Mobile: Sam - 072 437 1742
Mobile: Luke - 083 784 1997
Email: info@enviro-insight.co.za
Website: www.enviro-insight.co.za

Appendix D2:

Preconstruction Avifauna Assessment

Avifaunal Specialist Assessment:
Proposed Red Sands Wind and Solar Energy Facilities
Southwest of Aggeneys
Northern Cape Province

October 2022

For

FE Red Sands (Pty) Ltd

Enviro-Insight CC

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

sam@enviro-insight.co.za

Professional Team

The technical team responsible for the pre-construction monitoring surveys and Impact Assessment reporting is presented.

Team member	Qualification	Role on project
Samuel Laurence	*Pr. Sci. Nat.* No. 400450/13	Lead Avifaunal Specialist Field Observer Data analysis Report compilation
AE Van Wyk	*Cand. Sci. Nat.*	Field Observer

Specialist Declaration

I, Sam Laurence *Pr. Sci. Nat.,* declare that the work presented in this report is our own and has not been influenced in any way by the developer or the EAP. At no point has the developer asked us as specialists to manipulate the results in order to make it more favourable for the proposed development. We consider ourselves bound to the rules and ethics of the South African Council for Natural Scientific Professions (SACNASP) and the EIA Regulations (2014, as amended). We have the necessary qualifications and expertise (*Pr. Sci. Nat. Zoological Science)* in conducting this specialist report.

Sam Laurence *Pr. Sci. Nat.*

TABLE OF CONTENTS

LIST OF FIGURES 5

LIST OF TABLES 6

GLOSSARY AND ACRONYMS 7

1 Introduction and Project Background 9

1.1 Scope of Work 9

1.2 Study Area 9

1.3 Study Limitations 12

2 Legislative Framework 12

2.1 National environmental screening tool and Environmental Theme Protocols 12

2.1.1 Screening Report 12

2.2 Renewable Energy Development Zone 14

2.3 Birds and Wind-Energy Best-Practice Guidelines (2015) 14

2.4 Birds and Solar Energy Best-Practice Guidelines (2017) 14

3 Methods 15

3.1 GIS 15

3.2 Desktop and Literature Survey 15

3.3 Preconstruction Bird Monitoring Survey Design 18

3.3.1 Vantage Points 19

3.3.2 Walked Transects 20

3.3.3 Driven Transects 21

3.3.4 Wetlands 22

3.3.5 Specialist Nest Survey 22

3.3.6 Incidental Observations of Priority Species 22

3.3.7 Species Collision Risk and Bird Passage Rate 23

3.4 Species of Conservation Concern 23

4 Results 24

4.1 Regional Vegetation 24
4.2 Protected Areas and Important Bird Areas 28
4.3 Critical Biodiversity Areas 30
4.4 Flagship species for the region 34
4.5 Description of Major Bird Habitats 34
4.5.1 Pans and Drainage Lines 35
4.5.2 Sandy Grassland 36
4.5.3 Shrubland 37
4.6 Observed and Expected Avifauna 38
4.6.1 Total species composition and abundance 38
4.6.2 Priority species list 38
4.7 Preconstruction Monitoring main results 44
4.7.1 Walked and Driven Transects counts 44
4.7.2 Vantage Points 44
4.7.3 Focal Sites 48
4.7.4 Nest Survey 48
4.8 Collision Risk Summary 48
4.9 WEF and Solar Site Sensitivity 50
5 Potential Impacts 52
5.1 Background to Interactions between Wind Energy Facilities, Power Lines and Birds 52
5.2 Impact Assessment 55
5.2.1 Construction Phase 55
5.2.2 Operational Phase 57
5.3 Cumulative Impacts 61
5.4 Mitigation of Impacts 63
5.5 Summary of Proposed Mitigation Measures 64
5.6 Species Specific Risk Analysis and Recommended Mitigations 65

5.6.1 Ludwig's Bustard (*Neotis ludwigii*) 65

5.6.2 Red Lark (*Calendulauda burra*) 66

5.6.3 Raptors and Vultures 68

6 Monitoring Requirements 70

7 Conclusions 71

7.1 Professional Opinion 72

8 References 73

9 Appendix 75

9.1 APPENDIX 1: Expected Avifauna Species List 75

9.2 APPENDIX 2: NON-PRIORITY Species Contact Data Per season (Walked Transect) 78

9.3 APPENDIX 3: NON-PRIORITY Species Contact Data Per season (Vantage Point) 83

LIST OF FIGURES

Figure 1-1: Locality map of the proposed Wind and Solar Farms. 10

Figure 1-2: Proposed turbine and solar infrastructure layout and Project Area of Influence (PAOI) of the proposed Red Sands Solar and WEF. 11

Figure 2-1: Environmental Screening Tool avifauna sensitivity theme map the proposed Red Sands Solar and WEF. 13

Figure 3-1: The Red Sands Solar and WEF in relation to the SABAP2 pentads. 17

Figure 3-2: Avifauna survey sites and specialist coverage (GPS tracks) for the proposed Red Sands Solar and WEF. 19

Figure 4-1: Regional vegetation types in relation to Red Sands Northwest WEF (SANBI, 2018). 25

Figure 4-2: Regional vegetation types in relation to Red Sands Northeast WEF (SANBI, 2018). 26

Figure 4-3: Regional vegetation types in relation to Red Sands Southwest WEF (SANBI, 2018) 26

Figure 4-4: Regional vegetation types in relation to Red Sands Southeast WEF (SANBI, 2018). 27

Figure 4-5: Regional vegetation types in relation to Red Sands Solar WEST (SANBI, 2018). 27

Figure 4-6: Regional vegetation types in relation to Red Sands Solar EAST (SANBI, 2018). 28

Figure 4-7: Red Sands Solar and WEF in relation to the adjacent IBAs 30

Figure 4-8: Red Sands Northwest WEF in relation to the Northern Cape Critical Biodiversity Areas (2016). 32

Figure 4-9: Red Sands Northeast WEF in relation to the Northern Cape Critical Biodiversity Areas (2016). 32

Figure 4-10: Red Sands Southeast WEF in relation to the Northern Cape Critical Biodiversity Areas (2016). 33

Figure 4-11: Red Sands Southwest WEF in relation to the Northern Cape Critical Biodiversity Areas (2016)..........................33

Figure 4-12: Avifauna Priority and SCC observed within the proposed Red Sands Solar and WEF PAOI. 40

Figure 4-13: Overall Avifauna Sensitivity Buffers with preferred turbine and solar panel placements overlaid with 500 metre buffered pan indicated (due to stochastic presence of vultures). 51

