indigenous |
| **Asteraceae** | *Euryops tenuissimus subsp. tenuissimus* | (L.) DC. | LC | Indigenous |
| **Asteraceae** | *Felicia hirsuta* | DC. | LC | Indigenous |
| **Asteraceae** | *Felicia hyssopifolia subsp. glabra* | (P.J.Bergius) Nees | LC | Indigenous; Endemic |
| **Asteraceae** | *Felicia merxmuelleri* | Grau | LC | Indigenous; Endemic |
| **Asteraceae** | *Felicia namaquana* | (Harv.) Merxm. | LC | Indigenous |
| **Iridaceae** | *Ferraria divaricata* | Sweet | LC | Indigenous; Endemic |
| **Iridaceae** | *Ferraria ferrariola* | (Jacq.) Willd. | LC | Indigenous; Endemic |
| **Iridaceae** | *Ferraria flava* | Goldblatt & J.C.Manning | LC | Indigenous; Endemic |
| **Iridaceae** | *Ferraria foliosa* | G.J.Lewis | NT | Indigenous; Endemic |
| **Iridaceae** | *Ferraria uncinata* | Sweet | LC | Indigenous; Endemic |
| **Iridaceae** | *Ferraria variabilis* | Goldblatt & J.C.Manning | LC | Indigenous; Endemic |
| **Cyperaceae** | *Ficinia argyropa* | Nees | LC | Indigenous; Endemic |
| **Cyperaceae** | *Ficinia dunensis* | Levyns | LC | Indigenous; Endemic |
| **Apiaceae** | *Foeniculum vulgare var. vulgare* | Mill. | | Not indigenous; Cultivated; Naturalised; Invasive |
| **Asteraceae** | *Foveolina dichotoma* | (DC.) Kallersjo | LC | Indigenous |
| **Asteraceae** | *Foveolina tenella* | (DC.) Kallersjo | LC | Indigenous; Endemic |
| **Frankeniaceae** | *Frankenia repens* | (P.J.Bergius) Fourc. | LC | Indigenous; Endemic |
| **Aizoaceae** | *Galenia africana* | L. | LC | Indigenous |
| **Aizoaceae** | *Galenia crystallina var. crystallina* | (Eckl. & Zeyh.) Fenzl ex Harv. & Sond. | LC | Indigenous |
| **Aizoaceae** | *Galenia fruticosa* | (L.f.) Sond. | LC | Indigenous |
| **Aizoaceae** | *Galenia herniariaefolia* | (C.Presl) Fenzl | LC | Indigenous; Endemic |
| **Aizoaceae** | *Galenia pubescens* | (Eckl. & Zeyh.) Druce | LC | Indigenous; Endemic |
| **Aizoaceae** | *Galenia sarcophylla* | Fenzl | LC | Indigenous |
| **Asphodelaceae** | *Gasteria pillansii* | Kensit | | Indigenous |
| **Asphodelaceae** | *Gasteria pillansii var. pillansii* | Kensit | LC | Indigenous; Endemic |
| **Iridaceae** | *Geissorhiza exscapa* | (Thunb.) Goldblatt | LC | Indigenous; Endemic |

| | | | | |
|---|---|---|---|---|
| **Amaryllidaceae** | *Gethyllis britteniana subsp. britteniana* | Baker | LC | Indigenous; Endemic |
| **Amaryllidaceae** | *Gethyllis hallii* | D.Mull.-Doblies | LC | Indigenous; Endemic |
| **Amaryllidaceae** | *Gethyllis lanuginosa* | Marloth | LC | Indigenous; Endemic |
| **Amaryllidaceae** | *Gethyllis lata* | L.Bolus | | Indigenous; Endemic |
| **Amaryllidaceae** | *Gethyllis linearis* | L.Bolus | LC | Indigenous; Endemic |
| **Amaryllidaceae** | *Gethyllis sp.* | | | |
| **Iridaceae** | *Gladiolus arcuatus* | Klatt | LC | Indigenous; Endemic |
| **Iridaceae** | *Gladiolus equitans* | Thunb. | LC | Indigenous; Endemic |
| **Iridaceae** | *Gladiolus orchidiflorus* | Andrews | LC | Indigenous |
| **Iridaceae** | *Gladiolus watermeyeri* | L.Bolus | LC | Indigenous; Endemic |
| **Asteraceae** | *Gnaphalium englerianum* | (O.Hoffm.) Hilliard & B.L.Burtt | LC | Indigenous; Endemic |
| **Thymelaeaceae** | *Gnidia clavata* | Schinz | LC | Indigenous; Endemic |
| **Thymelaeaceae** | *Gnidia imbricata* | L.f. | LC | Indigenous; Endemic |
| **Neuradaceae** | *Grielum grandiflorum* | (L.) Druce | LC | Indigenous; Endemic |
| **Amaranthaceae** | *Halopeplis sp.* | | | |
| **Orobanchaceae** | *Harveya pauciflora* | (Benth.) Hiern | LC | Indigenous |
| **Orobanchaceae** | *Harveya squamosa* | (Thunb.) Steud. | LC | Indigenous; Endemic |
| **Asphodelaceae** | *Haworthia arachnoidea var. namaquensis* | (L.) Duval | NE | Indigenous; Endemic |
| **Scrophulariaceae** | *Hebenstretia cordata* | L. | LC | Indigenous |
| **Scrophulariaceae** | *Hebenstretia repens* | Jaroscz | LC | Indigenous; Endemic |
| **Asteraceae** | *Helichrysum alsinoides* | DC. | LC | Indigenous |
| **Asteraceae** | *Helichrysum dunense* | Hilliard | VU | Indigenous; Endemic |
| **Asteraceae** | *Helichrysum leontonyx* | DC. | LC | Indigenous |
| **Asteraceae** | *Helichrysum marmarolepis* | S.Moore | NT | Indigenous; Endemic |
| **Asteraceae** | *Helichrysum micropoides* | DC. | LC | Indigenous |
| **Asteraceae** | *Helichrysum revolutum* | (Thunb.) Less. | LC | Indigenous |
| **Asteraceae** | *Helichrysum simulans* | Harv. & Sond. | LC | Indigenous; Endemic |
| **Asteraceae** | *Helichrysum sp.* | | | |
| **Brassicaceae** | *Heliophila juncea* | (P.J.Bergius) Druce | LC | Indigenous; Endemic |
| **Brassicaceae** | *Heliophila pusilla var. pusilla* | L.f. | LC | Indigenous; Endemic |
| **Boraginaceae** | *Heliotropium curassavicum* | L. | | Not indigenous; Naturalised |
| **Scrophulariaceae** | *Hemimeris racemosa* | (Houtt.) Merr. | LC | Indigenous; Endemic |
| **Malvaceae** | *Hermannia alnifolia* | L. | LC | Indigenous; Endemic |
| **Malvaceae** | *Hermannia amoena* | Dinter ex Friedr.-Holzh. | LC | Indigenous |
| **Malvaceae** | *Hermannia coccocarpa* | (Eckl. & Zeyh.) Kuntze | LC | Indigenous |
| **Malvaceae** | *Hermannia cordata* | (E.Mey. ex E.Phillips) De Winter | LC | Indigenous; Endemic |
| **Malvaceae** | *Hermannia cuneifolia var. cuneifolia* | Jacq. | LC | Indigenous |
| **Malvaceae** | *Hermannia desertorum* | Eckl. & Zeyh. | LC | Indigenous |

| | | | | |
|---|---|---|---|---|
| **Malvaceae** | *Hermannia heterophylla* | (Cav.) Thunb. | LC | Indigenous; Endemic |
| **Malvaceae** | *Hermannia multiflora* | Jacq. | LC | Indigenous; Endemic |
| **Malvaceae** | *Hermannia scordifolia* | Jacq. | LC | Indigenous; Endemic |
| **Malvaceae** | *Hermannia sp.* | | | |
| **Malvaceae** | *Hermannia trifurca* | L. | LC | Indigenous |
| **Iridaceae** | *Hesperantha bachmannii* | Baker | LC | Indigenous; Endemic |
| **Amaryllidaceae** | *Hessea breviflora* | Herb. | LC | Indigenous; Endemic |
| **Orchidaceae** | *Holothrix aspera* | (Lindl.) Rchb.f. | LC | Indigenous; Endemic |
| **Orchidaceae** | *Holothrix grandiflora* | (Sond.) Rchb.f. | DD | Indigenous; Endemic |
| **Asteraceae** | *Hoplophyllum spinosum* | DC. | LC | Indigenous; Endemic |
| **Poaceae** | *Hordeum murinum subsp. glaucum* | L. | NE | Not indigenous; Naturalised |
| **Orobanchaceae** | *Hyobanche atropurpurea* | Bolus | LC | Indigenous; Endemic |
| **Asteraceae** | *Ifloga ambigua* | (L.) Druce | LC | Indigenous; Endemic |
| **Asteraceae** | *Ifloga lerouxiae* | (Beyers) N.G.Bergh | LC | Indigenous; Endemic |
| **Asteraceae** | *Ifloga polycnemoides* | Fenzl | LC | Indigenous; Endemic |
| **Fabaceae** | *Indigofera exigua* | Eckl. & Zeyh. | LC | Indigenous; Endemic |
| **Fabaceae** | *Indigofera sp.* | | | |
| **Fabaceae** | *Indigofera venusta* | Eckl. & Zeyh. | LC | Indigenous; Endemic |
| **Scrophulariaceae** | *Jamesbrittenia racemosa* | (Benth.) Hilliard | LC | Indigenous; Endemic |
| **Aizoaceae** | *Jordaaniella cuprea* | (L.Bolus) H.E.K.Hartmann | LC | Indigenous |
| **Aizoaceae** | *Jordaaniella spongiosa* | (L.Bolus) H.E.K.Hartmann | LC | Indigenous; Endemic |
| **Aizoaceae** | *Jordaaniella uniflora* | (L.Bolus) H.E.K.Hartmann | NT | Indigenous; Endemic |
| **Acanthaceae** | *Justicia cuneata subsp. cuneata* | Vahl | LC | Indigenous; Endemic |
| **Cucurbitaceae** | *Kedrostis psammophylla* | Bruyns | LC | Indigenous; Endemic |
| **Kewaceae** | *Kewa angrae-pequenae* | (Friedrich) Christenh. | LC | Indigenous |
| **Hyacinthaceae** | *Lachenalia patula* | Jacq. | LC | Indigenous; Endemic |
| **Hyacinthaceae** | *Lachenalia punctata* | Jacq. | | Indigenous; Endemic |
| **Hyacinthaceae** | *Lachenalia sp.* | | | |
| **Hyacinthaceae** | *Lachenalia splendida* | Diels | LC | Indigenous; Endemic |
| **Hyacinthaceae** | *Lachenalia undulata* | Masson ex Baker | LC | Indigenous; Endemic |
| **Hyacinthaceae** | *Lachenalia violacea* | Jacq. | | Indigenous; Endemic |
| **Aizoaceae** | *Lampranthus procumbens* | Klak | VU | Indigenous; Endemic |
| **Aizoaceae** | *Lampranthus sp.* | | | |
| **Aizoaceae** | *Lampranthus watermeyeri* | (L.Bolus) N.E.Br. | LC | Indigenous; Endemic |
| **Iridaceae** | *Lapeirousia anceps* | (L.f.) Ker Gawl. | LC | Indigenous; Endemic |
| **Iridaceae** | *Lapeirousia angustifolia* | Schltr. | | Indigenous; Endemic |
| **Iridaceae** | *Lapeirousia arenicola* | Schltr. | LC | Indigenous; Endemic |

| | | | | |
|---|---|---|---|---|
| **Iridaceae** | *Lapeirousia jacquinii* | N.E.Br. | LC | Indigenous; Endemic |
| **Iridaceae** | *Lapeirousia pyramidalis subsp. pyramidalis* | (Lam.) Goldblatt | LC | Indigenous; Endemic |
| **Iridaceae** | *Lapeirousia simulans* | Goldblatt & J.C.Manning | VU | Indigenous; Endemic |
| **Asteraceae** | *Lasiopogon glomerulatus* | (Harv.) Hilliard | LC | Indigenous |
| **Fabaceae** | *Lebeckia ambigua* | E.Mey. | LC | Indigenous; Endemic |
| **Aizoaceae** | *Leipoldtia klaverensis* | L.Bolus | EN | Indigenous; Endemic |
| **Aizoaceae** | *Leipoldtia schultzei* | (Schltr. & Diels) Friedrich | LC | Indigenous; Endemic |
| **Fabaceae** | *Lessertia diffusa* | R.Br. | LC | Indigenous |
| **Fabaceae** | *Lessertia excisa* | DC. | LC | Indigenous; Endemic |
| **Fabaceae** | *Lessertia frutescens subsp. frutescens* | (L.) Goldblatt & J.C.Manning | LC | Indigenous |
| **Fabaceae** | *Lessertia herbacea* | (L.) Druce | LC | Indigenous |
| **Fabaceae** | *Lessertia meyeri* | Boatwr., T.Nkonki & B.-E.van Wyk | LC | Indigenous |
| **Fabaceae** | *Lessertia prostrata* | DC. | LC | Indigenous |
| **Fabaceae** | *Lessertia rigida* | E.Mey. | LC | Indigenous; Endemic |
| **Fabaceae** | *Lessertia sp.* | | | |
| **Proteaceae** | *Leucadendron pubescens* | R.Br. | LC | Indigenous; Endemic |
| **Asteraceae** | *Leucoptera nodosa* | (Thunb.) B.Nord. | VU | Indigenous; Endemic |
| **Asteraceae** | *Leucoptera subcarnosa* | B.Nord. | LC | Indigenous; Endemic |
| **Proteaceae** | *Leucospermum calligerum* | (Salisb. ex Knight) Rourke | LC | Indigenous; Endemic |
| **Proteaceae** | *Leucospermum rodolentum* | (Salisb. ex Knight) Rourke | VU | Indigenous; Endemic |
| **Limeaceae** | *Limeum africanum* | L. | | Indigenous |
| **Limeaceae** | *Limeum africanum subsp. africanum* | L. | LC | Indigenous; Endemic |
| **Plumbaginaceae** | *Limonium equisetinum* | (Boiss.) R.A.Dyer | LC | Indigenous; Endemic |
| **Plumbaginaceae** | *Limonium scabrum var. scabrum* | (Thunb.) Kuntze | NE | Indigenous |
| **Boraginaceae** | *Lobostemon cinereus* | DC. & A.DC. | | Indigenous; Endemic |
| **Fabaceae** | *Lotononis falcata* | (E.Mey.) Benth. | LC | Indigenous |
| **Fabaceae** | *Lotononis involucrata subsp. peduncularis* | (P.J.Bergius) Benth. | LC | Indigenous; Endemic |
| **Fabaceae** | *Lotononis leptoloba* | Bolus | LC | Indigenous; Endemic |
| **Fabaceae** | *Lotononis parviflora* | (P.J.Bergius) D.Dietr. | LC | Indigenous; Endemic |
| **Solanaceae** | *Lycium horridum* | Thunb. | LC | Indigenous |
| **Solanaceae** | *Lycium oxycarpum* | Dunal | LC | Indigenous; Endemic |
| **Solanaceae** | *Lycium tetrandrum* | Thunb. | LC | Indigenous |
| **Scrophulariaceae** | *Lyperia tristis* | (L.f.) Benth. | LC | Indigenous |
| **Aizoaceae** | *Malephora crocea* | (Jacq.) Schwantes | LC | Indigenous; Endemic |
| **Aizoaceae** | *Malephora framesii* | (L.Bolus) H.Jacobsen & Schwantes | LC | Indigenous; Endemic |
| **Aizoaceae** | *Malephora purpureocrocea* | (Haw.) Schwantes | LC | Indigenous; Endemic |
| **Aizoaceae** | *Malephora sp.* | | | |

| | | | | |
|---|---|---|---|---|
| **Scrophulariaceae** | *Manulea altissima subsp. altissima* | L.f. | LC | Indigenous; Endemic |
| **Scrophulariaceae** | *Manulea altissima subsp. glabricaulis* | L.f. | LC | Indigenous; Endemic |
| **Scrophulariaceae** | *Manulea altissima subsp. longifolia* | L.f. | LC | Indigenous; Endemic |
| **Scrophulariaceae** | *Manulea decipiens* | Hilliard | LC | Indigenous; Endemic |
| **Fabaceae** | *Melilotus albus* | Medik. | NE | Not indigenous; Naturalised; Invasive |
| **Fabaceae** | *Melilotus indicus* | (L.) All. | NE | Not indigenous; Naturalised; Invasive |
| **Fabaceae** | *Melolobium adenodes* | Eckl. & Zeyh. | LC | Indigenous |
| **Fabaceae** | *Melolobium aethiopicum* | (L.) Druce | LC | Indigenous; Endemic |
| **Fabaceae** | *Melolobium candicans* | (E.Mey.) Eckl. & Zeyh. | LC | Indigenous |
| **Fabaceae** | *Melolobium sp.* | | | |
| **Aizoaceae** | *Mesembryanthemum articulatum* | Thunb. | | Indigenous |
| **Aizoaceae** | *Mesembryanthemum barklyi* | N.E.Br. | LC | Indigenous |
| **Aizoaceae** | *Mesembryanthemum brevicarpum* | (L.Bolus) Klak | | Indigenous |
| **Aizoaceae** | *Mesembryanthemum dinteri* | Engl. | | Indigenous |
| **Aizoaceae** | *Mesembryanthemum fastigiatum* | Thunb. | LC | Indigenous; Endemic |
| **Aizoaceae** | *Mesembryanthemum granulicaule* | Haw. | | Indigenous |
| **Aizoaceae** | *Mesembryanthemum guerichianum* | Pax | LC | Indigenous |
| **Aizoaceae** | *Mesembryanthemum junceum* | Haw. | | Indigenous; Endemic |
| **Aizoaceae** | *Mesembryanthemum leptarthron* | A.Berger | | Indigenous; Endemic |
| **Aizoaceae** | *Mesembryanthemum nitidum* | Haw. | | Indigenous; Endemic |
| **Aizoaceae** | *Mesembryanthemum noctiflorum* | L. | | Indigenous |
| **Aizoaceae** | *Mesembryanthemum nodiflorum* | L. | LC | Indigenous |
| **Aizoaceae** | *Mesembryanthemum pallens subsp. pallens* | Aiton | | Indigenous; Endemic |
| **Aizoaceae** | *Mesembryanthemum salicornioides* | Pax | | Indigenous |
| **Aizoaceae** | *Mesembryanthemum serotinum* | (L.Bolus) Klak | | Indigenous |
| **Aizoaceae** | *Mesembryanthemum sp.* | | | |
| **Aizoaceae** | *Mesembryanthemum spinuliferum* | Haw. | | Indigenous; Endemic |
| **Aizoaceae** | *Mesembryanthemum trichotomum* | Thunb. | | Indigenous; Endemic |
| **Campanulaceae** | *Microcodon linearis* | (L.f.) H.Buek | LC | Indigenous; Endemic |
| **Apocynaceae** | *Microloma sagittatum* | (L.) R.Br. | LC | Indigenous; Endemic |
| **Aizoaceae** | *Monilaria moniliformis* | (Thunb.) Ihlenf. & S.Jorg. | LC | Indigenous; Endemic |
| **Aizoaceae** | *Monilaria pisiformis* | (Haw.) Schwantes | EN | Indigenous; Endemic |
| **Geraniaceae** | *Monsonia spinosa* | L'Her. | LC | Indigenous; Endemic |
| **Iridaceae** | *Moraea ciliata* | (L.f.) Ker Gawl. | LC | Indigenous; Endemic |

| | | | | |
|---|---|---|---|---|
| **Iridaceae** | *Moraea ciliata subsp. cuprina* | (L.f.) Ker Gawl. | | Indigenous; Endemic |
| **Iridaceae** | *Moraea falcifolia* | Klatt | LC | Indigenous |
| **Iridaceae** | *Moraea miniata* | Andrews | LC | Indigenous; Endemic |
| **Iridaceae** | *Moraea quartzicola* | Goldblatt & J.C.Manning | VU | Indigenous |
| **Iridaceae** | *Moraea serpentina* | Baker | LC | Indigenous; Endemic |
| **Polygalaceae** | *Muraltia obovata* | DC. | VU | Indigenous; Endemic |
| **Polygalaceae** | *Muraltia spinosa* | (L.) F.Forest & J.C.Manning | LC | Indigenous; Endemic |
| **Scrophulariaceae** | *Nemesia bicornis* | (L.) Pers. | LC | Indigenous; Endemic |
| **Scrophulariaceae** | *Nemesia cheiranthus* | E.Mey. ex Benth. | LC | Indigenous; Endemic |
| **Scrophulariaceae** | *Nemesia euryceras* | Schltr. | LC | Indigenous; Endemic |
| **Scrophulariaceae** | *Nemesia ligulata* | E.Mey. ex Benth. | LC | Indigenous; Endemic |
| **Scrophulariaceae** | *Nemesia macroceras var. macroceras* | Schltr. | NE | Indigenous; Endemic |
| **Scrophulariaceae** | *Nemesia pulchella* | Schltr. ex Hiern | LC | Indigenous; Endemic |
| **Scrophulariaceae** | *Nemesia sp.* | | | |
| **Poaceae** | *Odyssea paucinervis* | (Nees) Stapf | LC | Indigenous |
| **Asteraceae** | *Oedera silicicola* | (K.Bremer) Anderb. & K.Bremer | VU | Indigenous; Endemic |
| **Asteraceae** | *Oncosiphon grandiflorus* | (Thunb.) Kallersjo | LC | Indigenous |
| **Asteraceae** | *Oncosiphon suffruticosus* | (L.) Kallersjo | LC | Indigenous |
| **Aizoaceae** | *Oophytum oviforme* | (N.E.Br.) N.E.Br. | LC | Indigenous; Endemic |
| **Ophioglossaceae** | *Ophioglossum polyphyllum var. polyphyllum* | A.Braun | LC | Indigenous |
| **Hyacinthaceae** | *Ornithogalum hallii* | Oberm. | EN | Indigenous; Endemic |
| **Hyacinthaceae** | *Ornithogalum maculatum* | Jacq. | LC | Indigenous; Endemic |
| **Hyacinthaceae** | *Ornithogalum naviculum* | W.F.Barker | VU | Indigenous; Endemic |
| **Orobanchaceae** | *Orobanche ramosa* | L. | NE | Not indigenous; Naturalised; Invasive |
| **Aizoaceae** | *Oscularia lunata* | (Willd.) H.E.K.Hartmann | LC | Indigenous; Endemic |
| **Aizoaceae** | *Oscularia steenbergensis* | (L.Bolus) H.E.K.Hartmann | LC | Indigenous; Endemic |
| **Asteraceae** | *Osteospermum amplectens* | (Harv.) Norl. | LC | Indigenous; Endemic |
| **Asteraceae** | *Osteospermum moniliferum subsp. pisiferum* | L. | LC | Indigenous; Endemic |
| **Asteraceae** | *Osteospermum oppositifolium* | (Aiton) Norl. | LC | Indigenous |
| **Asteraceae** | *Osteospermum sinuatum var. sinuatum* | (DC.) Norl. | LC | Indigenous |
| **Asteraceae** | *Osteospermum sp.* | | | |
| **Fabaceae** | *Otholobium incanum* | C.H.Stirt. | EN | Indigenous; Endemic |
| **Asteraceae** | *Othonna arborescens* | L. | LC | Indigenous; Endemic |
| **Asteraceae** | *Othonna cakilefolia* | DC. | VU | Indigenous; Endemic |
| **Asteraceae** | *Othonna furcata* | (Lindl.) Druce | LC | Indigenous |

| | | | | |
|---|---|---|---|---|
| **Asteraceae** | *Othonna hallii* | B.Nord. | VU | Indigenous; Endemic |
| **Asteraceae** | *Othonna intermedia* | Compton | NT | Indigenous; Endemic |
| **Asteraceae** | *Othonna obtusiloba* | Harv. | LC | Indigenous; Endemic |
| **Asteraceae** | *Othonna sp.* | | | |
| **Oxalidaceae** | *Oxalis glabra* | Thunb. | LC | Indigenous; Endemic |
| **Oxalidaceae** | *Oxalis gracilis* | Jacq. | | Indigenous |
| **Oxalidaceae** | *Oxalis sp.* | | | |
| **Poaceae** | *Panicum maximum* | Jacq. | LC | Indigenous |
| **Poaceae** | *Panicum repens* | L. | LC | Indigenous |
| **Poaceae** | *Paspalum dilatatum* | Poir. | NE | Not indigenous; Naturalised; Invasive |
| **Geraniaceae** | *Pelargonium appendiculatum* | (L.f.) Willd. | EN | Indigenous; Endemic |
| **Geraniaceae** | *Pelargonium capitatum* | (L.) L'Her. | LC | Indigenous |
| **Geraniaceae** | *Pelargonium carnosum subsp. carnosum* | (L.) L'Her. | LC | Indigenous |
| **Geraniaceae** | *Pelargonium crassipes* | Harv. | EN | Indigenous; Endemic |
| **Geraniaceae** | *Pelargonium crithmifolium* | Sm. | LC | Indigenous |
| **Geraniaceae** | *Pelargonium echinatum* | Curtis | LC | Indigenous; Endemic |
| **Geraniaceae** | *Pelargonium fulgidum* | (L.) L'Her. | LC | Indigenous; Endemic |
| **Geraniaceae** | *Pelargonium oenothera* | (L.f.) Jacq. | LC | Indigenous; Endemic |
| **Geraniaceae** | *Pelargonium paniculatum* | Jacq. | LC | Indigenous |
| **Geraniaceae** | *Pelargonium praemorsum subsp. praemorsum* | (Andrews) F.Dietr. | LC | Indigenous; Endemic |
| **Geraniaceae** | *Pelargonium senecioides* | L'Her. | LC | Indigenous; Endemic |
| **Poaceae** | *Pennisetum setaceum* | (Forssk.) Chiov. | NE | Not indigenous; Naturalised; Invasive |
| **Poaceae** | *Phalaris minor* | Retz. | NE | Not indigenous; Naturalised |
| **Molluginaceae** | *Pharnaceum aurantium* | (DC.) Druce | LC | Indigenous |
| **Molluginaceae** | *Pharnaceum croceum* | E.Mey. ex Fenzl | LC | Indigenous |
| **Molluginaceae** | *Pharnaceum exiguum* | Adamson | LC | Indigenous |
| **Scrophulariaceae** | *Phyllopodium phyllopodioides* | (Schltr.) Hilliard | LC | Indigenous; Endemic |
| **Scrophulariaceae** | *Phyllopodium pumilum* | Benth. | LC | Indigenous |
| **Scrophulariaceae** | *Phyllopodium sp.* | | | |
| **Plantaginaceae** | *Plantago cafra* | Decne. | LC | Indigenous |
| **Plantaginaceae** | *Plantago lanceolata* | L. | LC | Indigenous |
| **Scrophulariaceae** | *Polycarena gracilis* | Hilliard | LC | Indigenous; Endemic |
| **Polygalaceae** | *Polygala ephedroides* | Burch. | LC | Indigenous |
| **Polygonaceae** | *Polygonum maritimum* | L. | | Not indigenous; Naturalised |
| **Poaceae** | *Polypogon monspeliensis* | (L.) Desf. | NE | Not indigenous; Naturalised |
| **Pottiaceae** | *Pseudocrossidium crinitum* | (Schultz) R.H.Zander | | Indigenous |

| | | | | |
|---|---|---|---|---|
| **Aizoaceae** | *Psilocaulon sp.* | | | |
| **Asteraceae** | *Pteronia ciliata* | Thunb. | LC | Indigenous |
| **Asteraceae** | *Pteronia divaricata* | (P.J.Bergius) Less. | LC | Indigenous |
| **Asteraceae** | *Pteronia glabrata* | L.f. | LC | Indigenous |
| **Asteraceae** | *Pteronia heterocarpa* | DC. | LC | Indigenous; Endemic |
| **Asteraceae** | *Pteronia incana* | (Burm.) DC. | LC | Indigenous; Endemic |
| **Asteraceae** | *Pteronia inflexa* | Thunb. ex L.f. | LC | Indigenous |
| **Asteraceae** | *Pteronia intermedia* | Hutch. & E.Phillips | LC | Indigenous; Endemic |
| **Asteraceae** | *Pteronia paniculata* | Thunb. | LC | Indigenous |
| **Orchidaceae** | *Pterygodium crispum* | (Thunb.) Schltr. | LC | Indigenous; Endemic |
| **Apocynaceae** | *Quaqua pulchra* | (Bruyns) Plowes | EN | Indigenous; Endemic |
| **Restionaceae** | *Restio longiaristatus* | (Pillans ex H.P.Linder) H.P.Linder & C.R.Hardy | LC | Indigenous; Endemic |
| **Restionaceae** | *Restio macer* | Kunth | LC | Indigenous; Endemic |
| **Zygophyllaceae** | *Roepera cordifolia* | (L.f.) Beier & Thulin | | Indigenous |
| **Zygophyllaceae** | *Roepera foetida* | (Schrad. & J.C.Wendl.) Beier & Thulin | | Indigenous |
| **Zygophyllaceae** | *Roepera morgsana* | (L.) Beier & Thulin | | Indigenous |
| **Iridaceae** | *Romulea lutea* | J.C.Manning & Goldblatt | CR | Indigenous; Endemic |
| **Iridaceae** | *Romulea sinispinosensis* | M.P.de Vos | EN | Indigenous; Endemic |
| **Aizoaceae** | *Ruschia bipapillata* | L.Bolus | VU | Indigenous; Endemic |
| **Aizoaceae** | *Ruschia langebaanensis* | L.Bolus | VU | Indigenous; Endemic |
| **Aizoaceae** | *Ruschia leucosperma* | L.Bolus | LC | Indigenous; Endemic |
| **Aizoaceae** | *Ruschia macowanii* | (L.Bolus) Schwantes | LC | Indigenous; Endemic |
| **Aizoaceae** | *Ruschia sp.* | | | |
| **Aizoaceae** | *Ruschia stricta* | L.Bolus | LC | Indigenous; Endemic |
| **Aizoaceae** | *Ruschia subpaniculata* | L.Bolus | LC | Indigenous; Endemic |
| **Aizoaceae** | *Ruschia tumidula* | (Haw.) Schwantes | LC | Indigenous; Endemic |
| **Aizoaceae** | *Ruschia versicolor* | L.Bolus | LC | Indigenous; Endemic |
| **Amaranthaceae** | *Salicornia sp.* | | | |
| **Salicaceae** | *Salix mucronata subsp. mucronata* | Thunb. | LC | Indigenous |
| **Amaranthaceae** | *Salsola araneosa* | Botsch. | LC | Indigenous |
| **Amaranthaceae** | *Salsola glabrescens* | Burtt Davy | LC | Indigenous |
| **Amaranthaceae** | *Salsola inaperta* | Botsch. | LC | Indigenous |
| **Amaranthaceae** | *Salsola patentipilosa* | Botsch. | LC | Indigenous; Endemic |
| **Amaranthaceae** | *Salsola sp.* | | | |
| **Amaranthaceae** | *Salsola tetramera* | Botsch. | LC | Indigenous; Endemic |
| **Amaranthaceae** | *Salsola tuberculata* | (Moq.) Fenzl | LC | Indigenous |
| **Amaranthaceae** | *Sarcocornia mossiana* | (Toelken) A.J.Scott | LC | Indigenous; Endemic |
| **Amaranthaceae** | *Sarcocornia natalensis var. natalensis* | (Bunge ex Ung.-Sternb.) A.J.Scott | LC | Indigenous |

| | | | | |
|---|---|---|---|---|
| **Amaranthaceae** | *Sarcocornia perennis var. lignosa* | (Mill.) A.J.Scott | LC | Indigenous |
| **Amaranthaceae** | *Sarcocornia perennis var. perennis* | (Mill.) A.J.Scott | LC | Indigenous |
| **Amaranthaceae** | *Sarcocornia pillansii var. pillansii* | (Moss) A.J.Scott | LC | Indigenous |
| **Amaranthaceae** | *Sarcocornia tegetaria* | S.Steffen, Mucina & G.Kadereit | LC | Indigenous |
| **Poaceae** | *Schismus barbatus* | (Loefl. ex L.) Thell. | LC | Indigenous |
| **Poaceae** | *Schismus schismoides* | (Stapf ex Conert) Verboom & H.P.Linder | LC | Indigenous |
| **Aizoaceae** | *Schlechteranthus spinescens* | (L.Bolus) R.F.Powell | | Indigenous; Endemic |
| **Anacardiaceae** | *Searsia dissecta* | (Thunb.) Moffett | LC | Indigenous; Endemic |
| **Anacardiaceae** | *Searsia incisa var. incisa* | (L.f.) F.A.Barkley | LC | Indigenous; Endemic |
| **Scrophulariaceae** | *Selago heterotricha* | Hilliard | EN | Indigenous; Endemic |
| **Scrophulariaceae** | *Selago sp.* | | | |
| **Asteraceae** | *Senecio arenarius* | Thunb. | LC | Indigenous |
| **Asteraceae** | *Senecio bulbinifolius* | DC. | LC | Indigenous |
| **Asteraceae** | *Senecio littoreus var. littoreus* | Thunb. | LC | Indigenous; Endemic |
| **Asteraceae** | *Senecio maritimus* | L.f. | LC | Indigenous; Endemic |
| **Asteraceae** | *Senecio sp.* | | | |
| **Loranthaceae** | *Septulina glauca* | (Thunb.) Tiegh. | LC | Indigenous |
| **Poaceae** | *Setaria pumila* | (Poir.) Roem. & Schult. | LC | Indigenous |
| **Caryophyllaceae** | *Spergularia media* | (L.) C.Presl | | Not indigenous; Naturalised |
| **Poaceae** | *Sphenopus divaricatus* | (Gouan) Rchb. | NE | Not indigenous; Naturalised; Invasive |
| **Poaceae** | *Stipagrostis ciliata var. capensis* | (Desf.) De Winter | LC | Indigenous |
| **Poaceae** | *Stipagrostis namaquensis* | (Nees) De Winter | LC | Indigenous |
| **Poaceae** | *Stipagrostis zeyheri subsp. macropus* | (Nees) De Winter | LC | Indigenous |
| **Asteraceae** | *Stoebe fusca* | (L.) Thunb. | LC | Indigenous; Endemic |
| **Asteraceae** | *Stoebe nervigera* | (DC.) Sch.Bip. | LC | Indigenous; Endemic |
| **Aizoaceae** | *Stoeberia frutescens* | (L.Bolus) Van Jaarsv. | LC | Indigenous |
| **Aizoaceae** | *Stoeberia utilis* | (L.Bolus) Van Jaarsv. | | Indigenous |
| **Amaryllidaceae** | *Strumaria truncata* | Jacq. | LC | Indigenous; Endemic |
| **Thymelaeaceae** | *Struthiola leptantha* | Bolus | LC | Indigenous; Endemic |
| **Thymelaeaceae** | *Struthiola striata* | Lam. | LC | Indigenous; Endemic |
| **Amaranthaceae** | *Suaeda fruticosa* | (L.) Forssk. | LC | Indigenous |
| **Amaranthaceae** | *Suaeda inflata* | Aellen | LC | Indigenous |
| **Zygophyllaceae** | *Tetraena retrofracta* | (Thunb.) Beier & Thulin | | Indigenous |
| **Aizoaceae** | *Tetragonia decumbens* | Mill. | LC | Indigenous |
| **Aizoaceae** | *Tetragonia fruticosa* | L. | LC | Indigenous |
| **Aizoaceae** | *Tetragonia nigrescens* | Eckl. & Zeyh. | LC | Indigenous; Endemic |
| **Aizoaceae** | *Tetragonia rosea* | Schltr. | LC | Indigenous; Endemic |

| | | | | |
|---|---|---|---|---|
| **Santalaceae** | *Thesium elatius* | Sond. | LC | Indigenous; Endemic |
| **Santalaceae** | *Thesium hispidulum var. hispidulum* | Lam. | LC | Indigenous; Endemic |
| **Santalaceae** | *Thesium pubescens* | A.DC. | LC | Indigenous; Endemic |
| **Santalaceae** | *Thesium sp.* | | | |
| **Santalaceae** | *Thesium spinosum* | L.f. | LC | Indigenous; Endemic |
| **Pottiaceae** | *Tortula atrovirens* | (Sm.) Lindb. | | Indigenous |
| **Asphodelaceae** | *Trachyandra ciliata* | (L.f.) Kunth | LC | Indigenous |
| **Asphodelaceae** | *Trachyandra divaricata* | (Jacq.) Kunth | LC | Indigenous; Endemic |
| **Asphodelaceae** | *Trachyandra falcata* | (L.f.) Kunth | LC | Indigenous |
| **Asphodelaceae** | *Trachyandra involucrata* | (Baker) Oberm. | LC | Indigenous; Endemic |
| **Asphodelaceae** | *Trachyandra muricata* | (L.f.) Kunth | LC | Indigenous |
| **Poaceae** | *Tribolium acutiflorum* | (Nees) Renvoize | LC | Indigenous; Endemic |
| **Poaceae** | *Tribolium pusillum* | (Nees) H.P.Linder & Davidse | LC | Indigenous; Endemic |
| **Crassulaceae** | *Tylecodon fragilis* | (R.A.Dyer) Toelken | EN | Indigenous; Endemic |
| **Crassulaceae** | *Tylecodon pearsonii* | (Schonland) Toelken | LC | Indigenous |
| **Crassulaceae** | *Tylecodon pygmaeus* | (W.F.Barker) Toelken | LC | Indigenous; Endemic |
| **Crassulaceae** | *Tylecodon reticulatus subsp. reticulatus* | (L.f.) Toelken | LC | Indigenous |
| **Crassulaceae** | *Tylecodon striatus* | (Hutchison) Toelken | LC | Indigenous; Endemic |
| **Crassulaceae** | *Tylecodon tenuis* | (Toelken) Bruyns | LC | Indigenous; Endemic |
| **Asteraceae** | *Ursinia speciosa* | DC. | LC | Indigenous |
| **Aizoaceae** | *Vanzijlia annulata* | (A.Berger) L.Bolus | LC | Indigenous; Endemic |
| **Campanulaceae** | *Wahlenbergia annularis* | A.DC. | LC | Indigenous |
| **Campanulaceae** | *Wahlenbergia asparagoides* | (Adamson) Lammers | NT | Indigenous; Endemic |
| **Campanulaceae** | *Wahlenbergia costata* | A.DC. | LC | Indigenous; Endemic |
| **Campanulaceae** | *Wahlenbergia polyclada* | A.DC. | DD | Indigenous; Endemic |
| **Fabaceae** | *Wiborgia mucronata* | (L.f.) Druce | LC | Indigenous; Endemic |
| **Fabaceae** | *Wiborgia obcordata* | (P.J.Bergius) Thunb. | LC | Indigenous; Endemic |
| **Fabaceae** | *Wiborgia sp.* | | | |
| **Restionaceae** | *Willdenowia glomerata* | (Thunb.) H.P.Linder | LC | Indigenous; Endemic |
| **Scrophulariaceae** | *Zaluzianskya affinis* | Hilliard | LC | Indigenous; Endemic |
| **Scrophulariaceae** | *Zaluzianskya benthamiana* | Walp. | LC | Indigenous |
| **Scrophulariaceae** | *Zaluzianskya pumila* | (Benth.) Walp. | LC | Indigenous; Endemic |
| **Zygophyllaceae** | *Zygophyllum sp.* | | | |

## 11.2 Appendix B – Amphibian species expected to occur in the project area

| Species | Common Name | Conservation Status | |
|---|---|---|---|
| | | Regional (SANBI, 2016) | IUCN (2021) |
| ***Amietia fuscigula*** | Common River Frog | LC | LC |
| ***Breviceps montanus*** | Cape Mountain Rain Frog | LC | LC |
| ***Breviceps namaquensis*** | Namaqua Rain Frog | LC | LC |
| ***Cacosternum karooicum*** | Karoo Caco | DD | LC |
| ***Cacosternum namaquense*** | Namaqua Caco | LC | LC |
| ***Capensibufo tradouwi*** | Tradouw Mountain Toad | LC | LC |
| ***Sclerophrys capensis*** | Raucous Toad | LC | LC |
| ***Strongylopus grayii*** | Clicking Stream Frog | LC | LC |
| ***Tomopterna delalandii*** | Cape Sand Frog | LC | LC |
| ***Vandijkophrynus angusticeps*** | Sand Toad | LC | LC |
| ***Vandijkophrynus gariepensis gariepensis*** | Karoo Toad | Not listed | Not listed |
| ***Vandijkophrynus robinsoni*** | Paradise toad | LC | LC |
| ***Xenopus laevis*** | Common Platanna | LC | LC |

## 11.3 Appendix C – Reptile species expected to occur in the project area

| Species | Common Name | Conservation Status | |
|---|---|---|---|
| | | Regional (SANBI, 2016) | IUCN (2021) |
| *Acontias grayi* | Gray's Dwarf Legless Skink | LC | LC |
| *Acontias lineatus* | Striped Dwarf Legless Skink | LC | LC |
| *Acontias litoralis* | Coastal Dwarf Legless Skink | LC | LC |
| *Acontias meleagris* | Cape Legless Skink | LC | LC |
| *Agama aculeata aculeata* | Western Ground Agama | LC | Unlisted |
| *Agama atra* | Southern Rock Agama | LC | LC |
| *Agama hispida* | Southern Spiny Agama | LC | LC |
| *Aspidelaps lubricus lubricus* | Cape coral snake | LC | LC |
| *Bitis arietans arietans* | Puff Adder | LC | Unlisted |
| *Boaedon capensis* | Brown House Snake | LC | LC |
| *Boaedon mentalis* | Bug-eyed House Snake | Unlisted | LC |
| *Bradypodion occidentale* | Western Dwarf Chameleon | LC | LC |
| *Chamaeleo namaquensis* | Namaqua Chameleon | LC | LC |
| *Chersina angulata* | Angulate Tortoise | LC | LC |
| *Chersobius signatus* | Speckled Dwarf Tortoise | EN | EN |
| *Chondrodactylus angulifer* | Common Giant Gecko | LC | LC |
| *Chondrodactylus bibronii* | Bibron's Gecko | LC | Unlisted |
| *Cordylosaurus subtessellatus* | Dwarf Plated Lizard | LC | LC |
| *Cordylus cordylus* | Cape Girdles Lizard | LC | LC |
| *Cordylus mclachlani* | Mclachlan's Girdled Lizard | LC | LC |
| *Crotaphopeltis hotamboeia* | Red-lipped Snake | LC | Unlisted |
| *Dasypeltis scabra* | Rhombic Egg-eater | LC | LC |
| *Dipsina multimaculata* | Dwarf Beaked Snake | LC | Unlisted |
| *Dispholidus typus* | Boomslang | LC | Unlisted |
| *Gerrhosaurus typicus* | Karoo plated lizard | Unlisted | Unlisted |
| *Goggia hexapora* | Cederberg Pygmy Gecko | LC | LC |
| *Goggia incognita* | Striped Pygmy Gecko | LC | LC |
| *Goggia matzikamaensis* | Matzikama Gecko | NT | LC |
| *Hemicordylus capensis* | Cape Cliff Lizard | LC | LC |
| *Hemidactylus mabouia* | Common Tropical House Gecko | LC | Unlisted |
| *Homoroselaps lacteus* | Spotted Harlequin Snake | LC | LC |
| *Karusasaurus polyzonus* | Southern Karusa Lizard | LC | LC |
| *Lamprophis guttatus* | Spotted Rock Snake | LC | LC |
| *Lygodactylus capensis* | Cape dwarf gecko | LC | LC |
| *Meroles knoxii* | Knox's Desert Lizard | LC | LC |
| *Naja nigricincta woodi* | Black Spitting Cobra | LC | Unlisted |

| | | | |
|---|---|---|---|
| ***Naja nivea*** | Cape Cobra | LC | Unlisted |
| ***Namazonurus peersi*** | Peer's Nama Lizard | LC | LC |
| ***Namibiana gracilior*** | Slender Thread Snake | LC | LC |
| ***Nucras tessellata*** | Western Sandveld Lizard | LC | Unlisted |
| ***Pachydactylus austeni*** | Austen's Thick-toed Gecko | Unlisted | LC |
| ***Pachydactylus capensis*** | Cape Gecko | LC | Unlisted |
| ***Pachydactylus formosus*** | Southern Rough Gecko | LC | LC |
| ***Pachydactylus geitje*** | Ocellated Gecko | LC | LC |
| ***Pachydactylus labialis*** | Western Cape Gecko | LC | LC |
| ***Pachydactylus mariquensis*** | Common Banded Gecko | LC | LC |
| ***Pachydactylus purcelli*** | Purcell's Gecko | LC | Unlisted |
| ***Pachydactylus weberi*** | Weber's Gecko | LC | LC |
| ***Pedioplanis laticeps*** | Karoo Sand Lizard | LC | LC |
| ***Pedioplanis lineoocellata pulchella*** | Common sand lizard | LC | LC |
| ***Pedioplanis namaquensis*** | Namaqua Sand Lizard | LC | Unlisted |
| ***Prosymna sundevallii*** | Sundevall's Shovel-snout | LC | LC |
| ***Psammobates tentorius*** | Tent Tortoise | LC | LC |
| ***Psammophis crucifer*** | Cross-marked Grass Snake | LC | LC |
| ***Psammophis leightoni*** | Cape Sand Snake | VU | VU |
| ***Psammophis notostictus*** | Karoo Sand Snake | LC | Unlisted |
| ***Psammophylax rhombeatus*** | Spotted Grass Snake | LC | Unlisted |
| ***Pseudaspis cana*** | Mole Snake | LC | Unlisted |
| ***Ptenopus garrulus maculatus*** | Spotted Barking Gecko | LC | Unlisted |
| ***Rhinotyphlops lalandei*** | Delalande's Beaked Blind Snake | LC | Unlisted |
| ***Scelotes caffer*** | Cape Dwarf Burrowing Skink | LC | LC |
| ***Scelotes gronovii*** | Gronovi's Dwarf Burrowing Skink | NT | NT |
| ***Scelotes sexlineatus*** | Striped Dwarf Burrowing Skink | LC | LC |
| ***Telescopus beetzi*** | Beetz's tiger snake | Unlisted | LC |
| ***Trachylepis capensis*** | Cape Skink | LC | Unlisted |
| ***Trachylepis sulcata sulcata*** | Westren Rock Skink | LC | Unlisted |
| ***Trachylepis variegata*** | Variegated Skink | LC | Unlisted |
| ***Typhlosaurus caecus*** | Southern Blind Legless Skink | LC | LC |

## 11.4 Appendix D – Mammal species expected to occur within the project area

| Species | Common Name | Conservation Status | |
|---|---|---|---|
| | | Regional (SANBI, 2016) | IUCN (2021) |
| ***Aethomys namaquensis*** | Namaqua rock rat | LC | LC |
| ***Antidorcas marsupialis*** | Springbok | LC | LC |
| ***Atilax paludinosus*** | Water Mongoose | LC | LC |
| ***Canis mesomelas*** | Black-backed Jackal | LC | LC |
| ***Caracal caracal*** | Caracal | LC | LC |
| ***Chrysochloris asiatica*** | Cape Golden Mole | LC | LC |
| ***Crocidura cyanea*** | Reddish-grey Musk Shrew | LC | LC |
| ***Crocidura flavescens*** | Greater Red Musk Shrew | LC | LC |
| ***Cryptomys hottentotus*** | Common Mole-rat | LC | LC |
| ***Cynictis penicillata*** | Yellow Mongoose | LC | LC |
| ***Dendromus melanotis*** | Grey Climbing Mouse | LC | LC |
| ***Desmodillus auricularis*** | Short-tailed Gerbil | LC | LC |
| ***Eptesicus hottentotus*** | Long-tailed Serotine Bat | LC | LC |
| ***Eremitalpa granti*** | Grant's Golden Mole | VU | Unlisted |
| ***Felis nigripes*** | Black-footed Cat | VU | VU |
| ***Felis silvestris*** | African Wildcat | LC | LC |
| ***Genetta genetta*** | Small-spotted Genet | LC | LC |
| ***Gerbilliscus afra*** | Cape Gerbil | LC | LC |
| ***Gerbillurus paeba*** | Hairy-footed Gerbil | LC | LC |
| ***Graphiurus ocularis*** | Spectacular Dormouse | NT | LC |
| ***Herpestes ichneumon*** | Large Grey Mongoose | LC | LC |
| ***Herpestes pulverulentus*** | Cape Grey Mongoose | LC | LC |
| ***Hystrix africaeaustralis*** | Cape Porcupine | LC | LC |
| ***Ictonyx striatus*** | Striped Polecat | LC | LC |
| ***Leptailurus serval*** | Serval | NT | LC |
| ***Lepus capensis*** | Cape Hare | LC | LC |
| ***Lepus saxatilis*** | Scrub Hare | LC | LC |
| ***Macroscelides proboscideus*** | Karoo Round-eared Sengi | LC | LC |
| ***Malacothrix typica*** | Gerbil Mouse | LC | LC |
| ***Mellivora capensis*** | Honey Badger | LC | LC |
| ***Mus minutoides*** | Pygmy Mouse | LC | LC |
| ***Mus musculus*** | House Mouse | Unlisted | LC |
| ***Myosorex varius*** | Forest Shrew | LC | LC |
| ***Mystromys albicaudatus*** | White-tailed Rat | VU | EN |
| ***Neoromicia capensis*** | Cape Serotine Bat | LC | LC |
| ***Nycteris thebaica*** | Egyptian Slit-faced Bat | LC | LC |

| | | | |
|---|---|---|---|
| ***Oreotragus oreotragus*** | Klipspringer | LC | LC |
| ***Orycteropus afer*** | Aardvark | LC | LC |
| ***Otocyon megalotis*** | Bat-eared Fox | LC | LC |
| ***Otomys saundersiae*** | Saunder's vlei rat | LC | LC |
| ***Otomys unisulcatus*** | Karoo Bush Rat | LC | LC |
| ***Panthera pardus*** | Leopard | VU | VU |
| ***Papio ursinus*** | Chacma Baboon | LC | LC |
| ***Parotomys brantsii*** | Brants' Whistling Rat | LC | LC |
| ***Parotomys littledalei*** | Littledale's Whistling Rat | NT | LC |
| ***Procavia capensis*** | Rock Hyrax | LC | LC |
| ***Proteles cristata*** | Aardwolf | LC | LC |
| ***Raphicerus campestris*** | Steenbok | LC | LC |
| ***Raphicerus melanotis*** | Southern grysbok | LC | LC |
| ***Rattus rattus*** | House Rat | Exotic (Not listed) | LC |
| ***Rhabdomys pumilio*** | Xeric Four-striped Mouse | LC | LC |
| ***Rhinolophus capensis*** | Cape Horseshoe Bat | LC | LC |
| ***Rhinolophus clivosus*** | Geoffroy's Horseshoe Bat | LC | LC |
| ***Suncus varilla*** | Lesser Dwarf Shrew | LC | LC |
| ***Suricata suricatta*** | Suricate | LC | LC |
| ***Sylvicapra grimmia*** | Common Duiker | LC | LC |
| ***Tadarida aegyptiaca*** | Egyptian Free-tailed Bat | LC | LC |
| ***Vulpes chama*** | Cape Fox | LC | LC |

# APPENDIX D

# SPECIALISTS' REPORTS

## APPENDIX D2 - Avifaunal Assessment

# AVIFAUNAL ASSESSMENT FOR THE PROPOSED SERE PHOTOVOLTAIC DEVELOPMENT

## Koekenaap, Western Cape Province

July 2022

**CLIENT**


**Prepared by:**

**The Biodiversity Company**

Cell: +27 81 319 1225

Fax: +27 86 527 1965

info@thebiodiversitycompany.com

www.thebiodiversitycompany.com

| | |
|---|---|
| Report Name | **AVIFAUNAL ASSESSMENT FOR THE PROPOSED SERE PHOTOVOLTAIC DEVELOPMENT** |
| Reference | **SERE PV** |
| Submitted to | NEMAI CONSULTING |
| Field Work (Summer), Report Writer | **Ernest Porter**<br>Ernest has gained birding experience in the Northern Cape, North West, Mpumalanga, Limpopo, KwaZulu-Natal, Free State, Western Cape and also Gauteng. He is a qualified FGASA NQF2 Field Guide and a committee member of Black Eagle Project Roodekrans and The Botanical Society of South Africa (Bankenveld Branch). |
| Report Writer Desktop | **Dr Lindi Steyn**<br>Dr Lindi Steyn has completed her PhD in Biodiversity and Conservation from the University of Johannesburg. Lindi is a terrestrial ecologist with a special interest in ornithology. She has completed numerous studies ranging from Basic Assessments to Environmental Impact Assessments following IFC standards. |
| Report Writer (Fauna and Flora) | **Martinus Erasmus**<br>Martinus Erasmus obtained his B-Tech degree in Nature Conservation in 2016 at the Tshwane University of Technology. Martinus has been conducting EIAs, basic assessments and assisting specialists in field during his studies since 2015. Martinus is Cand. Sci. Nat. registered (118630) is a specialist terrestrial ecologist and botanist which conducts floral surveys faunal surveys which include mammals, birds, amphibians and reptiles. |
| Reviewer | **Andrew Husted**<br>Andrew Husted is Pr Sci Nat registered (400213/11) in the following fields of practice: Ecological Science, Environmental Science and Aquatic Science. Andrew is an Aquatic, Wetland and Biodiversity Specialist with more than 12 years' experience in the environmental consulting field. Andrew has completed numerous wetland training courses, and is an accredited wetland practitioner, recognised by the DWS, and also the Mondi Wetlands programme as a competent wetland consultant. |
| Declaration | The Biodiversity Company and its associates operate as independent consultants under the auspice of the South African Council for Natural Scientific Professions. We declare that we have no affiliation with or vested financial interests in the proponent, other than for work performed under the Environmental Impact Assessment Regulations, 2017. We have no conflicting interests in the undertaking of this activity and have no interests in secondary developments resulting from the authorisation of this project. We have no vested interest in the project, other than to provide a professional service within the constraints of the project (timing, time and budget) based on the principals of science. |

# Executive Summary

The hybridisation of the existing Sere Wind Farm with the installation of photovoltaic (PV) capacity was identified as one of the Renewable initiatives in the Eskom Corporate Plan. Sere Wind Farm is a 105.8 MW wind facility located near Vredendal in the Western Cape, which entered into commercial operation on 31 March 2015. In order to address the urgent need for additional generating capacity, it has been proposed that PV technology be installed at the Sere Wind Farm site in phases.

Two layouts – one for the fixed technology (Option A) and the other for tracking technology (Option B) have been considered for two site alternatives. The two site alternatives comprise the two project alternatives being considered. These two site alternatives were assessed during two separate assessments.

The Biodiversity Company was appointed to undertake a Regime 2 avifaunal assessment for the proposed Sere Solar Photovoltaic (PV) facility.

Two main habitat types were verified/identified in the project area, namely Namaqualand Sand Fynbos and Namaqualand Inland Duneveld. The project area overlaps with limited portions of CBA1 and ESA, with the majority of the area OBA and ESA 2. The habitat has experienced some level of disturbance and mismanagement leading from being fenced of and the associated livestock impacts

Site 1 overlaps within sensitive habitats and other areas of high biodiversity potential in the form of a CBA1 area. Site 2 would be considered to have a minor negative impact as it would directly affect small area of the habitat and the faunal species that use these ecosystems.

The development will result in the loss of habitat for these SCCs, it will also lead to sensory disturbance, collision and electrocution risks. Even though the latter three impacts can be mitigated to some extent, the loss of habitat cannot be mitigated. These species could move into surrounding areas however based on the number of applications and current renewable energy development in the area the cumulative impact is also regarded as being high.

Further avifauna assessments may not be necessary, the review of previous reports and data have adequately supplemented the avifauna considerations for this project, however the final decision can be determined by the issuing authorities.

The main expected impacts of the proposed grid infrastructure will include the following:

- habitat loss and fragmentation;
- degradation of surrounding habitat;
- disturbance and displacement caused during the construction and maintenance phases; and
- direct mortality during the construction and operational phases.

Mitigation measures as described in this report can be implemented to achieve an average Moderately-Low residual impact for Site 1, and Low for Site 2. Development of Site 2 is considered acceptable, and Site 1 must remain undeveloped and managed accordingly.

Considering the above-mentioned information, no fatal flaws are evident for the proposed project. It is the opinion of the specialists that the project location, may be favourably considered on condition that all prescribed mitigation measures and supporting recommendations are implemented. Further avifauna assessments are also no recommended, the review of previous reports and data have adequately supplemented the avifauna considerations for this project.

# Table of Contents

# Tables

# Figures

# 1 Introduction

## 1.1 Background

The Biodiversity Company (TBC) was appointed to undertake a Regime 2 avifaunal assessment for the proposed Sere Solar Photovoltaic (PV) facility near Koekenaap, Western Cape (Figure 1-2).

The hybridisation of the existing Sere Wind Farm with the installation of PV capacity was identified as one of the Renewable initiatives in the Eskom Corporate Plan. Sere Wind Farm is a 105.8 MW wind facility located near Vredendal in the Western Cape, which entered into commercial operation on 31 March 2015. In order to address the urgent need for additional generating capacity, it has been proposed that PV technology be installed at the Sere Wind Farm site in phases.

Two layouts – one for the fixed technology (Option A) and the other for tracking technology (Option B) have been considered for two site alternatives (Figure 1-1). The two site alternatives comprise the two project alternatives being considered. These two site alternatives were assessed during two separate assessments. Collectively these two areas have been referred to as the 'project area' from hereon.

**Alternatives that will be considered are outlined below:**

1) Site 1 / First Project Area (Figure 1-3); and
2) Site 2 / Second Project Area (Figure 1-4).

This assessment was deemed a requirement based on information provided by the National Web-Based Environmental Screening Tool (DEA 2021), which demarcated the project area as highly sensitive for the animal environmental theme, the avifauna sensitivity were also rated as medium sensitivity in portion of the project area.

The approach was informed by the Environmental Impact Assessment Regulations. 2014 (GNR 326, 7 April 2017) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA). The approach has taken cognisance of the recently published Government Notices 320 (20 March 2020) in terms of NEMA, dated 20 March and 30 October 2020: "*Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998, when applying for Environmental Authorisation*" (Reporting Criteria). This is contingent of the PV facility providing electricity output of 20 megawatts (MW) or more.

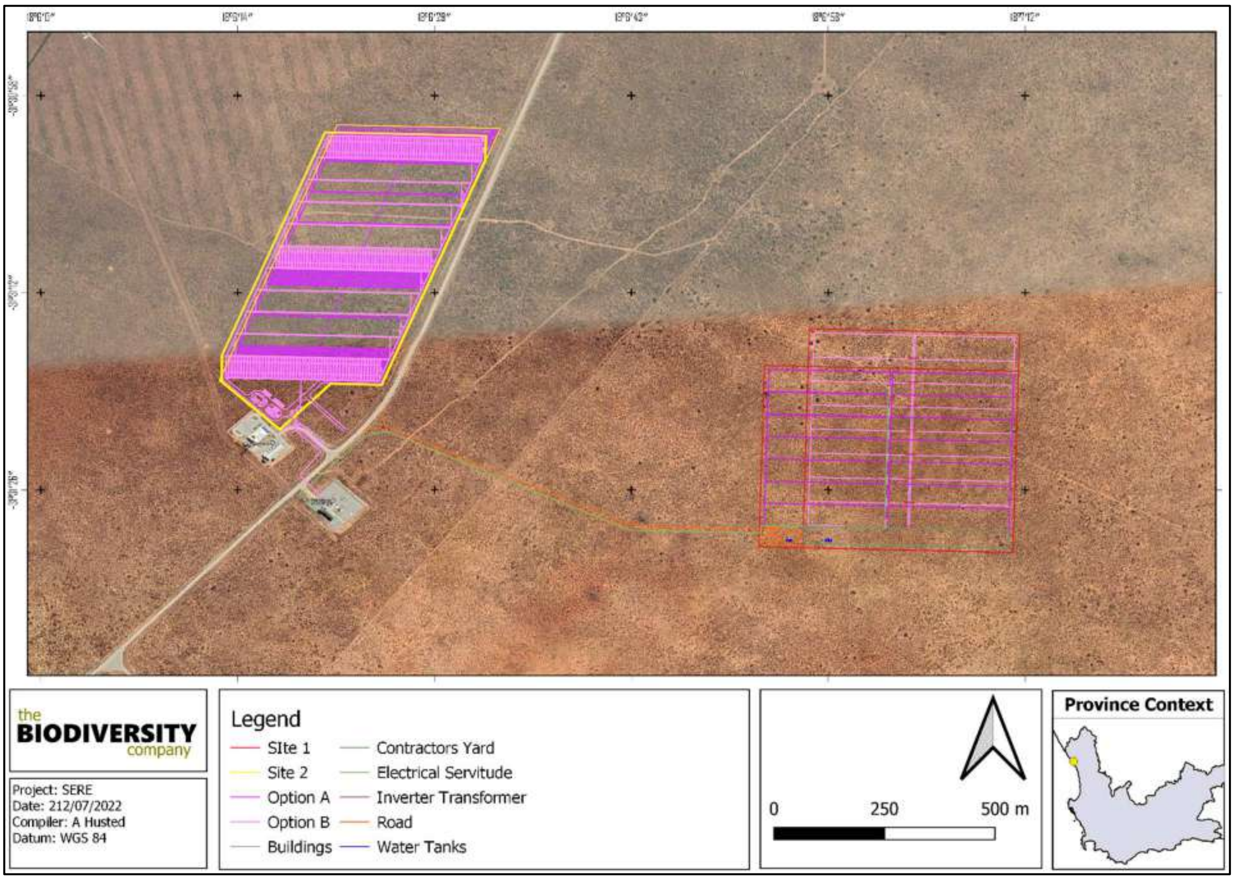



*Figure 1-1 Proposed project site and technology alternatives*

## 1.2 Project Specifications

This project is applicable for the first phase (Phase 1A) of the Sere PV project. Phase 1A aims to address Eskom's urgent need for additional generating capacity.

The facility proposed for Sere PV Phase 1A will include a total site area less than 20 hectares to allow for the construction of a PV facility up to 19.9 MW capacity and associated infrastructure:

- Solar PV modules, up to a total of 120,000 m$^2$, that convert solar radiation directly into electricity. The solar PV modules will be elevated off the ground and will be mounted on either fixed tilt systems or tracking systems. The Solar PV modules will be placed in rows in such a way that there is allowance for a perimeter road and security fencing along the site boundary, and access roads in between each PV module row. There will be underground cabling connecting Solar PV modules to the Inverter stations;
- Inverter stations, each occupying a footprint up to approximately 30 m2, with up to 20 Inverter stations installed on the site. Each Inverter station will contain an inverter, step-up transformer, and switchgear. The Inverter stations will be distributed on the site, located alongside its associated Solar PV module arrays. The Inverter station will perform conversion of DC (direct current) to AC (alternating current), and step-up the LV voltage of the inverter to 33kV, to allow the electricity to be fed into the Skaapvlei substation. Inverter stations will connect several arrays of Solar PV modules and will be placed along the internal roads for easy accessibility and maintenance;
- Adequately designed foundations and mounting structures that will support the Solar PV modules and Inverter stations;

- Existing roads that provide access to Sere Wind Farm will be used and extended where necessary (estimated up to 1 km long) to provide access to the PV site;
- A perimeter road around the site, approximately 5 m wide and 1.8 km in length;
- Internal roads for access to the Inverter stations, approximately 5 m wide and 3.4 km total length;
- Internal roads/paths between the Solar PV module rows, approximately 2.5 m wide, to allow access to the Solar PV modules for operations and maintenance activities;
- Laydown area, occupying a footprint up to 4,000 m2, located adjacent to the substation. The laydown area will also accommodate water storage tanks (estimated 32 kl for the first 4 months and 20 kl for the remaining 20 months, until construction is completed). This area will also accommodate the offices for construction contractors;
- Batching plant, occupying a footprint up to 7,675 $m^2$, for the mixing ingredients for concrete;
- The infrastructure required for the operation and maintenance of the Sere PV Plant – Phase 1a installation will be optimised to consider common usage of the existing Sere Wind Farm infrastructure;
- The Solar PV plant facility security cabin, occupying a footprint up to 10 $m^2$, including ablution facilities;
- Perimeter fencing of the Solar PV site, with access gates. Detailed requirements will be determined following the security risk assessment; and
- Construction and installation of underground electrical interconnection cables, with trenching up to 1 km long, connecting the Solar PV facility to the 33/132 kV Skaapvlei substation.

The solar PV plant has a design life of a minimum of 25 years. The extension of the life of the plant will be considered when assessing the plant's economic viability to remain operational after its end of life.

Total area of the Solar PV modules themselves will be 16 – 18 ha within the approximate 19.6 ha site boundary. Either fixed/static or tracking technology will be used, this has not been finalised by ESKOM both options are provided in this report, it is however not seen as alternatives for this assessment.

The technologies will be at different heights but will have the same 2 m deep foundations.

- Fixed or static PV – fixed mounted PV up to 3.5 m above ground level. Fixed or static PV – at 30º, north facing slope; and
- Tracking – single or double axis tracking up to 6 m above ground level. Tracking – PV module rows will track the sun path from east to west daily.

## 1.3 Scope of the Assessment

The assessment was achieved according to the above-mentioned legislation and the best-practice guidelines and principles for avifaunal assessment within solar energy facilities as outlined by Birdlife South Africa. The scope of the avifaunal assessment included the following:

- Description of the baseline avifaunal community;
- Identification of present or potentially occurring Species of Conservation Concern (SCC);
- Sensitivity assessment and map to identify sensitive areas in the project area; and
- Impact assessment, mitigation measures to prevent or reduce the possible impacts.

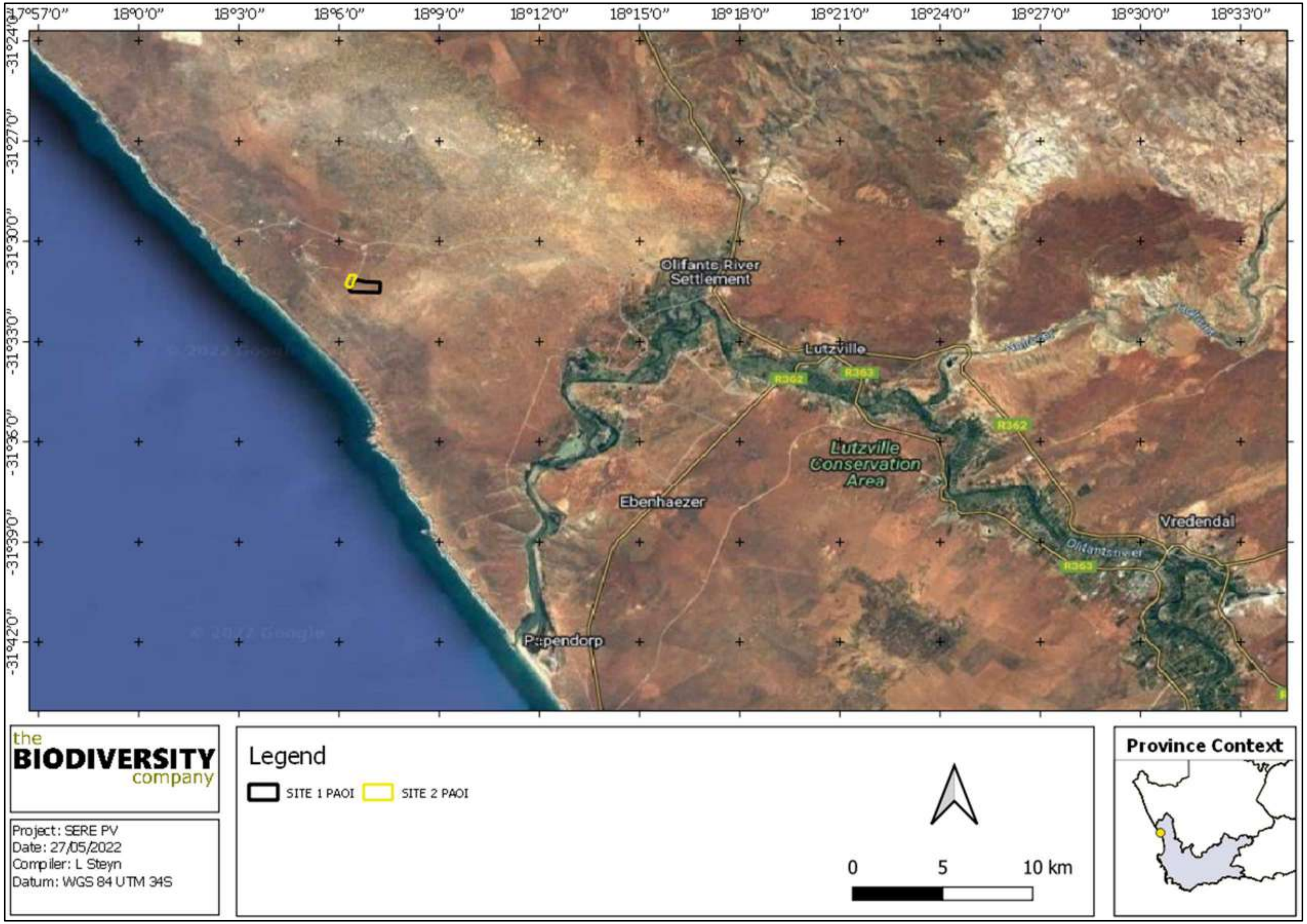



*Figure 1-2 Proposed project location.*

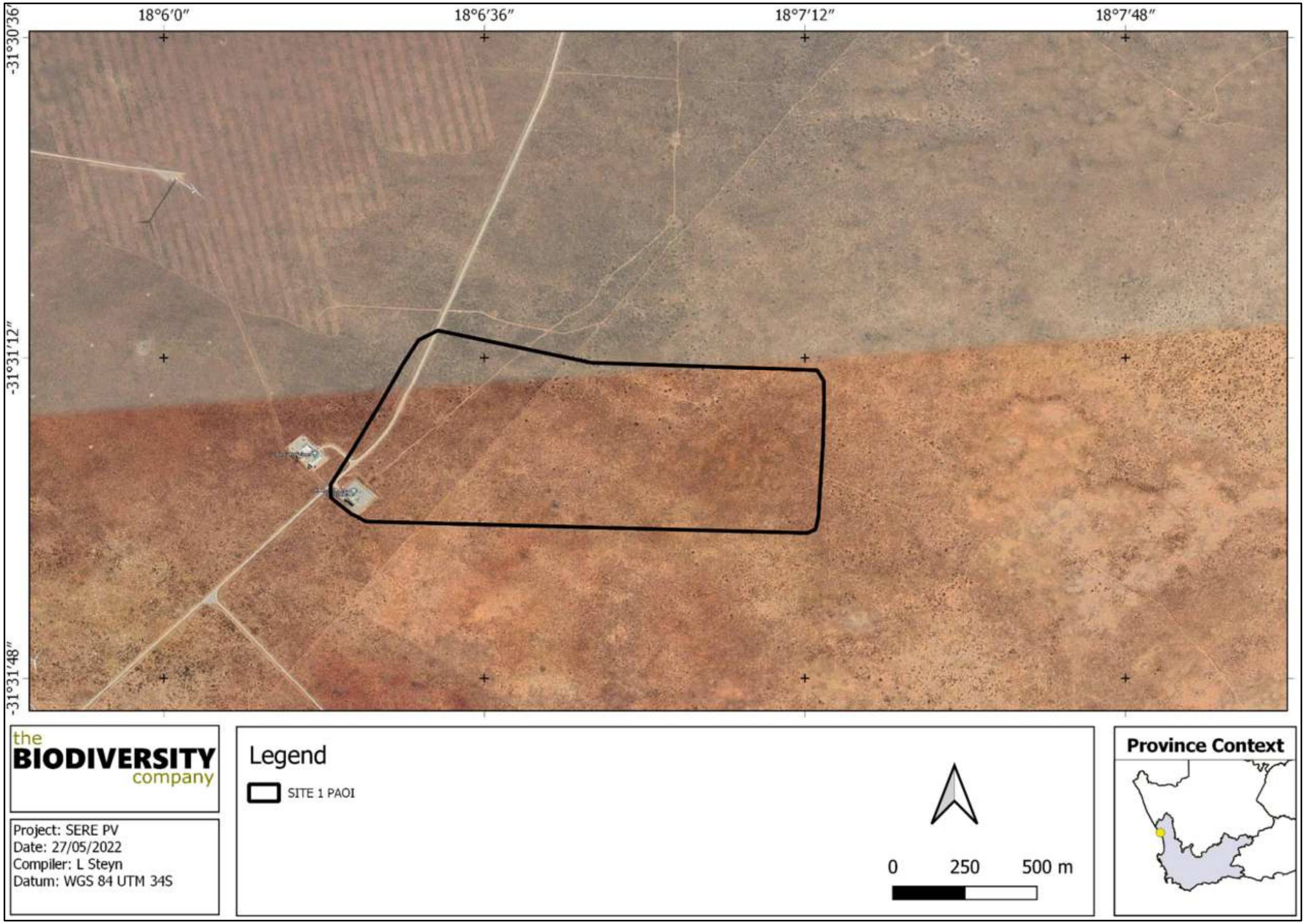



*Figure 1-3 Proposed first project area*

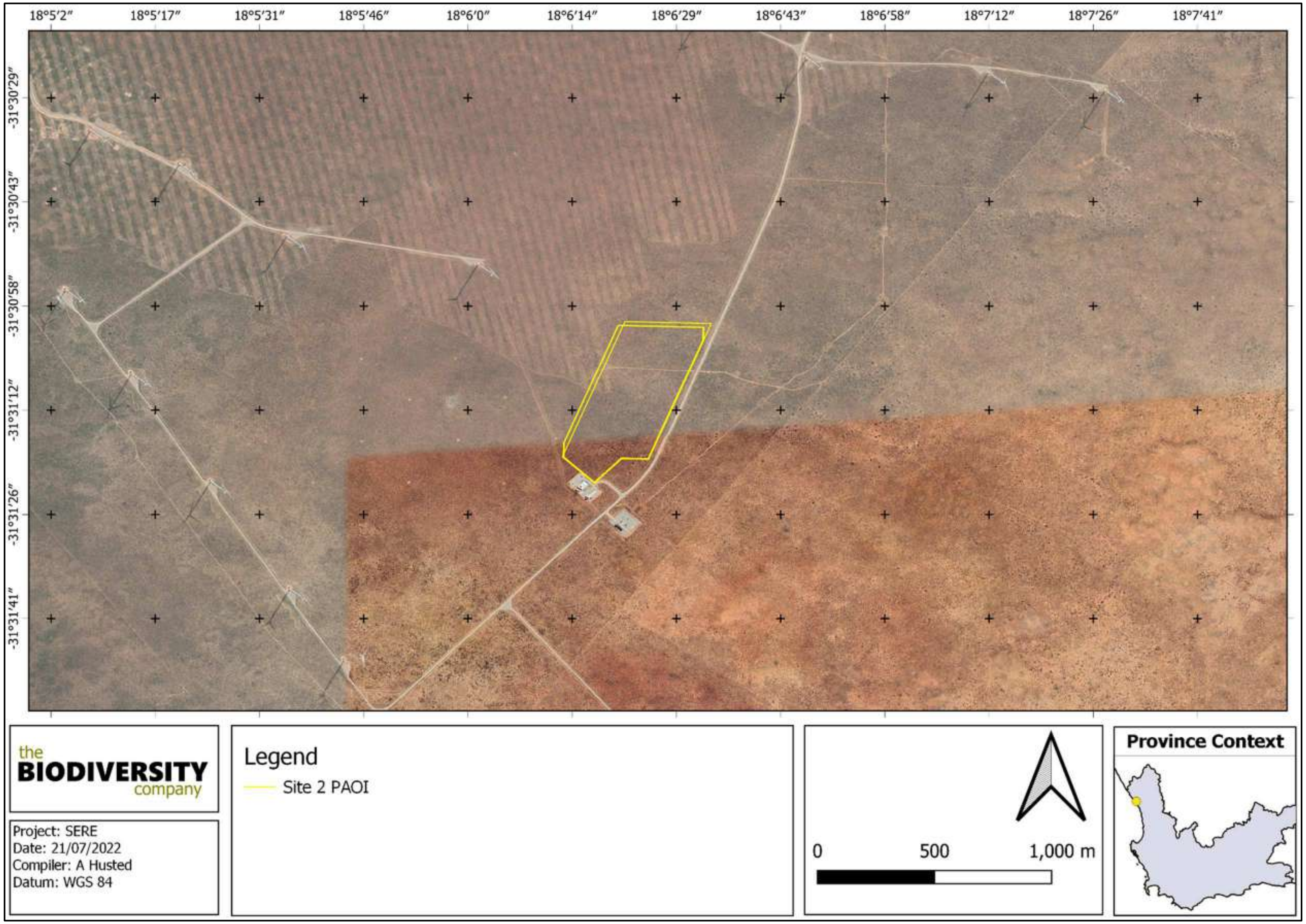



*Figure 1-4 Proposed second project area*

# 2 Key Legislative Requirements

The legislation, policies and guidelines listed below are applicable to the current project in terms of biodiversity and ecological support systems. The list below, although extensive, is not exhaustive and other legislation, policies and guidelines may apply in addition to those listed below (Table 2-1).

*Table 2-1 A list of key legislative requirements and guidelines*

| Region | Legislation and Guidelines |
|---|---|
| **International** | Convention on Biological Diversity (CBD, 1993) |
| | The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 1973) |
| | The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention, 1979) |
| **National** | Constitution of the Republic of South Africa (Act No. 108 of 1996) |
| | NEMA |
| | *Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998*, GNR 320 of Government Gazette 43310 (March 2020) |
| | *Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998*, GNR 1150 of Government Gazette 43855 (October 2020) |
| | The National Environmental Management: Protected Areas Act (Act No. 57 of 2003) |
| | The National Environmental Management: :Biodiversity Act (Act No. 10 of 2004) (NEMBA), Threatened or Protected Species Regulations |
| | The National Environmental Management: Waste Act, 2008 (Act 59 of 2008); |
| | The Environment Conservation Act (Act No. 73 of 1989) |
| | National Protected Areas Expansion Strategy (NPAES) |
| | Natural Scientific Professions Act (Act No. 27 of 2003) |
| | National Biodiversity Framework (NBF, 2009) |
| | National Spatial Biodiversity Assessment (NSBA) |
| | National Heritage Resources Act, 1999 (Act 25 of 1999) |
| | Alien and Invasive Species Regulations and Alien and Invasive Species List 2020, published under NEMBA |
| | South Africa's National Biodiversity Strategy and Action Plan (NBSAP) |
| | Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983) |
| | White Paper on Biodiversity |
| | South African National Biodiversity Institute (SANBI). 2020. *Species Environmental Assessment Guideline. Guidelines for the implementation of the Terrestrial Fauna and Terrestrial Flora Species Protocols for environmental impact assessments in South Africa*. South African National Biodiversity Institute, Pretoria. Version 1.2020. |
| | Best practice guidelines for avifaunal impact studies at solar developments, compiled by BirdLife South Africa (BLSA) in 2017 (Jenkins *et al*., 2017) |
| **Provincial** | Draft Western Cape Biodiversity Bill, 2019 |
| | Western Cape Biodiversity Sector Plan 2017 |
| | Nature and environmental conservation ordinance no. 19 of 1974 |

# 3 Assumptions and Limitations

The following assumptions and limitations should be noted for the assessment:

- Information relating to project activities, spatial data and infrastructure locations for the proposed development was obtained from information provided by the client. The potential impacts and recommendations described in this report apply specifically to the provided information;
- Although considerable time has been spent to ensure that information utilised in this report is verified. It is assumed that all third-party information utilised in the compilation of this report is correct at the time of compilation (e.g., spatial data, online databases, and species lists); and
- The scope and time constraints of a project of this nature does limit the collection of significant primary data on the proposed site.

# 4 Methods

## 4.1 Desktop Assessment

The following resources were consulted during the desktop assessment and for the compilation of the expected species list:

- Hockey *et al.* (2005), Roberts Birds of Southern Africa (seventh end.). The primary source for species identification, geographic range, and life history information;
- Sinclair and Ryan (2010), Birds of Africa. Secondary source for identification;
- South African Bird Atlas Project (SABAP 2). Full protocol atlassing data from relevant pentads used to construct expected species list; and
- Taylor *et al.* (2015), Eskom Red Data Book of Birds of South Africa, Lesotho, and Swaziland. Used for conservation status, nomenclature, and taxonomical ordering.
- A separate avifauna assessment was conducted in the form of post-construction bird monitoring which was initiated in May 2015, and year 2 operational bird monitoring from May 2016 until May 2017 (Appendix B and C); and

## 4.2 Field Assessment

A field survey was undertaken during 1st – 3rd of December 2021 by TBC to determine the presence of SCC for the "Previous Option" (Figure 4-1). An additional survey for the new project area was conducted in April 2022.


*Figure 4-1 Map illustrating the field survey area by TBC 2021*

## 4.3 Site Ecological Importance

The different habitat types within the assessment area were delineated and identified based on observations during the field assessment as well as available satellite imagery. These habitat types were assigned Ecological Importance (EI) categories based on their ecological integrity, conservation value, the presence of species of conservation concern and their ecosystem processes.

Site Ecological Importance (SEI) is a function of the Biodiversity Importance (BI) of the receptor (e.g., SCC, the vegetation/fauna community or habitat type present on the site) and Receptor Resilience (RR) (its resilience to impacts) as follows.

BI is a function of Conservation Importance (CI) and the Functional Integrity (FI) of the receptor as follows. The criteria for the CI and FI ratings are provided in Table 4-1 and Table 4-2, respectively.

*Table 4-1 Summary of Conservation Importance criteria*

| Conservation Importance | Fulfilling Criteria |
|---|---|
| Very High | Confirmed or highly likely occurrence of Critically Endangered (CR), Endangered (EN), Vulnerable (VU) or Extremely Rare or Critically Rare species that have a global Extent of Occurrence (EOO) of < 10 km$^2$.<br><br>Any area of natural habitat of a CR ecosystem type or large area (> 0.1% of the total ecosystem type extent) of natural habitat of an EN ecosystem type.<br><br>Globally significant populations of congregatory species (> 10% of global population). |
| High | Confirmed or highly likely occurrence of CR, EN, VU species that have a global EOO of > 10 km$^2$. IUCN threatened species (CR, EN, VU) must be listed under any criterion other than A.<br><br>If listed as threatened only under Criterion A, include if there are less than 10 locations or < 10 000 mature individuals remaining. |

| | |
|---|---|
| | Small area (> 0.01% but < 0.1% of the total ecosystem type extent) of natural habitat of EN ecosystem type or large area (> 0.1%) of natural habitat of VU ecosystem type.<br>Presence of Rare species.<br>Globally significant populations of congregatory species (> 1% but < 10% of global population). |
| **Medium** | Confirmed or highly likely occurrence of populations of NT species, threatened species (CR, EN, VU) listed under Criterion A only and which have more than 10 locations or more than 10 000 mature individuals.<br>Any area of natural habitat of threatened ecosystem type with status of VU.<br>Presence of range-restricted species.<br>> 50% of receptor contains natural habitat with potential to support SCC. |
| **Low** | No confirmed or highly likely populations of SCC.<br>No confirmed or highly likely populations of range-restricted species.<br>< 50% of receptor contains natural habitat with limited potential to support SCC. |
| **Very Low** | No confirmed and highly unlikely populations of SCC.<br>No confirmed and highly unlikely populations of range-restricted species.<br>No natural habitat remaining. |

*Table 4-2 Summary of Functional Integrity criteria*

| Functional Integrity | Fulfilling Criteria |
|---|---|
| **Very High** | Very large (> 100 ha) intact area for any conservation status of ecosystem type or > 5 ha for CR ecosystem types.<br>High habitat connectivity serving as functional ecological corridors, limited road network between intact habitat patches.<br>No or minimal current negative ecological impacts with no signs of major past disturbance. |
| **High** | Large (> 20 ha but < 100 ha) intact area for any conservation status of ecosystem type or > 10 ha for EN ecosystem types.<br>Good habitat connectivity with potentially functional ecological corridors and a regularly used road network between intact habitat patches.<br>Only minor current negative ecological impacts with no signs of major past disturbance and good rehabilitation potential. |
| **Medium** | Medium (> 5 ha but < 20 ha) semi-intact area for any conservation status of ecosystem type or > 20 ha for VU ecosystem types.<br>Only narrow corridors of good habitat connectivity or larger areas of poor habitat connectivity and a busy used road network between intact habitat patches.<br>Mostly minor current negative ecological impacts with some major impacts and a few signs of minor past disturbance. Moderate rehabilitation potential. |
| **Low** | Small (> 1 ha but < 5 ha) area.<br>Almost no habitat connectivity but migrations still possible across some modified or degraded natural habitat and a very busy used road network surrounds the area.<br>Low rehabilitation potential.<br>Several minor and major current negative ecological impacts. |
| **Very Low** | Very small (< 1 ha) area.<br>No habitat connectivity except for flying species or flora with wind-dispersed seeds.<br>Several major current negative ecological impacts. |

BI can be derived from a simple matrix of CI and FI as provided in Table 4-3.

*Table 4-3 Matrix used to derive Biodiversity Importance from Functional Integrity and Conservation Importance*

| Biodiversity Importance (BI) | | Conservation Importance (CI) | | | | |
|---|---|---|---|---|---|---|
| | | Very high | High | Medium | Low | Very low |
| Functional Integrity (FI) | **Very high** | Very high | Very high | High | Medium | Low |
| | **High** | Very high | High | Medium | Medium | Low |
| | **Medium** | High | Medium | Medium | Low | Very low |
| | **Low** | Medium | Medium | Low | Low | Very low |
| | **Very low** | Medium | Low | Very low | Very low | Very low |

The fulfilling criteria to evaluate RR are based on the estimated recovery time required to restore an appreciable portion of functionality to the receptor as summarised in Table 4-4.

*Table 4-4 Summary of Resource Resilience criteria*

| **Resilience** | **Fulfilling Criteria** |
|---|---|
| **Very High** | Habitat that can recover rapidly (~ less than 5 years) to restore > 75% of the original species composition and functionality of the receptor functionality, or species that have a very high likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a very high likelihood of returning to a site once the disturbance or impact has been removed. |
| **High** | Habitat that can recover relatively quickly (~ 5–10 years) to restore > 75% of the original species composition and functionality of the receptor functionality, or species that have a high likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a high likelihood of returning to a site once the disturbance or impact has been removed. |
| **Medium** | Will recover slowly (~ more than 10 years) to restore > 75% of the original species composition and functionality of the receptor functionality, or species that have a moderate likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a moderate likelihood of returning to a site once the disturbance or impact has been removed. |
| **Low** | Habitat that is unlikely to be able to recover fully after a relatively long period: > 15 years required to restore ~ less than 50% of the original species composition and functionality of the receptor functionality, or species that have a low likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a low likelihood of returning to a site once the disturbance or impact has been removed. |
| **Very Low** | Habitat that is unable to recover from major impacts, or species that are unlikely to remain at a site even when a disturbance or impact is occurring, or species that are unlikely to return to a site once the disturbance or impact has been removed. |

Subsequent to the determination of the BI and RR, the SEI can be ascertained using the matrix as provided in Table 4-5.

*Table 4-5 Matrix used to derive Site Ecological Importance from Receptor Resilience and Biodiversity Importance*

| **Site Ecological Importance** | | **Biodiversity Importance** | | | | |
|---|---|---|---|---|---|---|
| | | **Very high** | **High** | **Medium** | **Low** | **Very low** |
| **Receptor Resilience (RR)** | **Very Low** | Very high | Very high | High | Medium | Low |
| | **Low** | Very high | Very high | High | Medium | Very low |
| | **Medium** | Very high | High | Medium | Low | Very low |
| | **High** | High | Medium | Low | Very low | Very low |

| Site Ecological Importance | | Biodiversity Importance | | | | |
|---|---|---|---|---|---|---|
| | | Very high | High | Medium | Low | Very low |
| | Very High | Medium | Low | Very low | Very low | Very low |

Interpretation of the SEI in the context of the proposed development activities is provided in Table 4-6.

*Table 4-6 Guidelines for interpreting Site Ecological Importance in the context of the proposed development activities*

| Site Ecological Importance | Interpretation in relation to proposed development activities |
|---|---|
| Very High | Avoidance mitigation – no destructive development activities should be considered. Offset mitigation not acceptable/not possible (i.e., last remaining populations of species, last remaining good condition patches of ecosystems/unique species assemblages). Destructive impacts for species/ecosystems where persistence target remains. |
| High | Avoidance mitigation wherever possible. Minimisation mitigation – changes to project infrastructure design to limit the amount of habitat impacted, limited development activities of low impact acceptable. Offset mitigation may be required for high impact activities. |
| Medium | Minimisation and restoration mitigation – development activities of medium impact acceptable followed by appropriate restoration activities. |
| Low | Minimisation and restoration mitigation – development activities of medium to high impact acceptable followed by appropriate restoration activities. |
| Very Low | Minimisation mitigation – development activities of medium to high impact acceptable and restoration activities may not be required. |

The SEI evaluated for each taxon can be combined into a single multi-taxon evaluation of SEI for the assessment area. Either a combination of the maximum SEI for each receptor should be applied, or the SEI may be evaluated only once per receptor but for all necessary taxa simultaneously. For the latter, justification of the SEI for each receptor is based on the criteria that conforms to the highest CI and FI, and the lowest RR across all taxa.

# 5 Receiving Environment

## 5.1 Desktop Spatial Assessment

The following features describes the general area and habitat, this assessment is based on spatial data that are provided by various sources such as the provincial environmental authority and SANBI. The desktop analysis and their relevance to this project are listed in Table 5-1.

*Table 5-1 Desktop spatial features examined.*

| Desktop Information Considered | Relevant/Not relevant | Section |
|---|---|---|
| **Conservation Plan** | The project area is classified as ESA 2 and ONA, with small section of CBA1 | 5.1.1 |
| **Important Bird and Biodiversity Areas** | The project area is approximately 13 km from the Olifants River Estuary IBA. | 5.1.2 |
| **Vegetation Type** | The project area overlaps with the Namaqualand Inland Duneveld and the Namaqualand Sand Fynbos. | 5.1.3 |
| **Aquatic Habitat** | The project area does not overlap, with any water sources. It is however just over a kilometre from the closest wetland, 13 km from the Olifants River and 3 km from the coastline | 5.1.4 |
| **Succulent Karroo Ecosystem Programme** | Project area can be found 9.6 km from a unique bird habitat | 5.1.5 |
| **National Protected Areas Expansion Strategy** | The project area does overlap with an NPAES. | 5.1.6- |
| **Coordinated Avifaunal Road (CAR) count** | The project area is 135 km away from the closest CAR route. | - |
| **Renewable Energy Development Zones REDZ Phase 2** | The project area does not overlap with a REDZ zone. 15 km from the closest one | - |
| **Coordinated Waterbird Count (CWAC)** | Three coordinated waterbird counts (CWAC) can be found approximately 20 km from the project area. Detailed information can be seen in Appendix B. | |
| **Protected Areas (SAPAD & SACAD)** | The project area is approximately 30 km form the closest SAPAD area, the Knersvlakte Nature Reserve | - |

### 5.1.1 Western Cape Biodiversity Spatial Plan

The Western Cape CBA classified areas within the province on the basis of its contribution to reach the conservation targets within the province. The C-Plan uses the following terms to categorise the various land used types according to their biodiversity and environmental importance:

- Critical Biodiversity Area (CBA);
- Ecological Support Area (ESA);
- Other Natural Area (ONA); and
- Protected Area (PA).

In the spatial datasets a further distinction is made between CBAs that are likely to be in a natural condition (CBA 1) and those that are potentially degraded or represent secondary vegetation (CBA 2). This distinction is based on best available land cover data. Similarly, a distinction is made between ESAs that are likely to be functional (i.e., in a natural, near-natural or moderately degraded condition; ESA 1), and Ecological Support Areas that are likely severely degraded or have no natural cover remaining and therefore require restoration where feasible (ESA 2).The project area is located in an area classified as CBA1 (limited), ESA1 (limited), ESA 2 and ONA (Figure 5-1).

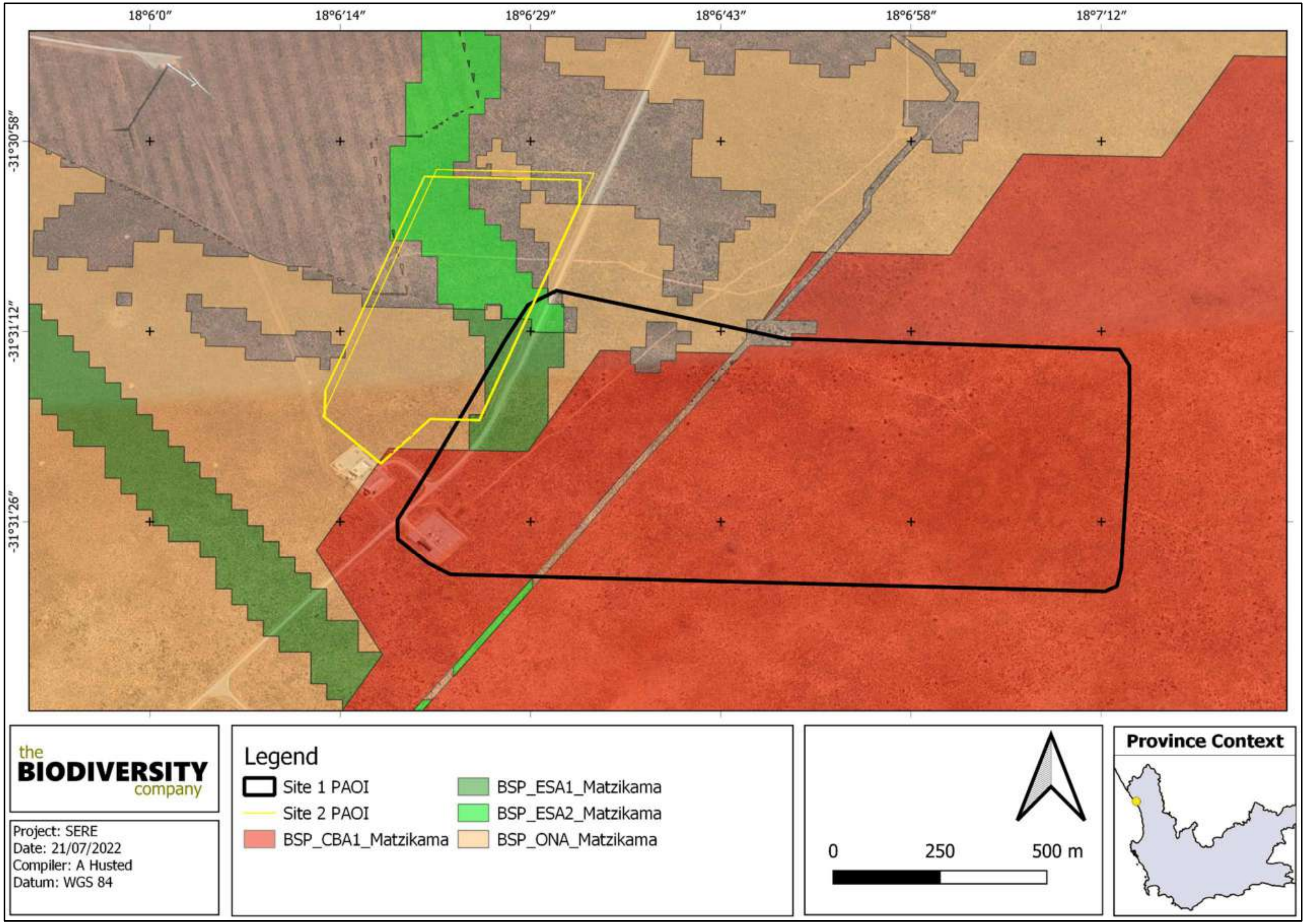



*Figure 5-1 The project area superimposed on the Western Cape Biodiversity Spatial Plan (WCBCP, 2017)*

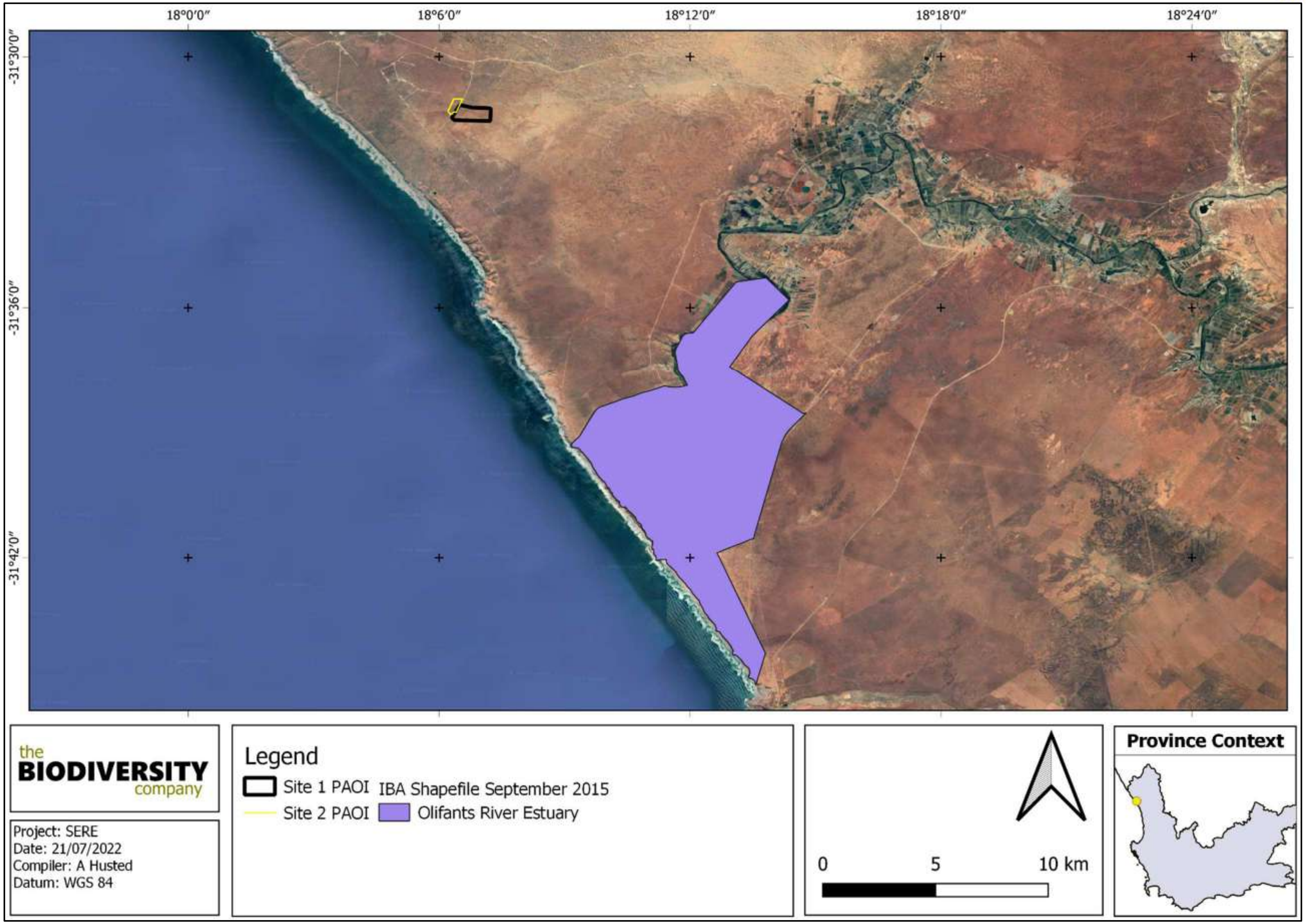
### 5.1.2 Important Bird and Biodiversity Area

Important Bird & Biodiversity Areas (IBAs) are the sites of international significance for the conservation of the world's birds and other conservation significant species as identified by BirdLife International. These sites are also all Key Biodiversity Areas; sites that contribute significantly to the global persistence of biodiversity (Birdlife, 2017).

According to Birdlife International (2017), the selection of IBAs is achieved through the application of quantitative ornithological criteria, grounded in up-to-date knowledge of the sizes and trends of bird populations. The criteria ensure that the sites selected as IBAs have true significance for the international conservation of bird populations and provide a common currency that all IBAs adhere to, thus creating consistency among, and enabling comparability between, sites at national, continental and global levels.

Figure 5-2 shows that the project area is approximately 13 km from the Olifants River Estuary IBA. Approximately 127 bird species have been recorded at the Olifants River estuary and its environs, at least 60 of which are waterbirds. The estuary is estimated to support 15 000 waterbirds, amongst these are the threatened species such as: Lesser Flamingo *Phoeniconaias minor*, Greater Flamingo *Phoenicopterus roseus*, Caspian Tern *Sterna caspia*, African Marsh Harrier *Circus ranivorus*, Black Harrier *C. maurus* , African Black Oystercatcher *Haematopus moquini,* and Great White Pelicans *Pelecanus onocrotalus*.

The vegetation surrounding the estuary is suitable for many Namib-Karoo biome-restricted assemblage and other arid-zone species, including Karoo Korhaan *Eupodotis vigorsii*, Grey Tit *Parus afer*, Karoo Lark *Calendulauda albescens*, Tractrac Chat *Cercomela tractrac*, Karoo Chat *C. schlegelii*, Sickle-winged Chat *C. sinuata* and Black-headed Canary *Serinus alario*.


18°0'0"
18°6'0"
18°12'0"
18°18'0"
18°24'0"
-31°30'0"
-31°36'0"
-31°42'0"
the BIODIVERSITY company
Project: SERE
Date: 21/07/2022
Compiler: A Husted
Datum: WGS 84
Legend
Site 1 PAOI
Site 2 PAOI
IBA Shapefile September 2015
Olifants River Estuary
0
5
10 km
Province Context

### 5.1.3 Vegetation Types

The project area overlaps with the Namaqualand Inland Duneveld and the Namaqualand Sand Fynbos. These two vegetation types are found in the Succulent Karroo and Fynbos Biomes respectively. The Namaqualand Inland Duneveld is made up of tall shrublands dominated by non succulent shrubs and grasses. The Namaqua Sand Fynbos is made up of scattered 1–1.5 m tall shrubs 1–3 m in diameter and is dominated by Restionaceae. On a fine-scale vegetation type, Site 1 overlaps with two vegetation type: the Namaqualand Inland Duneveld and the Namaqualand Sand Fynbos, while Site 2 only falls across the latter vegetation type (Figure 5-3).