Figure 4-13: Lappet-faced vultures drinking from the large north-western impoundment within the PAOI................................52

Figure 5-1: Local and regional renewable energy applications and operations 62

Figure 5-2: Red lark (Calendulauda burra) distribution map (BirdLife International, 2021[b]). 67

LIST OF TABLES

Table 3-1: Avifauna monitoring sampling period for Red Sands Solar and WEF and Control Site. 18

Table 3-2: Locations description of the eight Vantage Points plus Control surveyed..20

Table 3-3: Walk and Drive transect lengths and total length. 21

Table 3-4: Drive transects lengths and total length. 22

Table 4-1: Attributes of the Bushmanland Arid Grassland vegetation type (Mucina and Rutherford, 2006 as amended)..........24

Table 4-2: Attributes of the Bushmanland Basin Shrubland vegetation type (Mucina and Rutherford, 2006 as amended). 25

Table 4-3: Priority avifauna species list (both expected and recorded as defined by Ralston-Paton et al 2017) for the study area. 39

Table 4-4: Summary of avifauna species of conservation concern of known distribution, previously recorded in or adjacent to the study area pentads...41

Table 4-5: Per season priority species recorded during Walked Transects and Drive Transects. 45

Table 4-6: Per season priority species recorded at vantage points during the surveys. 47

Table 4-7: Selected bird species crude passage rates and crude predicted fatality at the Red Sands Solar and WEF.............50

Table 5-1: Habitat loss and fragmentation impacts during the construction phase. 53

Table 5-2: Collision mortality with turbines and panels 53

Table 5-3: Disturbance of flight/migratory pathways. 54

Table 5-4: Disturbance due to lights, noise, machinery movements and maintenance operations...55

Table 5-5: Consolidation table of impacts due to habitat destruction during construction phase. 55

Table 5-6: Consolidation table of impacts due to the destruction or disturbance of bird roosts during the construction phase. 56

Table 5-7: Consolidation table of impacts from bird mortalities during the operational phase. 56

Table 5-8: Consolidation table of impacts due to disruption of bird migratory pathways during the operational phase. 57

Table 5-9: Wind Related Bird mortalities during the operational phase. 57

Table 5-10: Solar related bird mortalities during the operational phase. 58

Table 5-11: Loss of Bird Foraging Habitat. 59

Table 5-12: Disruption of bird migratory pathways during the operational phase. 59

Table 5-13: The attraction of some novel bird species due to the development of a solar farm with associated infrastructure such as lake effect, perches, nest and shade opportunities. 60

Table 5-14: Chemical pollution: Chemicals being used to keep the PV panels clean from dust (suppressants) etc. 60

Table 5-15: Cumulative impact of the project and other projects in the area. 62

GLOSSARY AND ACRONYMS

AI	Artificial Intelligence
BA	Basic Assessment
BARESG	Bird and Renewable Energy Specialist Group
CITES	Convention on International Trade in Endangered Species
Cumulative impact	Impacts on a species, ecosystem or resource as a result of the sum of actions in the past, present and foreseeable future, from multiple WEFs or a WEF in combination with other developments.
CWAC	Coordinated Waterbird Counts, a programme of bird censuses at a number of South African wetlands. See http://cwac.adu.org.za for more information.
ESKOM	Electricity Supply Commission (ESCOM), established in 1923.
Environmental Impact Assessment (EIA)	The process of identifying environmental impacts due to activities and assessing and reporting these impacts
GIS	Geographic Information Systems
GN	General Notice
IBA	Important Bird and Biodiversity Area. Part of a global network of sites that are critical for the long-term viability of bird populations. Now known as Important Bird and Biodiversity Areas.
IBA	Important Bird Area
IUCN	International Union for Conservation of Nature.

Rotor swept area	The area where birds are at risk of colliding with turbine blades. The area of the circle or volume of the sphere swept by the turbine blades.
NEPA	National Freshwater Ecosystem Priority Areas
PAOI	Project Area of Influence
Preconstruction Phase	The period prior to the construction of a wind energy facility
Wind Energy related Priority species	Threatened or rare birds (in particular those unique to the region and especially those which are possibly susceptible to wind-energy impacts as defined by Ralston Paton *et al*. 2017), which occur in the given development area at relatively high densities or have high levels of activity in the area. These species should be the primary (but not the sole) focus of all subsequent monitoring and assessment.
Solar Facility related Priority species	Threatened or rare birds (in particular those unique to the region and especially those which are possibly susceptible to solar energy impacts), which occur in the given development area at relatively high densities or have high levels of activity in the area. These species should be the primary (but not the sole) focus of all subsequent monitoring and assessment.
SABAP	The Southern African Bird Atlas Project. A project in which data on bird distribution and relative abundance are collected by volunteers. There have been two SABAP projects; i.e. SABAP1 (completed in 1991) and SABAP2 (started in 2007 and on-going). See http://sabap2.adu.org.za for more information.
SACNASP	South African Council for Natural Scientific Professions
SANBI	South African National Biodiversity Institute
SCC	Species of Conservation Concern
SEA	Strategic Environmental Assessment
STC	Strategic Transmission Corridors
TOPS	Threatened or Protected Species Regulations
REDZ	Renewable Energy Development Zones
VP	Vantage point
WEF	Wind energy facility. A power plant that uses wind to generate electricity, also colloquially known as a wind farm

1 INTRODUCTION AND PROJECT BACKGROUND

Enviro-Insight CC was commissioned by FE Red Sands (Pty) (via Energy Team) Ltd to perform an Avifauna Assessment for the proposed Red Sands Wind Energy Facility (WEF) and Red Sands Solar Energy Facilities (SEF) located southwest of Aggeneys in the Northern Cape Province, South Africa.

The Applicant wishes to apply for environmental authorisations for the proposed development of four (4) WEFs and two (2) SEFs as well as the associated infrastructure (all six projects will be referred to as "the study area"). The Red Sands WEFs will consist of up to 207 wind turbines, with a generation capacity of up to 7.5 MW per turbine. Each turbine will have a hub height of up to 150 m and a rotor diameter of up to 175 m. The final turbine model to be utilised will only be determined closer to the time of construction, depending on the technology available at the time.

The six projects will be referred to as:

- Red Sands Northwest WEF
- Red Sands Northeast WEF
- Red Sands Southeast WEF
- Red Sands Southwest WEF
- Red Sands Solar West
- Red Sands Solar East

All six projects are located within Zone 8 (Springbok) of the Renewable Energy Development Zones (REDZ) and accordingly BA processes will be followed. The six projects, being assessed together are hereby referred to as the "Project" or Red Sands Projects.