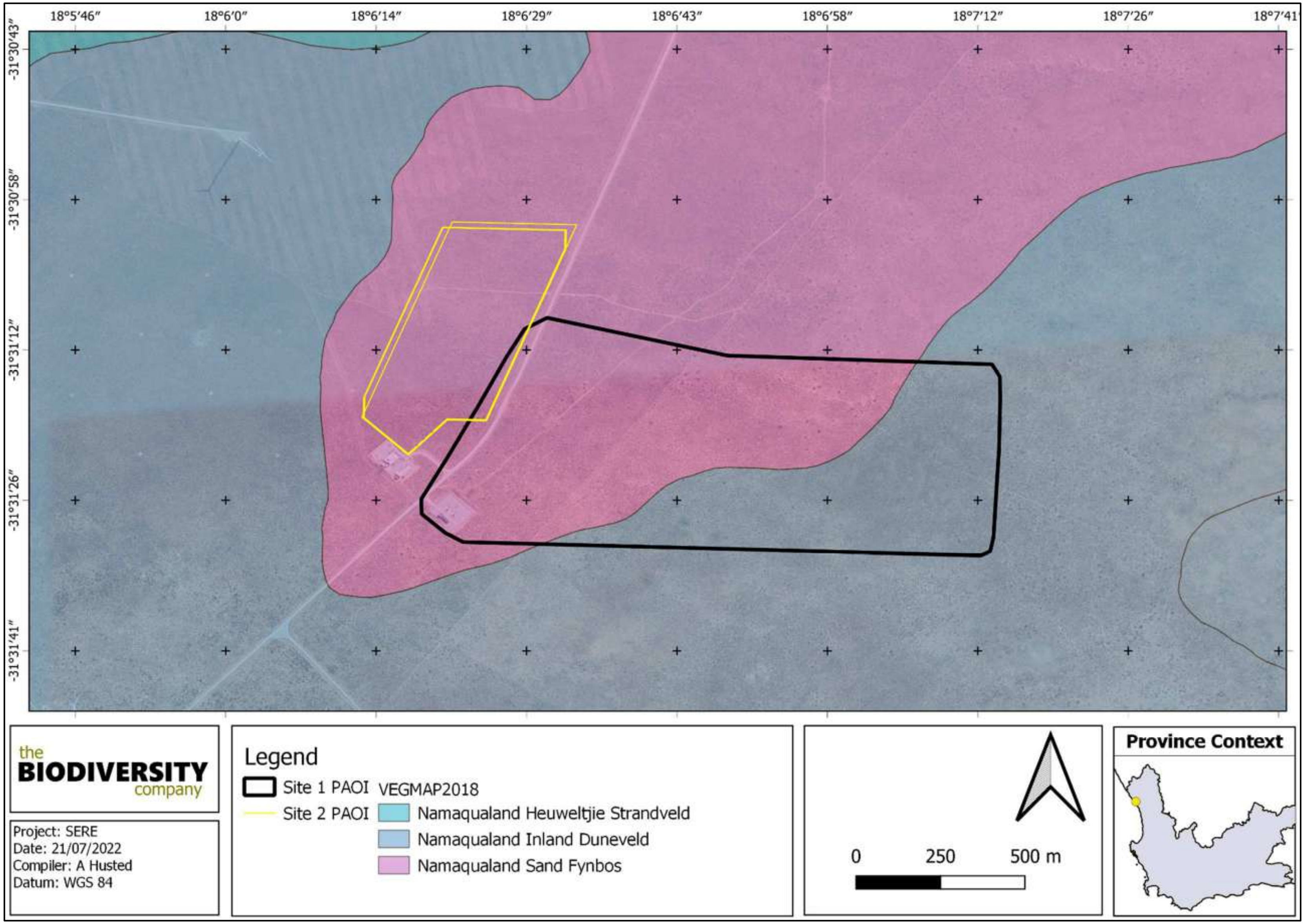



*Figure 5-3 The project area showing the vegetation type based on the Vegetation Map of South Africa, Lesotho & Swaziland (BGIS, 2018)*

### 5.1.4 Aquatic Habitat

The project area does not overlap, with any water sources. It is however just over a kilometre from the closest wetland, 13 km from the Olifants River and 3 km from the coastline (Figure 5-4).

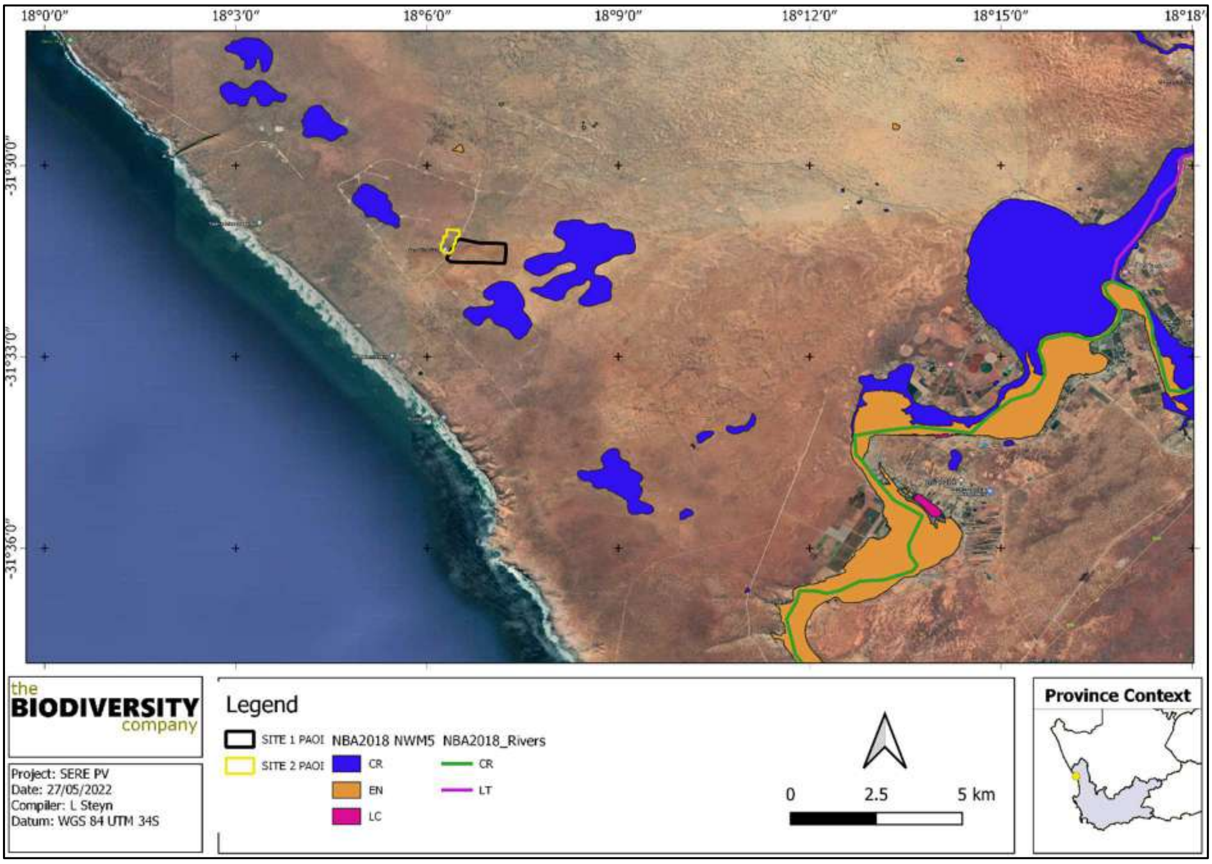



*Figure 5-4 The project area in relation to the water resources*

### 5.1.5 Succulent Karoo Ecosystem Programme Birds

Succulent Karoo Ecosystem Programme (SKEP) is a long term bioregional conservation programme, with the aim to conserve ecosystems and to develop conservation as a land-use rather than instead of land-use (SANBI, 2021). Their focal areas are:

- Increasing local, national and international awareness of the unique biodiversity of the Succulent Karoo;
- Expanding protected areas and improving conservation management, particularly through the expansion of public-private-communal-corporate partnerships;
- Support the creation of a matrix of harmonious land uses; and
- Improve institutional co-ordination to generate momentum and focus on priorities, maximise opportunities for partnerships, and ensure sustainability.

The areas of SKEP birds were assessed in relation to the project area, it was found that the project area can be found 9.6 km from a unique bird habitat (Figure 5-5).

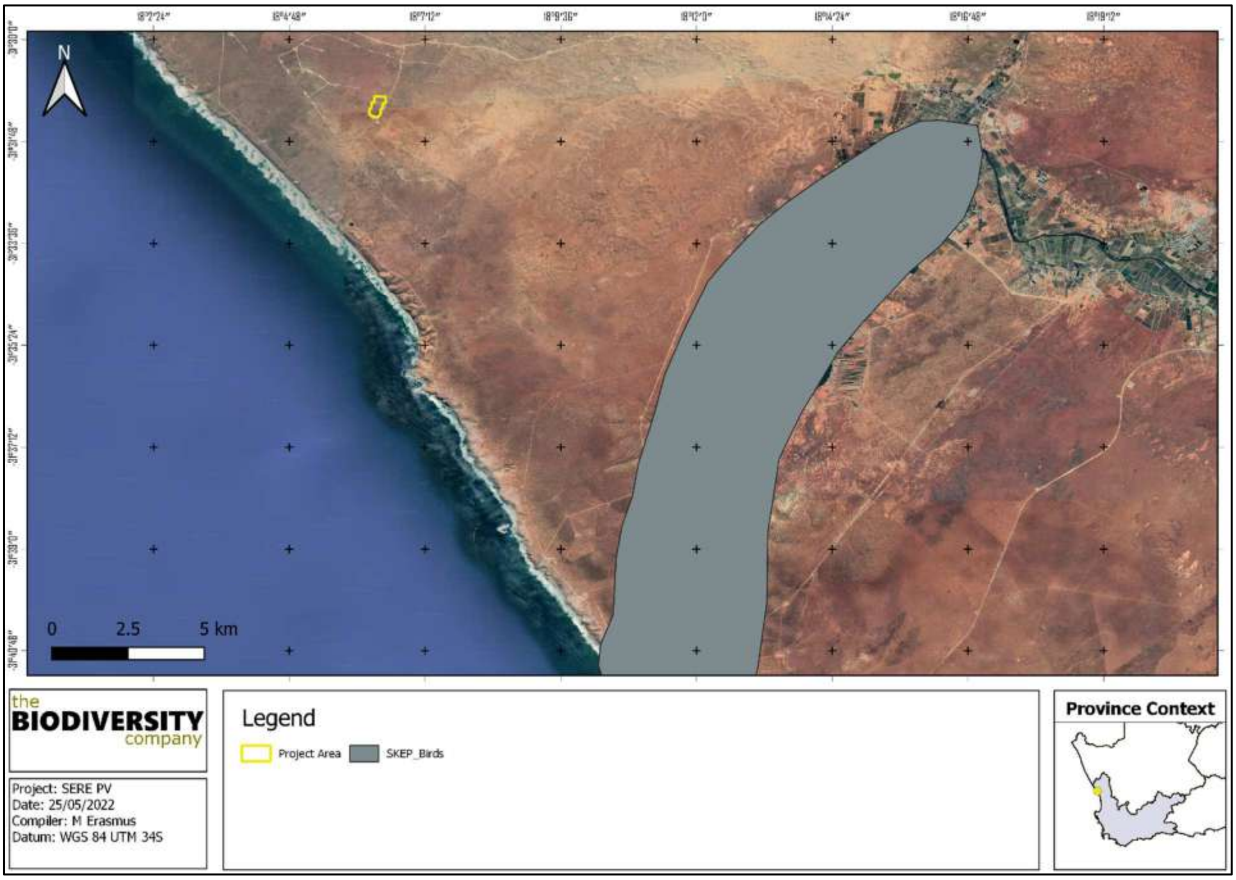



*Figure 5-5 The project area in relation to the bird SKEP areas*

### 5.1.6 National Protected Area Expansion Strategy

National Protected Area Expansion Strategy 2017 (NPAES) were identified through a systematic biodiversity planning process. They present the best opportunities for meeting the ecosystem-specific protected area targets set in the NPAES and were designed with strong emphasis on climate change resilience and requirements for protecting freshwater ecosystems. These areas should not be seen as future boundaries of protected areas, as in many cases only a portion of a particular focus area would be required to meet the protected area targets set in the NPAES. They are also not a replacement for finescale planning which may identify a range of different priority sites based on local requirements, constraints and opportunities (NPAES, 2017). The project area overlaps with a Priority Focus Area, while Site 2 falls just outside of the NPAES as can be seen in Figure 5-6.

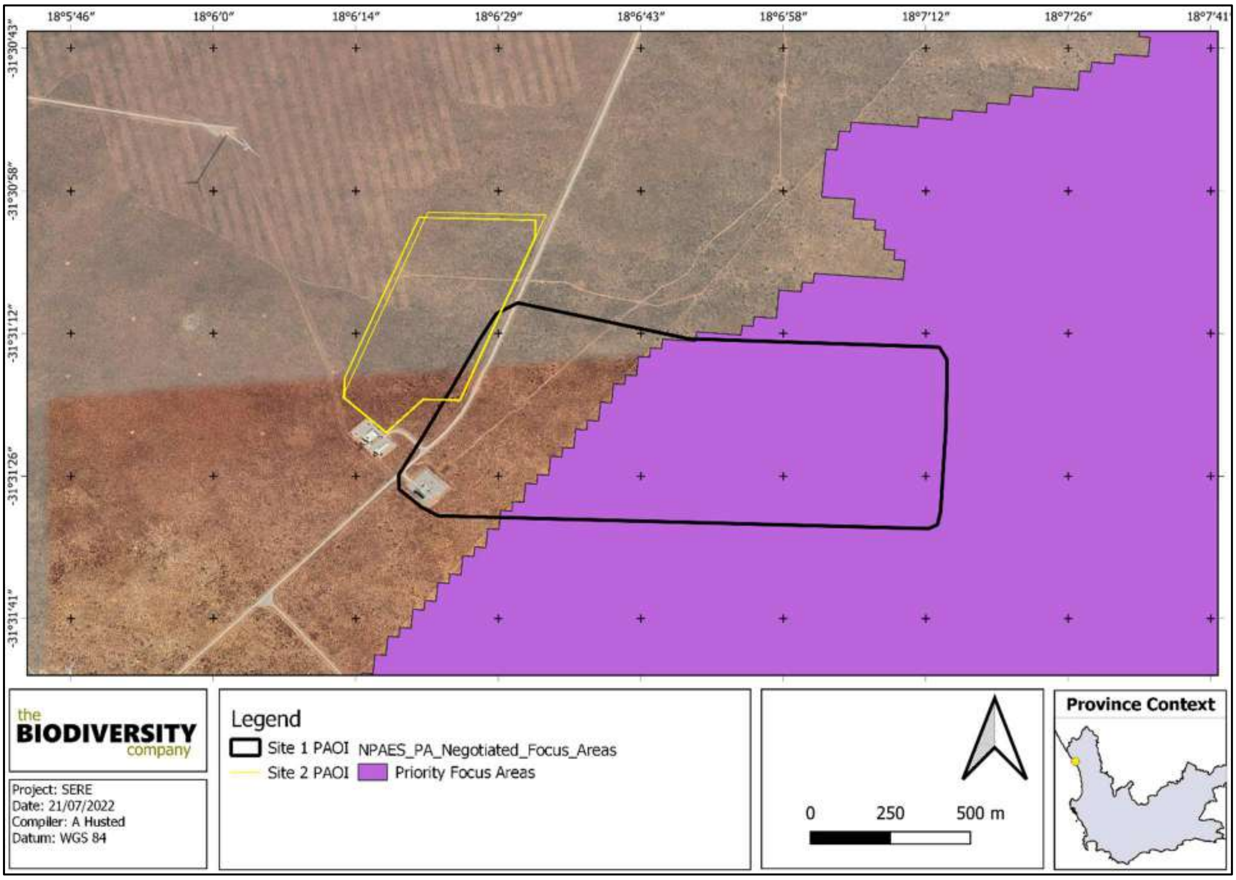



*Figure 5-6 The project areas in relation to the National Protected Area Expansion Strategy*

### 5.1.7 South African Bird Atlas Project 2

Based on the South African Bird Atlas Project, Version 2 (SABAP2) database, 189 bird species have the potential to occur in the vicinity of the project area. The full list of potential bird species is provided in Appendix A, the list was compiled from all the pentads along the project area : (3125_1800, 3125_1805, 3125_1810, 3130_1800, 3130_1805, 3130_1810, 3135_1805, 3135_1810, 3135_1815). Of the potential bird species, seventeen (17) species are listed as SCC either on a regional or global scale (Table 5-2). Seven of the species were given a low likelihood of occurrence due to the lack of suitable habitat in the area and the level of disturbance already found in the area.

*Table 5-2 List of bird SCCs that are expected to occur in close vicinity to the project area and their reporting rates (SABAP2).*

| Common Name | Scientific Name | Conservation Status | | Pentad | | | | | | | | | Likelihood of occurrence |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Regional (SANBI, 2021) | IUCN (2021) | 3125_1800 | 3125_1805 | 3125_1810 | 3130_1800 | 3130_1805 | 3130_1810 | 3135_1805 | 3135_1810 | 3135_1815 | |
| **Ludwig's Bustard** | *Neotis ludwigii* | EN | EN | | | 66.7 | | | | 6.7 | 4.8 | | High |
| **Bank Cormorant** | *Phalacrocorax neglectus* | EN | EN | 25.0 | | | 100.0 | | | 6.7 | | | Low |
| **Cape Cormorant** | *Phalacrocorax capensis* | EN | EN | 62.5 | | | 100.0 | | | 100.0 | 14.3 | | Moderate |
| **Crowned Cormorant** | *Microcarbo coronatus* | NT | NT | 12.5 | | | | | | 66.7 | | | Moderate |
| **Maccoa Duck** | *Oxyura maccoa* | NT | VU | | | | | | | | 14.3 | | Low |
| **Martial Eagle** | *Polemaetus bellicosus* | EN | EN | | | 66.7 | | | 0.0 | | | | High |
| **Greater Flamingo** | *Phoenicopterus roseus* | NT | LC | | | | | | 5.6 | | 52.4 | 16.7 | High |
| **Lesser Flamingo** | *Phoeniconaias minor* | NT | NT | | | | | | | | 23.8 | | High |
| **Cape Gannet** | *Morus capensis* | VU | EN | 12.5 | | | | | | 26.7 | | | Low |
| **African Marsh Harrier** | *Circus ranivorus* | EN | LC | | | | | | | | 33.3 | | Moderate |
| **Black Harrier** | *Circus maurus* | EN | EN | | | | | | 5.6 | 0.0 | 9.5 | | High |
| **Southern Black Korhaan** | *Afrotis afra* | VU | VU | 12.5 | | | | 0.0 | 5.6 | 13.3 | | 50 | High |
| **Great White Pelican** | *Pelecanus onocrotalus* | VU | LC | | | | | | | | 14.3 | | Low |
| **Curlew Sandpiper** | *Calidris ferruginea* | LC | NT | 12.5 | | | | | | | 28.6 | | Low |
| **Caspian Tern** | *Hydroprogne caspia* | VU | LC | | | | | | 22.2 | | 66.7 | | Moderate |
| **Cape Vulture** | *Gyps coprotheres* | EN | EN | | | | | | | | 0.0 | | Low |
| **Ground Woodpecker** | *Geocolaptes olivaceus* | LC | NT | 12.5 | | | | | | | | | Low |

*Neotis ludwigii* (Ludwig's Bustard) is listed as EN both locally and internationally. This species is found in the desert, grassland and shrubland specifically in rocky areas such as mountains and cliffs. The main reason for the decline in the numbers are ascribed to the collisions with power lines. The project area does have suitable habitat for the Ludwig's Bustard and therefore the likelihood of occurrence is rated as high.

*Phalacrocorax capensis* (Cape Cormorant) is endemic to the southwestern coast of Africa, but during the non breeding season they spread inland and up the east coast of South Africa. The IUCN as well as Birdlife South Africa lists these birds as endangered, and the main cause of the decline is as a result of the decline of the epipelagic fish stock, oil spills and avian cholera. Although the project area does not consist of breeding habitat of Cape Cormorant, the coast-line is adjacent the project area and the Olifants River is only 13km from the project area, which means that the birds could move over and around the project area. This is why the likelihood of occurrence is rated as moderate.

*Phalacrocorax coronatus* (Crowned Cormorant) is listed as a NT on a regional scale and as NT on a global scale. Human disturbance, to which the species is particularly susceptible, is a major threat. This species is largely sedentary, with some movement occurring to the north and east of its breeding range. Although the project area does not consist of breeding habitat of Crowned Cormorant, the coast-line is adjacent the project area which means that the birds could move over and around the project area. This is why the likelihood of occurrence is rated as moderate.

*Polemaetus bellicosus* (Martial Eagle) is listed as EN on a regional scale and on a global scale. This species has an extensive range across much of sub-Saharan Africa, but populations are declining due to deliberate and incidental poisoning, habitat loss, reduction in available prey, pollution and collisions with power lines (IUCN, 2017). It inhabits open woodland, wooded savanna, bushy grassland, thorn-bush and, in southern Africa, more open country and even sub-desert (IUCN, 2017). The project area does consist of suitable habitat for the Martial Eagle, a number of prey species were observed in the project area and therefore the likelihood of occurrence is rated as high.

*Phoenicopterus minor* (Lesser Flamingo) is listed as NT on a global and regional scale whereas *Phoenicopterus roseus* (Greater Flamingo) is listed as NT on a regional scale only. Both species have similar habitat requirements and the species breed on large undisturbed alkaline and saline lakes, salt pans or coastal lagoons, usually far out from the shore after seasonal rains have provided the flooding necessary to isolate remote breeding sites from terrestrial predators and the soft muddy material for nest building (IUCN, 2017). The Olifant's River being 11 km away makes that the Lesser Flamingo could move over and around the project area therefore the likelihood of occurrence is rated as high. Lesser Flamingos were observed during the assessment at the olifants river estuary.

*Circus ranivorus* (African Marsh Harrier) is listed as EN in South Africa (ESKOM, 2014). This species has an extremely large distributional range in sub-equatorial Africa. South African populations of this species are declining due to the degradation of wetland habitats, loss of habitat through over-grazing and human disturbance and possibly, poisoning owing to over-use of pesticides (IUCN, 2017). This species breeds in wetlands and forages primarily over reeds and lake margins. There are some wetlands and dams close to the project area, however the project area itself is not regarded as suitable breeding habitat. The species might still move cross the project area and as such the likelihood of occurrence is regarded as moderate.

*Circus maurus* (Black Harrier) is listed as EN on a local basis and is restricted to southern Africa, where it is mainly found in the fynbos and Karoo of the Western and Eastern Cape. It is also found in the grasslands of Free State, Lesotho and KwaZulu-Natal. Harriers breed close to coastal and upland marshes, damp sites, near vleis or streams with tall shrubs or reeds. South-facing slopes are preferred in mountain areas where temperatures are cooler, and vegetation is taller (IUCN, 2017). During the non-breeding season, they will also be found in dry grassland areas further north and they also visit coastal river floodplains in Namibia. The likelihood of occurrence is rated as high as suitable habitat can be found in the project area.

*Afrotis afra* (Southern Black Korhaan) is listed as VU on a regional and global scale (IUCN, 2017). They are endemic to the South-Western side of South Africa. Their habitat varies from non-grassy areas to the Fynbos biome, Karoo biome and the western coastline of South Africa. The main threat to them is habitat loss, in an eight year span they loss 80% of their range due to agricultural developments. Their diet consists of insects, small reptiles and plant material, including seeds and green shoots (Hockey *et al.* 2005). Suitable habitat and food can be found in the project area as such the likelihood of occurrence is rated as high.

*Sterna caspia* (Caspian Tern) is native to South Africa and are known to occur in inland freshwater systems such as large rivers, creeks, floodlands, reservoirs and sewage ponds. The nearby dam provides suitable habitat for this species, therefore this species were given a moderate likelihood of occurrence.

### 5.1.8 Renewable Energy Projects

A number of existing and planned applications for renewable energy developments are found around the project area (Figure 5-7). The data used to determine the number of applications in the nearby area were obtained from SA Renewable Energy EIA Application Database (REEA) (https://egis.environment.gov.za/) and were accurate as per 31 August 2021. The cumulative impact of all these projects on avifauna would be high, especially in an area where a large number of endemic species are found.

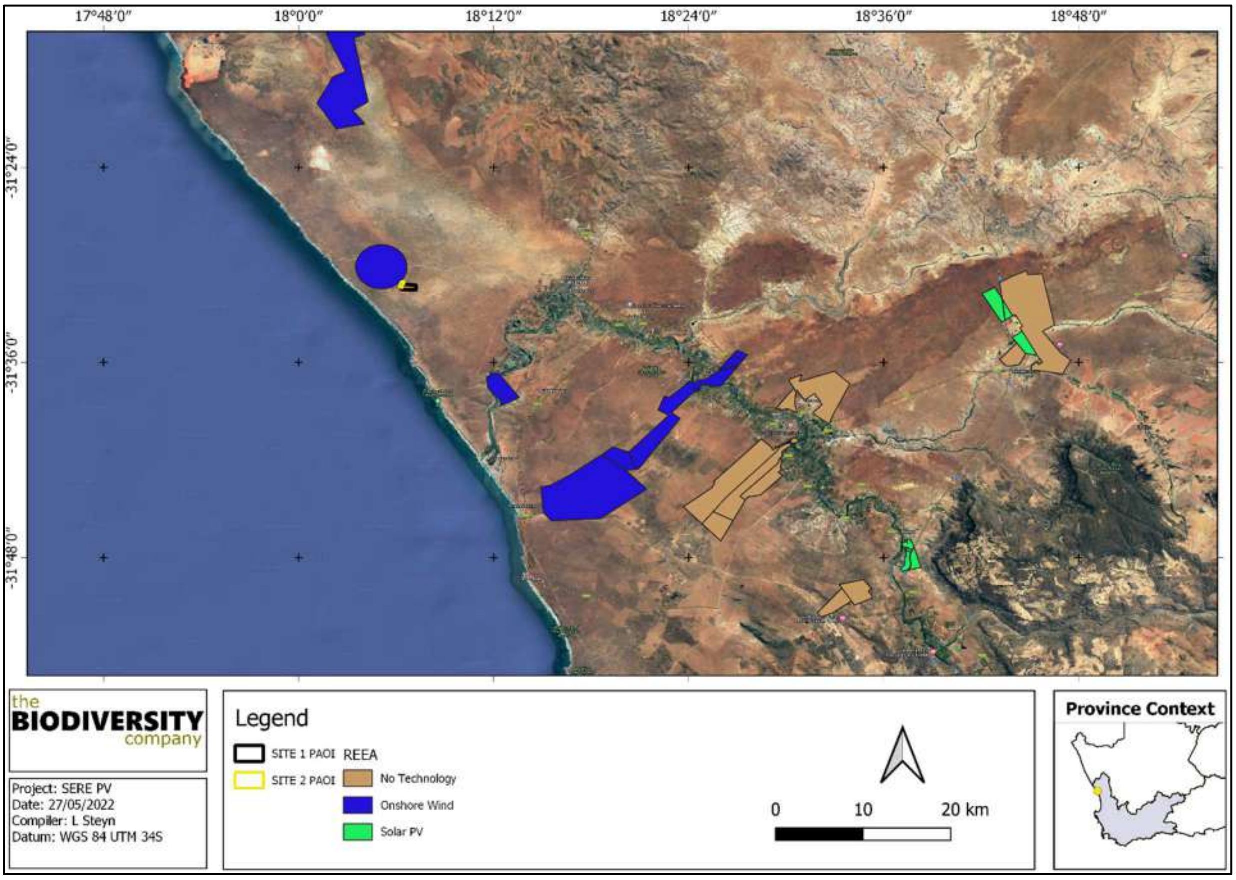



*Figure 5-7 The renewable energy applications found in the area*

## 5.2 Literature Review

### 5.2.1 Post-construction Bird Monitoring

Two operational monitoring reports were utilised, these were compiled by L Strugnell, from WildSkies Ecological Services, 2016 and 2017 respectively.

In the final report summary (2017), the following was stated:

- 76 bird species were recorded on site during this programme, 6 of which are Red Listed. The Pre-construction monitoring recorded 65 bird species.
- Six (6) large terrestrial and raptor species were recorded on site through drive transects, one of which is a Red Listed species. Pre-construction bird monitoring recorded eight species using drive transects. They recorded that the abundance per km of the species recorded on driven transects, showed a dramatic decrease in Ludwig's Bustard abundance, however suspected that it likely due to natural variation in species movements.
- Twelve bird species were recorded flying on site during this period. The Red List species included:
- Black Harrier *Circus maurus* (EN),
- Lanner Falcon *Falco biarmicus* (VU),
- Ludwig's Bustard *Neotis ludwigii* (EN),
- Southern Black Korhaan *Afrotis afra* (VU) and
- Secretarybird Sagittarius serpentarius (VU).
- The author classified the habitats into two types, Namaqualand Strandveld and Namaqualand Sand Fynbos.

### 5.2.2 Review of Nearby Assessments

An Environmental Impact Assessment was conducted for a wind energy facility in the Western Cape on the west coast close to Vredendal, consisting of 100 wind turbines occupying a surface area of about 25 $km^2$, and serviced by a 132 kV power line connecting the facility to the Juno Substation, about 35 km to the southeast (EWT, 2007). Potential impacts of the proposed Wind Energy Facility on the birdlife were identified as:

- Inflated morality of threatened and/or endemic species (especially Ludwig's Bustard and Secretarybird) cause by collisions with the blades of the wind turbines and/or the overhead power line servicing the site; and
- Loss of habitat for threatened and/or endemic species (especially Ludwig's Bustard and Black Harrier), either by direct destruction or degradation during construction or indirectly by disturbance during the operation of the wind farm.

The avifauna assessment for this EIA was conducted by Andrew Jenkins from the Endangered Wildlife Trust, they confirmed that the proposed wind energy facility will probably have limited negative impacts on the avifauna in the surrounding area. Their summary table of impacts lists only one moderate-highly significant, taxon-specific impact; Ludwig's Bustard collision with both the turbine blades and the 132kV powerline.

## 5.3 Field Assessment

A Regime 2 assessment has been completed for this development. This comprised a summer survey (December 2021), with a rapid assessment terrestrial assessment completed in April 2022. To supplement the two survey requirements for Regime 2, avifauna data and reports from the adjacent wind farm have been considered. The preceding section of this report (Section 5.2) presents the data/report review. The full list of species recorded, their threat status, guild and location observed is shown in Appendix B.

### 5.3.1 Avifauna Species

Thirty-five (35) bird species were recorded in the summer survey from 1 December 2021 to 3 December 2021. Two of the species recorded were classified as SCCs for this environmental impact assessment based on regional and global red list status, endemism, diurnal birds of prey and big flying birds at risk of collision:

- Twenty Lesser Flamingos were observed flying west, following the Olifants River towards the coast, this observation is located 12.6 km away from the project area; and
- A single Caspian Tern was observed flying east, following the Olifants River away from the coast, this observation is located 12.6 km away from the project area.

Table 5-3 lists the species of conservation concern as well as their threatened status, Figure 5-8 shows photographs of the recorded species.

*Table 5-3 Species of conservation concern observed during the survey (VU, Vulnerable; NT, Near Threatened)*

| Common Name | Scientific Name | Conservation Status | |
|---|---|---|---|
| | | Regional (SANBI, 2021) | IUCN (2021) |
| **Lesser Flamingo** | *Phoeniconaias minor* | NT | NT |
| **Caspian Tern** | *Hydroprogne caspia* | VU | LC |

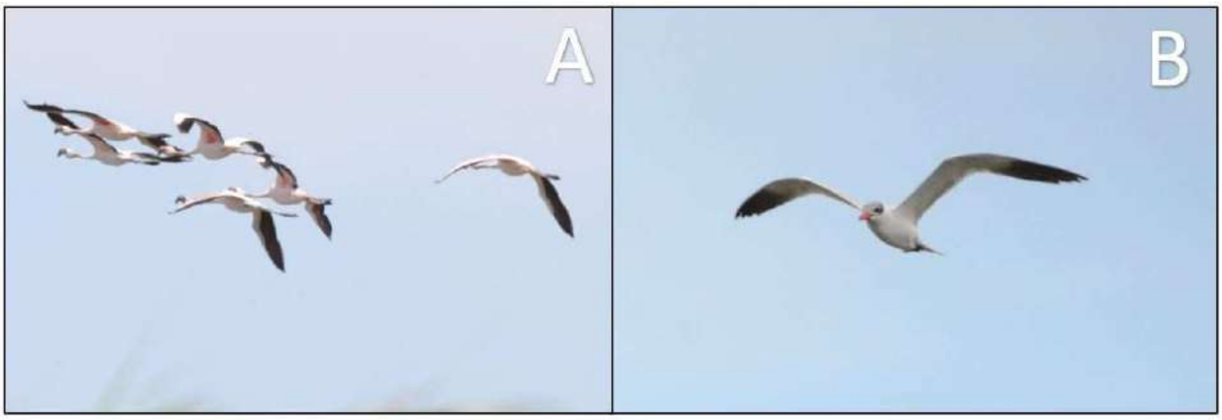



*Figure 5-8 Photographs of recorded species, A) Lesser Flamingo, B) Caspian Tern*

Twenty-five (25) species were recorded in the project area during the April 2022 survey based on direct observation (Table 5-4). No species were listed as provincially protected. Photographs of species recorded for the area are presented in Figure 5-9.

The vegetation type encountered was Namaqua Shrubland, areas of Namaqualand shrubland which is intact and with low degree of disturbance, has been impacted by secondary roads, grazing, mismanagement. Even though this habitat is partly disturbed, it supports largely intact vegetation. Most avifauna species encountered were recorded within this habitat type. The Namaqua Shrubland included habitat variation in the form of rocky outcrops that occur within the shrubland habitat. This variation in available habitat is instrumental in certain bird species encountered. The rocky outcrops micro habitat is used by avifaunal species as fine-scale habitats and is important to consider for mitigation actions, especially when an area is potentially cleared for placement of the infrastructure.

*Table 5-4 Species of observed during the survey*

| Common Name | Species | Conservation Status | |
|---|---|---|---|
| | | Regional (SANBI, 2021) | IUCN (2021) |
| **African Stonechat** | *Saxicola torquatus* | LC | LC |
| **Ant-eating Chat** | *Myrmecocichla formicivora* | LC | LC |
| **Barn Swallow** | *Hirundo rustica* | LC | LC |
| **Black-headed Heron** | *Ardea melanocephala* | LC | LC |
| **Blacksmith Lapwing** | *Vanellus armatus* | LC | LC |
| **Bokmakierie** | *Telophorus zeylonus* | LC | LC |
| **Cape Bulbul** | *Pycnonotus capensis* | LC | LC |
| **Cape Sparrow** | *Passer melanurus* | LC | LC |
| **Cape Turtle (Ring-necked) Dove** | *Streptopelia capicola* | LC | LC |
| **European Bee-eater** | *Merops apiaster* | LC | LC |
| **Fiscal Flycatcher** | *Melaenornis silens* | LC | LC |
| **Grey-backed Cisticola** | *Cisticola subruficapilla* | LC | LC |
| **Karoo Lark** | *Calendulauda albescens* | LC | LC |
| **Karoo Prinia** | *Prinia maculosa* | LC | LC |
| **Karoo Scrub Robin** | *Cercotrichas coryphoeus* | LC | LC |
| **Large-billed Lark** | *Galerida magnirostris* | LC | LC |
| **Namaqua Dove** | *Oena capensis* | LC | LC |
| **Namaqua Sandgrouse** | *Pterocles namaqua* | LC | LC |
| **Pale Chanting Goshawk** | *Melierax canorus* | LC | LC |
| **Pied Crow** | *Corvus albus* | LC | LC |
| **Pied Starling** | *Lamprotornis bicolor* | LC | LC |
| **Spotted Thick-knee** | *Burhinus capensis* | LC | LC |
| **Spotted Eagle-Owl** | *Bubo africanus* | LC | LC |
| **Southern Double-collared Sunbird** | *Cinnyris chalybeus* | LC | LC |
| **Three-banded Plover** | *Charadrius tricollaris* | LC | LC |


*Figure 5-9 Photographs of recorded species, A) Long-billed Crombec, B) Namaqua Dove*

#### 5.3.1.1 Dominant Species

Table 5-5 provide lists of the dominant species for the survey together with the frequency with which each species appeared in the point count samples. The data shows the Southern Double-collared Sunbird, Lesser Flamingos, Karoo Prinia, Bokmakierie, Karoo Lark and Grey-backed Cisticola were the most abundant species during the survey. Due to the high number of Flamingos recorded, they were the second most abundant species found, their frequency was low as they were only recorded once at the Olifants River. Figure 5-10 shows some of the birds that were recorded during the survey.

*Table 5-5 Dominant avifaunal species within the project area during the summer survey as defined as those species whose relative abundances cumulatively account for more than 75.6% of the overall abundance shown alongside the frequency with which a species was detected among point counts*

| Common Name | Species | Conservation Status | | Relative Abundance | Frequency |
|---|---|---|---|---|---|
| **Southern Double-collared Sunbird** | *Cinnyris chalybeus* | LC | LC | 0,228 | 89,47 |
| **Lesser Flamingo** | *Phoeniconaias minor* | NT | NT | 0,157 | 5,26 |
| **Karoo Prinia** | *Prinia maculosa* | LC | LC | 0,126 | 57,89 |
| **Bokmakierie** | *Telophorus zeylonus* | LC | LC | 0,110 | 47,37 |
| **Karoo Lark** | *Calendulauda albescens* | LC | LC | 0,079 | 26,32 |
| **Grey-backed Cisticola** | *Cisticola subruficapilla* | LC | LC | 0,055 | 36,84 |

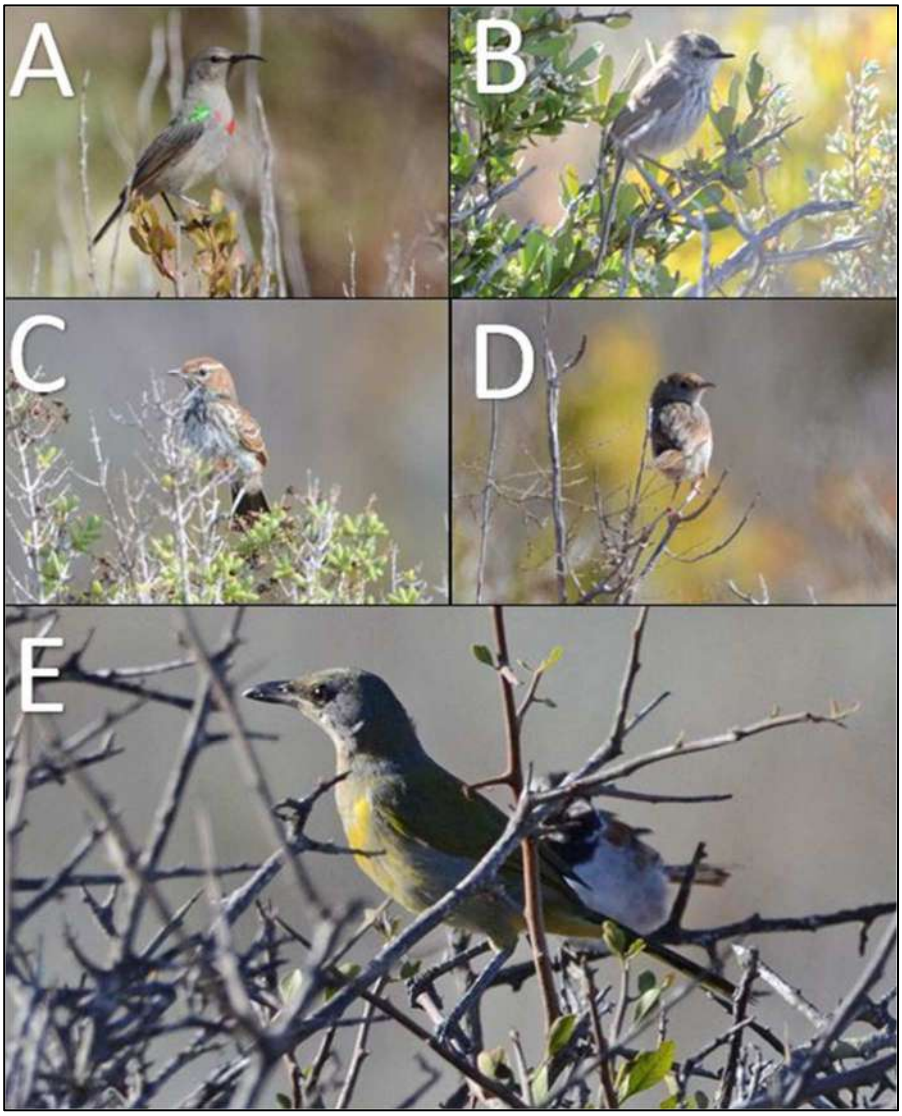



*Figure 5-10 Some of the birds recorded in the project area: A) Southern Double-collared Sunbird, B) Karoo Prinia, C) Karoo Lark, E) Grey-backed Cisticola and E) Bokmakierie*

#### 5.3.1.2 Trophic Guilds

Trophic guilds are defined as a group of species that exploit the same class of environmental resources in a similar way (González-Salazar *et al,* 2014). The guild classification used in this assessment is as per González-Salazar *et al* (2014); they divided avifauna into 13 major groups based on their diet, habitat, and main area of activity. The analysis of the major avifaunal guilds reveals that the species composition during the survey was dominated by insectivorous birds that feed on the ground during the day (IGD) (35,3%) (Figure 5-11). Granivores that feed on the ground (GGD), Insectivores that feed in the air and carnivores that are water dependent made up the second highest group (11.7%). It is important to note that all the carnivores that are water dependent were observed at the Olifants River.

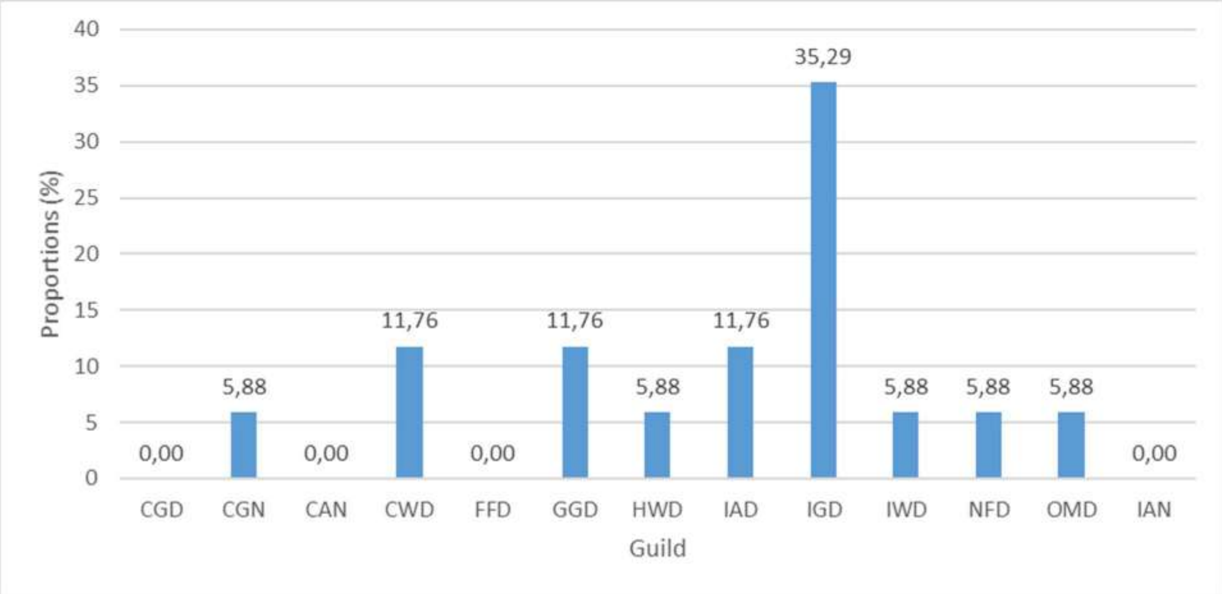



*Figure 5-11 Avifaunal trophic guilds. CGD, carnivore ground diurnal; CGN, carnivore ground nocturnal, CAN, carnivore air nocturnal, CWD, carnivore water diurnal; FFD, frugivore foliage diurnal; GCD, granivore ground diurnal; HWD, herbivore water diurnal; IAD, insectivore air diurnal; IGD, insectivore ground diurnal; IWD, insectivore water diurnal; NFD, nectivore foliage diurnal; OMD, omnivore multiple diurnal; IAN, Insectivore air nocturnal.*

### 5.3.2 Risk Species

A number of species were found that would be regarded as high risk species (Figure 5-12). Risk species are endemic species that would be sensitive to habitat loss and species that are regarded as collision prone species. Potential species along the Olifants River were included as they could very likely be influenced should they be moving between water sources. Even though the panels does not pose an extensive collision risk for larger birds, guidelines (anchor lines) and connection lines does pose a risk. The fence could also pose a collision risk for various species as described in section 7.2.

*Table 5-6 At risk species found in the survey.*

| Common Name | Scientific Name | Regional (SANBI, 2021) | IUCN (2021) | Endemism | Collision | Disturbance/ Habitat Loss |
|---|---|---|---|---|---|---|
| **Cape Bulbul** | *Pycnonotus capensis* | LC | LC | E | | x |
| **Cape Long-billed Lark** | *Certhilauda curvirostris* | LC | LC | E | | x |
| **Pied Starling** | *Lamprotornis bicolor* | LC | LC | E | | x |
| **Pale Chanting Goshawk** | *Melierax canorus* | LC | LC | | x | |
| **Rock Kestrel** | *Falco rupicolus* | LC | LC | | x | |
| **Spotted Eagle-Owl** | *Bubo africanus* | LC | LC | | x | |
| **Black-headed Heron** | *Ardea melanocephala* | LC | LC | | x | |
| **Cape Crow** | *Corvus capensis* | LC | LC | | x | |
| **Namaqua Sandgrouse** | *Pterocles namaqua* | LC | LC | | x | |
| **Spotted Thick-knee** | *Burhinus capensis* | LC | LC | | x | |
| **Blacksmith Lapwing** | *Vanellus armatus* | LC | LC | | x | |
| **Reed Cormorant** | *Microcarbo africanus* | LC | LC | | x | |

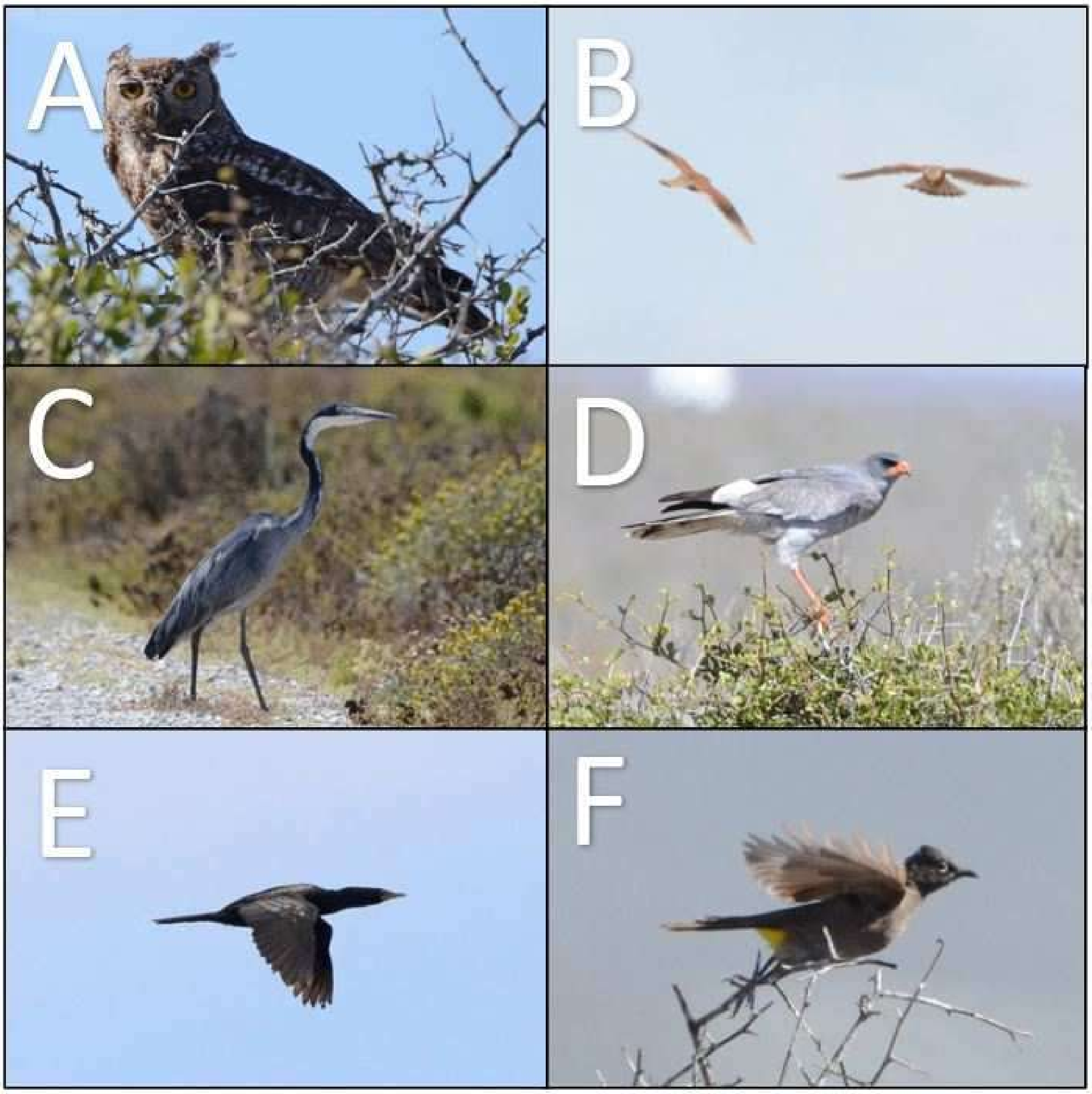



*Figure 5-12 One species at risk for habitat loss and five high collision risk species photographed on site: A) Spotted Eagle-Owl, B) Rock Kestrel, C) Black-headed Heron, D) Pale Chanting Goshawk, E) Reed Cormorant, F) Cape Bulbul*

### 5.3.3 Nest and Flight Analysis

There were no active nests recorded in the project area during the survey. There were however 4 abandoned Common Ostrich nesting spots found on the project area with eggs still present (Figure 5-14). With regards to flight paths, there were no significant patterns detected on the project area during the survey. There were two flight patterns detected at the Olifants River, the first being a Caspian Tern flying east following the river flying away from the coast, and secondly a flock of twenty Lesser Flamingo flying west following the river towards the coast (Figure 5-13).

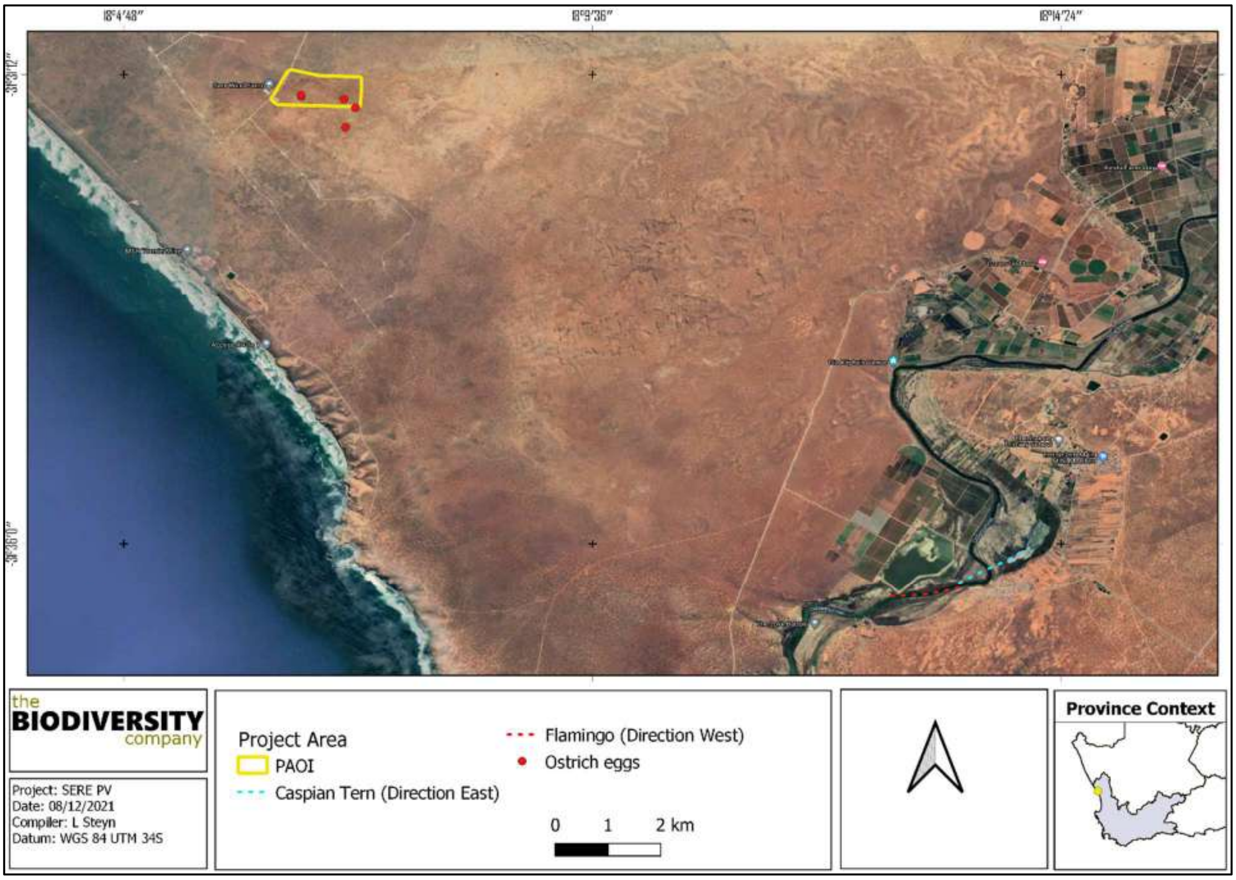



*Figure 5-13 The flight directions observed*

*Figure 5-14 Four Abandoned Common Ostrich nesting sites*

### 5.3.4 Fine-Scale Habitat Use

Fine-scale habitats within the landscape are important in supporting a diverse avifauna community as they provide differing nesting, foraging and reproductive opportunities. The assessment area consisted of two habitat types: Namaqua Sand Fynbos and Namaqua Inland Duneveld, these two habitats were similar with regards to the bird species recorded. Two more habitats were planned to be assessed: the coast west of the survey area and the Olifants River. Only the Olifants River was assessed in this survey as access to the coast was not possible due to the property belonging to Tormin Mineral Sand Mine.

The Namaqualand Sand Fynbos, slightly undulating plains comprising both isolated streets and dune fields of aeolian sand. Scattered 1-1.5m tall shrubs 1-3m in diameter, but dominated by Restionaceae in between, can have a dense canopy cover (50%), but is easily overgrazed to a sparse cover (20%). Restioid and asteraceous fynbos predominate, with localised pockets of proteoid fynbos. The overall state of the area was regarded as pristine, with very little degradation noticed while on site. The habitat supported a good level of plant species and insect life. The habitat hosted a number of insectivorous bird species such as Karoo Prinia, Karoo Lark and Grey-backed Cisticola that was recorded in the project area.

The Namaqualand Inland Duneveld is described as a coastal peneplain with mobile dunes. Vegetation is tall shrubland dominated by non-succulent shrubs (*Berkheya,Eriocephalus, Euclea, Gloveria, Lycium, Searsia, Tetragonia, Tripteris, Zygophyllum*) as well as some grasses (*Ehrharta*) and restioids (*Willdenowia*). The Overall state of the area was regarded as pristine, with a few degraded patches with less plant cover. The habitat supported a good level of plant species and insect life. The habitat hosted a number of insectivorous bird species such as Karoo Prinia, Karoo Lark and Grey- backed Cisticola that was recorded in the project area.

The Olifants River acts as a major water source and habitat for a large number of bird species in this arid landscape. Four species were recorded here that were found exclusively in this habitat type. These species were Lesser Flamingo, Three-banded Plover, Reed Cormorant and Caspian Tern.

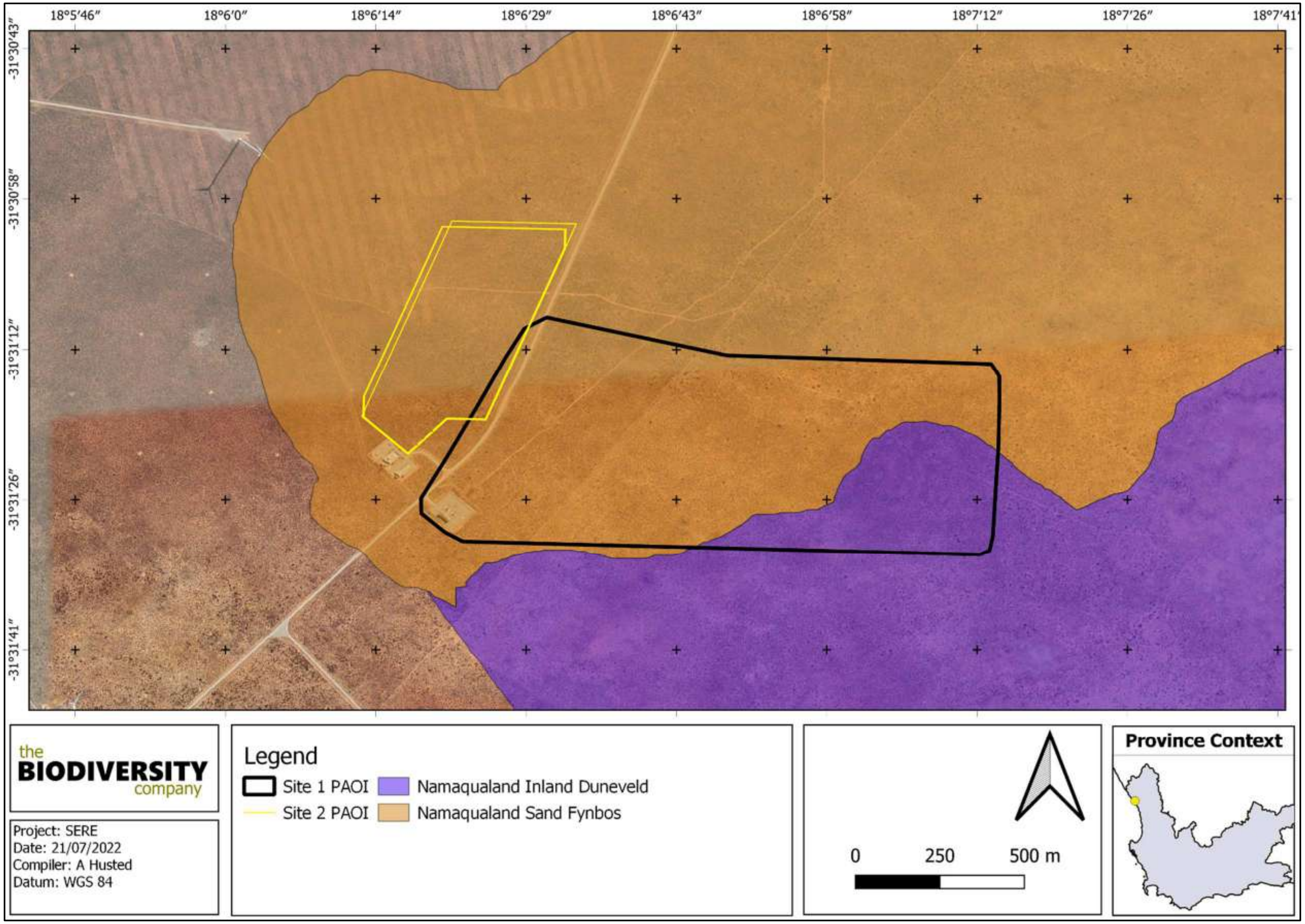



*Figure 5-15 The avifauna habitats found in the project area*

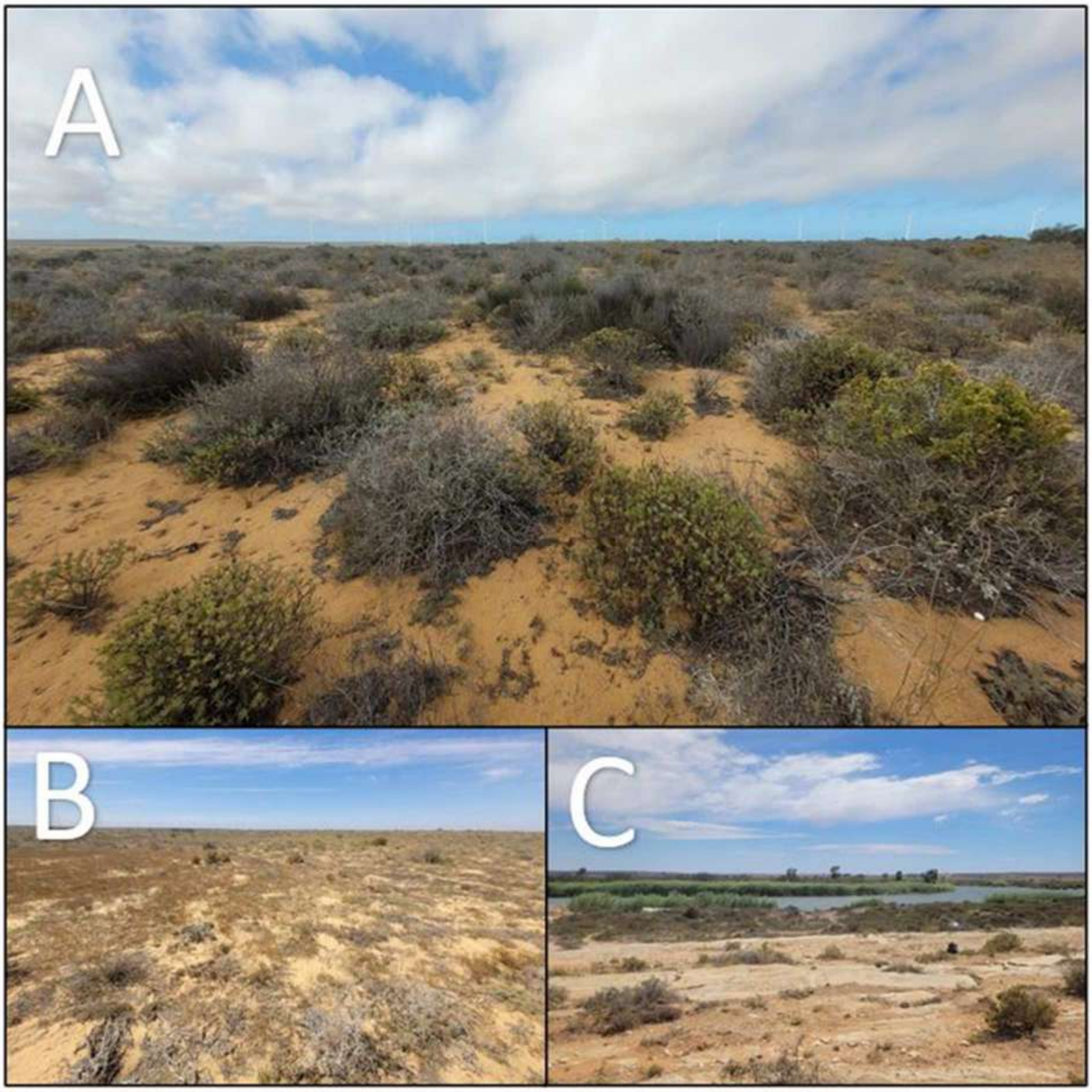



*Figure 5-16 Photographs illustrating examples of A) Namaqua Sand Fynbos, B) Namaqua Inland Duneveld and C) Olifants River*

# 6 Site Sensitivity

The Department of Environment, Forestry and Fisheries (DEFF) National Screening Tool classifies a section of the project area as highly sensitive from an avifaunal perspective (Figure 6-1). Consequently, by application of the protocol and associated guidelines, this project warrants an avifaunal assessment. The national environmental screening tool is a web-based application hosted by the Department of Environmental Affairs that allows developers to screen their prospective site for environmental sensitives. Importantly, this tool now serves as the first step in the environmental authorisation process as laid out in the gazetted assessment protocols for each environmental theme. Guidance towards achieving these protocols for terrestrial biodiversity is provided in the Species Environmental Assessment Guideline (SANBI, 2020) which, in turn, relies on the results of the screening tool to inform the level of assessment required. The screening tool provides an avifaunal sensitivity theme. However, this layer is applicable to wind energy developments and for all other projects, the user must evaluate the animal species sensitivity's theme for any avifaunal triggers. The avian species sensitivity theme shows that the project area has a moderate sensitivity, this is as Ludwig's Bustard and the Black Harrier has a moderate change of occurring.

MAP OF RELATIVE ANIMAL SPECIES THEME SENSITIVITY


Where only a sensitive plant unique number or sensitive animal unique number is provided in the screening report and an assessment is required, the environmental assessment practitioner (EAP) or specialist is required to email SANBI at eiadatarequests@sanbi.org.za listing all sensitive species with their unique identifiers for which information is required. The name has been withheld as the species may be prone to illegal harvesting and must be protected. SANBI will release the actual species name after the details of the EAP or specialist have been documented.

| Very High sensitivity | High sensitivity | Medium sensitivity | Low sensitivity |
|---|---|---|---|
| | x | | |

Sensitivity Features:

| Sensitivity | Feature(s) |
|---|---|
| High | Aves-Afrotis afra |
| Medium | Aves-Neotis ludwigii |
| Medium | Aves-Circus maurus |
| Medium | Sensitive species 32 |
| Medium | Invertebrate-Pachysoma endroedyi |
| Medium | Invertebrate-Brinckiella mauerbergerorum |

*Figure 6-1 The screening sensitivity for animals for the two project areas.*

In completion of the field assessment, two verified habitat types were subjected to the SEI methods as described in section 4.3 and allocated a sensitivity category (Table 6-1 and Table 6-2). The sensitivities of the habitats delineated is illustrated in Figure 6-2.

*Table 6-1 Summary of habitat types delineated within the field assessment area of the project*

| Habitat | Conservation Importance | Functional Integrity | Biodiversity Importance | Receptor Resilience | Site Ecological Importance |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Namaqua Shrubland | Medium | High | Medium | Low | High |
| Transformed | Low | Very Low | Very Low | Low | Very Low |

*Table 6-2 SEI Summary of habitat types delineated within field assessment area of site 2*

| Habitat | Conservation Importance | Functional Integrity | Biodiversity Importance | Receptor Resilience | Site Ecological Importance |
|---|---|---|---|---|---|
| Namaqua Shrubland | Medium | High | Medium | Medium | Medium |
| Transformed | Low | Very Low | Very Low | Low | Very Low |

*Table 6-3 Guidelines for interpreting Site Ecological Importance in the context of the proposed development activities*

| Site Ecological Importance | Interpretation in relation to proposed development activities |
|---|---|
| High | Avoidance mitigation wherever possible. Minimisation mitigation – changes to project infrastructure design to limit the amount of habitat impacted, limited development activities of low impact acceptable. Offset mitigation may be required for high impact activities. |
| Medium | Minimisation and restoration mitigation – development activities of medium impact acceptable followed by appropriate restoration activities. |
| Very Low | Minimisation mitigation – development activities of medium to high impact acceptable and restoration activities may not be required. |

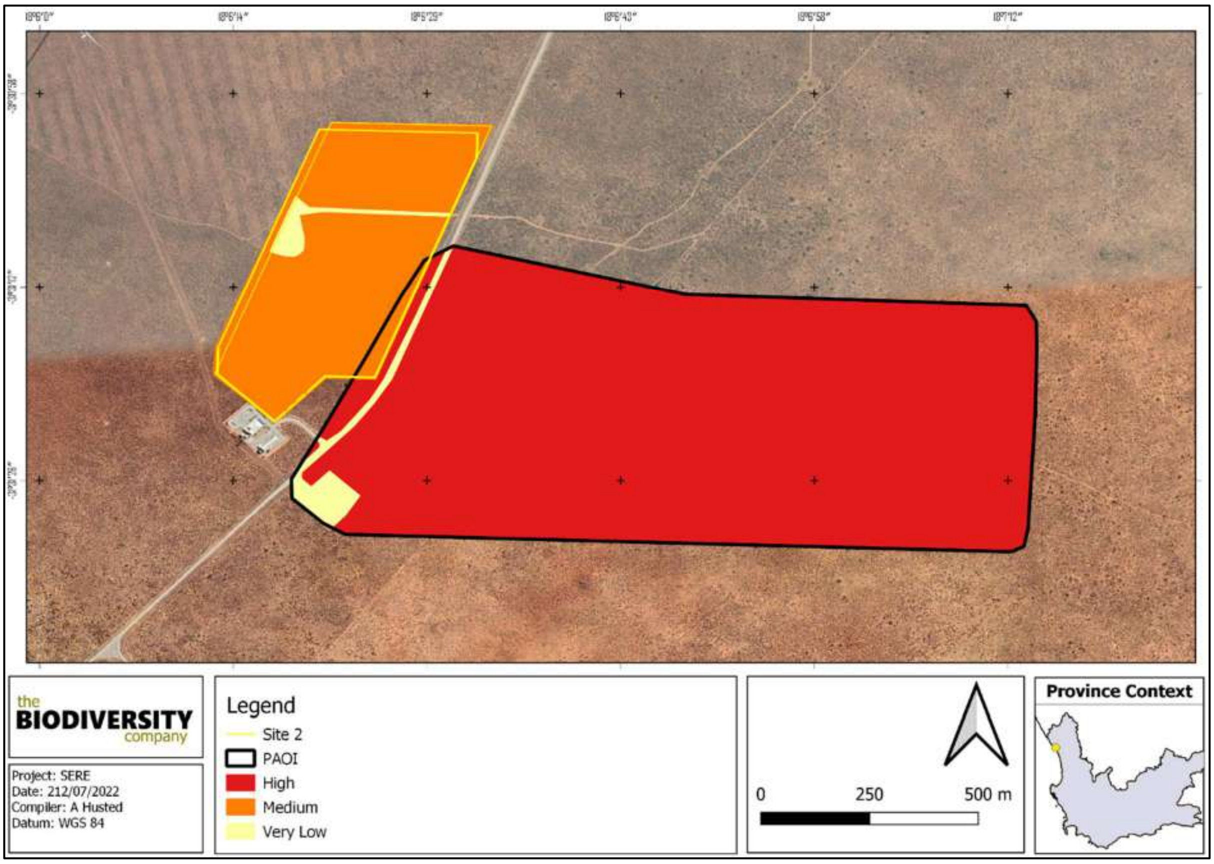



*Figure 6-2 Site Ecological Importance for the project area*

# 7 Impact Assessment

The section below and associated tables serve to indicate and summarise the significance of perceived impacts on the terrestrial ecology of the project area. Potential impacts were evaluated against the data captured during the desktop and field assessment to identify relevance to the project area. The relevant impacts associated with the proposed construction of the development were then subjected to a prescribed impact assessment methodology which is available on request.

## 7.1 Current Impacts

The current impacts observed during the survey are listed below.

- Multiple high voltage powerlines;
- Grazing and trampling of natural vegetation by livestock;
- Farm roads and main roads (and associated traffic and wildlife road mortalities);
- Fences; and
- Existing Wind Energy Facilities in the surrounding landscape.

## 7.2 Impact Assessment

This section describes the potential impacts on avifauna associated with the construction and operational phases of the proposed development and is only relevant to the PV site and associated infrastructure and does not consider the powerline grid system. This impact assessment is based on the desktop information as well as the assimilated information of the provided data sources. The assimilation of data and the survey completed for this area are considered to satisfy the requirements of a Regime 2 approach.

During the construction phase vegetation clearing and brush cutting of vegetation for the associated infrastructure will lead to direct habitat loss. Vegetation clearing will create a disturbance and will therefore potentially lead to the displacement of avifaunal species. The operation of construction machinery on site will generate noise and cause dust pollution. Should non-environmentally friendly dust suppressants be used, chemical pollution can take place. Increased human presence can lead to poaching and the increase in vehicle traffic will potentially lead to roadkill.

The principle impacts of the operational phase are collisions, fencing, chemical pollution if these are used for the cleaning of the PV panels and habitat loss. Solar panels have been implicated as a potential risk for bird collisions. Collisions are thought to arise when birds (particularly waterbirds) mistake the panels for waterbodies, known as the “lake effect” (Lovich & Ennen, 2011), or when migrating or dispersing birds become disorientated by the polarised light reflected by the panels. This “lake-effect” hypothesis has not been substantiated or refuted to date (Visser *et al.,* 2019). It can however be said that the combination of powerlines, fencing and large infrastructure will influence avifauna species. Visser *et al.* (2019) performed a study at a utility-scale photovoltaic solar energy facility in the Northern Cape and found that most of the species affected by the facility were passerine species. Larger species were said to be more influenced by the facilities when they were found foraging close by and were disturbed by predators which resulted in collisions.

Large passerines are particularly susceptible to electrocution because owing to their relatively large bodies, they are able to touch conductors and ground/earth wires or earthed devices simultaneously. The chances of electrocution are increased when feathers are wet, during periods of high humidity or during defecation. Prevailing wind direction also influences the rate of electrocution casualties.

Fencing of the PV site can influence birds in six ways (Birdlife SA, 2015);

1. Snagging: Occurs when a body part is impaled on one or more barbs or razor points of a fence.
2. Snaring: When a birds foot/leg becomes trapped between two overlapping wires.
3. Impact injuries: birds flying into a fence, the impact may kill or injure the bird
4. Snarling: When birds try and push through a mesh or wire stands, ultimately becoming trapped (uncommon).
5. Electrocution: Electrified fence can kill or severely injure birds. Fences will not be electrified for the facility.
6. Barrier effect: Fences may limit flightless birds (e.g. Moulting waterfowl) from resources.

PV sites require the overall removal of vegetation, this is a measure that is implemented to restrict the risk of fire (Birdlife, 2017). The removal of vegetation results in the loss of habitat for a number of species in this case it would be displacing grassland, tree dwellers from the alien clumps and waterfowl.

### 7.2.1 Loss of Irreplaceable Resources

Portions of a CBA 1 will be lost, with limited encroachment for temporary access road by Site 2. Considerable encroachment into a designated CBA 1 area for Site 1.

## 7.3 Assessment of Impact Significance

The assessment of impact significance considers pre-mitigation as well as implemented of post-mitigation scenarios. Although different species and groups will react differently to the development, the risk assessment was undertaken bearing in mind the potential impacts to the priority species listed in this report. Mitigations can be seen in section 9.

### 7.3.1 Construction Phase

The following potential impacts on the biodiversity were considered for the construction phase. This phase refers to the period during construction when the proposed infrastructure is constructed, and the area's surface is cleared. This phase usually has the largest direct impact on biodiversity: The following potential impacts were considered:

- Destruction, fragmentation and degradation of habitats;
- Displacement of avifaunal community (Including several SCC) due to disturbance such as noise, light, dust, vibration;
- Collection of eggs and poaching;
- Roadkill.
- The destruction of the habitat was rated as High pre-mitigation for Site 1 (Table 7-1), and Moderate for Site 2 (Table 7-2). The post-mitigation impacts for habitat loss for Site 1 and Site 2 are Moderately-High and Moderate. This impact can however not be mitigated completely as the habitat will still be lost.
- The use of environmentally friendly dust suppressants can reduce the risk of chemical pollution to a Low residual impact for both sites.
- The post-mitigation impacts caused by sensory disturbances, roadkill and egg poaching was also determined to be low for both sites.
- The construction phase of the road and cable route were assessed separately for the two alternatives. A Moderately-High impact significance is expected for the "Destruction,

fragmentation and degradation of habitats" at Site 1 (Table 7-3). The habitat loss and degradation could be mitigated to Low impact for both site alternatives.

### 7.3.2 Operational Phase

The operational phase of the impact of daily activities is anticipated to lead to collisions and electrocutions. Moving vehicles don't only cause sensory disturbances to avifauna, affecting their life cycles and movement, but will lead to direct mortalities due to collisions. The area surrounding the direct footprint will be maintained to prevent uncontrolled events such as fire, this practice will however result in the disturbance and displacement of breeding and non-breeding species. The pre-mitigation impact ratings are 'generally' higher for Site 1 (Table 7-5) when compared to Site 2 (Table 7-6), this is largely attributed to the assigned sensitivities of the two areas. The overall residual risk for Site 2 is Low, with the residual risk for habitat fragmentation and deterioration for Site 1 determined to remain Moderate. The following potential impacts were considered:

- Collisions with PV panels, associated powerlines and connection lines and fences;
- Electrocution with solar plant connections, although cables will be positioned below ground;
- Roadkill during maintenance procedures; and
- Habitat degradation and displacement of resident, visiting and breeding species (as well as SCCs).
- The risk of collisions, habitat loss and the construction of fencing all has a high risk prior to mitigations. With the successful implementation of the mitigations these impacts can be reduced to Low or Absent.

### 7.3.3 Decommissioning Phase

This phase is when the scaling down of activities ahead of temporary or permanent closure is initiated. During this phase, the operational phase impacts will persist until of the activity reduces and the rehabilitation measures are implemented. The residual impacts for both sites were determined to be Low (Table 7-7 and Table 7-8).

The following potential impacts were considered:

- Continued fragmentation and degradation of habitats;
- Displacement of faunal community (including SCC) due disturbance (road collisions, noise, dust, vibration).

Should the development be decommissioned it is imperative that the infrastructure be removed, and the area rehabilitated. The habitat will be disturbed again due to the removal of the infrastructure, this impact was rated as Moderately-High pre-mitigations, with the successful implementation of a rehabilitation and erosion control plan this impact can be reduced to Low.

*Table 7-1 The impacts associated with the construction phase for Site 1*

| | Prior to mitigation | | | | | | Post mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Impact** | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance |
| | 5 | 3 | 4 | 4 | 5 | | 5 | 3 | 4 | 4 | 4 | |
| **Habitat Loss (Destroy, fragment and degrade habitat, ultimately displacing avifauna)** | Permanent | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Great / harmful/ ecosystem structure and function largely altered | Ecology highly sensitive /important | Definite | **High** | Permanent | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Great / harmful/ ecosystem structure and function largely altered | Ecology highly sensitive /important | Highly likely | **Moderately High** |
| | 4 | 3 | 3 | 3 | 4 | | 3 | 2 | 2 | 2 | 3 | |
| **Sensory disturbances (e.g. noise, dust, vibrations)** | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Highly likely | **Moderate** | One year to five years: Medium Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |
| | 3 | 3 | 3 | 3 | 4 | | 2 | 2 | 2 | 2 | 3 | |
| **Collection of eggs and poaching** | One year to five years: Medium Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Highly likely | **Moderate** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3 | 3 | 3 | 3 | 4 | | 2 | 2 | 2 | 2 | 3 | |
| **Roadkill** | One year to five years: Medium Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Highly likely | **Moderate** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |
| | 3 | 4 | 4 | 3 | 4 | | 2 | 2 | 2 | 2 | 3 | |
| **Chemical pollution associated with dust suppressants** | One year to five years: Medium Term | Regional within 5 km of the site boundary / < 2000ha impacted / Linear features affected < 3000m | Great / harmful/ ecosystem structure and function largely altered | Ecology moderately sensitive/ /important | Highly likely | **Moderately High** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |

*Table 7-2 The impacts associated with the construction phase for Site 2*

| Impact | Prior to mitigation | | | | | | Post mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance |
| | 5 | 3 | 3 | 3 | 3 | | 5 | 3 | 3 | 3 | 2 | |
| **Habitat Loss (Destroy, fragment and degrade habitat, ultimately** | Permanent | Local area/ within 1 km of the site boundary / < 5000ha impacted / | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Likely | **Moderate** | Permanent | Local area/ within 1 km of the site boundary / < 5000ha impacted / | Significant / ecosystem structure and function | Ecology moderately sensitive/ /important | Possible | **Moderate** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **displacing avifauna)** | | Linear features affected < 1000m | | | | | | Linear features affected < 1000m | moderately altered | | | |
| | 4 | 3 | 3 | 3 | 3 | | 3 | 2 | 2 | 2 | 3 | |
| **Sensory disturbances (e.g. noise, dust, vibrations)** | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Likely | **Moderate** | One year to five years: Medium Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |
| | 3 | 3 | 3 | 3 | 2 | | 2 | 2 | 2 | 2 | 3 | |
| **Collection of eggs and poaching** | One year to five years: Medium Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Possible | **Low** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |
| | 3 | 3 | 3 | 3 | 3 | | 2 | 2 | 2 | 2 | 3 | |
| **Roadkill** | One year to five years: Medium Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Likely | **Moderate** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |
| | 3 | 3 | 3 | 3 | 4 | | 2 | 2 | 2 | 2 | 3 | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical pollution associated with dust suppressants** | One year to five years: Medium Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Highly likely | **Moderate** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |

*Table 7-3 Impacts associated routes for the cable and road route for Site 1*

| | **Prior to mitigation** | | | | | | **Post mitigation** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Impact** | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance |
| | 4 | 3 | 3 | 3 | 4 | | 3 | 2 | 3 | 3 | 3 | |
| **Habitat Loss: Destroy, fragment and degrade habitat** | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Highly likely | **Moderate** | One year to five years: Medium Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Likely | **Low** |

*Table 7-4 Impacts associated routes for the cable and road route for Site 2*

| **Impact** | **Prior to mitigation** | **Post mitigation** |
|---|---|---|

| | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Habitat Loss: Destroy, fragment and degrade habitat of permanent route** | 4 | 3 | 3 | 3 | 3 | | 3 | 2 | 3 | 3 | 3 | |
| | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Likely | **Moderate** | One year to five years: Medium Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Likely | **Low** |
| **Habitat Loss: Destroy, fragment and degrade habitat of temporary access route** | 4 | 3 | 3 | 3 | 3 | | 3 | 2 | 2 | 3 | 3 | |
| | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Likely | **Moderate** | One year to five years: Medium Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology moderately sensitive/ /important | Likely | **Low** |

*Table 7-5 The impacts associated with the operational phase for Site 1*

| **Impact** | **Prior to mitigation** | | | | | | **Post mitigation** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance |
| **Habitat Loss (Destroy, fragment and degrade habitat,** | 5 | 4 | 4 | 3 | 4 | | 4 | 3 | 3 | 3 | 3 | |
| | Permanent | Regional within 5 km of the site boundary / < 2000ha | Great / harmful/ ecosystem structure | Ecology moderately sensitive/ /important | Highly likely | **High** | Life of operation or less than 20 | Local area/ within 1 km of the site boundary / < | Significant / ecosystem structure | Ecology moderately sensitive/ /important | Likely | **Moderate** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ultimately displacing avifauna)** | | impacted / Linear features affected < 3000m | and function largely altered | | | | years: Long Term | 5000ha impacted / Linear features affected < 1000m | and function moderately altered | | | |
| | 4 | 3 | 3 | 3 | 3 | | 2 | 2 | 2 | 2 | 3 | |
| **Sensory disturbances (e.g. noise, dust, vibrations)** | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Likely | **Moderate** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |
| | 4 | 4 | 3 | 4 | 3 | | 3 | 2 | 2 | 2 | 2 | |
| **Collection of eggs and poaching** | Life of operation or less than 20 years: Long Term | Regional within 5 km of the site boundary / < 2000ha impacted / Linear features affected < 3000m | Significant / ecosystem structure and function moderately altered | Ecology highly sensitive /important | Likely | **Moderately High** | One year to five years: Medium Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Possible | **Low** |
| | 4 | 3 | 4 | 4 | 4 | | 2 | 2 | 2 | 2 | 3 | |
| **Roadkill** | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Great / harmful/ ecosystem structure and function largely altered | Ecology highly sensitive /important | Highly likely | **Moderately High** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4 | 3 | 4 | 3 | 3 | | 2 | 2 | 2 | 2 | 3 | |
| **Collisions with PV and associated infrastructure** | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Great / harmful/ ecosystem structure and function largely altered | Ecology moderately sensitive/ /important | Likely | **Moderate** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |
| | 5 | 4 | 4 | 4 | 4 | | 3 | 3 | 3 | 2 | 2 | |
| **Electrocution by infrastructure and connections to PV** | Permanent | Regional within 5 km of the site boundary / < 2000ha impacted / Linear features affected < 3000m | Great / harmful/ ecosystem structure and function largely altered | Ecology highly sensitive /important | Highly likely | **High** | One year to five years: Medium Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology with limited sensitivity/importance | Possible | **Low** |
| | 5 | 3 | 4 | 4 | 5 | | 2 | 2 | 2 | 2 | 2 | |
| **Chemical pollution associated with measures to keep PV clean** | Permanent | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Great / harmful/ ecosystem structure and function largely altered | Ecology highly sensitive /important | Definite | **High** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Possible | **Absent** |
| | 5 | 4 | 4 | 4 | 5 | | 2 | 3 | 3 | 3 | 3 | |
| **Fencing of PV site** | Permanent | Regional within 5 km of the site boundary / < 2000ha | Great / harmful/ ecosystem structure | Ecology highly sensitive /important | Definite | **High** | One month to one year: | Local area/ within 1 km of the site boundary / < | Significant / ecosystem structure | Ecology moderately sensitive/ /important | Likely | **Low** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | impacted / Linear features affected < 3000m | and function largely altered | | | | Short Term | 5000ha impacted / Linear features affected < 1000m | and function moderately altered | | | |

*Table 7-6 The impacts associated with the operational phase for Site 2*

| Impact | Prior to mitigation | | | | | | Post mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance |
| **Habitat Loss (Destroy, fragment and degrade habitat, ultimately displacing avifauna)** | 4 | 3 | 3 | 3 | 3 | | 4 | 2 | 2 | 2 | 3 | |
| | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Likely | **Moderately** | Life of operation or less than 20 years: Long Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |
| **Sensory disturbances (e.g. noise, dust, vibrations)** | 4 | 3 | 3 | 3 | 3 | | 2 | 2 | 2 | 2 | 3 | |
| | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Likely | **Moderate** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |
| **Collection of eggs and poaching** | 4 | 4 | 3 | 3 | 3 | | 3 | 2 | 2 | 2 | 2 | |
| | | | | | Likely | **Moderate** | | | | | Possible | **Low** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Life of operation or less than 20 years: Long Term | Regional within 5 km of the site boundary / < 2000ha impacted / Linear features affected < 3000m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | | | One year to five years: Medium Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | | |
| | 4 | 3 | 3 | 3 | 3 | | 2 | 2 | 2 | 2 | 3 | |
| **Roadkill** | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Likely | **Moderate** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |
| | 4 | 3 | 3 | 3 | 3 | | 2 | 2 | 2 | 2 | 3 | |
| **Collisons with PV and associated infrastructure** | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Likely | **Moderate** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |
| | 4 | 4 | 3 | 3 | 3 | | 3 | 3 | 3 | 2 | 2 | |
| **Electrocution by infrastructure and connections to PV** | Life of operation or less than 20 years: Long Term | Regional within 5 km of the site boundary / < 2000ha impacted / Linear features affected < 3000m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Likely | **Moderate** | One year to five years: Medium Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features | Significant / ecosystem structure and function moderately altered | Ecology with limited sensitivity/importance | Possible | **Low** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | affected < 1000m | | | | |
| | 4 | 3 | 4 | 3 | 3 | | 2 | 2 | 2 | 2 | 2 | |
| **Chemical pollution associated with measures to keep PV clean** | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Great / harmful/ ecosystem structure and function largely altered | Ecology moderately sensitive/ /important | Likely | **Moderate** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Possible | **Absent** |
| | 4 | 4 | 4 | 3 | 3 | | 2 | 3 | 3 | 3 | 3 | |
| **Fencing of PV site** | Life of operation or less than 20 years: Long Term | Regional within 5 km of the site boundary / < 2000ha impacted / Linear features affected < 3000m | Great / harmful/ ecosystem structure and function largely altered | Ecology moderately sensitive/ /important | Likely | **Moderate** | One month to one year: Short Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Likely | **Low** |

*Table 7-7 The impacts associated with the decommissioning phase for Site 1*

| **Impact** | **Prior to mitigation** | | | | | | **Post mitigation** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance |
| | 4 | 3 | 3 | 3 | 3 | | 3 | 3 | 2 | 3 | 3 | |
| **Continued fragmentation and degradation of habitats** | Life of operation or less than 20 years: | Local area/ within 1 km of the site boundary | Significant / ecosystem structure and function | Ecology moderately sensitive/ /important | Likely | **Moderately High** | One year to five years: Medium Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / | Small / ecosystem structure and function | Ecology moderately sensitive/ /important | Likely | **Low** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Long Term | / < 5000ha impacted / Linear features affected < 1000m | moderately altered | | | | | Linear features affected < 1000m | largely unchanged | | | |
| | 4 | 3 | 2 | 3 | 3 | | 2 | 2 | 2 | 2 | 3 | |
| **Displacement of faunal community (including SCC) due disturbance (road collisions, noise, dust, vibration)** | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Small / ecosystem structure and function largely unchanged | Ecology moderately sensitive/ /important | Likely | **Moderate** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |

*Table 7-8 The impacts associated with the decommissioning phase for Site 2*

| **Impact** | **Prior to mitigation** | | | | | | **Post mitigation** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance |
| | 4 | 3 | 2 | 2 | 3 | | 3 | 3 | 2 | 3 | 3 | |
| **Continued fragmentation and degradation of habitats** | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Moderate** | One year to five years: Medium Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Small / ecosystem structure and function largely unchanged | Ecology moderately sensitive/ /important | Likely | **Low** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | features affected < 1000m | | | | | | | | | | |
| | 4 | 3 | 2 | 3 | 3 | | 2 | 2 | 2 | 2 | 3 | |
| **Displacement of faunal community (including SCC) due disturbance (road collisions, noise, dust, vibration)** | Life of operation or less than 20 years: Long Term | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Small / ecosystem structure and function largely unchanged | Ecology moderately sensitive/ /important | Likely | **Moderate** | One month to one year: Short Term | Development specific/ within the site boundary / < 100 ha impacted / Linear features affected < 100m | Small / ecosystem structure and function largely unchanged | Ecology with limited sensitivity/importance | Likely | **Low** |

## 7.4 Cumulative Impacts

The impacts of projects are often assessed by comparing the post-project situation to a pre-existing baseline. Where projects can be considered in isolation this provides a good method of assessing a project's impact. However, in areas where baselines have already been affected, or where future development will continue to add to the impacts in an area or region, it is appropriate to consider the cumulative effects of development. This is similar to the concept of shifting baselines, which describes how the environmental baseline at a point in time may represent a significant change from the original state of the system. This section describes the potential impacts of the project that are cumulative for terrestrial fauna and flora.

Localised cumulative impacts include the cumulative effects from operations that are close enough to potentially cause additive effects on the environment or sensitive receivers (such as the nearby existing wind facility and the existing powerlines). These include dust deposition, noise and vibration, disruption of corridors or habitat, groundwater drawdown, groundwater and surface water quality, and transport.

Long-term cumulative impacts due to the large number of development close by (Section 5.1.8) can lead to the loss of endemic and threatened species, loss of habitat and vegetation types and even degradation of well conserved areas. A number of renewable energy plants and powerlines can already be found around the project area, this combination of obstacles increases the risk of bird collisions and habitat loss as well as territorial disputes (species forced out of the one area to just again be forced out). In the light of all above, the expected cumulative impact is expected to be highly detrimental (Table 7-9) for Site 1, a mitigated Moderate impact for Site 2 (Table 7-10).

*Table 7-9 Cumulative impact of the solar facility for Site 1*

| Impact | Prior to mitigation | | | | | | Post mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance |
| **Habitat Loss (Destroy, fragment and degrade habitat, ultimately displacing avifauna)** | 5 | 4 | 4 | 4 | 5 | | 5 | 4 | 4 | 4 | 4 | |
| | Permanent | Regional within 5 km of the site boundary / < 2000ha impacted / Linear features affected < 3000m | Great / harmful/ ecosystem structure and function largely altered | Ecology highly sensitive /important | Definite | **High** | Permanent | Regional within 5 km of the site boundary / < 2000ha impacted / Linear features affected < 3000m | Great / harmful/ ecosystem structure and function largely altered | Ecology highly sensitive /important | Highly likely | **High** |

*Table 7-10 Cumulative impact of the solar facility for Site 2*

| Impact | Prior to mitigation | | | | | | Post mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance | Duration of Impact | Spatial Scope | Severity of Impact | Sensitivity of Receiving Environment | Probability of Impact | Significance |
| **Habitat Loss (Destroy, fragment and degrade habitat, ultimately displacing avifauna)** | 5 | 4 | 3 | 3 | 5 | | 5 | 3 | 3 | 3 | 3 | |
| | Permanent | Regional within 5 km of the site boundary / < 2000ha impacted / Linear features affected < 3000m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Definite | **Moderately High** | Permanent | Local area/ within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m | Significant / ecosystem structure and function moderately altered | Ecology moderately sensitive/ /important | Likely | **Moderate** |

# 8 Specialist Management Plan

The aim of the management outcomes is to present the mitigations in such a way that they can be incorporated into the Environmental Management Programme (EMPr), allowing for more successful implementation and auditing of the mitigations and monitoring guidelines.

Table 8-1 presents the recommended mitigation measures and the respective timeframes, targets, and performance indicators for the avifaunal study.

*Table 8-1 Summary of management outcomes pertaining to impacts to avifauna and their habitats*

| Impact Management Actions | Implementation | | Monitoring | |
|---|---|---|---|---|
| | Phase | Responsible Party | Aspect | Frequency |
| **Management outcome: Habitats** | | | | |
| Areas outside of the direct project footprint, should under no circumstances be fragmented or disturbed further. Clearing of vegetation should be minimized and avoided where possible. | Life of operation | Project manager, Environmental Officer | Areas of indigenous vegetation | Ongoing |
| The development footprint must be used for storage and the contractors' camps as well. This may not be outside the direct project area to ensure the disturbance area is as small as possible. | Construction | Project manager, Environmental Officer | Project footprint | During Stage |
| Where possible, existing access routes and walking paths must be made use of. | Construction/Operational Phase | Environmental Officer & Design Engineer | Roads and paths used | Ongoing |
| Areas that are denuded during construction need to be re-vegetated with indigenous vegetation to prevent erosion during flood and wind events. This will also reduce the likelihood of encroachment by alien invasive plant species. | Closure Phase/Rehabilitation phase | Environmental Officer & Contractor | Assess the state of rehabilitation and encroachment of alien vegetation | Quarterly for up to two years after the closure |
| Any woody material removed can be shredded and used in conjunction with the topsoil to augment soil moisture and prevent further erosion. | Closure Phase/ Post Closure Phase | Environmental Officer & Contractor | Road edges and project area footprint | During Phase |
| Rehabilitation of the disturbed areas existing in the project area must be made a priority. Topsoil must also be utilised, and any disturbed area must be re-vegetated with plant and grass species which are endemic to this vegetation type. | Operational/Closure Phase | Environmental Officer & Contractor | Road edges and footprint | During Phase |
| Erosion control and alien invasive management plan must be compiled. | Life of operation | Environmental Officer & Contractor | Erosion and alien invasive species | Ongoing |
| Environmentally friendly dust suppressants need to be utilised | Operational phase | Environmental Officer & Contractor | Water pollution | During Phase |
| A fire management plan needs to be compiled and implemented to restrict the impact fire might have on the surrounding areas. | Life of operation | Environmental Officer & Contractor | Fire Management | During Phase |
| **Management outcome: Avifauna** | | | | |
| **Impact Management Actions** | **Implementation** | | **Monitoring** | |

| | Phase | Responsible Party | Aspect | Frequency |
|---|---|---|---|---|
| The areas to be developed must be specifically demarcated to prevent movement of staff or any individual into the surrounding environments. Signs must be put up to enforce this. | Construction/Operational Phase | Project manager, Environmental Officer | Infringement into these areas | Ongoing |
| All personnel should undergo environmental induction with regards to avifauna and in particular awareness about not harming, collecting, or hunting terrestrial species (e.g., guineafowl and francolin), and owls, which are often persecuted out of superstition. Signs must be put up to enforce this. | Life of operation | Environmental Officer | Evidence of trapping etc | Ongoing |
| Any powerlines or connection lines must have bird flappers installed. This must be inline with the designs as advised by Birdlife South Africa. | Life of operation | Environmental Officer | Evidence of bird carcasses | Ongoing |
| The duration of the construction should be kept to a minimum to avoid disturbing avifauna. | Construction/Operational Phase | Project manager, Environmental Officer & Design Engineer | Construction/Closure Phase | During Phase |
| Outside lighting should be designed and limited to minimize impacts on fauna. All outside lighting should be directed away from highly sensitive areas. Fluorescent and mercury vapor lighting should be avoided and sodium vapor (red/green) lights should be used wherever possible. | Construction/Operational Phase | Project manager, Environmental Officer & Design Engineer | Light pollution and period of light. | During Phase |
| All construction and maintenance motor vehicle operators should undergo an environmental induction that includes instruction on the need to comply with speed limit (40km/h), to respect all forms of wildlife. Speed limits must still be enforced to ensure that road killings and erosion is limited. | Life of operation | Health and Safety Officer | Compliance to the training. | Ongoing |
| Schedule or limit (where feasible) activities and operations during least sensitive periods, to avoid migration, nesting and breeding seasons (June – August) | Construction/Operational Phase | Project manager, Environmental Officer & Design Engineer | Activities should take place during the day in winter. | During Phase |
| All project activities must be undertaken with appropriate noise mitigation measures to avoid disturbance to avifauna population in the region | Construction/Operational Phase | Project manager, Environmental Officer | Noise | During Phase |
| All areas to be developed must be walked through prior to any activity to ensure no nests or avifauna species are found in the area. Should any Species of Conservation Concern be found and not move out of the area, or their nest be found in the area a suitably qualified specialist must be consulted to advise on the correct actions to be taken. | Planning, Construction and Decommissioning | Project manager, Environmental Officer | Presence of Nests and faunal species | During Phase |
| The design of the proposed PV must be of a type or similar structure as endorsed by the Eskom-EWT Strategic Partnership on Birds and Energy, considering the mitigation guidelines | Planning and construction | Environmental Officer & Contractor, Engineer | Presence of electrocuted birds or bird strikes | During Phase |

| | | | | |
|---|---|---|---|---|
| recommended by Birdlife South Africa (Jenkins *et al.,* 2015). | | | | |
| Infrastructure should be consolidated where possible in order to minimise the amount of ground and air space used. | Planning and construction | Environmental Officer & Contractor, Engineer | Presence of bird collisions | During phase |
| All the parts of the infrastructure must be nest proofed and anti-perch devices placed on areas that can lead to electrocution | Planning and construction | Environmental Officer & Contractor, Engineer | Presence of electrocuted birds | During phase |
| Use environmentally friendly cleaning and dust suppressant products | Construction and operation | Environmental Officer & Contractor, Engineer | Presence of chemicals in and around the project area | During phase |
| Fencing mitigations:<br>• Top 2 strands must be smooth wire<br>• Routinely retention loose wires<br>• Minimum 30cm between wires<br>• Place markers on fences | Planning, construction, and operation | Environmental Officer & Contractor, Engineer | Presence of birds stuck /dead in fences Monitor fences for slack wires | During phase |
| As far as possible power cables within the project area should be thoroughly insulated and preferably buried. | Planning and construction | Environmental Officer & Contractor, Engineer | Exposed cables | During phase |
| Any exposed parts must be covered (insulated) to reduce electrocution risk | Planning and construction | Environmental Officer & Contractor, Engineer | Presence of electrocuted birds | During phase |
| White strips should be placed along the edges of the panels, to reduce similarity to water and deter birds and insects (Horvath *et al,* 2010). Consider the use of bird deterrent devices to limit collision risk. | Planning and construction | Environmental Officer & Contractor, Engineer | Presence of dead birds in the project area | During phase |

# 9 Recommendations

The following recommendations are proposed for the project:

- As very little is known about the impacts of solar facilities on birds in South Africa, a construction monitoring regime is recommended for the proposed project area to document any impacts and this data must be used for improving mitigation measures to reduce the impact on biological resources, particularly avifauna; and

- A follow-up assessment on avian biodiversity and species abundance within the project area and surrounding areas must be conducted within one year after the facility has been in operation and should be repeated every 3-5 years.

# 10 Conclusion and Impact Statement

In completion of the report, taking into consideration the results from a desktop perspective as well as review from the nearby assessments and results from the field assessments the following is concluded:

Two main habitat types were verified/identified in the project area, namely Namaqualand Sand Fynbos and Namaqualand Inland Duneveld. The project area overlaps with limited portions of CBA1 and ESA, with the majority of the area OBA and ESA 2. The habitat has experienced some level of disturbance and mismanagement leading from being fenced of and the associated livestock impacts

Site 1 overlaps within sensitive habitats and other areas of high biodiversity potential in the form of a CBA1 area. Site 2 would be considered to have a minor negative impact as it would directly affect small area of the habitat and the faunal species that use these ecosystems.

The development will result in the loss of habitat for these SCCs, it will also lead to sensory disturbance, collision and electrocution risks. Even though the latter three impacts can be mitigated to some extent, the loss of habitat cannot be mitigated. These species could move into surrounding areas however based on the number of applications and current renewable energy development in the area the cumulative impact is also regarded as being high.