1.1 SCOPE OF WORK

The main objective is to fully understand and successfully mitigate the possible negative impacts of wind and solar energy production (and associated infrastructure) on the avifauna within the Project Area of Influence (PAOI). This report will provide baseline information to assess avifauna habitat use in a pre-construction (impact) scenario and evaluate the potential impact of the Project WEF on avifauna (such as collision mortality, displacement due to disturbance, barrier effects and habitat loss).

1.2 STUDY AREA

The proposed study area for the WEF development is located approximately 38 km southwest of Aggeneys in the Northern Cape. The site can be reached via the N14, which is ~11 km to the northwest of the project area (Figure 1-1). The WEF footprint is approximately 20 000 hectares (ha) and will be located on the Remaining Extent of the Farm Donkerduispraat 95 (Portion of this will be for solar), Remaining Extent of the Farm Rooi Duin 100, Remaining Extent of the Farm Kliphakskeen 98, Portion 1 of the Farm Kliphakskeen 98, Remaining Extent of the Farm Kraalbosch Vlei 99, Portion 1 of the Farm Kraalbosch Vlei 99, within the Nama-Khoi Local Municipality. The proposed preferred layout is shown as Figure 1-2.

The only land use in the area is sheep farming due to the lack of rainfall and nearby permanent water sources, and several farm smallholdings are present within the study area, but many have been abandoned. The closest existing WEF is the Kangnas WEF, which is situated approximately 30 km west of the proposed Red Sands WEF study area.

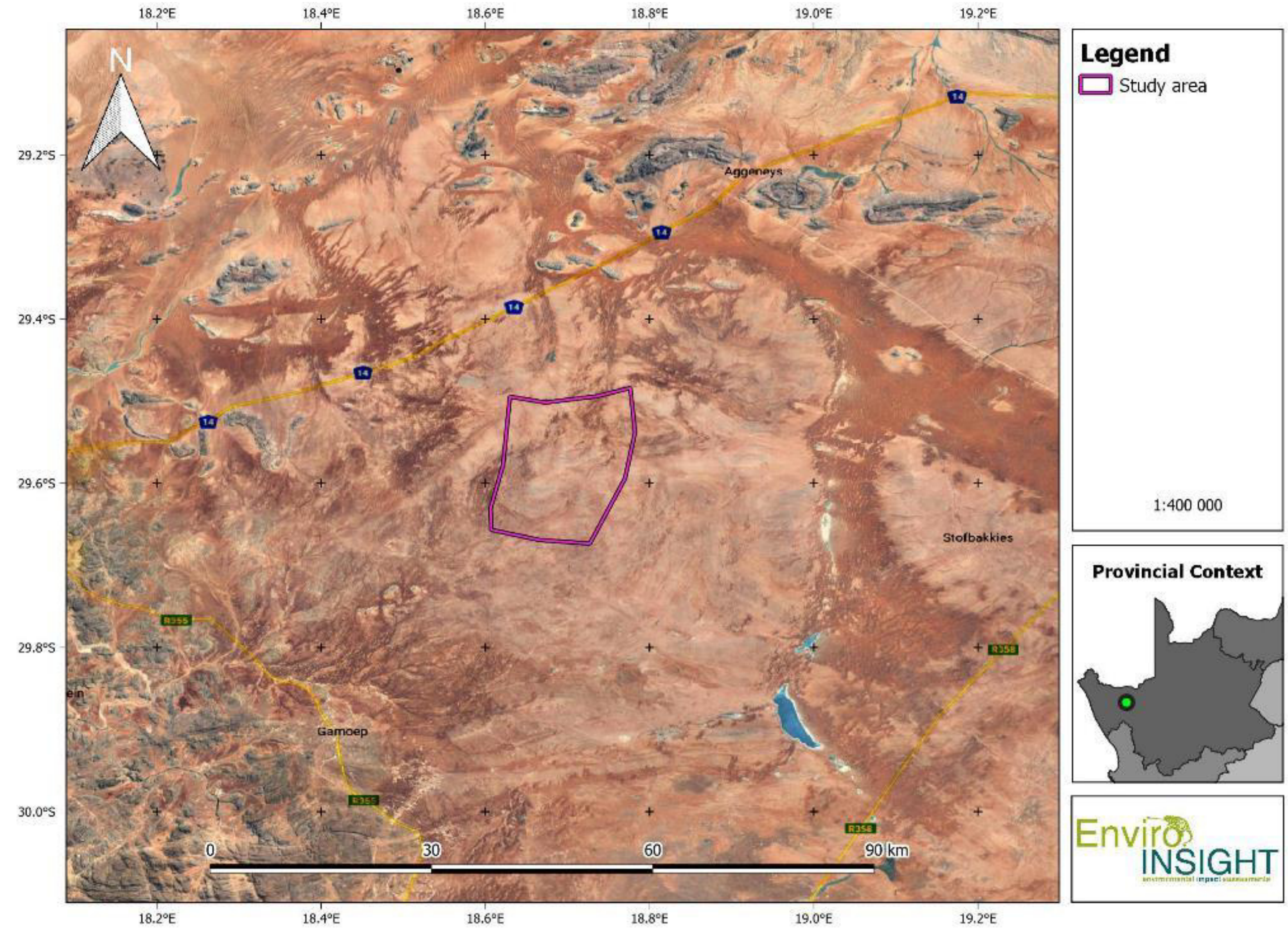

Figure 1-1: Locality map of the proposed Wind and Solar Farms.