Further avifauna assessments may not be necessary, the review of previous reports and data have adequately supplemented the avifauna considerations for this project, however the final decision can be determined by the issuing authorities.

## 10.1 Impact Statement

The main expected impacts of the proposed grid infrastructure will include the following:

- habitat loss and fragmentation;
- degradation of surrounding habitat;
- disturbance and displacement caused during the construction and maintenance phases; and
- direct mortality during the construction and operational phases.

Mitigation measures as described in this report can be implemented to achieve an average Moderately-Low residual impact for Site 1, and Low for Site 2. Development of Site 2 is considered acceptable, and Site 1 must remain undeveloped and managed accordingly.

Considering the above-mentioned information, no fatal flaws are evident for the proposed project. It is the opinion of the specialists that the project location, may be favourably considered on condition that all prescribed mitigation measures and supporting recommendations are implemented. Further avifauna assessments are also no recommended, the review of previous reports and data have adequately supplemented the avifauna considerations for this project.

# 11 References

ADU (Animal Demography Unit). (2020). Virtual Museum.

Bennun, L., van Bochove, J., Ng, C., Fletcher, C., Wilson, D., Phair, N., Carbone, G. 2021. Mitigating biodiversity impacts associated with solar and wind energy development. Guidelines for project developers. Gland, Switzerland: IUCN and Cambridge, UK: The Biodiversity Consultancy.

BGIS (Biodiversity GIS). (2018). http://bgis.sanbi.org/

Birdlife South Africa. (2015). Checklist of Birds - List of Threatened Species. https://www.birdlife.org.za/publications

BirdLife South Africa. (2017). Important Bird Areas Factsheet. http://www.birdlife.org

Del Hoyo, J., Elliott, A. and Christie, D. 2004. *Handbook of the Birds of the World, Vol. 9: Cotingas to Pipits and Wagtails*. Lynx Editions, Barcelona, Spain.

Eskom. (2015). Taylor, M.R., Peacock, F. & Wanless, R.M. (Eds). The 2015 Eskom Red Data Book of birds of South Africa, Lesotho, and Swaziland. BirdLife South Africa, Johannesburg.

EWT (2007). Eskom Generation Wind Energy Facility-Western Cap . Avifaunal Impact Assessment.

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 Voelcker Bird Book Fund, Cape Town.

IUCN. (2021). The IUCN Red List of Threatened Species. www.iucnredlist.org

Jenkins, A.R., Ralston-Paton, S., & Smit-Robinson, H. (2017). Best Practice Guidelines: Birds and Solar Energy: Guidelines for assessing and monitoring the impact of solar power generating facilities on birds in southern Africa.

Mucina, L. and Rutherford, M.C. (Eds.) (2006). The Vegetation of South Africa, Lesotho and Swaziland, Strelitzia 19. South African National Biodiversity Institute, Pretoria.

Peacock, F. 2015. In: Taylor, M. R.; Peacock, F.; Wanless, R. M. (ed.), *The 2015 Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland*, pp. 322-324. BirdLife South Africa, Johannesburg, South Africa.

SABAP2 (Bird Atlas Project). (2017). http://vmus.adu.org.za/.

SANBI. (2017). Technical guidelines for CBA Maps: Guidelines for developing a map of Critical Biodiversity Areas & Ecological Support Areas using systematic biodiversity planning. Driver, A., Holness, S. & Daniels, F. (Eds). 1st Edition. South African National Biodiversity Institute, Pretoria.

Taylor, M.R., Peacock, F. & Wanless, R.M. (Eds). (2015). The 2015 Eskom Red Data Book of birds of South Africa, Lesotho, and Swaziland. BirdLife South Africa, Johannesburg.

Van Rooyen, C.S. and Ledger, J.A. 1999. Birds and utility structures: developments in southern Africa. In: Ferrer, M. and Walston, L. J., Rollins, K.E., Smith, K.P., LaGory, K.E., Sinclair, K., Turchi, C., Wendelin, T. & Souder, H. 2015. A review of avian monitoring and mitigation information at existing utility- scale solar facilities.

Visser, E., Perold, V., Ralston-Paton, S., Cardenal, A. C., & Ryan, P. G. (2019). Assessing the impacts of a utility-scale photovoltaic solar energy facility on birds in the Northern Cape, South Africa. Renewable energy, 133, 1285-1294.

Wildskies Ecological Services, SERE Wind Farm Western Cape Operational bird monitoring programme, Year 1 Final report: September 2016

Wildskies Ecological Services, SERE Wind Farm Western Cape Operational bird monitoring programme, Year 1 Final report: August 2017

# 12 Appendices

## 12.1 Appendix A: Avifaunal species expected in the area.

| Common Name | Scientific Name | Regional (SANBI, 2021) | IUCN (2021) | Endemism |
|---|---|---|---|---|
| Bar-throated Apalis | *Apalis thoracica* | LC | LC | |
| Pied Avocet | *Recurvirostra avosetta* | LC | LC | |
| Acacia Pied Barbet | *Tricholaema leucomelas* | LC | LC | |
| Pririt Batis | *Batis pririt* | LC | LC | |
| European Bee-eater | *Merops apiaster* | LC | LC | |
| Southern Red Bishop | *Euplectes orix* | LC | LC | |
| Bokmakierie | *Telophorus zeylonus* | LC | LC | |
| Cape Bulbul | *Pycnonotus capensis* | LC | LC | E |
| African Red-eyed Bulbul | *Pycnonotus nigricans* | LC | LC | |
| Cape Bunting | *Emberiza capensis* | LC | LC | |
| Lark-like Bunting | *Emberiza impetuani* | LC | LC | |
| Ludwig's Bustard | *Neotis ludwigii* | EN | EN | |
| Kori Bustard | *Ardeotis kori* | NT | NT | |
| Common Buzzard | *Buteo buteo* | LC | LC | |
| Jackal Buzzard | *Buteo rufofuscus* | LC | LC | |
| White-throated Canary | *Crithagra albogularis* | LC | LC | |
| Yellow Canary | *Crithagra flaviventris* | LC | LC | |
| Cape Canary | *Serinus canicollis* | LC | LC | |
| Ant-eating Chat | *Myrmecocichla formicivora* | LC | LC | |
| Familiar Chat | *Oenanthe familiaris* | LC | LC | |
| Sickle-winged Chat | *Emarginata sinuata* | LC | LC | |
| Karoo Chat | *Emarginata schlegelii* | LC | LC | |
| Tractrac Chat | *Emarginata tractrac* | LC | LC | |
| Grey-backed Cisticola | *Cisticola subruficapilla* | LC | LC | |
| Levaillant's Cisticola | *Cisticola tinniens* | LC | LC | |
| Zitting Cisticola | *Cisticola juncidis* | LC | LC | |
| Red-knobbed Coot | *Fulica cristata* | LC | LC | |
| Bank Cormorant | *Phalacrocorax neglectus* | EN | EN | |
| Cape Cormorant | *Phalacrocorax capensis* | EN | EN | |
| Crowned Cormorant | *Microcarbo coronatus* | NT | NT | |
| White-breasted Cormorant | *Phalacrocorax lucidus* | LC | LC | |
| Reed Cormorant | *Microcarbo africanus* | LC | LC | |
| Long-billed Crombec | *Sylvietta rufescens* | LC | LC | |
| Pied Crow | *Corvus albus* | LC | LC | |
| Cape Crow | *Corvus capensis* | LC | LC | |

| | | | | |
|---|---|---|---|---|
| **Diederik Cuckoo** | *Chrysococcyx caprius* | LC | LC | |
| **African Darter** | *Anhinga rufa* | LC | LC | |
| **Cape Turtle Dove** | *Streptopelia capicola* | LC | LC | |
| **Laughing Dove** | *Spilopelia senegalensis* | LC | LC | |
| **Namaqua Dove** | *Oena capensis* | LC | LC | |
| **Red-eyed Dove** | *Streptopelia semitorquata* | LC | LC | |
| **Rock Dove** | *Columba livia* | LC | LC | |
| **Yellow-billed Duck** | *Anas undulata* | LC | LC | |
| **Maccoa Duck** | *Oxyura maccoa* | NT | VU | |
| **Martial Eagle** | *Polemaetus bellicosus* | EN | EN | |
| **African Fish Eagle** | *Haliaeetus vocifer* | LC | LC | |
| **Booted Eagle** | *Hieraaetus pennatus* | LC | LC | |
| **Spotted Eagle-Owl** | *Bubo africanus* | LC | LC | |
| **Little Egret** | *Egretta garzetta* | LC | LC | |
| **Western Cattle Egret** | *Bubulcus ibis* | LC | LC | |
| **Yellow-bellied Eremomela** | *Eremomela icteropygialis* | LC | LC | |
| **Southern Fiscal** | *Lanius collaris* | LC | LC | |
| **Greater Flamingo** | *Phoenicopterus roseus* | NT | LC | |
| **Lesser Flamingo** | *Phoeniconaias minor* | NT | NT | |
| **Chat Flycatcher** | *Melaenornis infuscatus* | LC | LC | |
| **Fairy Flycatcher** | *Stenostira scita* | LC | LC | |
| **Fiscal Flycatcher** | *Melaenornis silens* | LC | LC | |
| **Cape Gannet** | *Morus capensis* | VU | EN | |
| **Egyptian Goose** | *Alopochen aegyptiaca* | LC | LC | |
| **Spur-winged Goose** | *Plectropterus gambensis* | LC | LC | |
| **Pale Chanting Goshawk** | *Melierax canorus* | LC | LC | |
| **Little Grebe** | *Tachybaptus ruficollis* | LC | LC | |
| **Black-necked Grebe** | *Podiceps nigricollis* | LC | LC | |
| **Great Crested Grebe** | *Podiceps cristatus* | LC | LC | |
| **Common Greenshank** | *Tringa nebularia* | LC | LC | |
| **Helmeted Guineafowl** | *Numida meleagris* | LC | LC | |
| **Kelp Gull** | *Larus dominicanus* | LC | LC | |
| **Hartlaub's Gull** | *Chroicocephalus hartlaubii* | LC | Unlisted | |
| **Grey-headed Gull** | *Chroicocephalus cirrocephalus* | LC | LC | |
| **Hamerkop** | *Scopus umbretta* | LC | LC | |
| **Black Harrier** | *Circus maurus* | EN | EN | |
| **African Marsh Harrier** | *Circus ranivorus* | EN | LC | |
| **Black-headed Heron** | *Ardea melanocephala* | LC | LC | |
| **Grey Heron** | *Ardea cinerea* | LC | LC | |

| | | | | |
|---|---|---|---|---|
| **Black-crowned Night Heron** | *Nycticorax nycticorax* | LC | LC | |
| **Goliath Heron** | *Ardea goliath* | LC | LC | |
| **Greater Honeyguide** | *Indicator indicator* | LC | LC | |
| **African Hoopoe** | *Upupa africana* | LC | LC | |
| **Hadada Ibis** | *Bostrychia hagedash* | LC | LC | |
| **African Sacred Ibis** | *Threskiornis aethiopicus* | LC | LC | |
| **Glossy Ibis** | *Plegadis falcinellus* | LC | LC | |
| **Rock Kestrel** | *Falco rupicolus* | LC | LC | |
| **Greater Kestrel** | *Falco rupicoloides* | LC | LC | |
| **Lesser Kestrel** | *Falco naumanni* | LC | LC | |
| **Giant Kingfisher** | *Megaceryle maxima* | LC | LC | |
| **Pied Kingfisher** | *Ceryle rudis* | LC | LC | |
| **Malachite Kingfisher** | *Corythornis cristatus* | LC | LC | |
| **Black-winged Kite** | *Elanus caeruleus* | LC | LC | |
| **Southern Black Korhaan** | *Afrotis afra* | VU | VU | E |
| **Crowned Lapwing** | *Vanellus coronatus* | LC | LC | |
| **Blacksmith Lapwing** | *Vanellus armatus* | LC | LC | |
| **Cape Clapper Lark** | *Mirafra apiata* | LC | LC | |
| **Cape Long-billed Lark** | *Certhilauda curvirostris* | LC | LC | E |
| **Karoo Lark** | *Calendulauda albescens* | LC | LC | |
| **Large-billed Lark** | *Galerida magnirostris* | LC | LC | |
| **Red-capped Lark** | *Calandrella cinerea* | LC | LC | |
| **Spike-heeled Lark** | *Chersomanes albofasciata* | LC | LC | |
| **Cape Longclaw** | *Macronyx capensis* | LC | LC | |
| **Rock Martin** | *Ptyonoprogne fuligula* | LC | LC | |
| **Brown-throated Martin** | *Riparia paludicola* | LC | LC | |
| **Banded Martin** | *Riparia cincta* | LC | LC | |
| **Common Moorhen** | *Gallinula chloropus* | LC | LC | |
| **Red-faced Mousebird** | *Urocolius indicus* | LC | LC | |
| **Speckled Mousebird** | *Colius striatus* | LC | LC | |
| **White-backed Mousebird** | *Colius colius* | LC | LC | |
| **Neddicky** | *Cisticola fulvicapilla* | LC | LC | |
| **Common Ostrich** | *Struthio camelus* | LC | LC | |
| **African Oystercatcher** | *Haematopus moquini* | LC | LC | |
| **Great White Pelican** | *Pelecanus onocrotalus* | VU | LC | |
| **Speckled Pigeon** | *Columba guinea* | LC | LC | |
| **African Pipit** | *Anthus cinnamomeus* | LC | LC | |
| **Grey Plover** | *Pluvialis squatarola* | LC | LC | |
| **Kittlitz's Plover** | *Charadrius pecuarius* | LC | LC | |

| | | | | |
|---|---|---|---|---|
| **Three-banded Plover** | *Charadrius tricollaris* | LC | LC | |
| **White-fronted Plover** | *Charadrius marginatus* | LC | LC | |
| **Common Ringed Plover** | *Charadrius hiaticula* | LC | LC | |
| **Southern Pochard** | *Netta erythrophthalma* | LC | LC | |
| **Karoo Prinia** | *Prinia maculosa* | LC | LC | |
| **Ruff** | *Calidris pugnax* | LC | LC | |
| **Common Quail** | *Coturnix coturnix* | LC | LC | |
| **Cape Robin-Chat** | *Cossypha caffra* | LC | LC | |
| **Sanderling** | *Calidris alba* | LC | LC | |
| **Namaqua Sandgrouse** | *Pterocles namaqua* | LC | LC | |
| **Curlew Sandpiper** | *Calidris ferruginea* | LC | NT | |
| **Wood Sandpiper** | *Tringa glareola* | LC | LC | |
| **Common Sandpiper** | *Actitis hypoleucos* | LC | LC | |
| **Marsh Sandpiper** | *Tringa stagnatilis* | LC | LC | |
| **Karoo Scrub Robin** | *Cercotrichas coryphoeus* | LC | LC | |
| **South African Shelduck** | *Tadorna cana* | LC | LC | |
| **Cape Shoveler** | *Spatula smithii* | LC | LC | |
| **African Snipe** | *Gallinago nigripennis* | LC | LC | |
| **Cape Sparrow** | *Passer melanurus* | LC | LC | |
| **House Sparrow** | *Passer domesticus* | LC | LC | |
| **Grey-backed Sparrow-Lark** | *Eremopterix verticalis* | LC | LC | |
| **African Spoonbill** | *Platalea alba* | LC | LC | |
| **Cape Spurfowl** | *Pternistis capensis* | LC | LC | |
| **Common Starling** | *Sturnus vulgaris* | LC | LC | |
| **Pied Starling** | *Lamprotornis bicolor* | LC | LC | E |
| **Red-winged Starling** | *Onychognathus morio* | LC | LC | |
| **Wattled Starling** | *Creatophora cinerea* | LC | LC | |
| **Black-winged Stilt** | *Himantopus himantopus* | LC | LC | |
| **Little Stint** | *Calidris minuta* | LC | LC | |
| **African Stonechat** | *Saxicola torquatus* | LC | LC | |
| **White Stork** | *Ciconia ciconia* | LC | LC | |
| **Malachite Sunbird** | *Nectarinia famosa* | LC | LC | |
| **Southern Double-collared Sunbird** | *Cinnyris chalybeus* | LC | LC | |
| **Dusky Sunbird** | *Cinnyris fuscus* | LC | LC | |
| **Barn Swallow** | *Hirundo rustica* | LC | LC | |
| **White-throated Swallow** | *Hirundo albigularis* | LC | LC | |
| **Pearl-breasted Swallow** | *Hirundo dimidiata* | LC | LC | |
| **Greater Striped Swallow** | *Cecropis cucullata* | LC | LC | |
| **Little Swift** | *Apus affinis* | LC | LC | |

| | | | | |
|---|---|---|---|---|
| **African Black Swift** | *Apus barbatus* | LC | LC | |
| **Alpine Swift** | *Tachymarptis melba* | LC | LC | |
| **Common Swift** | *Apus apus* | LC | LC | |
| **White-rumped Swift** | *Apus caffer* | LC | LC | |
| **Cape Teal** | *Anas capensis* | LC | LC | |
| **Blue-billed Teal** | *Spatula hottentota* | LC | LC | |
| **Red-billed Teal** | *Anas erythrorhyncha* | LC | LC | |
| **Common Tern** | *Sterna hirundo* | LC | LC | |
| **Greater Crested Tern** | *Thalasseus bergii* | LC | LC | |
| **Caspian Tern** | *Hydroprogne caspia* | VU | LC | |
| **Sandwich Tern** | *Thalasseus sandvicensis* | LC | LC | |
| **Whiskered Tern** | *Chlidonias hybrida* | LC | LC | |
| **White-winged Tern** | *Chlidonias leucopterus* | LC | LC | |
| **Spotted Thick-knee** | *Burhinus capensis* | LC | LC | |
| **Water Thick-knee** | *Burhinus vermiculatus* | LC | LC | |
| **Karoo Thrush** | *Turdus smithi* | LC | LC | |
| **Cape Penduline Tit** | *Anthoscopus minutus* | LC | LC | |
| **Grey Tit** | *Melaniparus afer* | LC | LC | |
| **Cape Vulture** | *Gyps coprotheres* | EN | EN | |
| **Cape Wagtail** | *Motacilla capensis* | LC | LC | |
| **Layard's Warbler** | *Curruca layardi* | LC | LC | |
| **Rufous-eared Warbler** | *Malcorus pectoralis* | LC | LC | |
| **African Reed Warbler** | *Acrocephalus baeticatus* | LC | Unlisted | |
| **Chestnut-vented Warbler** | *Curruca subcoerulea* | LC | Unlisted | |
| **Lesser Swamp Warbler** | *Acrocephalus gracilirostris* | LC | LC | |
| **Little Rush Warbler** | *Bradypterus baboecala* | LC | LC | |
| **Namaqua Warbler** | *Phragmacia substriata* | LC | LC | |
| **Willow Warbler** | *Phylloscopus trochilus* | LC | LC | |
| **Common Waxbill** | *Estrilda astrild* | LC | LC | |
| **Cape Weaver** | *Ploceus capensis* | LC | LC | |
| **Southern Masked Weaver** | *Ploceus velatus* | LC | LC | |
| **Capped Wheatear** | *Oenanthe pileata* | LC | LC | |
| **Mountain Wheatear** | *Myrmecocichla monticola* | LC | LC | |
| **Eurasian Whimbrel** | *Numenius phaeopus* | LC | LC | |
| **Cape White-eye** | *Zosterops virens* | LC | LC | |
| **Pin-tailed Whydah** | *Vidua macroura* | LC | LC | |
| **Ground Woodpecker** | *Geocolaptes olivaceus* | LC | NT | E |

## 12.2 Appendix B: Avifauna species recorded in the survey

| Common Name | Species | Conservation Status | | Endemism in South Africa (E) | Guild code | Relative abundance | Frequency |
|---|---|---|---|---|---|---|---|
| | | Regional (SANBI, 2021) | IUCN (2021) | E = endemic | | | |
| **Southern Double-collared Sunbird** | *Cinnyris chalybeus* | LC | LC | | NFD | 0,228 | 89,47 |
| **Karoo Prinia** | *Prinia maculosa* | LC | LC | | IGD | 0,126 | 57,89 |
| **Pied Crow** | *Corvus albus* | LC | LC | | OMD | 0,039 | 26,32 |
| **Grey-backed Cisticola** | *Cisticola subruficapilla* | LC | LC | | IGD | 0,055 | 36,84 |
| **Spotted Eagle-Owl** | *Bubo africanus* | LC | LC | | CGN | 0,016 | 5,26 |
| **Karoo Lark** | *Calendulauda albescens* | LC | LC | | IGD | 0,079 | 26,32 |
| **Bokmakierie** | *Telophorus zeylonus* | LC | LC | | OMD | 0,110 | 47,37 |
| **Karoo Scrub Robin** | *Cercotrichas coryphoeus* | LC | LC | | IGD | 0,008 | 5,26 |
| **Cape Bulbul** | *Pycnonotus capensis* | LC | LC | E | OMD | 0,016 | 5,26 |
| **European Bee-eater** | *Merops apiaster* | LC | LC | | IAD | 0,008 | 5,26 |
| **Long-billed crombec** | *Sylvietta rufescens* | LC | LC | | IGD | 0,016 | 10,53 |
| **Namaqua Dove** | *Oena capensis* | LC | LC | | GGD | 0,016 | 10,53 |
| **Common Waxbill** | *Estrilda astrild* | LC | LC | | GGD | 0,031 | 5,26 |
| **Barn Swallow** | *Hirundo rustica* | LC | LC | | IAD | 0,047 | 21,05 |
| **Large-billed Lark** | *Galerida magnirostris* | LC | LC | | IGD | 0,008 | 5,26 |
| **Cape Long-billed Lark** | *Certhilauda curvirostris* | LC | LC | E | OMD | 0,008 | 5,26 |
| **Lesser Flamingo** | *Phoeniconaias minor* | NT | NT | | HWD | 0,157 | 5,26 |
| **Three-banded Plover** | *Charadrius tricollaris* | LC | LC | | IWD | 0,008 | 5,26 |
| **Reed Cormorant** | *Microcarbo africanus* | LC | LC | | CWD | 0,016 | 5,26 |
| **Caspian Tern** | *Hydroprogne caspia* | VU | LC | | CWD | 0,008 | 5,26 |
| **Birds seen while moving around and driving around in the area (Incidental Records)** | | | | | | | |
| **Pale Chanting Goshawk** | *Melierax canorus* | LC | LC | | | | |
| **Grey Tit** | *Melaniparus afer* | LC | LC | | | | |
| **Yellow Canary** | *Crithagra flaviventris* | LC | LC | | | | |
| **Black-headed Heron** | *Ardea melanocephala* | LC | LC | | | | |
| **Cape Penduline-tit** | *Anthoscopus minutus* | LC | LC | | | | |
| **African Stonechat** | *Saxicola torquatus* | LC | LC | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Rock Kestrel** | *Falco rupicolus* | LC | LC | | | | |
| **Namaqua Sandgrouse** | *Pterocles namaqua* | LC | LC | | | | |
| **Ant-eating Chat** | *Myrmecocichla formicivora* | LC | LC | | | | |
| **Cape Turtle (Ring-necked) Dove** | *Streptopelia capicola* | LC | LC | | | | |
| **Fiscal Flycatcher** | *Melaenornis silens* | LC | LC | | | | |
| **Blacksmith Lapwing** | *Vanellus armatus* | LC | LC | | | | |
| **Cape Sparrow** | *Passer melanurus* | LC | LC | | | | |
| **Pied Starling** | *Lamprotornis bicolor* | LC | LC | E | | | |
| **Spotted Thick-knee** | *Burhinus capensis* | LC | LC | | | | |

## 12.3 Appendix B: SERE Wind Farm Western Cape Operational bird monitoring programme, Year 1 Final report: September 2016

## 12.4 Appendix C: SERE Wind Farm Western Cape Operational bird monitoring programme, Year 1 Final report: August 2017.

# SERE Wind Farm

# Western Cape

## Operational bird monitoring programme

## Year 1 Final report

September 2016

Submitted to:
Endangered Wildlife Trust

Compiled by:
Luke Strugnell
WildSkies Ecological Services (Pty) Ltd
luke@wildskies.co.za

## EXECUTIVE SUMMARY

The Sere Wind Farm (SWF) consists of 46 Siemens wind turbines, each with a hub height of 115 metres and rotor diameter of 110 metres, situated near Lutzville, Western Cape. Construction of this facility was completed during 2014. In accordance with the conditions of the Environmental Authorisation, post-construction bird monitoring was initiated in May 2015.

The Endangered Wildlife Trust (EWT) designed and implemented the monitoring prograame, and appointed WildSkies Ecological Services (hereafter WildSkies) to analyse data and compile the report. Operational bird monitoring was initiated in late May 2015.

The most important findings of this monitoring programme are summarised below:

1. We estimate that approximately 37.58 hectares of vegetation was altered by the construction of this facility, including roads, turbine hard stands and the office-substation complex. This represents 1.18% of the total area of the site, defined as the polygon drawn around the outermost turbines and infrastructure on site. We also estimate that turbine rotors take up approximately 29.26 hectares of air space, which can now be considered either lost or hazardous habitat for birds and bats.
2. A total of 76 bird species were recorded on site during this programme, 6 of which are Red Listed. Pre-construction monitoring recorded 65 bird species.
3. Fifty-seven small passerine bird species were recorded. Based on our analyses, there has been a possible decrease in lark abundance on site compared to pre-construction data.
4. Six large terrestrial and raptor species were recorded on site through drive transects, one of which is a Red Listed species. Pre-construction bird monitoring recorded eight species using drive transects. The abundance per km of the species recorded on driven transects has shown a dramatic decrease in Ludwig's Bustard abundance. It is not known if this is a result of the SWF or just a natural variation in species movements. We suspect the latter is more likely.
5. Twelve target bird species were recorded flying on site during this period. The Red List species include: Black Harrier *Circus maurus* (Endangered), Lanner Falcon *Falco biarmicus* (Vulnerable), Ludwig's Bustard *Neotis ludwigii* (Endangered), Southern Black Korhaan *Afrotis afra* (Vulnerable) and Secretarybird *Sagittarius serpentarius* (Vulnerable). Most frequently recorded flying was Pale Chanting Goshawk *Melierax canorus* (53 minutes or 30% of all flight activity), Southern Black Korhaan *Afrotis afra* (40 minutes or 22.5% of all flight activity) and Black-chested Snake Eagle *Circaetus pectoralis* (20 minutes or 11.3% of all flight activity). Black Harrier, Black-chested Snake Eagle, Secretarybird, Lanner Falcon and Yellow-billed Kite *Milvus migrans* all spent the majority of their flight time in the turbine impact zone.

6. In the period 21 May 2015 to 20 May 2016 a total of 65 bird fatalities from at least 32 species were recorded (Appendix 6) by formal regular turbine searching at the 46 turbines. The most common species included: Black-chested Snake Eagle, Bokmakierie *Telophorus zeylonus* and Booted Eagle *Aquila pennatus*.
7. In terms of sensitive species recorded as fatalities the following Red listed species have been recorded: Southern Black Korhaan (Vulnerable), Greater Flamingo *Phoenicopterus roseus* (Near-threatened), Martial Eagle *Polemaetus bellicosus* (Endangered) and Secretarybird (Vulnerable). Only the Southern Black Korhaan was recorded as a fatality more than once on the above list (3 records). These occurred at Turbine 3 (2 records) and Turbine 19 (1 record). There is no real spatial pattern from this data with regard to the sensitive species above.
8. The 65 fatalities recorded at the 46 turbines searched regularly results in an unadjusted bird fatality rate of 1.41 birds.turbine.year or 0.65 birds.MW installed capacity.year.
9. Adjustment of this fatality rate to account for scavenger removal and carcass detection biases, results in an estimated fatality at the facility of 386 birds during the period over which fatalities were detected, with a range (95% confidence intervals) of between 237 and 670. This equates to 8.39 birds.turbine.year or 3.86 birds.MW installed capacity.year. However, we have low confidence in this model output for a number of reasons described in this report. This low confidence has likely resulted in an overestimation of the modelled output and it is thus not a reliable estimation. Actions detailed in the recommendations will be taken in the second year of operational monitoring to improve this estimation

We make the following recommendations for the future management of bird interaction at Sere Wind Farm:

1. Continue the live bird monitoring in year 2 as per year 1, including using the same schedule.
2. Conduct searcher efficiency trials only on the turbines that are regularly searched in order to enable us to specify efficiency for the different size classes of decoys used in the year 2 report.

## Table of contents

## List of Figures



## List of Tables

# 1. BACKGROUND

The Sere Wind Farm (SWF) consists of 46 Siemens wind turbines, each with a hub height of 115 metres and rotor diameter of 110 metres, situated near Lutzville, Western Cape. Construction of this facility was completed during 2014. In accordance with the conditions of the Environmental Authorisation, post-construction bird monitoring was initiated in May 2015.

The Endangered Wildlife Trust (EWT) designed and implemented the monitoring programme, and appointed WildSkies Ecological Services (hereafter WildSkies) to analyse data and compile reports. . Operational bird monitoring was initiated in late May 2015.

Operational phase bird monitoring consists of two components: live bird monitoring and bird fatality estimates. Overall this programme aims to measure what effect the construction and operation of the Sere Wind Farm has had on the birds in the area. This monitoring programme is conducted in accordance with the relevant guidelines. These are: the "Best practice guidelines for assessing and monitoring the impacts of wind energy facilities on birds in southern Africa" (Jenkins, van Rooyen, Smallie, Harrison, Diamond, Smit-Robbinson, & Ralston, 2015.)

The Sere Wind Farm site is classified into two different vegetation types, namely Namaqualand Strandveld and Namaqualand Sand Fynbos (Mucina and Rutherford, 2008). This vegetation is a mix of very hardy bushed and typical fynbos vegetation. The SWF site was previously grazed but this has stopped with the establishment of SWF.

A relatively low diversity of bird species occur in the area. Pre-construction monitoring (Bioinsight & Savannah,2014) identified the most important of these species with respect to the wind farm.

This report describes the findings after one year (12 months) of operational phase bird monitoring at Sere Wind Farm.

# 2. METHODS

## 2.1 Habitat Classification and Alteration on site.

The habitat on Sere Wind Farm was classified using Geographic Information Systems with the Mucina and Rutherford (2008) data available. The description of the vegetation was then accessed and used to describe the vegetation on site. In addition during the specialists site visits micro-habitats were photographed and presented in section 3.1 below.

Habitat alteration on site as a result of the construction of the SWF was estimated using Google Earth Pro to delineate and digitise as follows:

There are 46 hardstands. These were measured and averaged. The office building and substation were also measured using Google Earth Pro. The roads were measured and an average width was measured on Google Earth pro.

In order to express this as a proportion of the site total area, a polygon was drawn around the outer edge of all turbines and site entrance.

Since birds are largely aerial animals, above ground or air space habitat is also relevant. We estimate that the rotor swept area at SWF would account for 46 x $\pi R^2$ . Although not removed from the air space, this area must now be considered hazardous for birds.

## 2.2 Live bird monitoring

Live bird monitoring was conducted on site by the Endangered Wildlife Trust under the supervision of WildSkies. A total of 49 days were spent on site by the monitoring team during this programme. In addition several site visits were made by WildSkies' specialists. The layout of the monitoring activities is shown in Figure 1.

### *2.2.1 Small terrestrial bird species*

Although not traditionally the focus of wind farm–bird studies and literature, small terrestrial birds are an important component of this programme. Due to the rarity of many of our threatened bird species, it is anticipated that statistically significant trends in abundance and density may be difficult to observe. More common, similar species could provide early evidence for trends and point towards the need for more detailed future study. Given the large spatial scale of wind energy facilities (WEF's), these smaller species may also be particularly vulnerable to displacement and habitat level effects. Sampling these species is aimed at establishing indices of abundance for small terrestrial birds in the study area. These counts should be done when conditions are optimal. In this case this means the times when birds are most active and vocal, i.e. early mornings. A total of 12 walked transects (WT) were conducted on the SWF site. These WT's are positioned to represent the bird micro habitats available. Walked transects were laid out taking into account the location of these transects from pre-construction monitoring. These were however improved upon for the operational phase surveys.

#### 2.2.2. Large terrestrial bird species & raptors

This is a very similar data collection technique to that above, the aim being to establish indices of abundance for large terrestrial species and raptors. These species are relatively easily detected from a vehicle, hence vehicle based transects (VT) were conducted in order to determine the number of birds of relevant species in the study area. Detection of these large species is less dependent on their activity levels and calls, so these counts can be done later in the day. A total of 2 VT's have been established, totalling approximately 23.9 kilometres in length. Transects are conducted by driving slowly along the set route searching for large terrestrial species or raptors. All birds within 2 kilometres of the road (transect) were recorded. These vehicle transects followed (as far as possible) the pre-construction transects route.

### *2.2.3. Focal site surveys & monitoring*

During the first season of bird monitoring one focal site was monitored. This was a small dam on site. The dam had no water and hence no birds after this first season and hence these data are not very useful.

### *2.2.4. Direct observation of bird movements*

The above data collection efforts allow us to arrive at an estimate of the abundance or density of the relevant species on site. This allows the identification of any displacement and disturbance effects on these species. However in relating these species' flight activity to fatalities, their abundance is not sufficient. We also need to understand their flight behaviour. It is the flight behaviour which determines their exposure to collision risk. A bird which seldom flies, or typically flies lower than blade height is at lower risk than a frequent flier that typically flies at blade height. In order to gather data on this aspect, direct observations of bird flight behaviour are required. This is the most time consuming and possibly the most important activity to be conducted on site, and is elaborated on below.

The aim of direct observation is to record bird flight activity on site. An understanding of this flight behaviour will help explain any interactions between birds and the WEF. Spatial patterns in bird flight movement may also be detected, which will allow for comparison with the location of fatalities. Direct observation of bird flight is conducted through counts at four Vantage Point's (VP's) (Figure 1), identified to provide coverage of a reasonable and representative proportion of the entire study area (total coverage being unnecessary and impractical given resource constraints). The survey radius for VP counts is 2 kilometres, and VP counts are conducted by two observers, recording birds in a 360° radius. Data should be collected during representative conditions, so the sessions were spread throughout the day, with each VP being counted over 'early to mid-morning', 'mid to late morning', 'early to mid-afternoon', and 'mid-afternoon to evening'. Each session is 3 hours long, resulting in a total of 12 hours of observation being conducted at each vantage point on each site visit. There have been some slight modifications in terms of VP position from pre-construction. This is mainly as a result of improved access roads, new fences etc.

### *2.2.5 Control site*

Since only walk transects were undertaken on a control site during pre-construction monitoring, the same was done during operational monitoring. The control site walk transect is approximately 1.5 kilometers north of the site boundary.

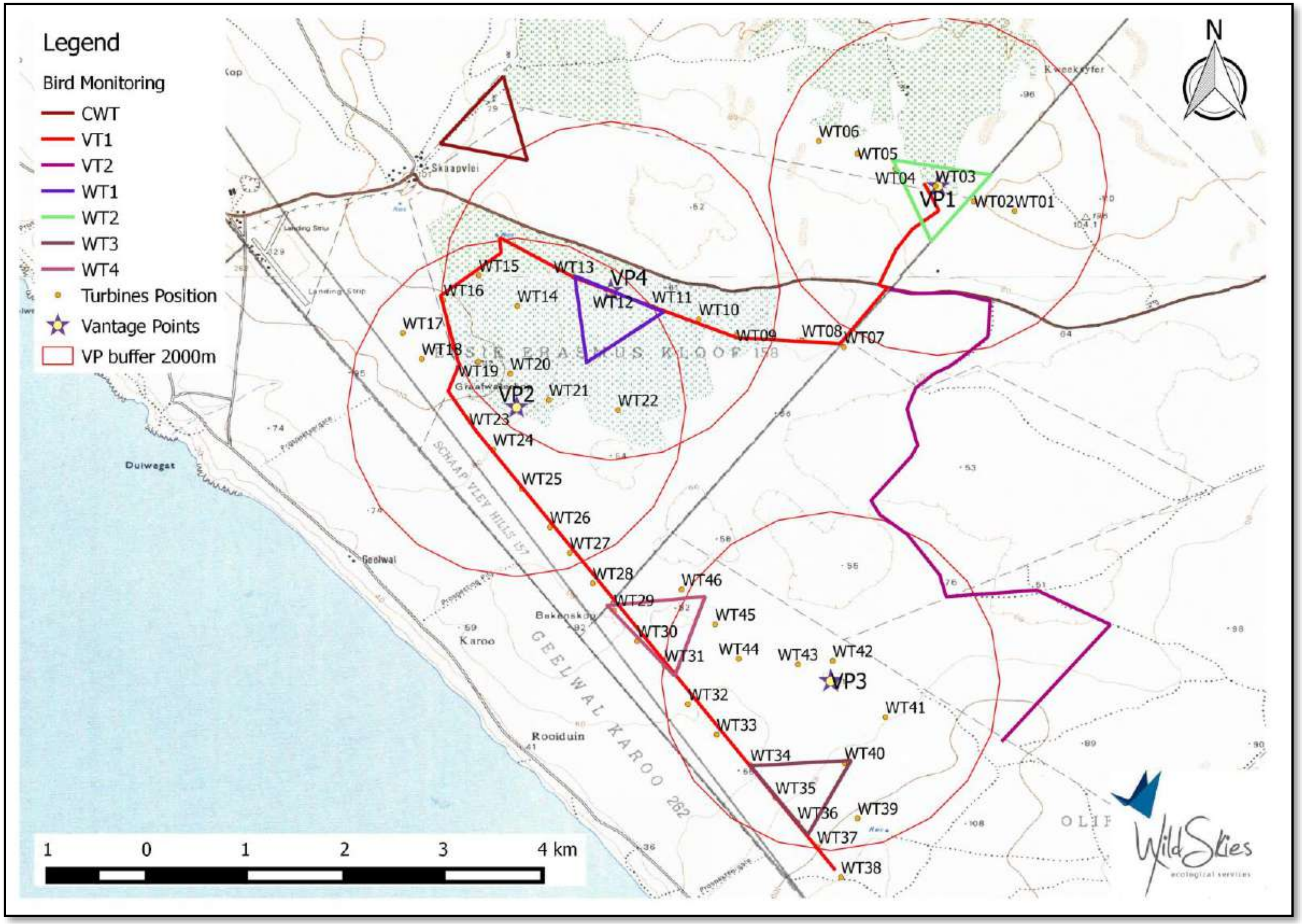



**Figure 1-** The Layout of the Sere Wind Farm post construction bird monitoring activities.

## 2.3 Bird fatality estimates

### *2.3.1 Turbine searches*

A team of four carcass searchers is employed and managed by Endangered Wildlife Trust on site to search for dead birds and bats beneath turbines. The search programme designed by the EWT results in 25 of the 46 turbines to be searched on a fixed schedule (i.e. every 2 weeks) and the remaining 21 to be searched on a random basis. The random search results in all of the random set of turbines being searched every 6 weeks. This is always done on a Thursday and the full search plot is searched as with the fixed set. At each of these turbines a team of 2 search a square search plot of 250 metre length sides around the base of the turbine. The pair of searchers walk straight line transects parallel to each other and 6 metres apart, to cover the search plot. The turbine search component of the project began on the 21st of May 2015.

On detecting a bird or bat carcass, the team marked its position with a small flag and then continued searching the plot to completion. The fatality was then processed as follows: *in situ* photographs of the carcass were taken, photographs of carcass relative to the turbine were taken, and photographs of vegetation were taken. A basic datasheet including information such as GPS coordinates, age of carcass, and vegetation type was completed. The carcass was then tagged, bagged and transported to the on-site freezer for storage. Datasheets, photographs and GPS tracks were uploaded to a shared dropbox file weekly.

Although WildSkies was not responsible for the design of the carcass search programme, employment, and management of the carcass search team, periodic site visits were conducted to provide support and refresher training. During these visits, freezer contents were also checked and identified to species where possible.

### *2.3.2 Estimates of scavenger removal or carcass persistence*

In order to obtain estimates of the rate at which turbine collision casualties are scavenged on site (and therefore potentially missed by the carcass search team), sets of surrogate carcasses were placed on site periodically and visited every day thereafter to determine when they were removed or scavenged. These carcasses were placed outside of the turbine search plots, to avoid confusion with real bird fatalities, and scavenger flooding or swamping at turbines. A carcass was considered removed once no detectable trace of it remained *in situ*. A total of 107 surrogate carcasses were placed on site during this monitoring period, spread across several seasons. These comprised of a range of small, medium and large indigenous bird species.

Carcasses used in the trials were placed in three visibility classes determined by vegetation height and density and rocky outcrops: good, moderate and poor. The searchers checked the carcasses once daily at the same time every day to look for evidence of scavenging and to note if the carcass was completely removed. The carcasses were checked until all carcasses had disappeared.

### *2.3.3 Estimates of carcass detection rates or searcher efficiency*

In order to obtain estimates of the rate at which collision casualties are detected by the carcass search team, sets of decoys were placed on site periodically across the various seasons. These decoys were placed within turbine search plots, at varying distance and bearing from turbines, and without the knowledge of the carcass search team. Decoys were located in representative visibility classes, classified as good (road, hard stand, bare ground), moderate (short vegetation), and poor (tall vegetation). In the case of birds, decoys were classed into three size categories, small – corresponding to a small passerine, medium – corresponding to a pigeon or small raptor, and large – corresponding to a goose, large terrestrial or large raptor. A total of 83 bird decoys were placed on site during this period.

Note: The carcass search team were informed during training and programme setup early in the year that at some point bird and bat decoys (plastic toys) would be placed on site, and that these should be reported as per normal processes when encountered. The exact dates of placement of decoys were however not shared with searchers.

## 2.4 Notes, Limitations & assumptions

Overall this programme has proceeded smoothly and without major challenges. However several aspects are worth noting:

- Carcass searches - Interruptions to productivity. Various practical factors played a part in the searching team achieving a longer average search interval at turbines than planned. These include weather, staff issues, weekends, and public holidays as well as Endangered Wildlife Trust’s training and conservation weeks which required the team to leave site.
- Significant time was also spent by the EWT conducting research into the use of dogs to find bird and bat carcasses, as well as camera trap surveys, extensive powerline surveys, roadkill surveys, associated infrastructure surveys (guy wires of met masts, office buildings, etc), etc. The EWT is commended for these efforts and it must be noted that these research projects will assist the wind energy industry in improving the monitoring in the future. Despite the fact that it did take time away from the core searching of turbines it is seen as a valuable component of the project. The results of these projects will be reported on by the EWT directly.

- WildSkies was not responsible for the staff management or design of the monitoring program. The Endangered Wildlife Trust contracted WildSkies for assistance in this regard and to write the final report. The search schedule was designed by the bat specialist (Bioinsight) and resulted in a less than ideal search interval, with the result that the estimated carcass numbers are not very accurate.

# 3. RESULTS & DISCUSSION

Post construction or operational phase (hereafter) bird monitoring is typically required at wind energy facilities (WEF's) to confirm what the actual impacts are, determine any necessary mitigation for these impacts, and improve our understanding of the relevant issues so that our future assessments are improved.

Operational phase monitoring can be grouped into three main activities: classification of habitat; collection of data on bird abundance, distribution and movement on site; and an estimation of the number of bird fatalities as a result of the facility.

## 3.1. Habitat on site

### *3.1.1 Habitat classification*

The Sere Wind Farm site is classified into two different vegetation types, namely Namaqualand Strandveld and Namaqualand Sand Fynbos (Mucina and Rutherford, 2008). This vegetation is a mix of very hardy bushed and typical fynbos vegetation. The SWF site was previously grazed but this has stopped with the establishment of SWF. Pictures of the typical micro-habitats can be seen below in Figure 2.

**Figure 2**- Relevant micro-habitats available to birds on the Sere Wind Farm site.

### *3.1.2. Habitat alteration as result of the WEF*

Habitat alteration on site as a result of the construction of the SWF was estimated using Google Earth to delineate and digitise as follows:

There are 46 hardstands of approximately 0.27 hectares each, resulting in 12.42 hectares of habitat lost to hardstands. The office building is 0.86 hectares in size while the substation is 0.71 hectares. There is approximately 29.49 kilometers of new road with an average width of 8 meters. This results in 23.59 hectares of land lost to new roads. The total habitat loss is therefore estimated at approximately 37.58 hectares.

In order to express this as a proportion of the site total area, a polygon was drawn around the outer edge of all turbines and site entrance. The approximate area of this polygon is 3 192.77 hectares.

Habitat alteration as a result of the construction of the SWF was therefore approximately 1.18% of the total area.

Since birds are largely aerial animals, above ground or air space habitat is also relevant. We estimate that the rotor swept area at SWF would account for 46 x $\pi R^2$ or 46 x 6 361 $m^2$ (45m rotor radius) or 292 606$m^2$ (or 29.26 hectares). Although not removed from the air space, this area must now be considered hazardous for birds.

## 3.2 Live bird abundance & activity on site

Overall our field team spent 49 days on site during this period, split into four iterations, between May 2015 and April 2016. In addition, the specialists made a number of visits to the site. The layout of the various bird monitoring activities is presented in Figure 1.

During this programme, a total of 76 species were recorded (Appendix 4). Species richness peaked in spring and summer with 52 species, followed by autumn (44) and winter (41). This included 6 Red Listed species (Taylor et al, 2015) and at least 35 South African endemics, breeding endemics or near-endemics. The most important of these species have been discussed in the other relevant sections below.

Pre-construction monitoring recorded a total of 65 bird species on site (Bioinsight & Savannah,2014). This included 12 Red listed species of which 4 were Raptors (African Marsh Harrier *Circus ranivorus*, Black Harrier *Circus maurus*, Martial Eagle *Polemaetus bellicosus* and Secretarybird *Sagittarius serpentarius*) and 4 were large terrestrials (Ludwig's Bustard *Neotis ludwigii*, Kori Bustard *Ardeotis kori*, Karoo Korhaan *Eupodotis vigorsii* and Southern Black Korhaan *Afrotis afra*).

Red List species recorded during pre-construction but not during operational phase include: Kori Bustard, Karoo Korhaan, African Marsh Harrier and Martial Eagle.

### *3.2.1 Small terrestrial bird species*

A total of 1 996 records of 2 896 individual birds were made using this method. A total of 57 bird species were recorded using this method, with a peak in species richness (38 species) recorded in spring and the lowest species diversity in winter (27 species) (see Appendix 1 for the full dataset). Of the 57 bird species, 29 species are considered southern African endemics or near-endemics. Figure 3 below shows the most common (those with more than 50 birds recorded) bird species recorded during the year of bird monitoring with the associated number of birds and number of records.

The most abundant bird species included: Karoo Prinia *Prinia maculosa* (5.11 birds/km), Karoo Lark *Calendulauda albescens* (4.71 birds/km), Southern Double-collared Sunbird *Cinnyris chalybeus* (4.70

birds/km), Yellow Canary *Crithagra flaviventris* (4.11 birds/km), Karoo Scrub-robin *Cercotrichas coryphoeus* (3.33 birds/km), Cape Sparrow *Passer melanurus* (2.98 birds/km), Grey-backed Cisticola *Cisticola subruficapilla* (2.83 birds/km) and Bokmakierie *Telophorus zeylonus* (2.14 birds/km). The full list is available in Appendix 1.

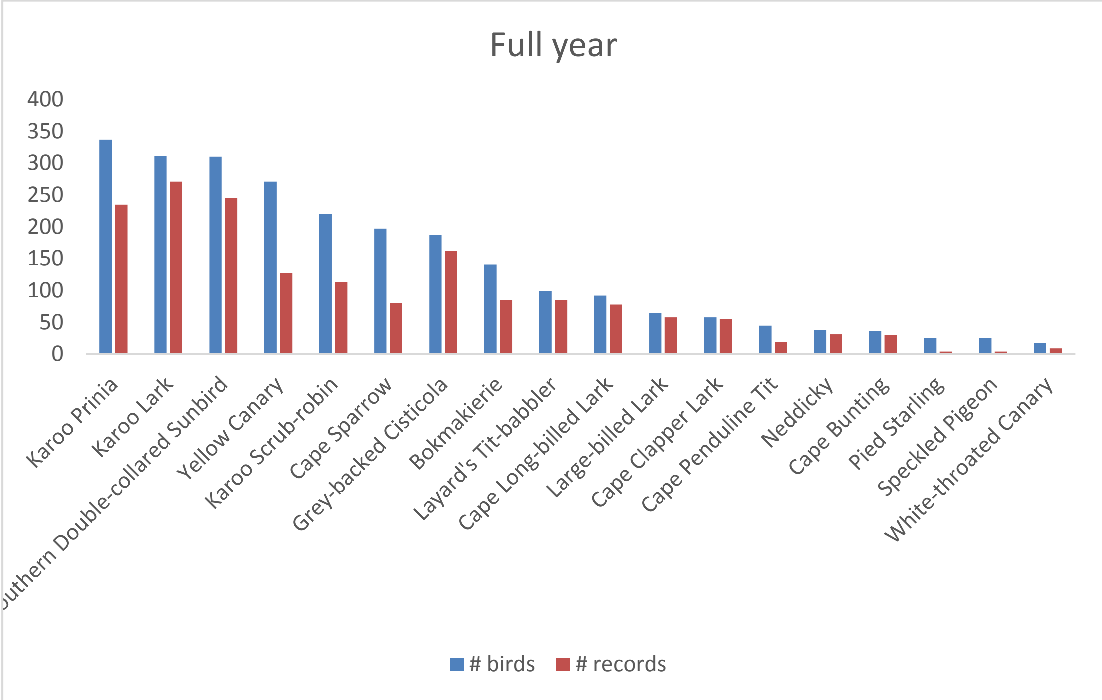



**Figure 3** - Small terrestrial bird species with more than 50 birds recorded during the year of monitoring at Sere Wind Farm.

In terms of the abundance of small terrestrial species on SWF during operational phase bird monitoring the density is presented in Appendix 1.

Pre-construction bird monitoring (Bioinsight & Savannah,2014) recorded 50 species of small passerines. The most abundant included: Cisticolas and allies (9.71 contacts/km), sunbirds (5.40 contacts/km), larks (4.52 contacts/km), chats and flycatchers (2.79 contacts/km). Since Bioinsight & Savannah (2014) grouped species into families in their data, direct comparison with our data is not very meaningful. There certainly seems to be a decrease in the cisticola abundance from 9.71 contacts/km pre-construction to 2.83 birds/km. The lark's abundance also seems to have decreased from pre-construction to operational phase monitoring.

Thirty of the sixty five (46%) recorded bird fatalities recorded at SWF during the operational phase carcass searching were small passerine bird species. Many of these were unidentified small passerines. Examples of the species recorded included Bokmakierie, Common Swift *Apus apus,* Cape Sparrow and Karoo Scrub Robin.

### *3.2.2. Large terrestrial birds & raptors*

A total of 6 species were recorded by driven transects on and near site (Appendix 2). A peak in species richness was recorded in summer (5), followed by autumn (4), and spring (3). The lowest species richness was recorded in winter (1). These data are presented in Figure 4.

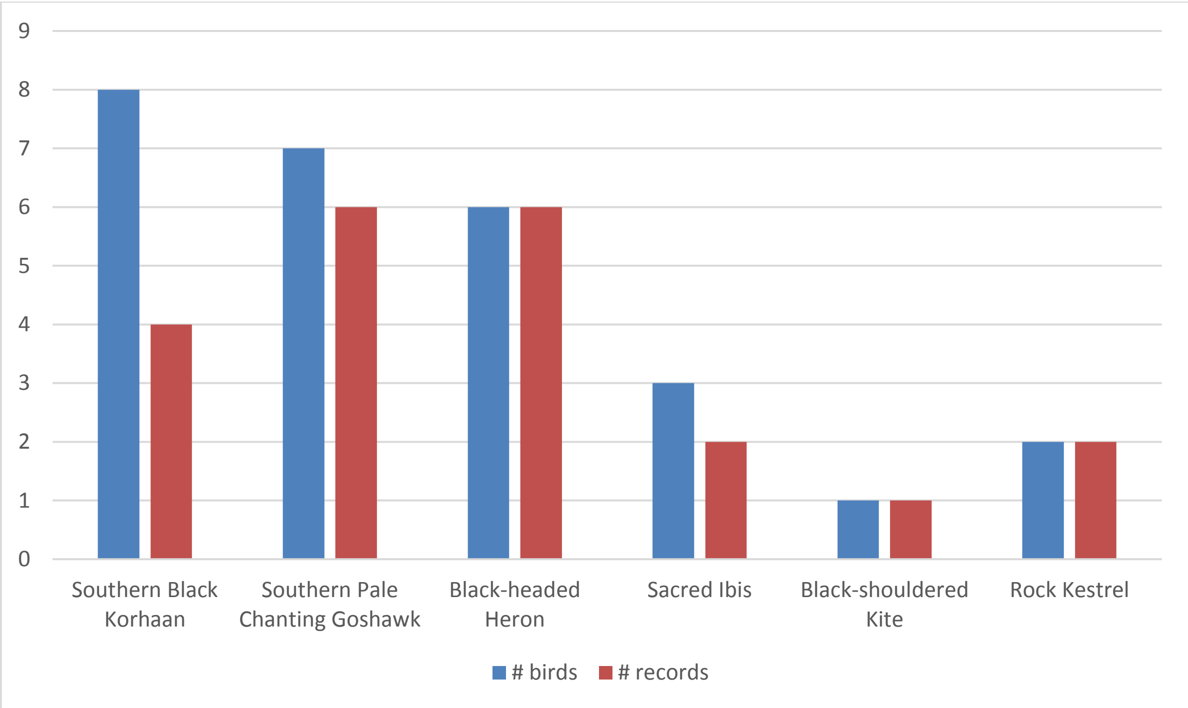



**Figure 4-** Number of large terrestrial birds and raptors recorded using driven transects at Sere Wind Farm.

Pre-construction data (Bioinsight & Savannah,2014) for large terrestrials recorded 8 species using driven transects. The most abundant of these included Ludwig's Bustard (0.07 birds/km), Pale Chanting Goshawk *Melierax canorus* (0.04 birds/km), Southern Black Korhaan (0.03 birds/km) and Rock Kestrel *Falco rupicolus* (0.02 birds/km). In addition the following species all had abundances of 0.01 birds/km: Black-headed Heron *Ardea melanocephala* , Martial Eagle, Greater Kestrel *Falco rupicoloides* and Pied Crow *Corvus albus*. The operational phase monitoring recorded the following abundances: Southern Black Korhaan (0.06 birds/km), Pale Chanting Goshawk (0.05 birds/km), Black-headed Heron (0.04 birds/km), Sacred Ibis *Threskiornis aethiopicus* (0.02 birds/km), Black-shouldered Kite (0.01 birds/km) and Rock Kestrel (0.01 birds/km). In most of these cases the operational abundance was slightly higher than the pre-construction abundance. One exception is the Ludwig's Bustard. The operation monitoring has recorded a definite reduction in abundance with regard to Ludwig's Bustard. This species was not recorded using driven transects during the operational phase of the project. One possible explanation for this is that the species was displaced from site due to the construction of the SWF. Unfortunately without data from a control site (since Bioinsight & Savannah

2014 did not monitor the control site adequately) we cannot draw this conclusion. Further, Ludwig's Bustard is an nomadic species which moves around the arid parts of the country in response to rainfall and food availability. We observe high inter annual variability in abundance of this species at many sites, and would rather attribute the SWF finding to this natural variability.

### *3.2.3 Incidental observations*

In total 41 individual birds were recorded during this monitoring period (Figure 5). These data comprise 10 species in total, with 5 species recorded in autum, spring and summer. In winter only 2 species were recorded (Appendix 4).

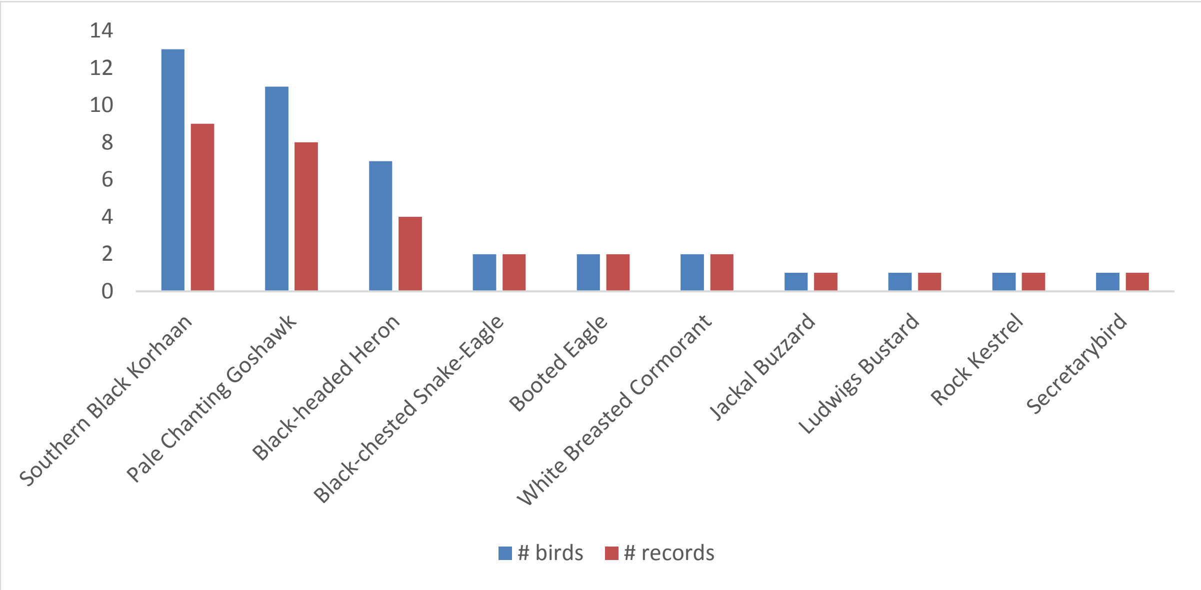



**Figure 5-** Number of birds and number of records from the incidental data for the Sere Wind Farm.

Southern Black Korhaan was by far the most frequently recorded species as an incidental followed by Pale Chanting Goshawk.

This data is not the product of formal searching, and the search effort is not measured, Various biases exist in the data, for example certain roads are driven more frequently and birds will therefore seem more abundant there. There is no value in comparing these data with pre-construction due to their incidental and unstructured nature.

### *3.2.4 Target bird species flight*

A total of 192 hours of target bird flight observation was conducted at the four vantage points on site over the four seasonal site visits, in sessions of 3 hours duration each. A total of 68 flight records of target bird species were made, including 12 species, of which five are Red List species (see Table 1).

This is an exceptionally low level of flight activity. The Red List species include: Black Harrier *Circus maurus* (Endangered), Lanner Falcon *Falco biarmicus* (Vulnerable), Ludwig's Bustard *Neotis ludwigii* (Endangered), Southern Black Korhaan *Afrotis afra* (Vulnerable) and Secretarybird *Sagittarius serpentarius* (Vulnerable).

Most frequently recorded flying was Pale Chanting Goshawk (53 minutes or 30% of all flight activity), Southern Black Korhaan (40 minutes or 22.5% of all flight activity) and Black-chested Snake Eagle *Circaetus pectoralis* (20 minutes or 11.3% of all flight activity). See Table 1 for the full breakdown.

Figure 8 shows the breakdown of flight records per season for each species.

**Table 1-** Summary data for the recorded target bird species flight on Sere Wind Farm.

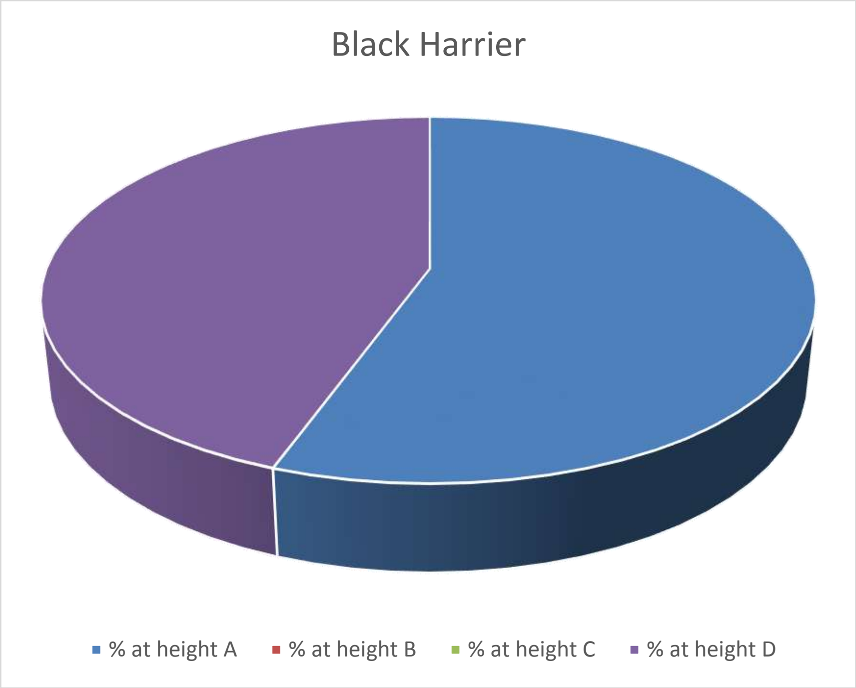
| Common name | # birds | # records | Total flight duration | Flight Height A | % at height A | Flight Height B | % at height B | Flight Height C | % at height C | Flight Height D | % at height D |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Southern Black Korhaan | 33 | 26 | 0:40:00 | 0:40:00 | 100.00 | 0:00:00 | 0.00 | 0:00:00 | 0.00 | 0:00:00 | 0.00 |
| Pale Chanting Goshawk | 17 | 17 | 0:53:00 | 0:45:00 | 84.91 | 0:04:00 | 7.55 | 0:04:00 | 7.55 | 0:00:00 | 0.00 |
| Rock Kestrel | 11 | 11 | 0:19:00 | 0:14:00 | 73.68 | 0:05:00 | 26.32 | 0:00:00 | 0.00 | 0:00:00 | 0.00 |
| Namaqua Sandgrouse | 8 | 2 | 0:04:00 | 0:04:00 | 100.00 | 0:00:00 | 0.00 | 0:00:00 | 0.00 | 0:00:00 | 0.00 |
| Black Harrier | 3 | 3 | 0:09:00 | 0:05:00 | 55.56 | 0:00:00 | 0.00 | 0:00:00 | 0.00 | 0:04:00 | 44.44 |
| Black-chested Snake Eagle | 2 | 2 | 0:20:00 | 0:00:00 | 0.00 | 0:14:00 | 70.00 | 0:06:00 | 30.00 | 0:00:00 | 0.00 |
| Secretarybird | 2 | 2 | 0:05:00 | 0:01:00 | 20.00 | 0:04:00 | 80.00 | 0:00:00 | 0.00 | 0:00:00 | 0.00 |
| Black-shouldered Kite | 1 | 1 | 0:07:00 | 0:07:00 | 100.00 | 0:00:00 | 0.00 | 0:00:00 | 0.00 | 0:00:00 | 0.00 |
| Jackal Buzzard | 1 | 1 | 0:03:00 | 0:03:00 | 100.00 | 0:00:00 | 0.00 | 0:00:00 | 0.00 | 0:00:00 | 0.00 |
| Lanner Falcon | 1 | 1 | 0:02:00 | 0:00:00 | 0.00 | 0:02:00 | 100.00 | 0:00:00 | 0.00 | 0:00:00 | 0.00 |
| Ludwig's Bustard | 1 | 1 | 0:03:00 | 0:03:00 | 100.00 | 0:00:00 | 0.00 | 0:00:00 | 0.00 | 0:00:00 | 0.00 |
| Yellow-billed Kite | 1 | 1 | 0:12:00 | 0:00:00 | 0.00 | 0:00:00 | 0.00 | 0:12:00 | 100.00 | 0:00:00 | 0.00 |

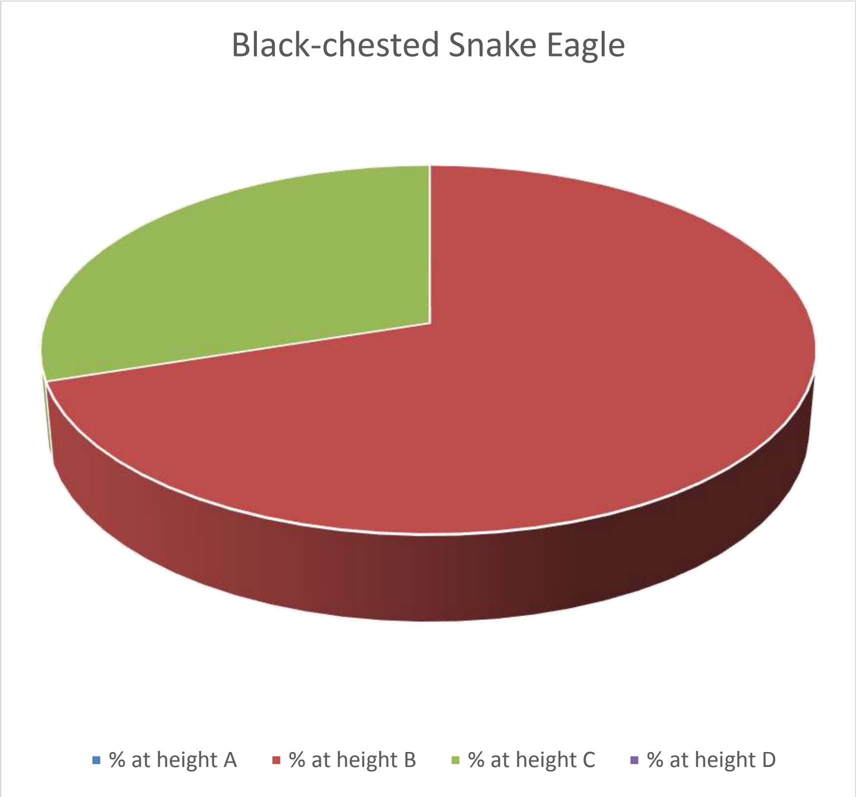
In terms of flight height and the risk zones of all species recorded using the vantage point method, the following categories were used:

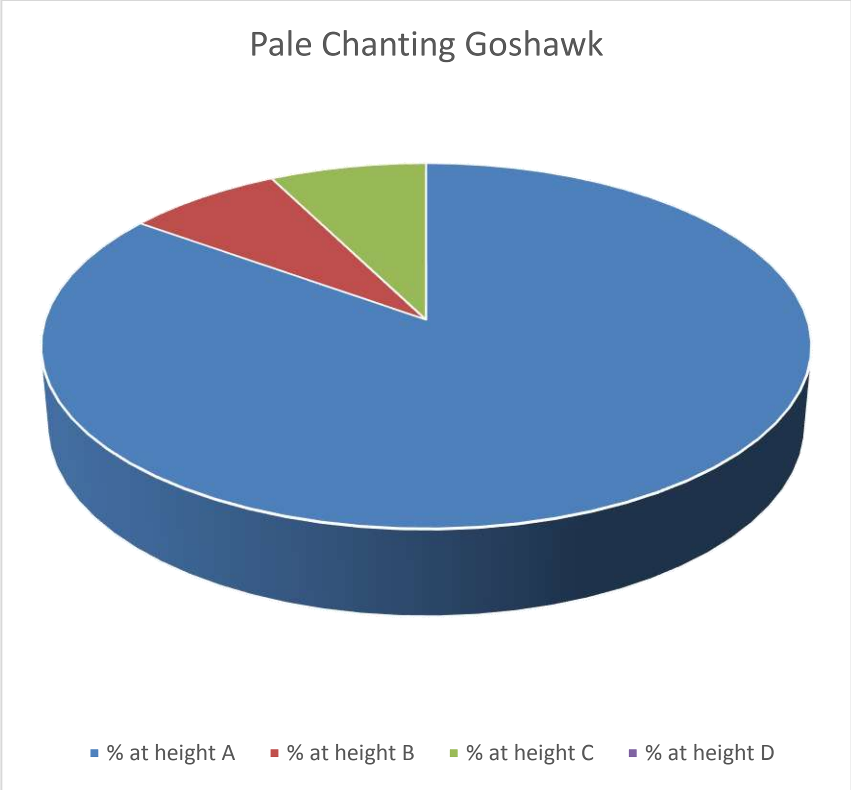
**A= Ground to Bottom of Blade**
**B= Bottom of Blade to Hub Height**
**C= Hub Height to Top of Blade**
**D= Above Blade Height**

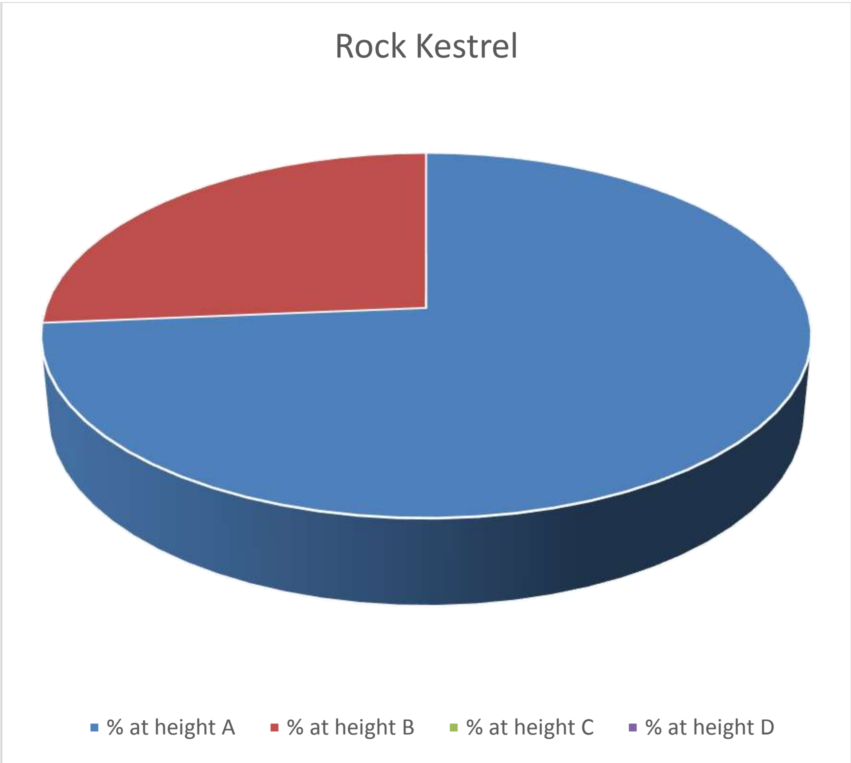
Flights at height categories B and C would have been at risk of collision.

The following pie charts were produced to visually show the species flying in the risk zones for those species recorded flying at least twice on site.




Pale Chanting Goshawk
% at height A
% at height B
% at height C
% at height D


Rock Kestrel
% at height A
% at height B
% at height C
% at height D

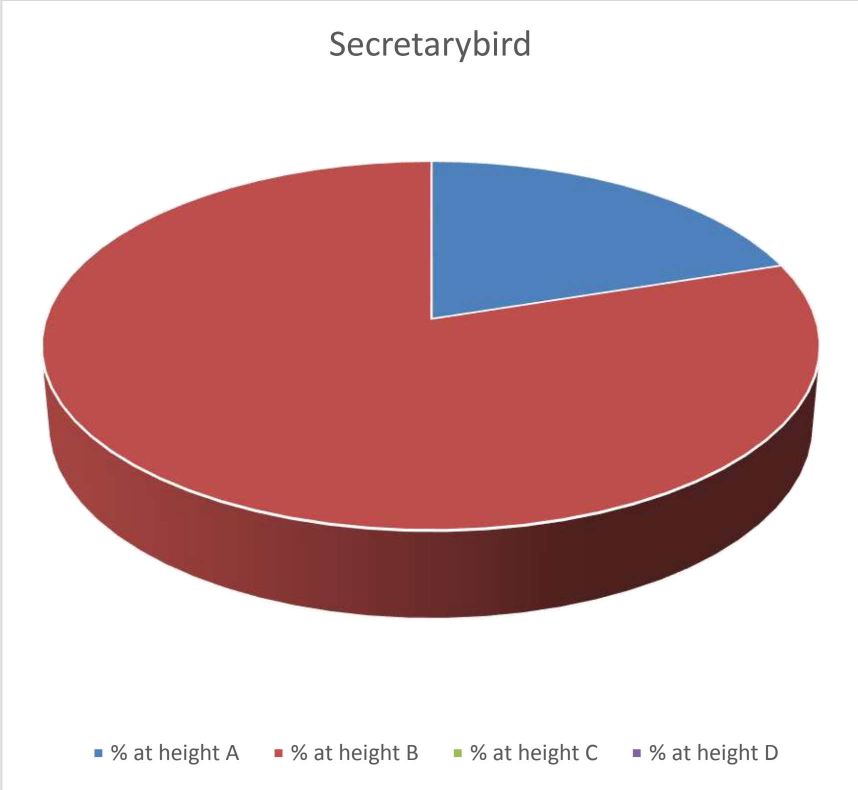



**Figure 6-** Pie charts showing flight height of target bird species.

As summarised above Black Harrier spent 56% of its time in zone A and the rest in zone D. These are both safe flight zones being below and above the turbine blades respectively. As an endangered species, the flight activity of Black Harrier on site is however still of some concern. This species has proven susceptible to collision with wind turbines at other sites (pers obs). This is a species which is well known to typically fly low over the ground, well below rotor height. Based on this alone, we would expect this species to be at low risk of collision with turbines. However several key flight behaviours of this species can place it at high risk at times when it flies higher above the ground. These include: aerial breeding displays; escorting of intruders/territory defence; food passing between mates; and migrating. Most of these behaviours are associated in some way with breeding. These behaviours could explain the flights above rotor zone recorded at SWF.

Black-chested Snake Eagle spent 70% of its time in zone B and the remaining 30% in zone C. These are both dangerous zones.

Pale Chanting Goshawk spent 85% of its time in zone A and the remaining 15% in the danger zones of B and C.

Rock Kestrel spent 70% of its time in zone A and the remaining in zone B (danger zone).

Secretarybird spent 80% of its time in zone B (danger zone) with the remaining time spent in zone A (safe zone).

The following species spent 100% of their time in zone A (safe zone) Black-shouldered Kite, Jackal Buzzard, Ludwig's Bustard, Namaqua Sandgrouse and Southern Black Korhaan.

Despite the fact that Southern Black Korhaan spent 100% of its time in the safe zones, this species is of concern. It is considered Vulnerable regionally according to Taylor *et al* (2015), having been up listed from "Near-threatened" in the previous classification (Barnes, 2000),. It is also a South African endemic. Allan & Anderson (2012) identified this as the fifth most threatened of ten bustard species in South Africa, and the most threatened korhaan (habitat destruction and disturbance being listed as the primary species threats); According to Hofmeyr (2012) the Southern Black Korhaan has had a dramatic decrease in abundance between 1997 and 2010 in the Overberg/Swartland region (and supported by Shaw, 2013; CAR Project http://car.adu.org.za/newsletters.php; and SABAP1 and SABAP2 comparison – Hofmeyr 2011). This decline is believed to be due to the loss of breeding habitat and the increase in disturbance associated with increased farming practices (Hofmeyr, 2012). Southern Black Korhaan also accounted for 3 fatalities during the year.

Lanner Falcon spent 100% of its time in zone B (danger zone).

Yellow-billed Kite spent 100% of its time in zone C (danger zone).

Of these species, we have recorded Black-chested Snake Eagle, Pale Chanting Goshawk, Rock Kestrel, Secretarybird and Southern Black Korhaan as fatalities at SWF, see section 3.4.

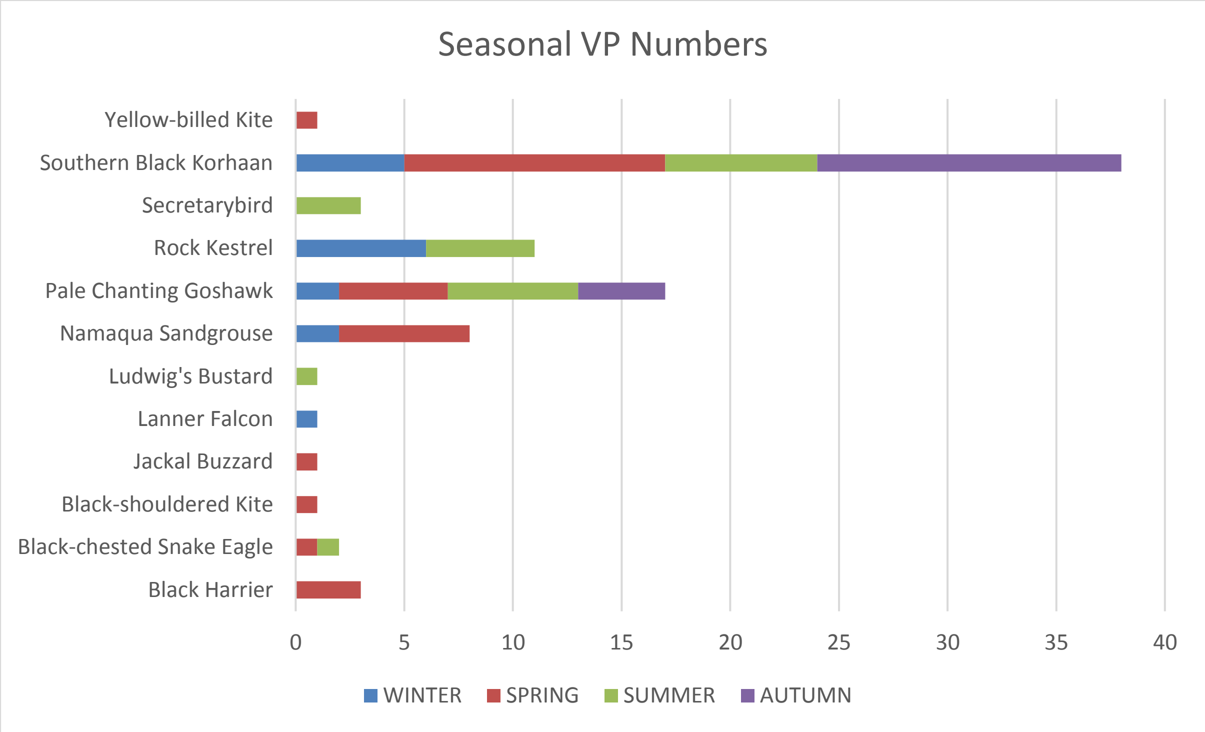



**Figure 7-** Seasonal breakdown of flight records for target bird species at Sere Wind Farm.

The location of these recorded flights is presented in Figure 8. As can be seen on this map, there were not a great deal of recorded flights on the site. These will be further discussed by looking at each individual vantage point (Figure 9).

**Vantage point 1:** The highest risk area is north of VP1. There are no turbines in this area. Another high risk area is south of VP1, half way beween Turbine 3 and 7. There is an area of medium risk south of Turbine number 4.

**Vantage point 2:** There is only one area of high risk around this vantage point and this occurs near Turbine 18. There is an area of medium riskbetween Turbine 18 and 25.

**Vantage point 3:** There is one area of high risk around VP3, and this occurs at Turbine 43. There are some medium sensitivity areas mainly to the east of VP3.

**Vantage point 4:** The high risk area from VP2 is shown in this VP’s map. Besides this area of high risk there are some medium risk areas near Turbine 13.

The relationship between the high risk flight areas and the actual location of the carcasses is discussed below in Section 3.3.

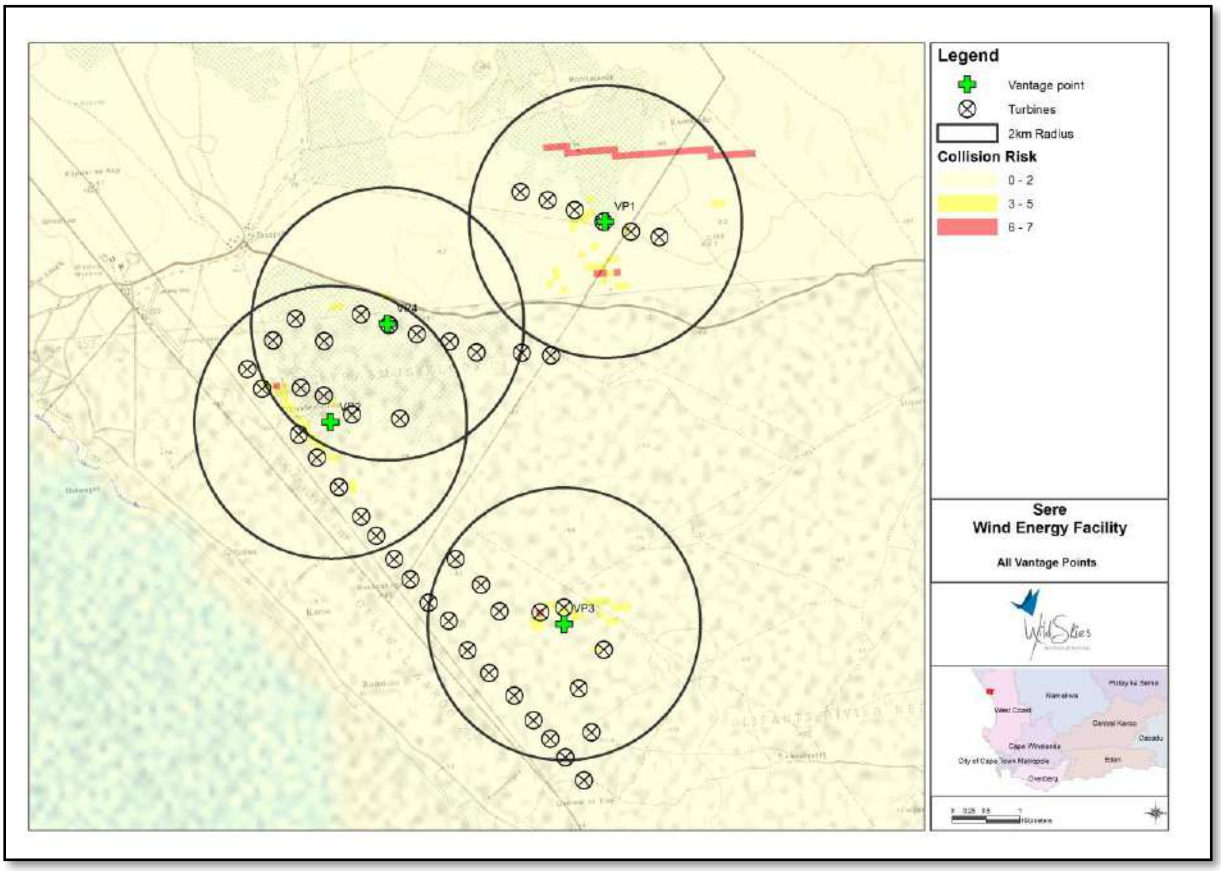
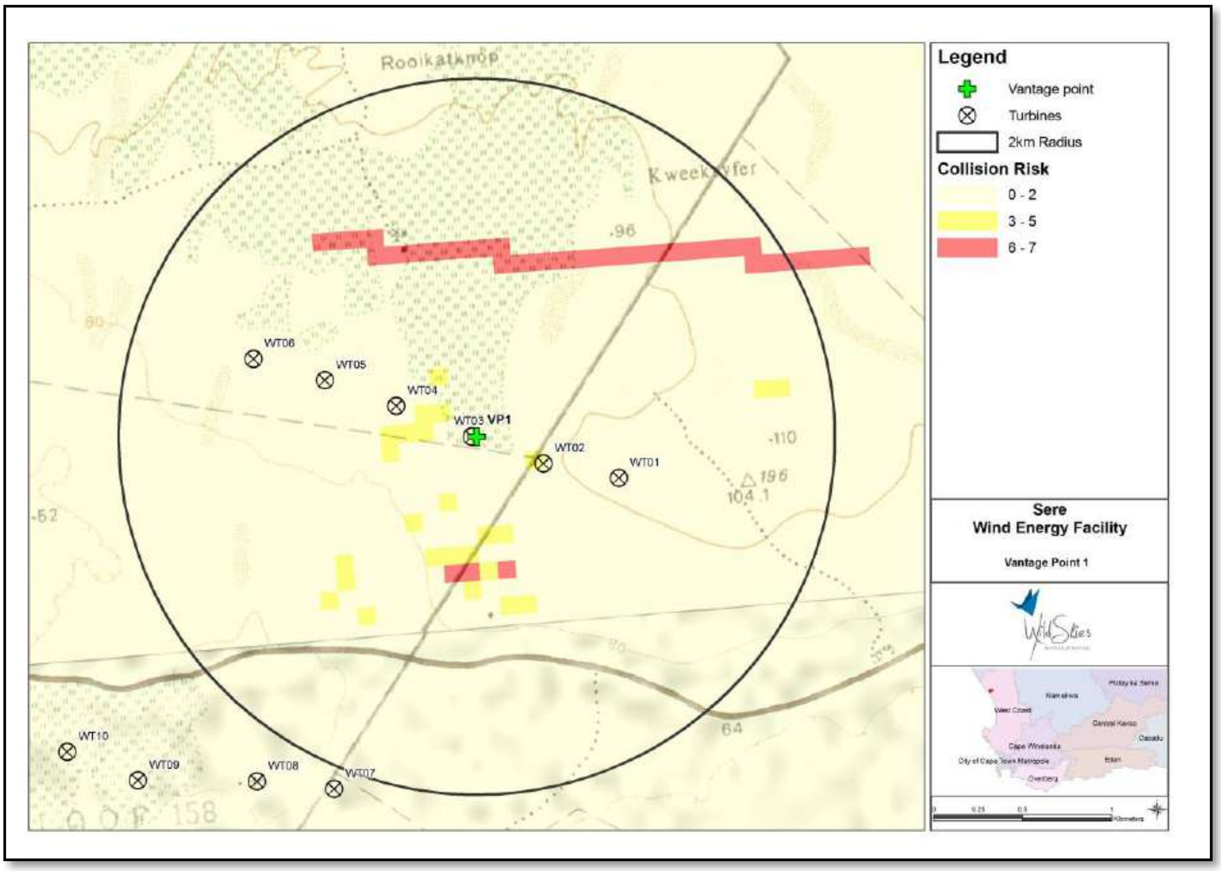
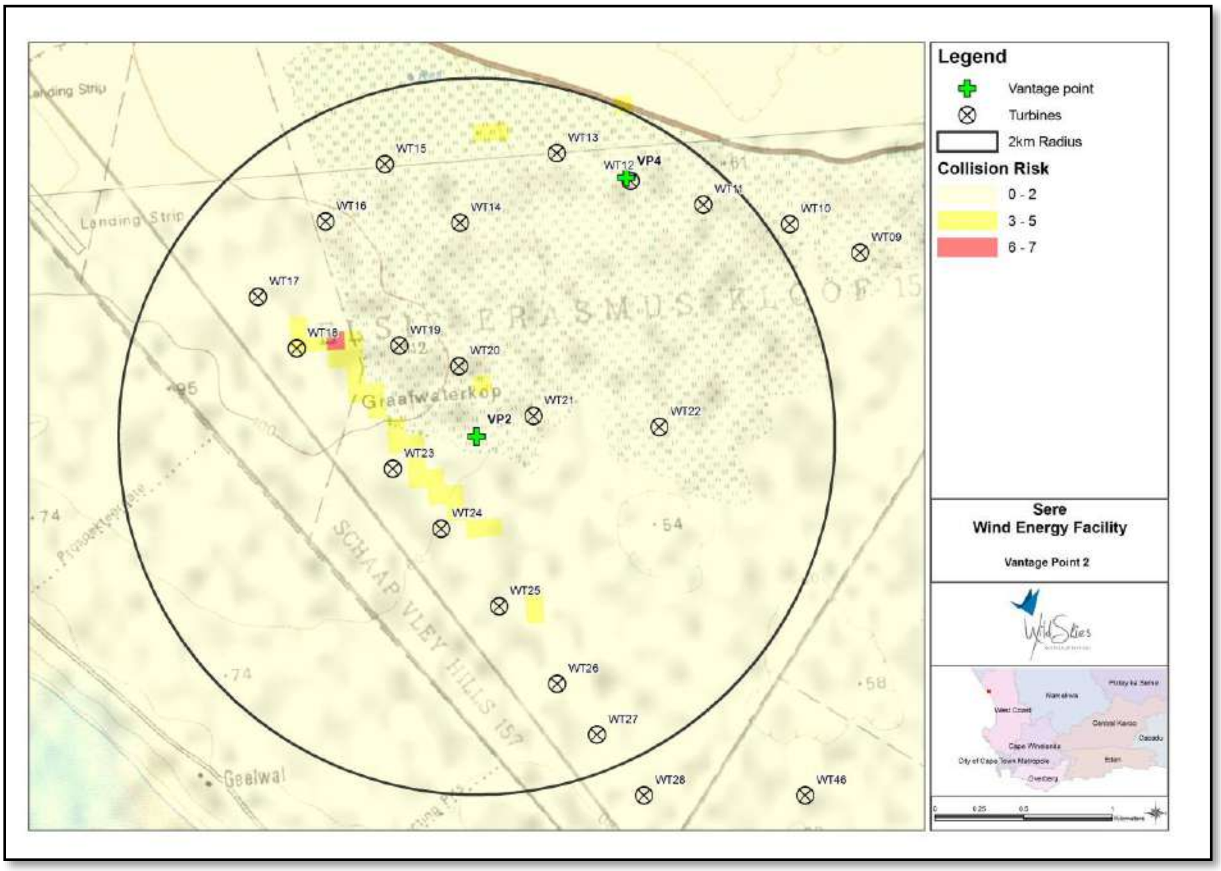
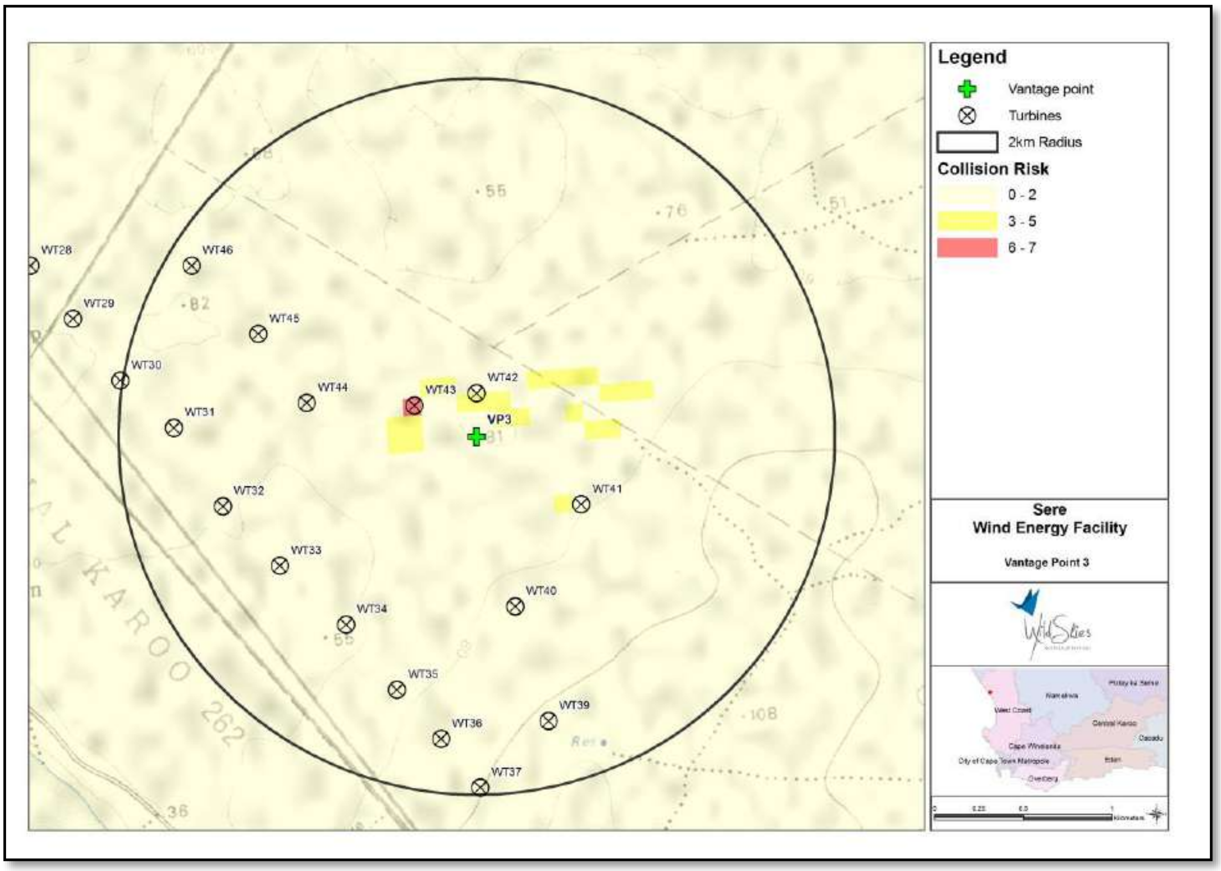



**Figure 8-** All recorded target bird species flight paths from the 4 Vantage Points at Sere Wind Farm.


Legend
Vantage point
Turbines
2km Radius
Collision Risk
0 - 2
3 - 5
6 - 7
Sere
Wind Energy Facility
Vantage Point 1
Rooikatknop
Kweekvlei
WT06
WT05
WT04
WT03 VP1
WT02
WT01
WT10
WT09
WT08
WT07


Legend
Vantage point
Turbines
2km Radius
Collision Risk
0 - 2
3 - 5
6 - 7
Sere
Wind Energy Facility
Vantage Point 2
Landing Strip
Graafwaterkop
Geelwal
SCHAAP VLEY HILLS 157
WT13
WT15
WT12 VP4
WT11
WT10
WT09
WT16
WT14
WT17
WT18
WT19
WT20
WT21
WT22
VP2
WT23
WT24
WT25
WT26
WT27
WT28
WT46



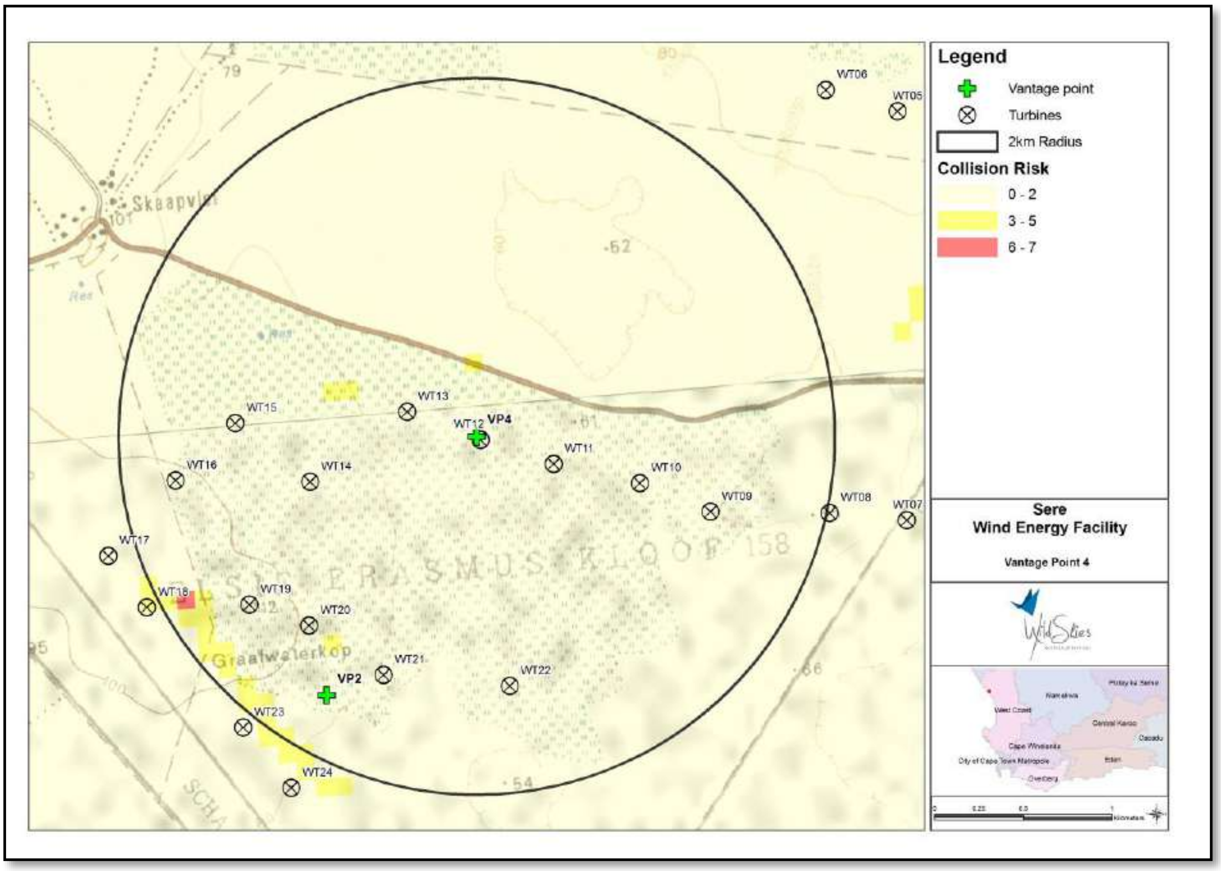




**Figure 9-** Individual vantage points and their associated recorded collision risk.

Pre-construction monitoring (Bioinsight & Savannah,2014) identified the highest risk species to be the Black Harrier, Steppe Buzzard and kestrel species. During the operational phase the highest risk species included: Black-chested Snake Eagle (Confirmed fatalities), Pale Chanting Goshawk (Confirmed fatalities), Rock Kestrel (Confirmed fatalities), Secretarybird (Confirmed fatalities), Lanner Falcon and Yellow-billed Kite.

The fatality data will be presented and discussed in more detail below.

## 3.3 Bird fatality estimates

The aim of this component of monitoring is to determine: the number and rate of bird fatalities; the species composition; and to identify mitigation measures where necessary.

### *3.3.1 Unadjusted bird fatality data*

In the period 21 May 2015 to 20 May 2016 a total of 65 bird fatalities from at least 32 species were recorded (Appendix 6) by formal regular turbine searching at the 46 turbines. The most common species included: Black-chested Snake Eagle (3 fatalities), Bokmakierie (6 fatalities), Booted Eagle *Aquila pennatus* (3 fatalities and Southern Black Korhaan (3 fatalities).

Several carcasses were unidentified as they were incomplete and/or heavily scavenged and impossible to identify. It is our view that many of these unidentified carcasses are legacy carcasses from before the monitoring activity started. Turbines were turning on the site for some time before actual monitoring started due to the required intermittent testing of the turbines and grid compliance testing requirements leading up to the start of operation on the wind farm.

Four of the species for which fatalities were recorded: the Black-chested Snake Eagle, Pale Chanting Goshawk, Rock Kestrel and Secretarybird were recorded flying on site by live bird monitoring (Section 3.2). The remaining species are smaller and/or of lower conservation significance and are therefore not typically recorded by vantage point monitoring, or were not recorded flying on site, such as the crows.

The location of the above recorded bird fatalities on site is presented in Figure 13.

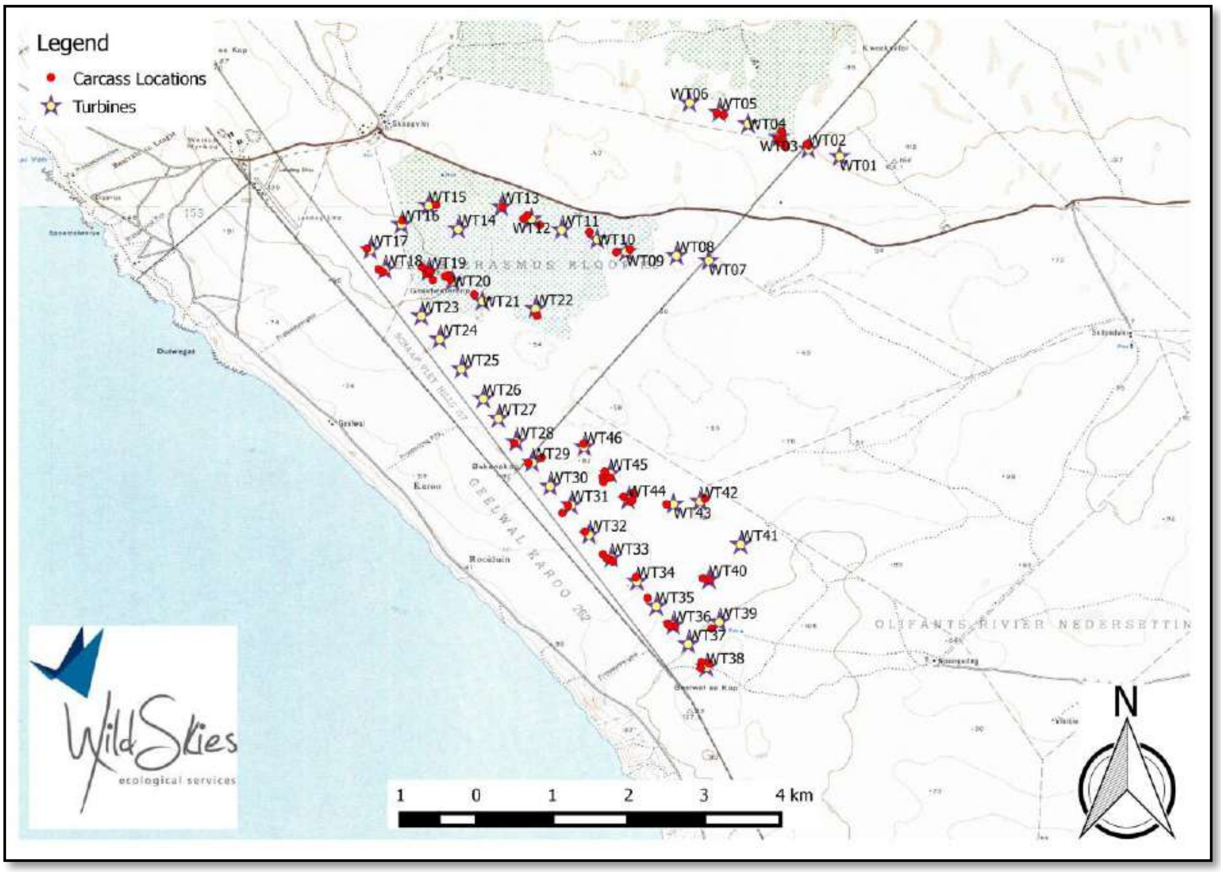



**Figure 10-** Carcass locations from the years carcass searching at Sere Wind Farm.

A summary table was drawn up showing which turbines accounted for the most incidents.