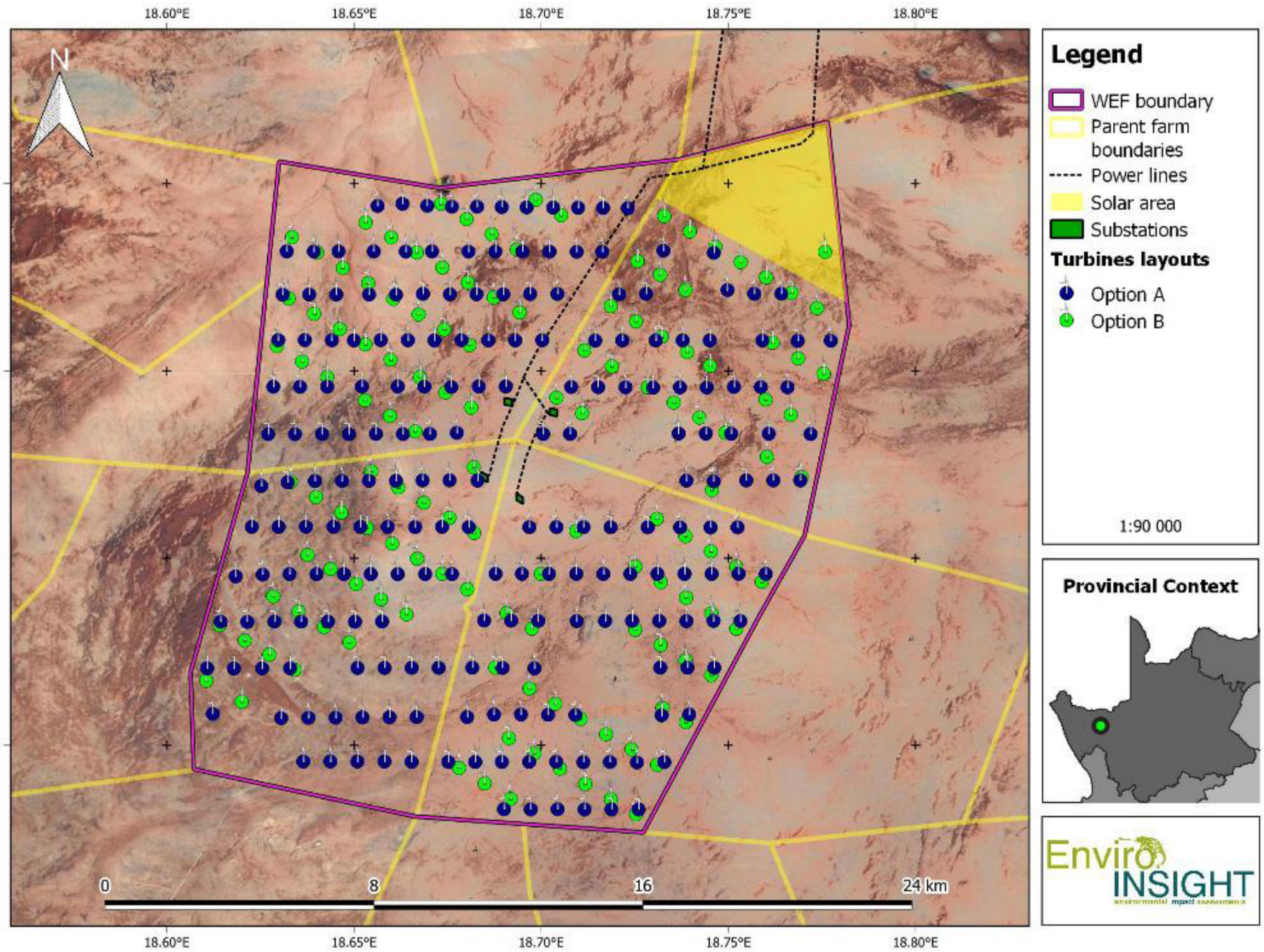

Figure 1-2: Proposed turbine and solar infrastructure layout and Project Area of Influence (PAOI) of the proposed Red Sands Solar and WEF.

1.3 STUDY LIMITATIONS

- It is assumed that all third-party information acquired is correct (e.g., GIS data, existing facility mortality data and the prescribed scope of work);
- There is still limited information available on the environmental effects of wind energy facilities in South Africa. Only a summary of the results of post-construction monitoring from eight wind farms in South Africa is available (Ralston Paton *et al*. 2017). Estimates of impacts are therefore also based on knowledge gained internationally, which should be applied with caution to local species and conditions;
- While sampling effort was conducted as recommended in the guidelines, to achieve statistically powerful results it would need to be increased beyond practical possibilities. The data was therefore interpreted using a precautionary approach.
- Vantage point surveys are only conducted during daylight. Therefore, any bird movement occurring at night was recorded under *ad hoc* conditions. Some waterbirds and night migrants are known to make regular flights and migration movements at night.

2 LEGISLATIVE FRAMEWORK

2.1 NATIONAL ENVIRONMENTAL SCREENING TOOL AND ENVIRONMENTAL THEME PROTOCOLS

2.1.1 Screening Report

The Minister of Environment, Forestry and Fisheries, gave notice that the submission of a report generated from the national web-based environmental screening tool[1], as contemplated in Regulation 16(1)(b)(v) of the Environmental Impact Assessment Regulations, 2014, published under Government Notice No. R982 in Government Gazette No. 38282 of 4 December 2014, as amended, will be compulsory from 4 October 2019 when submitting an application for environmental authorisation in terms of regulation 19 and regulation 21 of the Environmental Impact Assessment Regulations, 2014.

In addition, a set of protocols that an applicant needs to adhere to in the Environmental Authorisation (EA) process were developed and on 20 March 2020 the Minister of Forestry, Fisheries and the Environment gazetted the Protocols for national implementation purposes. The gazette '*Procedures to be followed for the Assessment and Minimum Criteria for Reporting of Identified Environmental Themes in terms of Section 24(5)(a) and (h) of the National Environmental Management Act (1998) when Applying for Environmental Authorisation*', has protocols that have been developed for environmental themes which include agriculture, avifauna, biodiversity (Terrestrial and Aquatic Biodiversity), noise, defence and civil aviation.

The protocols set requirements for the assessment and reporting of environmental impacts of activities requiring EA. The higher the sensitivity rating of the features on the proposed site as identified by the screening tool report, the more rigorous the assessment and reporting requirements. bird species sensitive to wind and solar energy developments.

[1] https://screening.environment.gov.za/screeningtool/#/pages/welcome

Based on the screening report generated on 03/02/2021, the Avian Combined Sensitivity Theme is indicated as **Very High** sensitivity in areas that are said to contain Red Larks (Figure 2-1). The sensitive features which trigger the Very High sensitivity include: Due to the coarse scale of the tool and the presence of other Species of Conservation Concern (SCC), the overall theme is to be treated as High Sensitivity.

Figure 2-1: Environmental Screening Tool avifauna sensitivity theme map the proposed Red Sands Solar and WEF.

2.2 RENEWABLE ENERGY DEVELOPMENT ZONE

On 17 February 2016, Cabinet approved the Renewable Energy Development Zones (REDZs) for large scale wind and solar photovoltaic development and associated Strategic Transmission Corridors (STC) which support areas where long term electricity grid will be developed. The procedure to be followed in applying for EA for a large-scale project in a REDZ or in a Power Corridor was formally gazetted on 16 February 2018 in GN113 and GN114. On 17 July 2020, Minister Barbara Dallas Creecy, published Government Gazette 43528, Notice 786 for consultation with the intention to identify three additional Renewable Energy Development Zones to the eight Renewable Energy Development Zones published under Government Notice No. 114 in Government Gazette No. 41445 of 16 February 2018. REDZs are also aligned with the powerline corridors that were identified in the Electricity Grid Infrastructure SEA completed in 2016 and gazetted as powerline corridors in February 2018. In this way, the combination of the REDZs and power corridors provides strategic guidance to ESKOM on where to prioritise investment in grid infrastructure.