**Table 2-** Summary table of bird mortality incidents (carcasses) per turbine.

| Turbine # | # Fatalities |
|---|---|
| 19 | 6 |
| 3 | 5 |
| 33 | 4 |
| 36 | 4 |
| 40 | 4 |
| 44 | 4 |
| 9 | 3 |
| 20 | 3 |
| 45 | 3 |
| 2 | 2 |
| 5 | 2 |
| 12 | 2 |
| 18 | 2 |
| 29 | 2 |
| 31 | 2 |
| 8 | 1 |

| | |
|---|---|
| 10 | 1 |
| 13 | 1 |
| 15 | 1 |
| 16 | 1 |
| 17 | 1 |
| 21 | 1 |
| 22 | 1 |
| 28 | 1 |
| 32 | 1 |
| 34 | 1 |
| 35 | 1 |
| 38 | 1 |
| 39 | 1 |
| 42 | 1 |
| 46 | 1 |
| 43 and 44 | 1 |

As can be seen Turbine 19 accounted for the most fatalities on the site with a total of 6. Turbine 3 accounted for 5 fatalities while Turbine numbers 33, 36, 40 and 44 accounted for 4 fatalities each.

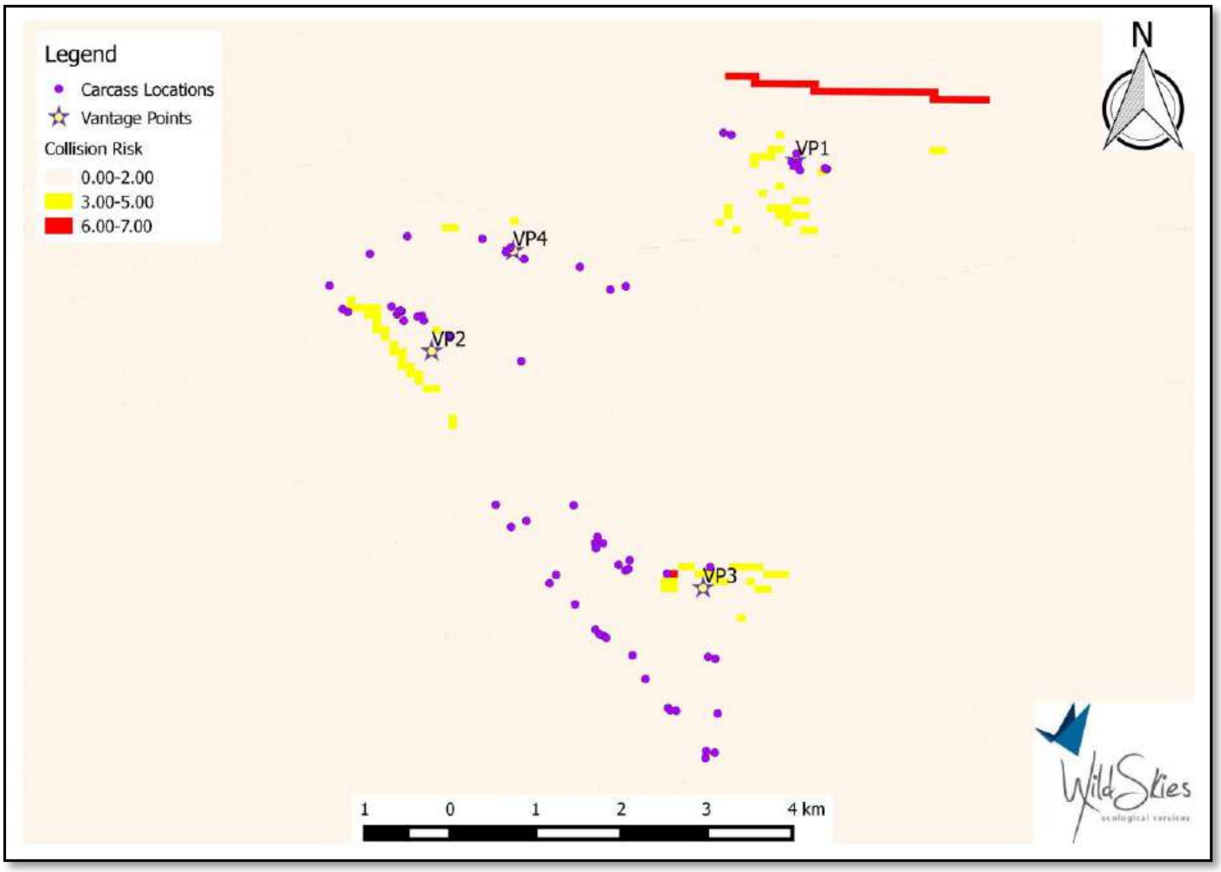



**Figure 11-** Carcass locations and collision risk index from live bird monitoring

The above map (Figure 11) shows the location of all recorded fatalities with the flight risk index produced from the live bird monitoring. The map shows fatalities near VP1 occurring in a medium flight risk area. A similar pattern is evident around VP2. There are however many fatalities recorded in low risk areas, and as per the above explanation, this can be explained by the fact that many of these fatalities are of small species not recorded during live bird monitoring.

Carcass location proximity (when detected) to turbine base ranged from 1m to 173m, with a mean of 73.67m (Figure 12). It must be noted that despite the turbine search area being 125m from the turbine base, due to the square search plots and the fact that birds are visible outside of the search plot some values are greater than 125m.

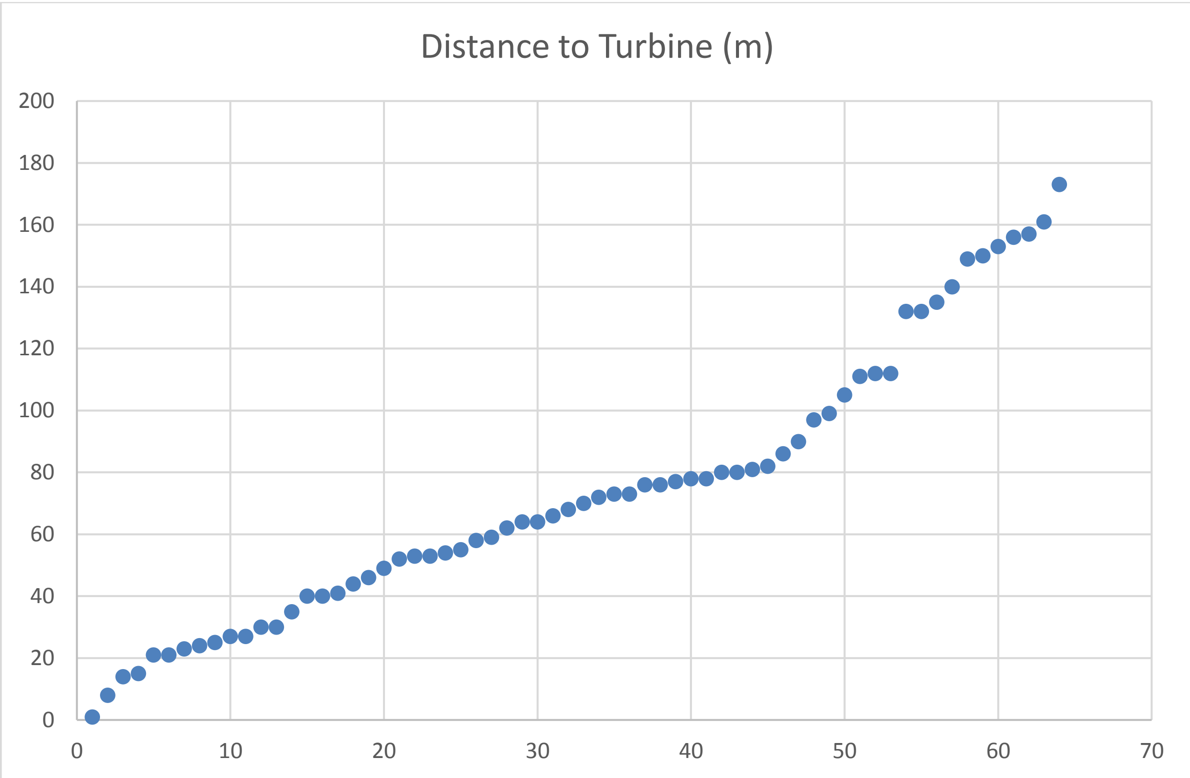



**Figure 12-** Bird carcass proximity to turbine base at Sere Wind Farm.

Figure 13 presents a summary of the bearing from the turbine base to the location of carcasses. The quadrant with the highest number of carcasses found was the north-west quadrant, followed by south-west and north-east.

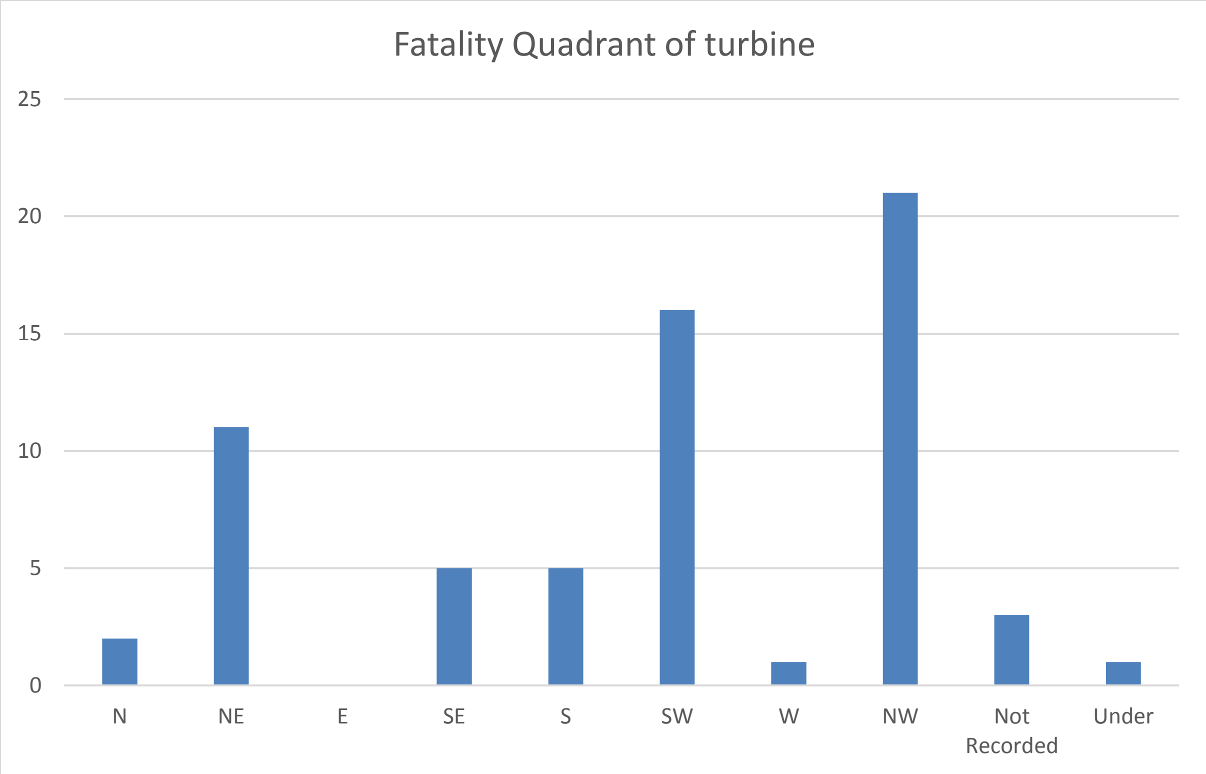



**Figure 13-** Bearing of bird carcass locations from base of turbine at Sere Wind Farm.

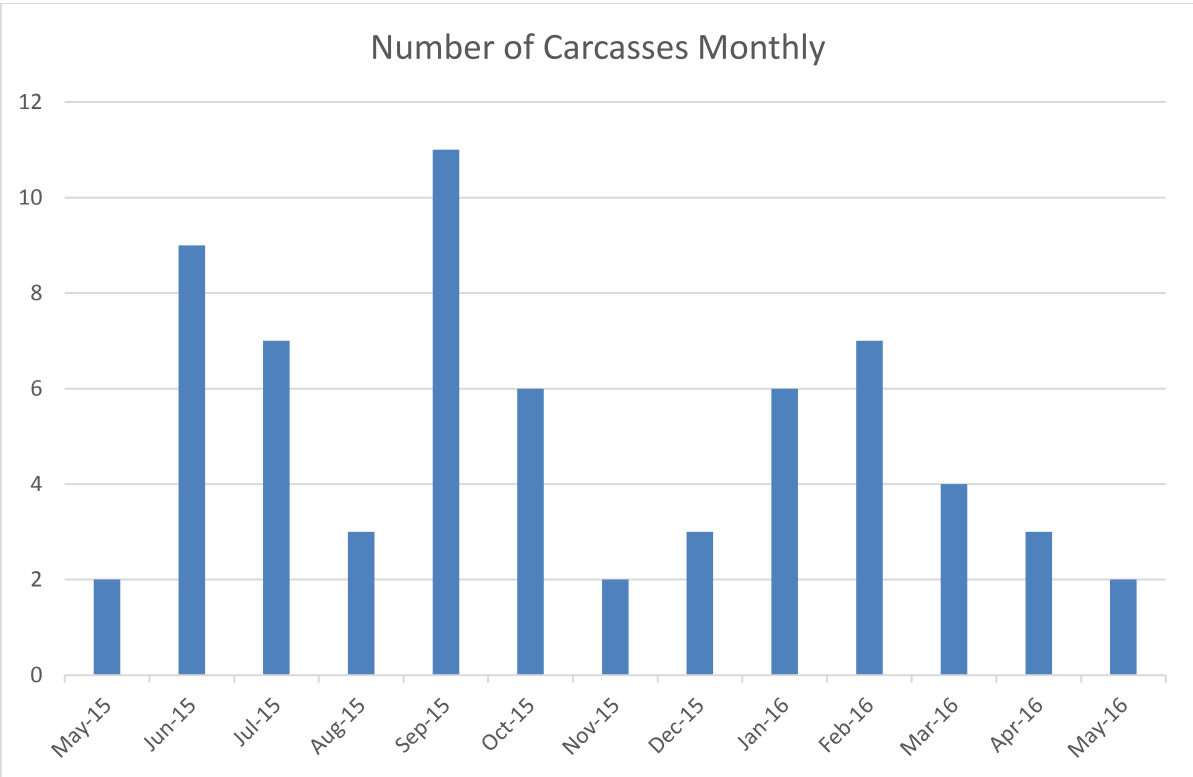



**Figure 14-** Seasonality of bird fatalities at Sere Wind Farm.

The month in which each fatality was recorded is presented in Figure 14. There are peaks in June 2015, July 2015, September 2015 and February 2016. The time of year does not seem to show any significant pattern.

The 65 fatalities recorded at the 46 turbines searched regularly results in an unadjusted bird fatality rate of 1.41 birds.turbine.year or 0.65 birds.MW installed capacity.year.

As can be seen in the above data the species most affected by collisions with the turbines is the Bokmakierie with 6 fatalities recorded on site. This is of low conservation significance however considering the Bokmakierie is not a Red listed species. It is, however a near-endemic species.

In terms of sensitive species recorded as fatalities the following Red listed species have been recorded: Southern Black Korhaan (Vulnerable), Greater Flamingo (Near-threatened), Martial Eagle (Endangered) and Secretarybird (Vulnerable). Only the Southern Black Korhaan was recorded as a fatality more than once on the above list (3 records). These occurred at Turbine number 3 (2 records) and turbine number 19 (1 record). There is no real spatial pattern from this data with regard to the sensitive species above.

Some other species of interest that have been recorded as fatalities include: Booted Eagle and Black-chested Snake Eagle. All medium to large raptors should be protected as far as possible from anthropogenic sources of mortality, so the Black-chested Snake Eagle and Booted Eagle fatalities are also worrying.  Both of these were found as fatalities on three occasions. Spotted Eagle Owl were also recorded as fatalities on two occasions.

### *3.3.3 Adjusted bird fatality data*

It is generally recognised in this field that not all birds killed by turbines are found by human searchers. This is due to birds falling outside of the search area, being injured, being removed by scavengers, or being undetected by the carcass search team. In order to adjust our raw data for these factors, we used the Fatality Estimator designed by Huso, Som and Ladd (2012, and updated 2015) to model the number of bird fatalities which may have occurred on site during this monitoring period. There are several other estimators available for use on data such as these (e.g. Erickson *et al* 2000, 2004; Shoenfeld 2004, Kerns *et al* 2005; Jain *et al* 2007; Korner-Nievergelt *et al* 2011; Korner-Niegevelt 2015). However, based on our understanding of estimators (from attending the IWS-USGS-BCI workshop on fatality estimators in July 2016 – facilitated by Manuela Huso, and the pros and cons of each of these, we decided Huso *et al* 2012 (updated in 2015) was the best suited to our data.

This model uses the recorded fatality data, scavenger removal trial data and detection trial data to model the total number of birds killed by the WEF (For a full explanation see Huso *et al* 2012 & Huso 2011).

For the purpose of this analysis we used only data from the 24 turbines searched regularly. Fourty four bird fatalities were found at these turbines. Important parameters used by this model for SWF were as follows: 24 of the 46 turbines were searched regularly. At all of these turbines a square search plot with radius 125m was searched. The best fit distribution for our data was a Loglostic distribution. We ran the model using 5 000 bootstraps. The calculated detection rate from the trials we conducted was: 46% (33 to 61% range – 95% confidence limits). Average carcass persistence calculated from trials was 5.99 days (3.88 to 10.87 range – 95% confidence levels). Taking these factors into account, the model estimated that 386 birds were killed at Sere Wind Farm during the period over which fatalities were detected with a range (95% confidence intervals) of between 237 and 670. This equates to 8.39 birds.turbine.year or 3.86 birds.MW installed capacity.year.

Although the results are mostly not publicly available, operational phase monitoring of at least a year has been completed at several South African wind farms. We have conducted these studies at 4 such wind farms. This data is important in order to contextualise the findings at SWF. Without naming these facilities, their unadjusted fatality rates range from 0.49 to 2.0 birds.turbine.year at the other 4 sites compared to 1.41 birds.turbine.year at SWF.

We advocate for cautious use of the outputs of this modelling, as it is subject to several assumptions and biases, discussed elsewhere in this report.

Pre-construction monitoring (Bioinsight & Savannah,2014) identified the highest risk species to be the Black Harrier, Steppe Buzzard and kestrel species. During the operational phase this was accurate when it came to Rock Kestrel but less accurate when we compare all of the fatality data presented above.

# 4. CONCLUSION & RECOMMENDATIONS

The most important findings of this monitoring programme are summarised below:

1. We estimate that approximately 37.58 hectares of vegetation was altered by the construction of this facility, including roads, turbine hard stands and the office-substation complex. This represents 1.18% of the total area of the site, defined as the polygon drawn around the outermost turbines and infrastructure on site. We also estimate that turbine rotors take up approximately 29.26 hectares of air space, which can now be considered either lost or hazardous habitat for birds and bats.
2. A total of 76 bird species were recorded on site during this programme, 6 of which are Red Listed. Pre-construction monitoring recorded 65 bird species.
3. Fifty-seven small passerine bird species were recorded. Based on our analyses, there has been a possible decrease in lark abundance on site.
4. Six large terrestrial and raptor species were recorded on site through drive transects, one of which is a Red Listed species. Pre-construction bird monitoring recorded eight species using drive transects. The abundance per km of the species recorded on driven transects has shown a dramatic decrease in Ludwig's Bustard abundance. It is not known if this is a result of the SWF or just a natural variation in species movements. We suspect the latter is more likely.
5. Twelve target bird species were recorded flying on site during this period. The Red List species include: Black Harrier (Endangered), Lanner Falcon (Vulnerable), Ludwig's Bustard (Endangered), Southern Black Korhaan (Vulnerable) and Secretarybird (Vulnerable). Most frequently recorded flying was Pale Chanting Goshawk (53 minutes or 30% of all flight activity), Southern Black Korhaan (40 minutes or 22.5% of all flight activity) and Black-chested Snake Eagle (20 minutes or 11.3% of all flight activity). Black Harrier, Black-chested Snake Eagle, Secreatrybird, Lanner Falcon and Yellow-billed Kite all spent the majority of their flight time in the turbine impact zone.
6. In the period 21 May 2015 to 20 May 2016 a total of 65 bird fatalities from at least 32 species were recorded (Appendix 6) by formal regular turbine searching at the 46 turbines. The most common species included: Black-chested Snake Eagle, Bokmakierie and Booted Eagle.
7. In terms of sensitive species recorded as fatalities the following Red listed species have been recorded: Southern Black Korhaan (Vulnerable), Greater Flamingo (Near-threatened), Martial Eagle (Endangered) and Secretarybird (Vulnerable). Only the Southern Black Korhaan was recorded as a fatality more than once on the above list (3 records). These occurred at Turbine 3 (2 records) and Turbine 19 (1 record). There is no real spatial pattern from this data with regard to the sensitive species above.

8. The 65 fatalities recorded at the 46 turbines searched regularly results in an unadjusted bird fatality rate of 1.41 birds.turbine.year or 0.65 birds.MW installed capacity.year.
9. Adjustment of this fatality rate to account for scavenger removal and carcass detection biases, results in an estimated fatality at the facility of 386 birds were killed at Sere Wind Farm during the period over which fatalities were detected with a range (95% confidence intervals) of between 237 and 670. This equates to 8.39 birds.turbine.year or 3.86 birds.MW installed capacity.year. However, we have low confidence in this model output for a number of reasons described in this report. This low confidence has likely resulted in an overestimation of the modelled output and it is thus not a reliable estimation. Actions detailed in the recommendations will be taken in the second year of operational monitoring to improve this estimation

We make the following recommendations for the future management of bird interaction at Sere Wind Farm:

1. Continue the live bird monitoring in year 2 as per year 1, including using the same schedule.
2. Conduct searcher efficiency trials only on the turbines that are regularly searched in order to enable us to specify efficiency for the different size classes of decoys used in the year 2 report.

## 5. ACKNOWLEDGEMENTS

We would like to thank the various field teams for their excellent and tireless work on SWF during this monitoring period. The carcass search team is particularly commended for their high quality work in a challenging environment. We thank Sere Wind Farm for implementing this critically important monitoring programme. Lourens Leeuwner is thanked for his ongoing help and assistance with the project. Matt Pretorius is thanked for help with the identification of the bird carcasses. Megan Murison is thanked for assistance in data cleaning and analysis.

# 6. REFERENCES


Allan. D. & Anderson, M. 2O12. Assessment of the threats faced by South Africa's bustard species. Unpublished BirdLife South Africa report.

Barnes, K.N. (ed.) 2000. The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland. Birdlife South Africa, Johannesburg.

Bioinsight & Savannah (2014). Eskom Sere wind energy facility – Bird monitoring. Construction phase. Final report October 2013 – September 2014.

Hofmeyr, S.D. 2011. Large terrestrial birds of the fynbos: how have they responded to land-use change? Oral presentation, Fynbos Forum, Stilbaai, June 2011

Hofmeyer, S. 2012. Impacts of environmental change on large terrestrial bird species in South Africa: insights from citizen science data. Department of Zoology, University of Cape Town.

Hull, C. & Muir, S. 2010. Search areas for monitoring bird and bat carcasses at wind farms using a Monte-Carlo model. Australian Journal of Environmental Management, v. 17, p. 77–87.

Huso, M.M.P., 2011, An estimator of wildlife fatality from observed carcasses: Environmetrics, v. 22, p. 318–329.

Huso, M., Som, N., & Ladd, L. 2012. Fatality estimator users guide: US Geological Survey Data Series 729.

Huso, M. & Dalthorp, D. 2013. Accounting for Unsearched Areas in Estimating Wind Turbine-Caused Fatality. The Journal of Wildlife Management; DOI: 10.1002/jwmg.663. p1-12.

Jenkins, A.R., Van Rooyen, C.S, Smallie, J., Harrison, J.A., Diamond, M., Smit-Robbinson, HA, and Ralston, S. 2015. Best practice guidelines for assessing and monitoring the impact of wind energy facilities on birds in southern Africa" Unpublished guidelines.

Mucina, L; Rutherford, C. 2006. The Vegetation of South Africa, Lesotho and Swaziland, South African National Biodiversity Institute, Pretoria.

Shaw, J.M. 2013. Power line collisions in the Karoo: Conserving Ludwig's Bustard. PhD thesis, University of Cape Town.

Smallwood, K.S. 2007. Estimating wind turbine-caused bird mortality.

Taylor, M. R, Peacock, F., & Wanless, R. 2015. The 2015 Eskom Red Data Book of Birds of South Africa, Lesotho & Swaziland.

## APPENDIX 1. SMALL PASSERINE BIRD SPECIES DATA RECORDED ON SERE WIND FARM.

| Common name | Full year | | | Autumn | | | Winter | | | Spring | | | Summer | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| # Species | 57 | | | 34 | | | 29 | | | 40 | | | 37 | | |
| Transect length | 66 | | | 16.5 | | | 16.5 | | | 16.5 | | | 16.5 | | |
| Common name | # birds | # records | birds/km | # birds | # records | birds/km | # birds | # records | birds/km | # birds | # records | birds/km | # birds | # records | birds/km |
| Karoo Prinia | 337 | 235 | 5.11 | 105 | 82 | 6.36 | 47 | 39 | 2.85 | 110 | 63 | 6.67 | 75 | 51 | 4.55 |
| Karoo Lark | 311 | 271 | 4.71 | 70 | 67 | 4.24 | 73 | 59 | 4.42 | 99 | 82 | 6.00 | 69 | 63 | 4.18 |
| Southern Double-collared Sunbird | 310 | 245 | 4.70 | 67 | 60 | 4.06 | 113 | 80 | 6.85 | 85 | 65 | 5.15 | 45 | 40 | 2.73 |
| Yellow Canary | 271 | 127 | 4.11 | 19 | 14 | 1.15 | 86 | 44 | 5.21 | 96 | 48 | 5.82 | 70 | 21 | 4.24 |
| Karoo Scrub-robin | 220 | 113 | 3.33 | 53 | 28 | 3.21 | 40 | 28 | 2.42 | 66 | 28 | 4.00 | 61 | 29 | 3.70 |
| Cape Sparrow | 197 | 80 | 2.98 | 26 | 16 | 1.58 | 40 | 23 | 2.42 | 90 | 32 | 5.45 | 41 | 9 | 2.48 |
| Grey-backed Cisticola | 187 | 162 | 2.83 | 41 | 39 | 2.48 | 53 | 44 | 3.21 | 63 | 53 | 3.82 | 30 | 26 | 1.82 |
| Bokmakierie | 141 | 85 | 2.14 | 24 | 14 | 1.45 | 44 | 30 | 2.67 | 29 | 19 | 1.76 | 44 | 22 | 2.67 |
| Layard's Tit-babbler | 99 | 85 | 1.50 | 6 | 5 | 0.36 | 35 | 30 | 2.12 | 46 | 38 | 2.79 | 12 | 12 | 0.73 |
| Cape Long-billed Lark | 92 | 78 | 1.39 | 24 | 23 | 1.45 | 35 | 27 | 2.12 | 22 | 18 | 1.33 | 11 | 10 | 0.67 |
| Rufous-eared Warbler | 86 | 80 | 1.30 | 29 | 27 | 1.76 | 16 | 15 | 0.97 | 14 | 14 | 0.85 | 27 | 24 | 1.64 |
| Large-billed Lark | 65 | 58 | 0.98 | 22 | 21 | 1.33 | 12 | 9 | 0.73 | 22 | 20 | 1.33 | 9 | 8 | 0.55 |
| Cape Clapper Lark | 58 | 55 | 0.88 | 17 | 14 | 1.03 | 16 | 16 | 0.97 | 23 | 23 | 1.39 | 2 | 2 | 0.12 |
| Cape Penduline Tit | 45 | 19 | 0.68 | 14 | 10 | 0.85 | | | 0.00 | | | 0.00 | 31 | 9 | 1.88 |
| Lark-like Bunting | 40 | 24 | 0.61 | 8 | 7 | 0.48 | | | 0.00 | 16 | 10 | 0.97 | 16 | 7 | 0.97 |
| Neddicky | 38 | 31 | 0.58 | 1 | 1 | 0.06 | 12 | 12 | 0.73 | 23 | 16 | 1.39 | 2 | 2 | 0.12 |
| Cape Bunting | 36 | 30 | 0.55 | 9 | 9 | 0.55 | 10 | 8 | 0.61 | 11 | 9 | 0.67 | 6 | 4 | 0.36 |
| Pied Starling | 25 | 4 | 0.38 | | | 0.00 | | | 0.00 | 25 | 4 | 1.52 | | | 0.00 |
| Speckled Pigeon | 25 | 4 | 0.38 | | | 0.00 | 22 | 3 | 1.33 | 3 | 1 | 0.18 | | | 0.00 |
| White-throated Canary | 17 | 9 | 0.26 | 3 | 2 | 0.18 | 4 | 1 | 0.24 | 3 | 1 | 0.18 | 7 | 5 | 0.42 |
| Black-headed Canary | 16 | 4 | 0.24 | | | 0.00 | | | 0.00 | 3 | 2 | 0.18 | 13 | 2 | 0.79 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cape Bulbul | 16 | 8 | 0.24 | | | 0.00 | | | 0.00 | 14 | 7 | 0.85 | 2 | 1 | 0.12 |
| Chat Flycatcher | 16 | 12 | 0.24 | 4 | 2 | 0.24 | 2 | 2 | 0.12 | 2 | 1 | 0.12 | 8 | 7 | 0.48 |
| Grey Tit | 16 | 12 | 0.24 | 1 | 1 | 0.06 | 3 | 2 | 0.18 | 4 | 3 | 0.24 | 8 | 6 | 0.48 |
| Familiar Chat | 15 | 12 | 0.23 | 2 | 2 | 0.12 | 5 | 3 | 0.30 | 5 | 4 | 0.30 | 3 | 3 | 0.18 |
| Spike-heeled lark | 15 | 9 | 0.23 | 4 | 2 | 0.24 | 4 | 3 | 0.24 | 1 | 1 | 0.06 | 6 | 3 | 0.36 |
| Namaqua Dove | 11 | 7 | 0.17 | | | 0.00 | | | 0.00 | 11 | 7 | 0.67 | | | 0.00 |
| Capped Wheatear | 10 | 7 | 0.15 | 1 | 1 | 0.06 | 3 | 2 | 0.18 | 5 | 3 | 0.30 | 1 | 1 | 0.06 |
| Yellow-belled Eremomela | 10 | 9 | 0.15 | 3 | 3 | 0.18 | 2 | 1 | 0.12 | 3 | 3 | 0.18 | 2 | 2 | 0.12 |
| Long-billed Crombec | 9 | 8 | 0.14 | 1 | 1 | 0.06 | | | 0.00 | 5 | 5 | 0.30 | 3 | 2 | 0.18 |
| Cape Wagtail | 8 | 8 | 0.12 | 4 | 4 | 0.24 | 1 | 1 | 0.06 | 2 | 2 | 0.12 | 1 | 1 | 0.06 |
| Fiscal Shrike | 8 | 8 | 0.12 | 5 | 5 | 0.30 | 1 | 1 | 0.06 | | | 0.00 | 2 | 2 | 0.12 |
| White-backed Mousebird | 8 | 1 | 0.12 | | | 0.00 | | | 0.00 | | | 0.00 | 8 | 1 | 0.48 |
| Barn Swallow | 7 | 7 | 0.11 | 5 | 5 | 0.30 | | | 0.00 | | | 0.00 | 2 | 2 | 0.12 |
| Bar-throated Apalis | 7 | 7 | 0.11 | | | 0.00 | | | 0.00 | 4 | 4 | 0.24 | 3 | 3 | 0.18 |
| Grey-backed Sparrow-Lark | 7 | 5 | 0.11 | 1 | 1 | 0.06 | | | 0.00 | 5 | 3 | 0.30 | 1 | 1 | 0.06 |
| Sickle-winged Chat | 7 | 4 | 0.11 | | | 0.00 | 7 | 4 | 0.42 | | | 0.00 | | | 0.00 |
| Cape Turtle Dove | 6 | 4 | 0.09 | | | 0.00 | | | 0.00 | 6 | 4 | 0.36 | | | 0.00 |
| African Stonechat | 5 | 5 | 0.08 | 2 | 2 | 0.12 | 1 | 1 | 0.06 | | | 0.00 | 2 | 2 | 0.12 |
| Malachite Sunbird | 5 | 4 | 0.08 | 1 | 1 | 0.06 | 3 | 2 | 0.18 | 1 | 1 | 0.06 | | | 0.00 |
| Southern Masked Weaver | 5 | 1 | 0.08 | | | 0.00 | | | 0.00 | 5 | 1 | 0.30 | | | 0.00 |
| Anteating Chat | 4 | 2 | 0.06 | | | 0.00 | | | 0.00 | | | 0.00 | 4 | 2 | 0.24 |
| Arctic Tern | 4 | 1 | 0.06 | | | 0.00 | | | 0.00 | 4 | 1 | 0.24 | | | 0.00 |
| Common Quail | 4 | 1 | 0.06 | | | 0.00 | | | 0.00 | 4 | 1 | 0.24 | | | 0.00 |
| Namaqua Sandgrouse | 4 | 1 | 0.06 | | | 0.00 | | | 0.00 | | | 0.00 | 4 | 1 | 0.24 |
| Black-headed Heron | 3 | 1 | 0.05 | | | 0.00 | | | 0.00 | 3 | 1 | 0.18 | | | 0.00 |
| Fairy Flycatcher | 2 | 2 | 0.03 | 2 | 2 | 0.12 | | | 0.00 | | | 0.00 | | | 0.00 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Penduline Tit | 2 | 1 | 0.03 | 2 | 1 | 0.12 | | | 0.00 | | | 0.00 | | | 0.00 |
| African Pippit | 1 | 1 | 0.02 | | | 0.00 | 1 | 1 | 0.06 | | | 0.00 | | | 0.00 |
| Black-eared Sparrow-lark | 1 | 1 | 0.02 | | | 0.00 | | | 0.00 | | | 0.00 | 1 | 1 | 0.06 |
| Cape Robin-chat | 1 | 1 | 0.02 | 1 | 1 | 0.06 | | | 0.00 | | | 0.00 | | | 0.00 |
| Common Ant-eating Chat | 1 | 1 | 0.02 | | | 0.00 | | | 0.00 | 1 | 1 | 0.06 | | | 0.00 |
| Crowned Lapwing | 1 | 1 | 0.02 | | | 0.00 | | | 0.00 | 1 | 1 | 0.06 | | | 0.00 |
| Karoo Thrush | 1 | 1 | 0.02 | | | 0.00 | | | 0.00 | 1 | 1 | 0.06 | | | 0.00 |
| Lesser Grey Shrike | 1 | 1 | 0.02 | 1 | 1 | 0.06 | | | 0.00 | | | 0.00 | | | 0.00 |
| Red-capped Lark | 1 | 1 | 0.02 | | | 0.00 | 1 | 1 | 0.06 | | | 0.00 | | | 0.00 |
| White-browed Scrub-Robin | 1 | 1 | 0.02 | 1 | 1 | 0.06 | | | 0.00 | | | 0.00 | | | 0.00 |

## APPENDIX 2. LARGE TERRESTRIAL & RAPTOR DATA RECORDED ON SERE WIND FARM.

| | | | Full year | | | Winter | | | Spring | | | Summer | | | Autumn | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Length of transect | | 141.1 | | | 34.2 | | | 35.7 | | | 35.7 | | | 35.5 | | |
| | Number of species | | 6 | | | 1 | | | 3 | | | 5 | | | 4 | | |
| **Common name** | **Conservation Status** | **Endemism** | **# birds** | **# records** | **birds/km** | **# birds** | **# records** | **birds/km** | **# birds** | **# records** | **birds/km** | **# birds** | **# records** | **birds/km** | **# birds** | **# records** | **birds/km** |
| Southern Black Korhaan | VU | Endemic | 8 | 4 | 0.06 | | | | | | | 6 | 3 | 0.17 | 2 | 1 | 0.06 |
| Southern Pale Chanting Goshawk | | Near-endemic | 7 | 6 | 0.05 | 1 | 1 | 0.03 | 1 | 1 | 0.03 | 1 | 1 | 0.03 | 4 | 3 | 0.11 |
| Black-headed Heron | | | 6 | 6 | 0.04 | | | | 4 | 4 | 0.11 | 2 | 2 | 0.06 | | | |
| Sacred Ibis | | | 3 | 2 | 0.02 | | | | 1 | 1 | 0.03 | | | | 2 | 1 | 0.06 |
| Black-shouldered Kite | | | 1 | 1 | 0.01 | | | | | | | 1 | 1 | 0.03 | | | |
| Rock Kestrel | | | 2 | 2 | 0.01 | | | | | | | 1 | 1 | 0.03 | 1 | 1 | 0.03 |

## APPENDIX 3. INCIDENTAL RECORDS OF TARGET BIRD SPECIES ON SERE WIND FARM.

| Common name | Conservation status | Endemism | Full year | | Autumn | | Winter | | Spring | | Summer | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | # Species | 10 | | 5 | | 2 | | 5 | | 5 | |
| **Common name** | | | # birds | # records | # birds | # records | # birds | # records | # birds | # records | # birds | # records |
| Southern Black Korhaan | VU | Endemic | 13 | 9 | 6 | 4 | | | 2 | 2 | 5 | 3 |
| Pale Chanting Goshawk | | Near-endemic | 11 | 8 | 3 | 3 | | | 7 | 4 | 1 | 1 |
| Black-headed Heron | | | 7 | 4 | | | | | 7 | 4 | | |
| Black-chested Snake-Eagle | | | 2 | 2 | 1 | 1 | | | | | 1 | 1 |
| Booted Eagle | | | 2 | 2 | 1 | 1 | | | | | 1 | 1 |
| White Breasted Cormorant | | | 2 | 2 | 1 | 1 | 1 | 1 | | | | |
| Jackal Buzzard | | Endemic | 1 | 1 | | | | | | | 1 | 1 |
| Ludwigs Bustard | EN | Near-endemic | 1 | 1 | | | 1 | 1 | | | | |
| Rock Kestrel | | | 1 | 1 | | | | | 1 | 1 | | |
| Secretarybird | VU | | 1 | 1 | | | | | 1 | 1 | | |

## APPENDIX 4. SEASONAL BIRD SPECIES LISTS FOR SERE WIND FARM.

'1' denotes presence, not abundance.

| Species name | Red data | Endemism | Winter | Spring | Summer | Autumn |
|---|---|---|---|---|---|---|
| **Total** | | | **41** | **52** | **52** | **44** |
| African Pipit | | | 1 | | | |
| African Stonechat | | | | | 1 | 1 |
| Ant-eating Chat | | E | | 1 | 1 | |
| Arctic Tern | | | | 1 | | |
| Barn Swallow | | | | | 1 | |
| Bar-throated Apalis | | | 1 | 1 | 1 | 1 |
| Black Harrier | EN | E | | 1 | | |
| Black-chested Snake Eagle | | | | 1 | 1 | 1 |
| Black-eared Sparrow-lark | | E | | | 1 | |
| Black-headed Canary | | E | | 1 | 1 | |
| Black-headed Heron | | | | 1 | 1 | |
| Black-shouldered Kite | | | | 1 | 1 | |
| Bokmakierie | | NE | 1 | 1 | 1 | 1 |
| Booted Eagle | | | | | 1 | 1 |
| Cape Bulbul | | E | | 1 | 1 | |
| Cape Bunting | | | 1 | 1 | 1 | 1 |
| Cape Clapper Lark | | E | 1 | 1 | 1 | 1 |
| Cape Cormorant | EN | BE | | 1 | 1 | 1 |
| Cape Long-billed Lark | | E | 1 | 1 | 1 | 1 |
| Cape Penduline Tit | | NE | | | 1 | 1 |
| Cape Robin-chat | | | | | | 1 |
| Cape Sparrow | | NE | 1 | 1 | 1 | 1 |
| Cape Turtle Dove | | | | | 1 | |
| Cape Wagtail | | | 1 | 1 | 1 | 1 |
| Capped Wheatear | | | 1 | 1 | 1 | 1 |
| Chat Flycatcher | | NE | 1 | 1 | 1 | 1 |
| Common Quail | | | | 1 | | |
| Crowned Lapwing | | | | 1 | | |
| Egyptian Goose | | | 1 | | 1 | |
| Fairy Flycatcher | | E | | | | 1 |
| Familiar Chat | | | 1 | 1 | 1 | 1 |
| Fiscal Shrike | | | 1 | | 1 | 1 |
| Greater Kestrel | | | | | 1 | |
| Grey Tit | | E | 1 | 1 | 1 | 1 |
| Grey-backed Cisticola | | NE | 1 | 1 | 1 | 1 |
| Grey-backed Sparrow-lark | | NE | | 1 | 1 | 1 |
| Hadidae Ibis | | | 1 | | | |
| Jackal Buzzard | | E | | 1 | 1 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Karoo Lark | | E | 1 | 1 | 1 | 1 |
| Karoo Prinia | | E | 1 | 1 | 1 | 1 |
| Karoo Scrub-robin | | E | 1 | 1 | 1 | 1 |
| Karoo Thrush | | E | | 1 | | |
| Lanner Falcon | VU | | 1 | | | |
| Large-billed Lark | | E | 1 | 1 | 1 | 1 |
| Lark-like Bunting | | NE | | 1 | 1 | 1 |
| Layard's Tit-babbler | | E | 1 | 1 | 1 | 1 |
| Lesser Grey Shrike | | | | | | 1 |
| Long-billed Crombec | | | | 1 | 1 | 1 |
| Ludwig's Bustard | EN | NE | 1 | | 1 | |
| Malachite Sunbird | | | 1 | 1 | | 1 |
| Namaqua Dove | | | | 1 | | |
| Namaqua Sandgrouse | | NE | 1 | 1 | 1 | |
| Neddicky | | | 1 | 1 | 1 | 1 |
| Pale Chanting Goshawk | | NE | 1 | 1 | 1 | 1 |
| Penduline Tit | | | | | | 1 |
| Pied Crow | | | 1 | 1 | 1 | |
| Pied Starling | | E | | 1 | | |
| Red-capped Lark | | | 1 | | | |
| Rock Kestrel | | | 1 | 1 | 1 | 1 |
| Rufous-eared Warbler | | E | 1 | 1 | 1 | 1 |
| Sacred Ibis | | | | | | 1 |
| Secretarybird | VU | | | 1 | 1 | |
| Sickle-winged Chat | | E | 1 | | | |
| Southern Black Korhaan | VU | E | 1 | 1 | 1 | 1 |
| Southern Double-collared Sunbird | | E | 1 | 1 | 1 | 1 |
| Southern Masked Weaver | | | | 1 | | |
| Speckled Pigeon | | | 1 | 1 | | |
| Spike-heeled Lark | | NE | 1 | 1 | 1 | 1 |
| Spotted-eagle Owl | | | 1 | | | |
| White-backed Mousebird | | E | | | 1 | |
| White-breasted Cormorant | | | 1 | | | 1 |
| White-browed Scrub-Robin | | | | | | 1 |
| White-throated Canary | | NE | 1 | 1 | 1 | 1 |
| Yellow Canary | | NE | 1 | 1 | 1 | 1 |
| Yellow-bellied Eromomela | | | 1 | 1 | 1 | 1 |
| Yellow-billed Kite | | | | 1 | | |

## APPENDIX 5. BIRD FATALITIES RECORDED AT SERE WIND FARM

| ID Number | ID | Date Found | Turbine Number |
|---|---|---|---|
| SE_WT21_20150521_Bi_01 | Fiscal Shrike | 2015/05/21 | WT22 |
| SE_WT20_20150520_Bi_01 | Unknown | 2015/05/21 | WT20 |
| SE-WT3_20150601_Bi_03 | Bokmakierie | 2015/06/01 | WT3 |
| SE_WT3_20150601_Bi_02 | Cormorant spp | 2015/06/01 | WT3 |
| SE_WT3_20150601_Bi_01 | Southern Black Korhaan | 2015/06/01 | WT3 |
| SE_WT8_20150604_Bi_01 | Spotted Eagle Owl | 2015/06/04 | WT8 |
| SE_WT2_20150611_Bi_01 | Secretarybird | 2015/06/11 | WT2 |
| SE_WT44_20150617_Bi_01 | Bokmakierie | 2015/06/17 | WT44 |
| SE_WT44_20150617_Bi_02 | Juvenile Martial Eagle | 2015/06/17 | WT44 |
| SE_WT12_20150627_Bi_01 | Crowned Lapwing | 2015/06/23 | WT12 |
| SE_WT29_20150629_Bi_01 | Pale chanting Goshawk | 2015/06/29 | WT29 |
| SE_WT10_20150707_Bi_01 | Unknown feather | 2015/07/07 | WT10 |
| SE_WT36_20150714_Bi_01 | Rock Kestrel | 2015/07/14 | WT36 |
| SE_WT34_20150714_Bi_01 | Unknown | 2015/07/14 | WT34 |
| SE_WT02_20150716_Bi_01 | Unknown | 2015/07/16 | WT2 |
| SE_WT12_20150721_Bi_01 | Unknown | 2015/07/21 | WT12 |
| SE_WT9_20150723_Bi_01 | Guinea fowl | 2015/07/23 | WT9 |
| SE-WT33_20150727_Bi_01 | Unknown feather | 2015/07/27 | WT33 |
| SE_WT33_20150817_BI_01 | Unknown | 2015/08/17 | WT33 |
| SE_WT33_20150824_BI_01 | Bokmakierie | 2015/08/24 | WT33 |
| SE_WT29_20150824_BI_01 | Unknown | 2015/08/24 | WT29 |
| SE_WT19_20150902_BI_01 | Unknown | 2015/09/02 | WT19 |
| SE_WT31_20150910_BI_01 | Unknown | 2015/09/10 | WT31 |
| SE_WT18_20150911_Bi_01 | Spotted Eagle Owl | 2015/09/11 | WT18 |

| | | | |
|---|---|---|---|
| SE_WT05_20150914_BI_01 | Black-chested Snake Eagle | 2015/09/14 | WT5 |
| SE_WT03_20150914_BI_01 | Common Quail | 2015/09/14 | WT3 |
| SE_WT19_20150915_BI_01 | Cape sparrow | 2015/09/15 | WT19 |
| SE_WT17_20150915_BI-01 | Common Swift | 2015/09/15 | WT17 |
| SE_WT19_20150915_BI_02 | Common Swift | 2015/09/15 | WT19 |
| SE_WT19_20150915_BI_03 | Red-capped Lark | 2015/09/15 | WT19 |
| SE_WT28_20150917_BI_01 | Grey-backed Cisticola | 2015/09/17 | WT28 |
| SE_WT40_20150922_BI_01 | Common Quail | 2015/09/22 | WT40 |
| SE_WT36_20151006_BI_01 | White-rumped swift | 2015/10/06 | WT36 |
| SE_WT15_20151013_BI_01 | Unknown | 2015/10/13 | WT15 |
| SE_WT36_20151022_BI_01 | Turtle Dove | 2015/10/20 | WT36 |
| SE_WT44_20151021_BI_01 | Unknown | 2015/10/21 | WT44 |
| SE_WT20_20151029_BI_01 | Unknown chick | 2015/10/29 | WT20 |
| SE_WT40_20151030_BI_01 | Cape weaver | 2015/10/30 | WT40 |
| SE_WT32_20151105_Bi_01 | Karoo Scrub Robin | 2015/11/05 | WT32 |
| SE_WT40_20151106_BI_01 | Clapper Lark | 2015/11/06 | WT40 |
| SE_WT40_20151203_Bi_01 | Booted Eagle | 2015/12/03 | WT40 |
| SE_WT19_20151207_Bi_01 | Cape sparrow | 2015/12/07 | WT19 |
| SE_WT4344_20151214_Bi_01 | Lanner Falcon | 2015/12/14 | WT43 and WT44 |
| SE_WT44_20160106_bi_01 | Bokmakierie | 2016/01/06 | WT44 |
| SE_WT45_20160107_bi_01 | Black chested snake eagle | 2016/01/07 | WT45 |
| SE_WT36_20160108_bi_01 | Unknown | 2016/01/08 | WT36 |
| SE_WT09_20160114_bi_01 | Booted Eagle | 2016/01/14 | WT9 |
| SE_WT42_20160120_bi_01 | Unknown | 2016/01/20 | WT42 |
| SE_WT20_20160128_bi_01 | White-backed mousebird | 2016/01/28 | WT20 |
| SE_WT35_20160201_bi_01 | Common tern | 2016/02/01 | WT35 |
| SE_WT03_20160208_bi_01 | Southern Black Korhaan | 2016/02/08 | WT03 |
| SE_WT45_20160211_bi_02 | Black-Chested Snake Eagle | 2016/02/11 | WT45 |

| | | | |
|---|---|---|---|
| SE_WT45_20160211_bi_05 | Pied Crow | 2016/02/11 | WT45 |
| SE_WT5_20160222_Bi_01 | Booted Eagle | 2016/02/22 | WT5 |
| SE_WT19_20160224_Bi_01 | Southern Black Korhaan | 2016/02/24 | WT19 |
| SE_WT45_20160225_Bi_01 | Yellow Canary | 2016/02/25 | WT13 |
| SE_WT31_20160103_BI_01 | Bokmakierie | 2016/03/01 | WT31 |
| SE_WT16_20160303_BI_01 | Bokmakierie | 2016/03/03 | WT16 |
| SE_WT33_20160307_Bi_01 | Greater flamingo | 2016/03/07 | WT33 |
| SE_WT38_20160315_Bi_01 | Karoo Scrub Robin | 2016/03/15 | WT38 |
| SE_WT21_20160406_BI_01 | Laughing Dove | 2016/04/06 | WT21 |
| SE_WT9_20160407_BI_01 | Tern sp. | 2016/04/07 | WT9 |
| SE_WT18_20160419_Bi_01 | Little Swift | 2016/04/19 | WT18 |
| SE_WT39_20160505_BI_01 | Unknown | 2016/05/05 | WT39 |
| SE_WT46_20160511_BI_01 | Pale Chanting Goshawk | 2016/05/11 | WT46 |

# SERE Wind Farm

# Western Cape

## Operational bird monitoring programme

## Year 2 Final report

August 2017

Submitted to:
Endangered Wildlife Trust

Compiled by:
Luke Strugnell
WildSkies Ecological Services (Pty) Ltd
luke@wildskies.co.za

## EXECUTIVE SUMMARY

The Sere Wind Farm (SWF) consists of 46 Siemens wind turbines, each with a hub height of 115 metres and rotor diameter of 110 metres, situated near Lutzville, Western Cape. Construction of this facility was completed during 2014. In accordance with the conditions of the Environmental Authorisation, post-construction bird monitoring was initiated in May 2015.

The Endangered Wildlife Trust (EWT) designed and implemented the monitoring programme, and appointed WildSkies Ecological Services (hereafter WildSkies) to analyse data and compile reports. Operational bird monitoring was initiated in late May 2015. The final Year 1 report was completed in September 2016 (Strugnell, 2016). This current report details the findings of Year 2 operational bird monitoring from May 2016 until May 2017.

The most important findings of this monitoring programme are summarised below:

1. A total of 54 bird species were recorded on site during this programme, 4 of which are Red Listed. Pre-construction bird monitoring recorded 65 bird species.
2. Forty small passerine bird species were recorded. There is a general decrease in abundance in Year 2 of operational monitoring on site as compared with Year 1.
3. Four large terrestrial and raptor species were recorded on site through drive transects, one of which is a Red Listed species (Southern Black Korhaan- Vulnerable). Pre-construction bird monitoring recorded eight species using drive transects. The abundance per km of the species recorded on driven transects has shown a dramatic decrease in Ludwig's Bustard abundance since the facility became operational. Once again, no Ludwig's Bustard were recorded using drive transects on site in Year 2. In addition, one Ludwig's Bustard fatalities did occur in Year 2. In general, there is a decrease in all species abundance in Year 2 of operational phase monitoring compared to Year 1 of operational monitoring.
4. Eleven target bird species were recorded flying on site during this period. The Red List species include: Black Harrier (Endangered), Cape Cormorant (Endangered), Ludwig's Bustard (Endangered), Southern Black Korhaan (Vulnerable) and Martial Eagle (Endangered). Most frequently recorded flying was Southern Black Korhaan (65.23% of all flight activity), Pale Chanting Goshawk (15.63% of all flight activity), and Greater Kestrel (11.05% of all flight activity). Only Steppe Buzzard, Black-chested Snake Eagle and Greater Kestrel spent any of their flight time in the turbine impact zone.
5. In the period 21 May 2016 to 20 May 2017 a total of 19 (c.f.65 in Year 1) bird fatalities from at least 11 species were recorded (Appendix 6) by formal regular turbine searching at the 46 turbines. The most common species killed included: Black-shouldered Kite (3), Bokmakierie (3) and Southern Black Korhaan (2).

6. In terms of sensitive species recorded as fatalities the following Red listed species have been recorded: Southern Black Korhaan (2 recorded- Vulnerable) and Ludwig's Bustard (1 recorded-Endangered).
7. The 19 fatalities recorded at the 46 turbines searched regularly results in an unadjusted bird fatality rate of 0.431 birds.turbine.year or 0.19 birds.MW installed capacity.year. This is a dramatic decrease in fatalities from Year 1 of operational bird monitoring which recorded 1.41 birds.turbine.year.
8. Adjustment of this fatality rate to account for scavenger removal and carcass detection biases, results in an estimated fatality at the facility of 259 birds killed during the period over which fatalities were detected, with a range (95% confidence intervals) of between 139 and 544. This equates to 5.63 birds.turbine.year or 2.59 birds.MW installed capacity.year. However, we have low confidence in this model output for a number of reasons described in this report. This low confidence has likely resulted in an overestimation of the modelled output and it is thus not a reliable estimation.

We make the following recommendations for the future management of bird interaction at Sere Wind Farm:

1. Conduct an ongoing modified carcass search programme of the wind farm, with a focus on recording the important species such as Ludwig's Bustard and Southern Black Korhaan should these collide with turbines in future. This should be done until year 5 of operation, when a more detailed monitoring program must once again be completed in keeping with the best practice guidelines.
2. Conduct more detailed research into the Ludwig's Bustard population. More time should be spent surveying this species to determine if the species has indeed been displaced by the wind farm. In order to do this a research project should be initiated using a suitable control site.

## Table of contents

## List of Figures



## List of Tables

# 1. BACKGROUND

The Sere Wind Farm (SWF) consists of 46 Siemens wind turbines, each with a hub height of 115 metres and rotor diameter of 110 metres, situated near Lutzville, Western Cape. Construction of this facility was completed during 2014. In accordance with the conditions of the Environmental Authorisation, post-construction bird monitoring was initiated in May 2015.

The Endangered Wildlife Trust (EWT) designed and implemented the monitoring programme, and appointed WildSkies Ecological Services (hereafter WildSkies) to analyse data and compile reports. Operational bird monitoring was initiated in late May 2015. The final Year 1 report was completed in September 2016 (Strugnell, 2016). This current report details the findings of Year 2 operational bird monitoring from May 2016 until May 2017.

Overall this programme aims to measure what effect the construction and operation of the Sere Wind Farm has had on the birds in the area. Operational phase bird monitoring consists of two components: live bird monitoring and bird fatality estimates. This monitoring programme is conducted in accordance with the relevant guidelines. These are: the “Best practice guidelines for assessing and monitoring the impacts of wind energy facilities on birds in southern Africa” (Jenkins, van Rooyen, Smallie, Harrison, Diamond, Smit-Robbinson, & Ralston, 2015.)

The Sere Wind Farm site is classified into two different vegetation types, namely Namaqualand Strandveld and Namaqualand Sand Fynbos (Mucina and Rutherford, 2008). This vegetation is a mix of very hardy bushed and typical Fynbos vegetation. The SWF site was previously grazed but this has stopped with the establishment of SWF.

A relatively low diversity of bird species occur in the area. Pre-construction monitoring (Bioinsight & Savannah,2014) identified the most important of these species with respect to the wind farm.

# 2. METHODS

## 2.1 Habitat Classification and Alteration on site.

This was reported on in the Year 1 report and not repeated here.

## 2.2 Live bird monitoring

Live bird monitoring was conducted on site by the Endangered Wildlife Trust under the supervision of WildSkies. A total of 49 days were spent on site by the monitoring team during this programme. In addition several site visits were made by WildSkies' specialists. The layout of the monitoring activities is shown in Figure 1.

### *2.2.1 Small terrestrial bird species*

Although not traditionally the focus of wind farm–bird studies and literature, small terrestrial birds are an important component of this programme. Due to the rarity of many of our threatened bird species, it is anticipated that statistically significant trends in abundance and density may be difficult to observe. More common, similar species could provide early evidence for trends and point towards the need for more detailed future study. Given the large spatial scale of wind energy facilities (WEF's), these smaller species may also be particularly vulnerable to displacement and habitat level effects. Sampling these species is aimed at establishing indices of abundance for small terrestrial birds in the study area. These counts should be done when conditions are optimal. In this case this means the times when birds are most active and vocal, i.e. early mornings. A total of 12 walked transects (WT) were conducted on the SWF site. These WT's are positioned to represent the bird micro habitats available. Walked transects were laid out taking into account the location of these transects from pre-construction monitoring. These were however improved upon for the operational phase surveys.

### *2.2.2. Large terrestrial bird species & raptors*

This is a very similar data collection technique to that above, the aim being to establish indices of abundance for large terrestrial species and raptors. These species are relatively easily detected from a vehicle, hence vehicle based transects (VT) were conducted in order to determine the number of birds of relevant species in the study area. Detection of these large species is less dependent on their activity levels and calls, so these counts can be done later in the day. A total of 2 VT's have been established, totalling approximately 23.9 kilometres in length. Transects are conducted by driving slowly along the set route searching for large terrestrial species or raptors. All birds within 2 kilometres of the road (transect) were recorded. These vehicle transects followed (as far as possible) the pre-construction transects route.

### 2.2.3. Focal site surveys & monitoring

During the first season of bird monitoring in Year 1 of operational bird monitoring one focal site was monitored. This was a small dam on site. The dam had no water and hence no birds after this first season and hence these data are not very useful. This focal site was abandoned after this and not monitored in Year 2.

### 2.2.4. Direct observation of bird movements

The above data collection efforts allow us to arrive at an estimate of the abundance or density of the relevant species on site. This allows the identification of any displacement and disturbance effects on these species. However in relating these species' flight activity to fatalities, their abundance is not sufficient. We also need to understand their flight behaviour. It is the flight behaviour which determines their exposure to collision risk. A bird which seldom flies, or typically flies lower than blade height is at lower risk than a frequent flier that typically flies at blade height. In order to gather data on this aspect, direct observations of bird flight behaviour are required. This is the most time consuming and possibly the most important activity to be conducted on site, and is elaborated on below.

The aim of direct observation is to record bird flight activity on site. An understanding of this flight behaviour will help explain any interactions between birds and the WEF. Spatial patterns in bird flight movement may also be detected, which will allow for comparison with the location of fatalities. Direct observation of bird flight is conducted through counts at four Vantage Point's (VP's) (Figure 1), identified to provide coverage of a reasonable and representative proportion of the entire study area (total coverage being unnecessary and impractical given resource constraints). The survey radius for VP counts is 2 kilometres, and VP counts are conducted by two observers, recording birds in a 360° radius. Data should be collected during representative conditions, so the sessions were spread throughout the day, with each VP being counted over 'early to mid-morning', 'mid to late morning', 'early to mid-afternoon', and 'mid-afternoon to evening'. Each session is 3 hours long, resulting in a total of 12 hours of observation being conducted at each vantage point on each site visit. There have been some slight modifications in terms of VP position from pre-construction. This is mainly as a result of improved access roads, new fences etc.

### 2.2.5 Control site

Since only walk transects were undertaken on a control site during pre-construction monitoring, the same was done during operational monitoring. The control site walk transect is approximately 1.5 kilometres north of the site boundary.

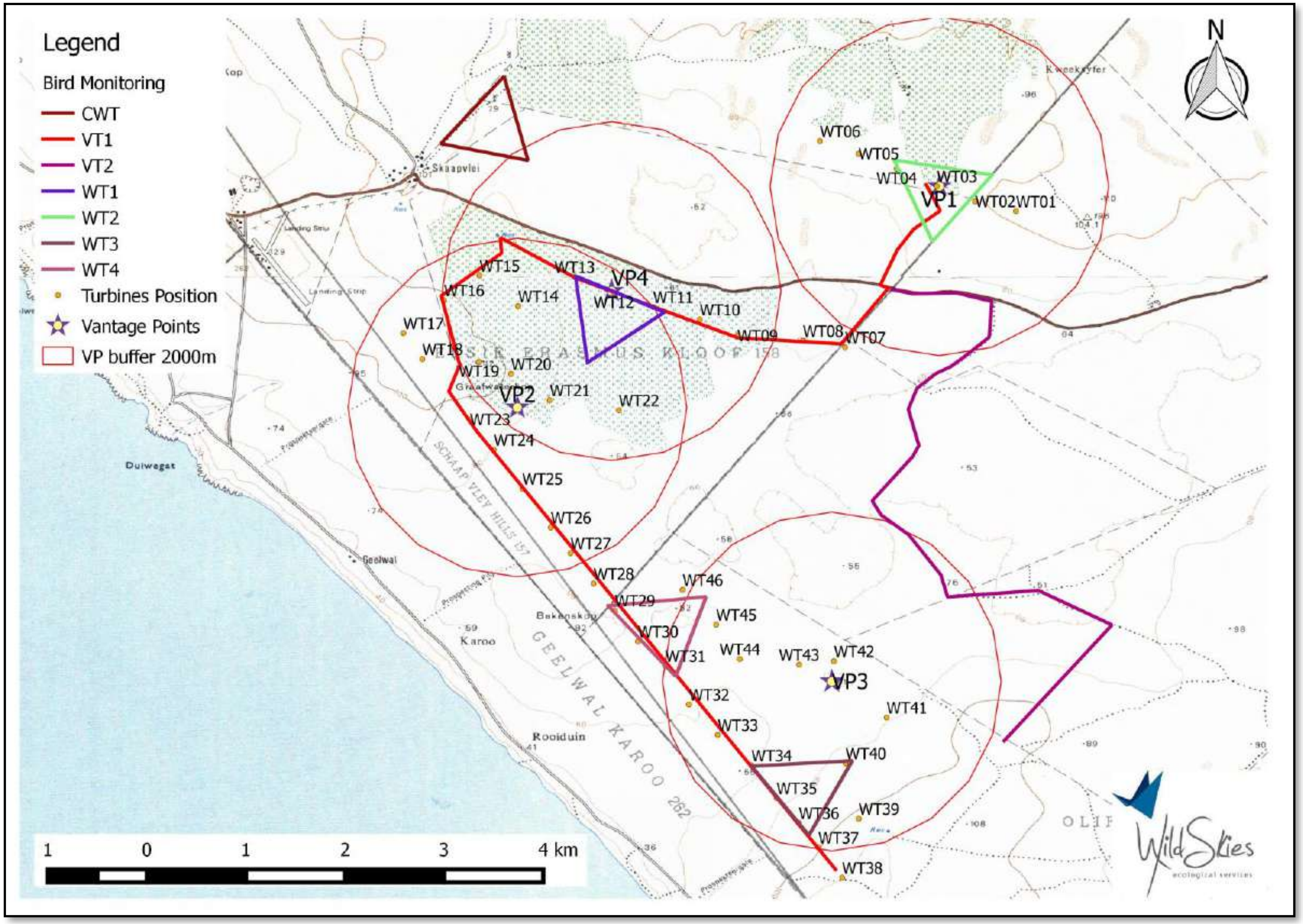



**Figure 1-** The Layout of the Sere Wind Farm post construction bird monitoring activities.

## 2.3 Bird fatality estimates

### *2.3.1 Turbine searches*

A team of four carcass searchers is employed and managed by Endangered Wildlife Trust on site to search for dead birds and bats beneath turbines. The search programme designed by the EWT results in 24 of the 46 turbines to be searched on a fixed schedule (i.e. every 2 weeks) and the remaining 22 to be searched on a random basis. The random search results in all of the random set of turbines being searched every 6 weeks. This is always done on a Thursday and the full search plot is searched as with the fixed set of turbines. At each of these turbines a team of 2 search a square search plot of 250 metre length sides around the base of the turbine. The pair of searchers walk straight line transects parallel to each other and 6 metres apart, to cover the search plot.

On detecting a bird or bat carcass, the team marked its position with a small flag and then continued searching the plot to completion. The fatality was then processed as follows: *in situ* photographs of the carcass were taken, photographs of carcass relative to the turbine were taken, and photographs of vegetation were taken. A basic datasheet including information such as GPS coordinates, age of carcass, and vegetation type was completed. The carcass was then tagged, bagged and transported to the on-site freezer for storage. Datasheets, photographs and GPS tracks were uploaded to a shared dropbox file weekly.

Although WildSkies was not responsible for the design of the carcass search programme, employment, and management of the carcass search team, periodic site visits were conducted to provide support and refresher training. During these visits, freezer contents were also checked and identified to species where possible.

### *2.3.2 Estimates of scavenger removal or carcass persistence*

In order to obtain estimates of the rate at which turbine collision casualties are scavenged on site (and therefore potentially missed by the carcass search team), sets of surrogate carcasses were placed on site periodically and visited every day thereafter to determine when they were removed or scavenged. These carcasses were placed outside of the turbine search plots, to avoid confusion with real bird fatalities, and scavenger flooding or swamping at turbines. A carcass was considered removed once no detectable trace of it remained *in situ*. A total of 66 surrogate carcasses were placed on site during this monitoring period, spread across several seasons. These comprised of a range of small, medium and large indigenous bird species.

Carcasses used in the trials were placed in three visibility classes determined by vegetation height and density and rocky outcrops: good, moderate and poor. The searchers checked the carcasses once daily at the same time every day to look for evidence of scavenging and to note if the carcass was completely removed. The carcasses were checked until all carcasses had disappeared.

### *2.3.3 Estimates of carcass detection rates or searcher efficiency*

In order to obtain estimates of the rate at which collision casualties are detected by the carcass search team, sets of decoys were placed on site periodically across the various seasons. These decoys were placed within turbine search plots, at varying distance and bearing from turbines, and without the knowledge of the carcass search team. Decoys were located in representative visibility classes, classified as good (road, hard stand, bare ground), moderate (short vegetation), and poor (tall vegetation). In the case of birds, decoys were classed into three size categories, small – corresponding to a small passerine, medium – corresponding to a pigeon or small raptor, and large – corresponding to a goose, large terrestrial or large raptor. A total of 25 bird decoys were placed on site during this period.

Note: The carcass search team were informed during training and programme setup early in the year that at some point bird and bat decoys (plastic toys) would be placed on site, and that these should be reported as per normal processes when encountered. The exact dates of placement of decoys were however not shared with searchers.

## 2.4 Notes, Limitations & assumptions

Overall this programme has proceeded smoothly and without major challenges. However several aspects are worth noting:

- Carcass searches - Interruptions to productivity. Various practical factors played a part in the searching team achieving a longer average search interval at turbines than planned. These include weather, staff issues, weekends, and public holidays as well as Endangered Wildlife Trust's training and conservation weeks which required the team to leave site.
- Significant time was also spent by the EWT conducting extensive powerline surveys, roadkill surveys, associated infrastructure surveys (guy wires of met masts, office buildings, etc), etc. The EWT is commended for these efforts and it must be noted that these research projects will assist the wind energy industry in improving the monitoring in the future. Despite the fact that it did take time away from the core searching of turbines it is seen as a valuable component of the project. The results of these projects will be reported on by the EWT directly.
- WildSkies was not responsible for the staff management or design of the monitoring program. The Endangered Wildlife Trust contracted WildSkies for assistance in this regard and to write the final report. The search schedule was designed by the bat specialist (Bioinsight) and

resulted in a less than ideal search interval, with the result that the estimated fatality rates are not very accurate.

- During the second year of operational bird monitoring the senior carcass searcher left the employment of the EWT. There was a dramatic decrease in the quality of the data since then and it must be said that the overall quality of the data, including the live bird data, is of a poor standard and required extensive remediation work to be useful. There is also missing data in terms of searcher efficiency and carcass persistence trials that could not be located.

# 3. RESULTS & DISCUSSION

Post construction or operational phase (hereafter) bird monitoring is typically required at wind energy facilities (WEF's) to confirm what the actual impacts are, determine any necessary mitigation for these impacts, and improve our understanding of the relevant issues so that our future assessments are improved.

Operational phase monitoring can be grouped into three main activities: classification of habitat; collection of data on bird abundance, distribution and movement on site; and an estimation of the number of bird fatalities as a result of the facility.

## 3.1. Habitat on site

### *3.1.1 Habitat classification*

No additional infrastructure was constructed during Year 2 resulting in no change on the reported values from the Year 1 report.

## 3.2 Live bird abundance & activity on site

Overall the field team spent 49 days on site during this period, split into four iterations, between May 2016 and April 2017. In addition, the specialists made a number of visits to the site. The layout of the various bird monitoring activities is presented in Figure 1.

During this programme, a total of 54 species were recorded (Appendix 4). Species richness peaked in spring with 45 species, followed by autumn and winter (37) and summer with 36. This included 4 Red Listed species (Black Harrier-Endangered, Ludwig's Bustard-Endangered, Martial Eagle-Endangered and Southern Black Korhaan-Vulnerable (Taylor *et al*, 2015)) and at least 32 South African endemics, breeding endemics or near-endemics. The most important of these species have been discussed in the other relevant sections below.

Pre-construction monitoring recorded a total of 65 bird species on site (Bioinsight & Savannah,2014). This included 12 Red listed species of which 4 were Raptors (African Marsh Harrier *Circus ranivorus*, Black Harrier *Circus maurus*, Martial Eagle *Polemaetus bellicosus* and Secretarybird *Sagittarius serpentarius*) and 4 were large terrestrials (Ludwig's Bustard *Neotis ludwigii*, Kori Bustard *Ardeotis kori*, Karoo Korhaan *Eupodotis vigorsii* and Southern Black Korhaan *Afrotis afra*).

Red List species recorded during pre-construction but not during operational phase include: Kori Bustard, Karoo Korhaan, African Marsh Harrier and Martial Eagle.

### 3.2.1 Small terrestrial bird species

A total of 1 630 records of 2 200 individual birds were made using this method (down from 1 996 and 2 896 respectively in Year 1). A total of 40 (down from 57 in year 1) bird species were recorded using this method, with a peak in species richness (31 species) recorded in summer and the lowest species diversity in spring (29 species) (see Appendix 1 for the full dataset). Of the 40 bird species, 24 species are considered southern African endemics or near-endemics (see Appendix 1). Figure 3 below shows the most common (those with more than 50 birds recorded) bird species recorded during the year of bird monitoring with the associated number of birds and number of records.

The most abundant bird species included: Karoo Prinia *Prinia maculosa* (4.32 birds/km), Southern Double-collared Sunbird *Cinnyris chalybeus* (3.82 birds/km), Karoo Scrub-robin *Cercotrichas coryphoeus* (3.64 birds/km), Karoo Lark *Calendulauda albescens* (3.30 birds/km), Yellow Canary *Crithagra flaviventris* (2.49 birds/km) and Bokmakierie *Telophorus zeylonus* (1.74 birds/km). The full list is available in Appendix 1.

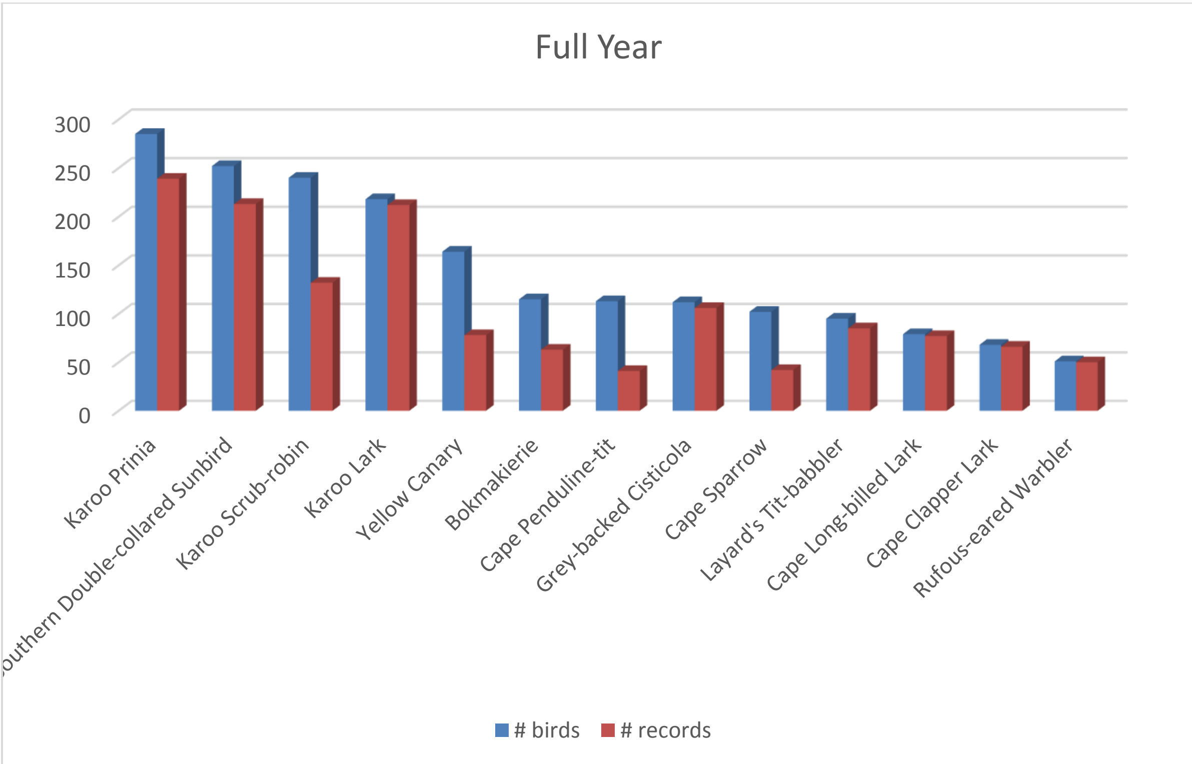



**Figure 2** - Small terrestrial bird species with more than 50 birds recorded during year 2 of monitoring at Sere Wind Farm.

In terms of the abundance of small terrestrial species on SWF during operational phase bird monitoring the density is presented in Appendix 1.

Pre-construction bird monitoring (Bioinsight & Savannah,2014) recorded 50 species of small passerines. The most abundant included: Cisticolas and allies (9.71 contacts/km), sunbirds (5.40 contacts/km), larks (4.52 contacts/km), chats and flycatchers (2.79 contacts/km). Since Bioinsight & Savannah (2014) grouped species into families in their data, direct comparison with our data is not very meaningful.

In terms of abundance between Year 1 and Year 2 operational monitoring, there does seem to be a decrease in abundance for example: Karoo Prinia decreased from 5.11 birds/km to 4.32 birds/km; Karoo Lark decreased from 4.71 birds/km to 3.3 birds/km; Southern Double-collared Sunbird decreased from 4.7 birds/km to 3.82 birds/km; Yellow Canary decreased from 4.11 birds/km to 2.49 birds/km; and Bokmakierie decreased from 2.14 birds/km to 1.74 birds/km. This could be explained by natural inter-annual variation but is something to consider going forward.

Seven of the nineteen (37%) of the recorded bird fatalities recorded at SWF during the operational phase carcass searching were small passerine bird species. The most common of these were the Bokmakierie.

### *3.2.2. Large terrestrial birds & raptors*

A total of 4 (down from 6 in Year 1) species were recorded by driven transects on and near site (Appendix 2). A peak in species richness was recorded in summer (2) and autumn (2), followed by spring and winter (1 each). These data are presented in Figure 4.

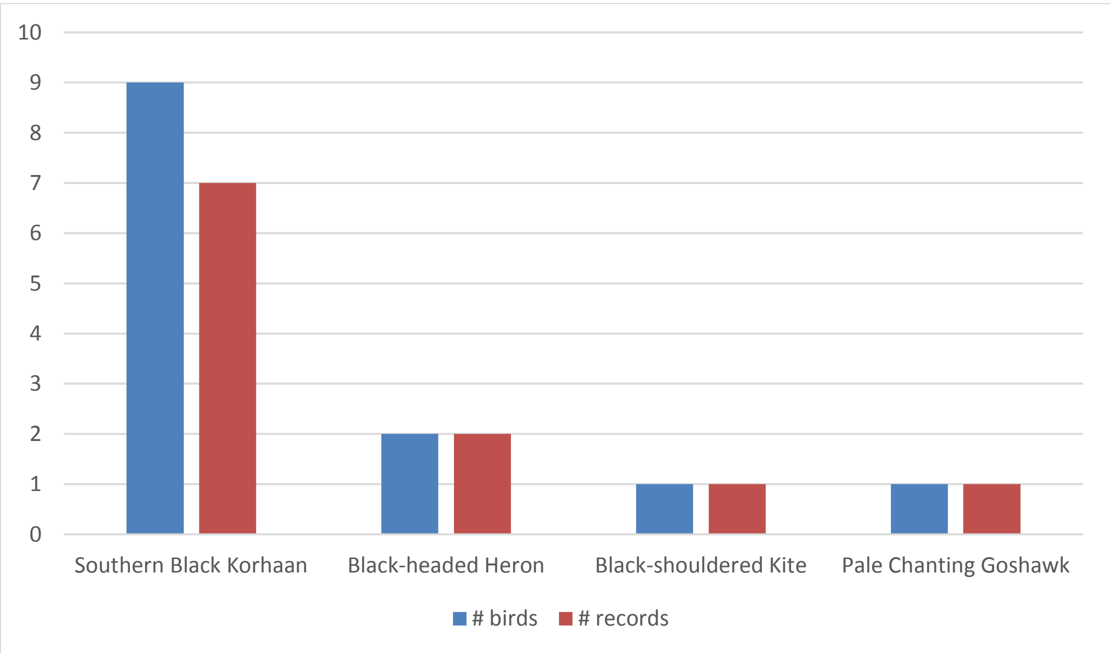



**Figure 3-** Number of large terrestrial birds and raptors recorded using driven transects at Sere Wind Farm during Year 2.

Pre-construction data (Bioinsight & Savannah,2014) for large terrestrials recorded 8 species using driven transects. The most abundant of these included Ludwig's Bustard (0.07 birds/km), Pale Chanting Goshawk *Melierax canorus* (0.04 birds/km), Southern Black Korhaan (0.03 birds/km) and Rock Kestrel *Falco rupicolus* (0.02 birds/km). In addition the following species all had abundances of 0.01 birds/km: Black-headed Heron *Ardea melanocephala* , Martial Eagle, Greater Kestrel *Falco rupicoloides* and Pied Crow *Corvus albus*. The operational phase monitoring in Year 1 recorded the following abundances: Southern Black Korhaan (0.06 birds/km), Pale Chanting Goshawk (0.05 birds/km), Black-headed Heron (0.04 birds/km), Sacred Ibis *Threskiornis aethiopicus* (0.02 birds/km), Black-shouldered Kite (0.01 birds/km) and Rock Kestrel (0.01 birds/km). In Year 2 of operational monitoring this was; Southern Black Korhaan (0.062 birds/km), Black-headed Heron (0.014 birds/km), Black-shouldered Kite (0.007 birds/km) and Pale Chanting Goshawk (0.007 birds/km). Southern Black Korhaan has a fairly consistent abundance in Year 2 compared to Year 1, it is also higher than pre-construction monitoring. The other three species recorded in Year 2 show lower density than Year 1 of operational bird monitoring and most are lower than pre-construction monitoring too. Once again Ludwig's Bustard were not recorded using this method. The operation monitoring has recorded a definite reduction in abundance with regard to Ludwig's Bustard. One possible explanation for this is that the species was displaced from site due to the construction of the SWF. Unfortunately without data from a control site (since Bioinsight & Savannah 2014 did not monitor the control site adequately) we cannot draw this conclusion. Further, Ludwig's Bustard is a nomadic species which moves around the arid parts of the country in response to rainfall and food availability. We observe high inter annual variability in abundance of this species at many sites, and would rather attribute the SWF finding to this natural variability without evidence to the contrary. Ludwig's Bustard have also been recorded as fatalities during Year 2 (1 fatality during Year 2 and 1 that occurred just after the cut off for Year 2) of operational bird monitoring, perhaps offering an insight into why the abundance of this species has decreased.

### *3.2.3 Incidental observations*

In total 47 (up from 41 in year 1) individual birds were recorded during this monitoring period (Figure 4). These data comprise 8 (down from 10 in Year 1) species in total, with 4 recorded every season (Appendix 4).

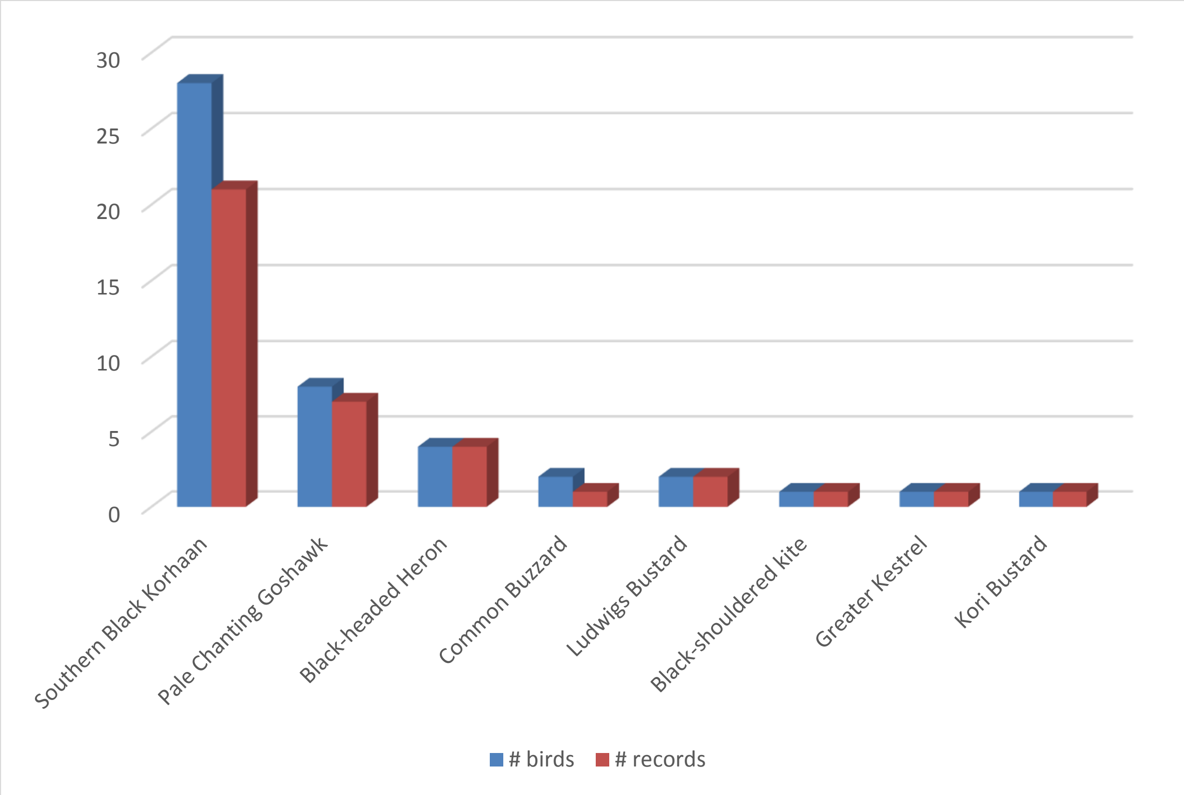



**Figure 4-** Number of birds and number of records from the incidental data for the Sere Wind Farm during Year 2 operational monitoring.

Southern Black Korhaan was by far the most frequently recorded species as an incidental followed by Pale Chanting Goshawk.

This data is not the product of formal searching, and the search effort is not measured, Various biases exist in the data, for example certain roads are driven more frequently and birds will therefore seem more abundant there. There is no value in comparing these data with pre-construction due to their incidental and unstructured nature.

### *3.2.4 Target bird species flight*

A total of 192 hours of target bird flight observation was conducted at the four vantage points on site over the four seasonal site visits, in sessions of 3 hours duration each. A total of 80 (up from 68 in Year 1) flight records of target bird species were made, including 11 (down from 12 in Year 1) species, of which five are Red List species (see Table 1). This is an exceptionally low level of flight activity. The Red List species include: Black Harrier *Circus maurus* (Endangered), Cape Cormorant *Phalacrocorax capensis* (Endangered), Ludwig's Bustard (Endangered), Martial Eagle (Endangered) and Southern Black Korhaan (Vulnerable).

Most frequently recorded flying was Southern Black Korhaan (4 hours and 2 minutes or 65.23% of all flight activity), Pale Chanting Goshawk ( 58 minutes or 15.63% of all flight activity), and Greater Kestrel (41 minutes or 11.05% of all flight activity). See Table 1 for the full breakdown.

Figure 6 shows the breakdown of flight records per season for each species.

In terms of flight height and the risk zones of all species recorded using the vantage point method, the following categories were used:

**A= Ground to Bottom of Blade**
**B= Bottom of Blade to Hub Height**
**C= Hub Height to Top of Blade**
**D= Above Blade Height**

Flights at height categories B and C would have been at risk of collision.

Only the Greater Kestrel used all zones and a pie chart of the breakdown of these zones is shown below in Figure 5.

**Table 1-** Summary data for the recorded target bird species flight on Sere Wind Farm.

| Common name | # birds | # records | Total flight duration | Flight Height A | % at height A | Flight Height B | % at height B | Flight Height C | % at height C | Flight Height D | % at height D |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Southern Black Korhaan | 37 | 35 | 04:02:00 | 04:02:00 | 100 | 00:00:00 | 0 | 00:00:00 | 0 | 00:00:00 | 0 |
| Pale Chanting Goshawk | 24 | 23 | 00:58:00 | 00:58:00 | 100 | 00:00:00 | 0 | 00:00:00 | 0 | 00:00:00 | 0 |
| Greater Kestrel | 14 | 12 | 00:41:00 | 00:20:00 | 49 | 00:03:00 | 7 | 00:16:00 | 39 | 00:02:00 | 5 |
| Martial Eagle | 1 | 1 | 00:08:00 | 00:08:00 | 100 | 00:00:00 | 0 | 00:00:00 | 0 | 00:00:00 | 0 |
| Black-chested Snake Eagle | 1 | 1 | 00:07:00 | 00:00:00 | 0 | 00:00:00 | 0 | 00:07:00 | 100 | 00:00:00 | 0 |
| Ludwig's Bustard | 3 | 3 | 00:04:00 | 00:04:00 | 100 | 00:00:00 | 0 | 00:00:00 | 0 | 00:00:00 | 0 |
| Steppe Buzzard | 1 | 1 | 00:04:00 | 00:00:00 | 0 | 00:00:00 | 0 | 00:04:00 | 100 | 00:00:00 | 0 |
| Cape Cormorant | 1 | 1 | 00:02:00 | 00:02:00 | 100 | 00:00:00 | 0 | 00:00:00 | 0 | 00:00:00 | 0 |
| Rock Kestrel | 1 | 1 | 00:02:00 | 00:02:00 | 100 | 00:00:00 | 0 | 00:00:00 | 0 | 00:00:00 | 0 |
| Black-shouldered Kite | 1 | 1 | 00:02:00 | 00:02:00 | 100 | 00:00:00 | 0 | 00:00:00 | 0 | 00:00:00 | 0 |
| Black Harrier | 1 | 1 | 00:01:00 | 00:01:00 | 100 | 00:00:00 | 0 | 00:00:00 | 0 | 00:00:00 | 0 |

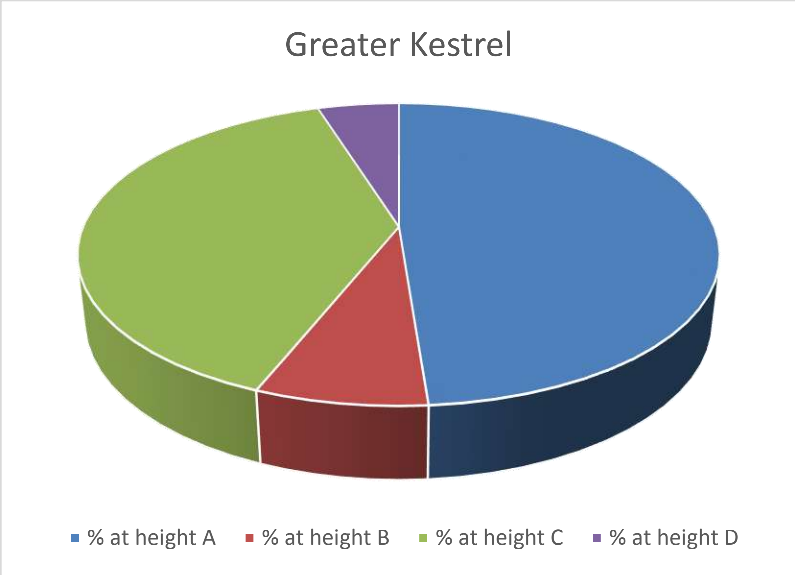



**Figure 5-** Pie chart showing flight height of Greater Kestrel.

These data show a marked difference from the results of Year 1 operational monitoring, when multiple species flew in multiple zones. During Year 2 of operational bird monitoring most species remained in Zone A, with only the Greater Kestrel using all zones. Black-chested Snake Eagle and Steppe Buzzard flew 100% of the time in Zone C, placing these species at risk of collisions.

Despite the fact that Southern Black Korhaan spent 100% of its time in the safe zones, this species is of concern. Southern Black Korhaan accounted for 2 fatalities during Year 2 of operational bird monitoring.It is considered Vulnerable regionally according to Taylor *et al* (2015), having been up listed from "Near-threatened" in the previous classification (Barnes, 2000). It is also a South African endemic. Allan & Anderson (2012) identified this as the fifth most threatened of ten bustard species in South Africa, and the most threatened korhaan (habitat destruction and disturbance being listed as the primary species threats). According to Hofmeyr (2012) the Southern Black Korhaan has had a dramatic decrease in abundance between 1997 and 2010 in the Overberg/Swartland region (and supported by Shaw, 2013; CAR Project http://car.adu.org.za/newsletters.php; and SABAP1 and SABAP2 comparison – Hofmeyr 2011). This decline is believed to be due to the loss of breeding habitat and the increase in disturbance associated with increased farming practices (Hofmeyr, 2012).

Rock Kestrel, Ludwig's Bustard and Black-shouldered Kite all spent 100% of their recorded flight time in the safe zone (A) yet all three of these species have been recorded as fatalities during Year 2 of operational bird monitoring.

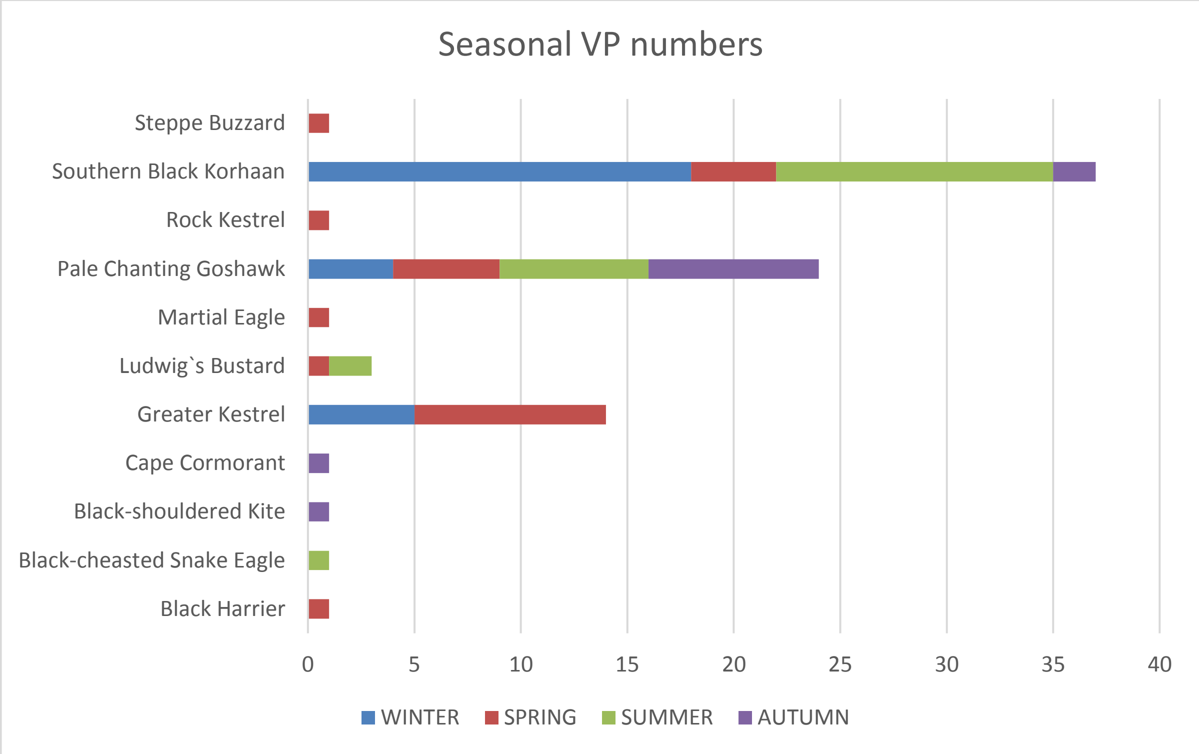



**Figure 6-** Seasonal breakdown of flight records for target bird species at Sere Wind Farm.

The location of these recorded flights is presented in Figure 7. As can be seen on this map, there were not a great deal of recorded flights on the site. These will be further discussed by looking at each individual vantage point (Figure 8).

**Vantage point 1:** The highest risk area is south of VP1. There are no turbines in this area, although Turbine 2 and 3 are in close proximity to this zone. Another small high risk zone is north of Turbine 4 and 5.

**Vantage point 2:** There is a high risk zone to the very north of the VP, close to Turbines 12 and 13. There is another high risk zone to the west of the VP with no turbines in this zone. The last high risk zone occurs between Turbine 22 and 26.

**Vantage point 3:** There is one area of high risk around VP3, and this occurs at Turbine 43 (This is the same area that was a high risk area in Year 1 of operational monitoring).

**Vantage point 4:** The high risk area from VP2 is shown in this VP's map. Besides this area of high risk there are some high risk areas near Turbines 12 and 13.

The relationship between the high risk flight areas and the actual location of the carcasses is discussed below in Section 3.3.