As previously stated, all six projects are located within Zone 8 (Springbok) of the Renewable Energy Development Zones (REDZ) and accordingly BA processes will be followed.

Best Practice for both Birds and Wind Energy and Birds and Solar Energy Guidelines were followed for the study.

2.3 BIRDS AND WIND-ENERGY BEST-PRACTICE GUIDELINES (2015)

The "*Best-Practice Guidelines for assessing and monitoring the impact of wind-energy facilities on birds in southern Africa*" (Jenkins et al., 2015) are followed in order to fulfil the outlined requirements. This document became a legal requirement due to the NEMA Protocols (March 2020).

As per Appendix 2 - *Minimum requirements for avifaunal impact assessment*, an avifaunal impact assessment for a WEF should follow a two-tier process:

1. Scoping - a review of the existing literature and data, as well as a site visit to inform the design of a site-specific survey and preconstruction monitoring plan.
2. Impact assessment – systematic and quantified monitoring over four seasons that will inform a full EIA detailing and analysing the significance of likely impacts and available mitigation options.

2.4 BIRDS AND SOLAR ENERGY BEST-PRACTICE GUIDELINES (2017)

The "*Best-Practice Guidelines for assessing and monitoring the impact of solar energy facilities on birds in southern Africa*" (Jenkins *et al*., 2017) are followed in order to fulfil the outlined requirements.

As per Appendix 2 - *Minimum requirements for avifaunal impact assessment*, an avifaunal impact assessment for a SEF should follow a two-tier process:

3. **Scoping report**- process to identify issues that are likely to be important in the impact assessment process and to define the scope of work required in the assessment (e.g. timing, spatial extent and data collection methodologies). Largely based on desktop analysis of available data, but preferably also informed by a brief site visit.
4. **Preliminary assessment** – This is part of the planning for the EIA application, giving an overview on the biological

context, likely impacts and potential red flags to the development, identifying alternatives and determining the appropriate assessment regime.

5. **In-depth Study** – Could including structured and repeated data collection on which to base the impact assessment report and provide a baseline against which post-construction monitoring can be compared.
6. **Impact assessment -** Informed by the data collected during the preliminary assessment.

3 METHODS

3.1 GIS

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

- Vegetation Map of South Africa, Lesotho and Swaziland (SANBI, 2018);
- NFEPA wetlands and rivers (CSIR 2011);
- Important Bird Areas (IBAs) (Marnewick *et al*., 2015); and
- GIS layers provided by the client.

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

3.2 DESKTOP AND LITERATURE SURVEY

Prior to the initiation of field surveys, a desktop survey was conducted to consider the best information available, in order to provide a better evaluation of all conditions present within the study area. An initial literature review was undertaken to assess which bird species could potentially occur in the vicinity of the proposed WEF using data from the second South African Bird Atlas Project (SABAP 2[3]; [SABAP2, 2020]). SABAP 2 records were developed based on records per pentad (i.e., 5’ X 5’). A list of species potentially occurring was developed from SABAP 2 data for the pentads within which the study area falls (920_1825, 2920_1830, 2920_1835, 2920_1840, 2920_1845, 2920_1850, 2925_1825, 2925_1830, 2925_1835, 2925_1840, 2925_1845, 2925_1850, 2930_1825, 2930_1830, 2930_1835, 2930_1840, 2930_1845, 2930_1850, 2935_1825, 2935_1830, 2935_1835, 2935_1840, 2935_1845, 2935_1850, 2940_1825, 2940_1830, 2940_1835, 2940_1840, 2940_1845, 2940_1850, 2945_1825, 2945_1830, 2945_1835, 2945_1840, 2945_1845, 2945_1850) (

[2] http://qgis.osgeo.org/en/site/
[3] http://sabap2.birdmap.africa/

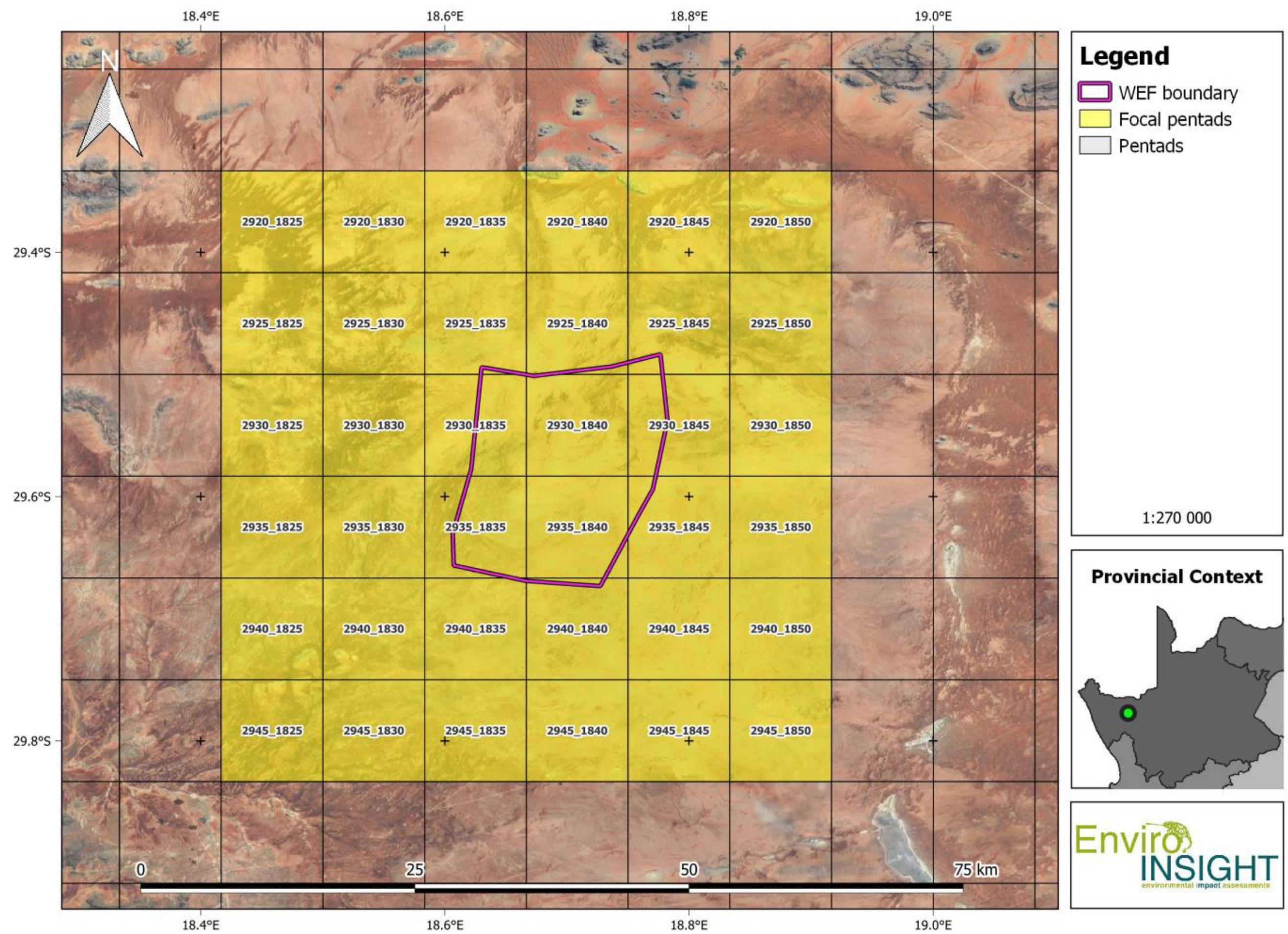

Figure 3-1). The expected species list (Appendix 1) is therefore based on an area much larger than the actual study area and was therefore subsequently refined. This approach was adopted to ensure that all species potentially occurring within the study area, whether resident, nomadic, or migratory, are identified.

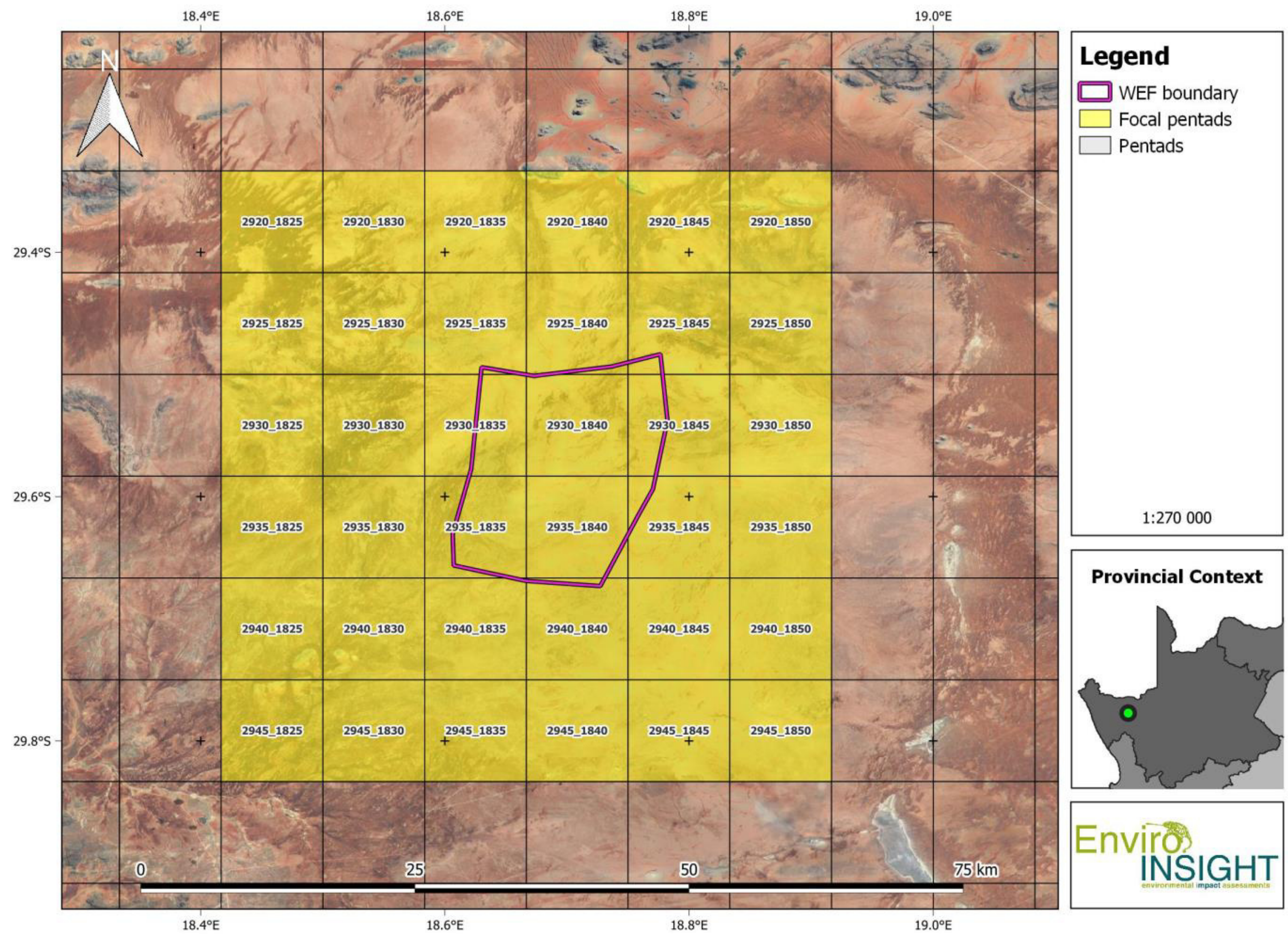

Figure 3-1: The Red Sands Solar and WEF in relation to the SABAP2 pentads.

From the generated expected species list, the sensitivity of avifauna species towards the potential impacts from the Project was evaluated using the Avian Wind Sensitivity Map (Retief *et al.*, 2012). Other species not listed in the referred document were also considered sensitive because of their abundance, flight characteristics, ecological role, population trend and conservation status. A preliminary list of focal species impacts for this study area was compiled based on existing Avifaunal Environmental Impact Assessment and post-construction mortality monitoring reports for similar projects in the region the area and supplemented with sensitive species identified in the previous steps.