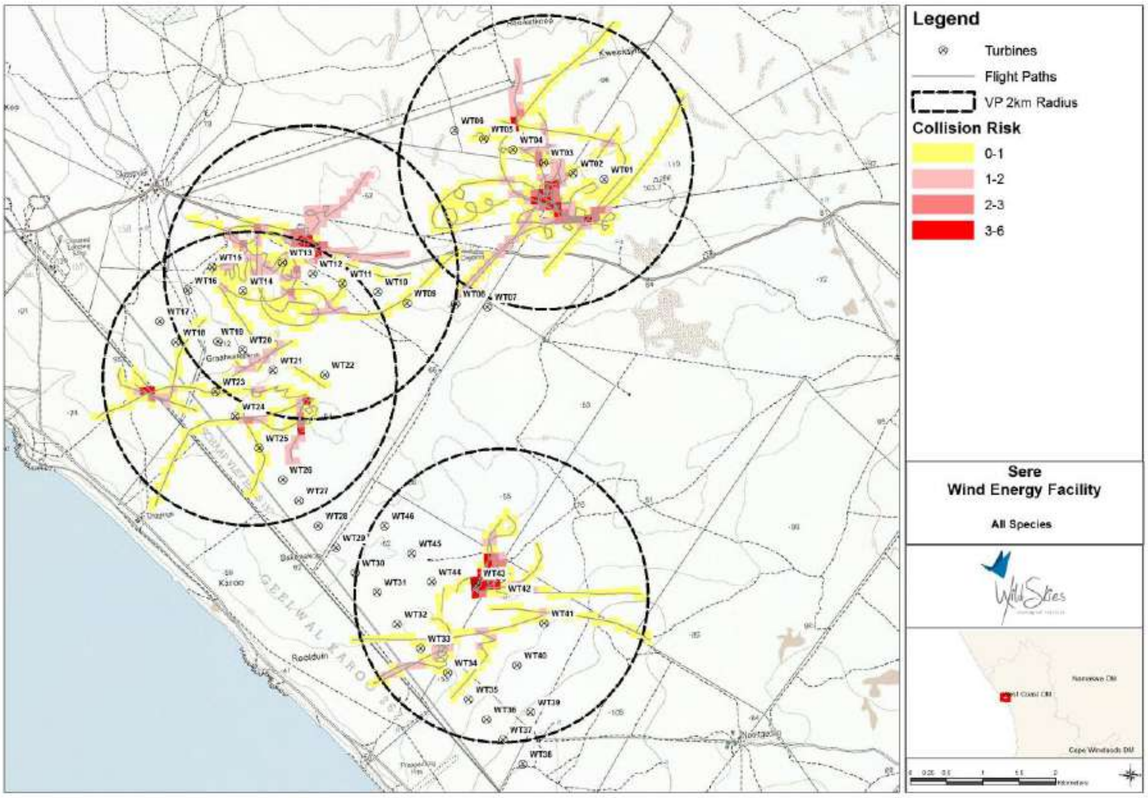
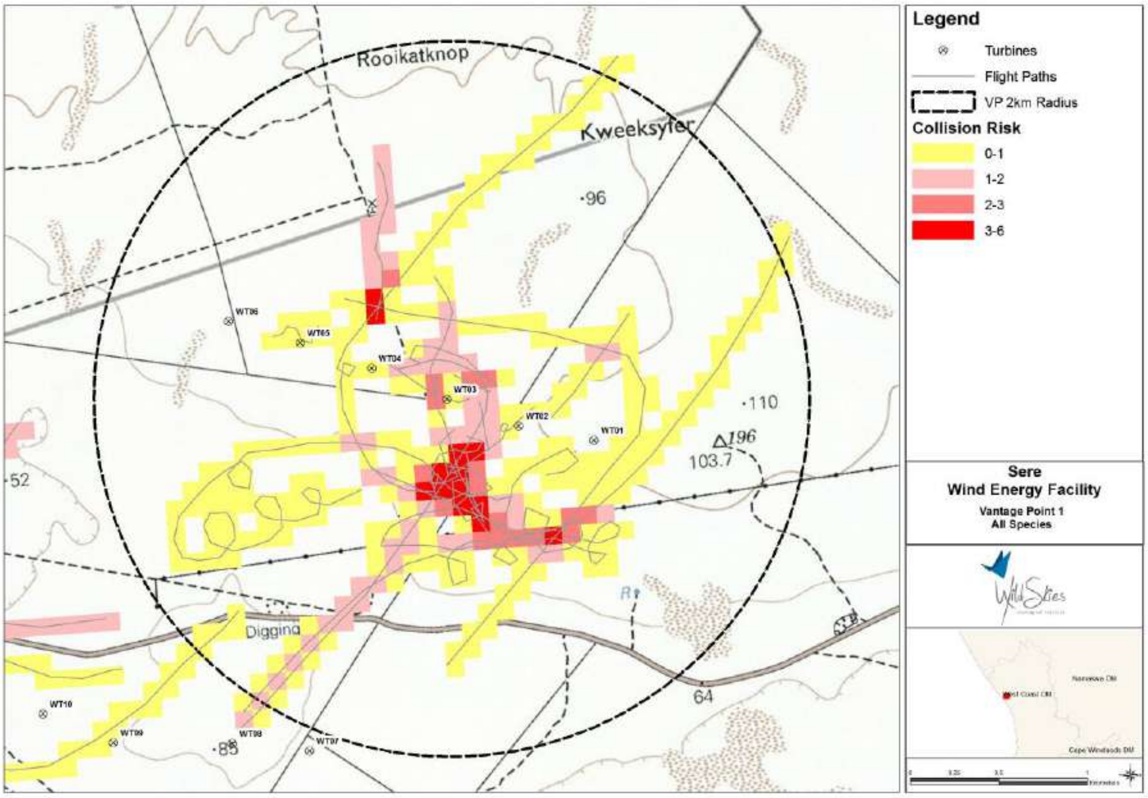
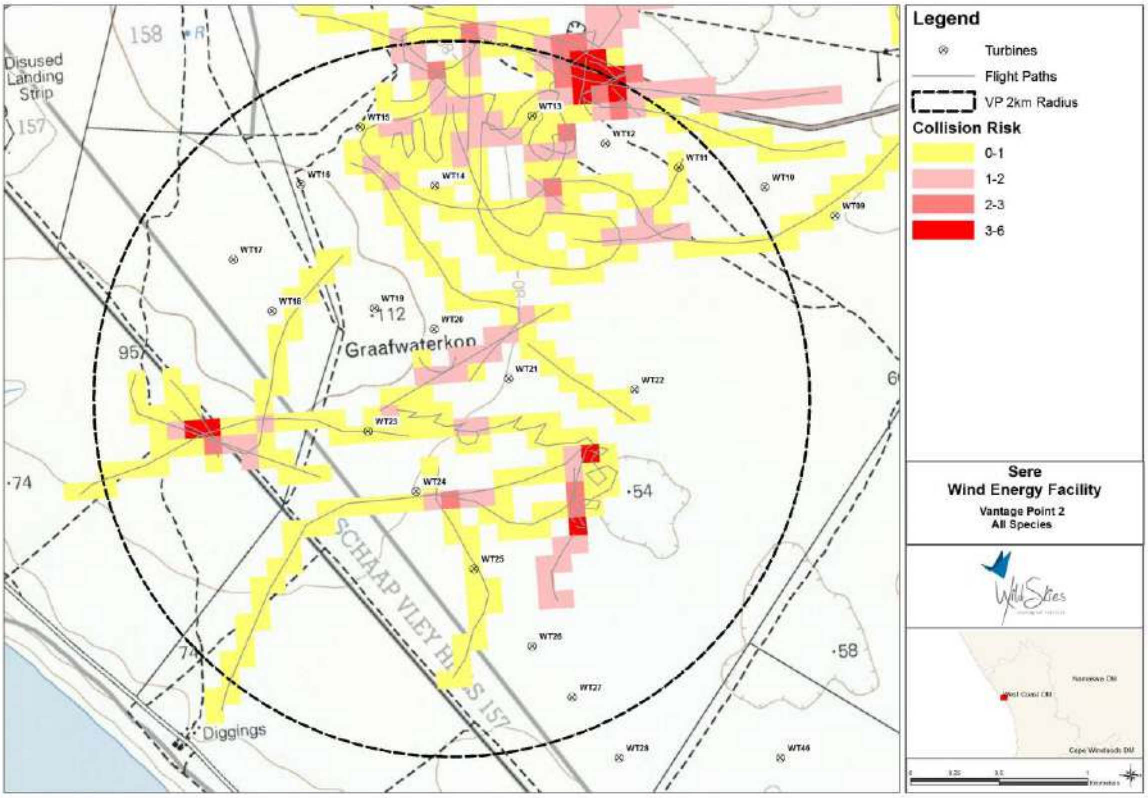
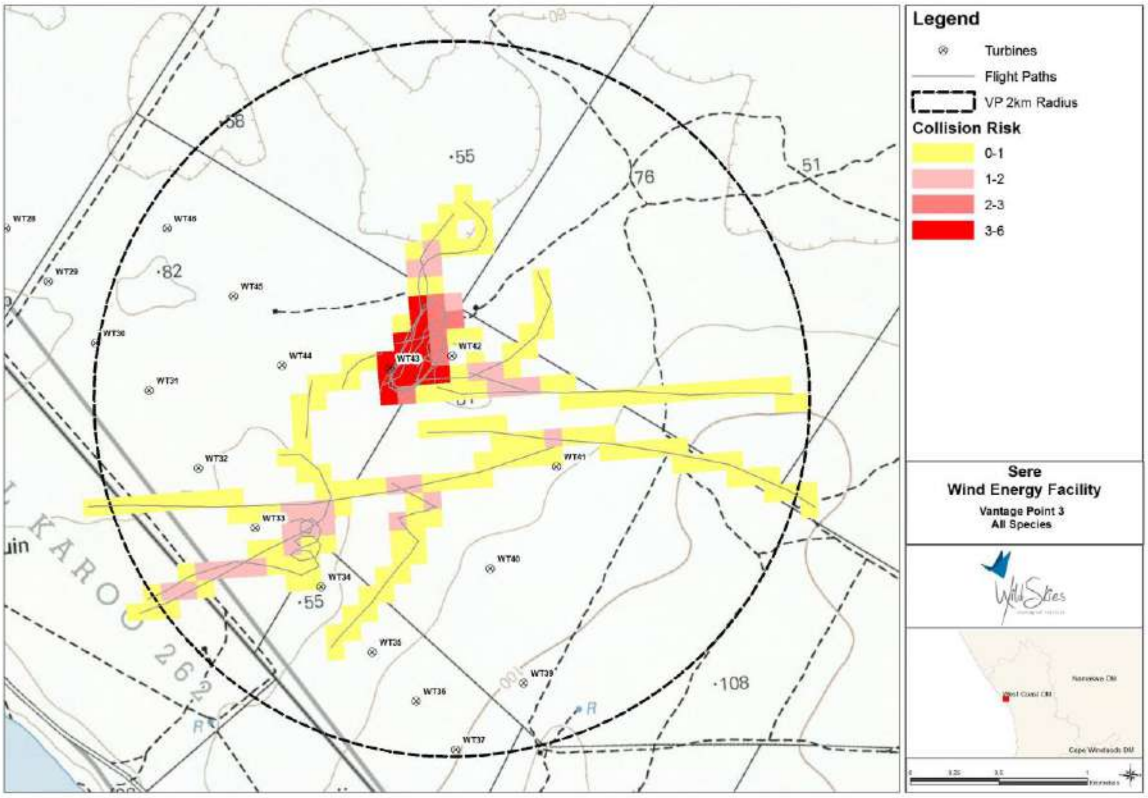



**Figure 7-** All recorded target bird species flight paths from the 4 Vantage Points at Sere Wind Farm.


Legend
Turbines
Flight Paths
VP 2km Radius
Collision Risk
0-1
1-2
2-3
3-6
Sere
Wind Energy Facility
Vantage Point 1
All Species
Rooikatknop
Kweeksyfer
Digging
WT01
WT02
WT03
WT04
WT05
WT06
WT07
WT08
WT09
WT10


Legend
Turbines
Flight Paths
VP 2km Radius
Collision Risk
0-1
1-2
2-3
3-6
Sere
Wind Energy Facility
Vantage Point 2
All Species
Disused
Landing
Strip
Graafwaterkop
Diggings
WT09
WT10
WT11
WT12
WT13
WT14
WT15
WT16
WT17
WT18
WT19
WT20
WT21
WT22
WT23
WT24
WT25
WT26
WT27
WT28
WT46



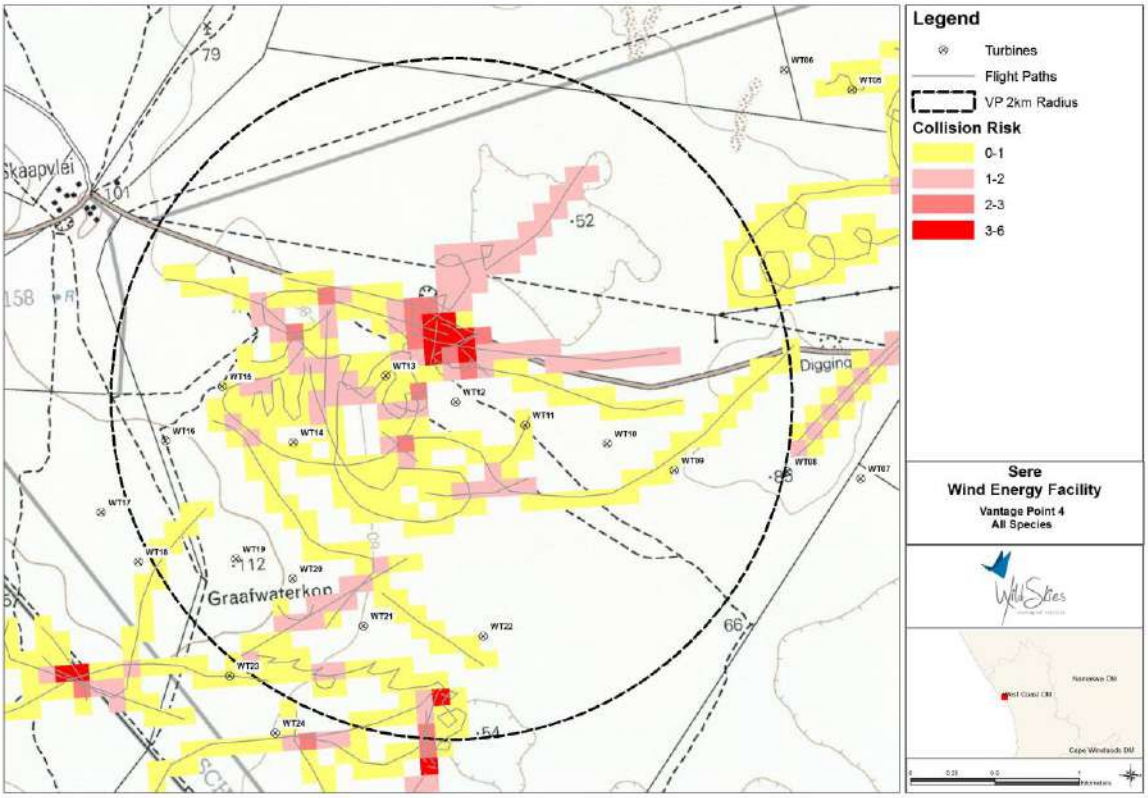




**Figure 8-** Individual vantage points and their associated recorded collision risk.

Pre-construction monitoring (Bioinsight & Savannah,2014) identified the highest risk species to be the Black Harrier, Steppe Buzzard and kestrel species. During the operational phase Year 1 the highest risk species included: Black-chested Snake Eagle (Confirmed fatalities), Pale Chanting Goshawk (Confirmed fatalities), Rock Kestrel (Confirmed fatalities), Secretarybird (Confirmed fatalities), Lanner Falcon and Yellow-billed Kite. During Year 2 of operational monitoring the highest risk species as identified by live bird monitoring included Black-chested Snake Eagle and Steppe Buzzard. However neither of these two species have been recorded as fatalities during Year 2.

The fatality data will be presented and discussed in more detail below.

## 3.3 Bird fatality estimates

The aim of this component of monitoring is to determine: the number and rate of bird fatalities; the species composition; and to identify mitigation measures where necessary.

### *3.3.1 Unadjusted bird fatality data*

In the period 21 May 2016 to 20 May 2017 a total of 19 bird fatalities from at least 11 species were recorded (Appendix 6) by formal regular turbine searching at the 46 turbines. The most common species included: Black-shouldered Kite (3 fatalities), Bokmakierie (3 fatalities) and Southern Black Korhaan (2 fatalities).

Several carcasses were unidentified as they were incomplete and/or heavily scavenged and impossible to identify.

Four of the species for which fatalities were recorded: the Black-chested Snake Eagle, Pale Chanting Goshawk, Ludwig's Bustard and Southern Black Korhaan were recorded flying on site by live bird monitoring (Section 3.2). The remaining species are smaller and/or of lower conservation significance and are therefore not typically recorded by vantage point monitoring, or were not recorded flying on site, such as the crows.

The location of the above recorded bird fatalities on site is presented in Figure 9.

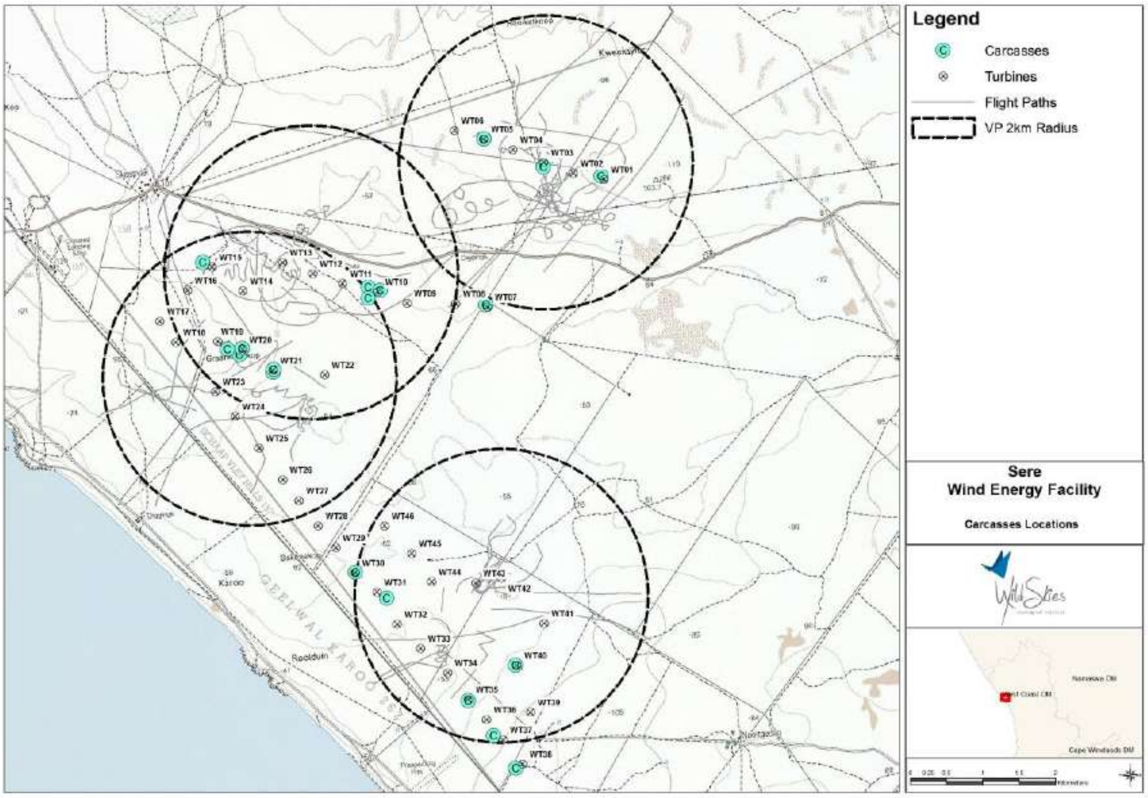



**Figure 9-** Carcass locations from the years carcass searching at Sere Wind Farm.

A summary table was drawn up showing which turbines accounted for the most incidents.

**Table 2-** Summary table of bird mortality incidents (carcasses) per turbine.

| Turbine # | # Fatalities |
|---|---|
| 10 | 3 |
| 20 | 2 |
| 21 | 2 |
| 1 | 1 |
| 3 | 1 |
| 5 | 1 |
| 7 | 1 |
| 15 | 1 |
| 19 | 1 |
| 30 | 1 |
| 31 | 1 |
| 35 | 1 |
| 37 | 1 |
| 38 | 1 |
| 40 | 1 |

As can be seen Turbine 10 accounted for the most fatalities on the site with a total of 3. Turbine 20 and 21 accounted for 2 fatalities while the rest all had single fatalities.

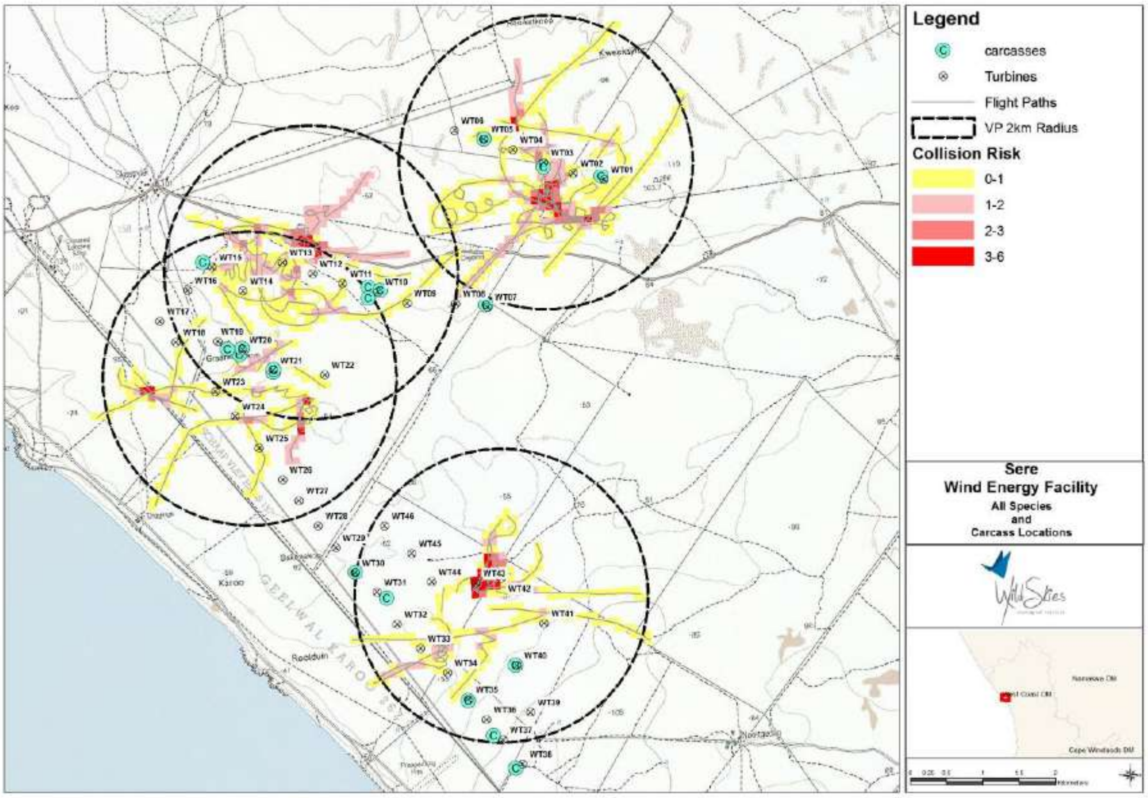



**Figure 10-** Carcass locations and collision risk index from live bird monitoring

The above map (Figure 10) shows the location of all recorded fatalities with the flight risk index produced from the live bird monitoring. The map does not show any carcasses recorded in high risk areas. This can be explained by having very few carcasses as well as very little live bird data. This results in no real patterns for this analysis.

Carcass location proximity (when detected) to turbine base ranged from 0 m to 161m, with a mean of 68.89m (Figure 11). It must be noted that despite the turbine search area being 125m from the turbine base, due to the square search plots and the fact that birds are visible outside of the search plot some values are greater than 125m.

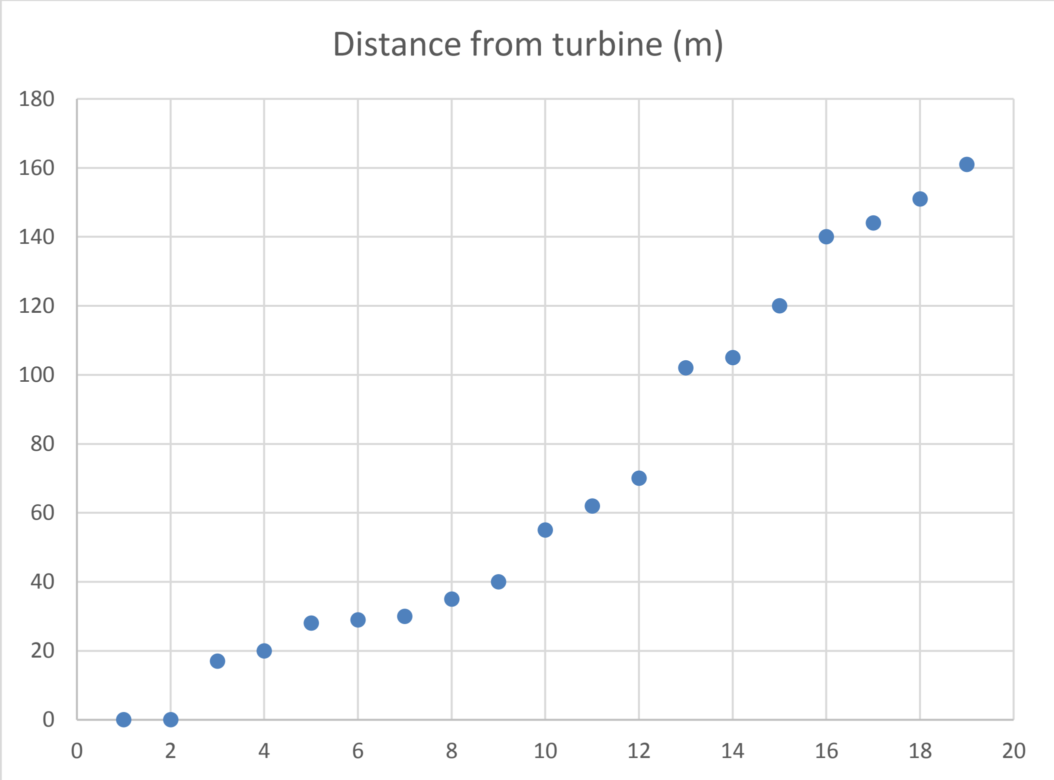



**Figure 11-** Bird carcass proximity to turbine base at Sere Wind Farm.

Figure 12 presents a summary of the bearing from the turbine base to the location of carcasses. The quadrant with the highest number of carcasses found was the north-west quadrant (same as Year 1), followed by north-east. This is probably as a result of the predominant wind direction on site and this finding can be used to plan the Year 3 carcass search effort.

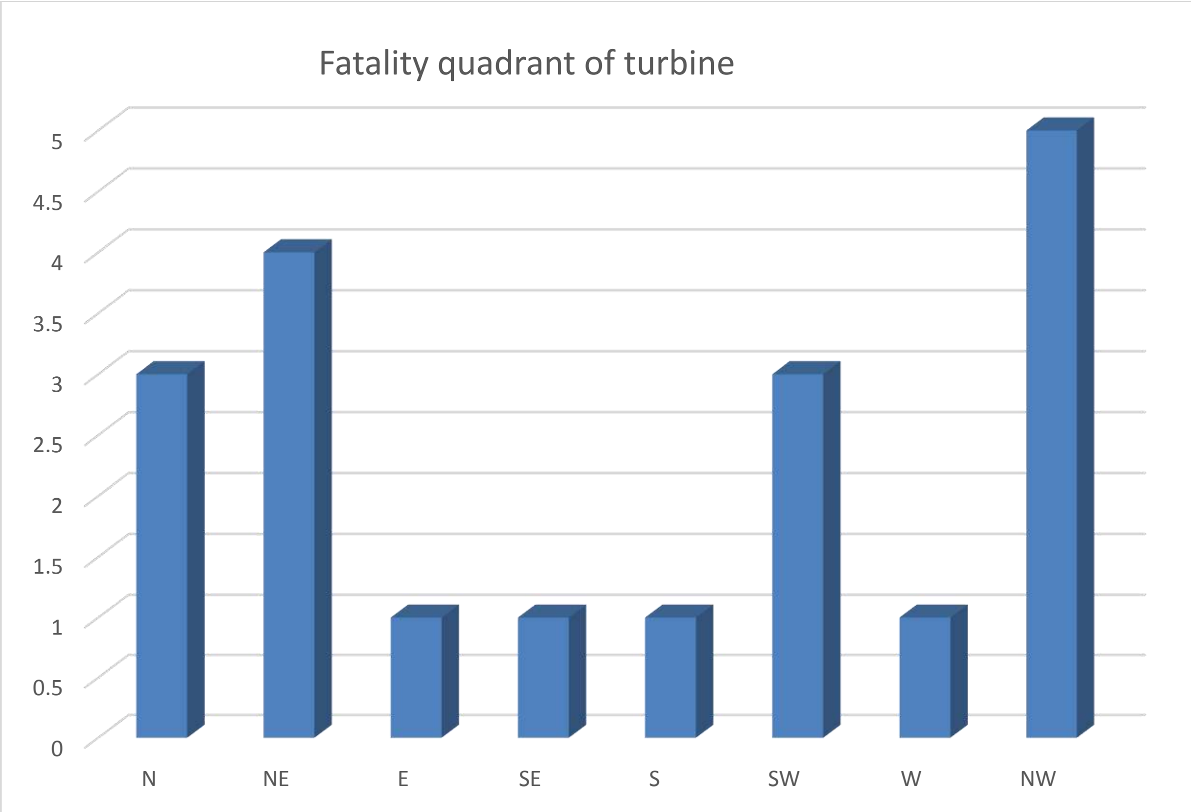



**Figure 12-** Bearing of bird carcass locations from base of turbine at Sere Wind Farm.

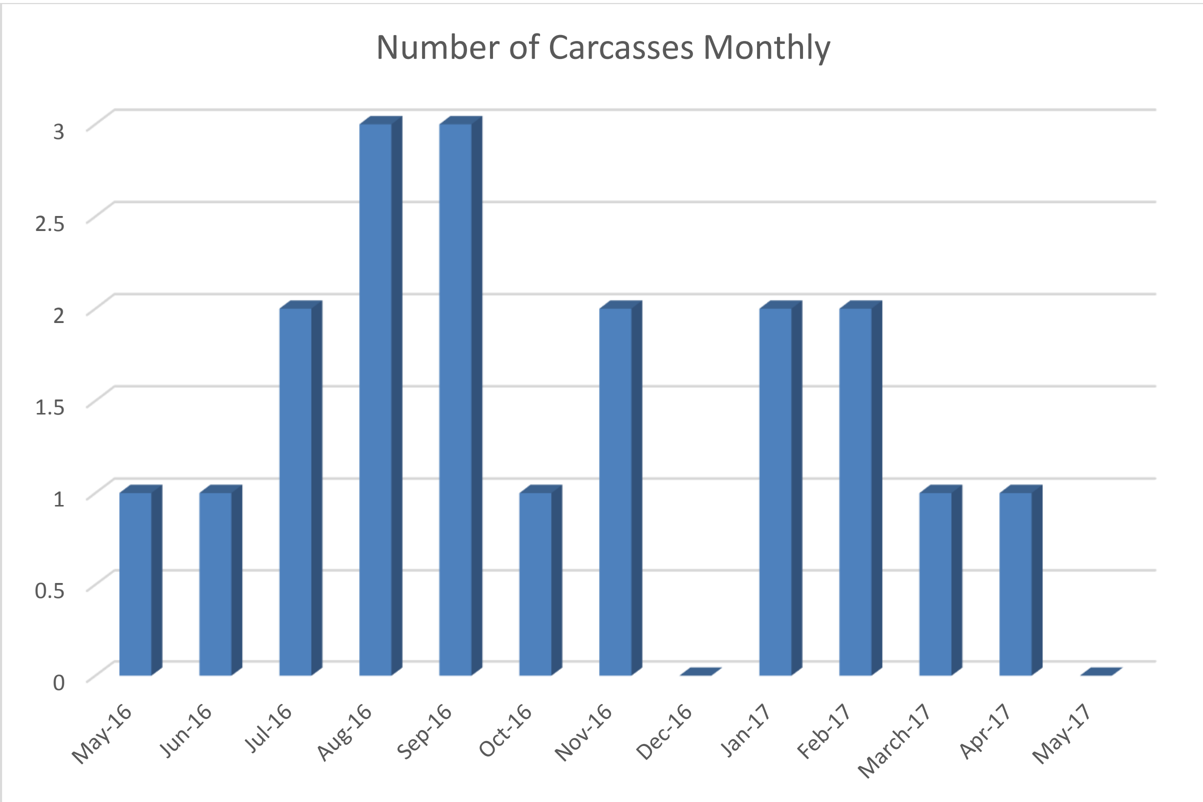



**Figure 13-** Seasonality of bird fatalities at Sere Wind Farm.

The month in which each fatality was recorded is presented in Figure 13. There are peaks in August 2016 and September 2016. The time of year does not seem to show any significant pattern.

The 19 fatalities recorded at the 46 turbines searched regularly results in an unadjusted bird fatality rate of 0.413 birds.turbine.year or 0.19 birds.MW installed capacity.year.

As can be seen in the above data the species most affected by collisions with the turbines is the Black-shouldered Kite, Bokmakierie and Southern Black Korhaan. Of these the Black-shouldered Kite and Bokmakierie are less significant due to their lower conservation status. The Southern Black Korhaan is the most sensitive collision affected species at Sere due to its Vulnerable status and the fact that 2 were recorded as fatalities. In terms of the most sensitive species from a conservation status perspective, this would be the Ludwig's Bustard as it is an Endangered species and has now been recorded as a fatality at Sere, possibly the first fatality of this species in the country. While only 1 fatality was recorded in Year 2 of operational monitoring we know of at least 1 other that has been recorded on site after the end of the Year 2 data collection period. This increases the significance of the results as it would seem that this is not just a once off event.

### *3.3.3 Adjusted bird fatality data*

It is generally recognised in this field that not all birds killed by turbines are found by human searchers. This is due to birds falling outside of the search area, being injured, being removed by scavengers, or being undetected by the carcass search team. In order to adjust our raw data for these factors, we used the Fatality Estimator designed by Huso, Som and Ladd (2012, and updated 2015) to model the number of bird fatalities which may have occurred on site during this monitoring period. There are several other estimators available for use on data such as these (e.g. Erickson *et al* 2000, 2004; Shoenfeld 2004, Kerns *et al* 2005; Jain *et al* 2007; Korner-Nievergelt *et al* 2011; Korner-Niegevelt 2015). However, based on our understanding of estimators (from attending the IWS-USGS-BCI workshop on fatality estimators in July 2016 – facilitated by Manuela Huso, and the pros and cons of each of these, we decided Huso *et al* 2012 (updated in 2015) was the best suited to our data.

This model uses the recorded fatality data, scavenger removal trial data and detection trial data to model the total number of birds killed by the WEF (For a full explanation see Huso *et al* 2012 & Huso 2011).

For the purpose of this analysis we used only data from the 24 turbines searched regularly. Thirteen bird fatalities were found at these turbines. Important parameters used by this model for SWF were as follows: 24 of the 46 turbines were searched regularly. At all of these turbines a square search plot with radius 125m was searched. The best fit distribution for our data was a Lognormal distribution. We ran the model using 5 000 bootstraps. The calculated detection rate from the trials we conducted was: 44% (24 to 64% range – 95% confidence limits). Average carcass persistence calculated from trials was 2.9 days (1.99 to 4.26 range – 95% confidence levels). Taking these factors into account, the model estimated that 259 birds were killed at Sere Wind Farm during the period over which fatalities were detected with a range (95% confidence intervals) of between 139 and 544. This equates to 5.63 birds.turbine.year or 2.59 birds.MW installed capacity.year.

Ralston-Paton, Smallie, Pearson & Ramalho (in prep) reviewed the results from the first 8 wind farms in SA to complete a full year of post construction bird monitoring. The adjusted (for carcass persistence and searcher efficiency) fatality rates ranged from 2.06 to 8.95 birds/turbine/year with a mean of 4.01birds/turbine/year. This is compared to 5.63 birds.turbine.year at SWF, well within the range.

We advocate for cautious use of the outputs of this modelling, as it is subject to several assumptions and biases, discussed elsewhere in this report. In particularthe following factors make these data unreliable: the poor search interval; the fact that so few turbines were regularly searched; the carcass persistence value is lower than the search interval; and the fact that the searcher efficiency was only 44%.

Pre-construction monitoring (Bioinsight & Savannah,2014) identified the highest risk species to be the Black Harrier, Steppe Buzzard and kestrel species. During the operational phase this was accurate when it came to Rock Kestrel but less accurate when we compare all of the fatality data presented above.

# 4. CONCLUSION & RECOMMENDATIONS

The most important findings of this monitoring programme are summarised below:

1. A total of 54 bird species were recorded on site during this programme, 4 of which are Red Listed. Pre-construction bird monitoring recorded 65 bird species.
2. Forty small passerine bird species were recorded. There is a general decrease in abundance in Year 2 of operational monitoring on site as compared with Year 1.
3. Four large terrestrial and raptor species were recorded on site through drive transects, one of which is a Red Listed species (Southern Black Korhaan- Vulnerable). Pre-construction bird monitoring recorded eight species using drive transects. The abundance per km of the species recorded on driven transects has shown a dramatic decrease in Ludwig's Bustard abundance since the facility became operational. Once again, no Ludwig's Bustard were recorded using drive transects on site in Year 2. In addition, one Ludwig's Bustard fatalities did occur in Year 2. In general, there is a decrease in all species abundance in Year 2 of operational phase monitoring compared to Year 1 of operational monitoring.
4. Eleven target bird species were recorded flying on site during this period. The Red List species include: Black Harrier (Endangered), Cape Cormorant (Endangered), Ludwig's Bustard (Endangered), Southern Black Korhaan (Vulnerable) and Martial Eagle (Endangered). Most frequently recorded flying was Southern Black Korhaan (65.23% of all flight activity), Pale Chanting Goshawk (15.63% of all flight activity), and Greater Kestrel (11.05% of all flight activity). Only Steppe Buzzard, Black-chested Snake Eagle and Greater Kestrel spent any of their flight time in the turbine impact zone.
5. In the period 21 May 2016 to 20 May 2017 a total of 19 (c.f.65 in Year 1) bird fatalities from at least 11 species were recorded (Appendix 6) by formal regular turbine searching at the 46 turbines. The most common species killed included: Black-shouldered Kite (3), Bokmakierie (3) and Southern Black Korhaan (2).
6. In terms of sensitive species recorded as fatalities the following Red listed species have been recorded: Southern Black Korhaan (2 recorded- Vulnerable) and Ludwig's Bustard (1 recorded- Endangered).
7. The 19 fatalities recorded at the 46 turbines searched regularly results in an unadjusted bird fatality rate of 0.431 birds.turbine.year or 0.19 birds.MW installed capacity.year. This is a dramatic decrease in fatalities from Year 1 of operational bird monitoring which recorded 1.41 birds.turbine.year.
8. Adjustment of this fatality rate to account for scavenger removal and carcass detection biases, results in an estimated fatality at the facility of 259 birds killed during the period over which fatalities were detected, with a range (95% confidence intervals) of between 139 and 544. This equates to 5.63 birds.turbine.year or 2.59 birds.MW installed capacity.year. However, we have low confidence in this model output for a number of reasons described in this report.

This low confidence has likely resulted in an overestimation of the modelled output and it is thus not a reliable estimation.

We make the following recommendations for the future management of bird interaction at Sere Wind Farm:

1. Conduct an ongoing modified carcass search programme of the wind farm, with a focus on recording the important species such as Ludwig's Bustard and Southern Black Korhaan should these collide with turbines in future. This should be done until year 5 of operation, when a more detailed monitoring program must once again be completed in keeping with the best practice guidelines.
2. Conduct more detailed research into the Ludwig's Bustard population. More time should be spent surveying this species to determine if the species has indeed been displaced by the wind farm. In order to do this a research project should be initiated using a suitable control site.

## 5. ACKNOWLEDGEMENTS

We would like to thank the various field teams for their excellent and tireless work on SWF during this monitoring period. The carcass search team is particularly commended for their high quality work in a challenging environment. We thank Sere Wind Farm for implementing this critically important monitoring programme. Lourens Leeuwner is thanked for his ongoing help and assistance with the project. Matt Pretorius is thanked for help with the identification of the bird carcasses. Megan Murison is thanked for assistance in data cleaning and analysis.

# 6. REFERENCES

Allan. D. & Anderson, M. 2O12. Assessment of the threats faced by South Africa's bustard species. Unpublished BirdLife South Africa report.

Barnes, K.N. (ed.) 2000. The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland. Birdlife South Africa, Johannesburg.

Bioinsight & Savannah (2014). Eskom Sere wind energy facility – Bird monitoring. Construction phase. Final report October 2013 – September 2014.

Hofmeyr, S.D. 2011. Large terrestrial birds of the fynbos: how have they responded to land-use change? Oral presentation, Fynbos Forum, Stilbaai, June 2011

Hofmeyer, S. 2012. Impacts of environmental change on large terrestrial bird species in South Africa: insights from citizen science data. Department of Zoology, University of Cape Town.

Hull, C. & Muir, S. 2010. Search areas for monitoring bird and bat carcasses at wind farms using a Monte-Carlo model. Australian Journal of Environmental Management, v. 17, p. 77–87.

Huso, M.M.P., 2011, An estimator of wildlife fatality from observed carcasses: Environmetrics, v. 22, p. 318–329.

Huso, M., Som, N., & Ladd, L. 2012. Fatality estimator users guide: US Geological Survey Data Series 729.

Huso, M. & Dalthorp, D. 2013. Accounting for Unsearched Areas in Estimating Wind Turbine-Caused Fatality. The Journal of Wildlife Management; DOI: 10.1002/jwmg.663. p1-12.

Jenkins, A.R., Van Rooyen, C.S, Smallie, J., Harrison, J.A., Diamond, M., Smit-Robbinson, HA, and Ralston, S. 2015. Best practice guidelines for assessing and monitoring the impact of wind energy facilities on birds in southern Africa" Unpublished guidelines.

Mucina, L; Rutherford, C. 2006. The Vegetation of South Africa, Lesotho and Swaziland, South African National Biodiversity Institute, Pretoria.

Shaw, J.M. 2013. Power line collisions in the Karoo: Conserving Ludwig's Bustard. PhD thesis, University of Cape Town.

Smallwood, K.S. 2007. Estimating wind turbine-caused bird mortality.

Strugnell, 2016, Sere Wind Farm, Western Cape, Opperational Bird Monitoring program, Year 1 Final Report.

Taylor, M. R, Peacock, F., & Wanless, R. 2015. The 2015 Eskom Red Data Book of Birds of South Africa, Lesotho & Swaziland.

## APPENDIX 1. SMALL PASSERINE BIRD SPECIES DATA RECORDED ON SERE WIND FARM.

| Common name | Endemism | Full year | | | Autumn | | | Winter | | | Spring | | | Summer | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **# Species** | | 40 | | | 30 | | | 30 | | | 29 | | | 31 | | |
| **Transect length** | | 66 | | | 16.5 | | | 16.5 | | | 16.5 | | | 16.5 | | |
| **Common name** | | # birds | # records | birds/km | # birds | # records | birds/km | # birds | # records | birds/km | # birds | # records | birds/km | # birds | # records | birds/km |
| Karoo Prinia | E | 285 | 239 | 4.318 | 66 | 54 | 4.000 | 90 | 78 | 5.455 | 89 | 67 | 5.394 | 40 | 40 | 2.424 |
| Southern Double-collared Sunbird | E | 252 | 213 | 3.818 | 6 | 6 | 0.364 | 105 | 88 | 6.364 | 132 | 110 | 8.000 | 9 | 9 | 0.545 |
| Karoo Scrub-robin | E | 240 | 132 | 3.636 | 48 | 30 | 2.909 | 66 | 33 | 4.000 | 63 | 30 | 3.818 | 63 | 39 | 3.818 |
| Karoo Lark | E | 218 | 212 | 3.303 | 36 | 36 | 2.182 | 70 | 70 | 4.242 | 69 | 64 | 4.182 | 43 | 42 | 2.606 |
| Yellow Canary | NE | 164 | 78 | 2.485 | 48 | 21 | 2.909 | 46 | 24 | 2.788 | 51 | 22 | 3.091 | 19 | 11 | 1.152 |
| Bokmakierie | NE | 115 | 63 | 1.742 | 31 | 17 | 1.879 | 26 | 15 | 1.576 | 27 | 14 | 1.636 | 31 | 17 | 1.879 |
| Cape Penduline-tit | NE | 113 | 41 | 1.712 | 30 | 11 | 1.818 | 18 | 7 | 1.091 | 29 | 8 | 1.758 | 36 | 15 | 2.182 |
| Grey-backed Cisticola | NE | 112 | 106 | 1.697 | 23 | 20 | 1.394 | 39 | 38 | 2.364 | 39 | 37 | 2.364 | 11 | 11 | 0.667 |
| Cape Sparrow | NE | 102 | 42 | 1.545 | 27 | 10 | 1.636 | 39 | 16 | 2.364 | 15 | 6 | 0.909 | 21 | 10 | 1.273 |
| Layard's Tit-babbler | E | 95 | 85 | 1.439 | 0 | 0 | 0.000 | 53 | 50 | 3.212 | 42 | 35 | 2.545 | 0 | 0 | 0.000 |
| Cape Long-billed Lark | E | 79 | 77 | 1.197 | 16 | 16 | 0.970 | 26 | 25 | 1.576 | 19 | 18 | 1.152 | 18 | 18 | 1.091 |
| Cape Clapper Lark | E | 68 | 66 | 1.030 | 19 | 17 | 1.152 | 20 | 20 | 1.212 | 25 | 25 | 1.515 | 4 | 4 | 0.242 |
| Rufous-eared Warbler | E | 51 | 50 | 0.773 | 8 | 7 | 0.485 | 17 | 17 | 1.030 | 11 | 11 | 0.667 | 15 | 15 | 0.909 |
| Cape Bunting | | 45 | 39 | 0.682 | 14 | 13 | 0.848 | 11 | 10 | 0.667 | 13 | 9 | 0.788 | 7 | 7 | 0.424 |
| Large-billed Lark | E | 37 | 37 | 0.561 | 6 | 6 | 0.364 | 16 | 16 | 0.970 | 5 | 5 | 0.303 | 8 | 8 | 0.485 |
| Pied Starling | E | 37 | 4 | 0.561 | 21 | 1 | 1.273 | 8 | 1 | 0.485 | 4 | 1 | 0.242 | 4 | 1 | 0.242 |
| Cape Bulbul | E | 31 | 21 | 0.470 | 8 | 6 | 0.485 | 4 | 3 | 0.242 | 10 | 7 | 0.606 | 9 | 5 | 0.545 |
| White-throated Canary | NE | 25 | 13 | 0.379 | 3 | 3 | 0.182 | 18 | 7 | 1.091 | 1 | 1 | 0.061 | 3 | 2 | 0.182 |
| Chat Flycatcher | NE | 17 | 16 | 0.258 | 4 | 4 | 0.242 | 4 | 3 | 0.242 | 1 | 1 | 0.061 | 8 | 8 | 0.485 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bar-throated apalis | | 15 | 15 | 0.227 | 3 | 3 | 0.182 | 6 | 6 | 0.364 | 5 | 5 | 0.303 | 1 | 1 | 0.061 |
| Long-billed Crombec | | 14 | 14 | 0.212 | 3 | 3 | 0.182 | 7 | 7 | 0.424 | 0 | 0 | 0.000 | 4 | 4 | 0.242 |
| Spike-heeled lark | NE | 12 | 5 | 0.182 | 4 | 1 | 0.242 | 0 | 0 | 0.000 | 0 | 0 | 0.000 | 8 | 4 | 0.485 |
| Grey tit | E | 11 | 10 | 0.167 | 2 | 2 | 0.121 | 4 | 3 | 0.242 | 1 | 1 | 0.061 | 4 | 4 | 0.242 |
| Neddicky | | 11 | 9 | 0.167 | 1 | 1 | 0.061 | 5 | 4 | 0.303 | 5 | 4 | 0.303 | 0 | 0 | 0.000 |
| Malachite Sunbird | | 8 | 7 | 0.121 | 1 | 1 | 0.061 | 1 | 1 | 0.061 | 6 | 5 | 0.364 | 0 | 0 | 0.000 |
| Familiar Chat | | 7 | 6 | 0.106 | 1 | 1 | 0.061 | 1 | 1 | 0.061 | 0 | 0 | 0.000 | 5 | 4 | 0.303 |
| Yellow-bellied Eromomela | | 7 | 7 | 0.106 | 1 | 1 | 0.061 | 2 | 2 | 0.121 | 2 | 2 | 0.121 | 2 | 2 | 0.121 |
| Ant-eating Chat | | 4 | 4 | 0.061 | 1 | 1 | 0.061 | 1 | 1 | 0.061 | 0 | 0 | 0.000 | 2 | 2 | 0.121 |
| Black-headed canary | E | 4 | 2 | 0.061 | 3 | 1 | 0.182 | 0 | 0 | 0.000 | 0 | 0 | 0.000 | 1 | 1 | 0.061 |
| Karoo Thrush | E | 4 | 4 | 0.061 | 0 | 0 | 0.000 | 3 | 3 | 0.182 | 1 | 1 | 0.061 | 0 | 0 | 0.000 |
| Sickle-winged Chat | E | 4 | 4 | 0.061 | 1 | 1 | 0.061 | 1 | 1 | 0.061 | 1 | 1 | 0.061 | 1 | 1 | 0.061 |
| White-backed Mousbird | E | 4 | 1 | 0.061 | 0 | 0 | 0.000 | 0 | 0 | 0.000 | 4 | 1 | 0.242 | 0 | 0 | 0.000 |
| African Stone Chat | | 2 | 1 | 0.030 | 0 | 0 | 0.000 | 0 | 0 | 0.000 | 0 | 0 | 0.000 | 2 | 1 | 0.121 |
| Cape Wagtail | | 1 | 1 | 0.015 | 0 | 0 | 0.000 | 0 | 0 | 0.000 | 1 | 1 | 0.061 | 0 | 0 | 0.000 |
| Capped Wheatear | | 1 | 1 | 0.015 | 0 | 0 | 0.000 | 0 | 0 | 0.000 | 0 | 0 | 0.000 | 1 | 1 | 0.061 |
| Common Fiscal | | 1 | 1 | 0.015 | 0 | 0 | 0.000 | 0 | 0 | 0.000 | 0 | 0 | 0.000 | 1 | 1 | 0.061 |
| Fairy Flycatcher | E | 1 | 1 | 0.015 | 0 | 0 | 0.000 | 1 | 1 | 0.061 | 0 | 0 | 0.000 | 0 | 0 | 0.000 |
| Fiery-necked Nightjar | | 1 | | 0.015 | 0 | 0 | 0.000 | 0 | 0 | 0.000 | 1 | 1 | 0.061 | 0 | 0 | 0.000 |
| Fiscal shrike | | 1 | 1 | 0.015 | 1 | 1 | 0.061 | 0 | 0 | 0.000 | 0 | 0 | 0.000 | 0 | 0 | 0.000 |
| Rufous-cheeked nightjar | | 1 | 1 | 0.015 | 0 | 0 | 0.000 | 0 | 0 | 0.000 | 0 | 0 | 0.000 | 1 | 1 | 0.061 |

## APPENDIX 2. LARGE TERRESTRIAL & RAPTOR DATA RECORDED ON SERE WIND FARM.

| | | | Full year | | | Winter | | | Spring | | | Summer | | | Autumn | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Length of transect | | 144.6 | | | 36.9 | | | 36.1 | | | 35.6 | | | 36 | | |
| | Number of species | | 4 | | | 1 | | | 1 | | | 2 | | | 2 | | |
| Common name | Conservation Status | Endemism | # birds | # records | birds/km | # birds | # records | birds/km | # birds | # records | birds/km | # birds | # records | birds/km | # birds | # records | birds/km |
| Southern Black Korhaan | VU | Endemic | 9 | 7 | 0.062 | 1 | 1 | 0.027 | | | 0.000 | 1 | 1 | 0.028 | 7 | 5 | 0.194 |
| Black-headed Heron | | | 2 | 2 | 0.014 | | | 0.000 | 2 | 2 | 0.055 | | | 0.000 | | | 0.000 |
| Black-shouldered Kite | | | 1 | 1 | 0.007 | | | 0.000 | | | 0.000 | | | 0.000 | 1 | 1 | 0.028 |
| Pale Chanting Goshawk | | Near-endemic | 1 | 1 | 0.007 | | | 0.000 | | | 0.000 | 1 | 1 | 0.028 | | | 0.000 |

## APPENDIX 3. INCIDENTAL RECORDS OF TARGET BIRD SPECIES ON SERE WIND FARM.

| **Common name** | **Conservation status** | **Endemism** | **Full year** | | **Autumn** | | **Winter** | | **Spring** | | **Summer** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | # Species | 8 | | 4 | | 4 | | 4 | | 4 | |
| **Common name** | | | # birds | # records | # birds | # records | # birds | # records | # birds | # records | # birds | # records |
| Southern Black Korhaan | VU | Endemic | 28 | 21 | 8 | 7 | 4 | 4 | 2 | 1 | 14 | 9 |
| Pale Chanting Goshawk | | Near-endemic | 8 | 7 | 2 | 2 | 2 | 2 | 1 | 1 | 3 | 2 |
| Black-headed Heron | | | 4 | 4 | | | 1 | 1 | 1 | 1 | 2 | 2 |
| Common Buzzard | | | 2 | 1 | | | | | | | 2 | 1 |
| Ludwigs Bustard | EN | Near-endemic | 2 | 2 | 2 | 2 | | | | | | |
| Black-shouldered kite | | | 1 | 1 | 1 | 1 | | | | | | |
| Greater Kestrel | | | 1 | 1 | | | | | 1 | 1 | | |
| Kori Bustard | NT | | 1 | 1 | | | 1 | 1 | | | | |

## APPENDIX 4. SEASONAL BIRD SPECIES LISTS FOR SERE WIND FARM.

'1' denotes presence, not abundance.

| Species name | Red data | Endemism | Winter | Spring | Summer | Autumn |
|---|---|---|---|---|---|---|
| **Total** | | | **37** | **45** | **36** | **37** |
| African Stonechat | | | | | 1 | |
| Ant-eating Chat | | E | 1 | 1 | 1 | 1 |
| Bar-throated Apalis | | | 1 | 1 | 1 | 1 |
| Black Harrier | EN | E | | 1 | | |
| Black-headed Canary | | E | | 1 | 1 | 1 |
| Black-headed Heron | | | 1 | 1 | 1 | |
| Black-shouldered Kite | | | | | | 1 |
| Bokmakierie | | NE | 1 | 1 | 1 | 1 |
| Cape Bulbul | | E | 1 | 1 | 1 | 1 |
| Cape Bunting | | | | | 1 | 1 |
| Cape Canary | | NE | | 1 | | |
| Cape Clapper Lark | | E | 1 | 1 | 1 | 1 |
| Cape Long-billed Lark | | E | 1 | 1 | 1 | 1 |
| Cape Penduline Tit | | NE | 1 | 1 | 1 | 1 |
| Cape Sparrow | | NE | 1 | 1 | 1 | 1 |
| Cape Wagtail | | | | 1 | | 1 |
| Capped Wheatear | | | 1 | 1 | 1 | 1 |
| Chat Flycatcher | | NE | 1 | 1 | 1 | 1 |
| European Bee-eater | | | | 1 | | |
| Fairy Flycatcher | | E | 1 | | | |
| Familiar Chat | | | 1 | | 1 | 1 |
| Fiery-necked Nightjar | | | | 1 | | |
| Fiscal Shrike | | | | 1 | 1 | 1 |
| Greater Kestrel | | | 1 | 1 | 1 | |
| Grey Tit | | E | 1 | 1 | 1 | 1 |
| Grey-backed Cisticola | | NE | 1 | 1 | | 1 |
| Grey-backed Sparrow-lark | | NE | 1 | 1 | | 1 |
| Karoo Lark | | E | 1 | 1 | 1 | 1 |
| Karoo Prinia | | E | 1 | 1 | 1 | 1 |
| Karoo Scrub-robin | | E | 1 | 1 | 1 | 1 |
| Karoo Thrush | | E | 1 | | | |
| Kori Bustard | | | 1 | | | |
| Large-billed Lark | | E | 1 | 1 | 1 | 1 |
| Lark-like Bunting | | NE | | 1 | | |
| Layard's Tit-babbler | | E | 1 | 1 | | |
| Long-billed Crombec | | | 1 | | 1 | 1 |
| Ludwig's Bustard | EN | NE | | 1 | 1 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Malachite Sunbird | | | 1 | 1 | | 1 |
| Martial Eagle | EN | | | 1 | | |
| Neddicky | | | 1 | 1 | | 1 |
| Pale Chanting Goshawk | | NE | 1 | 1 | 1 | 1 |
| Pied Starling | | E | 1 | 1 | 1 | 1 |
| Rock Kestrel | | | | 1 | | |
| Rufous-cheeked Nightjar | | | | | 1 | |
| Rufous-eared Warbler | | E | 1 | 1 | 1 | 1 |
| Sickle-winged Chat | | E | 1 | 1 | 1 | 1 |
| Southern Black Korhaan | VU | E | 1 | 1 | 1 | 1 |
| Southern Double-collared Sunbird | | E | 1 | 1 | 1 | 1 |
| Spike-heeled Lark | | NE | 1 | 1 | 1 | 1 |
| Steppe Buzzard | | | | 1 | 1 | |
| White-backed Mousebird | | E | | 1 | | |
| White-throated Canary | | NE | 1 | 1 | 1 | 1 |
| Yellow Canary | | NE | 1 | 1 | 1 | 1 |
| Yellow-bellied Eromomela | | | 1 | 1 | 1 | 1 |

## APPENDIX 5. BIRD FATALITIES RECORDED AT SERE WIND FARM

| Date | Turbine number | Distance to wind turbine (m) | Wind turbine quadrant | Species |
|---|---|---|---|---|
| 2016/05/26 | WT20 | 70 | SW | Southern Black Korhaan |
| 2016/06/13 | WT03 | 62 | S | Un-identified Feathers |
| 2016/07/13 | WT37 | 140 | NW | Karoo Scrub Robin |
| 2016/07/20 | WT40 | 28 | NW | Un-identified Feathers |
| 2016/08/16 | WT30 | 0 | N | Bokmakierie |
| 2016/08/22 | WT05 | 0 | NW | Common Fiscal |
| 2016/08/24 | WT21 | 29 | N | Pale chanting Goshawk |
| 2016/09/06 | WT7 | 35 | NW | Rock Kestrel |
| 2016/09/12 | WT31 | 151 | SE | Bokmakierie |
| 2016/09/13 | WT38 | 105 | SW | Turtle Dove |
| 2016/10/27 | WT20 | 17 | NE | Un-identified Feathers |
| 2016/11/10 | WT35 | 20 | SW | Kestrel spp |
| 2016/11/17 | WT21 | 40 | NE | Bokmakierie |
| 2017/01/18 | WT10 | 161 | W | Black-shoudered Kite |
| 2017/01/18 | WT10 | 120 | N | Southern Black Korhaan |
| 2017/02/13 | WT1 | 55 | NE | Black-shoudered Kite |
| 2017/02/28 | WT15 | 144 | NW | Black-shoudered Kite |
| 2017/03/10 | WT19 | 102 | E | Ludwig's Bustard |
| 2017/04/25 | WT10 | 30 | NE | Cape Sparrow |

# APPENDIX D

# SPECIALISTS' REPORTS

## APPENDIX D3 - Desktop Paleontological Assessment

BANZAI ENVIRONMENTAL

# PALAEONTOLOGICAL DESKTOP ASSESSMENT

## 10738 – SERE SOLAR PHOTOVOLTIAC PLANT PHASE 1A AND ASSOCIATED INFRASTRUCTURE

WESTERN CAPE PROVINCE

2022

COMPILED FOR

NEMAI CONSULTING

Declaration of Independence

I, Elize Butler, declare that –

General declaration:

- I act as the independent palaeontological specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favorable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work.
- I have expertise in conducting palaeontological impact assessments, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity.
- I will comply with the Act, Regulations, and all other applicable legislation.
- I will take into account, to the extent possible, the matters listed in section 38 of the NHRA when preparing the application and any report relating to the application.
- I have no, and will not engage in, conflicting interests in the undertaking of the activity.
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan, or document to be prepared by myself for submission to the competent authority.
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application.
- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favorable to the applicant or not
- All the particulars furnished by me in this form are true and correct.
- I will perform all other obligations as expected a palaeontological specialist in terms of the Act and the constitutions of my affiliated professional bodies; and
- I realize that a false declaration is an offense in terms of regulation 71 of the Regulations and is punishable in terms of section 24F of the NEMA.

Disclosure of Vested Interest

I do not have and will not have any vested interest (either business, financial, personal, or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Regulations.

| | |
|---|---|
| PALAEONTOLOGICAL CONSULTANT: | Banzai Environmental (Pty) Ltd |
| CONTACT PERSON: | Elize Butler |
| | Tel: +27 844478759 |
| | Email: info@banzai-group.com |

SIGNATURE: Butler.

This Palaeontological Impact Assessment report has been compiled considering the National Environmental Management Act 1998 (NEMA) and Environmental Impact Regulations 2014 as amended, requirements for specialist reports, Appendix 6, as indicated in the table below.

*Table 1 - NEMA Table*

| Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017 | Relevant section in report | Comment where not applicable. |
|---|---|---|
| 1.(1) (a) (i) Details of the specialist who prepared the report | Page ii and Section 2 of Report – Contact details and company and Appendix A | - |
| (ii) The expertise of that person to compile a specialist report including a curriculum vitae | Section 2 – refer to Appendix A | - |
| (b) A declaration that the person is independent in a form as may be specified by the competent authority | Page ii of the report | - |
| (c) An indication of the scope of, and the purpose for which, the report was prepared | Section 4 – Objective | - |
| (cA) An indication of the quality and age of base data used for the specialist report | Section 5 – Geological and Palaeontological history | - |
| (cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change; | Section 8 | - |
| (d) The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment | Desktop Assessment | |
| (e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used | Section 6 Approach and Methodology | - |
| (f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated | Section 1 and 9 | |

| Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017 | Relevant section in report | Comment where not applicable. |
|---|---|---|
| structures and infrastructure, inclusive of a site plan identifying site alternatives; | | |
| (g) An identification of any areas to be avoided, including buffers | Section 5<br>No buffers or areas of sensitivity identified | |
| (h) A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers; | Section 5 – Geological and Palaeontological history | |
| (i) A description of any assumptions made and any uncertainties or gaps in knowledge; | Section 6.1 – Assumptions and Limitation | - |
| (j) A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment | Section 1 and 9 | |
| (k) Any mitigation measures for inclusion in the EMPr | Section 1 | |
| (l) Any conditions for inclusion in the environmental authorisation | Section 10 | Desktop Study |
| (m) Any monitoring requirements for inclusion in the EMPr or environmental authorisation | Section 10 | Desktop Study |
| (n)(i) A reasoned opinion as to whether the proposed activity, activities or portions thereof should be authorised and | Section 1 and 10 | |
| (n)(iA) A reasoned opinion regarding the acceptability of the proposed activity or activities; and | | |
| (n)(ii) If the opinion is that the proposed activity, activities or portions | Section 1 and 10 | - |

| Requirements of Appendix 6 – GN R326 EIA Regulations of 7 April 2017 | Relevant section in report | Comment where not applicable. |
|---|---|---|
| thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan | | |
| (o) A description of any consultation process that was undertaken during the course of carrying out the study | N/A | Not applicable. A public consultation process will be conducted as part of the EIA and EMPr process. |
| (p) A summary and copies if any comments that were received during any consultation process | N/A | |
| (q) Any other information requested by the competent authority. | N/A | . |
| (2) Where a government notice by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply. | Section 3 compliance with SAHRA guidelines | |

## EXECUTIVE SUMMARY

Banzai Environmental was appointed by Nemai Consulting (Pty) Ltd to conduct the Palaeontological Desktop Assessment to assess the proposed SERE Solar Photovoltaic Plant Phase 1A and associated infrastructure in the Western Cape Province. To comply with the National Heritage Resources Act (No 25 of 1999, section 38) (NHRA), this PIA is necessary to verify if fossil material could potentially be present in the planned development and the impact thereof on fossils Heritage.

The proposed Sere PV Plant is underlain by the Cenozoic deposits of the West Coast Group that mantles the bedrock of the Gariep Supergroup. According to the PalaeoMap of the South African Heritage Resources Information System (SAHRIS) database the Palaeontological Sensitivity of the West Coast Group is Very High (Almond and Pether 2008, SAHRIS website).

Two Layout alternatives for the proposed Sere Photovoltaic Plant have been proposed. All alternatives are underlain by the West Coast Group. The geology of the proposed site alternatives is the same and thus no preferences on the grounds of palaeontological fossil heritage, for any specific alternative layout under consideration was identified. The PalaeoMap on the South African Heritage Resources Information System (SAHRIS) database indicates that the Palaeontological Sensitivity of the West Coast Group is Very High (Almond and Pether 2008, SAHRIS website). However, the geotechnical report conducted for the Sere Wind Energy Farm (BKS Palace Consortium, 2010) found that bedrock occurs between 14 m and at a depth greater than 102m. The depth of the sand in the development area is 0-22m, while the approximate excavation depths for the Sere PV project are 1.5m. It is thus anticipated that excavations will not extend into the underlying bedrock of the PV project.

It is therefore considered that the proposed development will not lead to detrimental impacts on the palaeontological resources of the area. The construction and operation of the project may be authorised, as the whole extent of the development footprint is not considered sensitive in terms of palaeontological heritage.

However, if any fossil remains or trace fossils are discovered during any phase of construction or operation, either on the surface or exposed by excavations, a Chance Find Protocol must be implemented by the ECO in charge of this development. These discoveries should be protected (if possible, *in situ*) and the ECO must report such discovery to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). Suitable mitigation (*e.g.* recording and collection) will consequently be undertaken by a palaeontologist.

Preceding any collection of fossil material, the palaeontologist would need to apply for a collection permit from SAHRA. Fossil material must be curated in an accredited collection (museum or university collection), while all fieldwork and reports should meet the minimum standards for palaeontological impact studies required by SAHRA.

These recommendations should be incorporated into the EMPr for the development.

It is consequently recommended that no further palaeontological heritage studies, ground truthing and/or specialist mitigation are required pending the discovery of newly discovered fossils.

.

TABLE OF CONTENT



List of Figures

List of Tables



Appendix A: CV

# 1 INTRODUCTION

## 1.1 Background and Motivation

The proposed Sere PV facility is situated about 14km west of Koekenaap on the Namaqualand Coast in the Vredendal District, in the Western Cape (Figure 1-7).

Information provided by Nemai

The hybridisation of the existing Sere Wind Farm with the installation of PV capacity was identified as one of the Renewable initiatives in the Eskom Corporate Plan. Sere Wind Farm is a 105.8 MW wind facility located near Vredendal in the Western Cape, which entered into commercial operation on 31 March 2015. To address the urgent need for additional generating capacity, it has been proposed that PV technology be installed at the Sere Wind Farm site in phases.

This project is applicable for the first phase (Phase 1A) of the Sere PV project. Phase 1A aims to address Eskom's urgent need for additional generating capacity.

The facility proposed for Sere PV Phase 1A will include a total site area less than 20 hectares to allow for the construction of a PV facility up to 19.9 MW capacity and associated infrastructure:

- Solar PV modules, up to a total of 120,000 $m^2$, that convert solar radiation directly into electricity. The solar PV modules will be elevated off the ground and will be mounted on either fixed tilt systems or tracking systems. The Solar PV modules will be placed in rows in such a way that there is allowance for a perimeter road and security fencing along the site boundary, and access roads in between each PV module row. There will be underground cabling connecting Solar PV modules to the Inverter stations.
- Inverter stations, each occupying a footprint up to approximately 30 $m^2$, with up to 20 Inverter stations installed on the site. Each Inverter station will contain an inverter, step-up transformer, and switchgear. The Inverter stations will be distributed on the site, located alongside its associated Solar PV module arrays. The Inverter station will perform conversion of DC (direct current) to AC (alternating current), and step-up the LV voltage of the inverter to 33kV, to allow the electricity to be fed into the Skaapvlei substation. Inverter stations will connect several arrays of Solar PV modules and will be placed along the internal roads for easy accessibility and maintenance.
- Adequately designed foundations and mounting structures that will support the Solar PV modules and Inverter stations.

- Existing roads that provide access to Sere Wind Farm will be used and extended where necessary (estimated up to 1 km long) to provide access to the PV site.
- A perimeter road around the site, approximately 5 m wide and 1.8 km in length.
    - Internal roads for access to the Inverter stations, approximately 5 m wide and 3.4 km total length.
- Internal roads/paths between the Solar PV module rows, approximately 2.5 m wide, to allow access to the Solar PV modules for operations and maintenance activities.
- Laydown area, occupying a footprint up to 4,000 $m^2$, located adjacent to the substation. The laydown area will also accommodate water storage tanks (estimated 32 kl for the first 4 months and 20 kl for the remaining 20 months, until construction is completed). This area will also accommodate the offices for construction contractors.
- Batching plant, occupying a footprint up to 7,675 $m^2$, for the mixing ingredients for concrete.
- The infrastructure required for the operation and maintenance of the Sere PV Plant – Phase 1a installation will be optimized to consider common usage of the existing Sere Wind Farm infrastructure.
- The Solar PV plant facility security cabin, occupying a footprint up to 10 $m^2$, including ablution facilities.
- Perimeter fencing of the Solar PV site, with access gates. Detailed requirements will be determined following the security risk assessment.
- Construction and installation of underground electrical interconnection cables, with trenching up to 1 km long, connecting the Solar PV facility to the 22-33/132 kV Skaapvlei substation.

Total area of the Solar PV modules will be 16 – 18 ha within the approximate 19.6 ha site

- Proposed PV will be either fixed or tracking PV
    - Fixed or static PV – fixed mounted PV up to 3.5 m above ground level. Fixed or static PV – at 30º, north facing slope
    - Tracking – single or double axis tracking up to 6 m above ground level. Tracking – PV module rows will track the sun path from east to west daily

The foundation of the PV structures will be the main excavation work besides the excavation for the cable connecting the site with the existing substation. Approximate excavation depths are 1.5m.

Eskom confirmed that the batching plant area would be rehabilitated if used by the contractor, but if not used by contractor would be used for extra PV panel installation (of approximately 1.5 MW addition).

Eskom confirmed that the contractors site camp area (0.4 ha) would be used for parking and office buildings for Operation & Maintenance after construction (and would not be rehabilitated).

The solar PV plant has a design life of a minimum of 25 years. The extension of the life of the plant will be considered when assessing the plant's economic viability to remain operational after its end of life.

A Geotechnical report was conducted for the SERE WEF.

BKS Palace Consortium, 2010. Report on the Geotechnical foundation investigation for the proposed Sere Wind Energy at Koekenaap, Western, Cape Province.

*Table 2: Stratigraphy of the SERE WEF (Taken from Pether,2020)*

| |
|---|
| **Aeolian Deposits of the Cenozoic Era**<br>Pale red and orange, very loose to loose, sand. No gravel |
| **Marine Deposits of the Cenozoic Era**<br>Lighter coloured, brown and beige, sand, silt, gravel and boulders.<br>Significantly denser than the aeolian deposits above. |
| **Bedrock**<br>Phylite, sandstone and quartzitic sandstone of the Gariep Supergroup. |

This detailed geotechnical report found sandstone and quartzitic sandstone as well as phylite, of the Gariep Supergroup present at a depth of between 14m and at a depth greater than 102m (see report for detail). The thickness of the Cenozoic deposits varies but test drilling (in proximity of the PV development) found sand at a depth of up to 20 m. The approximate excavation depths for the Sere PV project are 1.5m. It is thus anticipated that excavations will not extend into the underlying bedrock of the PV project.

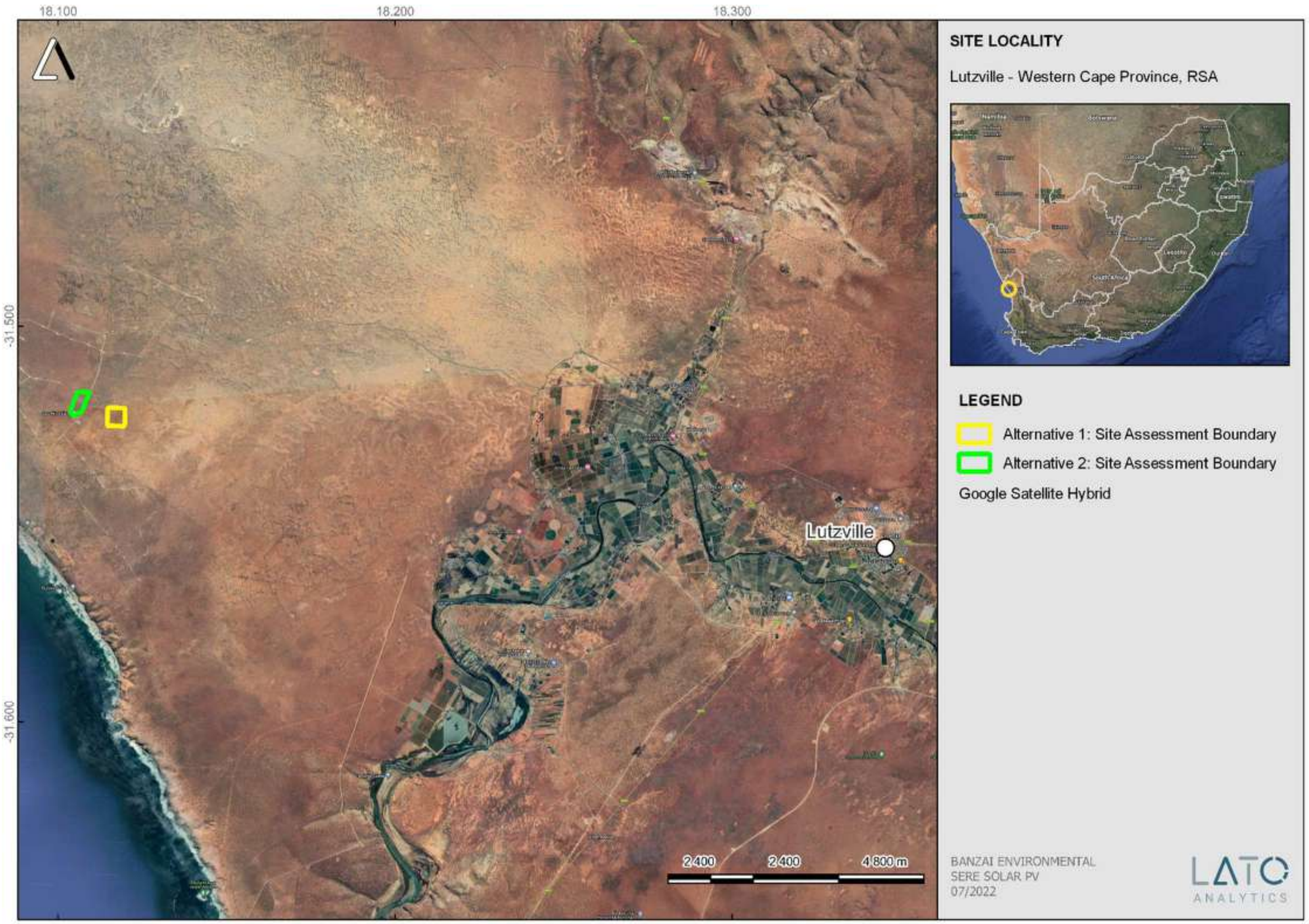



*Figure 1:Regional site locality*

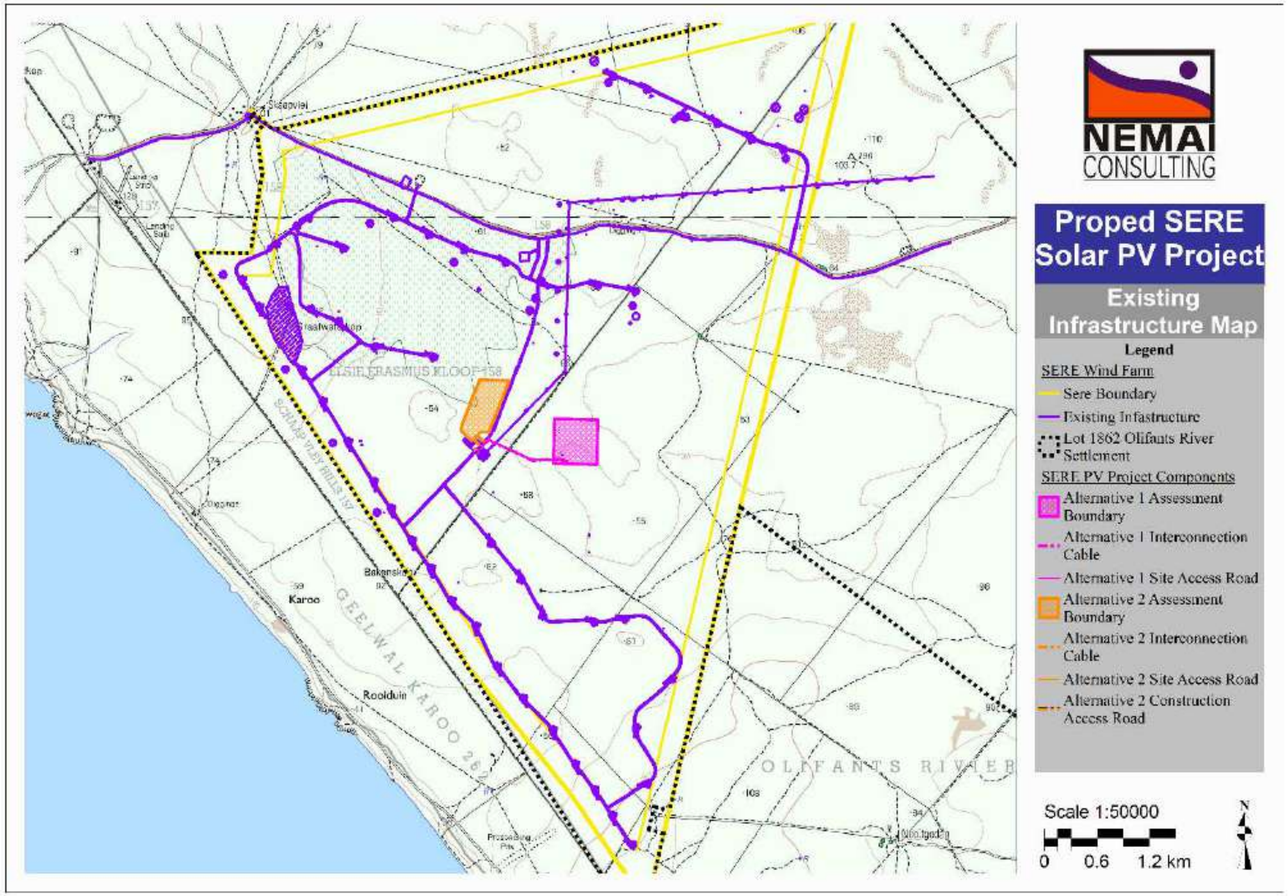



*Figure 2: Proposed Sere PV site in relation to the Sere Wind Farm Facility*

## 1.2 Alternatives to be considered

### *1.2.1 Alternative 1 (see Figure 4 below)*

- Sere PV Fixed Technology Layout with buildings in the south of the site.
- Sere PV Tracking Technology Layout with buildings in the south of the site.
- Access Road that connects to the south of the site.
- Interconnection electrical cable that connects to the south of the site.


*Figure 3: Alternative 1 - Fixed and Tracking layouts within the Assessment Site Boundary (yellow) showing cable and access road routes.*

### 1.2.2 *Alternative 2 (see Figure 5 below)*

An alternative site has been proposed to the west of the original site (Alternative 1)

- Access roads connecting to the existing access road to the east
- Cable route between the site and the substation will follow the exiting road as close as possible
- The excavation for the cable route will be 1 m wide (and 1m deep), with an estimated 10 m working servitude

*Figure 4: Alternative 2 - Fixed and Tracking layouts within the Assessment Site Boundary showing Alternative cable and road routes.*

## 2 QUALIFICATIONS AND EXPERIENCE OF THE AUTHOR

This present study has been conducted by Mrs Elize Butler. She has conducted approximately 300 palaeontological impact assessments for developments in the Free State, KwaZulu-Natal, Eastern, Central, and

Northern Cape, Northwest, Gauteng, Limpopo, and Mpumalanga. She has an MSc (*cum laude*) in Zoology (specializing in Palaeontology) from the University of the Free State, South Africa and has been working in Palaeontology for more than twenty-five years. She has experience in locating, collecting, and curating fossils. She has been a member of the Palaeontological Society of South Africa (PSSA) since 2006 and has been conducting PIAs since 2014.

# 3 LEGISLATION

## 3.1 National Heritage Resources Act (25 of 1999)

Cultural Heritage in South Africa, includes all heritage resources, is protected by the National Heritage Resources Act (Act 25 of 1999) (NHRA). Heritage resources as defined in Section 3 of the Act include "all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens".

The identification, evaluation and assessment of any cultural heritage site, artefact or finds in the South African context is required and governed by the following legislation:

- National Environmental Management Act (NEMA) Act 107 of 1998
- National Heritage Resources Act (NHRA) Act 25 of 1999
- Minerals and Petroleum Resources Development Act (MPRDA) Act 28 of 2002
- Notice 648 of the Government Gazette 45421- general requirements for undertaking an initial site sensitivity verification where no specific assessment protocol has been identified.

The next section in each Act is directly applicable to the identification, assessment, and evaluation of cultural heritage resources.
GNR 982 (Government Gazette 38282, 14 December 2014, amended 2017) promulgated under the National Environmental Management Act (NEMA) Act 107 of 1998

- Basic Assessment Report (BAR) – Regulations 19 and 23
- Environmental Impacts Assessment (EIA) – Regulation 23
- Environmental Scoping Report (ESR) – Regulation 21
- Environmental Management Programme (EMPr) – Regulations 19 and 23

National Heritage Resources Act (NHRA) Act 25 of 1999

- Protection of Heritage Resources – Sections 34 to 36
- Heritage Resources Management – Section 38

In agreement with legislative requirements, EIA rating standards as well as SAHRA policies the following comprehensive and legally compatible PIA report have been compiled.

Palaeontological heritage is exceptional and non-renewable and is protected by the NHRA. Palaeontological resources and may not be unearthed, broken moved, or destroyed by any development without prior assessment and without a permit from the relevant heritage resources authority as per section 35 of the NHRA.

This Palaeontological Impact assessment forms part of the Heritage Impact Assessment (HIA) and adhere to the conditions of the Act. According to Section 38 (1), an HIA is required to assess any potential impacts to palaeontological heritage within the development footprint where:

- the construction of a road, wall, power line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length.
- the construction of a bridge or similar structure exceeding 50 m in length.
- any development or other activity which will change the character of a site—
- (Exceeding 5 000 $m^2$ in extent; or
- involving three or more existing erven or subdivisions thereof; or
- involving three or more erven or divisions thereof which have been consolidated within the past five years; or
- the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority
- the re-zoning of a site exceeding 10 000 $m^2$ in extent.
- or any other category of development provided for in regulations by SAHRA or a Provincial heritage resources authority.

# 4 OBJECTIVE

The aim of a Palaeontological Impact Assessment (PIA) is to decrease the effect of the development on potential fossils at the development site.

According to the "SAHRA APM Guidelines: Minimum Standards for the Archaeological and Palaeontological Components of Impact Assessment Reports" the purpose of the PIA is: 1) to identify the palaeontological importance of the rock formations in the footprint; 2) to evaluate the palaeontological magnitude of the formations; 3) to clarify the impact on fossil heritage; and 4) to suggest how the developer might protect and lessen possible damage to fossil heritage.

The palaeontological status of each rock section is calculated as well as the possible impact of the development on fossil heritage by a) the palaeontological importance of the rocks, b) the type of development and c) the quantity of bedrock removed.

When the development footprint has a moderate to high palaeontological sensitivity a field-based assessment is necessary. The desktop and the field survey of the exposed rock determine the impact significance of the planned development and recommendations for further studies or mitigation are made. Destructive impacts on palaeontological heritage usually only occur during the construction phase while the excavations will change the current topography and destruct or permanently seal-in fossils at or below the ground surface. Fossil Heritage will then no longer be accessible for scientific research.

Mitigation usually precede construction or may occur during construction when potentially fossiliferous bedrock is exposed. Mitigation comprises the collection and recording of fossils. Preceding excavation of any fossils a permit from SAHRA must be obtained and the material will have to be housed in a permitted institution. When mitigation is applied correctly, a positive impact as possible because our knowledge of local palaeontological heritage may be increased.

The terms of reference of a PIA are as follows:

General Requirements:

- Adherence to the content requirements for specialist reports in accordance with Appendix 6 of the EIA Regulations 2014, as amended.
- Adherence to all applicable best practice recommendations, appropriate legislation, and authority requirements.
- Submit a comprehensive overview of all appropriate legislation, guidelines.
- Description of the proposed project and provide information regarding the developer and consultant who commissioned the study.
- Description and location of the proposed development and provide geological and topographical maps.
- Provide Palaeontological and geological history of the affected area.
- Identification sensitive areas to be avoided (providing shapefiles/kml's) in the proposed development.
- Evaluation of the significance of the planned development during the Pre-construction, Construction, Operation, Decommissioning Phases and Cumulative impacts. Potential impacts should be rated in terms of the direct, indirect, and cumulative:
    a. Direct impacts are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity.
    b. Indirect impacts of an activity are indirect or induced changes that may occur as a result of the activity.
    c. Cumulative impacts result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present, or reasonably foreseeable future activities.

- Fair assessment of alternatives (infrastructure alternatives have been provided):
- Recommend mitigation measures to minimise the impact of the proposed development; and
- Implications of specialist findings for the proposed development (such as permits, licenses etc).

# 5 GEOLOGICAL AND PALAEONTOLOGICAL HISTORY

The geology of the SERE Solar Photovoltaic Plant in the Western Cape Province is depicted on the 1:250 000 Calvinia 3118 (2001) Geological map (Council of Geoscience, Pretoria) (Figure 6, Table 3) with a short sheet explanation by Theron *et al.* (1991). According to this map the proposed Sere PV Plant is underlain by superficial Cenozoic deposits (Ç – s, red dune sand). Recent Shape files compiled by the Council of Geosciences (Pretoria) indicates that the proposed SERE development is underlain by the West Coast Group (Figure 7-9). The PalaeoMap on the South African Heritage Resources Information System (SAHRIS) database indicates that the Palaeontological Sensitivity of the West Coast Group is Very High (Figure 10) (Almond and Pether 2008, SAHRIS website).

As previously stated in this report the excavations for the PV development will only be approximately 1.5m deep and these excavations will only penetrate into the aeolian sands. The West Coast Group is in depth underlain by various bedrock types that is not of palaeontological interest. North of the proposed development superficial sediments is underlain by basement gneisses of the Namaqua Metamorphic Province that are older than 1000 million years. These basement rocks include the Gifberg Metasediments, Table Mountain Group sandstones as well as intrusions comprising of dykes, pipes, and plutons.

The West Coast Group comprises of Cenozoic coastal deposits located between the Orange River and Elandsbaai (Roberts *et al*., 2006). The early coastal plane was flooded by the sea during the late Cretaceous. Nowadays the marine record of the palaeo-shorelines are uplifted to 150 to 2000asl. These older portions of the coastal plain are kaolinized (white china clay) and deeply weathered and mantled by silcrete in places. The latter developed in poorly drained low areas in tropical, stages of humid weathering during the latest Cretaceous and earlier Cenozoic. The deep weathering and formation of silcrete formed from tropical weathering in humid times during the latest Cretaceous or earlier Cenozoic.

Ancient river channels (representing wetter climates during the early Cenozoic) are buried between the major Namaqualand rivers. During the early Cenozoic more rivers drained the coastal plane. These channels infill have also been kaolinized while silcrete formed in places within the upper channels (the so-called Channel-clays) now known as the Koingnaas Formation (De Beer, 2010). The outcrops around the development are formed by the sands and white, kaolinitic quartz gravels of the Koingnaas Formation. These exposures are the best-preserved natural exposures of the Koingnaas Formation in Namaqualand. This Formation is mantled by younger deposits.

Plant fossils occur in carbonaceous beds of peaty material, while fossilized wood of the tropical African mahogany has been found. Silicified, fossil wood has been uncovered in the gravels of the Olifants Rivier (near Vredendal) and was presumably reworked from the Koingnaas Formation. Fossil pollen represents numerous trees (including yellowwood forests, conifers, and ironwoods).

The aeolian coversands of the Namaqualand coastal plain comprises of extensive marine formations containing warm-water mollusc assemblages. Currently these formations are formally divided in the Alexander Bay Formation comprising of the Kleinzee, Avontuur and Hondeklipbaai Members. But each of these marine formations occupy a detailed spatial position in the stratigraphic geometry, is characterized by different faunas of different ages and are worthy of full formation status (Pether, 2018). The Quaternary Curlew Strand Formation is close to the coast and includes three "raised beaches" comprising of modern cold-water fauna. The Alexander Bay Formation is thus endorsed to Subgroup and includes all four marine formations (Pether, 2018).

The SERE Solar PV development footprint is located on the outer margin of the coastal plain and the formations that could be impacted are the marine and younger aeolian formations. Extensive research has been conducted on deposits of the West Coast Group and includes papers by Carrington & Kensley, 1969; Kensley & Pether, 1986, De Beer et al. (2002), Elferink (2005).

### Kleinzee Formation (90m Package)

The Kleinzee Formation (Mid-Miocene Climatic Optimum) is the oldest marine formation located on the inner high part of the coastal bevel/cliff extending seawards from about 90m asl (above sea level) or commonly known as the 90m Package. This Formation was deposited about 17 to 15 Ma ago when the high sea level of the warm Mid-Miocene Climatic Optimum dropped. Miocene marine beds weathered when the sea-level rose during the Early Pliocene Warm Period. A hominoid tooth as well as petrified teeth of extinct pigs were described from the basal gravels of this Formation (18 - 17.5 Ma) (Pickford & Senut, 1997). These fossils were reworked from earlier terrestrial deposits. The Kleinzee Formation has a rare shelly fauna that is poorly preserved and relatively unstudied. The zone fossil for this formation is the thick-shelled bivalve *Isognomon gariesensis*

### Avontuur Formation (50m Package)

The Avontuur Formation (50m Package) represents the Early Pliocene Warm Period and was deposited as the sea-level retreated from the transgression high of almost 50m asl and the shoreline advanced seawards (about 5-4 Mya). The Avontuur Formation was also eroded by a rising in sea-level about ~3 Mya during the Mid-Pliocene Warm Period. Fossils of the Avontuur Formation is generally decalcified, fairly well preserved and thus fairly well sampled (Carrington & Kensley, 1969; Kensley & Pether, 1986). The zone fossil is the extinct *Donax haughtoni* "surf clam". This Formation also contains petrified wood as well as reworked vertebrate remains from older periods. The latter includes the teeth and bones of extinct proboscideans, bovids and equids, rhinocerotids, shark teeth, as well as whales. The bear-dog *Agnotherium* sp. (13 - 12 Ma) and gomphothere *Tetralophodon* (12 - 9 Ma), represents the oldest fossils in the basal assemblage but the general age of fossils in this formation is late Miocene (7.5 - 5 Ma). Important finds in this formation include the suid (bushpig) *Nyanzachoerus kanamensis* and phocid (seal) *Homiphoca capensis*. These fossils are contemporaneous with the Pliocene Varswater Formation uncovered at the West Coast Fossil Park near Saldanha.

Hondeklipbaai Formation (30 m Package)

The 30 m Package (Hondeklipbaai Formation) represents the Mid-Pliocene Warm Period and accumulated as the sea-level dropped from a high of about 30-33 m asl while the marine formation extended seawards (Pether, 1994; Pether, in Roberts et al., 2006). This Formation could extend up to a few km in width. The marine formations of the Miocene and Pliocene contain fossil shells of warm water species as well as extinct shell species that characterise the Formation. This formation is the last major formation of the coastal plane and was deposited during a very high sea level that has never since been surpassed. Molluscs lived and thrived in the warm waters, and it is difficult to postdate the commencement of the major cooling of the Benguela System. Core samples taken from Lüderitz indicates that the diatom microfossil assemblages extend from 4.5 Ma. The water temperatures declined from about 3Ma ago with a previous high of about 26° during the late Pliocene (Marlow et al., 2000).

This 30m Package is probably older than 3 Ma and corresponds to the “Mid-Pliocene Warm Period” where the Pliocene sea-level was high (about 3.0 to 3.4 Ma). This Formation consists of coarse-sand and is extensively decalcified and reddened. At present fossils shell of this formation is rare and the collection needs to be expanded. Early fossil collection was conducted by Haughton (1926, 1928, 1932) and are kept in the IZIKO Collections . As in most cases the collection date was neglected and most of these specimens lack precise locations. Fossil collection in this Formation was bias towards robust shells . The zone fossil is the large extinct “surf clam” *Donax Rogers*’.

Curlew Strand Formation

The Curlew Strand Formation consists of the amalgamation of old beaches comparable to the Velddrif Formation of the SW Cape Coast. This Formation consist of an 8 - 12 m Package that is about 400 ka years old (ka = thousand years ago), the 4 - 6 m Package of the Last Interglacial (~125 ka) and the 2 - 3 m Package (6-4 ka, mid-Holocene High).

Fossils of this formation are mostly resent cold-water fauna. Extended erosion of the older marine deposits has taken place, mostly by wind deflation decalcification, pedogenic reddening and the formation of pedocretes beneath palaeosurfaces. The eroded marine sequences are overlain by various terrestrial deposits. These deposits are mostly extensive aeolian dune and sandsheet deposits. Pether (2018) conducted the PIA for the Tormin mine extension just west of the proposed development. He recognized aeolian formations of later Miocene, mid-Pliocene, late Pliocene, and several Quaternary ages.

Quaternary raised beaches is present more north of the development where bedrock with low gradients occurs inland. Fossils in the Quaternary Curlew Strand Formation is rare but may comprise of marine animals and sea birds. These specimens may be closely related to modern marine species, but unexpected, rare fossils may occur and would be of scientific value.

Older Aeolianite Formations

The Terrestrial record

Various terrestrial deposits are also present in the coastal plain of Namaqualand. These deposits are mostly aeolian dune and sandsheet deposits that overlie the weathered tops of the marine formations. Locally these deposits may be ephemeral stream channel and colluvial (sheetwash) deposits linked with hillslopes and are sometimes interbedded with aeolian deposits. In the upper parts of the terrestrial and marine sequences a variety of palaeosols and pedocretes is present with different compositions and degrees of development. These sediment have not yet been stratigraphically formalized, and formations are only generally defined.

The Aeolianite formations is inadequately studied and comprise of the following formations.
The Graauw Duinen Formation is aeolianites of Pliocene age. This Formation is a thick aeolianite accumulation in the south of the West Coast. Fossilized eggshells of the extinct Pliocene giant ostrich, Struthio daberasensis (Roberts, in Roberts et al., 2006), skeletal remains of the bovid *Numidocapra crassicornis*, and teeth of the extinct sabre-toothed felid, *Dinofelis barlow*. have been recorded. The Dorbank Formation varies in thickness and is a large, compact red-brown unit.

Younger Aeolianite Formations

The younger aeolianite formations are pale-hued in colour and comprise of relatively-soft aeolianite units. The coastal units of this formations comprise of the following

- Koekenaap Formation overlies the Dorbank Formation, compact but unconsolidated red sands, widely distributed in Namaqualand (Roberts et al., 2006; De Beer, 2010). These sands occupy large areas of the Namaqualand coastal plain
- The Hardevlei Formation occurs mostly inland and comprise of pale-yellow dunes with a complex, reticulate morphology
- *Swartlintjies and Swartduine Formations* *is* large, semi-stabilized, pale plumes of, parabolic dune Ridges. The latter expands from the beaches north of the major rivers (Roberts *et al*., 2006; De Beer, 2010). The Swartduine Formation is present in interdune areas between the Swartlintjies Formation and comprise of grey sandsheet as well as small dunes with smooth vegetation.
- The Witzand Formation comprise of sand and shell fragments. Originated in the Holocene and has blown from sandy beaches. This formation is located northward from the Sandveld Group of the southwestern Cape

### Fossils from the Aeolian Formations

Fossils in the aeolian sands are extremely rare and usually found in sand dunes. These fossils include tortoise shells, mole bones as well as land snails. Rarer fossils consist of small mammal and bird bones. Fossils are more abundantly found in palaeosurfaces and their soils that formed when dunes stabilized. Larger fossil bones are more commonly found along palaeosurfaces overlying marine deposits as well as palaeosurfaces between main aeolianite units. Dune slopes along the coast usually contain more fossils as it is utilized for foraging and scavenging. Jackals and hyaenas carry they prey to sand slopes and bones are collected around hyaena dens. These dens are often found on sea-facing aeolianite slopes. Fossils are noticed when bones is exposed to the surface and are falling downslope. These rare fossils find are important as they are important in biostratigraphic, palaeobiological and palaeoclimatic research.

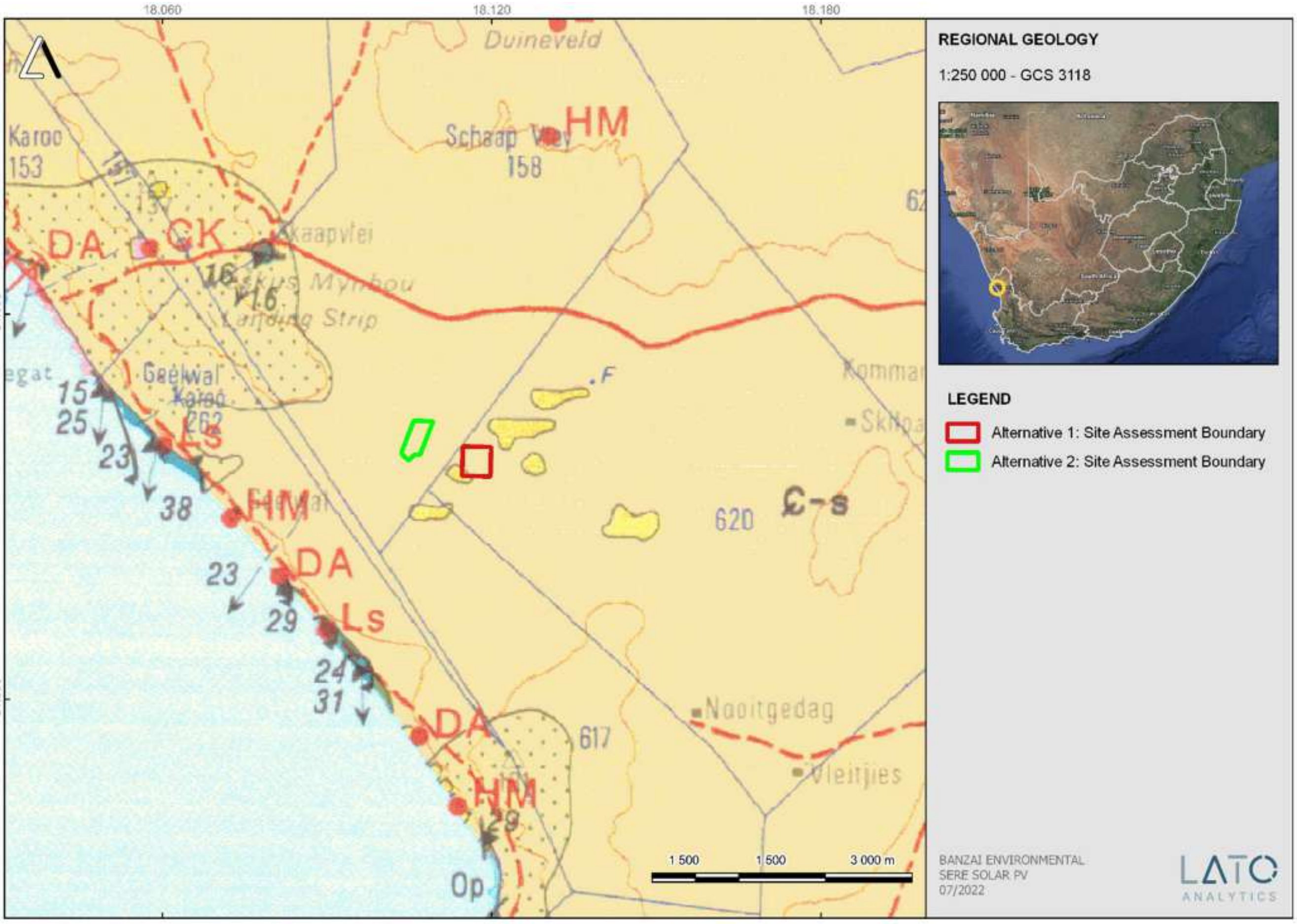
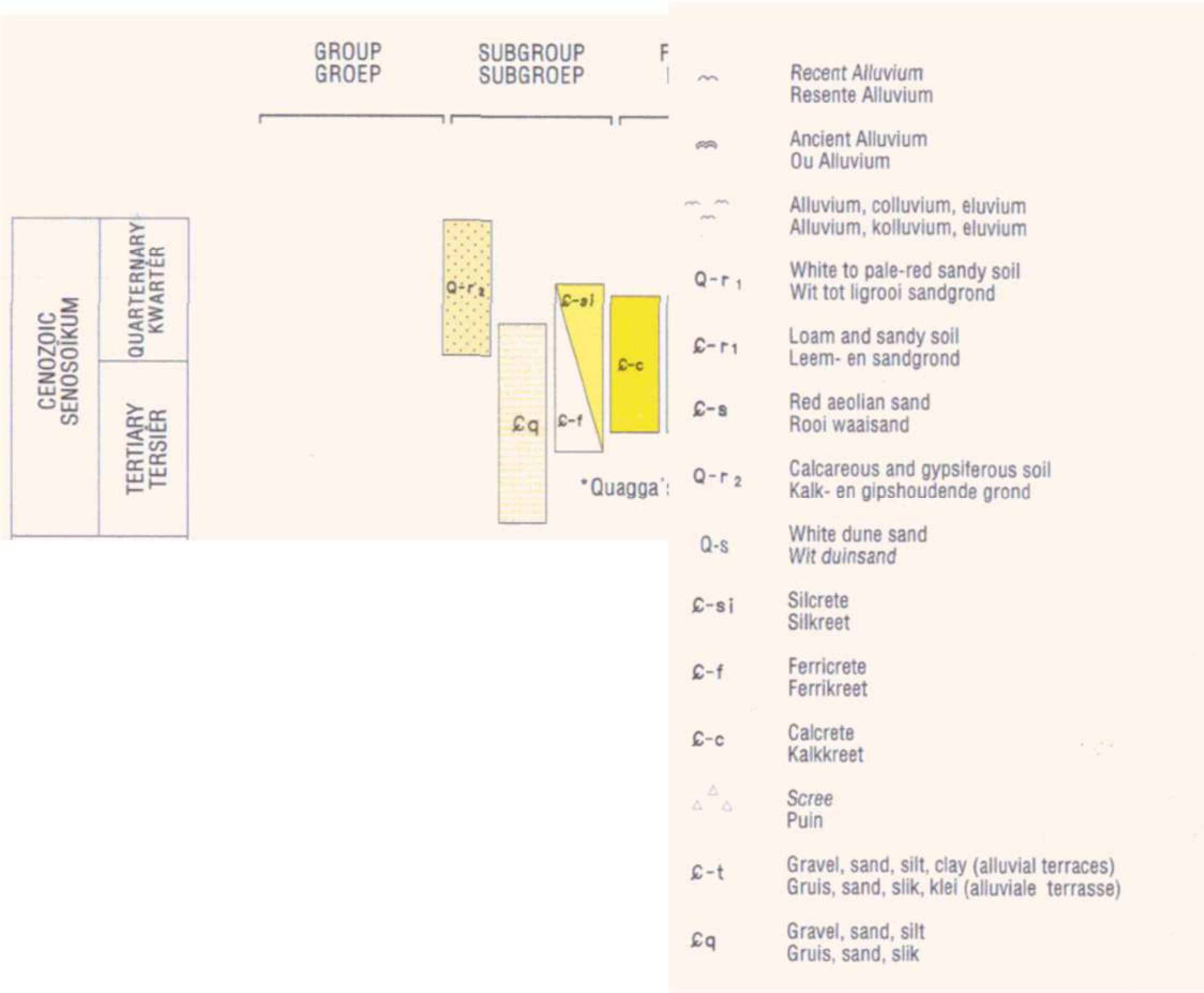



*Figure 5: Extract of the 1: 250 000 Calvinia 3118 Geological Map (Council of Geosciences, Pretoria) indicates that the proposed SERE PV and associated infrastructure is underlain by sediments of the West Coast Group.*

*Table 3:Legend of the 1:250 000 Calvinia 3118 (2001) Geological map (Council of Geoscience, Pretoria)*



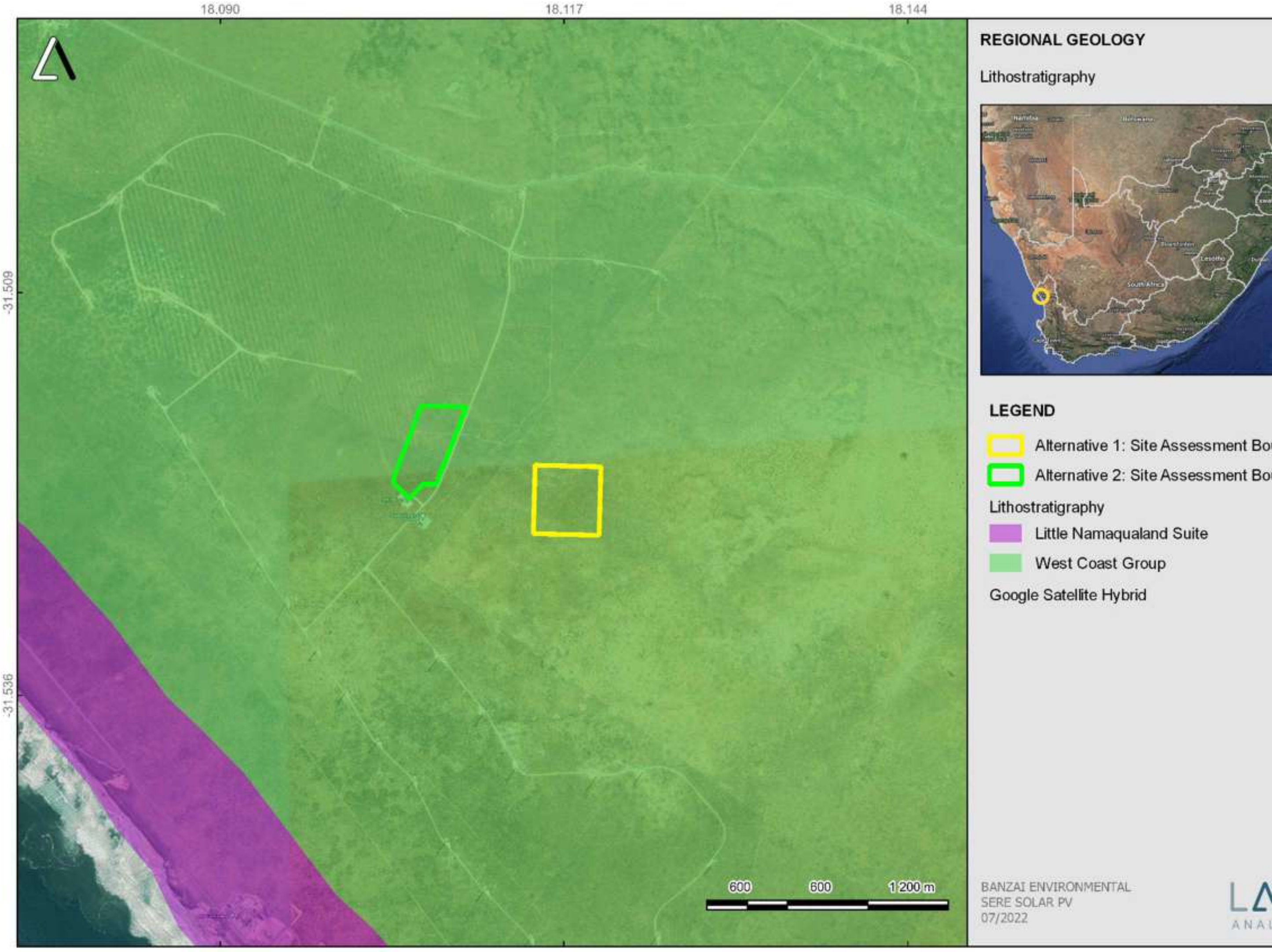



*Figure 6:Regional Geology indicated by Shape Files produced by the Council of Geosciences, Pretoria.*

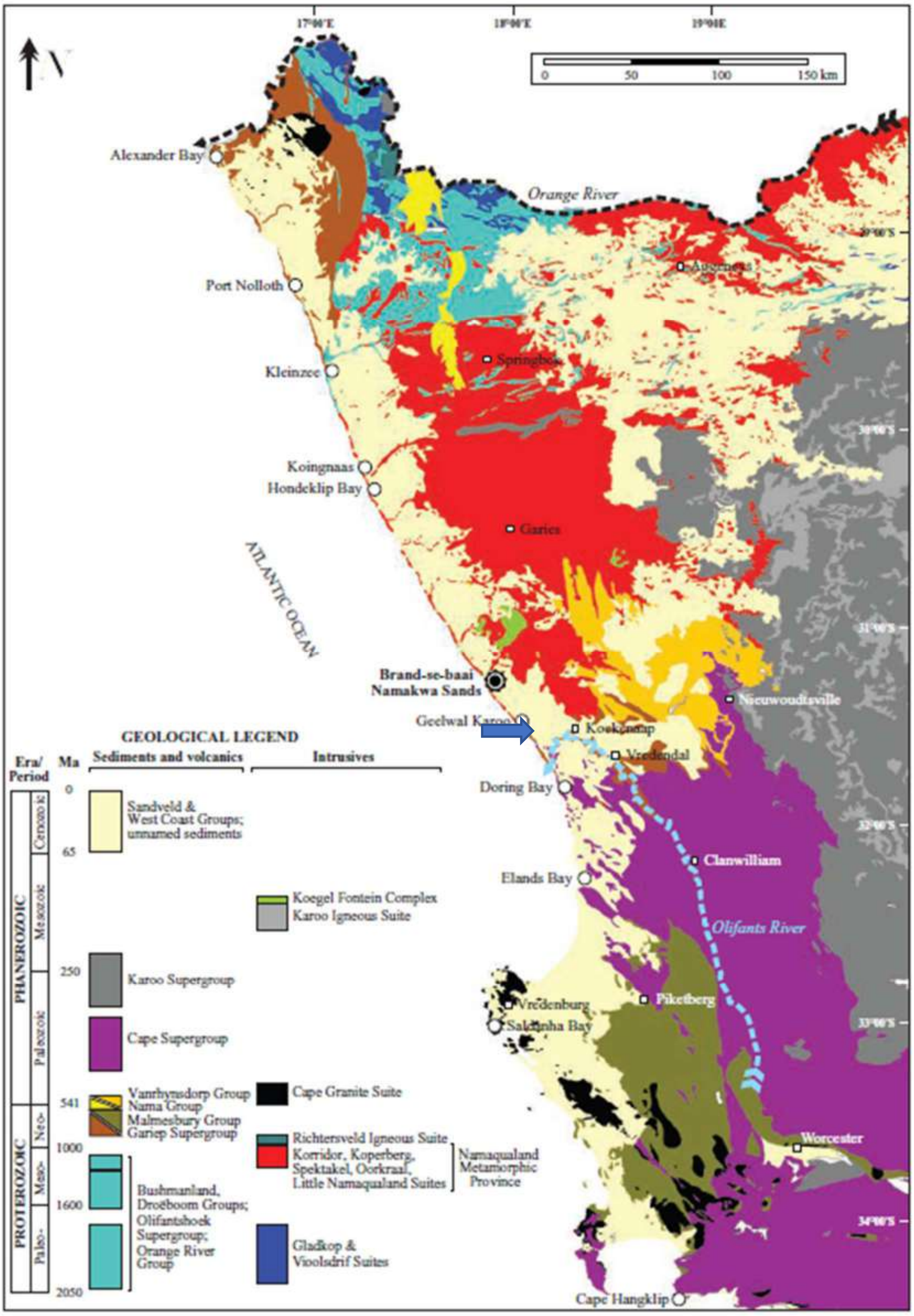



*Figure 7: Simplified geology and stratigraphy of the western portion of South Africa (Council of Geosciences unpublished data). Proposed development it indicated in a blue arrow. Image from (Philander en Rosendaal ,2015)*

*Table 4: Stratigraphy of the Cenozoic West Coast Group (after De Beer, 2010)*

| Age | | Era/Period/Epoch | | Sedimentary deposits |
|---|---|---|---|---|
| 11.5 ka | CENOZOIC | QUATERNARY | Holocene | Witzand Formation |
| | | | | Swartduine Formation° |
| 1.8 Ma | | | Pleistocene | Swartlintjies Formation° |
| | | | | Hardevlei Formation |
| | | | | Curlew Strand Formation° |
| | | | | Koekenaap Formation |
| | | | | Panvlei Formation° |
| 24 Ma | | NEOGENE | Pliocene | Graauw Duinen Formation° |
| | | | | Alexander Bay Formation |
| | | | | Hondeklip Bay Member° |
| | | | | (30m Package) |
| | | | | Avontuur Member° |
| | | | | (50m Package) |
| | | | Miocene | Kleinsee Member° |
| | | | | (90m Package) |
| 65 Ma | | PALEOGENE | Oligocene | Koingnaas Formation° |
| | | | | De Toren Formation° |

Note: ° = not approved by the South African Committee for Stratigraphy (SACS)

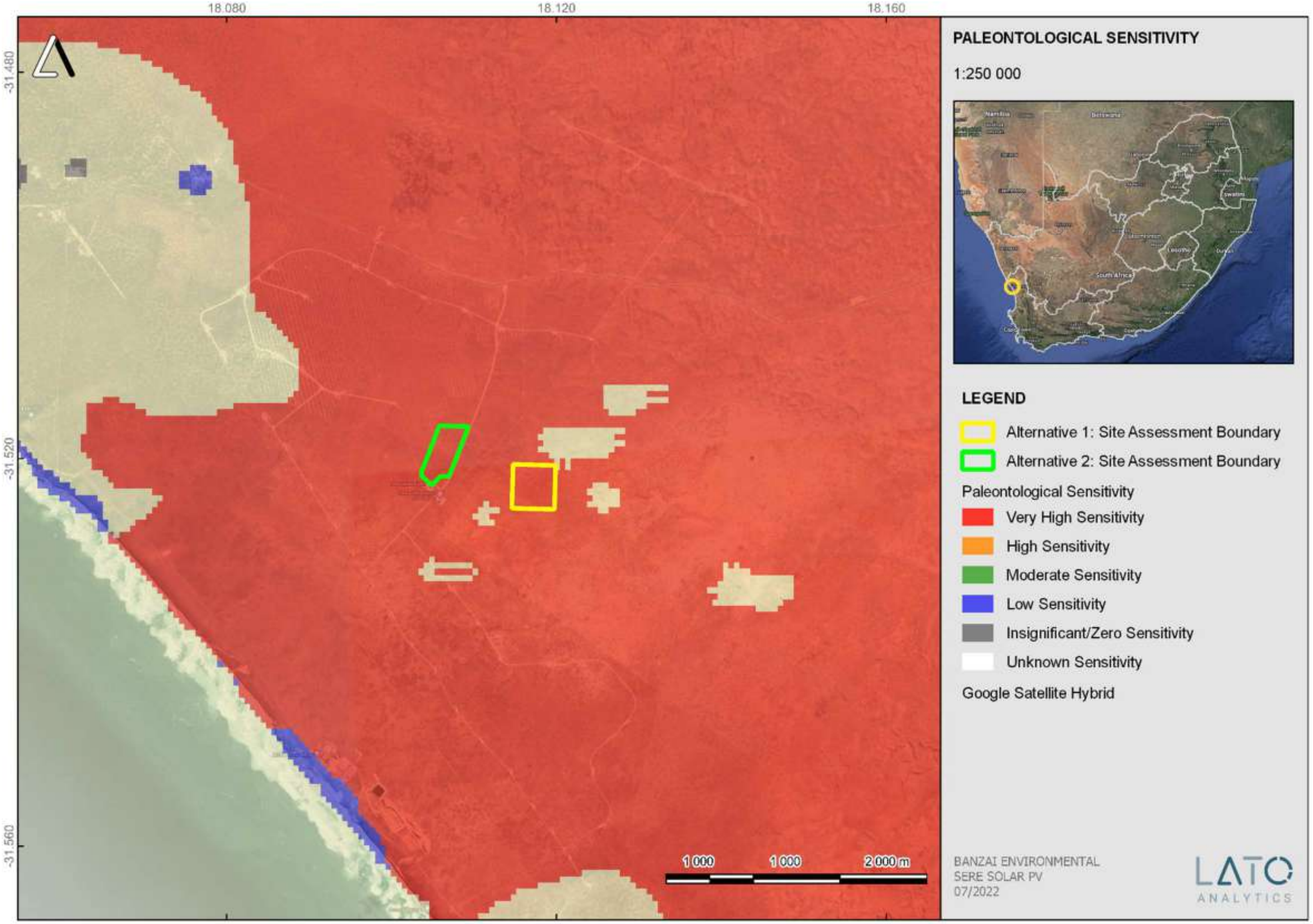



*Figure 8:* Extract of the 1:250 000 SAHRIS PalaeoMap map (Council of Geosciences) indicating the proposed development.