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

- Information relating to avifauna species of conservation concern (SCC) was obtained from Taylor *et al.* (2015) and the IUCN Red List of threatened species (IUCN, 2022);
- del Hoyo *et al.* (1992) and Hockey *et al.* (2005) were consulted for general information on the life history attributes of relevant bird species;

- Distributional data (apart from those obtained during the surveys) was sourced from the Southern Africa Bird Atlas Project (SABAP 2, 2021), del Hoyo *et al.* (1992) and Sinclair & Ryan (2010);
- Nomenclature and taxonomy followed the IOC World Bird Names unless otherwise specified (see www.worldbirdnames.org; Gill & Donsker, 2012); and
- Priority species (including rankings) with regards to wind farms are based on Retief *et al.* (2012) which has been further applied in the region by Ralston-Paton *et al*. (2017).

3.3 PRECONSTRUCTION BIRD MONITORING SURVEY DESIGN

The field surveys were arranged so that the study area and control sites were surveyed for a total of 12 months and completed in May 2022. This complies with the requirements of the Best Practice Guidelines available at the time (Jenkins *et al.* 2015). The preconstruction monitoring programme has included a total of four visits to the site, covering the study area through a twelve-month period that included the spring, summer, autumn and winter seasons of the (non-calendar) year. The first survey conducted in All survey dates are summarised as Table 3-1 below.

Table 3-1: Avifauna monitoring sampling period for Red Sands Solar and WEF and Control Site.

Date	Season	Methodology applied
July 2021	Winter	VP, DT, WT, WB, NE
October 2021	Spring	VP, DT, WT, WB, NE
January 2022	Summer	VP, DT, WT, WB, NE
May 2022	Autumn	VP, DT, WT, WB, NE

*** VP – Vantage points; WT – Walked transects; DT – Drive transects; NE – Nest searches, inspection and monitoring; WB – Water body inspections.**

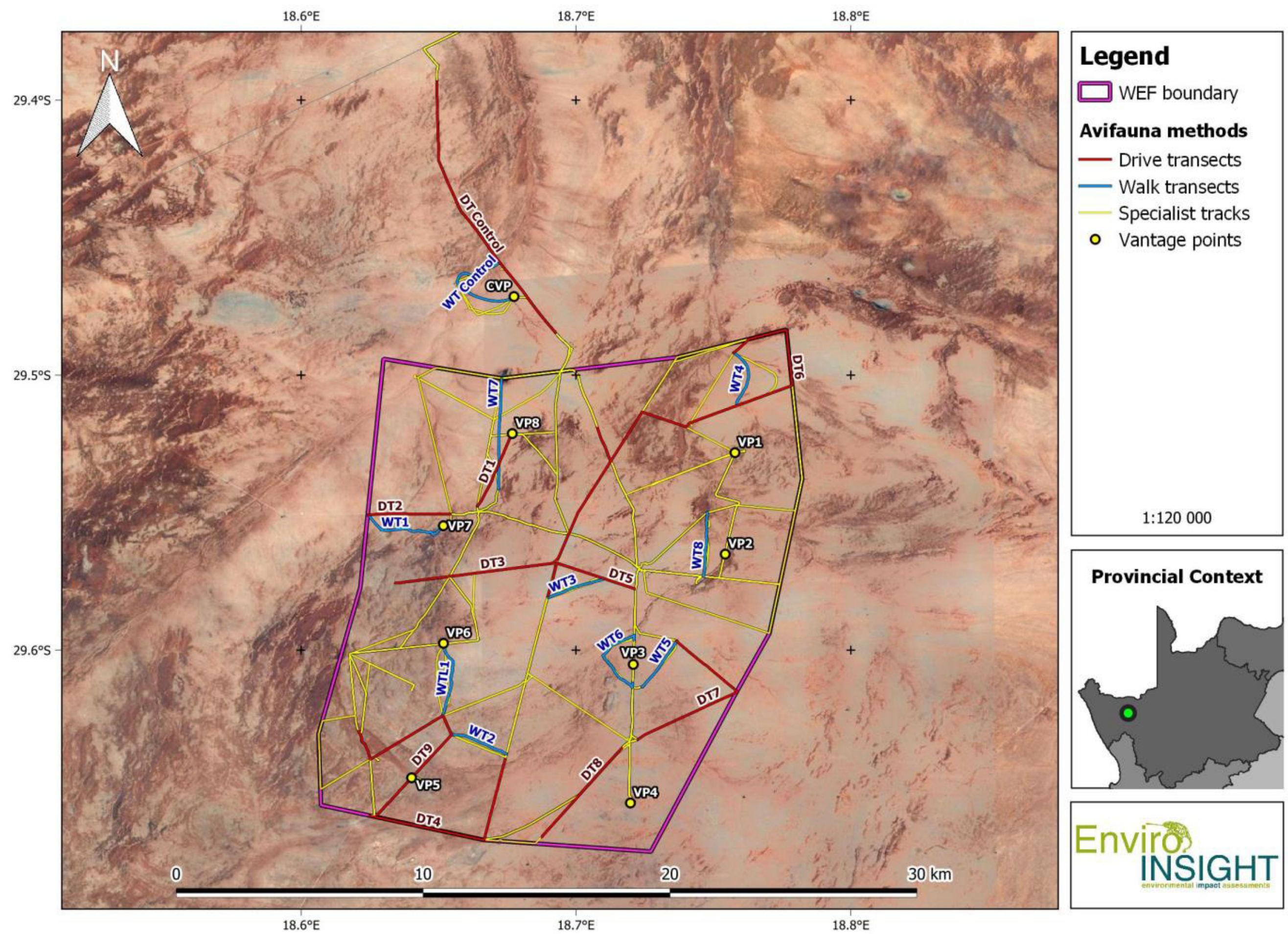

Figure 3-2: Avifauna survey sites and specialist coverage (GPS tracks) for the proposed Red Sands Solar and WEF.

3.3.1 Vantage Points

Eight vantage points (VPs) within the project study area were identified based on the preliminary desktop and scoping survey in the Red Sands Solar and WEF, and one identified at the control area, to record the flight altitude and patterns of priority species (totaling seven VPs). These sampling points were located at strategic locations within the Project Footprint and set up to allow the visual coverage of the wind farm (placing special emphasis on the proposed turbine locations) and its immediate surroundings. VP surveys were conducted accordingly to the most recent recommendation from the best practice guidelines at the time (Jenkins *et al.* 2015). Each location was surveyed for a minimum of 12 hours of observation per season divided through the early morning, midday and late afternoon times of day (Jenkins *et al.* 2015). For more information on each VP, refer to Table 3-2.