*Table 5:* Palaeontological Significance

| Colour | Sensitivity | Required Action |
|---|---|---|
| RED | VERY HIGH | Field assessment and protocol for finds is required |
| ORANGE/YELLOW | HIGH | desktop study is required and based on the outcome of the desktop study; a field assessment is likely |
| GREEN | MODERATE | desktop study is required |
| BLUE | LOW | no palaeontological studies are required however a protocol for finds is required |
| GREY | INSIGNIFICANT/ZERO | no palaeontological studies are required |
| WHITE/CLEAR | UNKNOWN | these areas will require a minimum of a desktop study. As more information comes to light, SAHRA will continue to populate the map. |

The colours on the PalaeoMap indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero

According to the SAHRIS Palaeosensitivity map (Figure 10) the proposed development is underlain by sediments of Very High (red) Palaeontological Sensitivity. However, the geotechnical report conducted for the Sere Wind Energy Farm (BKS Palace Consortium, 2010) found that the sand depth of the development area is 0-22m, while the approximate excavation depths for the Sere PV project are 1.5m. It is thus anticipated that excavations will not extend into the underlying bedrock of the PV project and that the Palaeontological Significance of the proposed development will thus be LOW.

# 6 METHODS

The aim of a desktop study is to evaluate the risk to palaeontological heritage in the proposed development. This includes all trace fossils and fossils. All available information is consulted to compile a desktop study and includes Palaeontological impact assessment reports in the same area, aerial photos, and Google Earth images, topographical as well as geological maps.

## 6.1 Assumptions and Limitations

When conducting a PIA several factors can affect the accuracy of the assessment. The focal point of geological maps is the geology of the area, and the sheet explanations were not meant to focus on palaeontological heritage. Many inaccessible regions of South Africa have not been reviewed by palaeontologists and data is generally based on aerial photographs. Locality and geological information of museums and universities databases have not been kept up to date or data collected in the past have not always been accurately documented.

Comparable Assemblage Zones in other areas is used to provide information on the existence of fossils in an area which was not yet been documented. When similar Assemblage Zones and geological formations for Desktop studies is used it is generally assumed that exposed fossil heritage is present within the footprint.

# 7 ADDITIONAL INFORMATION CONSULTED

In compiling this report the following sources were consulted:

- Geological map 1:100 000, Geology of the Republic of South Africa (Visser 1984).
- 1: 250 000 1:250 000 Calvinia 3118 (2001) Geological map (Council of Geoscience, Pretoria). Calvinia Area, Sheet explanation: Sheet 3118 Calvinia, 1:250 000 scale, The Council for Geoscience, Geological Survey of South Africa)
- A Google Earth map with polygons of the proposed development was obtained from Bokomaso Landscape Architects & Environmental Consultants CC.
- *Geotechnical Report conducted for the SERE WEF (BKS Palace Consortium, 2010)*

# 8 IMPACT ASSESSMENT METHODOLOGY

Impact assessment must take account of the nature, scale, and duration of impacts on the environment whether such impacts are positive or negative. Each impact is also assessed according to the following project phases:

- Construction;
- Operation; and
- Decommissioning.

Where necessary, the proposal for mitigation or optimisation of an impact should be detailed. A brief discussion of the impact and the rationale behind the assessment of its significance should also be included. The rating system is applied to the potential impacts on the receiving environment and includes an objective evaluation of the mitigation of the impact. In assessing the significance of each impact, the following criteria is used:

Only one Impact Assessment is included in this report as the geology of the two alternatives is the same and thus impacts on the two alternatives will be the same.

Specific values allocated to each impact is indicated in yellow

*Table 6:* The rating system

| | | |
|---|---|---|
| NATURE | | |
| The Nature of the Impact is the possible destruction of fossil heritage | | |
| GEOGRAPHICAL EXTENT | | |
| This is defined as the area over which the impact will be experienced. | | |
| 1 | Site | The impact will only affect the site. |
| 2 | Local/district | Will affect the local area or district. |
| 3 | Province/region | Will affect the entire province or region. |
| 4 | International and National | Will affect the entire country. |
| PROBABILITY | | |
| This describes the chance of occurrence of an impact. | | |

| | | |
|---|---|---|
| 1 | Unlikely | The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence). |
| 2 | Possible | The impact may occur (Between a 25% to 50% chance of occurrence). |
| 3 | Probable | The impact will likely occur (Between a 50% to 75% chance of occurrence). |
| 4 | Definite | Impact will certainly occur (Greater than a 75% chance of occurrence). |
| DURATION | | |
| This describes the duration of the impacts. Duration indicates the lifetime of the impact as a result of the proposed activity. | | |
| 1 | Short term | The impact will either disappear with mitigation or will be mitigated through natural processes in a span shorter than the construction phase (0 – 1 years), or the impact will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years). |
| 2 | Medium term | The impact will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years). |
| 3 | Long term | The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 30 years). |
| 4 | Permanent | The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered indefinite. |
| INTENSITY/ MAGNITUDE | | |
| Describes the severity of an impact. | | |

| | | |
|---|---|---|
| 1 | Low | Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible. |
| 2 | Medium | Impact alters the quality, use and integrity of the system/component but system/component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity). |
| 3 | High | Impact affects the continued viability of the system/ component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation. |
| 4 | Very high | Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired. Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation. |
| REVERSIBILITY | | |
| This describes the degree to which an impact can be successfully reversed upon completion of the proposed activity. | | |
| 1 | Completely reversible | The impact is reversible with implementation of minor mitigation measures. |
| 2 | Partly reversible | The impact is partly reversible but more intense mitigation measures are required. |
| 3 | Barely reversible | The impact is unlikely to be reversed even with intense mitigation measures. |
| 4 | Irreversible | The impact is irreversible and no mitigation measures exist. |
| IRREPLACEABLE LOSS OF RESOURCES | | |
| This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity. | | |

| | | |
|---|---|---|
| 1 | No loss of resource | The impact will not result in the loss of any resources. |
| 2 | Marginal loss of resource | The impact will result in marginal loss of resources. |
| 3 | Significant loss of resources | The impact will result in significant loss of resources. |
| 4 | Complete loss of resources | The impact is result in a complete loss of all resources. |
| CUMULATIVE EFFECT | | |
| This describes the cumulative effect of the impacts. A cumulative impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question. | | |
| 1 | Negligible cumulative impact | The impact would result in negligible to no cumulative effects. |
| 2 | Low cumulative impact | The impact would result in insignificant cumulative effects. |
| 3 | Medium cumulative impact | The impact would result in minor cumulative effects. |
| 4 | High cumulative impact | The impact would result in significant cumulative effects |
| SIGNIFICANCE | | |
| Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The calculation of the significance of an impact uses the following formula:<br><br>(Extent (1) + probability (1) + reversibility (4) + irreplaceability (4) + duration (4) + cumulative effect(2)) x magnitude/intensity (1)= 16.<br><br>The summation of the different criteria will produce a non-weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating. | | |
| Points | Impact significance rating | Description |
| 6 to 28 | Negative low impact | The anticipated impact will have negligible negative effects and will require little to no mitigation. |
| 6 to 28 | Positive low impact | The anticipated impact will have minor positive effects. |

| | | |
|---|---|---|
| 29 to 50 | Negative medium impact | The anticipated impact will have moderate negative effects and will require moderate mitigation measures. |
| 29 to 50 | Positive medium impact | The anticipated impact will have moderate positive effects. |
| 51 to 73 | Negative high impact | The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact. |
| 51 to 73 | Positive high impact | The anticipated impact will have significant positive effects. |
| 74 to 96 | Negative very high impact | The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws". |
| 74 to 96 | Positive very high impact | The anticipated impact will have highly significant positive |

## **8.1** Summary of Impact Tables

Loss of fossil heritage will be a negative impact. Only the site will be affected by the proposed development. The expected duration of the impact is assessed as potentially permanent to long term. In the absence of mitigation procedures, the damage or destruction of any palaeontological materials will be permanent. Impacts on palaeontological heritage during the construction phase could potentially occur but are regarded as having a low probability. As fossil heritage will be destroyed the impact is irreversible. The significance of the impact occurring will be low.

*Table 7: Summary of Impacts*

| | Site | Probability | Duration | Magnitude | Reversibility | Irreplicable Loss | Cumulative Effect | Significance | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Pre-mitigation | 1 | 1 | 4 | 4 | 4 | 4 | 2 | 64 | Negative high Impact |
| Post-mitigation | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 16 | Negative low Impact |

## 9 FINDINGS AND RECOMMENDATIONS

The proposed Sere PV Plant is underlain by West Coast Group. According to the PalaeoMap of the South African Heritage Resources Information System (SAHRIS) database the Palaeontological Sensitivity of the West Coast Group is Very High (Almond and Pether 2008, SAHRIS website).

Two Layout alternatives for the proposed Sere Photovoltaic Plant have been proposed. All alternatives are underlain by the West Coast Group. The geology of the proposed site alternatives is the same and thus no preferences on the grounds of palaeontological fossil heritage, for any specific alternative layout under consideration was identified. The PalaeoMap on the South African Heritage Resources Information System (SAHRIS) database indicates that the Palaeontological Sensitivity of the West Coast Group is Very High (Almond and Pether 2008, SAHRIS website). However, the geotechnical report conducted for the Sere Wind Energy Farm (BKS Palace Consortium, 2010) found that the sand depth of the development area is 0-22m, while the approximate excavation depths for the Sere PV project are 1.5m. It is thus anticipated that excavations will not extend into the underlying bedrock of the PV project.

It is therefore considered that the proposed development will not lead to detrimental impacts on the palaeontological resources of the area. The construction and operation of the project may be authorised, as the whole extent of the development footprint is not considered sensitive in terms of palaeontological heritage.

However, if any fossil remains or trace fossils are discovered during any phase of construction or operation, either on the surface or exposed by excavations, a Chance Find Protocol must be implemented by the ECO in charge of this development. These discoveries should be protected (if possible, *in situ*) and the ECO must report such discovery to SAHRA (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). Suitable mitigation (*e.g.* recording and collection) will consequently be undertaken by a palaeontologist.

Preceding any collection of fossil material, the palaeontologist would need to apply for a collection permit from SAHRA. Fossil material must be curated in an accredited collection (museum or university collection), while all fieldwork and reports should meet the minimum standards for palaeontological impact studies required by SAHRA.

These recommendations should be incorporated into the EMPr for the development.

It is consequently recommended that no further palaeontological heritage studies, ground truthing and/or specialist mitigation are required pending the discovery of newly discovered fossils.

.

## **10** CHANCE FINDS PROTOCOL

The following procedure will only need to be followed if fossils are uncovered during excavation. This informational document is intended for workmen and foremen on the construction site. It describes the actions to be taken when mining or construction activities accidentally uncovers fossil material.

It is the responsibility of the Environmental Site Officer (ESO) or site manager of the project to train the workmen and foremen in the procedure to follow when a fossil is accidentally uncovered. In the absence of the ESO, a member of the staff must be appointed to be responsible for the proper implementation of the Chance Find Protocol as not to compromise the conservation of fossil material.

## 10.1 Legislation

Cultural Heritage in South Africa (includes all heritage resources) is protected by the National Heritage Resources Act (Act 25 of 1999) (NHRA). According to Section 3 of the Act, all Heritage resources include "all objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens".

Palaeontological heritage is unique and non-renewable and is protected by the NHRA and is the property of the State. It is thus the responsibility of the State to manage and conserve fossils on behalf of the citizens of South Africa. Palaeontological resources may not be excavated, broken, moved, or destroyed by any development without prior assessment and without a permit from the relevant heritage resources authority as per section 35 of the NHRA.
A fossil is the naturally preserved remains (or traces) of plants or animals embedded in rock. These plants and animals lived in the geologic past millions of years ago. Fossils are extremely rare and irreplaceable. By studying fossils, it is possible to determine the environmental conditions that existed in a specific geographical area millions of years ago.

## 10.2 Protocol

- If a chance find is made the person responsible for the find must immediately stop working and all work that could impact that finding must cease in the immediate vicinity of the find.
- The person who made the find must immediately report the find to his/her direct supervisor which in turn must report the find to his/her manager and the ESO or site manager. The ESO or site manager must report the find to the relevant Heritage Agency (South African Heritage Research Agency, SAHRA). (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za). The information to the Heritage Agency must include photographs of the find, from various angles, as well as the GPS co-ordinates.
- A preliminary report must be submitted to the Heritage Agency within 24 hours of the find and must include the following: 1) date of the find; 2) a description of the discovery and a 3) description of the fossil and its context (depth and position of the fossil), GPS co-ordinates.

- Photographs (the more the better) of the discovery must be of high quality, in focus, accompanied by a scale. It is also important to have photographs of the vertical section (side) where the fossil was found.
- Upon receipt of the preliminary report, the Heritage Agency will inform the ESO (or site manager) whether a rescue excavation or rescue collection by a palaeontologist is necessary.
- The site must be secured to protect it from any further damage. No attempt should be made to remove material from their environment. The exposed finds must be stabilized and covered by a plastic sheet or sand bags. The Heritage agency will also be able to advise on the most suitable method of protection of the find.
- In the event that the fossil cannot be stabilized the fossil may be collected with extreme care by the ESO (site manager). Fossils finds must be stored in tissue paper and in an appropriate box while due care must be taken to remove all fossil material from the rescue site.
- Once Heritage Agency has issued the written authorization, the developer may continue with the development on the affected area.

## 11 REFERENCES


Almond, J., Pether, J, and Groenewald, G. 2013. South African National Fossil Sensitivity Map. SAHRA and Council for Geosciences. Schweitzer *et al*. (1995) pp p288.

BKS Palace Consortium, 2010. Report on the Geotechnical foundation investigation for the proposed Sere Wind Energy at Koekenaap, Western, Cape Province.

Carrington, A.J. and Kensley, B.F. 1969. Pleistocene molluscs from the Namaqualand coast. Annals of the South African Museum, 52, 189 223.

Chase, B. 2006. Late Quaternary palaeoenvironments of the west coast of South Africa: the aeolian record. Unpublished D.Phil. Thesis, The University of Oxford.

Chase, B.M. & Thomas, D.S.G. 2006. Late Quaternary dune accumulation along the western margin of South Africa: distinguishing forcing mechanisms through the analysis of migratory dune forms. Earth and Planetary Science Letters 251: 318–333.

Chase, B.M. & Thomas, D.S.G. 2007. Multiphase late Quaternary aeolian sediment accumulation in western South Africa: timing and relationship to palaeoclimatic changes inferred from the marine record. Quaternary International 166: 29–41.

Cole, D.I. and Roberts, D.L. (2000). Lignite potential of the western coast, Western Cape Province, South Africa. Memoir of the Council for Geoscience 89: 107 pp.

De Beer, C.H. 2010. The geology of the Garies area. Explanation: 1:250000 Sheet 3017 Garies. Council for Geoscience South Africa. 100 pp

De Beer, C.H., Gresse, P.G., Theron, J.N. and Almond, J.E. (2002). The Geology of the Calvinia Area. Explanation: Sheet 3118 Calvinia, 1:250 000 scale. The Council for Geoscience, Geological Survey of South Africa.

De Villiers, S. E. & Cadman, A. 2002. An analysis of the palynomorphs obtained from Tertiary sediments at Koingnaas, Namaqualand, South Africa. Journal of African Earth Sciences 33:17–47.

Elferink, L. 2005. The Cenozoic stratigraphy and associated heavy mineral palaeo-placer deposit on Geelwal Karoo, West Coast, South Africa. M.Sc. thesis, University of Stellenbosch.

Haq, B.U., Hardenbol, J. and Vail, P.R. 1988. Mesozoic and Cenozoic chronostratigraphy and cycles of sea-level change. In: Sea-level Changes: an Integrated Approach. Special Publication of the Society for Economic Paleontologists and Mineralogists, 42, 71-108.

Haughton, S.H. (1926). On some new mollusca from Tertiary beds in the west of the Cape Province. Trans. Roy. Soc. S. Afr., 13, 159 162.

Haughton, S.H. 1928. Appendix: The palaeontology of the Namaqualand coastal deposits. In: Wagner, P.A. and Merensky, H. The diamond deposits on the coast of Little Namaqualand. Transactions of the Geological Society of South Africa, 31, 1 41.

Haughton, S.H. 1932. The Late Tertiary and Recent deposits of the west coast of South Africa. Transactions of the Geological Society of South Africa, 34: 19-58.

Kensley, B. 1985. The fossil occurrence in southern Africa of the South American intertidal mollusc Concholepas concholepas. Annals of the South African Museum 97: 1-7.

Kensley, B. and Pether, J. 1986. Late Tertiary and Early Quaternary fossil Mollusca of the Hondeklip, area, Cape Province, South Africa. *Annals of the South African Museum,* 97 (6): 141-225.

Kilburn, R.N. and Tankard, A.J. 1975. Pleistocene molluscs from the West and South coasts of the Cape Province, South Africa. Annals of the South African Museum 67: 111 122.

Lear, C.H, Elderfield, H. and Wilson, P.A. 2000. Cenozoic Deep-Sea Temperatures and Global Ice Volumes from Mg/Ca in Benthic Foraminiferal Calcite. Science 287: 269-272.

Marlow, J.R., Lange, C.B., Wefer, G., and Rosell-Melé, A. 2000. Upwelling intensification as part of the Pliocene-Pleistocene climate transition. Science, 290: 2288-2291.

Muller, J. 1981. Fossil pollen records of extant angiosperms. The Botanical Review 47:1 142.

Pether, J, Roberts, D.L. and Ward, J.D. 2000. Deposits of the West Coast (Chapter 3). In: Partridge, T.C. and Maud, R.R. eds. The Cenozoic of Southern Africa. Oxford Monographs on Geology and Geophysics No. 40. Oxford University Press: 33-55.

Pether, J., 2020. Palaeontological Impact Assessment For Proposed Extension Of Tormin mine, West Coast, South Africa.

Pickford, M. and Senut, B. 1997. Cainozoic mammals from coastal Namaqualand, South Africa. Palaeontologia Africana., 34, 199-217.

Pickford, M., and Senut, B. 2000. Geology and palaeobiology of the central and southern Namib Desert, southwestern Africa; Volume 1, Geology and history of study. Geological Survey of Namibia, Memoir 18. 155pp.

Philander, C and Rozendaal, A. 2015. Geology of the Cenozoic Namakwa Sands Heavy Mineral Deposit, West Coast of South Africa: A World-Class Resource of Titanium and Zircon. Economic Geology 110: 1577-1632.

Roberts, D.L. & Mthembi, P. 2015. Lithostratigraphy of the Graauw Duinen Formation (Cenozoic West Coast Group), South Africa. South African Journal of Geology 118: 331-334.

Roberts, D.L., Botha, G.A., Maud, R.R. and Pether, J. 2006. Coastal Cenozoic Deposits (Chapter 30). In: Johnson, M. R., Anhaeusser, C. R. and Thomas, R. J. (eds.), The Geology of South Africa. Geological Society of South Africa, Johannesburg/Council for Geoscience, Pretoria: 605-628.

Rogers, J., Pether, J., Molyneux, R., Hill, R.S., Kilham, J.L.C., Cooper, G. and Corbett, I. 1990. Cenozoic geology and mineral deposits along the west coast of South Africa and the Sperrgebiet.

Guidebook Geocongress '90 Geological Society of South Africa, PR1: 1 111.

Siddall, M., Chappell, J. and Potter, E.-K. 2007. Eustatic sea level during past interglacials. The Climate of Past Interglacials: Developments in Quaternary Science 7: 75-92.

Stynder, D & Reed, K. 2015. Permit application for archaeological and palaeontological excavations at CP-537 on the farm Geelwal Karoo 262.

Stynder, D. 2012. Report on Permit 2009/05/01 – Cliff Point 1. Heritage Western Cape.

Verboom, G. A., Archibald, J. K., Bakker, F. T., Bellstedt, D. U., Conrad, F., Dreyer, L. L., Forest, F., Galley, C., Goldblatt, P., Henning, J. F., Mummenhoff, K., Linder, H. P., Muasya, A. M., Oberlander, K. C., Savolainen, V., Snijman, D. A., van der Niet, T. & Nowell, T. L. 2009 Origin and diversification of the Greater Cape flora: Ancient species repository, hot-bed of recent radiation, or both? Molecular Phylogenetics and Evolution 51: 44–53.

Visser, H.N. & Toerien, D.K. 1969. Map Sheet 254: 3118C (Doringbaai) & 3218A (Lamberts Bay). Geological Survey of South Africa.

Visser, H.N. & Toerien, D.K. 1971. Die geologie van die gebied tussen Vredendal en Elandsbaai.

Explanation of Sheet 254: 3118C (Doring Bay) and 3218A (Lambert's Bay). Geological Survey of South Africa. 63 pp.

Zachos, J. C., Dickens G. R., Zeebe, R. E. 2008. An early Cenozoic perspective on greenhouse warming and carboncycle dynamics. Nature 451: 279–283.

Appendix A: CURRICULUM VITAE

ELIZE BUTLER

PROFESSION: Palaeontologist

YEARS' EXPERIENCE: 26 years in Palaeontology

EDUCATION: B.Sc Botany and Zoology, 1988

University of the Orange Free State

B.Sc (Hons) Zoology, 1991

University of the Orange Free State

Management Course, 1991

University of the Orange Free State

M. Sc. *Cum laude* (Zoology), 2009

University of the Free State

Dissertation title: The postcranial skeleton of the Early Triassic non-mammalian Cynodont *Galesaurus planiceps*: implications for biology and lifestyle

MEMBERSHIP

Palaeontological Society of South Africa (PSSA) 2006-currently

EMPLOYMENT HISTORY

Part-time Laboratory assistant — Department of Zoology & Entomology University of the Free State Zoology 1989-1992

Part-time laboratory assistant Department of Virology

University of the Free State Zoology 1992

Research Assistant National Museum, Bloemfontein 1993 – 1997

Principal Research Assistant National Museum, Bloemfontein

and Collection Manager 1998–currently

TECHNICAL REPORTS

Butler, E. 2014. Palaeontological Impact Assessment of the proposed development of private dwellings on portion 5 of farm 304 Matjesfontein Keurboomstrand, Knysna District, Western Cape Province. Bloemfontein.

Butler, E. 2014. Palaeontological Impact Assessment for the proposed upgrade of existing water supply infrastructure at Noupoort, Northern Cape Province. 2014. Bloemfontein.

Butler, E. 2015. Palaeontological impact assessment of the proposed consolidation, re-division, and development of 250 serviced erven in Nieu-Bethesda, Camdeboo local municipality, Eastern Cape. Bloemfontein.

Butler, E. 2015. Palaeontological impact assessment of the proposed mixed land developments at Rooikraal 454, Vrede, Free State. Bloemfontein.

Butler, E. 2015. Palaeontological exemption report of the proposed truck stop development at Palmiet 585, Vrede, Free State. Bloemfontein.

Butler, E. 2015. Palaeontological impact assessment of the proposed Orange Grove 3500 residential development, Buffalo City Metropolitan Municipality East London, Eastern Cape. Bloemfontein.

Butler, E. 2015. Palaeontological Impact Assessment of the proposed Gonubie residential development, Buffalo City Metropolitan Municipality East London, Eastern Cape Province. Bloemfontein.

Butler, E. 2015. Palaeontological Impact Assessment of the proposed Ficksburg raw water pipeline. Bloemfontein.

Butler, E. 2015. Palaeontological Heritage Impact Assessment report on the establishment of the 65 mw Majuba Solar Photovoltaic facility and associated infrastructure on portion 1, 2 and 6 of the farm Witkoppies 81 HS, Mpumalanga Province. Bloemfontein.

Butler, E. 2015. Palaeontological Impact Assessment of the proposed township establishment on the remainder of portion 6 and 7 of the farm Sunnyside 2620, Bloemfontein, Mangaung metropolitan municipality, Free State, Bloemfontein.

Butler, E. 2015. Palaeontological Impact Assessment of the proposed Woodhouse 1 photovoltaic solar energy facilities and associated infrastructure on the farm Woodhouse729, near Vryburg, North West Province. Bloemfontein.

Butler, E. 2015. Palaeontological Impact Assessment of the proposed Woodhouse 2 photovoltaic solar energy facilities and associated infrastructure on the farm Woodhouse 729, near Vryburg, North West Province. Bloemfontein.

Butler, E. 2015.Palaeontological Impact Assessment of the proposed Orkney solar energy farm and associated infrastructure on the remaining extent of Portions 7 and 21 of the farm Wolvehuis 114, near Orkney, North West Province. Bloemfontein.

Butler, E. 2015. Palaeontological Impact Assessment of the proposed Spectra foods broiler houses and abattoir on the farm Maiden Manor 170 and Ashby Manor 171, Lukhanji Municipality, Queenstown, Eastern Cape Province. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment of the proposed construction of the 150 MW Noupoort concentrated solar power facility and associated infrastructure on portion 1 and 4 of the farm Carolus Poort 167 and the remainder of Farm 207, near Noupoort, Northern Cape. Prepared for Savannah Environmental. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment of the proposed Woodhouse 1 Photovoltaic Solar Energy facility and associated infrastructure on the farm Woodhouse 729, near Vryburg, North West Province. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment of the proposed Woodhouse 2 Photovoltaic Solar Energy facility and associated infrastructure on the farm Woodhouse 729, near Vryburg, North West Province. Bloemfontein.

Butler, E. 2016. Proposed 132kV overhead power line and switchyard station for the authorised Solis Power 1 CSP project near Upington, Northern Cape. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment of the proposed Senqu Pedestrian Bridges in Ward 5 of Senqu Local Municipality, Eastern Cape Province. Bloemfontein.

Butler, E. 2016. Recommendation from further Palaeontological Studies: Proposed Construction of the Modderfontein Filling Station on Erf 28 Portion 30, Founders Hill, City of Johannesburg, Gauteng Province. Bloemfontein.

Butler, E. 2016. Recommendation from further Palaeontological Studies: Proposed Construction of the Modikwa Filling Station on a Portion of Portion 2 of Mooihoek 255 Kt, Greater Tubatse Local Municipality, Limpopo Province. Bloemfontein.

Butler, E. 2016. Recommendation from further Palaeontological Studies: Proposed Construction of the Heidedal filling station on Erf 16603, Heidedal Extension 24, Mangaung Local Municipality, Bloemfontein, Free State Province. Bloemfontein.

Butler, E. 2016. Recommended Exemption from further Palaeontological studies: Proposed Construction of the Gunstfontein Switching Station, 132kv Overhead Power Line (Single or Double Circuit) and ancillary infrastructure for the Gunstfontein Wind Farm Near Sutherland, Northern Cape Province. Savannah South Africa. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment of the proposed Galla Hills Quarry on the remainder of the farm Roode Krantz 203, in the Lukhanji Municipality, division of Queenstown, Eastern Cape Province. Bloemfontein.

Butler, E. 2016. Chris Hani District Municipality Cluster 9 water backlog project phases 3a and 3b: Palaeontology inspection at Tsomo WTW. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment of the proposed construction of the 150 MW Noupoort concentrated solar power facility and associated infrastructure on portion 1 and 4 of the farm Carolus Poort 167 and the remainder of Farm 207, near Noupoort, Northern Cape. Savannah South Africa. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment of the proposed upgrading of the main road MR450 (R335) from Motherwell to Addo within the Nelson Mandela Bay Municipality and Sunday's River valley Local Municipality, Eastern Cape Province. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment construction of the proposed Metals Industrial Cluster and associated infrastructure near Kuruman, Northern Cape Province. Savannah South Africa. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment for the proposed construction of up to a 132kv power line and associated infrastructure for the proposed Kalkaar Solar Thermal Power Plant near Kimberley, Free State and Northern Cape Provinces. PGS Heritage. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment of the proposed development of two burrow pits (DR02625 and DR02614) in the Enoch Mgijima Municipality, Chris Hani District, Eastern Cape.

Butler, E. 2016. Ezibeleni waste Buy-Back Centre (near Queenstown), Enoch Mgijima Local Municipality, Eastern Cape. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment for the proposed construction of two 5 Mw Solar Photovoltaic Power Plants on Farm Wildebeestkuil 59 and Farm Leeuwbosch 44, Leeudoringstad, North West Province. Bloemfontein.

Butler, E. 2016. Palaeontological Impact Assessment for the proposed development of four Leeuwberg Wind farms and basic assessments for the associated grid connection near Loeriesfontein, Northern Cape Province. Bloemfontein.

Butler, E. 2016. Palaeontological impact assessment for the proposed Aggeneys south prospecting right project, Northern Cape Province. Bloemfontein.

Butler, E. 2016. Palaeontological impact assessment of the proposed Motuoane Ladysmith Exploration right application, KwaZulu Natal. Bloemfontein.

Butler, E. 2016. Palaeontological impact assessment for the proposed construction of two 5 MW solar photovoltaic power plants on farm Wildebeestkuil 59 and farm Leeuwbosch 44, Leeudoringstad, North West Province. Bloemfontein.

Butler, E. 2016: Palaeontological desktop assessment of the establishment of the proposed residential and mixed-use development on the remainder of portion 7 and portion 898 of the farm Knopjeslaagte 385 Ir, located near Centurion within the Tshwane Metropolitan Municipality of Gauteng Province. Bloemfontein.

Butler, E. 2017. Palaeontological impact assessment for the proposed development of a new cemetery, near Kathu, Gamagara local municipality and John Taolo Gaetsewe district municipality, Northern Cape. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of The Proposed Development of The New Open Cast Mining Operations on The Remaining Portions Of 6, 7, 8 And 10 Of the Farm Kwaggafontein 8 In the Carolina Magisterial District, Mpumalanga Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the Proposed Development of a Wastewater Treatment Works at Lanseria, Gauteng Province. Bloemfontein.

Butler, E. 2017. Palaeontological Scoping Report for the Proposed Construction of a Warehouse and Associated Infrastructure at Perseverance in Port Elizabeth, Eastern Cape Province.

Butler, E. 2017. Palaeontological Desktop Assessment for the Proposed Establishment of a Diesel Farm and a Haul Road for the Tshipi Borwa mine Near Hotazel, In the John Taolo Gaetsewe District Municipality in the Northern Cape Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the Proposed Changes to Operations at the UMK Mine near Hotazel, In the John Taolo Gaetsewe District Municipality in the Northern Cape Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment for the Development of the Proposed Ventersburg Project-An Underground Mining Operation near Ventersburg and Henneman, Free State Province. Bloemfontein.

Butler, E. 2017. Palaeontological desktop assessment of the proposed development of a 3000 MW combined cycle gas turbine (CCGT) in Richards Bay, Kwazulu-Natal. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment for the Development of the Proposed Revalidation of the lapsed General Plans for Elliotdale, Mbhashe Local Municipality. Bloemfontein.

Butler, E. 2017. Palaeontological assessment of the proposed development of a 3000 MW Combined Cycle Gas Turbine (CCGT) in Richards Bay, Kwazulu-Natal. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed development of the new open cast mining operations on the remaining portions of 6, 7, 8 and 10 of the farm Kwaggafontein 8 10 in the Albert Luthuli Local Municipality, Gert Sibande District Municipality, Mpumalanga Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed mining of the farm Zandvoort 10 in the Albert Luthuli Local Municipality, Gert Sibande District Municipality, Mpumalanga Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the proposed Lanseria outfall sewer pipeline in Johannesburg, Gauteng Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed development of open pit mining at Pit 36W (New Pit) and 62E (Dishaba) Amandelbult Mine Complex, Thabazimbi, Limpopo Province. Bloemfontein.

Butler, E. 2017. Palaeontological impact assessment of the proposed development of the sport precinct and associated infrastructure at Merrifield Preparatory school and college, Amathole Municipality, East London. PGS Heritage. Bloemfontein.

Butler, E. 2017. Palaeontological impact assessment of the proposed construction of the Lehae training and fire station, Lenasia, Gauteng Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed development of the new open cast mining operations of the Impunzi mine in the Mpumalanga Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the construction of the proposed Viljoenskroon Munic 132 KV line, Vierfontein substation and related projects. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed rehabilitation of 5 ownerless asbestos mines. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed development of the Lephalale coal and power project, Lephalale, Limpopo Province, Republic of South Africa. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed construction of a 132KV powerline from the Tweespruit distribution substation (in the Mantsopa local municipality) to the Driedorp rural substation (within the Naledi local municipality), Free State province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed development of the new coal-fired power plant and associated infrastructure near Makhado, Limpopo Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed construction of a Photovoltaic Solar Power station near Collett substation, Middelburg, Eastern Cape. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment for the proposed township establishment of 2000 residential sites with supporting amenities on a portion of farm 826 in Botshabelo West, Mangaung Metro, Free State Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the proposed prospecting right project without bulk sampling, in the Koa Valley, Northern Cape Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the proposed Aroams prospecting right project, without bulk sampling, near Aggeneys, Northern Cape Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed Belvior aggregate quarry II on portion 7 of the farm Maidenhead 169, Enoch Mgijima Municipality, division of Queenstown, Eastern Cape. Bloemfontein.

Butler, E. 2017. PIA site visit and report of the proposed Galla Hills Quarry on the remainder of the farm Roode Krantz 203, in the Lukhanji Municipality, division of Queenstown, Eastern Cape Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed construction of Tina Falls Hydropower and associated power lines near Cumbu, Mthlontlo Local Municipality, Eastern Cape. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed construction of the Mangaung Gariep Water Augmentation Project. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed Belvoir aggregate quarry II on portion 7 of the farm Maidenhead 169, Enoch Mgijima Municipality, division of Queenstown, Eastern Cape. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed construction of the Melkspruit-Rouxville 132KV Power line. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed development of a railway siding on a Portion of portion 41 of the farm Rustfontein 109 is, Govan Mbeki local municipality, Gert Sibande district municipality, Mpumalanga Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed consolidation of the proposed Ilima Colliery in the Albert Luthuli local municipality, Gert Sibande District Municipality, Mpumalanga Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed extension of the Kareerand Tailings Storage Facility, associated borrow pits as well as a storm water drainage channel in the Vaal River near Stilfontein, North West Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed construction of a filling station and associated facilities on the Erf 6279, district municipality of John Taolo Gaetsewe District, Ga-Segonyana Local Municipality Northern Cape. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed of the Lephalale Coal and Power Project, Lephalale, Limpopo Province, Republic of South Africa. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed Overvaal Trust PV Facility, Buffelspoort, North West Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed development of the $H_2$ Energy Power Station and associated infrastructure on Portions 21; 22 And 23 of the farm Hartebeestspruit in the Thembisile Hani Local Municipality, Nkangala District near Kwamhlanga, Mpumalanga Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed upgrade of the Sandriver Canal and Klippan Pump station in Welkom, Free State Province. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed upgrade of the 132kv and 11kv power line into a dual circuit above ground power line feeding into the Urania substation in Welkom, Free State Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment of the proposed Swaziland-Mozambique border patrol road and Mozambique barrier structure. Bloemfontein.

Butler, E. 2017. Palaeontological Impact Assessment of the proposed diamonds alluvial & diamonds general prospecting right application near Christiana on the remaining extent of portion 1 of the farm Kaffraria 314, registration division HO, North West Province. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the proposed development of Wastewater Treatment Works on Hartebeesfontein, near Panbult, Mpumalanga. Bloemfontein.

Butler, E. 2017. Palaeontological Desktop Assessment for the proposed development of Wastewater Treatment Works on Rustplaas near Piet Retief, Mpumalanga. Bloemfontein.

Butler, E. 2018. Palaeontological Impact Assessment for the Proposed Landfill Site in Luckhoff, Letsemeng Local Municipality, Xhariep District, Free State. Bloemfontein.

Butler, E. 2018. Palaeontological Impact Assessment of the proposed development of the new Mutsho coal-fired power plant and associated infrastructure near Makhado, Limpopo Province. Bloemfontein.

Butler, E. 2018. Palaeontological Impact Assessment of the authorisation and amendment processes for Manangu mine near Delmas, Victor Khanye local municipality, Mpumalanga. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment for the proposed Mashishing township establishment in Mashishing (Lydenburg), Mpumalanga Province. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment for the Proposed Mlonzi Estate Development near Lusikisiki, Ngquza Hill Local Municipality, Eastern Cape. Bloemfontein.

Butler, E. 2018. Palaeontological Phase 1 Assessment of the proposed Swaziland-Mozambique border patrol road and Mozambique barrier structure. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment for the proposed electricity expansion project and Sekgame Switching Station at the Sishen Mine, Northern Cape Province. Bloemfontein.

Butler, E. 2018. Palaeontological field assessment of the proposed construction of the Zonnebloem Switching Station (132/22kV) and two loop-in loop-out power lines (132kV) in the Mpumalanga Province. Bloemfontein.

Butler, E. 2018. Palaeontological Field Assessment for the proposed re-alignment and de-commissioning of the Firham-Platrand 88kv Powerline, near Standerton, Lekwa Local Municipality, Mpumalanga province. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment of the proposed Villa Rosa development In the Buffalo City Metropolitan Municipality, East London. Bloemfontein.

Butler, E. 2018. Palaeontological field Assessment of the proposed Villa Rosa development In the Buffalo City Metropolitan Municipality, East London. Bloemfontein.

Butler, E. 2018. Palaeontological desktop assessment of the proposed Mookodi – Mahikeng 400kV line, North West Province. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment for the proposed Thornhill Housing Project, Ndlambe Municipality, Port Alfred, Eastern Cape Province. Bloemfontein.

Butler, E. 2018. Palaeontological desktop assessment of the proposed housing development on portion 237 of farm Hartebeestpoort 328. Bloemfontein.

Butler, E. 2018. Palaeontological desktop assessment of the proposed New Age Chicken layer facility located on holding 75 Endicott near Springs in Gauteng. Bloemfontein.

Butler, E. 2018 Palaeontological Desktop Assessment for the development of the proposed Leslie 1 Mining Project near Leandra, Mpumalanga Province. Bloemfontein.

Butler, E. 2018. Palaeontological field assessment of the proposed development of the Wildealskloof mixed use development near Bloemfontein, Free State Province. Bloemfontein.

Butler, E. 2018. Palaeontological Field Assessment of the proposed Megamor Extension, East London. Bloemfontein

Butler, E. 2018. Palaeontological Impact Assessment of the proposed diamonds Alluvial & Diamonds General Prospecting Right Application near Christiana on the Remaining Extent of Portion 1 of the Farm Kaffraria 314, Registration Division HO, North West Province. Bloemfontein.

Butler, E. 2018. Palaeontological Impact Assessment of the proposed construction of a new 11kV (1.3km) Power Line to supply electricity to a cell tower on farm 215 near Delportshoop in the Northern Cape. Bloemfontein.

Butler, E. 2018. Palaeontological Field Assessment of the proposed construction of a new 22 kV single wood pole structure power line to the proposed MTN tower, near Britstown, Northern Cape Province. Bloemfontein.

Butler, E. 2018. Palaeontological Exemption Letter for the proposed reclamation and reprocessing of the City Deep Dumps in Johannesburg, Gauteng Province. Bloemfontein.

Butler, E. 2018. Palaeontological Exemption letter for the proposed reclamation and reprocessing of the City Deep Dumps and Rooikraal Tailings Facility in Johannesburg, Gauteng Province. Bloemfontein.

Butler, E. 2018. Proposed Kalabasfontein Mine Extension project, near Bethal, Govan Mbeki District Municipality, Mpumalanga. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment for the development of the proposed Leslie 1 Mining Project near Leandra, Mpumalanga Province. Bloemfontein.

Butler, E. 2018. Palaeontological Desktop Assessment of the proposed Mookodi – Mahikeng 400kV Line, North West Province. Bloemfontein.

Butler, E. 2018. Environmental Impact Assessment (EIA) for the Proposed 325mw Rondekop Wind Energy Facility between Matjiesfontein and Sutherland in the Northern Cape Province.

Butler, E. 2018. Palaeontological Impact Assessment of the proposed construction of the Tooverberg Wind Energy Facility, and associated grid connection near Touws River in the Western Cape Province. Bloemfontein.

Butler, E. 2018. Palaeontological impact assessment of the proposed Kalabasfontein Mining Right Application, near Bethal, Mpumalanga.

Butler, E., 2019. Palaeontological Desktop Assessment of the proposed Westrand Strengthening Project Phase II.

Butler, E., 2019. Palaeontological Field Assessment for the proposed Sirius 3 Photovoltaic Solar Energy Facility near Upington, Northern Cape Province

Butler, E., 2019. Palaeontological Field Assessment for the proposed Sirius 4 Photovoltaic Solar Energy Facility near Upington, Northern Cape Province

Butler, E., 2019. Palaeontological Field Assessment for Heuningspruit PV 1 Solar Energy Facility near Koppies, Ngwathe Local Municipality, Free State Province.

Butler, E., 2019. Palaeontological Field Assessment for the Moeding Solar Grid Connection, North West Province.

Butler, E., 2019. Recommended Exemption from further Palaeontological studies for the Proposed Agricultural Development on Farms 1763, 2372 And 2363, Kakamas South Settlement, Kai! Garib Municipality, Mgcawu District Municipality, Northern Cape Province.

Butler, E., 2019. Recommended Exemption from further Palaeontological studies: of Proposed Agricultural Development, Plot 1178, Kakamas South Settlement, Kai! Garib Municipality

Butler, E., 2019. Palaeontological Desktop Assessment for the Proposed Waste Rock Dump Project at Tshipi Borwa Mine, near Hotazel, Northern Cape Province:

Butler, E., 2019. Palaeontological Exemption Letter for the proposed DMS Upgrade Project at the Sishen Mine, Gamagara Local Municipality, Northern Cape Province

Butler, E., 2019. Palaeontological Desktop Assessment of the proposed Integrated Environmental Authorisation process for the proposed Der Brochen Amendment project, near Groblershoop, Limpopo

Butler, E., 2019. Palaeontological Desktop Assessment of the proposed updated Environmental Management Programme (EMPr) for the Assmang (Pty) Ltd Black Rock Mining Operations, Hotazel, Northern Cape

Butler, E., 2019. Palaeontological Desktop Assessment of the proposed Kriel Power Station Lime Plant Upgrade, Mpumalanga Province

Butler, E., 2019. Palaeontological Impact Assessment for the proposed Kangala Extension Project Near Delmas, Mpumalanga Province.

Butler, E., 2019. Palaeontological Desktop Assessment for the proposed construction of an iron/steel smelter at the Botshabelo Industrial area within the Mangaung Metropolitan Municipality, Free State Province.

Butler, E., 2019. Recommended Exemption from further Palaeontological studies for the proposed agricultural development on farms 1763, 2372 and 2363, Kakamas South settlement, Kai! Garib Municipality, Mgcawu District Municipality, Northern Cape Province.

Butler, E., 2019. Recommended Exemption from further Palaeontological Studies for Proposed formalisation of Gamakor and Noodkamp low-cost Housing Development, Keimoes, Gordonia Rd, Kai !Garib Local Municipality, ZF Mgcawu District Municipality, Northern Cape Province.

Butler, E., 2019. Recommended Exemption from further Palaeontological Studies for proposed formalisation of Blaauwskop Low-Cost Housing Development, Kenhardt Road, Kai !Garib Local Municipality, ZF Mgcawu District Municipality, Northern Cape Province.

Butler, E., 2019. Palaeontological Desktop Assessment of the proposed mining permit application for the removal of diamonds alluvial and diamonds kimberlite near Windsorton on a certain portion of Farm Zoelen's Laagte 158, Registration Division: Barkly Wes, Northern Cape Province.

Butler, E., 2019. Palaeontological Desktop Assessment of the proposed Vedanta Housing Development, Pella Mission 39, Khâi-Ma Local Municipality, Namakwa District Municipality, Northern Cape.

Butler, E., 2019. Palaeontological Desktop Assessment for The Proposed 920 KWP Groenheuwel Solar Plant Near Augrabies, Northern Cape Province

Butler, E., 2019. Palaeontological Desktop Assessment for the establishment of a Super Fines Storage Facility at Amandelbult Mine, Near Thabazimbi, Limpopo Province

**Butler, E., 2019.** Palaeontological Impact Assessment for the proposed Sace Lifex Project, Near Emalahleni, Mpumalanga Province

**Butler, E., 2019.** Palaeontological Desktop Assessment for the proposed Rehau Fort Jackson Warehouse Extension, East London

**Butler, E., 2019.** Palaeontological Desktop Assessment for the proposed Environmental Authorisation Amendment for moving 3 Km of the Merensky-Kameni 132KV Powerline

**Butler, E., 2019.** Palaeontological Impact Assessment for the proposed Umsobomvu Solar PV Energy Facilities, Northern and Eastern Cape

**Butler, E., 2019.** Palaeontological Desktop Assessment for six proposed Black Mountain Mining Prospecting Right Applications, without Bulk Sampling, in the Northern Cape.

**Butler, E., 2019.** Palaeontological field Assessment of the Filling Station (Rietvlei Extension 6) on the Remaining Portion of Portion 1 of the Farm Witkoppies 393JR east of the Rietvleidam Nature Reserve, City of Tshwane, Gauteng

**Butler, E., 2019.** Palaeontological Desktop Assessment of The Proposed Upgrade of The Vaal Gamagara Regional Water Supply Scheme: Phase 2 And Groundwater Abstraction

**Butler, E., 2019.** Palaeontological Desktop Assessment of The Expansion of The Jan Kempdorp Cemetery on Portion 43 Of Farm Guldenskat 36-Hn, Northern Cape Province

**Butler, E., 2019.** Palaeontological Desktop Assessment of the Proposed Residential Development on Portion 42 Of Farm Geldunskat No 36 In Jan Kempdorp, Phokwane Local Municipality, Northern Cape Province

**Butler, E.,** 2019. Palaeontological Impact Assessment of the proposed new Township Development, Lethabo Park, on Remainder of Farm Roodepan No 70, Erf 17725 And Erf 15089, Roodepan Kimberley, Sol Plaatjies Local Municipality, Frances Baard District Municipality, Northern Cape

**Butler, E.,** 2019. Palaeontological Protocol for Finds for the proposed 16m WH Battery Storage System in Steinkopf, Northern Cape Province

**Butler, E.,** 2019. Palaeontological Exemption Letter of the proposed 4.5WH Battery Storage System near Midway-Pofadder, Northern Cape Province

**Butler, E.,** 2019. Palaeontological Exemption Letter of the proposed 2.5ml Process Water Reservoir at Gloria Mine, Black Rock, Hotazel, Northern Cape

**Butler, E.,** 2019. Palaeontological Desktop Assessment for the Establishment of a Super Fines Storage Facility at Gloria Mine, Black Rock Mine Operations, Hotazel, Northern Cape:

**Butler, E.,** 2019. Palaeontological Desktop Assessment for the Proposed New Railway Bridge, and Rail Line Between Hotazel and the Gloria Mine, Northern Cape Province

**Butler, E.,** 2019. Palaeontological Exemption Letter of The Proposed Mixed Use Commercial Development on Portion 17 of Farm Boegoeberg Settlement Number 48, !Kheis Local Municipality in The Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E.,** 2019. Palaeontological Desktop Assessment of the Proposed Diamond Mining Permit Application Near Kimberley, Sol Plaatjies Municipality, Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E.,** 2019. Palaeontological Desktop Assessment of the Proposed Diamonds (Alluvial, General & In Kimberlite) Prospecting Right Application near Postmasburg, Registration Division; Hay, Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E.,** 2019. Palaeontological Desktop Assessment of the proposed diamonds (alluvial, general & in kimberlite) prospecting right application near Kimberley, Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E.,** 2019. Palaeontological Phase 1 Impact Assessment of the proposed upgrade of the Vaal Gamagara regional water supply scheme: Phase 2 and groundwater abstraction. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E.,** 2019. Palaeontological Desktop Assessment of the proposed seepage interception drains at Duvha Power Station, Emalahleni Municipality, Mpumalanga Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E.,** 2019. Palaeontological Desktop Assessment letter for the Proposed PV Solar Facility at the Heineken Sedibeng Brewery, near Vereeniging, Gauteng. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E.,** 2019. Palaeontological Phase 1 Assessment for the Proposed PV Solar Facility at the Heineken Sedibeng Brewery, near Vereeniging, Gauteng. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E.,** 2019. Palaeontological field Assessment for the Proposed Upgrade of the Kolomela Mining Operations, Tsantsabane Local Municipality, Siyanda District Municipalitty, Northern Cape Province, Northern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E.,** 2019. Palaeontological Desktop Assessment of the proposed feldspar prospecting rights and mining application on portion 4 and 5 of the farm Rozynen 104, Kakamas South, Kai! Garib Municipality, Zf Mgcawu District Municipality, Northern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E.,** 2019. Palaeontological Phase 1 Field Assessment of the proposed Summerpride Residential Development and Associated Infrastructure on Erf 107, Buffalo City Municipality, East London. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E.,** 2019. Palaeontological Desktop Impact Assessment for the proposed re-commission of the Old Balgay Colliery near Dundee, KwaZulu Natal.

**Butler, E.,** 2019. Palaeontological Phase 1 Impact Assessment for the Proposed Re-Commission of the Old Balgay Colliery near Dundee, KwaZulu Natal. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E.,** 2019. Palaeontological Desktop Assessment for the Proposed Environmental Authorisation and Amendment Processes for Elandsfontein Colliery. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E.,** 2019. Palaeontological Impact Assessment and Protocol for Finds of a Proposed New Quarry on Portion 9 (of 6) of the farm Mimosa Glen 885, Bloemfontein, Free State Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E.,** 2019. Palaeontological Impact Assessment and Protocol for Finds of a proposed development on Portion 9 and 10 of the Farm Mimosa Glen 885, Bloemfontein, Free State Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E.,** 2019. Palaeontological Exemption Letter for the proposed residential development on the Remainder of Portion 1 of the Farm Strathearn 2154 in the Magisterial District of Bloemfontein, Free State. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E.,** 2019. Palaeontological Field Assessment for the Proposed Nigel Gas Transmission Pipeline Project in the Nigel Area of the Ekurhuleni Metropolitan Municipality, Gauteng Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E.,** 2019. Palaeontological Desktop Assessment for five Proposed Black Mountain Mining Prospecting Right Applications, Without Bulk Sampling, in the Northern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E.** 2019. Palaeontological Desktop Assessment for the Proposed Environmental Authorisation and an Integrated Water Use Licence Application for the Reclamation of the Marievale Tailings Storage Facilities, Ekurhuleni Metropolitan Municipality - Gauteng Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E.,** 2019. Palaeontological Impact Assessment for the Proposed Sace Lifex Project, near Emalahleni, Mpumalanga Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E.,** 2019. Palaeontological Desktop Assessment for the proposed Golfview Colliery near Ermelo, Msukaligwa Local Municipality, Mpumalanga Province

**Butler, E.,** 2019. Palaeontological Desktop Assessment for the Proposed Kangra Maquasa Block C Mining development near Piet Retief, in the Mkhondo Local Municipality within the Gert Sibande District Municipality. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E.,** 2019. Palaeontological Desktop Assessment for the Proposed Amendment of the Kusipongo Underground and Opencast Coal Mine in Support of an Environmental Authorization and Waste Management License Application. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2019. Palaeontological Exemption Letter of the Proposed Mamatwan Mine Section 24g Rectification Application, near Hotazel, Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Field Assessment for the Proposed Environmental Authorisation and Amendment Processes for Elandsfontein Colliery. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Desktop Assessment for the Proposed Extension of the South African Nuclear Energy Corporation (Necsa) Pipe Storage Facility, Madibeng Local Municipality, North West Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Field Assessment for the Proposed Piggery on Portion 46 of the Farm Brakkefontien 416, Within the Nelson Mandela Bay Municipality, Eastern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological field Assessment for the proposed Rietfontein Housing Project as part of the Rapid Land Release Programme, Gauteng Province Department of Human Settlements, City of Johannesburg Metropolitan Municipality. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Desktop Assessment for the Proposed Choje Wind Farm between Grahamstown and Somerset East, Eastern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Desktop Assessment of the Proposed Prospecting Right Application for the Prospecting of Diamonds (Alluvial, General & In Kimberlite), Combined with A Waste License Application, Registration Division: Gordonia and Kenhardt, Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Impact Assessment for the Proposed Clayville Truck Yard, Ablution Blocks and Wash Bay to be Situated on Portion 55 And 56 Of Erf 1015, Clayville X11, Ekurhuleni Metropolitan Municipality, Gauteng Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Desktop Assessment for the Proposed Hartebeesthoek Residential Development. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Desktop Assessment for the Proposed Mooiplaats Educational Facility, Gauteng Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Impact Assessment for the Proposed Monument Park Student Housing Establishment. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Field Assessment for the Proposed Standerton X10 Residential and Mixed-Use Developments, Lekwa Local Municipality Standerton, Mpumalanga Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Field Assessment for the Rezoning and Subdivision of Portion 6 Of Farm 743, East London. Banzai Environmental (Pty) Ltd, Bloemfontein. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Field Assessment for the Proposed Matla Power Station Reverse Osmosis Plant, Mpumalanga Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Desktop Assessment of the Proposed Prospecting Right Application Without Bulk Sampling for the Prospecting of Diamonds Alluvial near Bloemhof on Portion 3 (Portion 1) of the Farm Boschpan 339, the Remaining Extent of Portion 8 (Portion 1), Portion 9 (Portion 1) and Portion 10 (Portion 1) and Portion 17 (Portion 1) of the Farm Panfontein 270, Registration Division: Ho, North West Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Desktop Assessment of the Proposed Prospecting Right Application Combined with a Waste Licence Application for the Prospecting of Diamonds Alluvial, Diamonds General and Diamonds near Wolmaransstad on the Remaining Extent, Portion 7 and Portion 8 Of Farm Rooibult 152, Registration Division: HO, North West Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Desktop Assessment of the Proposed Prospecting Right Application With Bulk Sampling combined with a Waste Licence Application for the Prospecting of Diamonds Alluvial (Da), Diamonds General (D), Diamonds (Dia) and Diamonds In Kimberlite (Dk) near Prieska On Portion 7, a certain Portion of the Remaining Extent of Portion 9 (Wouter), Portion 11 (De Hoek), Portion 14 (Stofdraai) (Portion of

Portion 4), the Remaining Extent of Portion 16 (Portion Of Portion 9) (Wouter) and the Remaining Extent of Portion 18 (Portion of Portion 10) of the Farm Lanyon Vale 376, Registration Division: Hay, Northern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Desktop Assessment of the Proposed Prospecting Right Area and Mining Permit Area near Ritchie on the Remaining Extent of Portion 3 (Anna's Hoop) of the Farm Zandheuvel 144, Registration Division: Kimberley, Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Desktop Assessment of the Proposed Okapi Diamonds (Pty) Ltd Mining Right of Diamonds Alluvial (Da) & Diamonds General (D) Combined with a Waste Licence Application on the Remaining Extent of Portion 9 (Wouter) of the Farm Lanyon Vale 376; Registration Division: Hay; Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Field Assessment of the Proposed Prospecting Right Application for the Prospecting of Diamonds (Alluvial & General) between Douglas and Prieska on Portion 12, Remaining Extent of Portion 29 (Portion of Portion 13) and Portion 31 (Portion of Portion 29) on the Farm Reads Drift 74, Registration Division; Herbert, Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Desktop Assessment for the Proposed Mining Permit Application Combined with a Waste License Application for the Mining of Diamonds (Alluvial) Near Schweitzer-Reneke on a certain Portion of Portion 12 (Ptn of Ptn 7) of the Farm Doornhoek 165, Registration Division: HO, North West Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Desktop Assessment for Black Mountain Koa South Prospecting Right Application, Without Bulk Sampling, in the Northern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Impact Assessment of the Proposed AA Bakery Expansion, Sedibeng District Municipality, Gauteng. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Desktop Assessment for the Proposed Boegoeberg Township Expansion,! Kheis Local Municipality, ZF Mgcawu District Municipality, Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Desktop Assessment for the Proposed Gariep Township Expansion, !Kheis Local Municipality, ZF Mgcawu District Municipality, Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Desktop Assessment for the Proposed Groblershoop Township Expansion, !Kheis Local Municipality, Zf Mgcawu District Municipality, Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Desktop Assessment for the Proposed Grootdrink Township Expansion, !Kheis Local Municipality, ZF Mgcawu District Municipality, Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Exemption Letter for the Proposed Opwag Township Expansion,! Kheis Local Municipality, ZF Mgcawu District Municipality, Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Exemption Letter for the Proposed Topline Township Expansion, !Kheis Local Municipality, ZF Mgcawu District Municipality, Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Desktop Assessment for the Proposed Wegdraai Township Expansion, !Kheis Local Municipality, Zf Mgcawu District Municipality, Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological field Assessment for the Proposed Establishment of an Emulsion Plant on Erf 1559, Hardustria, Harrismith, Free State. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler. 2020. Part 2 Environmental Authorisation (EA) Amendment Process for the Kudusberg Wind Energy Facility (WEF) near Sutherland, Western and Northern Cape Provinces- Palaeontological Impact Assessment. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Desktop Assessment Proposed for the Construction and Operation of the Battery Energy Storage System (BESS) and Associated Infrastructure and inclusion of Additional Listed Activities for the Authorised Droogfontein 3 Solar Photovoltaic (PV) Energy Facility Located near Kimberley in the Sol Plaatje Local Municipality, Francis Baard District Municipality, in the Northern Cape Province of South Africa. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Impact Assessment for the Proposed Development of a Cluster of Renewable Energy Facilities between Somerset East and Grahamstown in the Eastern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Desktop Assessment for the Proposed Amaoti Secondary School, Pinetown, eThekwini Metropolitan Municipality KwaZulu Natal. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Impact Assessment for the Proposed an Inland Diesel Depot, Transportation Pipeline and Associated Infrastructure on Portion 5 of the Farm Franshoek No. 1861, Swinburne, Free State Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Impact Assessment for the proposed erosion control gabion installation at Alpine Heath Resort on the farm Akkerman No 5679 in the Bergville district Kwazulu-Natal. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Impact Assessment for the proposed Doornkloof Residential development on portion 712 of the farm Doornkloof 391 Jr, City of Tshwane Metropolitan Municipality in Gauteng, South Africa. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Desktop Assessment for the Proposed Expansion of the Square *Kilometre* Array (SKA) Meerkat Project, on the Farms Mey's Dam RE/68, Brak Puts RE /66, Swartfontein RE /496 & Swartfontein 2/496, in the Kareeberg Local Municipality, Pixley Ka Seme District Municipality, and the Farms Los Berg 1/73 & Groot Paardekloof RE /74, in the Karoo Hoogland Local Municipality, Namakwa District Municipality, Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Desktop Assessment for De Beers Consolidated Mines: Proposed Drilling on Portion 6 of Scholtzfontein 165 and Farm Arnotsdale 175, Herbert District in the Northern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Desktop Assessment for De Beers Consolidated Mines: Proposed Drilling on the Remaining Extent of Biessie Laagte 96, and Portion 2 and 6 of Aasvogel Pan 141, Near Hopetown in the Northern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Desktop Assessment for De Beers Consolidated Mines: Proposed Drilling in the North West Province: on Portions 7 (RE) (of Portion 3), 11, 12 (of Portion 3), 34 (of Portion 30), 35 (of Portion 7) of the Farm Holfontein 147 IO and Portions 1, 2 and the RE) of the Farm Kareeboschbult 76 Ip and Portions 1, 2, 4, 5, 6, (of Portion 3), 7 (of Portion 3), 13, 14, and the Re of the farm Oppaslaagte 100IP and portions 25 (of Portion 24) and 30 of the farm Slypsteen 102 IP. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Desktop Assessment for the Proposed Expansion of the Cavalier Abattoir on farm Oog Van Boekenhoutskloof of Tweefontein 288 JR, near Cullinan, City of Tshwane Metropolitan Municipality, Gauteng. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Impact Assessment for the Proposed Doornkloof Residential Development on Portion 712 of the Farm Doornkloof 391 JR, City of Tshwane Metropolitan Municipality in Gauteng, South Africa. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Desktop Assessment for the proposed High Density Social Housing Development on part of the Remainder of Portion 171 and part of Portion 306 of the farm Derdepoort 326 JR, City of Tshwane. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Desktop Assessment for the proposed Red Rock Mountain Farm activities on Portions 2, 3 and 11 of the Farm Buffelskloof 22, near Calitzdorp in the Western Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Desktop Assessment for the proposed Mixed-use Development on a Part of Remainder of Portion 171 and Portion 306 of the farm Derdepoort 326 JR, City of Tshwane. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Impact Assessment for the Proposed Realignment of the D 2809 Provincial Road as well as the Mining Right Application for the Glisa and Paardeplaats Sections of the NBC Colliery (NBC) near Belfast (eMakhazeni), eMakhazeni Local Municipality, Nkangala District Municipality, Mpumalanga Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Desktop Assessment for the proposed construction of Whittlesea Cemetery within Enoch Mgijima Local Municipality area, Eastern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Impact Assessment for the establishment of a mixed-use development on Portion 0 the of Erf 700, Despatch, Nelson Mandela Bay Municipality, Eastern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Desktop Assessment for the proposed East Orchards Poultry Farm, Delmas/Botleng Transitional Local Council, Mpumalanga. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Impact Assessment for the proposed East Orchards Poultry Farm, Delmas/Botleng Transitional Local Council, Mpumalanga. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Desktop Assessment to assess the proposed Gariep Road upgrade near Groblershoop, Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Impact Assessment for the Ngwedi Solar Plant which forms part of the authorised Paleso Solar Powerplant near Viljoenskroon in the Free State. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Impact Assessment for the Noko Solar Power Plant and power line which forms part of the authorised Paleso Solar Powerplant near Orkney in the North West. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Impact Assessment for the Proposed Power Line as part of the Paleso Solar Power Plant near Viljoenskroon in the Free State. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Impact Assessment for the Thakadu Solar Plant which forms part of the authorised Paleso Solar Powerplant near Viljoenskroon in the Free State. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Desktop Assessment for the proposed Farming Expansions on Portions 50 of the Farm Rooipoort 555 JR, Portion 34 of the Farm Rooipoort 555 JR, Portions 20 and 49 of the Farm Rooipoort 555 JR and Portion 0(RE) of the Farm Oudou Boerdery 626 JR, Tshwane Metropolitan Municipality, Gauteng Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Desktop Assessment for the proposed Saselamani CBD on the Remainder of Tshikundu's Location 262 MT, and the Remainder of Portion 1 of Tshikundu's Location 262 MT, Collins Chabane Local Municipality, Limpopo Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Impact Assessment for the proposed expansions of the existing Molare Piggery infrastructure and related activities on Portion 0(Re) of the farm Arendsfontein 464 JS, Portion 0(Re) of the farm Wanhoop 443 JS, Portion 0(Re) of the farm Eikeboom 476 JS and Portions 2 & 7 of the farm Klipbank 467 JS within the jurisdiction of the Steve Tshwete Local Municipality, Mpumalanga Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Desktop Assessment for the proposed Nchwaning Rail Balloon Turn Outs at Black Rock Mine Operations (BRMO) near Hotazel in the John Taolo Gaetsewe District Municipality in the Northern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Desktop Assessment for the proposed Black Rock Mining Operations (BRMO) new rail loop and stacker reclaimer Project at Gloria Mine near Hotazel in the Northern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2020. Palaeontological Desktop Assessment for the proposed Nchwaning Rail Balloon Turn Outs at Black Rock Mine Operations (BRMO) near Hotazel in the John Taolo Gaetsewe District Municipality in the Northern Cape.

**Butler, E., 2021.** Palaeontological Impact Assessment for the proposed utilization of one Borrow Pit for the planned Clarkebury DR08034 Road Upgrade, Engcobo Local Municipality, Eastern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E., 2021.** Palaeontological Desktop Assessment for the proposed Kappies Kareeboom Prospecting Project on Portion 1 and the Remainder of the farm Kappies Kareeboom 540, the Remainder of Farm 544, Portion 5 of farm 534 and Portion 1 of the farm Putsfontein 616, ZF Mgcawu District Municipality, Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E., 2021.** Palaeontological Desktop Assessment for the proposed Kameel Fontein Prospecting Project on the Remainder of the farm Kameel Fontein 490, a portion of the farm Strydfontein 614 and the farm Soetfontein 606, ZF Mgcawu District Municipality, Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E., 2021.** Palaeontological Desktop Assessment for the proposed Lewis Prospecting Project on Portions of the Farms Lewis 535, Spence 537, Wright 538, Symthe 566, Bredenkamp 567, Brooks 568, Beaumont 569 and Murray 570, John Taolo Gaetsewe District Municipality in the Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E., 2021.** Palaeontological Desktop Assessment for the Construction of the Ganspan Pering 132kV Powerline, Phokwane Local Municipality, Frances Baard District Municipality in the Northern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E., 2021.** Palaeontological Desktop Assessment for the Longlands Prospecting Project on a Portion of the farm Longlands 350, Frances Baard District Municipality, Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E., 2021.** Palaeontological Impact Assessment for the proposed development of 177 new units in the northern section of Mpongo Park in the Eastern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E., 2021.** Palaeontological Desktop Assessment for the proposed Qhumanco Irrigation Project, Chris Hani District Municipality Eastern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E., 2021.** Palaeontological Desktop Assessment for the proposed Raphuti Settlement Project on Portions of the Farm Weikrans 539KQ in the Waterberg District Municipality of the Limpopo Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E., 2021.** Palaeontological Impact Assessment for the Senqu Rural Project, Joe Gqabi District Municipality, Senqu Local Municipality, in the Eastern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E., 2021.** Palaeontological Impact Assessment for the proposed new Township development on portion of the farm Klipfontein 716 and farm Ceres 626 in Bloemfontein, Mangaung Metropolitan Municipality, Free State. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E., 2021.** Palaeontological Desktop Assessment for the ECDOT Borrow Pits and WULA near Sterkspruit, Joe Gqabi District Municipality in the Eastern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E., 2021.** Palaeontological Desktop Assessment for the proposed SANRAL Stone Crescent Embankment Stabilisation Works along the N2 on the farm Zyfer Fonteyn 253 (Portion 0, 11 and 12RE) and Palmiet Rivier 305 (Portion 34, 36) near Grahamstown in the Eastern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E., 2021.** Palaeontological Impact Assessment for the Klein Rooipoort Trust Citrus Development, in the Eastern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E., 2021.** Palaeontological Impact Assessment for the proposed Victoria West water augmentation project in the Northern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E., 2021.** Palaeontological Desktop Assessment for the proposed Campbell Sewer, Internal Reticulation, Outfall Sewer Line and Oxidation Ponds, located on ERF 1, Siyancuma Local Municipality in the Northern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E., 2021.** Palaeontological Desktop Assessment for the proposed Development and Upgrades within the Great Fish River Nature Reserve, Eastern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Desktop Assessment for proposed Parsons Power Park a portion of Erf 1. within the Nelson Mandela Bay Municipality in the Eastern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Desktop Assessment for the proposed expansion of the farming operations on part of portions 7 and 8 of farm Boerboonkraal 353 in the Greater Tubatse Local Municipality of Sekhukhune District, Limpopo Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Desktop Assessment to assess the proposed low-level pedestrian bridge, in Heilbron, Free State. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Desktop Assessment to assess the proposed township developments in Hertzogville, Malebogo, in Heilbron, Free State. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Impact Assessment for the proposed construction of Malangazana Bridge on Farm No.64 Nkwenkwana, Engcobo Local Municipality, Eastern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Impact Assessment to assess the proposed Construction of Middelburg Integrated Transport Control Centre on Portion 14 of Farm 81 Division of Middelburg, Chris Hani District Municipality in the Eastern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Desktop Assessment for the Witteberge Sand Mine on the remainder of farm Elandskrag Plaas 269 located in the Magisterial District of Laingsburg and Central Karoo District Municipality in the Western Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Impact Assessment (PIA) to assess the proposed Agrizone 2, Dube Trade Port in KwaZulu Natal Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2021. Palaeontological Desktop Assessment assessing the proposed Prospecting Right application without bulk sampling for the prospecting of Chrome ore and platinum group metals on the Remaining Extent of the farm Doornspruit 106, Registration Division: HO; North West Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2022. Palaeontological Desktop Assessment for the proposed Ennerdale Extension 2 Township Establishment on the Undeveloped Part of Portion 134 of the Farm Roodepoort 302IQ, City of Johannesburg Metropolitan Municipality, Gauteng Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2022. Palaeontological Desktop Assessment for the Construction of the ESKOM Mesong 400kV Loop-In Loop-Out Project, Ekurhuleni Municipality, Gauteng Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2022. Palaeontological Desktop Assessment for the Proposed Vinci Prospecting Right Application on the Remainder of the Farm Vinci 580, ZF Mgcawu District Municipality, in the Northern Cape Province, Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2022. Palaeontological Desktop Assessment for the proposed Farm 431 Mining Right Application (MRA), near Postmasburg, ZF Mgcawu District Municipality, in the Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2022. Palaeontological Impact Assessment for the Leeuw Braakfontein Colliery Expansion Project (LBC) in the Amajuba District Municipality, KwaZulu-Natal. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2022. Palaeontological Desktop Assessment for the proposed reclamation of the 5L23 TSF in Ekurhuleni, Gauteng Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2022. Palaeontological Desktop Assessment for the Proposed Mogalakwena Mine Infrastructure Expansion (near Mokopane in the Mogalakwena Local Municipality, Limpopo Province). Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2022. Palaeontological Desktop Assessment for the proposed 10km Cuprum to Kronos Double Circuit 132kV Line and Associated Infrastructure in Copperton in the Northern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

Butler, E., 2022. Palaeontological Impact Assessment for the proposed Hoekplaas WEF near Victoria West in the Northern Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E., 2022.** Palaeontological Desktop Assessment (PDA) assessing the proposed Prospecting Right Application without bulk sampling for the Prospecting of Diamonds Alluvial (DA), Diamonds General (D), Diamonds in Kimberlite (DK) & Diamonds (DIA) on the Remaining Extent of the Farm Goede Hoop 547, Remaining Extent of the Farm 548, Remaining Extent of Portion 2 and Portion 3 of the Farm Skeyfontein 536, Registration Division: Hay, Northern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E., 2022.** Palaeontological Impact Assessment for the proposed extension of Duine Weg Road between Pellsrus and Marina Martinique as well as a Water Use Authorisation (WUA) for the project. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E., 2022.** Proposed Mimosa Residential Development and Associated Infrastructure on Fairview Erven, in Gqeberha (Port Elizabeth), Nelson Mandela Bay Metropolitan Municipality, Eastern Cape Province. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E., 2022.** Palaeontological Impact Assessment for the Witteberge Sand Mine on the remainder of farm Elandskrag Plaas 269 located in the Magisterial District of Laingsburg and Central Karoo District Municipality in the Western Cape. Banzai Environmental (Pty) Ltd, Bloemfontein.

**Butler, E., 2022.** Palaeontological Desktop Assessment to assess the Palaeontology for the Somkhele Anthracite Mine's Prospecting Right Application, on the Remainder of the Farm Reserve no 3 No 15822 within the uMkhanyakude District Municipality and the Mtubatuba Local Municipality, KwaZulu Natal. Banzai Environmental (Pty) Ltd, Bloemfontein.

# APPENDIX D

# SPECIALISTS' REPORTS

## APPENDIX D4 - Visual Impact Assessment

ENVIRONMENTAL & ENGINEERING

# REPORT

## ESKOM HOLDINGS SOC LTD

### VISUAL IMPACT ASSESSMENT (VIA)

**REPORT REF: 21-1632**

**MATZIKAMA MUNICIPALITY - WESTERN CAPE PROVINCE.)**

**2022-04-13**

VERSION 2.2

**Updated- 20/7/2022**

## Document and Quality Control:

| Document No: | 21-1632 (Sere PV - VIA) | | | |
|---|---|---|---|---|
| AA – draft | 2021-12-10 | Neel Breitenbach | | First draft for review / comments |
| BB – draft | | | | Technical Review |
| CC– draft | | | | Quality review |
| DD– draft | | | | Client review |
| EE - draft | | | | Final Review |
| Approved for Distribution: | | | | |
| 0.1 | | | | Final report |
| 2.0 | 2022-04-13 | Neel Breitenbach | | Added extra site layout option |

## Quality Control BY:

| Nature of Signoff: | Responsible Person: | Role / Responsibility | Qualification |
|---|---|---|---|
| Author | Neel Breitenbach | Visual Impact and Air Quality specialist | Senior Environmental Consultant<br>B.Sc. Geography |
| Quality Reviewer | Leoni le Roux | Administrator | Professional Secretary and Personal Assistant |
| Reviewer | Vernon Siemelink | Senior Environmental Consultant<br>ISO 14001:2004 Auditor | M(EnvMan) Environmental Management UP |
| Client | | | |

## DISCLAIMER:

# EXECUTIVE SUMMARY

Eskom Holdings SOC Ltd appointed Nemai (Pty) Ltd to undertake environmental authorisations associated with the proposed Sere PV project. The applicant wants to construct a solar PV plant on an area of 20ha in the Matzikama Municipality in the Western Cape Province of South Africa.

Eco Elementum (Pty) Ltd is to undertake the Visual Impact Assessment for the Sere PV project.

The hybridisation of the existing Sere Wind Farm with the installation of PV capacity was identified as one of the Renewable initiatives in the Eskom Corporate Plan. Sere Wind Farm is a 105.8 MW wind facility located near Vredendal in the Western Cape, which entered into commercial operation on 31 March 2015. In order to address the urgent need for additional generating capacity, it has been proposed that PV technology be installed at the Sere Wind Farm site in phases. This project is applicable for the first phase (Phase 1A) of the Sere PV project. Phase 1A aims to address Eskom's urgent need for additional generating capacity.

The facility proposed for Sere PV Phase 1A will include a total site area less than 20 hectares to allow for the construction of a PV facility up to 19.9 MW capacity.

The scope of work for this Visual Impact Assessment will include:

1. Describe the existing visual characteristics of the proposed sites and its environs;
2. Viewshed and viewing distance using GIS analysis up to 30 km from the proposed structures;
3. Visual Exposure Analysis for two different site layout;
4. Compare the different site layout options and recommend the one with the least impact.

## SUMMARY OF FINDINGS

The construction and operation phase of the proposed Sere PV project related activities and its associated infrastructure will have a MODERATE visual impact on the natural scenic resources and the topography. However, with the correct mitigation measures the impact might decrease to a point where the visual impact can be seen as less significant. The moderating factors of the visual impact of the proposed solar PV project are the following:

- Number of human inhabitants located in the area;
- Existing wind farm;

### 1.1.1 Comparison

**Table 1: Comparison**

| Receptor | Alternative 1 | Alternative 2 |
|---|---|---|
| **1** | 0 | 1.45 |

Table 16 show the Visual Exposure Rating (VER) at each of the identified sensitive receptors for both the alternative 1 and 2 scenarios. Only 1 receptor had a VER for the Alternative 2 scenario. None of the rest of the receptors are modeled as having any VER for both the Alternative 1 and 2 scenarios.

Receptor 1 is predicted to have a VER of 1.45, which is considered low. Therefore, the impact difference is considered negligible due to only 1 receptors modeled with a low VER. Any of the Alternatives can be used from a visual impact perspective.

Table 2: The overall Assessment of the Visual Impact for Alternative 1

| Nature of impact: The overall Assessment of the Visual Impact of the area. | | | |
|---|---|---|---|
| | | **Unmitigated** | **Mitigated** |
| **Assessment Criteria** | **Severity** [Insignificant / non-harmful (1); Small / potentially harmful (2); Significant / slightly harmful (3); Great / harmful (4); Disastrous / extremely harmful / within a regulated sensitive area (5)] | **2** | **2** |
| | **Spatial Scale** [Area specific (at impact site) (1); Whole site (entire surface right) (2); Local (within 5km) (3); Regional / neighbouring areas (5 km to 50 km) (4); National (5)] | **4** | **2** |
| | **Duration** [One day to one month (immediate) (1); One month to one year (Short term) (2); One year to 10 years (medium term) (3); Life of the activity (long term) (4); Beyond life of the activity (permanent) (5)] | **4** | **4** |
| | **Frequency of Activity** [Annually or less (1); 6 monthly (2); Monthly (3); Weekly (4); Daily (5)] | **5** | **5** |
| | **Frequency of Incident/Impact** [Almost never / almost impossible / >20% (1); Very seldom / highly unlikely / >40% (2); Infrequent / unlikely / seldom / >60% (3); Often / regularly / likely / possible / >80% (4); Daily / highly likely / definitely / >100% (5) | **4** | **3** |
| | **Legal Issues** [No legislation(1); Fully covered by legislation (5)] | **1** | **1** |
| | **Detection** [Immediately(1); Without much effort (2); Need some effort (3); Remote and difficult to observe (4); Covered (5)] | **3** | **3** |
| **Consequence** | Severity + Spatial Scale + Duration | **10** | **8** |
| **Likelihood** | Frequency of Activity + Frequency of impact + Legal issues + Detection | **13** | **12** |
| **Risk** | Consequence * Likelihood | **MODERATE (130)** | **MODERATE (96)** |
| **Mitigation:** | Painting the supporting building dark natural colours. | | |
| **Cumulative Impact:** | The construction of the proposed Sere PV structures with its associated infrastructure will increase the cumulative visual impact of Solar PV infrastructure within the region.<br>In context of the existing wind farm, and desert landscape, the added structures will contribute to an increase in visual impact on the immediate land users. | | |

The Visual Impact due to the proposed solar PV project and associated infrastructure can be seen as having a MODERATE impact on the surrounding environment before mitigation measures are implemented. After mitigation, the visual impact can be seen as MODERATE although lower. Thus, <u>mitigation measures are very important</u> and one of the most significant mitigation measures are the <u>rehabilitation of the area at end of project life.</u> If the rehabilitation of the impact is not done correctly and the final landform do not fit into the surrounding area then the visual impact will remain high and become a concern. However, with correct rehabilitation, the impact will be minimal and there should be no visual impact after the landform has been restored.

Table 3: The overall Assessment of the Visual Impact for Alternative 2

| Nature of impact: The overall Assessment of the Visual Impact of the area. | | | |
|---|---|---|---|
| | | **Unmitigated** | **Mitigated** |
| **Assessment Criteria** | **Severity** [Insignificant / non-harmful (1); Small / potentially harmful (2); Significant / slightly harmful (3); Great / harmful (4); Disastrous / extremely harmful / within a regulated sensitive area (5)] | **2** | **2** |
| | **Spatial Scale** [Area specific (at impact site) (1); Whole site (entire surface right) (2); Local (within 5km) (3); Regional / neighbouring areas (5 km to 50 km) (4); National (5)] | **4** | **2** |
| | **Duration** [One day to one month (immediate) (1); One month to one year (Short term) (2); One year to 10 years (medium term) (3); Life of the activity (long term) (4); Beyond life of the activity (permanent) (5)] | **4** | **4** |
| | **Frequency of Activity** [Annually or less (1); 6 monthly (2); Monthly (3); Weekly (4); Daily (5)] | **5** | **5** |
| | **Frequency of Incident/Impact** [Almost never / almost impossible / >20% (1); Very seldom / highly unlikely / >40% (2); Infrequent / unlikely / seldom / >60% (3); Often / regularly / likely / possible / >80% (4); Daily / highly likely / definitely / >100% (5) | **4** | **3** |
| | **Legal Issues** [No legislation(1); Fully covered by legislation (5)] | **1** | **1** |
| | **Detection** [Immediately(1); Without much effort (2); Need some effort (3); Remote and difficult to observe (4); Covered (5)] | **3** | **3** |
| **Consequence** | Severity + Spatial Scale + Duration | **10** | **8** |
| **Likelihood** | Frequency of Activity + Frequency of impact + Legal issues + Detection | **13** | **12** |
| **Risk** | Consequence * Likelihood | **MODERATE (130)** | **MODERATE (96)** |
| **Mitigation:** | Painting the supporting building dark natural colours. | | |
| **Cumulative Impact:** | The construction of the proposed Sere PV structures with its associated infrastructure will increase the cumulative visual impact of Solar PV infrastructure within the region.<br>In context of the existing wind farm, and desert landscape, the added structures will contribute to an increase in visual impact on the immediate land users. | | |

The Visual Impact due to the proposed solar PV project and associated infrastructure can be seen as having a MODERATE impact on the surrounding environment before mitigation measures are implemented. After mitigation, the visual impact can be seen as MODERATE although lower. Thus, <u>mitigation measures are very important</u> and one of the most significant mitigation measures are the <u>rehabilitation of the area at end of project life.</u> If the rehabilitation of the impact is not done correctly and the final landform do not fit into the surrounding area then the visual impact will remain high and become a concern. However, with correct rehabilitation, the impact will be minimal and there should be no visual impact after the landform has been restored

Taking into account the modelled data, the visual impact on the identified sensitive receptors can be seen as insignificant for both the proposed and alternative scenarios.

## Mitigation Measures

Mitigation measures may be considered in two categories:

- Primary measures that intrinsically comprise part of the development design through an iterative process. Mitigation measures are more effective if they are implemented from project inception when alternatives are being considered.
- Secondary measures designed to specifically address the remaining negative effects of the final development proposals.

Primary measures that will be implemented will mainly be measures that will minimise the visual impact by softening the visibility of the structures by "blending" with the surrounding areas. Such measures will include rehabilitation of the area at end of life and painting the supporting infrastructure buildings dark natural colours.

Secondary measures will include final rehabilitation, after care and maintenance of the vegetation and to ensure that the final landform is maintained.

# CONTENTS

## List of Tables

## List of Figures

## Definition of Terms

| | |
|---|---|
| **Assessment** | A systematic, independent and documented review of operations and practises to ensure that relevant requirements are met. |
| **Construction** | The time period that corresponds to any event, process, or activity that occurs during the Construction phase (e.g., building of site, buildings, and processing units) of the proposed project. This phase terminates when the project goes into full operation or use. |
| **Critical viewpoints** | Important points from where viewers will be able to view the proposed or actual development and from where the development may be significant. |
| **Cumulative Impacts** | The summation of the effects that result from changes caused by a development in conjunction with the other past, present or reasonably foreseen actions (The landscape Institute, Institute of Environmental Management & Assessment. 2002) |
| **Decommissioning** | to remove or retire (a mine, etc.) from active service. |
| **Environmental Component** | An attribute or constituent of the environment (i.e., air quality; marine water; waste management; geology, seismicity, soil, and groundwater; marine ecology; terrestrial ecology, noise, traffic, socio-economic) that may be impacted by the proposed project. |
| **Environmental Impact** | A positive or negative condition that occurs to an environmental component as a result of the activity of a project or facility. This impact can be directly or indirectly caused by the project's different phases (i.e., Construction, Operation, and Decommissioning). |
| **Field of view:** | The field of view is the angular extent of the observable world that is seen at any given moment. Humans have an almost 180º forward-facing field of view. Note that human stereoscopic (binocular) vision only covers 140º of the field of view in humans; the remaining peripheral 40º have no binocular vision due to the lack of overlap of the images of the eyes. The lower the focal length of a lens (see below), the wider the field of view. |
| **Landscape Integrity** | Landscape integrity is visual qualities represented by the following qualities, which enhance the visual and aesthetic experience of the area |
| **Mitigation (in the context of Visual Impact Assessment):** | Any action taken or not taken in order to avoid, minimise, rectify, reduce, eliminate, or compensate for actual or potential adverse visual impacts. |
| **Operation** | The time period that corresponds to any event, process, or activity that occurs during the Operation (i.e., fully functioning) phase of the proposed project or development. (The Operation phase follows the Construction phase, and then terminates when the project or development goes into the Decommissioning phase.) |
| **Record of Decision** | Is an environmental authorisation issued by a state department. |
| **Scenic value** | Degree of visual quality resulting from the level of variety, harmony and contrast among the basic visual elements. |
| **Sense of place** | the character of a place, whether natural, rural or urban, it is allocated to a place or area through cognitive experience by the user. |
| **Visual absorption capacity (VAC):** | The ability of elements of the landscape to "absorb" or mitigate the visibility of an element in the landscape. Visual absorption capacity is based on factors such as vegetation height (the greater the height of vegetation, the higher the absorption capacity), structures (the larger and higher the intervening structures, the higher the absorption capacity) and topographical variation (rolling topography presents opportunities to hide an element in the landscape and therefore increases the absorption capacity). |
| **Visual character** | the overall impression of a landscape created by the order of the patterns composing it; the visual elements of these patterns are the form, line, colour and texture of the landscape's components. Their interrelationships are described in terms of dominance, scale, diversity and continuity. This characteristic is also associated with land use. |
| **Visual Exposure** | Visual exposure is based on distance from the project to selected viewpoints. Visual exposure or visual impact tends to diminish exponentially with distance. The visibility or visual exposure of any structure or activity is the point of departure for the visual impact assessment. It stands to reason that if the proposed mine activities and associated infrastructure were not visible, no visual impact would occur. Visual exposure is determined by the Viewshed or the view catchment being the area within which the proposed development will be visible. |
| **Visual Integrity** | Visual sensitivity can be determined by a number of factors in combination, such as prominent topographic or other scenic features, including high points, steep slopes and axial vistas |
| **Visually sensitive** | Areas in the landscape from where the visual impact is readily or excessively encountered. |

## Abbreviations

| | |
|---|---|
| **CA:** | Competent Authority |
| **DEA:** | Department of Environmental Affairs (The former Department of Environmental Affairs and Tourism) |
| **DMR:** | The Department of Mineral Resources (The former Department of Minerals and Energy) |
| **DWA:** | Department of Water Affairs (Is now referred to the Department of Water and Sanitation – DWS) |
| **EIA:** | Environmental Impact Assessment |
| **EMP:** | Environmental Management Plan |
| **EMPr**: | Environmental Management Programme |
| **I&AP's:** | Interested and Affected Parties |
| **IWUL:** | Integrated Water Use License |
| **IWWMP:** | Integrated Water and Water Management Plan |
| **MPRDA:** | Mineral and Petroleum Resources Development Act, 28 of 2002 |
| **NAAQS:** | National Ambient Air Quality Standards |
| **NEMA:** | National Environmental Management Act, 107 of 1998 |
| **NEMAQA:** | National Environmental Management: Air Quality Act, 39 of 2004 |
| **NEMBA:** | National Environmental Management: Biodiversity Act, 10 of 2004 |
| **NEMWA:** | National Environmental Management: Waste Act, 59 of 2008 |
| **NHRA:** | National Heritage Resources Act, 25 of 1999 |
| **NWA:** | National Water Act, 36 of 1998 |
| **ROD:** | Record of Decision |
| **VAC**: | Visual Absorption Capability |
| **VIA**: | Visual Impact Assessment |
| **WSA:** | Water Services Act, 108 of 1997 |
| **WUL**: | Water Use Licence |

# PROJECT INFORMATION

Table 4: Applicant Details

| Name of Applicant: | Eskom Holdings SOC Ltd |
|---|---|
| Contact Person: | |
| Contact Number: | |
| Email: | |
| Postal Address: | |
| Physical Address: | |
| File Reference Number DMR: | MP 30/5/1/1/2/394 PR |

Table 5: EAP Details

| EAP Company: | Nemai Consulting |
|---|---|
| Company Reg. No.: | |
| Physical Address: | 147 Bram Fischer Drive Ferndale, 2194, South Africa |
| Postal Address: | PO Box 1673, Sunninghill, 2157, South Africa |
| Contact Person: | Jacqui Davis |
| Contact Number: | 011 781 1730 |
| Email: | JacquiD@nemai.co.za |
| Website: | |

Table 6: Specialist Details

| Specialist Company: | Eco Elementum (Pty) Ltd |
|---|---|
| Company Reg. No.: | 2012/021578/07 |
| Physical Address: | 442 Rodericks Road, Lynwood, Pretoria, 0081 |
| Postal Address: | Postnet Suite #252, Private Bag X025. Lynnwood Ridge, Pretoria, 0040 |
| Contact Person: | |
| Contact Number: | 012 807 0383 |
| Email: | info@ecoe.co.za |
| Website: | www.ecoe.co.za |

## SPECIALIST DECLARATION OF INDEPENDENCE

*In support of an application in terms of the National Environmental Management Act 107 of 1998 (GNR983, GNR984 and GNR985, GG38282 of 4 December 2014 ("Listed Activities") that will require an environmental authorisation if triggered. As amended by GNR 327, GNR 325 and GNR 324.*

I, **Neel Breitenbach** as specialist, has been appointed in terms of regulation 12(1) or 12(2), and can confirm that I shall —

a. Be independent;
b. have expertise in undertaking specialist work as required, including knowledge of the Act, these Regulations and any guidelines that have relevance to the proposed activity;
c. ensure compliance with these Regulations;
d. perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the application'
e. take into account, to the extent possible, the matters referred to in regulation 18 when preparing the application and any report, plan or document relating to the application;
f. disclose to the proponent or applicant, registered interested and affected parties to the proponent or applicant, registered interested and affected parties and the competent authority all material information in the possession of the EAP and, where applicable, the specialist, that reasonably has or may have the potential of influencing –
g. any decision to be taken with respect to the application by the competent authority in terms of these Regulations; or
h. the objectivity of any report, plan or document to be prepared by the EAP or specialist, in terms of these Regulations for submission to the competent authority; and
i. Unless access to that information is protected by law, in which case it must be indicated that such protected information exists and is only provided to the competent authority.

| | |
|---|---|
| **Neel Breitenbach** | |
| Name and Surname | Signature |
| **2021-12-10** | **George** |
| Date | Signed at |

## 2. INTRODUCTION

Eskom Holdings SOC Ltd appointed Nemai (Pty) Ltd to undertake environmental authorisations associated with the proposed Sere PV project. The applicant wants to construct a solar PV plant on an area of 20ha in the Matzikama Municipality in the Western Cape Province of South Africa.

Eco Elementum (Pty) Ltd is to undertake the Visual Impact Assessment for the Sere PV project.

The hybridisation of the existing Sere Wind Farm with the installation of PV capacity was identified as one of the Renewable initiatives in the Eskom Corporate Plan. Sere Wind Farm is a 105.8 MW wind facility located near Vredendal in the Western Cape, which entered into commercial operation on 31 March 2015. In order to address the urgent need for additional generating capacity, it has been proposed that PV technology be installed at the Sere Wind Farm site in phases. This project is applicable for the first phase (Phase 1A) of the Sere PV project. Phase 1A aims to address Eskom's urgent need for additional generating capacity.

The facility proposed for Sere PV Phase 1A will include a total site area less than 20 hectares to allow for the construction of a PV facility up to 19.9 MW capacity and associated infrastructure:

- Solar PV modules, up to a total of 120,000 m2, that convert solar radiation directly into electricity. The solar PV modules will be elevated off the ground and will be mounted on either fixed tilt systems or tracking systems. The Solar PV modules will be placed in rows in such a way that there is allowance for a perimeter road and security fencing along the site boundary, and access roads in between each PV module row. There will be underground cabling connecting Solar PV modules to the Inverter stations.
- Inverter stations, each occupying a footprint up to approximately 30 m2, with up to 20 Inverter stations installed on the site. Each Inverter station will contain an inverter, step-up transformer, and switchgear. The Inverter stations will be distributed on the site, located alongside its associated Solar PV module arrays. The Inverter station will perform conversion of DC (direct current) to AC (alternating current), and step-up the LV voltage of the inverter to 33kV, to allow the electricity to be fed into the Skaapvlei substation. Inverter stations will connect several arrays of Solar PV modules and will be placed along the internal roads for easy accessibility and maintenance.
- Adequately designed foundations and mounting structures that will support the Solar PV modules and Inverter stations.
- Existing roads that provide access to Sere Wind Farm will be used and extended where necessary (estimated up to 1 km long) to provide access to the PV site.
- A perimeter road around the site, approximately 5 m wide and 1.8 km in length.
- Internal roads for access to the Inverter stations, approximately 5 m wide and 3.4 km total length.
- Internal roads/paths between the Solar PV module rows, approximately 2.5 m wide, to allow access to the Solar PV modules for operations and maintenance activities.
- Laydown area, occupying a footprint up to 4,000 m2, located adjacent to the substation. The laydown area will also accommodate water storage tanks (estimated 32 kl for the first 4 months and 20 kl for the remaining 20 months, until construction is completed). This area will also accommodate the offices for construction contractors.
- Batching plant, occupying a footprint up to 7,675 m2, for the mixing ingredients for concrete.
- The infrastructure required for the operation and maintenance of the Sere PV Plant – Phase 1a installation will be optimised to consider common usage of the existing Sere Wind Farm infrastructure.
- The Solar PV plant facility security cabin, occupying a footprint up to 10 m2, including ablution facilities.
- Perimeter fencing of the Solar PV site, with access gates. Detailed requirements will be determined following the security risk assessment.
- Construction and installation of underground electrical interconnection cables, with trenching up to 1 km long, connecting the Solar PV facility to the 33/132 kV Skaapvlei substation.

The solar PV plant has a design life of a minimum of 25 years. The extension of the life of the plant will be considered when assessing the plant's economic viability to remain operational after its end of life.

Fixed or tracking PV installations are planned, with two different site layout options. Due to budget constraints, only the possible worst case PV installation option, tracking panels, have been assessed for both site layout options.

**Table 7: Project Locality**

| **Farm Name:** | **Matzikama Municipality – Western Cape Province - South Africa** |
|---|---|
| **Application Area:** | 20ha |
| **Magisterial District:** | Matzikama District Municipality,<br>Western Cape Province<br>South Africa |
| **Distance and direction from nearest town:** | The Project Area is ~ 16km west of . See Figure 1. |

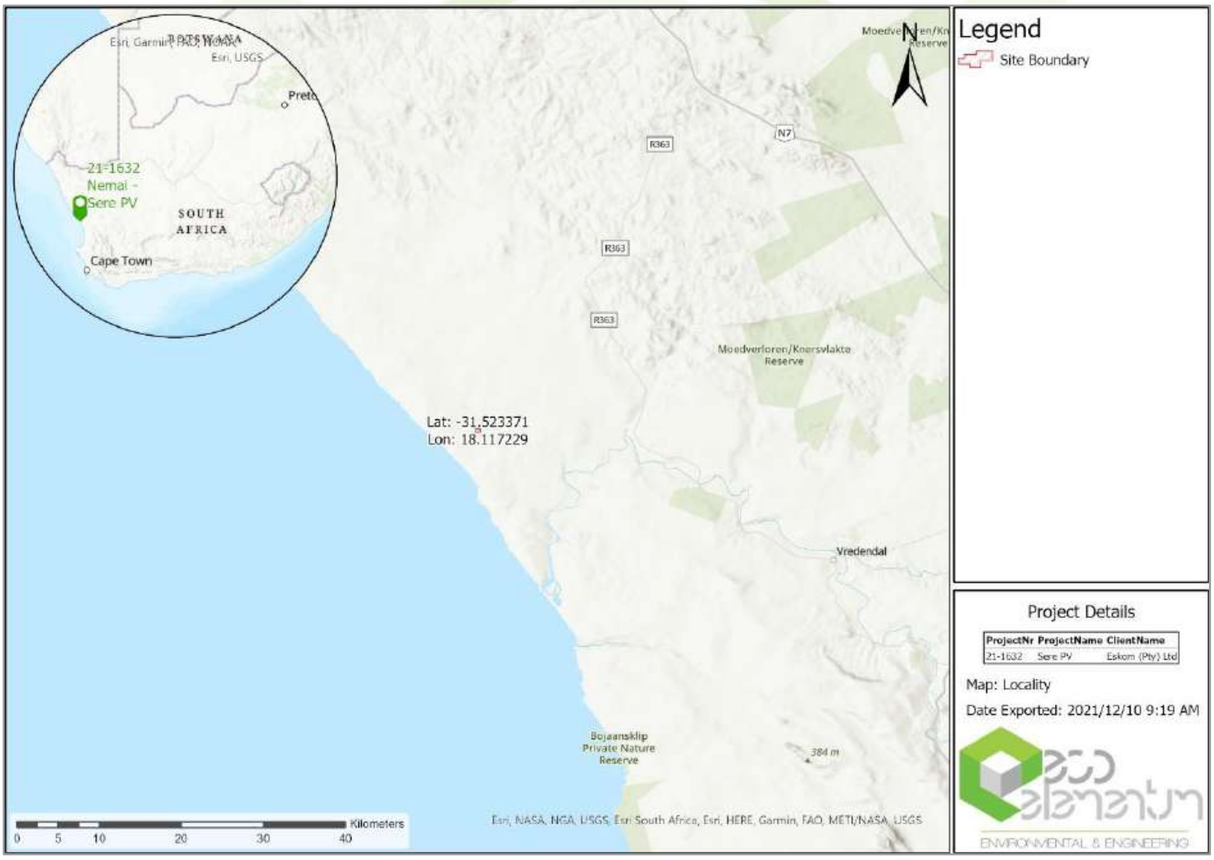



**Figure 1: Locality map of the proposed Sere PV project.**

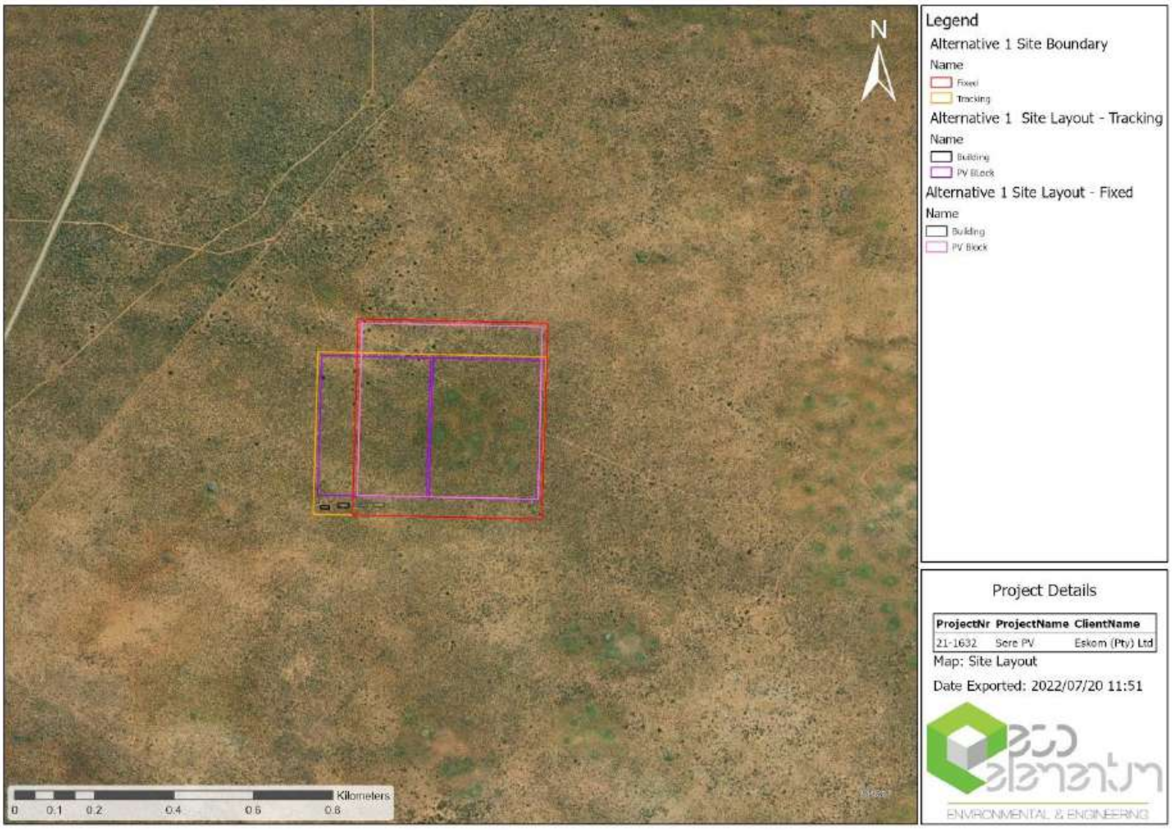



**Figure 2: Alternative 1 Site Layout for the proposed Sere PV project.**

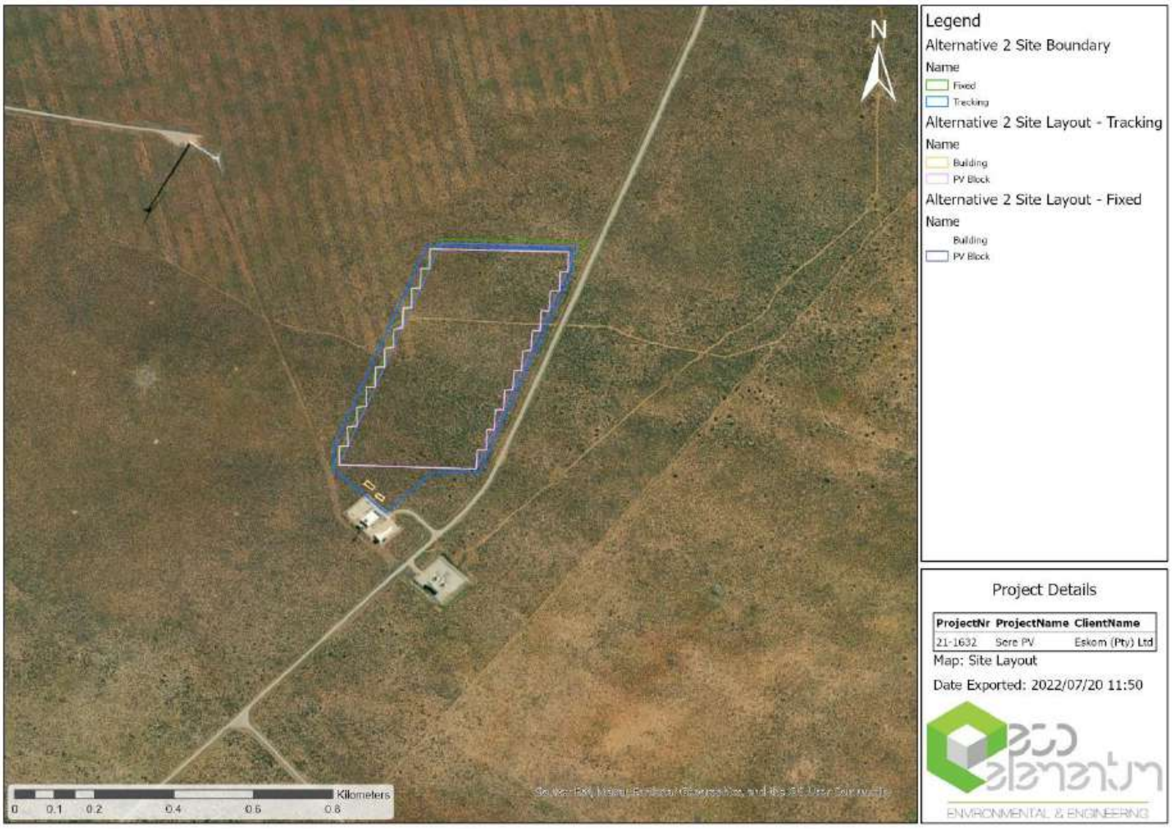



**Figure 3: Alternative 2 Site Layout for the proposed Sere PV project.**

## 3. SCOPE OF WORK

The scope of work for this Visual Impact Assessment will include:

1. Describe the existing visual characteristics of the proposed sites and its environs;
2. Viewshed and viewing distance using GIS analysis up to 30 km from the proposed structures.
3. Visual Exposure Analysis comprising the following aspects:
   - Terrain Slope;
     - Slope angle is determined from the Digital Terrain Model (DTM) and the location of the proposed structures given a ranking depending on the steepness of the slope.
   - Aspect of structure location;
     - Aspect of the slope where the structures are to be built, are calculated from the DTM and given a ranking determined by the Sun angle.
   - Landforms;
     - Landform of the location of the proposed structures are determined from the DTM and ranked according to the type of landform. Structures built on certain landforms, e.g. ridges, will be more visible than structures built in valleys.
   - Slope Position of structure;
     - Using GIS analysis, the position of the proposed structure is determined and ranked according to the position on the slope the structure is to be built.
   - Relative elevation of structure;
     - Using the DEM the elevation of the proposed structure relative to the surrounding elevation is determined and ranked according to the difference in height of the surrounding areas.
   - Terrain Ruggedness;
     - The terrain ruggedness is determined from the DEM and given a ranking based on the homogeneousness of the terrain.
   - Viewer Sensitivity;
     - The Viewer sensitivity ranking of the surrounding areas is determined using various land cover and land use datasets and ranked according to the sensitivity of the related structures to the environment.
   - Overall Visual Impact;
     - Combing all the above dataset a final visual impact of the proposed structures is calculated.
4. Compare both site-layouts and recommend the one with the least impact.

# 4. DESCRIPTION OF AFFECTED AREA AND ENVIRONMENT

This section of the report provides a description of the current status of the environment. This provides a baseline context for assessment of the proposed structures.

## 4.1 Location

### 4.1.1 Population


**Figure 4: Population areas within close proximity of the proposed Sere PV project.**

From a desktop study of satellite imagery various sensitive receptors in the form of human habitation areas, consisting of the town of Koekenaap to the east of the proposed Sere PV project area can be seen in Figure 4. It should be noted that the sensitive receptors in the area may differ from those identified as not all areas may have been identified from the imagery successfully.

### 4.1.2 Topography

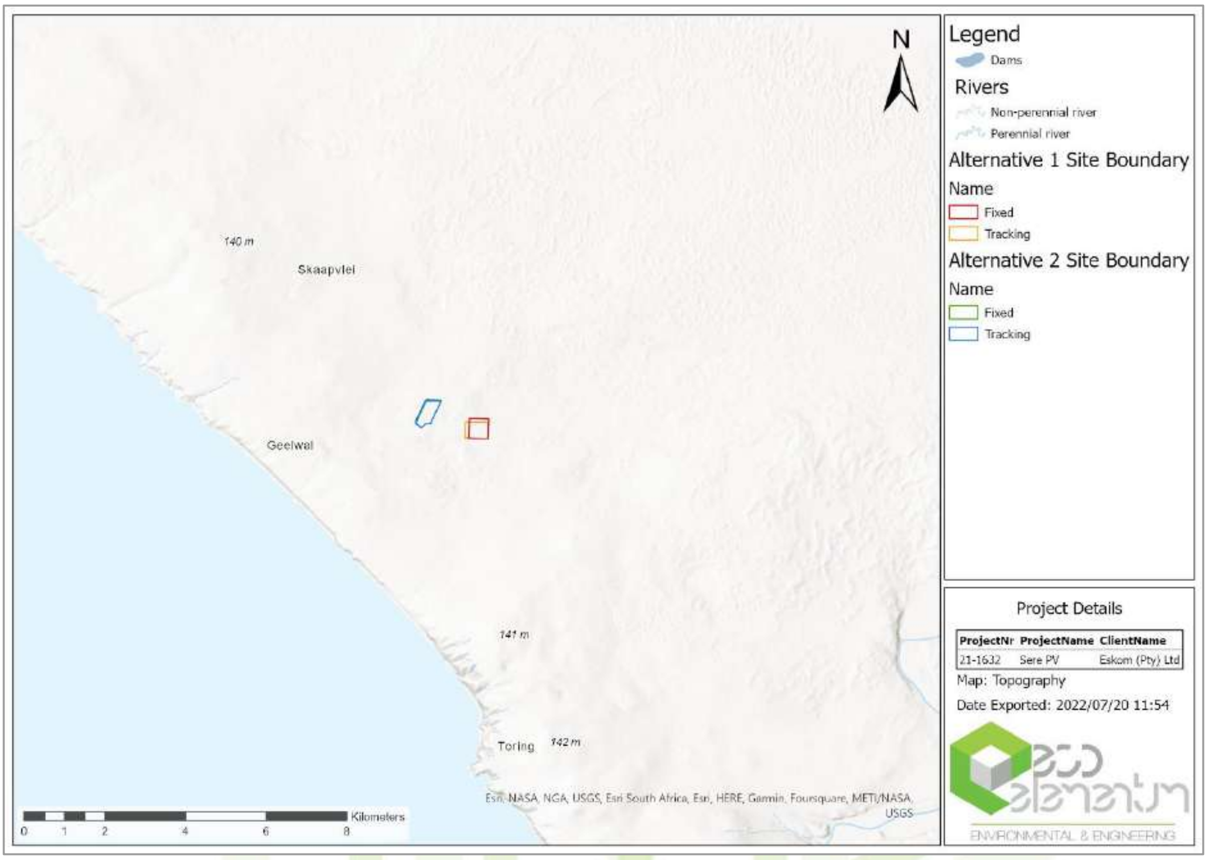



**Figure 5: Map showing the Topography surrounding the proposed Sere PV project.**

The proposed operation area is situated in flat terrain with no major topographical features found in the immediate vicinity as can be seen in Figure 5 above.

## 4.2 New Infrastructure

The proposed Sere PV project will comprise of various newly built structures. Some of the highest structures are included in this report as can been in Figure 6. It must be noted that no complete detail of the exact structures were available at the time of this report and general height and location assumptions were made where applicable.

**Table 8: Maximum Height of the Relevant Proposed Structures.**

| Description | Height (m) |
|---|---|
| **Tracking PV Panels** | 6 |
| **Supporting Infrastructure Buildings** | 3 |

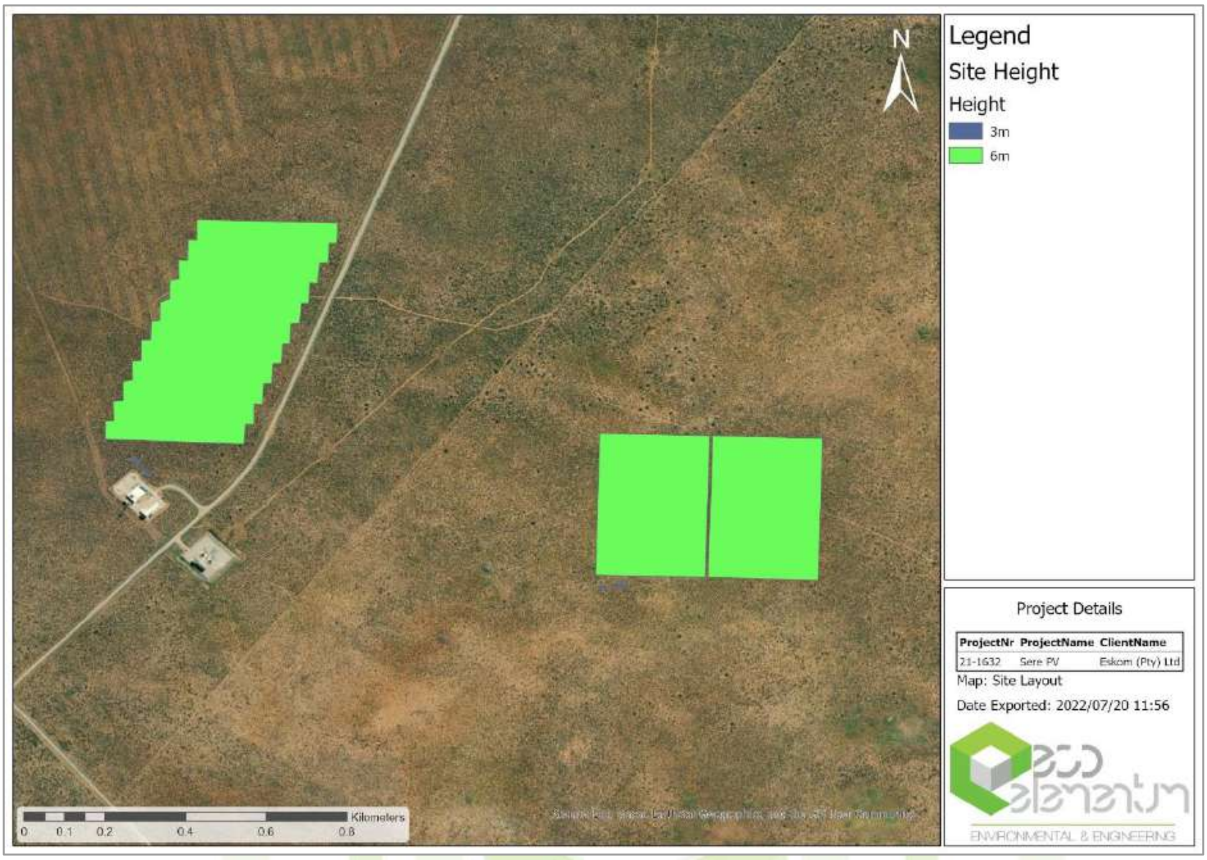



**Figure 6: Infrastructure surface heights**

## 4.3 Sense Of Place

The concept of "a Sense of Place" does not equate simply to the creation of picturesque landscapes or pretty buildings, but to recognize the importance of a sense of belonging. Embracing uniqueness as opposed to standardization attains quality of place. In terms of the natural environment, it requires the identification, a response to and the emphasis of the distinguishing features and characteristics of landscapes. Different natural landscapes suggest different responses. The sense of place is created by the dessert landscape together with the existing wind turbines in the area.

## 5. METHODOLOGY

The following sequence was employed in this Visual Assessment Report:

1. Viewshed and viewing distance using GIS analysis up to 30 km from the proposed structures utilizing ArcGIS Pro and Spatial Analyst extension.
2. In order to model the decreasing visual impact of the structures, concentric radii zones of 1 km to 30 km from the activities were superimposed on the viewshed to determine the level of visual exposure. The closest zone to the proposed structures indicates the area of most significant impact, and the zone further than 15 km from the structures indicates the area of least impact. The visual ratings of the zones have been defined as follows:
    - <1 km (very high);
    - 1 - 2 km (high);
    - 2 - 5 km (moderate);
    - 5 -10 km (moderate-low);
    - 10 - 15 km (low) and
    - >30km (insignificant).
3. A Visual Exposure Analysis were conducted that included the following parameters:
    - Terrain Slope
        - Slope angle is determined from the Digital Terrain Model (DTM) and the location of the proposed structures given a ranking depending on the steepness of the slope;
        - Structures built on steep slopes are assumed to be more visible and exposed than those on flat surfaces.
    - Aspect of structure location
        - Aspect of the slope where the structures are to be built, are calculated from the DTM and given a ranking determined by the Sun angle.
        - Structures on flat surface are illuminated by the sun the whole day and thus visible from all directions. In the southern hemisphere structures on North facing slopes are less visible from the south, structures on East and West facing slopes are only illuminated during half of the day thus less visible where structures on the southern slopes are mostly in the shade.
    - Landforms
        - Landform of the location of the proposed structures are determined from the DTM and ranked according to the type of landform. Structures built on certain landforms, e.g. ridges, will be more visible than structures built in valleys.
    - Slope Position of structure
        - Using GIS analysis, the position of the proposed structure is determined and ranked according to the position on the slope the structure is to be built.
    - Relative elevation of structure
        - Using the DEM the elevation of the proposed structure relative to the surrounding elevation is determined and ranked according to the difference in height of the surrounding areas. Structures built on higher ground are more visible than those built in low lying areas.
    - Terrain Ruggedness
        - The terrain ruggedness is determined from the DEM and given a ranking based on the homogeneousness of the terrain. Rugged terrain has a tendency to increase the visual absorption characteristics of the terrain.
    - Visual Absorption Capacity
        - To simulate the Visual Absorption Capacity (VAC) of the landscape, land cover data of the area were assigned a VAC ranking. The Visual Exposure results and VAC rankings of the landscape were use in an algorithm to determine a quantitative visual exposure for each sensitive receptor.

- Overall Visual Impact
    - Combing all the above dataset a final visual exposure ranking was determined for each of the identified sensitive receptor areas.

4. Compare the visual impact exposure rating at the relevant sensitive receptors to determine the site layout with the least impact.

## 5.1 ASSUMPTIONS

- The core study area can be defined as an area with a radius of not more than 30 km from the structures This is because the visual impact of PV structures beyond a distance of 30 km would be so reduced that it can be considered negligible even if there is direct line of sight.
- The height of the VIA is based on the heights as stipulated in Table 8.
- The assessment was undertaken during the planning stage of the project and is based on the information available at that time.

## 5.2 LIMITATIONS

- Visual perception is by nature a subjective experience, as it is influenced largely by personal values. For instance, what one-viewer experiences as an intrusion in the landscape, another may regard as positive. Such differences in perception are greatly influenced by culture, education and socio-economic background. A degree of subjectivity is therefore bound to influence the rating of visual impacts. In order to limit such subjectivity, a combination of quantitative and qualitative assessment methods were used. A high degree of reliance has been placed on GIS-based analysis viewshed, visibility analysis, and on making transparent assumptions and value judgements, where such assumptions or judgements are necessary.
- The viewshed generated in GIS cannot be guaranteed as 100% accurate. Some viewpoints, which are indicated on the viewshed as being inside of the viewshed, can be outside of the viewshed. This is due to the change of the natural environment by surrounding activities as well as natural vegetation that play a significant role and can have a positive or negative influence on the viewshed.

## 5.3 LEGAL REQUIREMENTS

There are no specific legal requirements for visual impact assessment in South Africa. Visual impacts are, however required to be assessed by implication when the provisions of relevant acts governing environmental impacts management are considered.

# 6. CRITERIA USED IN THE ASSESSMENT OF VISUAL IMPACTS

## 6.1 View Points And View Corridors

Viewpoints have been selected based on prominent viewing positions in the area. The selected viewpoints and view corridors are used as a basis for determining potential visual ability and visual impacts of the proposed structures.

## 6.2 Visual Exposure

Visual exposure is based on distance from the project to selected viewpoints. Visual exposure or visual impact tends to diminish exponentially with distance. The visibility or visual exposure of any structure or activity is the point of departure for the visual impact assessment. It stands to reason that if the proposed structures were not visible, no visual impact would occur. Visual exposure is determined by the following variables:

- Slope angle (Figure 7);
- Aspect of slope (Figure 8);
- Landforms (Figure 11);
- Slope Position of structure (Figure 12);
- Relative Elevation of structure (Figure 10); and
- Terrain Ruggedness (Figure 9).

## 6.3 Landscape Integrity

Landscape integrity is visual qualities represented by the following qualities, which enhance the visual and aesthetic experience of the area:

- Intactness of the natural and cultural landscape;
- Lack of visual intrusions or incompatible structures; and
- Presence of a 'sense of place'.

## 6.4 Determine The Visual Absorption Capacity (VAC)

The VAC is the capacity of the receiving environment to absorb the potential visual impact of the proposed facility. The VAC is primarily a function of the vegetation, and will be high if the vegetation is tall, dense and continuous. Conversely, low growing, sparse and patchy vegetation will have a low VAC. Topography and built forms have the capacity to 'absorb' visual impact.

The digital terrain model utilised in the calculation of the visual exposure of the facility does not incorporate potential visual absorption capacity (VAC). It is therefore necessary to determine the VAC by means of the interpretation of the vegetation cover, topography and structures. Land cover is used in the ranking of the VAC.

# 7. VIEWSHED

## 7.1 SLOPE

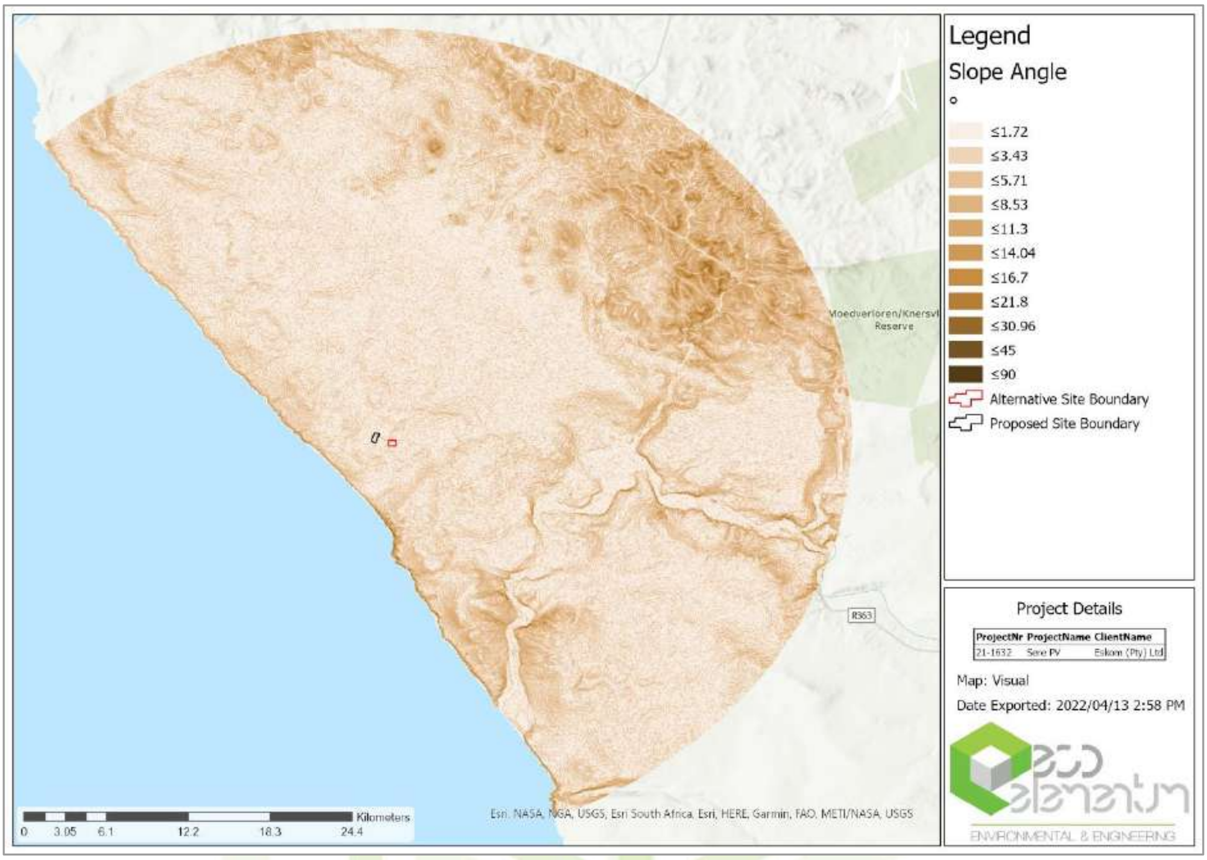



Figure 7: Slope angles of the terrain in the 30 km buffer area surrounding the proposed Sere PV project

## 7.2 Aspect

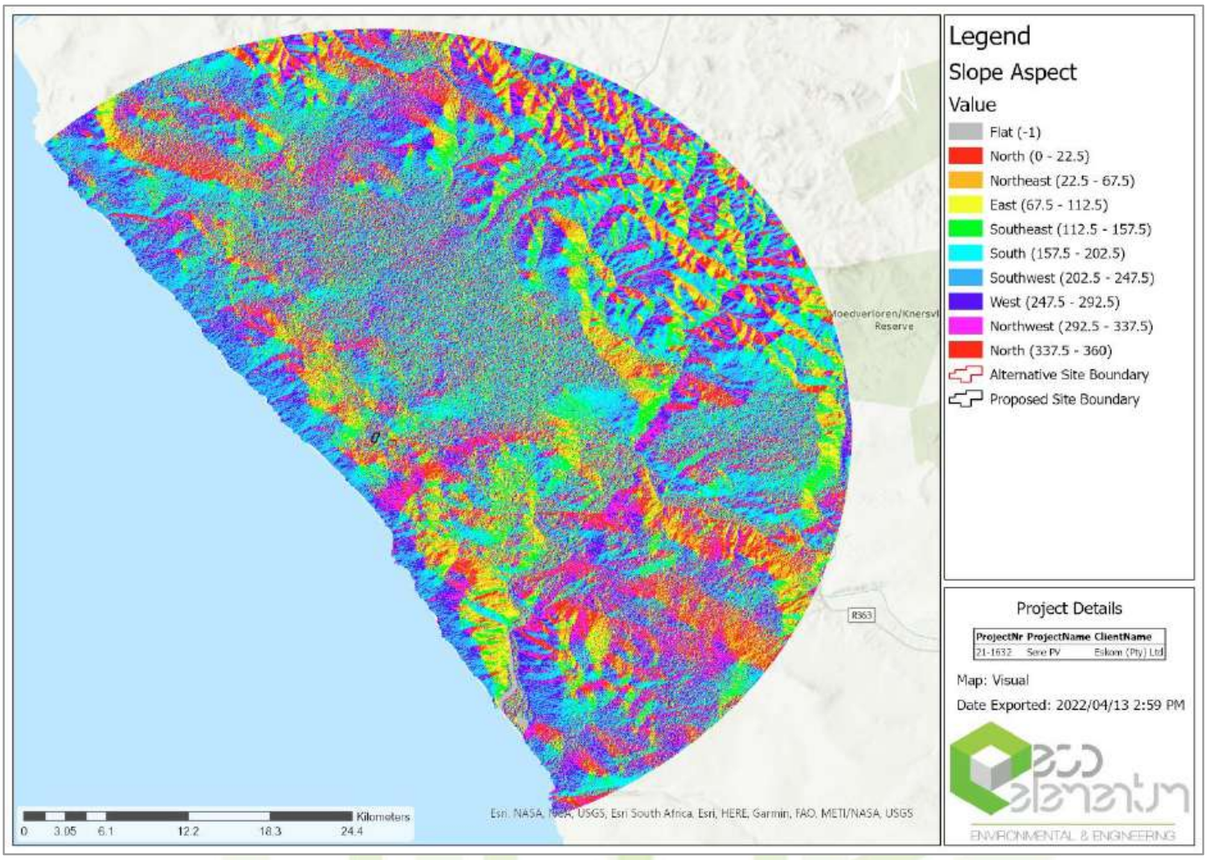



**Figure 8: Aspect direction of the terrain in a 30 km buffer area surrounding the proposed Sere PV project**

## 7.3 Terrain Ruggedness

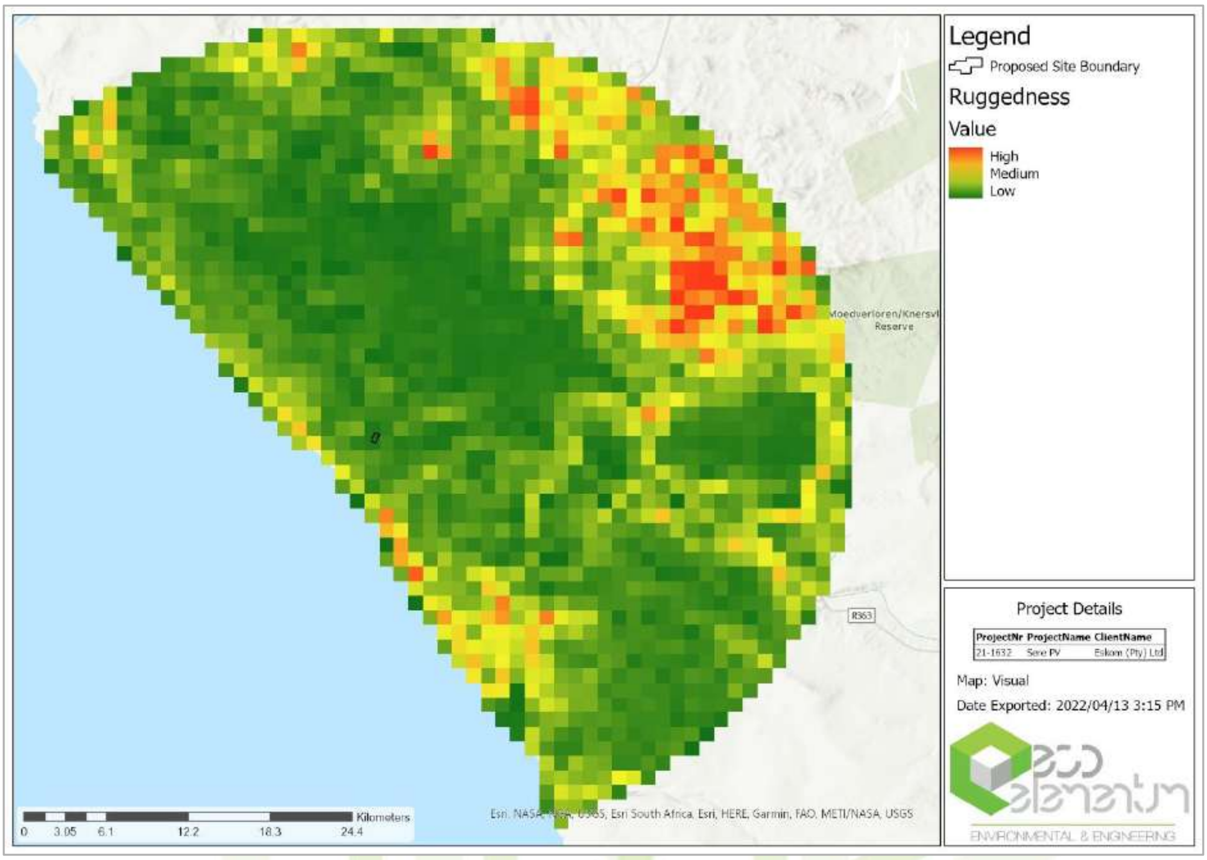



**Figure 9: Terrain ruggedness in a 30 km buffer area surrounding the proposed Sere PV project**

## 7.4 RELATIVE ELEVATION

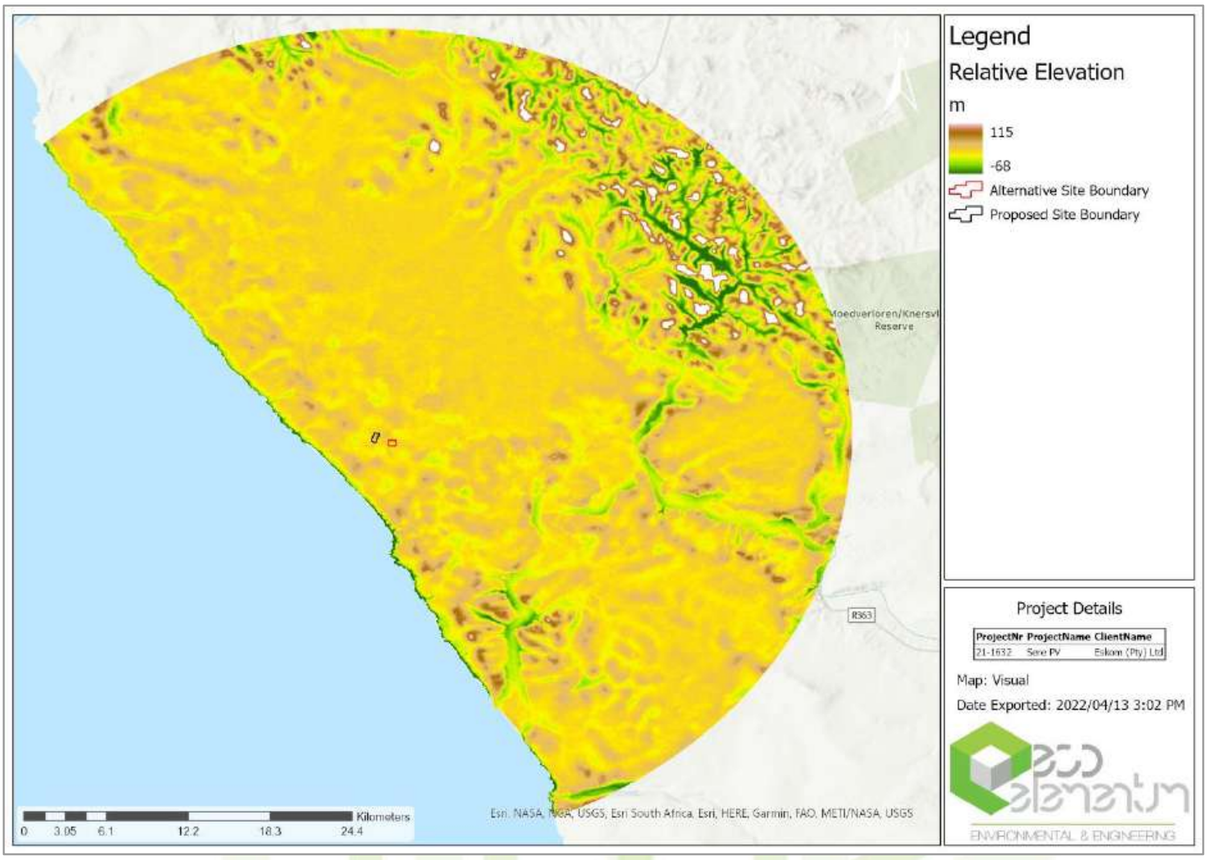



**Figure 10: Relative Elevation of terrain in a 30 km buffer area surrounding the proposed Sere PV project**

## 7.5 LANDFORMS

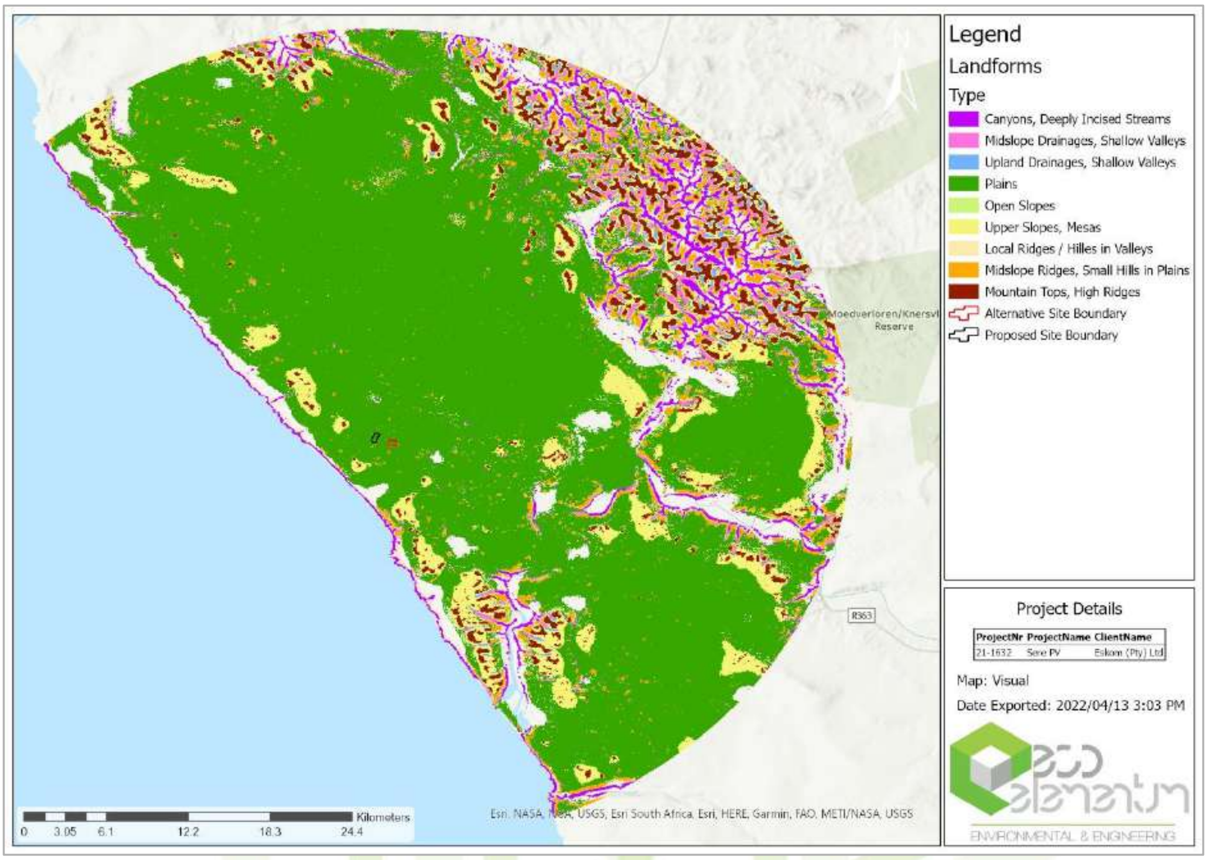



**Figure 11: Landforms in a 30 km buffer area surrounding the proposed Sere PV project**

## 7.6 Slope Position

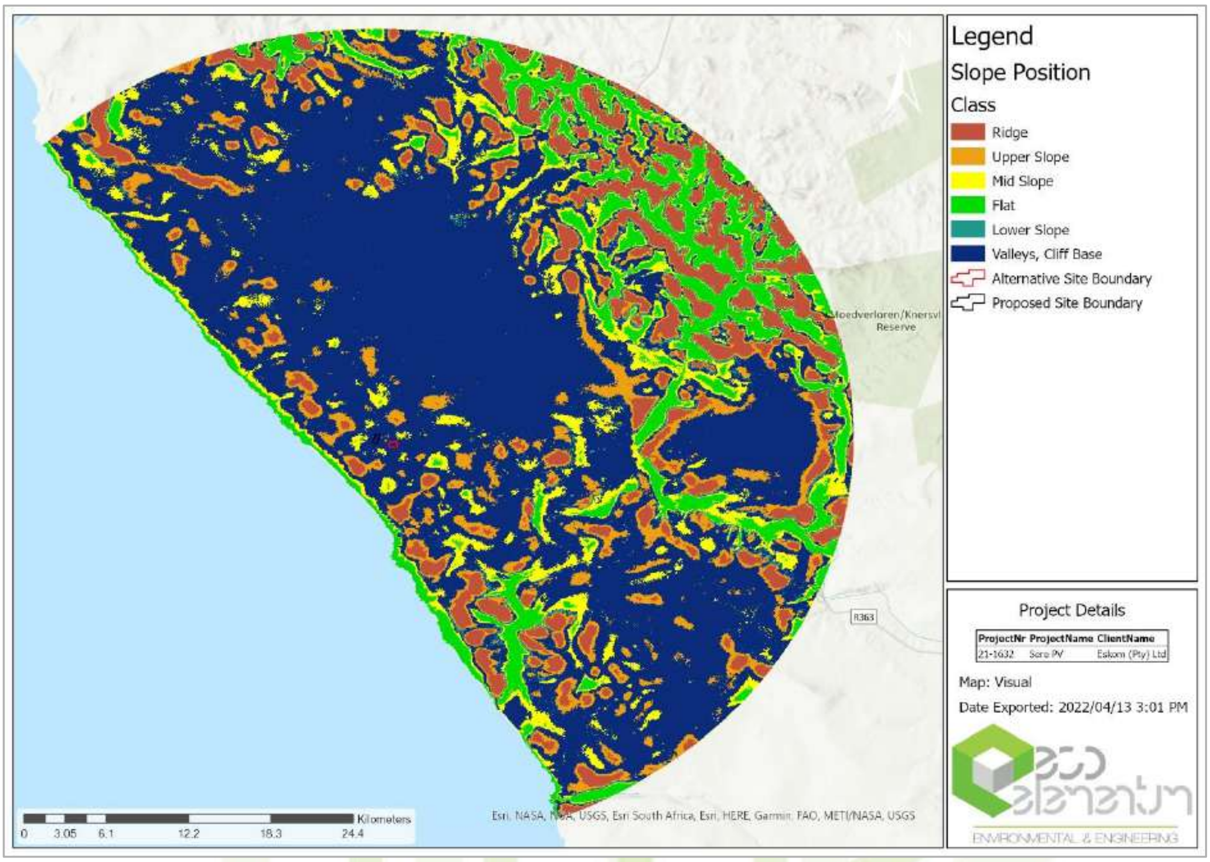



**Figure 12: Slope Positions in a 30 km buffer area surrounding the proposed Sere PV project**

## 7.7 LANDCOVER VAC

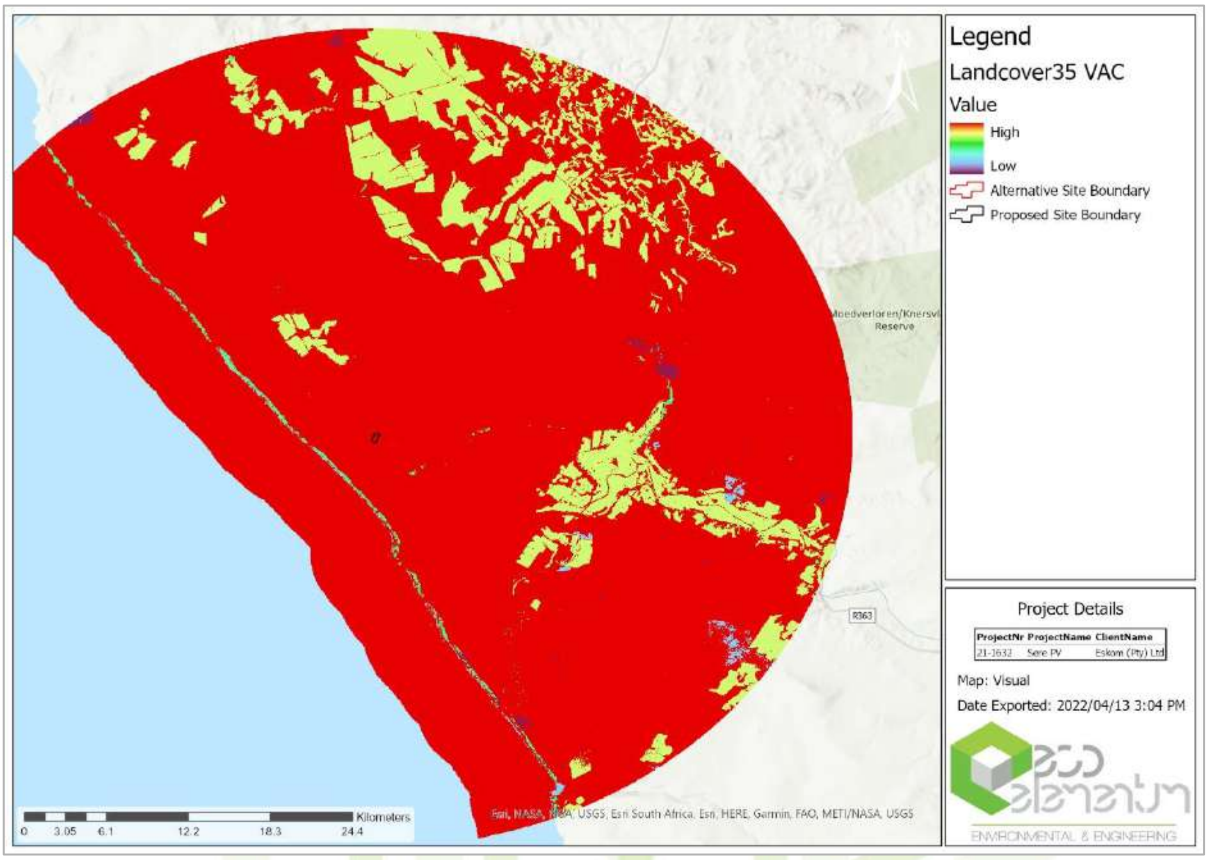



**Figure 13: Possible VAC of the Landcover in a 30 km buffer area surrounding the proposed Sere PV project**

## 7.8 VIEWSHED VISIBILITY

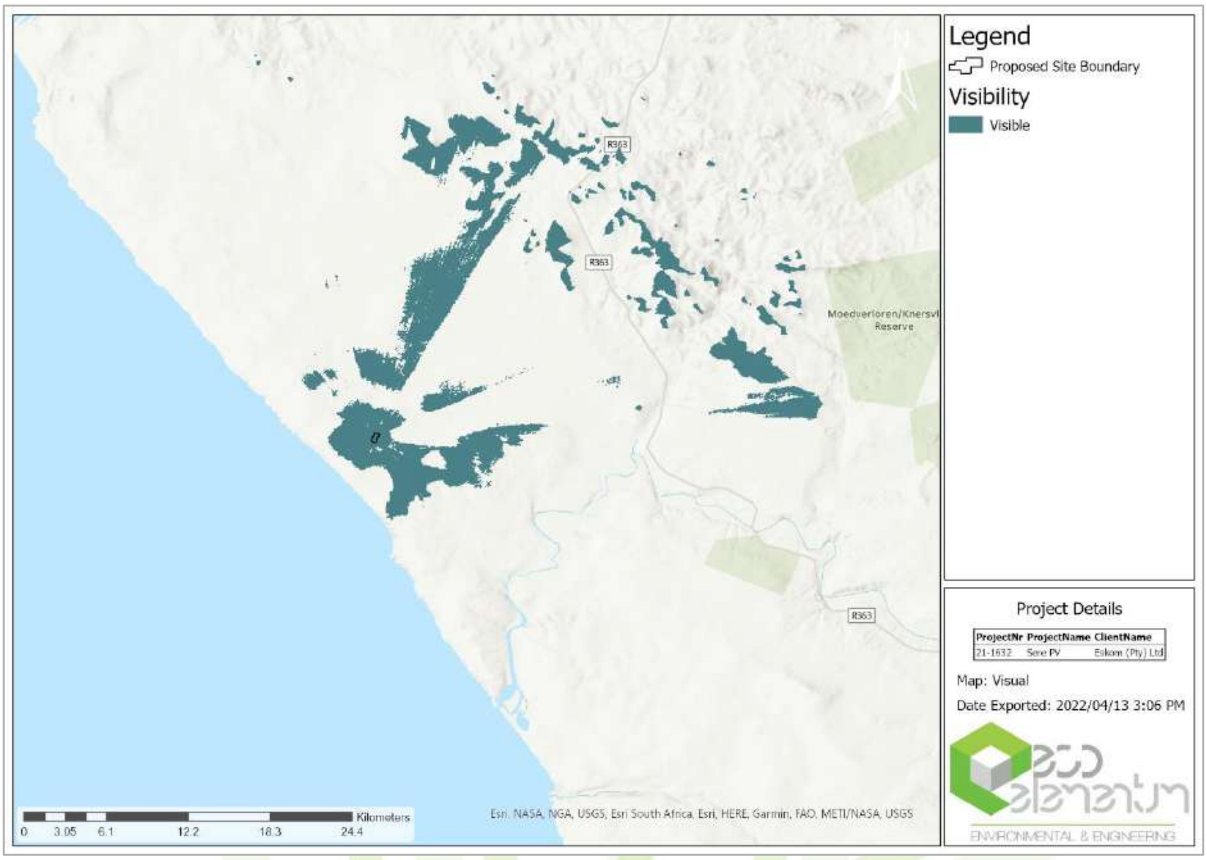



**Figure 14: Viewshed of proposed Sere PV project, Proposed Layout – Visibility (From where can the surface infrastructure locations can be seen from any location on the map)**

For the assessment of the visibility of the area, the viewshed has been calculated for the amount of surface infrastructure features that can be seen from any point on the map as seen in Figure 14.

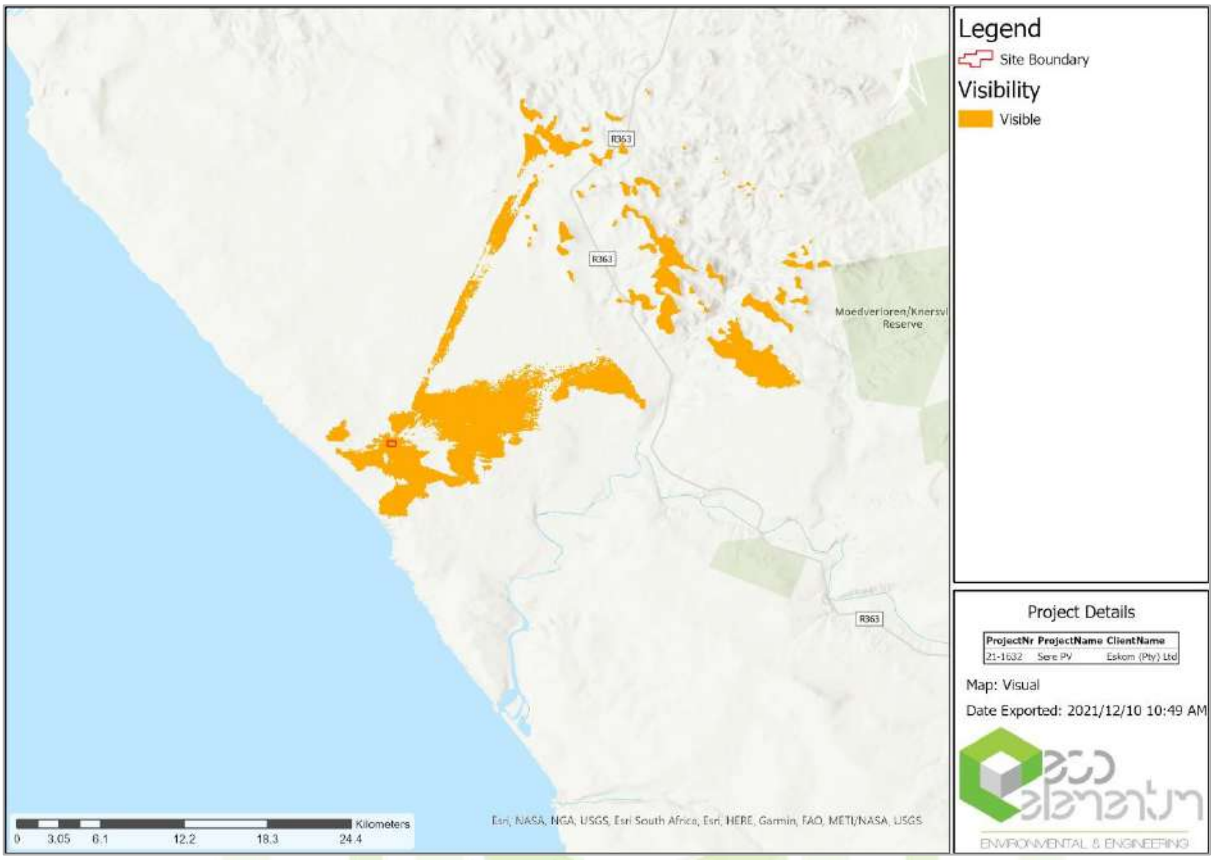



**Figure 15: Viewshed of proposed Sere PV project, Alternative Layout – Visibility (From where can the surface infrastructure locations can be seen from any location on the map)**

For the assessment of the visibility of the area, the viewshed has been calculated for the amount of surface infrastructure features that can be seen from any point on the map as seen in Figure 15.

## 7.9 VIEWSHED VISIBILITY – DISTANCE RANKING

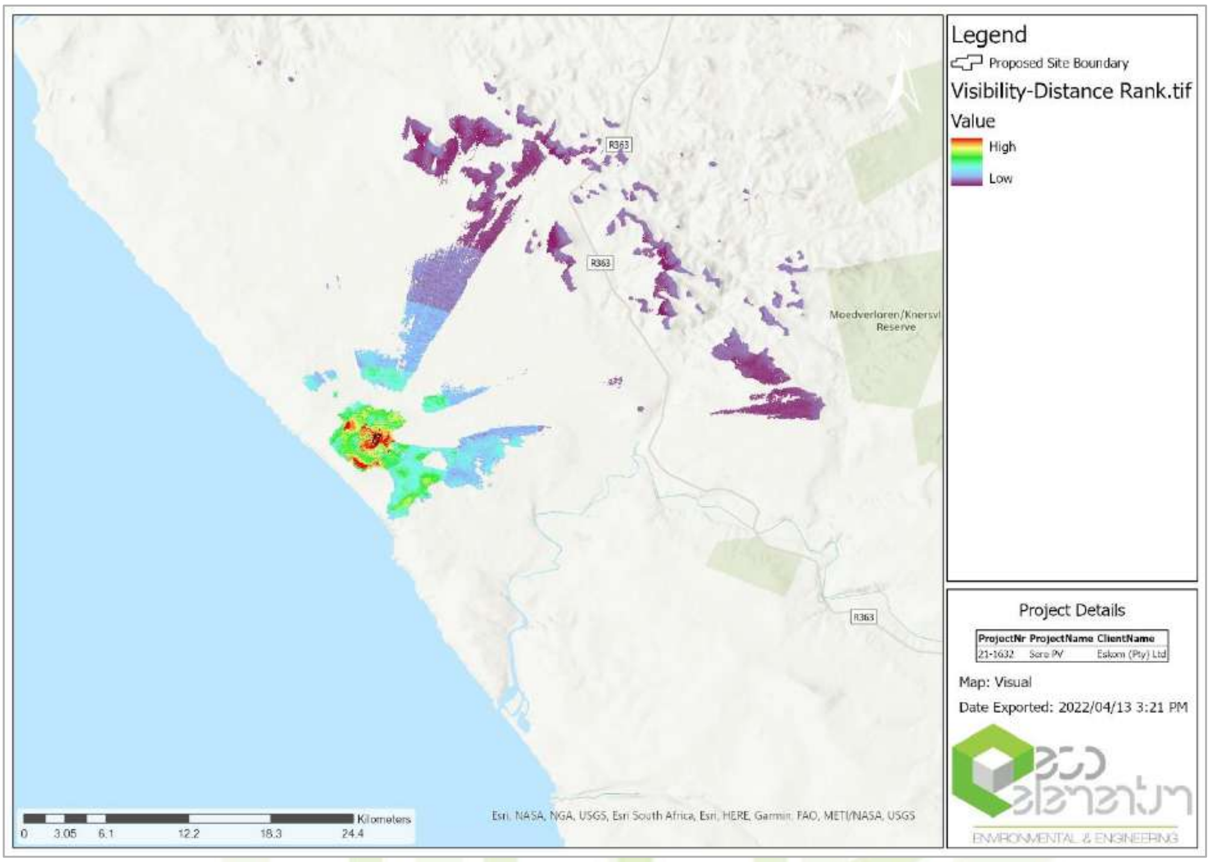



**Figure 16: Viewshed of proposed Sere PV project, Proposed Layout - Visible surface infrastructure locations that can be seen from any location on the map ranked according to distance from source**

The visibility section above is then further ranked based on distance from the centre of the proposed infrastructure site as seen in Figure 16.

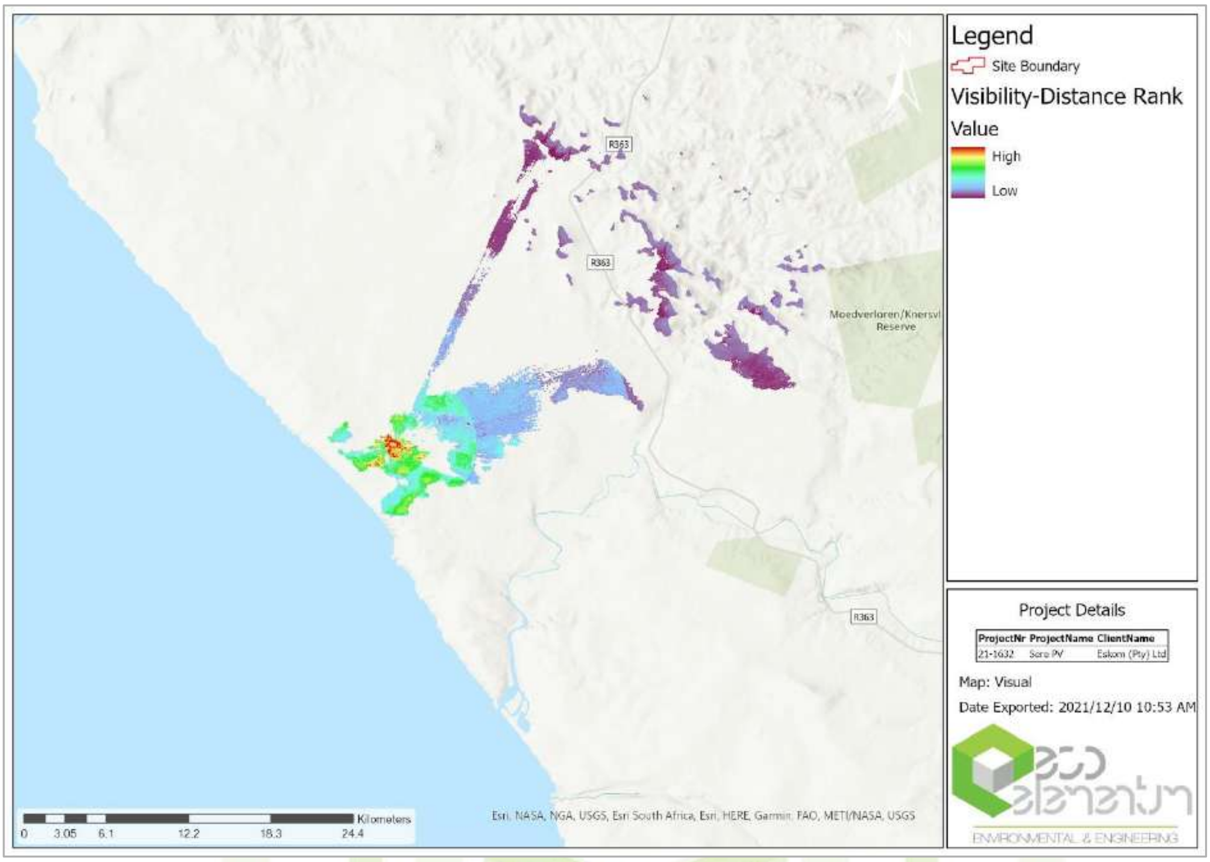



**Figure 17: Viewshed of proposed Sere PV project, Alternative Layout - Visible surface infrastructure locations that can be seen from any location on the map ranked according to distance from source**

The visibility section above is then further ranked based on distance from the centre of the proposed infrastructure site as seen in Figure 17Figure 16.

## 7.10 Visual Exposure Ranking

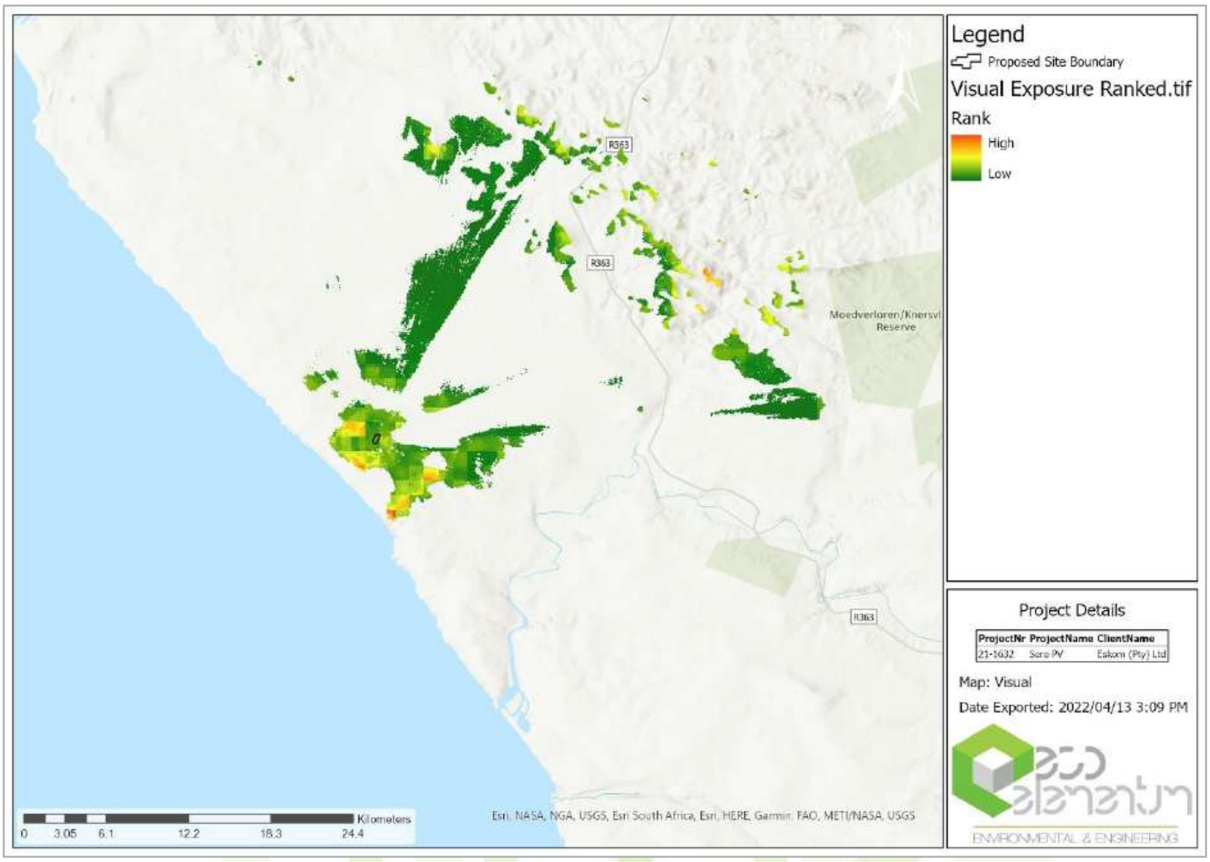



**Figure 18: Visual Exposure ranking within a 30 km radius of the proposed Sere PV project, Proposed Layout**

The visible infrastructure count is combined with the distance from the source ranking together with the VAC of the land cover types, the slope, aspect, ruggedness, relative elevation, landforms and slope position to get a quantitative Visual Exposure ranking of all the areas where it may be possible to see the proposed development as seen in Figure 18.

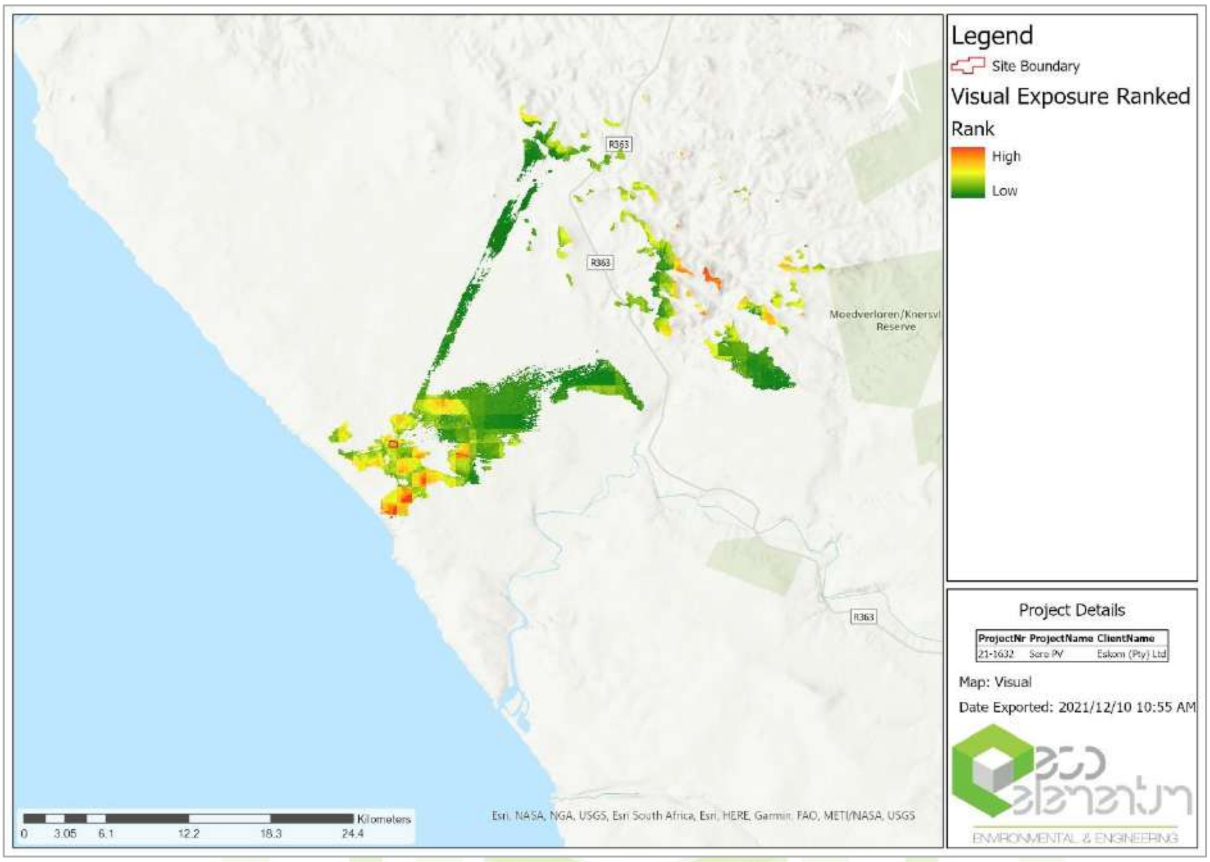



Figure 19: Visual Exposure ranking within a 30 km radius of the proposed Sere PV project, Alternative Layout

The visible infrastructure count is combined with the distance from the source ranking together with the VAC of the land cover types, the slope, aspect, ruggedness, relative elevation, landforms and slope position to get a quantitative Visual Exposure ranking of all the areas where it may be possible to see the proposed development as seen in Figure 19.

Table 9: Visual Exposure Ranking – Distance from Proposed Infrastructure Development

| | |
|---|---|
| 1 | Very Low |
| 2 | Low |
| 3 | Medium |
| 4 | High |
| 5 | Very High |

## 7.11 VIEW POINTS

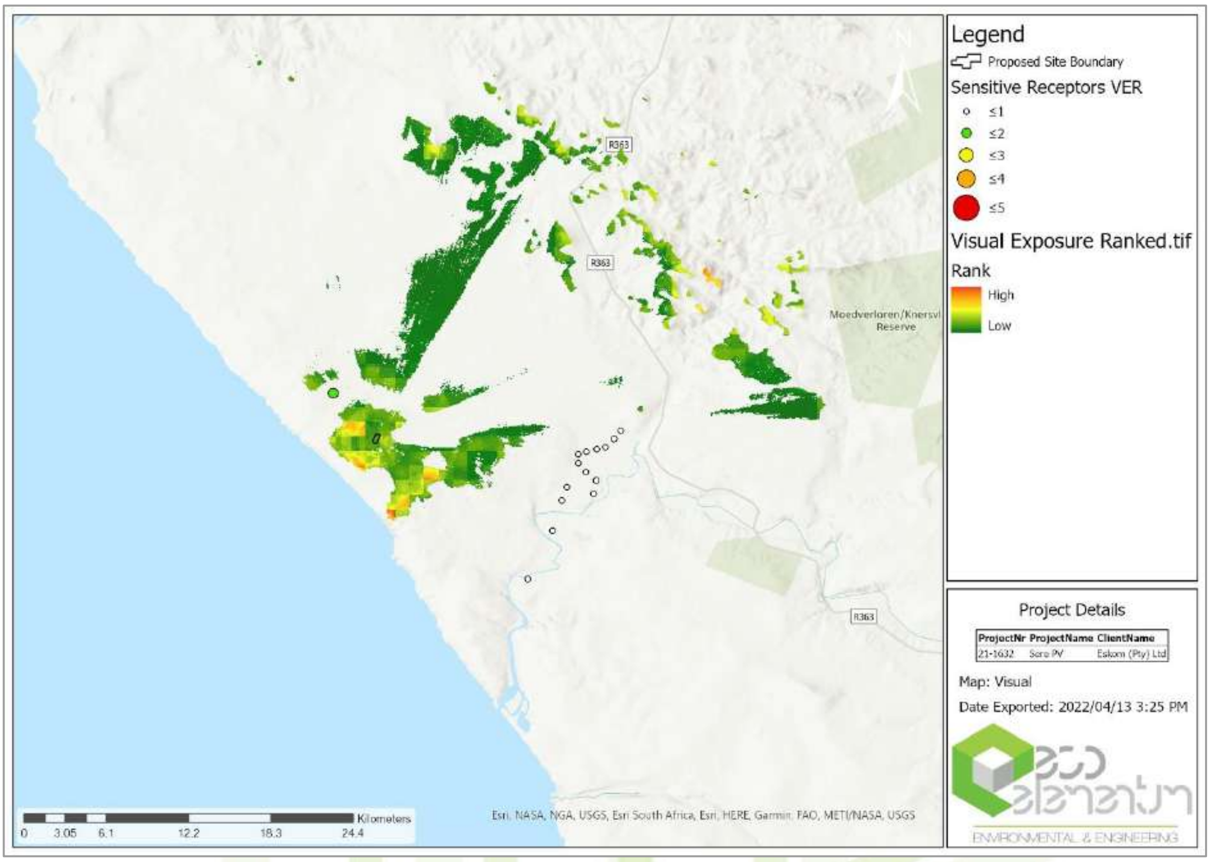



**Figure 20: Viewpoint sensitive receptors overlaid on the Visual Exposure Ranking, Proposed Layout**

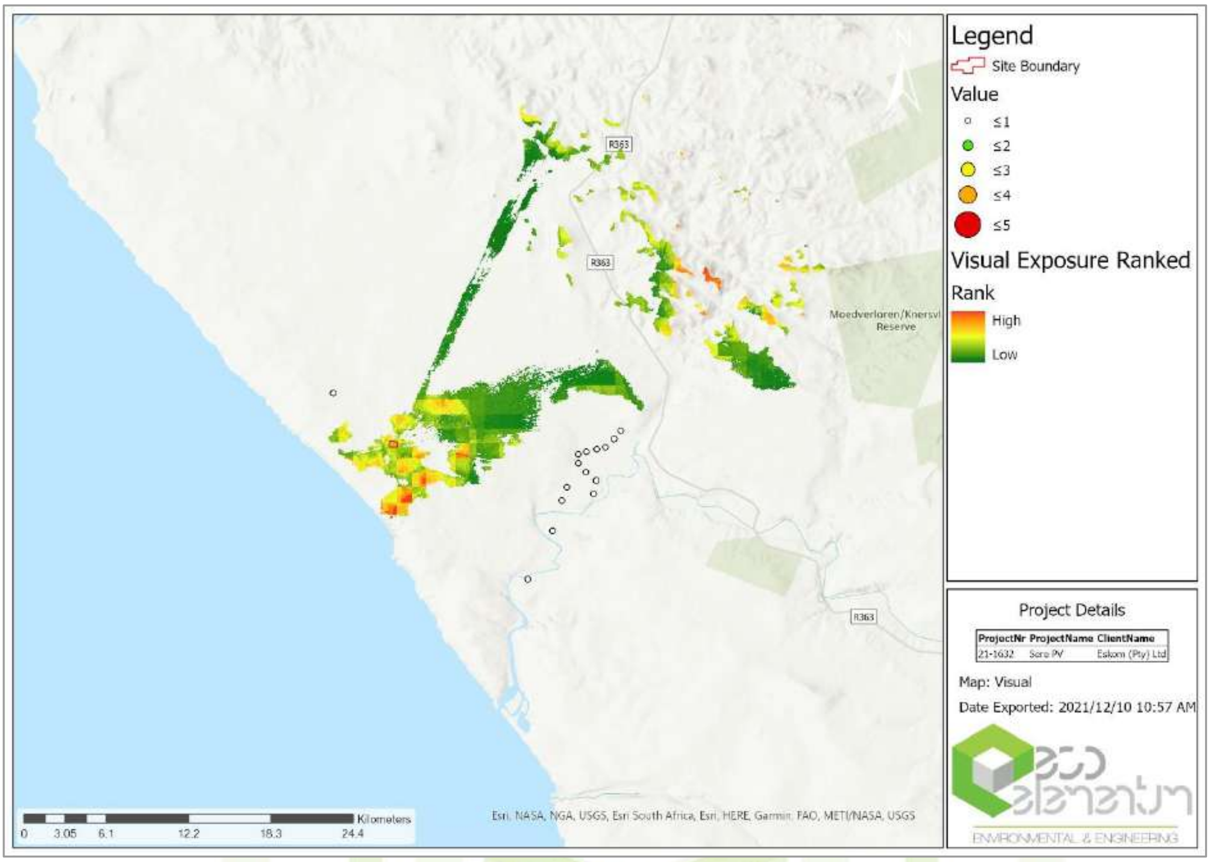



Figure 21: Viewpoint sensitive receptors overlaid on the Visual Exposure Ranking, Alternative Layout

Each identified sensitive receptor is then overlaid on the Visual Exposure Ranking and the value extracted to that pixel to give a quantitative ranking for each of the identified sensitive receptors as can be seen in Figure 20 and Figure 21.

Ranking is done from 1 to 10, 1 being very low and 10 very high.

Due to fact that topographic modification can take place by agricultural, vegetation and other activities in the area, the viewshed is only a theoretical study. The viewpoints have been identified based on the sensitivity of the areas to visual disturbance and areas that can be negatively impacted by the related structures.

From the GIS analysis is modelled that from none of the identified sensitive receptors, the proposed PV installation would be visible. Factors like real time and micro scale vegetation are not taken into account, thus it should be noted that in real life a different outcome may be possible.

### 7.11.1 Comparison

Table 10: Comparison

| Receptor | Alternative 1 | Alternative 2 |
|---|---|---|
| **1** | 0 | 1.45 |
| **2** | 0 | 0 |
| **3** | 0 | 0 |
| **4** | 0 | 0 |
| **5** | 0 | 0 |
| **6** | 0 | 0 |

| Receptor | Alternative 1 | Alternative 2 |
|---|---|---|
| **7** | 0 | 0 |
| **8** | 0 | 0 |
| **9** | 0 | 0 |
| **10** | 0 | 0 |
| **11** | 0 | 0 |
| **12** | 0 | 0 |
| **13** | 0 | 0 |
| **14** | 0 | 0 |
| **15** | 0 | 0 |

Table 10 show the Visual Exposure Rating (VER) at each of the identified sensitive receptors for both the alternative 1 and 2 scenarios. Only 1 receptor had a VER for the Alternative 2 scenario. None of the rest of the receptors are modeled as having any VER for both the Alternative 1 and 2 scenarios.

Receptor 1 is predicted to have a VER of 1.45, which is considered low. Therefore the impact difference is considered negligible.

## 7.12 Visual Impact Criteria

The level of detail as depicted in the EIA regulations were fine-tuned by assigning specific values to each impact. In order to establish a coherent framework within which all impacts could be objectively assessed, it was necessary to establish a rating system, which was applied consistently to all the criteria. For such purposes each aspect was assigned a value, ranging from one (1) to five (5), depending on its definition. This assessment is a relative evaluation within the context of all the activities and the other impacts within the framework of the project.

The impact assessment criteria used to determine the impact of the proposed development are as follows:

1. ***Severity*** of the impact;
2. **Spatial Scale** - The physical and spatial scale of the impact;
3. ***Duration*** - The lifetime of the impact, measured in relation to the lifetime of the proposed development;
4. ***Frequency of the Activity*** – How often do the activity take place;
5. ***Frequency of the incident/impact*** – How often does the activity impact on the environment;
6. ***Legal Issues*** – How is the activity governed by legislation; and
7. ***Detection*** – How quickly/easily the impacts/risks of the activity be detected on the environment, people and property.

To ensure uniformity, the assessment of potential impacts will be addressed in a standard manner so that a wide range of impacts is comparable. For this reason a clearly defined rating scale is provided for the specialist to assess impacts associated with the investigation.

**Table 11: Assessment criteria**

| SEVERITY | |
|---|---|
| Insignificant / non-harmful | 1 |
| Small / potentially harmful | 2 |
| Significant / slightly harmful | 3 |
| Great / harmful | 4 |
| Disastrous / extremely harmful / within a regulated sensitive area | 5 |

| | |
|---|---|
| **SPATIAL SCALE** | |
| Area specific (at impact site) | 1 |
| Whole site (entire surface right) | 2 |
| Local (within 5 km) | 3 |
| Regional / neighboring areas (5 km to 50 km) | 4 |
| National | 5 |
| **DURATION** | |
| One day to one month (immediate) | 1 |
| One month to one year (Short term) | 2 |
| One year to 10 years (medium term) | 3 |
| Life of the activity (long term) | 4 |
| Beyond life of the activity (permanent) | 5 |
| **FREQUENCY OF THE ACTIVITY** | |
| Annually or less | 1 |
| 6 monthly | 2 |
| Monthly | 3 |
| Weekly | 4 |
| Daily | 5 |
| **FREQUENCY OF THE INCIDENT/IMPACT** | |
| Almost never / almost impossible / >20% | 1 |
| Very seldom / highly unlikely / >40% | 2 |
| Infrequent / unlikely / seldom / >60% | 3 |
| Often / regularly / likely / possible / >80% | 4 |
| Daily / highly likely / definitely / >100% | 5 |
| **LEGAL ISSUES** | |
| No legislation | 1 |
| Fully covered by legislation | 5 |
| **DETECTION** | |
| Immediately | 1 |
| Without much effort | 2 |
| Need some effort | 3 |
| Remote and difficult to observe | 4 |
| Covered | 5 |
| Immediately | 1 |

The impacts that are generated by the development can be minimised if measures are implemented in order to reduce the impacts. The mitigation measures ensure that the development considers the environment and the predicted impacts in order to minimise impacts and achieve sustainable development.

### 7.12.1 Consequence

Consequence is determined by the following equation after the assessment of each impact.

**Consequence = Severity + Spatial Scale + Duration**

### 7.12.2 Likelihood

The Likelihood of the activity is then calculated based on frequency of the activity and impact, how easily it can be detected and whether the activity is governed by legislation. Thus:

**Likelihood = Frequency of activity + frequency of impact + legal issues + detection**

### 7.12.3 Risk

The risk is then based on the consequence and likelihood.

**Risk = Consequence x likelihood**

### 7.12.4 Impact Ratings

The impact is then rated according to the following table:

**Table 12: Impact Rating Table**

| Rating | Class |
|---|---|
| **1-55** | (L) Low Risk |
| **56-169** | (M) Moderate Risk |
| **170-600** | (H) High Risk |

# 8. VISUAL IMPACT ASSESSMENT

The previous section identified specific areas where, and likelihood of, the potential visual impact would occur as well as scenario with the least predicted visual impact on the sensitive receptors. This section will attempt to quantify these visual impacts in their respective geographic locations and in terms of the identified issues related to the visual impact.

## 8.1 Potential Construction Phase Visual Impact Of The Structures

**Table 13: Summarizing the significance of visual impacts on a viewpoint that may be visible in the real world during the Construction phase.**

| **Nature of impact: Potential visual impact of the proposed Solar PV project for the construction phase.** | | | |
|---|---|---|---|
| | | **Unmitigated** | **Mitigated** |
| **Assessment Criteria** | **Severity** [Insignificant / non-harmful (1); Small / potentially harmful (2); Significant / slightly harmful (3); Great / harmful (4); Disastrous / extremely harmful / within a regulated sensitive area (5)] | **2** | **2** |
| | **Spatial Scale** [Area specific (at impact site) (1); Whole site (entire surface right) (2); Local (within 5km) (3); Regional / neighbouring areas (5 km to 50 km) (4); National (5)] | **1** | **1** |
| | **Duration** [One day to one month (immediate) (1); One month to one year (Short term) (2); One year to 10 years (medium term) (3); Life of the activity (long term) (4); Beyond life of the activity (permanent) (5)] | **2** | **2** |
| | **Frequency of Activity** [Annually or less (1); 6 monthly (2); Monthly (3); Weekly (4); Daily (5)] | **4** | **4** |
| | **Frequency of Incident/Impact** [Almost never / almost impossible / >20% (1); Very seldom / highly unlikely / >40% (2); Infrequent / unlikely / seldom / >60% (3); Often / regularly / likely / possible / >80% (4); Daily / highly likely / definitely / >100% (5) | **4** | **3** |
| | **Legal Issues** [No legislation(1); Fully covered by legislation (5)] | **1** | **1** |
| | **Detection** [Immediately(1); Without much effort (2); Need some effort (3); Remote and difficult to observe (4); Covered (5)] | **3** | **3** |
| **Consequence** | Severity + Spatial Scale + Duration | **5** | **5** |
| **Likelihood** | Frequency of Activity + Frequency of impact + Legal issues + Detection | **12** | **11** |
| **Risk** | Consequence * Likelihood | **MODERATE (60)** | **LOW (55)** |
| **Mitigation:** | The visual impact can be minimized creating a visual barrier. The construction area will be cleared as soon as construction of the infrastructure is finished. | | |
| **Cumulative Impact:** | The construction of the proposed Sere PV project with its associated infrastructure will increase the cumulative visual impact of Solar PV type infrastructure within the region.<br>In context of the existing wind farm and desert landscape the construction phase of Sere PV structures will contribute to a regional increase in heavy vehicles on the roads in the region, with construction activity noticeable. | | |

The impact on the surrounding land users will be more significant but can still be seen as LOW because of the short time the proposed activity will be undertaken. Although the construction activities will be highly visible, the time of exposure is short and thus the impact on the users will be low after mitigation measures have been implemented.

## 8.2 Potential Permanent Visual Impact Of The Structures

Visibility is determined by a line of sight where nothing obscures the view of an object. Exposure is defined by the degree of visibility, in other words "how much" of it can be seen. This is influenced by topography and the incidence of objects such as trees and buildings that obscure the view partially or in total.

Potential permanent visual impact on the Viewpoints is expected to have a MODERATE impact before mitigation and MODERATE significance after mitigation, as indicated in the table below. The structures will be MODERATE visible from the Viewpoints, the time of exposure is permanent and thus the impact on the users will still remain MODERATE.

### 8.2.1 Alternative 1

**Table 14: Impact table summarising the significance of the structures on users of roads and land-users for Alternative 1**

| Nature of impact: Potential visual impact of the proposed Solar PV project. | | | |
|---|---|---|---|
| | | **Unmitigated** | **Mitigated** |
| **Assessment Criteria** | **Severity** [Insignificant / non-harmful (1); Small / potentially harmful (2); Significant / slightly harmful (3); Great / harmful (4); Disastrous / extremely harmful / within a regulated sensitive area (5)] | **2** | **2** |
| | **Spatial Scale** [Area specific (at impact site) (1); Whole site (entire surface right) (2); Local (within 5km) (3); Regional / neighbouring areas (5 km to 50 km) (4); National (5)] | **4** | **2** |
| | **Duration** [One day to one month (immediate) (1); One month to one year (Short term) (2); One year to 10 years (medium term) (3); Life of the activity (long term) (4); Beyond life of the activity (permanent) (5)] | **4** | **4** |
| | **Frequency of Activity** [Annually or less (1); 6 monthly (2); Monthly (3); Weekly (4); Daily (5)] | **5** | **5** |
| | **Frequency of Incident/Impact** [Almost never / almost impossible / >20% (1); Very seldom / highly unlikely / >40% (2); Infrequent / unlikely / seldom / >60% (3); Often / regularly / likely / possible / >80% (4); Daily / highly likely / definitely / >100% (5) | **4** | **3** |
| | **Legal Issues** [No legislation(1); Fully covered by legislation (5)] | **1** | **1** |
| | **Detection** [Immediately(1); Without much effort (2); Need some effort (3); Remote and difficult to observe (4); Covered (5)] | **3** | **3** |
| **Consequence** | Severity + Spatial Scale + Duration | **10** | **8** |
| **Likelihood** | Frequency of Activity + Frequency of impact + Legal issues + Detection | **13** | **12** |
| **Risk** | Consequence * Likelihood | **MODERATE (130)** | **MODERATE (96)** |
| **Mitigation:** | Painting the supporting building dark natural colours. | | |
| **Cumulative Impact:** | The construction of the proposed Sere PV structures with its associated infrastructure will increase the cumulative visual impact of Solar PV infrastructure within the region.<br>In context of the existing wind farm, and desert landscape, the added structures will contribute to an increase in visual impact on the immediate land users. | | |

The permanent impact on the surrounding farmers and land users will be increased due to the solar PV structures added to the area.

The modelling of visibility is merely conceptual. Being based on DEM and Land cover data, it does not take into account the real world effect of buildings, trees etc. that could shield the structures from being visible or could have changed over time.

The viewshed analysis therefore signifies a worst-case scenario. The immediate landscape surrounding the observer has a determining influence on long distance views. It is expected that different land cover may offer some degree of visual screening, especially where tall trees occur around farmsteads. This influence was quantified using the land cover data, it must however be noted that this can change on a micro scale or land cover may have changed over time.

The viewshed analysis was generated and refined to reflect the visual exposure of the development according to its actual position in the landscape, as per the general assumed mining related infrastructure.

### 8.2.2 Alternative 2

**Table 15: Impact table summarising the significance of the structures on users of roads and land-users for Alternative 2**

| Nature of impact: Potential visual impact of the proposed Solar PV project. | | | |
|---|---|---|---|
| | | **Unmitigated** | **Mitigated** |
| **Assessment Criteria** | **Severity** [Insignificant / non-harmful (1); Small / potentially harmful (2); Significant / slightly harmful (3); Great / harmful (4); Disastrous / extremely harmful / within a regulated sensitive area (5)] | **2** | **2** |
| | **Spatial Scale** [Area specific (at impact site) (1); Whole site (entire surface right) (2); Local (within 5km) (3); Regional / neighbouring areas (5 km to 50 km) (4); National (5)] | **4** | **2** |
| | **Duration** [One day to one month (immediate) (1); One month to one year (Short term) (2); One year to 10 years (medium term) (3); Life of the activity (long term) (4); Beyond life of the activity (permanent) (5)] | **4** | **4** |
| | **Frequency of Activity** [Annually or less (1); 6 monthly (2); Monthly (3); Weekly (4); Daily (5)] | **5** | **5** |
| | **Frequency of Incident/Impact** [Almost never / almost impossible / >20% (1); Very seldom / highly unlikely / >40% (2); Infrequent / unlikely / seldom / >60% (3); Often / regularly / likely / possible / >80% (4); Daily / highly likely / definitely / >100% (5) | **4** | **3** |
| | **Legal Issues** [No legislation(1); Fully covered by legislation (5)] | **1** | **1** |
| | **Detection** [Immediately(1); Without much effort (2); Need some effort (3); Remote and difficult to observe (4); Covered (5)] | **3** | **3** |
| **Consequence** | Severity + Spatial Scale + Duration | **10** | **8** |
| **Likelihood** | Frequency of Activity + Frequency of impact + Legal issues + Detection | **13** | **12** |
| **Risk** | Consequence * Likelihood | **MODERATE (130)** | **MODERATE (96)** |

| | |
|---|---|
| **Mitigation:** | Painting the supporting building dark natural colours. |
| **Cumulative Impact:** | The construction of the proposed Sere PV structures with its associated infrastructure will increase the cumulative visual impact of Solar PV infrastructure within the region.<br>In context of the existing wind farm, and desert landscape, the added structures will contribute to an increase in visual impact on the immediate land users. |

The permanent impact on the surrounding farmers and land users will be increased due to the solar PV structures added to the area.

The modelling of visibility is merely conceptual. Being based on DEM and Land cover data, it does not take into account the real world effect of buildings, trees etc. that could shield the structures from being visible or could have changed over time.

The viewshed analysis therefore signifies a worst-case scenario. The immediate landscape surrounding the observer has a determining influence on long distance views. It is expected that different land cover may offer some degree of visual screening, especially where tall trees occur around farmsteads. This influence was quantified using the land cover data, it must however be noted that this can change on a micro scale or land cover may have changed over time.

The viewshed analysis was generated and refined to reflect the visual exposure of the development according to its actual position in the landscape, as per the general assumed mining related infrastructure

## 8.3 CUMULATIVE IMPACTS

Cumulative landscape and visual effects (impacts) result from additional changes to the landscape or visual amenity caused by the proposed development in conjunction with other developments (associated with or separate to it), or actions that occurred in the past, present or are likely to occur in the foreseeable future. They may also affect the way in which the landscape is experienced. Cumulative effects may be positive or negative. Where they comprise of a range of benefits, they may be considered to form part of the mitigation measures.

Cumulative effects can also arise from the inter-visibility (visibility) of a range of developments and / or the combined effects of individual components of the proposed development occurring in different locations or over a period of time. The separate effects of such individual components or developments may not be significant, but together they may create an unacceptable degree of adverse effects on visual receptors within their combined visual envelopes. Inter-visibility depends upon general topography, aspect, tree cover or other visual obstruction, elevation and distance, as this affects visual acuity, which is also influenced by weather and light conditions. (Institute of Environmental Assessment and The Landscape Institute, 1996).

- The cumulative visual intrusion of the proposed Sere PV structures, will be MODERATE as it is a Solar PV project. The site location is however near a wind farm and far away from human habitation which decrease the visual impact further. The visual impact and impact on sense of place of the proposed project will contribute to the cumulative negative effect on the aesthetics of the study area. It is recommended however, that the environmental authorities consider the overall cumulative impact on the character and the areas sense of place before a final decision is taken with regard to the optimal number of solar activities in the area.

## 8.4 MITIGATION MEASURES

Mitigation measures may be considered in two categories:

- Primary measures that intrinsically comprise part of the development design through an iterative process. Mitigation measures are more effective if they are implemented from project inception when alternatives are being considered.
- Secondary measures designed to specifically address the remaining negative effects of the final development proposals.

Primary measures that will be implemented will mainly be measures that will minimise the visual impact by softening the visibility of the structures by "blending" with the surrounding areas. Such measures will include rehabilitation of the area at end of life and painting the supporting infrastructure buildings dark natural colours.

Secondary measures will include final rehabilitation, after care and maintenance of the vegetation and to ensure that the final landform is maintained.

# 9. CONCLUSION

The construction and operation phase of the proposed Sere PV project related activities and its associated infrastructure will have a MODERATE visual impact on the natural scenic resources and the topography. However, with the correct mitigation measures the impact might decrease to a point where the visual impact can be seen as less significant. The moderating factors of the visual impact of the proposed solar PV project are the following:

- Number of human inhabitants located in the area;
- Existing wind farm;

### 9.1.1 Comparison

Table 16: Comparison

| Receptor | Alternative 1 | Alternative 2 |
|---|---|---|
| **1** | 0 | 1.45 |

Table 16 show the Visual Exposure Rating (VER) at each of the identified sensitive receptors for both the alternative 1 and 2 scenarios. Only 1 receptor had a VER for the Alternative 2 scenario. None of the rest of the receptors are modeled as having any VER for both the Alternative 1 and 2 scenarios.

Receptor 1 is predicted to have a VER of 1.45, which is considered low. Therefore, the impact difference is considered negligible due to only 1 receptors modeled with a low VER. Any of the Alternatives can be used from a visual impact perspective.

Table 17: The overall Assessment of the Visual Impact for Alternative 1

| Nature of impact: The overall Assessment of the Visual Impact of the area. | | | |
|---|---|---|---|
| | | **Unmitigated** | **Mitigated** |
| **Assessment Criteria** | **Severity** [Insignificant / non-harmful (1); Small / potentially harmful (2); Significant / slightly harmful (3); Great / harmful (4); Disastrous / extremely harmful / within a regulated sensitive area (5)] | **2** | **2** |
| | **Spatial Scale** [Area specific (at impact site) (1); Whole site (entire surface right) (2); Local (within 5km) (3); Regional / neighbouring areas (5 km to 50 km) (4); National (5)] | **4** | **2** |
| | **Duration** [One day to one month (immediate) (1); One month to one year (Short term) (2); One year to 10 years (medium term) (3); Life of the activity (long term) (4); Beyond life of the activity (permanent) (5)] | **4** | **4** |
| | **Frequency of Activity** [Annually or less (1); 6 monthly (2); Monthly (3); Weekly (4); Daily (5)] | **5** | **5** |
| | **Frequency of Incident/Impact** [Almost never / almost impossible / >20% (1); Very seldom / highly unlikely / >40% (2); Infrequent / unlikely / seldom / >60% (3); Often / regularly / likely / possible / >80% (4); Daily / highly likely / definitely / >100% (5) | **4** | **3** |
| | **Legal Issues** [No legislation(1); Fully covered by legislation (5)] | **1** | **1** |
| | **Detection** [Immediately(1); Without much effort (2); Need some effort (3); Remote and difficult to observe (4); Covered (5)] | **3** | **3** |
| **Consequence** | Severity + Spatial Scale + Duration | **10** | **8** |
| **Likelihood** | Frequency of Activity + Frequency of impact + Legal issues + Detection | **13** | **12** |

| Nature of impact: The overall Assessment of the Visual Impact of the area. | | | |
|---|---|---|---|
| **Risk** | Consequence * Likelihood | **MODERATE (130)** | **MODERATE (96)** |
| **Mitigation:** | Painting the supporting building dark natural colours. | | |
| **Cumulative Impact:** | The construction of the proposed Sere PV structures with its associated infrastructure will increase the cumulative visual impact of Solar PV infrastructure within the region.<br>In context of the existing wind farm, and desert landscape, the added structures will contribute to an increase in visual impact on the immediate land users. | | |

The Visual Impact due to the proposed solar PV project and associated infrastructure can be seen as having a MODERATE impact on the surrounding environment before mitigation measures are implemented. After mitigation, the visual impact can be seen as MODERATE although lower. Thus, mitigation measures are very important and one of the most significant mitigation measures are the rehabilitation of the area at end of project life. If the rehabilitation of the impact is not done correctly and the final landform do not fit into the surrounding area then the visual impact will remain high and become a concern. However, with correct rehabilitation, the impact will be minimal and there should be no visual impact after the landform has been restored.

Table 18: The overall Assessment of the Visual Impact for Alternative 2

| Nature of impact: The overall Assessment of the Visual Impact of the area. | | | |
|---|---|---|---|
| | | **Unmitigated** | **Mitigated** |
| **Assessment Criteria** | **Severity** [Insignificant / non-harmful (1); Small / potentially harmful (2); Significant / slightly harmful (3); Great / harmful (4); Disastrous / extremely harmful / within a regulated sensitive area (5)] | **2** | **2** |
| | **Spatial Scale** [Area specific (at impact site) (1); Whole site (entire surface right) (2); Local (within 5km) (3); Regional / neighbouring areas (5 km to 50 km) (4); National (5)] | **4** | **2** |
| | **Duration** [One day to one month (immediate) (1); One month to one year (Short term) (2); One year to 10 years (medium term) (3); Life of the activity (long term) (4); Beyond life of the activity (permanent) (5)] | **4** | **4** |
| | **Frequency of Activity** [Annually or less (1); 6 monthly (2); Monthly (3); Weekly (4); Daily (5)] | **5** | **5** |
| | **Frequency of Incident/Impact** [Almost never / almost impossible / >20% (1); Very seldom / highly unlikely / >40% (2); Infrequent / unlikely / seldom / >60% (3); Often / regularly / likely / possible / >80% (4); Daily / highly likely / definitely / >100% (5) | **4** | **3** |
| | **Legal Issues** [No legislation(1); Fully covered by legislation (5)] | **1** | **1** |
| | **Detection** [Immediately(1); Without much effort (2); Need some effort (3); Remote and difficult to observe (4); Covered (5)] | **3** | **3** |
| **Consequence** | Severity + Spatial Scale + Duration | **10** | **8** |
| **Likelihood** | Frequency of Activity + Frequency of impact + Legal issues + Detection | **13** | **12** |
| **Risk** | Consequence * Likelihood | **MODERATE (130)** | **MODERATE (96)** |
| **Mitigation:** | Painting the supporting building dark natural colours. | | |

| Nature of impact: The overall Assessment of the Visual Impact of the area. | |
|---|---|
| **Cumulative Impact:** | The construction of the proposed Sere PV structures with its associated infrastructure will increase the cumulative visual impact of Solar PV infrastructure within the region.<br>In context of the existing wind farm, and desert landscape, the added structures will contribute to an increase in visual impact on the immediate land users. |

The Visual Impact due to the proposed solar PV project and associated infrastructure can be seen as having a MODERATE impact on the surrounding environment before mitigation measures are implemented. After mitigation, the visual impact can be seen as MODERATE although lower. Thus, <u>mitigation measures are very important</u> and one of the most significant mitigation measures are the <u>rehabilitation of the area at end of project life.</u> If the rehabilitation of the impact is not done correctly and the final landform do not fit into the surrounding area then the visual impact will remain high and become a concern. However, with correct rehabilitation, the impact will be minimal and there should be no visual impact after the landform has been restored

Taking into account the modelled data, the visual impact on the identified sensitive receptors can be seen as insignificant for both the proposed and alternative scenarios.

## 10. REFERENCE

- *Chief Director of National Geo-spatial Information, varying dates.* ***1:50 000 Topo-cadastral maps and digital data.***
- *CSIR/ARC, 2000. National Land-cover Database 2000 (NLC 2000).*
- *The Landscape Institute, Institute of Environmental Management & Assessment. 2002.* ***Guidelines for Landscape and Visual Impact Assessment****. Second Ed. E & FN Spon, London (117).*
- *Oberholzer, B. 2005.* ***Guideline for involving visual & aesthetic specialists in EIA processes: Edition 1****. CSIR Report No ENV---S---C 2005. Provincial Government of the Western Cape, Department of Environmental Affairs &Development Planning, Cape Town.*

**APPENDIX D**

**SPECIALISTS' REPORTS**

**APPENDIX D5 - Soil and Agricultural Study**

# REPORT

On contract research for

***SAVANNAH ENVIRONMENTAL***

ARC • LNR

# SOIL INFORMATION FOR POWER LINE ALTERNATIVES FOR THE PROPOSED WIND ENERGY FACILITY, WESTERN CAPE

By

D.G. Paterson (Pr. Sci. Nat. 400463/04)

Report Number GW/A/2007/XX

January 2008

ARC-Institute for Soil, Climate and Water,
Private Bag X79, Pretoria 0001, South Africa
Tel (012) 310 2500 Fax (012) 323 1157

## DECLARATION

I hereby declare that I am qualified to compile this report as a registered Natural Scientist and that I am independent of any of the parties involved and that I have compiled an impartial report, based solely on all the information available.

***D G Paterson***

**CONTENTS** **Page**

# 1. TERMS OF REFERENCE

The ARC-Institute for Soil, Climate and Water (ARC-ISCW) was contracted by Savannah Environmental to undertake a soil investigation north of the Olifants River, on the west coast of the Western Cape Province. The purpose of the investigation is to contribute to the Environmental Impact assessment (EIA) process for a proposed wind energy facility, and more specifically, for the proposed transmission line corridors to serve the facility. The objectives of the study are;

- To obtain all existing soil information and to produce a soil map of the specified area, as well as

- To assess broad agricultural potential.

# 2. SITE CHARACTERISTICS

## 2.1 Location

The area of the proposed facility lies on the farms, Grave Water Kop 158/5 and Portions 617 and 620 of the farm Olifants River Nedersetting. This area will have to be connected to the Juno Substation, near Vredendal by means of a 132 kV power line, of which there are two proposed alternative corridors. These are shown on the map in the Appendix, and comprise a northern route (Alternative 1), which partly follows the existing Juno-Koekenaap power line servitude, as well as a southern route (Alternative 2).

## 2.2 Terrain

The site lies inland of the coastal ridge at a height of 60-110 metres above sea level and consists of virtually flat to slightly undulating topography, with slopes of less than 4%. The only zones with slightly steeper slopes are where the line will cross two small side tributaries of the Olifants River.

## 2.3 Climate

The climate of the area was derived from the closest station, namely Vredendal, some 20 kms inland. The climate can be regarded as typical of the Cape west coast, with an extremely low, all-year round rainfall distribution, warm to hot summers and cool winters. The main climatic indicators are given in Table 1.

**Table 1.** Climate Data

| Month | Rainfall (mm) | Min. Temp (°C) | Max. Temp (°C) |
|---|---|---|---|
| Jan | 2.2 | 14.8 | 29.8 |
| Feb | 3.0 | 14.9 | 30.5 |
| Mar | 5.9 | 14.1 | 29.9 |
| Apr | 14.0 | 12.2 | 27.6 |
| May | 21.2 | 9.7 | 24.2 |
| Jun | 26.8 | 8.0 | 21.5 |
| Jul | 22.0 | 7.0 | 20.9 |
| Aug | 20.0 | 7.5 | 21.5 |
| Sep | 10.7 | 8.9 | 23.5 |
| Oct | 9.2 | 10.7 | 25.5 |
| Nov | 7.0 | 12.4 | 27.7 |
| Dec | 5.9 | 14.0 | 28.8 |
| **Year** | **147.9 mm** | **18.6°C (Average)** | |

The extreme high temperature that has been recorded is 46.0°C (presumably in “berg wind” conditions) and the extreme low –1.0°C.

### 2.4 Parent Material

The site has aeolian sandy material overlying granite and gneiss of the Namaqualand Metamorphic Complex (Geological Survey, 2001).

## 3. METHODOLOGY

Existing information was obtained from the map sheet 3118 Calvinia (Potgieter, 1995) from the national Land Type Survey, published at 1:250 000 scale. A land type is defined as an area with a uniform terrain type, macroclimate and broad soil pattern. The soils are classified according to MacVicar *et al* (1977).

The area under investigation is covered by five land types, as shown by the blue lines on the map in the Appendix, namely:

**Ae372** (red, high base status soils, usually deep)
**Ae373** (red, high base status soils, usually deep)
**Ag203** (shallow, red soils)
**Ai66** (yellow, sandy soils)
**Hb108** (deep, grey sands)

It should be clearly noted that, since the information contained in the land type survey is of a reconnaissance nature, only the general dominance of the soils in the landscape can be given, and not the actual areas of occurrence within a specific land type. Also, other soils that were not identified due to the scale of the survey may also occur. The site was not visited during the course of this study.

## 4. SOILS

A summary of the dominant soil characteristics is given in **Table 2**.

**Table 2**. Land types occurring (with soils in order of dominance)

| Land Type | Dominant soils | Depth (mm) | Percent of land type | Characteristics |
|---|---|---|---|---|
| Ae372 | Hutton 31 | 300-900 | 54.0% | Red, sandy, structureless soils on rock or calcrete |
| | Hutton 30/40/41 | 200-1200 | 14.9% | Red, sandy, structureless soils on rock or calcrete |
| | Oakleaf 11/21/10 | 300-1200 | 10.4% | Red, sandy, structureless soils on rock or calcrete |
| Ae373 | Hutton 31 | 300-900 | 54.0% | Red, sandy, structureless soils on rock or calcrete |
| | Hutton 30/40/41 | 200-1200 | 14.9% | Red, sandy, structureless soils on rock or calcrete |
| | Oakleaf 11/21/10 | 300-1200 | 10.4% | Red, sandy, structureless soils on rock or calcrete |
| Ag203 | Hutton 33/43 | 200-300 | 47.7% | Red, sandy, structureless soils on rock or calcrete |
| | Hutton 40/43 | 300-600 | 19.8% | Red, sandy, structureless soils on rock or calcrete |
| | Mispah/Glenrosa | 50-150 | 7.5% | Shallow lithosols with rock |
| Ai66 | Clovelly 31 | 600-1200 | 85% | Yellow, sandy, structureless soils on rock |
| | Kroonstad/Pinedene | 800-1200 | 10% | Grey/yellow, sandy soils on gleyed clay |
| Hb108 | Fernwood 21 | 1000-1200 | 62.0% | Grey, sandy, structureless soils |
| | Clovelly 31 | 800-12000 | 15.0% | Yellow-brown, sandy, structureless soils on rock |

## 5. AGRICULTURAL POTENTIAL

As can be seen from the information contained in Table 2, most of the area contains a greater or lesser proportion of deep soils, usually sandy.

However, these deeper soils have a low agricultural potential, due to a combination of:

- excessive drainage due to the sandy texture,
- low fertility associated with the low clay content and
- a susceptibility to wind erosion if exposed, caused by the fine to medium grade of sand. This may be especially prevalent in dune areas.

In addition, the low rainfall in the area (Table 1) means that there is little potential for arable agriculture in the area and that the soils are suited for extensive grazing at best. The grazing capacity of the area is low, namely around 30 ha for a large stock unit (cattle) and around 10 ha per small stock unit (sheep/goats) ARC-ISCW, 2004).

The fact that a power line is planned, with pylons at intervals, will mean that disturbance to surface soils will be minimal even if an access road has to be created alongside the power line.

The only possible area where higher potential soils might be affected would be could be along Alternative 2, where the route skirts the irrigated floodplain of the Olifants River (crossing it twice) and where areas with intensively irrigated, high value crops might well occur. Vines are grown along the route of Alternative 2, so care would have to be taken, both in the height of the lines above the crop, and positioning of pylons. Advice from experts in viticulture (such as at ARC- Nietvoorbij) could be sought to accurately determine the possible type of power line tower to use when crossing a vineyard.

## 6. IMPACTS

The siting of a power line will not have a severe impact on the soils and agricultural potential, especially if Alternative 1 is followed as this will mitigate/avoid any possible conflicts close to the Olifants River irrigation area. The proposed amendment, Alternative 1a, will not have a significant effect on the soils that might be disturbed.

With the general agricultural potential of the region being low (mainly due to the dryness), the areas of irrigable land that can be used productively should be treated as a precious resource and disturbed/affected as little as possible.

The impact can be summarised as follows:

**Table 3.** Impact significance

| | | |
|---|---|---|
| **Nature** of impact | Loss of agricultural land | Land that is no longer able to be utilised due to construction of infrastructure |
| **Extent** of impact | Site only (**1**) | Confined to transmission towers |
| **Duration** of impact | Long-term (**4**) | Will cease if operation of activity ceases |
| **Magnitude** of impact | Minor (**2**) | Very localised |
| **Probability** of impact | Some possibility (**2**) | |
| **Significance** of impact | Low (**14**) | Mainly due to low potential of area, as well as scattered nature of infrastructure |

| | |
|---|---|
| **Mitigation** factors | The main mitigation would be to ensure that the power line flows the existing servitude (Alternative 1 or sub-alternative 1a) and remains distant from the Olifants River and the areas of agricultural potential that mirror the watercourse. |

## REFERENCES


**ARC-ISCW,** 2004. Overview of the status of the agricultural natural resources of South Africa (First Edition). ARC-Institute for Soil, Climate and Water, Pretoria

**Geological Survey**, 2001. 1:250 000 scale geological map 3118 Calvinia. Department of Mineral and Energy Affairs, Pretoria.

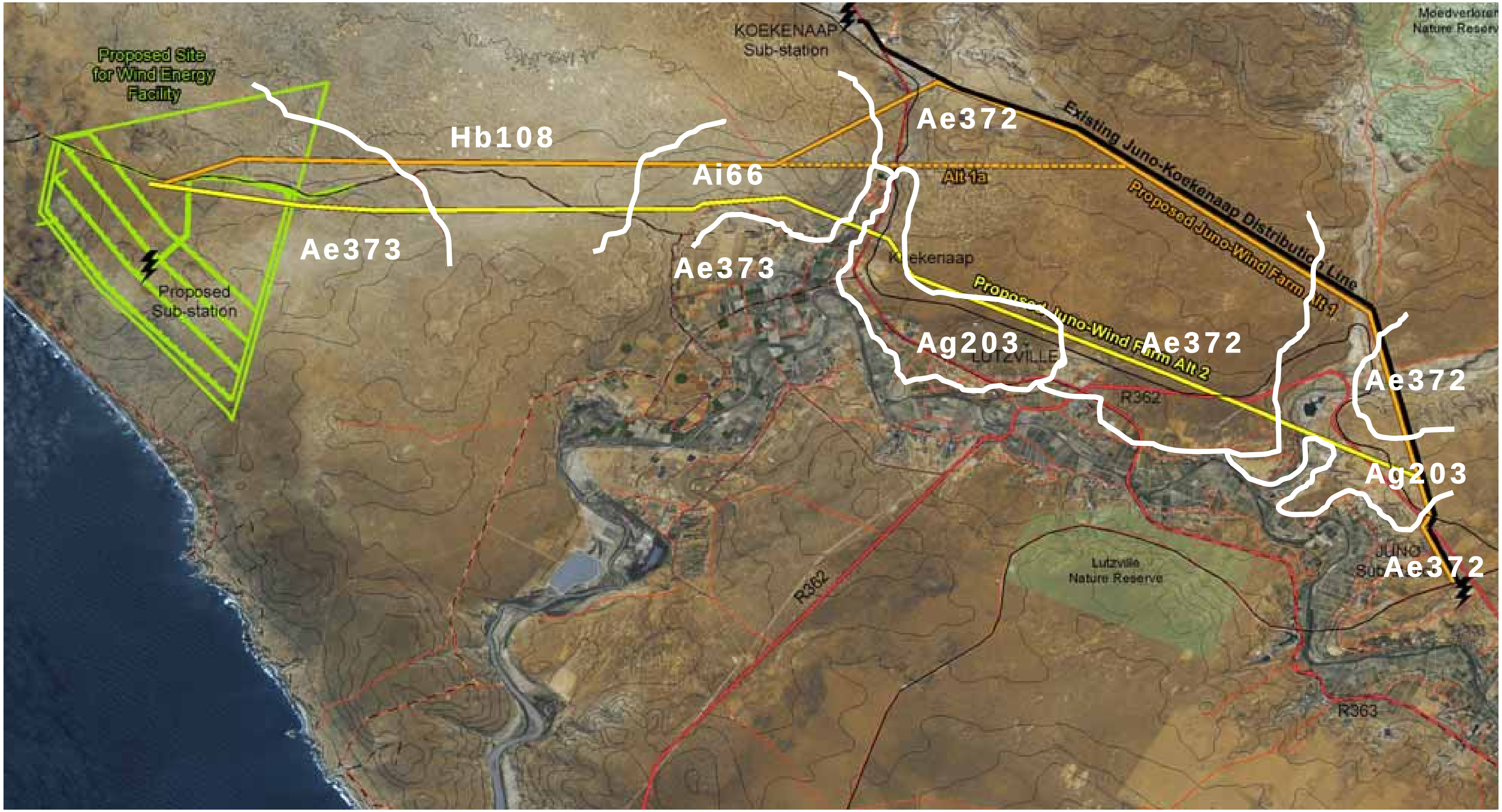
**MacVicar, C.N., de Villiers, J.M., Loxton, R.F, Verster, E., Lambrechts, J.J.N., Merryweather, F.R., le Roux, J., van Rooyen, T.H. & Harmse, H.J. von M.,** 1977. Soil classification. A binomial system for South Africa. ARC-Institute for Soil, Climate & Water, Pretoria.

**Potgieter, L.J.C.**, 1995. Land types of the map 3118 Calvinia. Field information. *Mem. Nat. Agric. Res. S. Afr.* No. 30. ARC-Institute for Soil, Climate and water, Pretoria.

**Soil Classification Working Group**, 1991. Soil classification. A taxonomic system for South Africa. ARC-Institute for Soil, Climate and Water, Pretoria.

# APPENDIX

# MAP OF LAND TYPES


Proposed Site for Wind Energy Facility
Proposed Sub-station
KOEKENAAP Sub-station
Moedverloren Nature Reserve
Hb108
Ai66
Ae372
Ae373
Ae373
Alt 1a
Existing Juno-Koekenaap Distribution Line
Proposed Juno-Wind Farm Alt 1
Koekenaap
Proposed Juno-Wind Farm Alt 2
Ag203
Ae372
LUTZVILLE
R362
Ae372
Ag203
JUNO
Ae372
Lutzville Nature Reserve
R362
R363

# APPENDIX D

# SPECIALISTS' REPORTS

## APPENDIX D6 - Heritage Impact Assessment

# Heritage Impact Assessment (prepared as part of an EIA) of a proposed Wind Energy Facility to be situated at Olifants River Settlement 617, 620 and Grave Water Kop 158/5 situated on the Namaqualand Coast in the Vredendal District, South Western Cape.

Prepared for

Savannah Environmental (Pty) Ltd

December 2007

*FINAL*

Prepared by

Tim Hart

Archaeology Contracts Office
Department of Archaeology
University of Cape Town
Private Bag
Rondebosch
7701

Phone (021) 650 2357
Fax (021) 650 2352
Email timothy.hart@uct.ac.za

## Executive summary

The Archaeology Contracts Office of the University of Cape Town was appointed by Savannah Environmental (Pty) Ltd on behalf of the proponent Eskom Generation, to undertake a heritage assessment (as part of an EIA process) of portions of the farms Olifants River Settlement 617 and 620 and Grave Water Kop 158/5 situated on the Namaqualand Coast in the Vredendal District, South Western Cape. The proposed activity is the development of a Wind Energy Facility which will involve 100 wind turbines distributed over a 25 sq km area. The study area in question is located 2 km inland of the shoreline above the coastal escarpment.

Research has shown that while the shoreline of Namaqualand is rich in archaeological sites, historical sites and other forms of generally protected heritage are relatively scarce. The area is characterised by rocky shorelines, beaches and dune fields, while the inland coastal plain is arid and flat occasionally punctuated by vegetated dunes and deflation bays. The area is remote being used mostly by local farmers (grazing of small stock), while the coastline has been subject to *ad hoc* alluvial diamond mining resulting in significant environmental damage in places.

A detailed field inspection has revealed that the dominant cultural resources that will be impacted are Late Stone Age (LSA) archaeological sites and the landscape itself. The distribution of archaeological sites on the landscape is very much as predicted in the heritage scoping report, but with some interesting exceptions.

The results of the study show that there are large expanses of the landscape that contain very few archaeological sites, however there are two clusters of archaeological sites (LSA middens) which are associated with what used to be two waterholes. While the most of the individual middens that form these clusters warrant a low conservation status (no more than grade 3b-c), they have high group value and are academically significant. Micro-adjustment of wind turbine locations combined with a program of sampling of the middens is expected to result in satisfactory mitigation.

Indications are:

- Historical sites and buildings do not exist in the study area and therefore will not be impacted.
- The wilderness qualities of the landscape will be significantly impacted by the proposed activity
- An estimated 13 Late Stone Age shell middens on the farm Skaapvlei (Grave Water Kop 158/5) will be directly impacted by the proposed activity.
- In heritage terms, no fatal flaws have been identified for the proposed turbine site, access roads, substation or power line corridor alternatives.

## CONTENTS

## GLOSSARY

**Archaeological material** *Remains resulting from human activity which are in a state of disuse and are in or on land and which are older than 100 years, including artefacts, human and hominid remains and artificial features and structures.*

**Calcrete** *A soft sandy calcium carbonate rock related to limestone which often forms in arid areas.*

**Doorbank horizon** *A cemented crusty hard surface from an ancient landscape that underlies Aeolian sands in many areas on the west coast.*

**Early Stone Age** *A very early period of human development dating between 300 000 and 2.6 million years ago.*

**Fossil** *Mineralised bones of animals, shellfish, plants and marine animals. A trace fossil is the track or footprint of a fossil animal that is preserved in stone or consolidated sediment.*

**Heritage** *That which is inherited and forms part of the National Estate (Historical places, objects, fossils as defined by the National Heritage Resources Act of 2000).*

**HWC (Heritage Western Cape)** *The provincial compliance agency responsible for the conservation of heritage.*

**Late Stone Age (LSA)** *In South Africa this time period represents fully modern people who were the ancestors of southern African KhoeKhoen and San groups (40 000 – 300 years ago).*

**Middle Stone Age (MSA)** *An early period in human history characterised by the development of early human forms into modern humans capable of abstract though process and cognition 300 000 – 40 000 years ago.*

**Midden** *A pile of debris or dump (shellfish, stone artefacts and bone fragments) left by people after they have occupied a place.*

**Palaeontological** *Any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or trace.*

**Pleistocene** A geological time period (of 3 million – 20 000 years ago).

**Pliocene** A geological time period (of 5 million – 3 million years ago).

**Miocene** A geological time period (of 23 million - 5 million years ago).

**SAHRA** *South African Heritage Resources Agency.*

**Structure (historic)** *Any building, works, device or other facility made by people and which is fixed to land, and includes any fixtures, fittings and equipment associated therewith. Protected structures are those which are over 60 years old.*

**National Heritage Resources Act (25) 1999 relevant definitions**

**"Archaeological''** means - *material remains resulting from human activity which are in a state of disuse and are in or on land and which are older than 100 years, including artefacts, human and hominid remains and artificial features and structures.* This means that an archaeological site is any area where there are artefacts (objects made by human hand) and ruins that are over 100 years of age. An archaeological find is therefore any object or collection of objects or structures in disuse made by human hand that is over 100 years old. This can range from ancient stone tools, ruins to the contents of historic rubbish dumps containing ceramic shards and bottles.

**''Palaeontological''** means - *any fossilised remain or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or trace.* The term 'fossil' means mineralised bones of animals, shellfish, plants, marine animals. A trace fossil is the track or footprint of a fossil animal that is preserved in stone or consolidated sediment.

**"Graves and human remains"** are protected by primarily by the NHRA but also provincial ordinances, local authorities and provincial health departments.

**''Structure''** means - any building, works, device or other facility made by people and which is fixed to land, and includes any fixtures, fittings and equipment associated therewith. Protected structures are those which are over 60 years old. Such structures may only be altered or demolished under a Section 42 permit issued by the heritage authority.

**"Cultural landscapes"** are protected by the Act as they are defined as being cultural heritage. Under certain circumstances the compliance authority may intervene and comment on the design and aesthetic qualities of any development that forms part of or is within sight of a heritage place or site or protected area.

**"Shipwrecks and aircraft wrecks"** on land and in the sea greater than 60 years of age are protected and defined as heritage in terms of the Act.

## 1. INTRODUCTION

The Archaeology Contracts Office (ACO) of the University of Cape Town was appointed by Savannah Environmental (Pty) Ltd on behalf of the proponent Eskom Generation, to undertake a heritage assessment of portion of the farms Olifants River Settlement 617, 620 and Grave Water Kop 158/5 situated on the Namaqualand Coast in the Vredendal District, South Western Cape. The proposed activity is the development of a Wind Energy Facility which will consist of 100 wind turbines distributed over a 25 sq km area, along with access roads, substation, visitors centre and a 132 kV transmission line to the Juno substation near Vredendal.

### 1.1 The need for the project

Studies completed by Eskom have forecast that the company's electricity generating capacity will be under pressure to meet the needs of the Nation, considering the current rate of growth of the economy. This is particularly so in the Western Cape Province, where local growth rates exceed the national average. Eskom is responding to this situation by taking measures to expand the organisation's generating, transmission and distribution capacity in a number of ways. Besides increasing the extent of other energy sources, Eskom is trying to raise the contribution of clean renewable energy such as wind and solar energy to the national transmission and grid. To this end, an experimental wind farm has been established near Klipheuwel in the Western Cape where three different kinds of wind turbines have been undergoing testing to establish what best suits local conditions. In order to optimise the use of the wind resource, Eskom has identified areas of the country that experience consistently high wind speeds for optimum daily power generation. An area on the Namaqualand coast just north of the Olifants River mouth has been identified as being suitable. Site selection has been a lengthy process involving work-shopping various options to make sure that the process is in line with the DEA&DP Strategic Initiative report.

### 1.2 The receiving environment

The study area lies on the arid coast of Namaqualand, Western Cape Province, 10 km to the north of the Olifants River mouth. The application that is now for consideration in the EIA process is a Wind Energy Facility of up to 100 turbines. Initially 50 turbines will be built and commissioned as phase 1, with a further 50 being constructed as a second phase. The area identified for the study is large, incorporating parts of farms Olifants River Settlement 617 and 620 and 158/5 Grave Water Kop. Eskom is investigating possible procurement and lease options of the above portions of land which will amount to ~37km$^2$, although only an area less than 25km$^2$ within this site is required for the facility. Initial planning has indicated that only the western half of the study area will be used for the construction of the 4 rows of wind turbines.

The land in question is entirely undeveloped and somewhat remote (Figure 1) being accessible via a gravel road from Koingnaas (some 50 km inland). The built environment is limited to a gravel provincial road, casual off-road tracks and the Skaapvlei Farm/Mining houses immediately to the north of the study area. On Skaapvlei previous attempts have been made to farm wheat. Currently wheat farming has been abandoned and the land is largely overgrown at present. In the immediate coastal zone to the west, concession diamond mining has significantly damaged an otherwise scenic coastline (characterised by cliffs, beaches and sheltered bays).


**Figure 1.** Satelite image showing the location of the study area along with power line alternatives. (image supplied by Savannah Environmental)

Within the study area, the landscape is characterised by low vegetated dunes, occasional deflation bays and fossil *Termiteria* mounds (*Heuweltjies*). The Strandveld vegetation is low and scrubby – there are no significant trees. Rocky outcrops are limited to a number of low ferricrete rafts which are mostly confined to the eastern side (inland) of the study area. The landscape is sandy throughout, however there is evidence of dried out wetlands and pans (many evidently highly saline), in particular on the farm Skilpadvlei, of which a portion lies within the study area. Two waterholes (which in the recent past contained potable water) were identified on the farm Skaapvlei.

**Figure 2** The study area - typical view

The study area, which is some 2 km from the immediate coastline, does not lie on any commonly used tourism route (although in recent years a local farmer has commenced an eco-tourism initiative) however the shoreline is frequented by people who regularly use the coast for recreational camping over the holiday season. Generally, apart from Transhex Diamond Mining staff and local farmers, the local area is scarcely populated.

Human-made environment is limited to occasional wind pumps, fenced stock camps and off-road tracks which are only accessible with a four wheel drive vehicle. Much of the landscape, even within the study area is untouched, being devoid of paths or tracks and is only accessible on foot. Wildlife is common, but species diversity is low – small and medium bovids (springbok, steenbok and duiker), small carnivores (meerkat and aardwolf) along with numerous rodents, birds and reptiles were observed during the course of this study.

Natural landscape and archaeological sites have been identified as the main heritage resource that requires assessment in this specialist study. The proposed activity does not involve deep excavation and is therefore unlikely to impact Cenozoic palaeontology which is likely to exist in deeply buried contexts.

### 1.3 The proposed activity

Eskom proposes to erect up to 100 wind turbines on a site of approximately 25 $km^2$. The turbines will be positioned so that each unit can make optimum use of the wind resource. They will be arranged in a series of 4 rows (a-d) across the western side of the study area roughly parallel to the coast. Each turbine will be approximately 300 m apart from the next while rows will be approximately 700 m apart. Each turbine consists of a steel tower 80 m high supporting a swivelling generator nacelle (containing the gearbox and generator) weighing 60 tons. Each blade will be 45 m long. The wind energy facility will be fenced. Associated infrastructure will consist of an access road, sub-station and visitors centre.

**Figure 3** Vesta type wind turbine similar to those envisioned for the study area (Eskom).

Initially 50 wind turbines will be built, with expansion to 100 turbines envisaged in later years.

The wind energy facility will be linked to the national power grid by a 132 KV transmission line. Three alternatives routes are under investigation for the transmission line;

- Alternative 1 runs mostly north of the Koekenaap-Skaapvlei road and joins the Koekenaap – Juno transmission line at Koekenaap.
- Alternative 1a is a variation on alternative 1 avoiding botanically sensitive areas.
- Alternative 2 runs south of Koekenaap-Skaapvlei the along the northern edge of the Olifants River Valley and links directly with Juno substation.

The comparative impacts of each alternative are assessed in this study.

## 2. METHODOLOGY

### 2.1 Information base

The information that has informed this study is derived from two main sources. The first of which is experience derived from a number of significant studies that have taken place close to the study area as well as the general body of information that has been derived from researchers mostly based at the University of Cape Town who have worked in the Elands Bay area since the 1960s. Major studies on Namakwa Sands property, Transhex, Namaqualand Diamond Mining Corporation and De Beers owned properties have provided a solid background of observations.

The second major source of information is derived from the detailed field survey of the study area itself which took place prior to the compilation of this report.

### 2.2 Assessment method

The study area was surveyed over a five day period by two accredited archaeologists. Co-ordinates of the boundary of the study area and turbine alignments were programmed into a Garmin GPSmap 60csx global positioning system which was carried into the field. Where parts of the study area were accessible to an off-road vehicle as many sandy tracks as possible were driven as this is the fastest way possible to cover large tracts of landscape. At intervals "forays" of between 1 and 12 km were made on foot into the *veld* so as much of the landscape as possible could be checked and assessed. However the remoteness of certain parts of the study area necessitated a great deal of walking. All heritage features were assigned co-ordinates using global positioning systems. After each field day, co-ordinates and walk paths were downloaded onto a computer so that adequacy of coverage could be checked. Borrow pits along the access road were inspected to understand the subsurface conditions of the study area as well as verify the presence of any buried archaeological material.

It is important to note that archaeological site co-ordinates presented in this report represent a single fix roughly in the middle of each site, and not the area of the site itself. For planning purposes and the variable accuracy of hand-held GPS, a radius of at least 30 m from each fix should be considered to be the boundary of any archaeological site.

Assessment of the significance of the archaeological material is based on draft grading guidelines used by both SAHRA and Heritage Western Cape (unpublished discussion material).

### 2.3 Assumptions and limitations

This survey conducted during the 5-day field assessment cannot claim to be a complete survey of the entire site – the work tended to be concentrated in those areas that revealed themselves to be archaeologically sensitive or/and were going to be directly affected by the proposed activity. However, every kind of landscape within the study area was visited and inspected so that an overall sense of the distribution patterns of archaeological sites could be obtained.

No trial excavations were carried out which means that there is a possibility that Late Stone Age archaeological sites (especially ephemeral ones) may lie under aeolian sands.

It is assumed that subsurface conditions within the study area are similar to those observed in 3 nearby borrow pits and in the mining operation at Namakwa sands to the north.

## 3. THE HERITAGE CONTEXT

The history and pre-history of Namaqualand, despite its obvious rich cultural resources, has been until recently one of the most neglected areas of study in the country. The first serious academic archaeological and anthropological studies of the area did not take place until the 1980s (Webley 1984, 1992). These focussed on the Nama reserves of the Kamiesberg mountains and the edge of Bushman land while a few initial archaeological studies have been conducted in the Richtersveld and southern Namibia (Robertshaw 1975).

The coastal archaeological wealth of the Namaqualand coast was only demonstrated circa 1988 when Eskom commissioned a series of preliminary studies to identify potential power station sites along the Namaqualand coast. Hundreds of Late Stone Age archaeological sites were located in the apparently waterless landscape (Parkington and Hart 1991). This observation was further illustrated in 1991 when Halkett and Hart (1997) of the ACO sample-surveyed the coastline of De Beers owned properties between Mitchell's Bay and Port Nolloth recording details of almost 1 000 archaeological sites. Archaeological work in the mining areas has been ongoing since 1991 with the result that a great deal of information is now available with respect to the coastal areas and the Gariep River. Recent research in the Kleinzee area (Halkett and Orton pers comm., Dewar 2007) has revealed that parts of Namaqualand were occupied by people almost a million years ago as is evident by massive scatters of Early Stone Age artefacts on high ground overlooking the coastal plain, however the greatest amount of archaeological sites are those which relate to the ancestors of the San and Khoekhoen which have been radiocarbon dated to within the last 5 000 years (mid-late Holocene). These sites are densest along the immediate coastline but may be found further inland close to water sources or natural foci (dunefields, rock outcrops) on the landscape. Colonial period sites, apart from those related to the relatively recent heritage of copper (in the north) and diamond mining, are uncommon.

### 3.1 The Vredendal Coastal Area

The Namaqualand coast north of the Olifants River was archaeologically unknown until 1987 when John Parkington of the ACO was appointed by the Environmental Evaluation Unit (EEU) on behalf of Namakwa Sands to assess the impacts of proposed heavy mineral sands mining. It became clear at that time that the dry areas of the West Coast were surprisingly archaeologically rich. Parkington and Poggenpoel (1991), after several preliminary assessments in the Brand Se Baai area near Vredendal, suggested that occupation of the coast during the Late Stone Age had taken place as a single burst of prehistoric occupation, probably within the last 2000 years. However, subsequent research (Parkington 2006) including archaeological excavation at several localities between Brand Se Baai and the Orange River Mouth has shown that people have been exploiting coastal resources since the Eemian interglacial period about 120 000 years ago with the discovery of rare Middle Stone Age shell middens, at Brand Se Baai, Liebenbergsbaai and Boegoeberg.

Historically the primary inhabitants of Namaqualand were San (bushmen) and Khoekhoen herders – the ancestors of the Nama speaking South Africans of the present day. Occupation of the area by San during the last 10 000 years (Holocene) was probably continuous but pulsed according to environmental patterns with events such as the "little ice age" circa 1400 AD playing a significant role (Dewar 2007). Although there is still much to be learned about the archaeology of the region, some interesting patterns in the distribution of archaeological sites are beginning to emerge. There are numerous archaeological sites on the immediate coast, mostly associated with rocky shoreline areas where marine resources were easy to obtain. Many of these sites contain ceramics and appear to be less than 2000 years old judging by the types of artefacts that are found on them. In contrast, the few sites that have been located further inland on the coastal plains tend to be much older, dating to over 3000 years ago. This hints at changes in the way that people used the landscape over time, which may reflect a combination of environmental and social factors combined with population pressure. Coastal occupation and pressure on coastal resources may have increased after 2000 years ago when Khoekhoen arrived in the Cape bringing with them herds of sheep, ceramic technology and a new economic order.

### 3.2 The inland areas

To date very little is known about the inland areas (from 10 km inland of the coast), with the few archaeological surveys that have been completed limited to the Nama reserves and the western edge of Bushman Land (Webley 1984, 1992). There are vast tracks of land in the mountains and between the escarpment and the coast for which absolutely no information is available.

### 3.3 Colonial period occupation

Compared with other parts of South Africa, colonial period occupation of the un-hospitable region of the Namaqualand is very late having taken place during the mid-late 19$^{th}$ century. Farmers clashed with “wild” Bushmen, who after years of attrition were finally wiped out by the commando operations launched from regional centres in the Northern Cape (Penn 1995). Rumour has it that the last “wild bushman” died in about the 1890s (Steenkamp 1977).

Built environment heritage tends to be restricted to towns and mines. Farms tend to be very large so farm houses are very sparse. Nevertheless many of these are greater than 60 years old and have unique vernacular characteristics. Formal building conservation studies in the region are in their infancy.

The industrial archaeology of Namaqualand is significant, and among some of the earliest mining, railway and transport heritage in South Africa. Like so much of Namaqualand heritage, it has never been subject to any form of academic assessment (Worth pers comm.).

### 3.4 Conservation status of heritage

In more than any other area of the Cape, impact assessments and heritage management studies commissioned by Namakwa Sands (Pty) Ltd, De Beers Namaqualand Mines Division, Trans Hex Mining Ltd and Namaqualand Diamond Corporation have provided the bulk of what is known about the archaeology of the Namaqualand coast. Not only has this work contributed to research, but also importantly it has allowed us to gauge the condition of the “National Estate” of archaeological sites on the west coast.

During the early 20$^{th}$ century large-scale diamond mining began and it was only in the 1990s that mining companies began to implement policies for the conservation and assessment of heritage sites. This means that in certain areas massive destruction of coastal archaeological sites has occurred without any mitigatory provisions. The worst hit areas are between Alexander Bay and Port Nolloth, the coastal areas of the Buffels Marine Complex at Kleinzee, parts of the Koingnaas mining area. However, the fact that many of these areas are off-limits to the public has resulted in the excellent preservation of archaeological sites in those parts of these high security areas that have not been developed. Unfortunately the area between the Spoeg and the Olifants River mouths have been impacted very seriously by years of small *ad hoc* diamond operations which has resulted in a plethora of informal off-road tracks to the coastal zone. Furthermore, there is hardly an area of the coastal fore-dunes that has not been subject to some form of disturbance. This means that virtually the entire material heritage of the immediate coastline (i.e. the Admiralty Zone – the coastal fore dunes) has already been lost. Fortunately, many sites have survived in the areas immediately inland of the coast. These are threatened by not only continued mining of these areas but especially by undisciplined use of off-road vehicles and the mass of informal roads/tracks that result.

The loss of heritage sites on the west coast is destined to continue as long as the coast and near coastal areas are subject to diamond mining, and in some instances, uncontrolled access by off-road vehicles. In the light of the substantial collective impacts that have already occurred to the population of archaeological sites, it is imperative that all effort is made to conserve the remaining sites, and where impacts will inevitably occur, sample them to ensure that loss of historical/cultural/scientific information resulting from their destruction is minimised.

The conservation status of colonial period archaeology, industrial archaeology and built environment has never been audited.

## 4. FINDINGS

### 4.1 Cultural landscape, built environment and historical sites

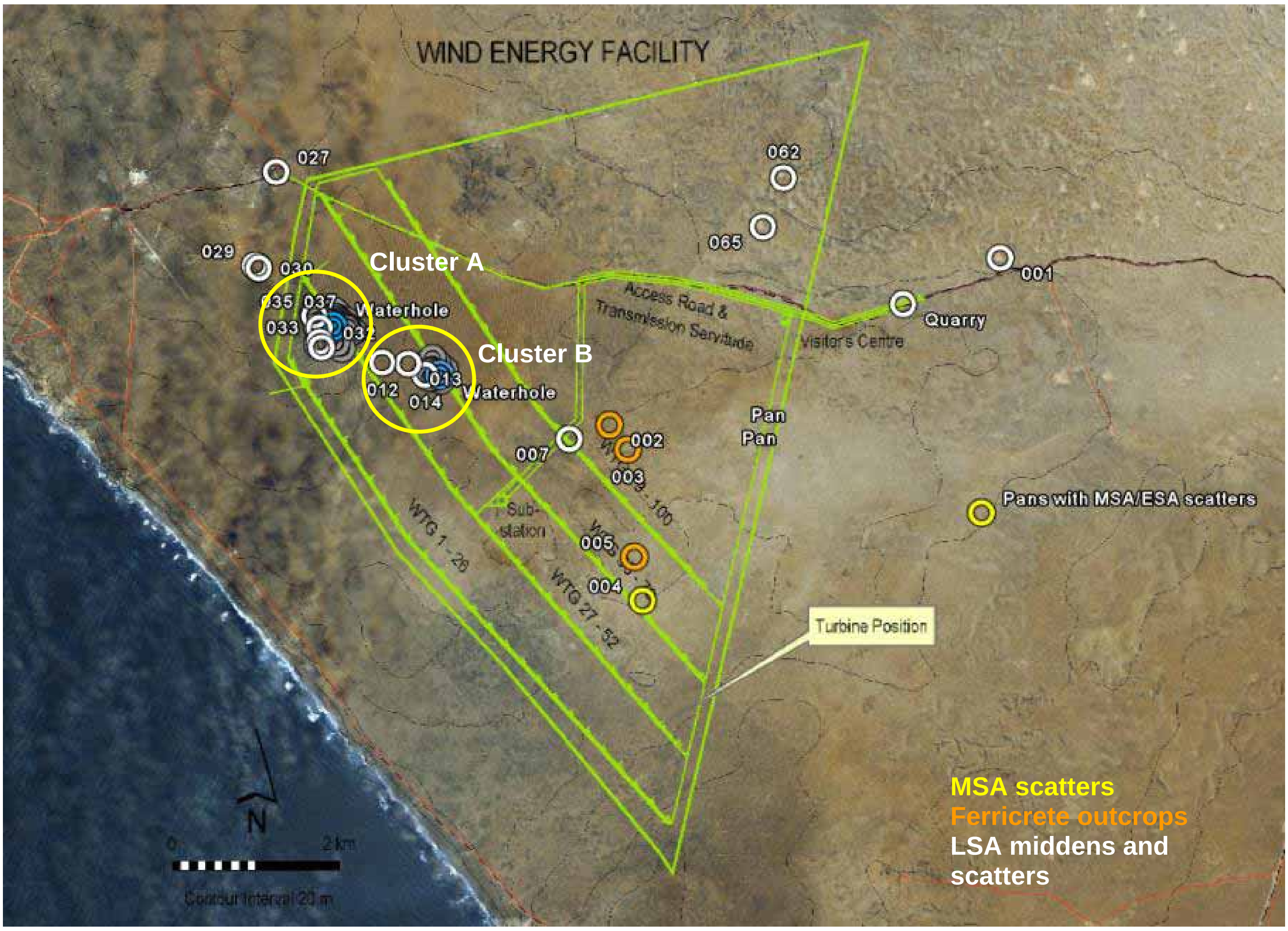
Colonial period heritage is extremely scarce in the study area and vicinity. There are no built structures close to, or within the study area apart from the provincial road, off-road tracks, stock drinking troughs, grazing camps and wind pump reservoirs. The nearest built settlement is the Skaapvlei farm (just to the north of the site) and the Transhex mining camp a number of kilometers to the south of the site. Neither of these places can be considered to be significant heritage resources, although buildings and family graves at Skaapvlei located outside of the study area may be more than 60 years old. Most of the Skaapvlei structures show evidence of *ad hoc* modernisation and are not worthy of high conservation status. The buildings have little aesthetic or historical value so the nearby presence of the wind energy facility will not compromise their cultural landscape qualities.

In essence, the landscape is ancient – the recent human presence being limited to ephemeral traces of agriculture and various impacts resulting from alluvial diamond mining activities, which are mostly restricted to the immediate coast. The cultural landscape qualities of the place are that of a relatively undisturbed landscape imprinted over by the archaeological sites of late Stone Age hunter gatherers then within the last 2 000 years, transhumant Koekhoen pastoralists. Colonial occupation up to now is ephemeral and of very recent duration.

### 4.2 Pre-colonial archaeology

Previous research has revealed that the bulk of archaeological sites (mainly Late Stone Age middens) lie within half a kilometer of the coast. Their frequency drops off rapidly with distance away from the coast. This spatial patterning reflects that people (typically in an arid environment) tended to focus their settlements, which were mostly of short seasonal duration, close to resource rich areas. Inland of the coast above the coastal escarpment archaeological sites are quite scarce being limited to ephemeral scatters situated in occasional deflation hollows. Where there is a rocky outcrop with shelters or overhangs, or any place that has the potential for providing a water source evidence of occupation is prolific. Within the study area, the general patterning of pre-colonial occupation is very much in keeping with what would be expected in an arid area. Some 65 observations of archaeological material (Appendix A) were recorded during the course of the study. Many of these are ephemeral scatters which will not be impacted by the proposed activity. The inland areas of the landscape are almost devoid of surface archaeological material, however ephemeral occurrences of mostly MSA material were noted associated with low ferricrete rafts, particularly in the central eastern part of the area. Almost every blowout/deflation that was inspected showed evidence of pre-colonial Late Stone Age occupation. These sites are generally ephemeral typically consisting of no more than 20-60 fragments of flaked quartz or silcrete with very little shell or bone.

**Figure 4.** Satellite photograph of study area showing distribution of archaeological sites (photo supplied by Savannah Environmental (Pty) Ltd)



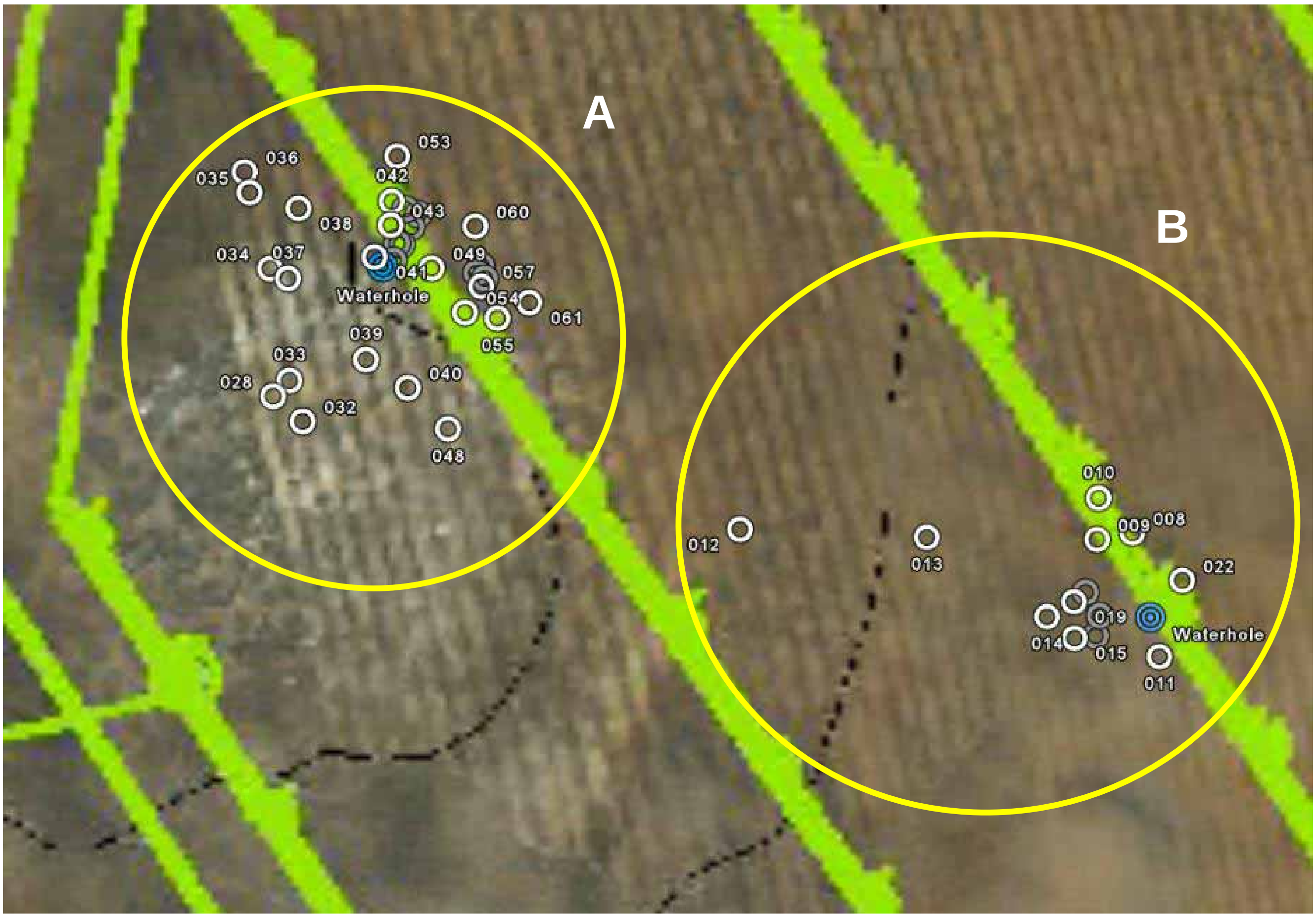



**Figure 5** Two clusters of LSA middens, each one associated with a water source. (photo supplied by Savannah Environmental (Pty) Ltd)

#### *4.2.1 Late Stone Age sites at Skaapvlei (Grave Water Kop 185/5)*

The most interesting archaeological occurrences occurred on the Farm Skaapvlei (Grave Water Kop 185/5). The study revealed the presence of two dried springs that were once waterholes (Figure 7) with potable water. Each one of these (see Figure 5) had attracted a concentration of small shell middens (sites clusters A and B, Figures 8, 9). The contents of the sites are varied – many are ephemeral limpet dominated shell scatters (Figure 6) that are visible in what was once ploughed land. Agriculture has affected some of these sites and compromised their "within-site" stratigraphy, however since the sites appear to be single occupation events, stratigraphic integrity is of only moderate importance. The sites retain scientific significance. *C. argenvillei* is the visually dominant shellfish species on most middens, however confirmation of this will require archaeological sampling. In contrast at least 3 of the sites are dense middens (even though they are some 3 kms from the present coastline. Stone artefacts are present on all sites. The raw materials used are wide ranging – notably quartz, crystal quartz, very high quality silcrete, hornfels, quartzite as well as cryptocrystalline silicates. Fragments of animal bone have been noted on the denser sites. The assemblages tend to be informal despite the high grades of raw material available. Ceramics are present on many of the waterhole associated sites indicating that part of the occupation span took place within the last 2 000 years. The value of the waterhole related sites is that they represent two complete systems of occupation (site clusters A and B) which are of scientific value in terms of their potential to provide information about the cultural affinities of the people who lived there, and the time depth of their occupancy of the area. Sites of both clusters A and B will be impacted by the disturbance corridors for the wind turbines.

**Figure 6.** One of the denser LSA middens found in site cluster A

**Figure 7** The water hole which was the focus of settlement at site cluster A

#### *4.2.2 Early and Middle Stone Age*

Older archaeological material dating from the Middle and Early Stone Ages has been found in areas where sand mining or overburden excavation/removal has resulted in the exposure of previous land surfaces. However due to the large amounts of aeolian sands that cover the study area none of this material is visible. Ephemeral occurrences of Middle Stone Age artefacts were noted within the study area associated with low outcrops of ferricrete, however none of these are considered significant. Many of these artefacts are probably in secondary context as it was noted that the outcrops had attracted burrow digging animals. The material was probably unearthed from the hardpan crust (Pleistocene Doorbank horizon) that underlies the surface sands throughout the region.

The inspection of local borrow pits has revealed that the stratigraphy of surface sediments throughout the study area is similar. Typically the surface consists of red-yellow aeolian sands deposited over compacted and cemented sand, in places enriched by the presence of heavy minerals. The interface is commonly known as the Doorbank horizon – a hard crust of cemented material that is quite resistant to mechanical intrusion. Middle Stone Age material was noted eroding out of the interface between the recent sands and the underlying harder layers. The implication of this is that (as has been noted throughout the region) there is a generalised scatter of Early and Middle Stone age material dispersed throughout the study area on the Doorbank horizon where it has become conflated and concentrated by natural processes over thousands of years.

The depth of the Doorbank Horizon is variable. Since this would probably be a good founding material for the erection of structures, it will be impacted by the foundation slabs for the proposed wind turbines.

#### *4.2.3 Pleistocene palaeontology and fossil rich archaeological sites*

Fossil bone-rich archaeological sites have been noted close to the shoreline near Cliff Point and at Brand Se Baai. Sites such as these are rare and considered to be extremely valuable heritage resources. There is a possibility that fossil-rich Pleistocene deposits do exist in the study area in the aeolian sand body lying above the Doorbank horizon, especially under the first row of turbines which are situated back from the summit of the coastal ridge. Unfortunately, there is no possible way of predicting where or if an impact could occur. However there are precautionary measures that can be put in place (see heritage management section).

## 5. ASSESSMENT OF IMPACTS

### 5.1 The way in which heritage sites will be impacted

The main cause of impacts to archaeological sites is physical disturbance of the material itself and its context. The heritage and scientific potential of an archaeological site is highly dependent on its geological and spatial context. This means that even though, for example a deep excavation may expose archaeological artefacts, the artefacts are relatively meaningless once removed from the area in which they were found. Large scale excavations will damage archaeological sites, as will road construction, building foundations and services.

The destruction of archaeological material is always considered to be a permanent and irreversible impact, although very often the intensity of an impact can be very low depending on the significance of the site in question.

#### *5.1.1 Bulk excavation*

The proposed activity is the building of 100 wind turbines aligned in 4 rows across the study area.

Each turbine will be mounted on a square cast concrete base of 15x15 sqm in extent. Each base will require a 2 m deep excavation of similar dimensions. Thus the proposed activity will require local excavations at each one of the proposed wind turbine sites. While the depth of excavation is relatively shallow, it is expected that the Doorbank horizon will be impacted along with any archaeological material lying on it. This will cause local destruction and disturbance of any material that may exist.

Each turbine site will need to be linked by buried electrical distribution cables with the substation to be built on site. The excavations for the cables will be an extensive linear disturbance of surface and below surface soils. The substation will also require excavations for cables and footings for transformers.

#### *5.1.2 Surface disturbance*

Each row of turbines will require a service road (initially 14m wide to accommodate a track for the heavy lift crane) which will need to be used for both construction purposes and maintenance. Effectively each row of turbines represents a corridor of surface disturbance which may impact later archaeological sites. Each turbine site will require an adjacent laydown area for plant, material and components as well as a compacted flat platform for a heavy duty crane which will be used to lift and position the steel columns, nacelle and turbine blades. This means that there will be an estimated 60x60 sqm area of surface disturbance required for each installation adjacent to the service road. This in particular has the potential to damage LSA middens at site clusters A and B.

A certain amount of excavation will be required for the construction of the access road to the site, as well as the substation and visitor's centre.

An overhead 132KV distribution power line (three alternative routes are offered) will be required to link the facility with the national power grid at Juno substation near Vredendal. The tower bases for the distribution line will require excavations for footings at intervals across the landscape. This is a minor form of surface and below surface disturbance which may impact buried heritage material.

#### *5.1.3 The impact of the proposed activity on historical sites*

Colonial period heritage is extremely scarce in the study area and vicinity. There are no built structures close to, or within the study area apart from the provincial road, off-road tracks, stock drinking troughs and wind pump reservoirs. No historical (colonial period) sites will be impacted by any of the proposed activities.

### 5.2 The impact of the development of the wind energy facility on pre-colonial archaeological sites

#### *5.2.1 Late Stone Age middens*

The areas of greatest concern are certain impacts to Late Stone Age shell middens that make up clusters A and B. Expanded views from the study area are presented in Figures 8 and 9. Indications are that disturbance corridors as well as turbine construction areas and footings will potentially destroy archaeological material. Turbine row B will directly affect an estimated 11 Late Stone Age shell middens (see Figures 8 and 9) and turbine row C will affect a further 5. The effect of the proposed activities will be the further lateral and vertical disturbance of midden material, destruction of artefactual material and bone and mixing of any preserved stratigraphy.

Accumulative impacts are a concern in that middens were once common archaeological resources throughout the Western Cape but which have been impacted to the extent that well conserved middens are now cherished heritage resources. Intact middens are increasingly only found in either remote localities or conservation areas. While the middens that have been found in the study area are not particularly rich or dense and many have suffered some disturbance from past agriculture, it is important to be aware that each one of them has research potential and heritage value in terms of their group value – they are all components of a past settlement pattern which responded to the pressures of the natural and social environments of the times. Unlike many other environmental resources, archaeological sites are non-renewable.

**Table 1** Summary of impact assessment: turbine construction and related activities on Late Stone Age shell middens

| *Bulk excavation and site preparation resulting in destruction of Late Stone Age shell middens* | ***Extent*** | ***Duration*** | ***Magnitude*** | ***Probability*** | ***Significance*** | ***Status*** | ***Confidence*** |
|---|---|---|---|---|---|---|---|
| With mitigation | Local (1) | Permanent (5) | Moderate (3) | Probable (3) | Medium-low (27) | Negative | Certain |
| Without mitigation | Local (1) | Permanent (5) | High (8) | Probable (4) | High (62) | Negative | Certain |

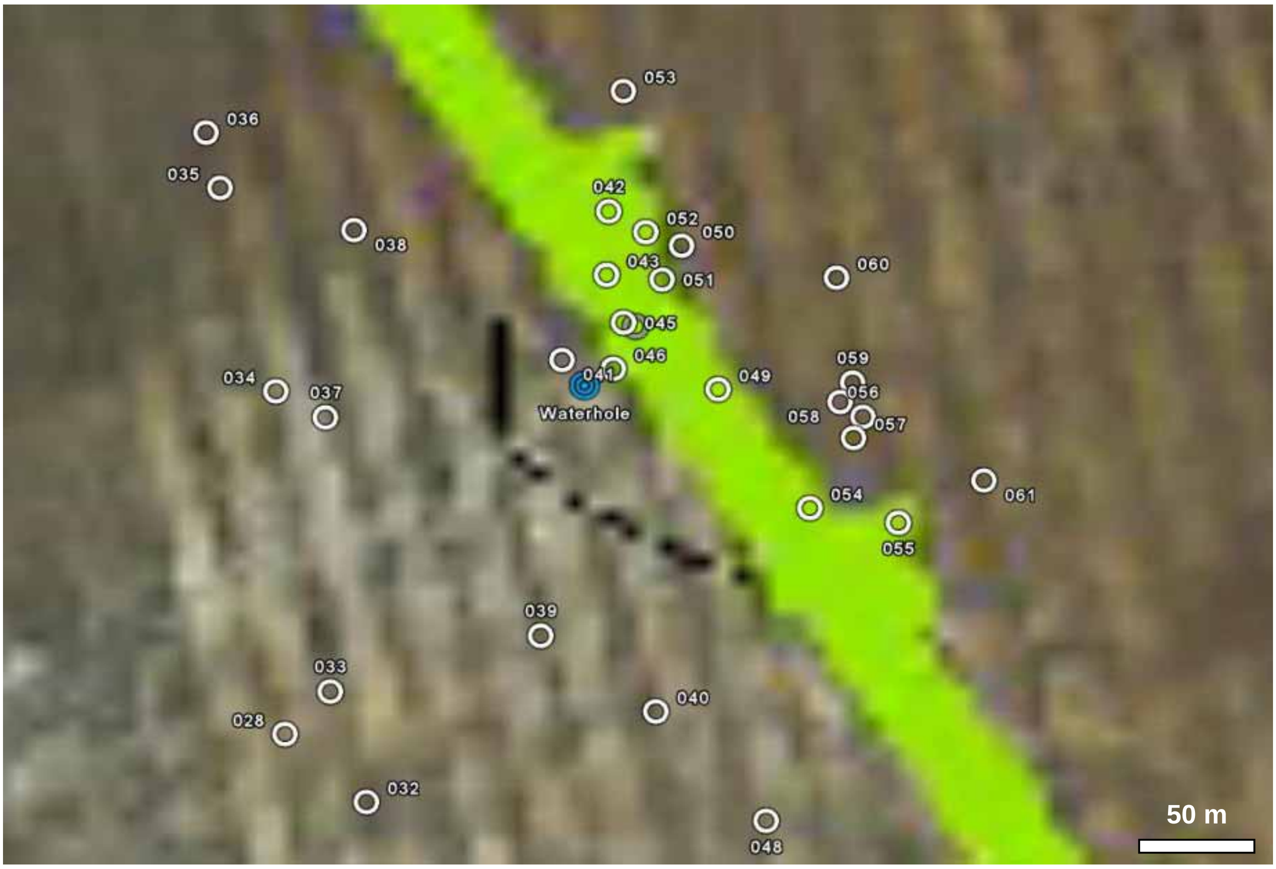



**Figure 8.** Row B passes through site cluster A resulting in likely impacts to LSA middens. Note each location is a single GPS fix – a radius of 30m around each point donates the site.

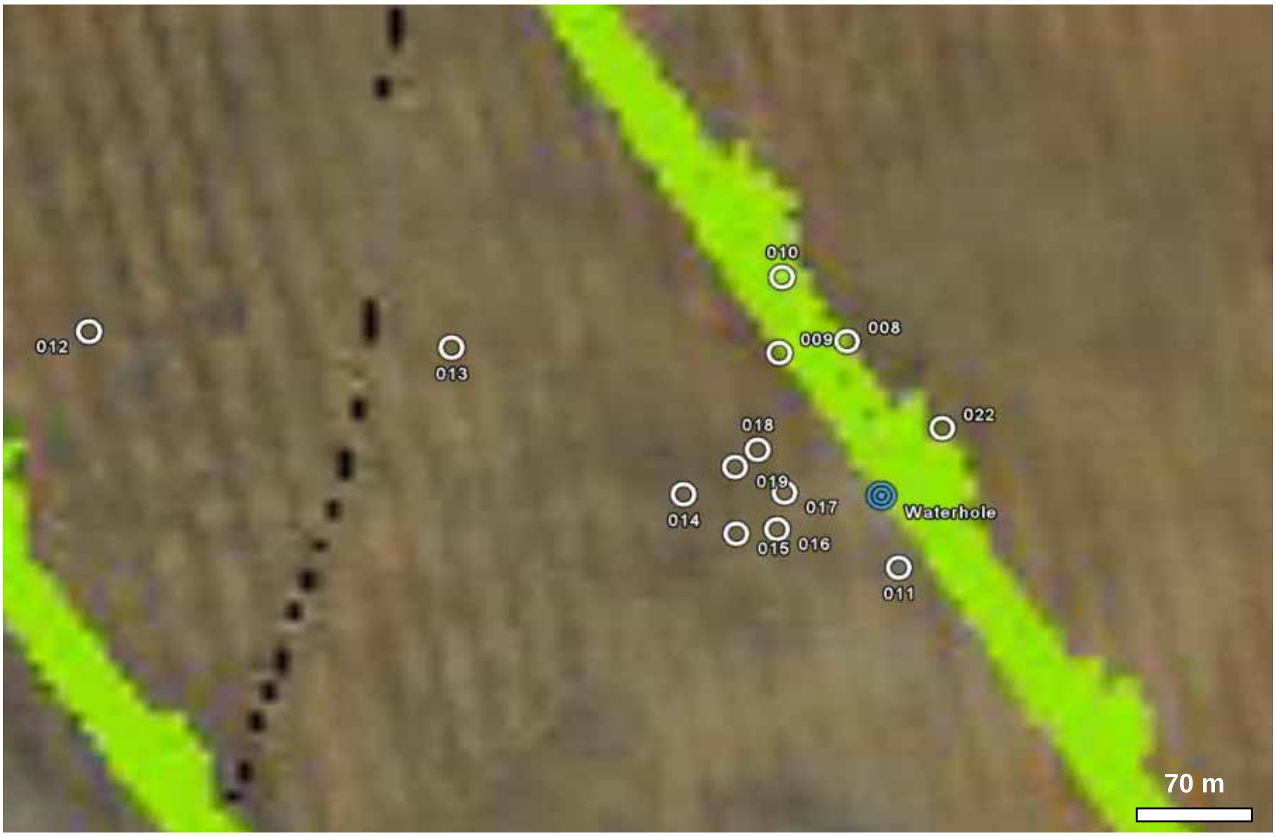



**Figure 9.** Row C passes through site cluster B resulting in likely impacts to LSA middens. Note each location is a single GPS fix – a radius of 30m around each point donates the site.

### *5.2.2 Pleistocene palaeontological/archaeological material*

The 2 m deep excavations for each of the wind turbine bases will penetrate aeolian sands and may impact on the Doorbank horizon displacing any Middle or Early Stone Age archaeological material that may exist. This material is deemed to be ubiquitous throughout the region and is therefore a very wide spread resource. Furthermore the material tends to be conflated down to a single layer which means that its provenance (original context) is in doubt. It is argued that the footing excavations will not diminish the resource significantly and that the impact is therefore tolerable in terms of the massive geographical extent of the resource. Away from the coast the upper aeolian sands are not calcareous or fossiliferous, however there is a low possibility that fossil bone with archaeological material in direct association may occur (none was noted in the 3 borrow pits inspected). Ancient sites with this degree of preservation are considered important and will need immediate investigation.

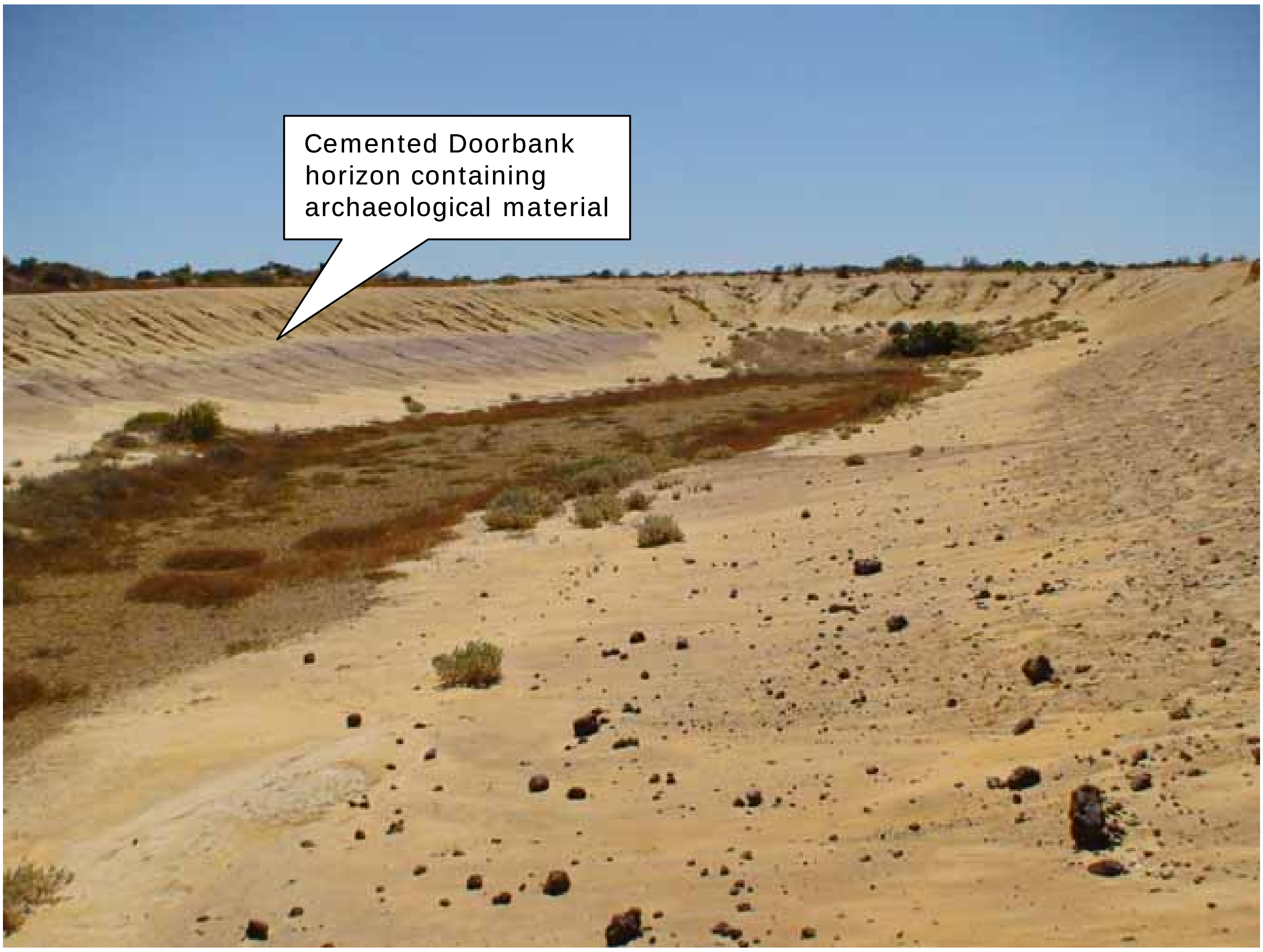



**Figure 10**. Borrow pit close to the study area showing the typical soil profiles that are expected to be encountered in turbine footing excavations

**Table 2** Summary of Impact assessment: turbine construction and related activities on Pleistocene archaeological material.

| *Possible bulk excavation impacts on buried Pleistocene archaeology/palaeontology* | ***Extent*** | ***Duration*** | ***Magnitude*** | ***Probability*** | ***Significance*** | ***Status*** | ***Confidence*** |
|---|---|---|---|---|---|---|---|
| With mitigation | Local (1) | Permanent (5) | Low (2) | Possible (2) | Low (16) | Neutral | Certain |
| Without mitigation | Local (1) | Permanent (5) | High (3) | Probable (2) | Low (18) | Negative | Certain |

### 5.3 The impact of the construction of 132KV distribution power lines on pre-colonial archaeological sites

Alternatives 1, 1a and 2 suggested for the 132KV distribution power lines run in a generally easterly direction from the proposed wind energy facility. Inspection of borrow pits and easily accessible deflation hollows along the route have shown that unless there is a specific resource focus on the landscape that would attract pre-colonial occupation, the likelihood of significant material is very low. Furthermore, the footprint of each tower is limited. This together with the fact that both options 1 and 2 traverse a landscape where heritage material is very sparse results in a very low potential for impacts.

The visual impact associated with the two distribution line alternatives are the subject of a separate visual assessment.

**Alternatives:**
Of the alternatives suggested, both carry similar weight in terms of expected impacts to archaeology, however the Koekenaap alternatives (1 or 1a) are supported over alternative 2 as it is preferable to confine any impacts that may occur to an existing corridor, and secondly the greater distance from the Olifants River reduces the possibility of impacting archaeological material.

**Table 3** Summary of Impact assessment: construction of 132KV distribution line

| *Possible impact of excavation of footings and related activities for 132KV distribution lines.* | ***Extent*** | ***Duration*** | ***Magnitude*** | ***Probability*** | ***Significance*** | ***Status*** | ***Confidence*** |
|---|---|---|---|---|---|---|---|
| With mitigation | Local (1) | Permanent (5) | Low (1) | improbable (1) | Low (6) | Neutral | Certain |
| Without mitigation | Local (1) | Permanent (5) | Low (1) | Improbable (1) | Low (6) | Neutral | Certain |

### 5.4 Cultural landscape and sense of place

The visual impact of the proposed activity forms the subject of an independent visual impact assessment, however the impacts on the cultural landscape and sense of place are considered part of the heritage environment. In the interest of producing as complete a heritage report as possible, the following comment is offered.

The cultural landscape is essentially a natural one with ephemeral traces of human modification. It has a quiet "unspoiled" character, somewhat bleak wide open spaces and uninterrupted views from horizon to horizon (Figure 11). Conspicuous changes to a landscape such as tall buildings, landscape scarring, massed housing development can change the "feel" and atmosphere of a place irrevocably. It takes only a small intervention to alter the sense of wilderness of a place and change its atmosphere. The sense of remoteness and wilderness of the place will change for the duration of the existence of the wind energy facility, and possibly beyond.

**Figure 11.** The wide open landscape that characterises the study area

## 6. MITIGATION AND CONSERVATION

### 6.1 Archaeological heritage

#### *6.1.1 Late Stone Age middens*

LSA middens in clusters A and B will be impacted by the proposed alignment of rows B and C of the wind energy facility. In the localities of the water holes the sites are densely distributed which means that micro-adjustment of wind turbine positions is not going to be possible without a local alteration of the alignment of the entire row , which according to Eskom is unfeasible outside of the 200m wide corridor of disturbance assigned to each row.

The field observations show that most of the sites are quite ephemeral being shallow single occupation middens, many of them already slightly disturbed. This means that successful mitigation can be achieved through archaeological sampling. To this end the following recommendations are made:

- The disturbance corridors of rows B and C will impact site clusters A and B and their associated waterholes. Eskom has indicated it will not be possible to move entire turbine corridors (which would be ideal mitigation). The density of sites is such that options for moving the road alignments and turbine sites within the 200m corridor are very limited. This means that there is no choice but to undertake sampling of sites that will be impacted by the proposed activity. Once this is done satisfactorily, a destruction permit for the affected sites will need to be applied for and obtained from HWC by Eskom. It is not necessary to loose turbine positions. Any other sites close to the proposed activity will need to be identified and flagged as no-go areas.

  It is estimated that the following identified sites will require sampling or protection:

  Cluster A Middens 42, 43, 44, 45, 46, 49, 52, 52, 55
  Cluster B Middens 10, 8, 9, 22

- It would be ideal if an archaeologist could accompany the Eskom Generation survey team so that sites requiring sampling or flagging can be accurately identified and on-site decisions made with respect to sampling, flagging or even wind turbine position adjustment (if possible). It would be best that all sampling is done ahead of construction work. This work is best done before commencement of construction or alternatively during construction as long as the construction work commences on non-sensitive areas first.

- Eskom Generation and the project archaeologist will need to apply for sampling permits from Heritage Western Cape for work on archaeological sites identified as needing intervention – in other words any archaeological site that will be affected by the access road, crane track, laydown areas, turbine bases and cable trenches. The permit application will need to be accompanied by detailed specifications of which sites are to be sampled, how large the samples will be, and how and where the sampled material will be stored (the NHRA requires indefinite institutional storage of all archaeological remains). The turn around period for the issuing of permits is generally about 5 weeks and permits are usually valid for a period of a year but can be extended for a further 2 years if needs be. One the archaeological sampling is completed, a permit for destruction of any remaining archaeological material on any of the development sites must be obtained from HWC.

- It is estimated that a sampling program will require 5 weeks of field time, with an equivalent amount of laboratory time required for follow-up curation. The expected costs of such an operation will be in the region of R400 000 – R450 000 in terms of current costing (November 2007) and level of impact.

#### *6.1.2 Buried Pleistocene archaeological material*

There is a possibility that Pleistocene material above or on the Doorbank horizon will be impacted by the excavation of the wind turbine bases. This applies to all turbine bases, however greatest likelihood of a find is in row A. Since the envisaged construction team is quite small, the most cost-effective mitigation would be to establish liaison with a responsible person on site who could photograph and report any finds to an archaeologist who would then arrange to mitigate/collect the find (if necessary). However this will only be successful with the full cooperation of contractors/site staff.

It would also be desirable that during the excavation phase for turbine bases, an archaeologist makes a visit to log exposed sections and check for the presence of any significant material.

If an important find is made, it may be necessary to divert plant to allow the necessary time to collect/record the find.

### 6.2 Human remains

Human remains can occur at any place on the landscape, but are particularly likely to be found on or close to archaeological sites. They are regularly exposed during construction activities along the west and south coasts. Such remains are protected by a plethora of legislation including the Human Tissues Act (Act No 65 of 1983), the Exhumation Ordinance of 1980 and the National Heritage Resources Act (Act No 25 of 1999). In the event of human bones being found on site, SAHRA must be informed immediately and the remains removed by an archaeologist under an emergency permit. This process will incur some expense as removal of human remains is at the cost of the developer. Time delays may result while application is made to the authorities and an archaeologist is appointed to do the work.

### 6.3 Un-identified archaeological material, fossils and fossil bone

There is always a chance that archaeological material may be exposed during bulk excavation for services and foundations. All archaeological material over 100 years of age is protected and may only be altered or removed from its place of origin under a permit issued by Heritage Western Cape (HWC). In the event of anything unusual being encountered, the Province Archaeologist at HWC and/or the projects heritage consultant must be consulted immediately so that mitigatory action can be determined and be implemented if necessary (find-stop scenario or skip to the next turbine). Mitigation is at the cost of the developer, while time delays and diversion of machinery/plant may be necessary until mitigation in the form of conservation or archaeological/palaeontological sampling is completed.

### 6.4 Cultural landscape and sense of place

This is perhaps the most difficult heritage impact to address. There is no doubt that the wind turbines will affect the wilderness qualities of the site, however the degree of impact will be very closely related to the visual impacts of the proposed activity (the visual impact will be separately addressed by MetroGIS).

## 7. CONCLUSION

Indications are that in terms of historical and archaeological heritage the proposed activity is viable, impacts are greater than initially expected, but are nevertheless controllable through with a program of archaeological sampling of Late Stone Age archaeological sites of site clusters A and B an where possible, micro adjustment of turbine and road positions. Controlling of impacts to buried archaeological material such as stone artefacts scatters on the Doorbank horizon will require the commitment of both site staff and archaeologists. However the resource is considered to be widespread and the cumulative impact is not excessive.

The construction of the site visitors centre, substation, access roads as well as the 132KV distribution lines are unlikely to result in any impacts and therefore no further action is required other than to report un-anticipated finds.

In terms of impacts to the natural cultural landscape qualities of the site, impacts are expected. This may be mitigated by the fact the study area is set back from the scenic coastal escarpment (which is most frequently used by people) and the fact that the proposed wind turbines will need very little by way of support structures or staff facilities. Input from visual assessment of the site will be needed in order to comprehensively assess potential impacts.

## 7. REFERENCES CONSULTED

Dewar, G.I. 2007. The Archaeology of the Coastal Desert of Namaqualand, South Africa: A regional synthesis. Unpublished Phd Dissertation, Department of Archaeology, University of Cape Town.

Halkett, D. 1998. Report on an initial visit to assess the impact of mining on archaeological sites in the Richtersveld. Unpublished report prepared for Trans Hex Mining Ltd. U.C.T: Archaeology Contracts Office.

Halkett, D. 1999. A phase one archaeological assessment of heritage resources in the TransHex Diamond Concession, Richtersveld. Unpublished report prepared for Trans Hex Mining Ltd. U.C.T: Archaeology Contracts Office.

Halkett, D and Hart, TJG.1987. An archaeological assessment of the coastal strip, and a proposed heritage management plan for De Beers Namaqualand Mines. Unpublished report prepared for De Beers Namaqualand Mines Division. U.C.T. Archaeology Contracts Office.

Halkett, D. 2003 A report on the archaeological mitigation program at DeBeers Namaqualand mines March 2002 to June 2003, Report for DeBeers created by the Archaeology Contracts Office, University of Cape Town, 2003.

Hart, T.J.G and Halkett, DJ. 1993. Excavations at six archaeological sites in the Near-Shore Diamond Mining Area, Brandsebaai , Namaqualand.

Hart, T.J.G and Halkett, DJ 1993, Namaqualand, Report on the monitoring of Borrow Pit #3: Namakwa Sands. Namakwa Sands Ltd.

Hart, T.J.G and Halkett, DJ. 1994. Archaeological survey of the Namakwa Sands trucking facility. Namakwa Sands Ltd.

Hart, T.J.G and Halkett, DJ .1994. Report On The Phase 2 Archaeological Excavations at the Namakwa Sands Project (first Phase), Vredendal District, Namaqualand., Namakwa Sands Ltd

Hart, T.J.G and Lanham, J. 1997. Phase 2 archaeological excavations at two Late Stone Age sites in the Phase II (WOB) mining area, Namakwa Sands, Vredendal District, Namaqualand., Namakwa Sands Ltd.

Hart TJG and Orton, J. 2005 Heritage Impact Assessment for the proposed Namakwa Sands Expansion Project. Unpublished report prepared for Golder International.

Parkington, JE 2006. Shorelines, Strandlopers and shell middens. Cape Town: Krakadouw Trust.

Parkington, J.E. and Hart, TJG 1991 Archaeological assessment of 3 potential power station sites, De Beers Namaqualand mines, Kleinzee. Unpublished report prepared for the EEU

Parkington, J.E and Poggenpoel, CE. 1990. West Coast Heavy Mineral Sand Project: archaeological report. (Namakwa Sands), Environmental Evaluation Unit, UCT

Parkington, J.E and Hart, T.J.G. 1993. Namakwa Sands main access road: archaeological survey, Environmental Evaluation Unit, UCT

Penn, N. 1995. The Orange River Frontier Zone C1700 –1805. In Smith A.B. eds. Einiqualand: University of Cape Town Press.

Robertshaw, P.T. 1978. Khoi and San: Aspects of the later prehistory of the western Cape,South Africa. Unpublished Ph.D. dissertation, University of Cambridge.

Robertshaw, P.T. 1978. The archaeology of an abandoned pastoralist camp-site. South African Journal of Science. 74:29-31

Robertshaw, P.T. 1978. Khoi and San: Aspects of the later prehistory of the western Cape,South Africa. Unpublished Ph.D. dissertation, University of Cambridge.

Ross, G. 2003. The romance of Cape mountain passes. Cape Town: David Phillip.

Steenkamp, W. 1977 Land of the thirst King. Cape Town: Howard Timmins.

Webley. L 1984. Archaeology and Ethnoarchaeology in the Lelliefontein Reserve and surrounds. Unpublished MA thesis. Department of Archaeology. University of Stellenbosch.

Webley, L 1992. The history and archaeology of pastoralist and hunter gatherer settlement in the North Western Cape, South Africa. Unpublished Phd Thesis. Department of Archaeology, University of Cape Town.

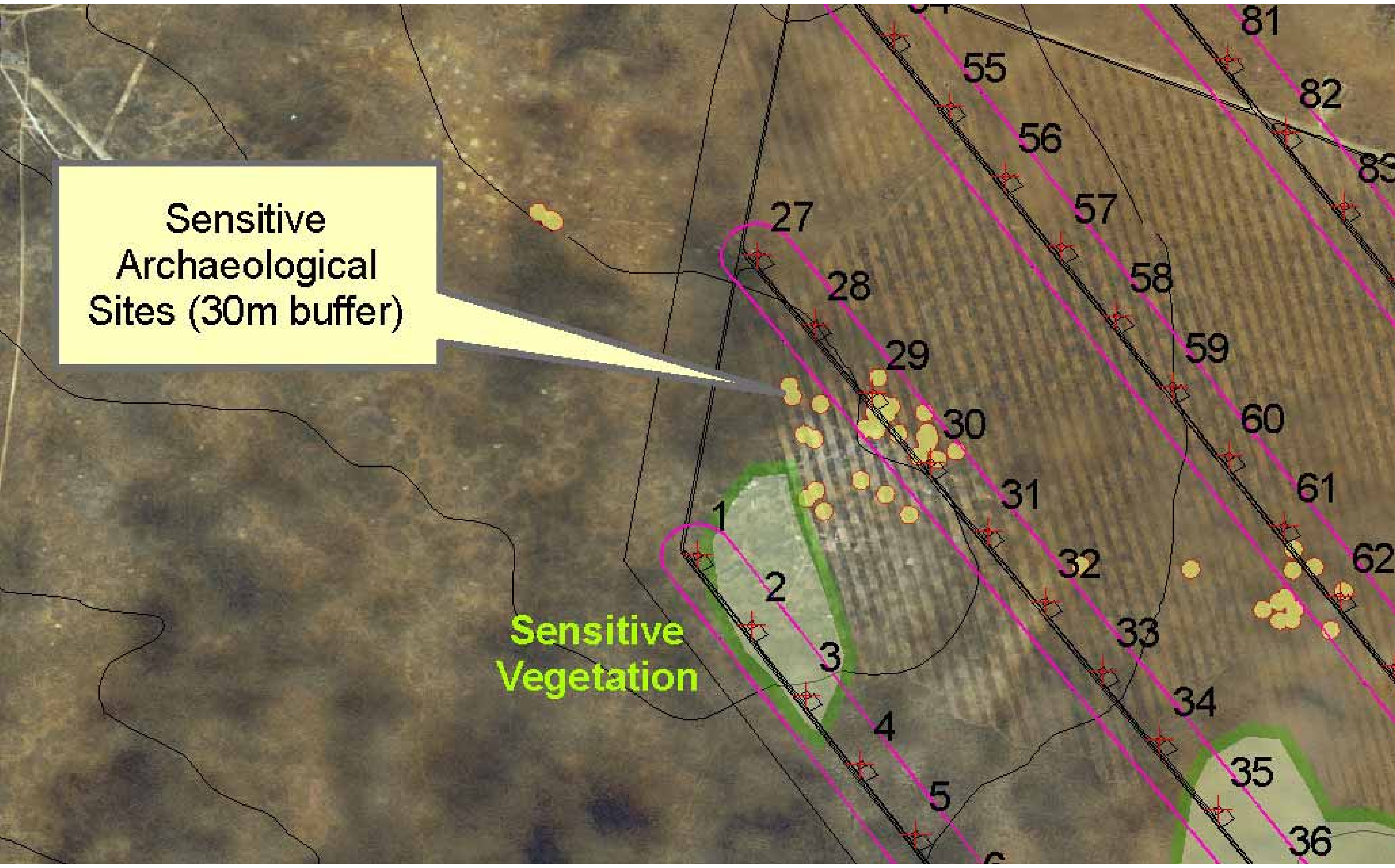
## APPENDIX A

The following are co-ordinates of archaeological sites recorded within or close to the study area. Each fix marks the center of a site. It is recommended that for planning purposes a safety radius of 30m is utilised around each co-ordinate. Sites printed in bold text are which are estimated to require sampling.

The co-ordinates were taken using a Garmin map 60csx set on WGS84

| | | | |
|---|---|---|---|
| 1 | S31.498849 | E018.168315 | DEFLATION HOLLOW SITE WITH EHEMERAL SCATTER OF LSA |
| 2 | S31.516602 | E018.119599 | FERRICRETE OUTCROP |
| 3 | S31.519217 | E018.121867 | FERRICRETE OUTCROP WITH MSA SCATTER |
| 4 | S31.535293 | E018.123731 | DEFLATED MSA SCATTER |
| 5 | S31.530666 | E018.122700 | FERRICRETE WITH MSA SCATTER |
| 7 | S31.518097 | E018.114596 | EPHEMERAL LSA MIDDEN |
| **8** | **S31.510032** | **E018.098113** | **LARGE LSA MIDDEN WITH STONE ARTEFACTS, CERAMICS** |
| **9** | **S31.510129** | **E018.097495** | **LSA MIDDEN WITH STONE ARTEFACTS** |
| **10** | **S31.509516** | **E018.097520** | **LSA MIDDEN WITH STONE ARTEFACTS** |
| 11 | S31.511871 | E018.098588 | EPHEMERAL LSA MIDDEN |
| 12 | S31.509976 | E018.091301 | EPHEMERAL LSA MIDDEN |
| 13 | S31.510095 | E018.094529 | EHPEMERAL LSA MIDDEN |
| 14 | S31.511275 | E018.096623 | EPHEMERAL LSA MIDDEN |
| 15 | S31.511594 | E018.097104 | DENSE LSA MIDDEN WITH STONE ARTEFACTS |
| 16 | S31.511559 | E018.097475 | EPHEMERAL LSA MIDDEN |
| 17 | S31.511261 | E018.097543 | LSA MIDDEN |
| 18 | S31.510913 | E018.097298 | LSA MIDDEN |
| 19 | S31.511053 | E018.097092 | EPHEMERAL LSA MIDDEN |
| **22** | **S31.510737** | **E018.098984** | **EPHEMERAL LSA MIDDEN** |
| 27 | S31.489733 | E018.078144 | LSA MIDDEN |
| 28 | S31.508032 | E018.083332 | EPHEMERAL MIDDEN |
| 29 | S31.499697 | E018.075522 | LSA MIDDEN |
| 30 | S31.499961 | E018.075984 | DENSE LSA MIDDEN WITH STONE ARTEFACTS |
| 31 | S31.499907 | E018.075891 | DENSE LSA MIDDEN WITH STONE ARTEFACTS |
| 32 | S31.508400 | E018.083840 | EPHEMERAL LSA MIDDEN |
| 33 | S31.507801 | E018.083613 | EPHERAL LSA MIDDEN |
| 34 | S31.506165 | E018.083265 | LSA MIDDEN |
| 35 | S31.505054 | E018.082917 | LSA MIDDEN |
| 36 | S31.504752 | E018.082829 | LSA MIDDEN |
| 37 | S31.506308 | E018.083574 | DENSE LSA MIDDEN WITH STONE ARTEFACTS |
| 38 | S31.505283 | E018.083748 | LSA MIDDEN |
| 39 | S31.507498 | E018.084919 | DENSE LSA MIDDEN WITH STONE ARTEFACTS |
| 40 | S31.507910 | E018.085634 | LSA MIDDEN |
| 41 | S31.505992 | E018.085045 | LSA MIDDEN |
| **42** | **S31.505175** | **E018.085336** | **LSA MIDDEN** |
| **43** | **S31.505525** | **E018.085323** | **LSA MIDDEN** |
| **44** | **S31.505807** | **E018.085504** | **LSA MIDDEN** |
| **45** | **S31.505786** | **E018.085429** | **LSA MIDDEN** |
| **46** | **S31.506040** | **E018.085365** | **LSA MIDDEN** |
| 48 | S31.508507 | E018.086319 | LSA MIDDEN WITH CERAMICS |
| **49** | **S31.506152** | **E018.086021** | **EPHEMERAL LSA MIDDEN** |
| 50 | S31.505363 | E018.085792 | EPHEMERAL LSA MIDDEN |
| **51** | **S31.505549** | **E018.085670** | **LSA MIDDEN WITH CERAMICS** |
| **52** | **S31.505289** | **E018.085568** | **EPHEMERAL LSA MIDDEN** |
| 53 | S31.504512 | E018.085427 | LSA MIDDEN |

| | | | |
|---|---|---|---|
| 54 | S31.506804 | E018.086595 | LSA MIDDEN WITH CERAMICS |
| **55** | **S31.506885** | **E018.087150** | **EPHEMERAL LSA MIDDEN** |
| 56 | S31.506303 | E018.086929 | EPHEMERAL LSA MIDDEN |
| 57 | S31.506419 | E018.086870 | EPHEMERAL LSA MIDDEN |
| 58 | S31.506221 | E018.086786 | EPHEMERAL LSA MIDDEN |
| 59 | S31.506114 | E018.086865 | EPHEMERAL LSA MIDDEN |
| 60 | S31.505537 | E018.086764 | EPHEMERAL LSA MIDDEN |
| 61 | S31.506653 | E018.087690 | EPHEMERAL LSA MIDDEN |
| 62 | S31.490389 | E018.141303 | EPHEMERAL LSA SCATTER IN DEFLATION HOLLOW |
| 65 | S31.495566 | E018.138756 | EPHEMERAL LSA SCATTER IN DEFLATION HOLLOW |




**Appendix A Figure 1:** Spatial patterning of shell middens in relation to corridors of disturbance.

iLifa leMveli leNtshona Koloni
Erfenis Wes-Kaap
Heritage Western Cape

Our Reference: HM/VANRHYNSDORP/PTN 5 OF GRAVEWATERKOP 158, & PTN 620 & 617
Email: Zshiceka@pgwc.gov.za
Enquiries: Zwelibanzi G Shiceka
Tel. (021) 483 9533
Date: 23-10-2007

**Heritage Western Cape hereby notifies:**

Ms. Karen Jodas
Savannah Environmental (PTY) LTD
PO Box 148
SUNNINGHILL
2157

**RECORD OF DECISION**

**Of its intention to comment in terms of**
**Section 38(8) of the National Heritage Resources Act (Act 25 of 1999)**
**and Regulation 3(3)(a) of PN 298 (29 August 2003)**

**For:** Proposed ESKOM Wind Energy Facility & Associated Infrastructure.

**At:** PTN 5 of Gravewaterkop 158, & PTN 620 & 617, De Punt, Olifants Rivier, Nedersetting & Erasmus Kloof Farms, VANRHYNSDORP

**Heritage Western Cape decided:**

- HWC has no objection to the Proposed ESKOM Wind Energy Facility & Associated Infrastructure on PTN 5 of Gravewaterkop 158, & PTN 620 & 617, De Punt, Olifants Rivier, Nedersetting & Erasmus Kloof Farms, VANRHYNSDORP.
- No further heritage related studies will be required as the nature of the application does not warrant such action.

**The following conditions apply:** NONE

**NOTE:**

- This decision does not exonerate the applicant from obtaining all the approvals relevant to this application, PRIOR to starting with the proposed work.

Yours sincerely

Zwelibanzi G Shiceka
**For Accounting Officer: Heritage Resources Management Service**
**p.p. Heritage Western Cape**
Copy to Matzikama Municipality, PO Box 98, VREDENDAL, 8160
Copy to Department of Environmental Affairs and Development Planning,
Private Bag X9086, CAPE TOWN, 8000

ACO Associates cc
Archaeology and Heritage Specialists

Postal: 8 Jacobs Ladder, St James, 7945
Physical: 5 Cannon Road, Plumstead, 7800
Tel: 078 616 2961
E-mail: john.gribble@aco-associates.com

25 July 2022

Ms Jacqui Davis
Nemai Consulting
Arcus Consultancy Services South Africa (Pty) Ltd
147 Bram Fischer Drive
Ferndale, 2194

Dear Jacqui

**SERE SOLAR PHOTOVOLTAIC PHASE 1 PROJECT:**

Thank you for your emailed request to Tim Hart for an opinion, as the author of the report, on whether the 2007 HIA for the Sere WEF remains valid and can be used in the current environmental application for the Sere Solar Photovoltaic project.

Tim has recently retired from ACO and I have been asked to respond to your request in his stead.

I have compared the proposed locations of the two solar PV sites you supplied with the positions of the archaeological sites and occurrences recorded by ACO during our survey of the WEF site in 2007. Although it appears that solar PV site options themselves were not extensively surveyed, the WEF site itself was subject to extensive survey and none of the sites recorded in 2007 will be impacted by the proposed solar PV project.

It is my opinion, therefore, that ACO's 2007 Sere WEF HIA remains valid and the baseline data it contains applicable to the proposed Sere Solar PV project.

Yours sincerely

John Gribble

for ACO Associates cc

**APPENDIX D**

**SPECIALISTS' REPORTS**

**APPENDIX D7 - Declarations**

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

| | (For official use only) |
|---|---|
| File Reference Number: | |
| NEAS Reference Number: | DEA/EIA/ |
| Date Received: | |

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

**PROJECT TITLE**

Proposed SERE Solar Photovoltaic Plant Phase 1A and Associated Infrastructure, Western Cape

**Kindly note the following:**

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

**Departmental Details**

**Postal address:**
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447
Pretoria
0001

**Physical address**:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

## 1. SPECIALIST INFORMATION

| | | | | |
|---|---|---|---|---|
| Specialist Company Name: | Banzai Environmental | | | |
| B-BBEE | Contribution level (indicate 1 to 8 or non-compliant) | 4 | Percentage Procurement recognition | 51 % |
| Specialist name: | Elize Butler | | | |
| Specialist Qualifications: | MSc | | | |
| Professional affiliation/registration: | PSSA | | | |
| Physical address: | 14 Eddie de Beer, Dan Pienaar, BFN | | | |
| Postal address: | | | | |
| Postal code: | 9301 | | Cell: | 084 4478 759 |
| Telephone: | | | Fax: | |
| E-mail: | elizebutler002@gmail.com | | | |

## 2. DECLARATION BY THE SPECIALIST

I, Elize Butler, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the Specialist

Banzai Environmental

Name of Company:

26-07-2021

Date

## 3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, Elize Butler, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

Signature of the Specialist

Banzai Environmental
Name of Company

26-07-2022
Date

Signature of the Commissioner of Oaths

Date

DANIEL NAUDÉ
KOMMISSARIS VAN EDE
COMMISSIONER OF OATHS
PRAKTISERENDE PROKUREUR
PRACTISING ATTORNEY
ALIWAL STR 26 ALIWAL ST
BLOEMFONTEIN • RSA

2022 -07- 26

ACO Associates cc
Archaeology and Heritage Specialists

Postal: 8 Jacobs Ladder, St James, 7945
Physical: 5 Cannon Road, Plumstead, 7800
Tel: 078 616 2961
E-mail: john.gribble@aco-associates.com

25 July 2022

Ms Jacqui Davis
Nemai Consulting
Arcus Consultancy Services South Africa (Pty) Ltd
147 Bram Fischer Drive
Ferndale, 2194

Dear Jacqui

**SERE SOLAR PHOTOVOLTAIC PHASE 1 PROJECT:**

Thank you for your emailed request to Tim Hart for an opinion, as the author of the report, on whether the 2007 HIA for the Sere WEF remains valid and can be used in the current environmental application for the Sere Solar Photovoltaic project.

Tim has recently retired from ACO and I have been asked to respond to your request in his stead.

I have compared the proposed locations of the two solar PV sites you supplied with the positions of the archaeological sites and occurrences recorded by ACO during our survey of the WEF site in 2007. Although it appears that solar PV site options themselves were not extensively surveyed, the WEF site itself was subject to extensive survey and none of the sites recorded in 2007 will be impacted by the proposed solar PV project.

It is my opinion, therefore, that ACO's 2007 Sere WEF HIA remains valid and the baseline data it contains applicable to the proposed Sere Solar PV project.

Yours sincerely

John Gribble

for ACO Associates cc

environmental affairs

Department:
Environmental Affairs
**REPUBLIC OF SOUTH AFRICA**

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

| | (For official use only) |
|---|---|
| File Reference Number: | |
| NEAS Reference Number: | DEA/EIA/ |
| Date Received: | |

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

**PROJECT TITLE**

Proposed SERE Solar Photovoltaic Plant Phase 1A and Associated Infrastructure, Western Cape

**Kindly note the following:**

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

**Departmental Details**

**Postal address:**
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447
Pretoria
0001

**Physical address**:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

## 1. SPECIALIST INFORMATION

| | | | | |
|---|---|---|---|---|
| Specialist Company Name: | Eco Elementum | | | |
| B-BBEE | Contribution level (indicate 1 to 8 or non-compliant) | | Percentage Procurement recognition | |
| Specialist name: | Neel Breitenbach | | | |
| Specialist Qualifications: | BSC Geography | | | |
| Professional affiliation/registration: | | | | |
| Physical address: | 361 Oberon Ave, Faerie Glen, Pretoria | | | |
| Postal address: | | | | |
| Postal code: | 0081 | | Cell: | |
| Telephone: | 012 807 0383 | | Fax: | |
| E-mail: | neel@ecoe.co.za | | | |

## 2. DECLARATION BY THE SPECIALIST

I, Johannes C Breitenbach, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the Specialist

Eco Elementum

Name of Company:

2022-07-20

Date

## 3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, JC Breitenbach, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

Signature of the Specialist

Eco Elementum

Name of Company

2022-07-20

Date

619898-8 ...

Signature of the Commissioner of Oaths

2022-07-20

Date

SUID-AFRIKAANSE POLISIEDIENS
STATION COMMANDER
COMMUNITY SERVICE CENTRE
2022 -07- 20
GEORGE
SOUTH AFRICAN POLICE SERVICE

# DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

| | (For official use only) |
|---|---|
| File Reference Number: | |
| NEAS Reference Number: | DEA/EIA/ |
| Date Received: | |

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

**PROJECT TITLE**

Proposed SERE Solar Photovoltaic Plant Phase 1A & Associated Infrastructure, Western Cape

**Kindly note the following:**

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

**Departmental Details**

**Postal address:**
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447
Pretoria
0001

**Physical address:**
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

## 1. SPECIALIST INFORMATION

| | | | | |
|---|---|---|---|---|
| Specialist Company Name: | THE BIODIVERSITY COMPANY | | | |
| B-BBEE | Contribution level (indicate 1 to 8 or non-compliant) | 4 | Percentage Procurement recognition | 100% |
| Specialist name: | ANDREW HUSTED | | | |
| Specialist Qualifications: | MSc AQUATIC HEALTH | | | |
| Professional affiliation/registration: | SACNASP 400213/11 | | | |
| Physical address: | 18 PERIDOT STREET, JUKSKEI PARK | | | |
| Postal address: | SAME AS ABOVE | | | |
| Postal code: | 2188 | Cell: | 081 319 1225 | |
| Telephone: | 081 319 1225 | Fax: | | |
| E-mail: | andrew@thebiodiversitycompany.com | | | |

## 2. DECLARATION BY THE SPECIALIST

I, ANDREW HUSTED, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the Specialist

THE BIODIVERSITY COMPANY

Name of Company:

13/07/22

Date

## 3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, ANDREW HUSTED, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

______________________________
Signature of the Specialist

THE BIODIVERSITY COMPANY
Name of Company

13/07/22
Date

______________________________
Signature of the Commissioner of Oaths

______________________________
Date

**Certified as a true copy of original**

Farai Shadreck Mbirimi BD52805
Minister of Religion / Commissioner of Oaths
391 11th Road, Erand, Midrand 1685

Date 13/07/2022

environmental affairs

Department:
Environmental Affairs
**REPUBLIC OF SOUTH AFRICA**

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

| | (For official use only) |
|---|---|
| File Reference Number: | |
| NEAS Reference Number: | DEA/EIA/ |
| Date Received: | |

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

**PROJECT TITLE**

Proposed SERE SOLAR Photovoltaic Plant Phase 1A & Associated Infrastructure, Western Cape

**Kindly note the following:**

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

**Departmental Details**

**Postal address:**
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447
Pretoria
0001

**Physical address**:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

## 1. SPECIALIST INFORMATION

| | | | | |
|---|---|---|---|---|
| Specialist Company Name: | THE BIODIVERSITY COMPANY | | | |
| B-BBEE | Contribution level (indicate 1 to 8 or non-compliant) | 4 | Percentage Procurement recognition | 100% |
| Specialist name: | ANDREW HUSTED | | | |
| Specialist Qualifications: | MSc AQUATIC HEALTH | | | |
| Professional affiliation/registration: | SACNASP 400213/11 | | | |
| Physical address: | 18 PERIDOT STREET, JUKSKEI PARK | | | |
| Postal address: | SAME AS ABOVE | | | |
| Postal code: | 2188 | | Cell: | 081 319 1225 |
| Telephone: | 081 319 1225 | | Fax: | |
| E-mail: | andrew@thebiodiversitycompany.com | | | |

## 2. DECLARATION BY THE SPECIALIST

I, ANDREW HUSTED, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the Specialist

THE BIODIVERSITY COMPANY

Name of Company:

13/07/22

Date

### 3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, ANDREW HUSTED, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

Signature of the Specialist

THE BIODIVERSITY COMPANY

Name of Company

13/07/22

Date

Signature of the Commissioner of Oaths

Date

Certified as a true copy of original

Farai Shadreck Mbirimi BD52805

Minister of Religion / Commissioner of Oaths

391 11th Road, Erand, Midrand 1685

Date 13/07/2022

AGRICULTURAL RESEARCH COUNCIL
NATURAL RESOURCES AND ENGINEERING

ARC • LNR

Enquiries:
**DG Paterson**

Ref. No:
**P07000018**

*SOIL, CLIMATE AND WATER*
*Private Bag X79, Pretoria, 0001*
*SOUTH AFRICA*
*600 Belvedere Street, Arcadia, 0083*
*Tel: 012 310 2500 • Int: + 27-12 310 2500*
*E-mail: adril@arc.agric.za*
*Website: www.arc.agric.za*

*AGRICULTURAL ENGINEERING*
*Private Bag X519, Silverton, 0127*
*SOUTH AFRICA*
*141 Cresswell Road, Weavind Park, 0184*
*Tel: 012 842 4000 • Int: + 27-12 842 4000*
*E-mail: stoltze@arc.agric.za*
*Website: www.arc.agric.za*

***To whom it may concern:***

**SERE Solar PV Project – Soil and Agriculture Study**

I can confirm that ARC-Soil, Climate and Water was responsible for the original report into the soils and associated agricultural potential for the project.

The main finding was that, despite the deep, generally sandy soils in the area, due to the dry and hot climate, there was almost no potential for any sort of arable cultivation. In addition, the grazing potential for livestock was also very limited.

This was supported by the absence of any agricultural infrastructure or other developments visible from sources such as Google Earth.

I can further confirm that no changes in the situation can be expected in the time since the report was compiled and that all the findings and conclusions will still be valid.

Yours sincerely,

**DG Paterson (Dr.)**

Research Team Manager (Soil Science)
garry@arc.agric.za
012 310 2601 or 083 556 2458

SACNASP Registration 400463/04