Table 3-2: Locations description of the eight Vantage Points plus Control surveyed

Vantage Point	Location	
	Latitude	Longitude
1	29°31'41.53"S	18°45'28.18"E
2	29°33'54.33"S	18°45'15.45"E
3	29°36'18.69"S	18°43'14.99"E
4	29°39'20.12"S	18°43'11.25"E
5	29°38'47.15"S	18°38'24.62"E
6	29°35'51.07"S	18°39'6.38"E
7	29°33'17.16"S	18°39'6.23"E
8	29°31'16.52"S	18°40'36.48"E
Control	29°28'17.12"S	18°40'38.78"E

3.3.2 Walked Transects

This method is utilised to monitor all birds, especially less obvious smaller bird species within the major habitat types within a study area. Transects were positioned at varying distances away from the proposed turbine arrays (see Table 3-3) to maximise the comparative value of the data which will be compared with the surveys from the post-construction phase results.

Ten (10) linear transects ranging from 2 km to 4.5 km in length (315.07 km total for the 12 month period), eight located in the proposed Project footprint and two within the control area, were walked in order to characterize the passerine and small bird communities (Table 3-3). These transects are representative of the biotopes present within the study area. These transects (excluding that in the control area) were located within the solar facility and turbine area of influence available at the time (Drewitt & Langston, 2006). To avoid pseudo-replication, transects were located at a minimum distance of 400 m apart from one another (Sutherland, 2006). Each transect was conducted by one expert bird observers at a time (more than one observer for all transects were used), who recorded all bird contacts (both seen and heard) by walking slowly along the predetermined transect. Observations were made on both the left and right side of the predetermined transect. Birds were only recorded (seen or heard) within a fixed maximum width of between 150 to 200 m on either side if the transect line. The same transects were repeated in every season. Surveys started after sunrise and were performed throughout the day to account for temporal variation in bird activity.

As a general rule, transects were not walked in adverse conditions, such as heavy rain, strong winds or thick mist. During the surveys, no adverse conditions were recorded that precluded successful analysis.

Table 3-3: Walk transect lengths and total length.

Name	length (m)
WT1	3489
WT2	2113
WT3	2214
WT4	2460
WT5	2389
WT6	3924
WT7	4548
WT8	2754
WT Control	4397
WTL1	3219

3.3.3 Driven Transects

Large terrestrial birds (e.g., cranes, bustards, and most raptors) cannot be adequately surveyed using walked transects. Populations of such birds should be estimated on each visit to the project area by means of road counts (vehicle-based sampling; best applied for relatively large proposed WEFs, especially those with good networks of roads and tracks).

Road counts of large terrestrial birds and raptors require that one or a number of driven transects be executed (depending on site size, terrain and infrastructure), comprising one or a number of set routes, limited by the existing roadways but as far as possible directed to include a representative cross section of habitats within the project area of influence (PAOI).

These transects were driven at a constant and slow speed (± 15 km/h), and all sightings of large terrestrial birds and raptors were recorded in terms of the same data-capture protocols used for walked transects (above), and in general compliance with the road-count protocols described for large terrestrial species (Young et al., 2003) and raptors (Malan, 2009). Nine drive transects were identified in the project footprint and one drive transect in the control area with a combined total length of 744. 35 km (Table 3-4). One observer travelling slowly in a vehicle recorded all species on both sides of the drive transect. The observer stopped at regular intervals (every 100 to 300 m) to scan the environment with binoculars.

Table 3-4: Drive transects lengths and total length.

Name	Length (m)
DT Control	11300
DT1	3125
DT2	2939
DT3	10221
DT4	7517
DT5	4325
DT6	14002
DT7	7026
DT8	4557
DT9	9423

3.3.4 Wetlands

Prior to the initiation of the preconstruction monitoring campaign, the main water bodies (including wetlands) present within the study area were identified on a Geographical Information System (GIS) by using 1:50 000 topographic maps and aerial photos. Several significant water bodies were identified on and surrounding the study area. These identified and mapped water bodies were surveyed to determine their level of utilisation by water birds. Due to seasonality, the birds were only be surveyed during periods with some prevailing inundation or rainfall. Some drainage lines within the greater PAOI were inundated during the 2021 spring surveys and were observed accordingly.

3.3.5 Specialist Nest Survey

Any habitats within the PAOI of the proposed WEF, or equivalent habitats around the study area, deemed likely to support nest sites of key raptor and other species of conservation concern, including power lines, stands of large trees, marshes and drainage lines, were surveyed. All potential breeding sites, once identified fully, were mapped, and checked during each survey to confirm occupancy, and all evidence of breeding and the outcomes of such activity, where possible, recorded.

3.3.6 Incidental Observations of Priority Species

All other sightings of priority species (and particularly those suggestive of breeding or important feeding or roosting sites or flight paths) on the WEF and control site as well as within the broader study area were recorded, along with additional relevant information such as habitat type, abundance, habits and weather data. These observations were used as complementary data to characterise the bird community and its utilisation of the site, as recommended by the Best Practice Guidelines (Jenkins *et al*., 2015).

3.3.7 Species Collision Risk and Bird Passage Rate

For pre-construction surveys of this nature, Collision Risks are usually calculated using the following equation:

Duration of medium and high-altitude flights x collision susceptibility calculated as the sum of morphology and behaviour ratings x number of planned turbines ÷100:

However, and for the survey area, this was not possible due to the extreme variations in undulations at the vantage points, not allowing for standardised measurements of duration. Therefore, collision risk was calculated based on a measurement of the three assumed variations of crude passage rates as described by Smallie and Strugnell (2020), primarily focusing on passage rate, flight height and total surface area of turbines.

3.4 SPECIES OF CONSERVATION CONCERN

The Red List of threatened species generated by the IUCN (http://www.iucnredlist.org/) provided the global conservation status of avifauna. However, Taylor *et al*. (2015) produced a regional conservation status assessment following the IUCN criteria which was used for this scoping report. The first three categories i.e., Critically Endangered, Endangered and Vulnerable, are collectively called 'threatened' species.

The conservation status categories defined by the IUCN, which are considered here to represent species of conservation concern (SCC), are defined as follows:

- **Critically Endangered (CR)** - Critically Endangered refers to species facing immediate threat of extinction in the wild.
- **Endangered (EN)** - Endangered species are those facing a very high risk of extinction in the wild within the foreseeable future.
- **Vulnerable (VU)** - Vulnerable species are those facing a high risk of extinction in the wild in the medium-term.
- **Near Threatened (NT)** - any indigenous species which does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

The National Environmental Management: Biodiversity Act (Act 10 of 2004) (NEMBA) provides for listing threatened or protected ecosystems, in one of four categories: critically endangered (CR), endangered (EN), vulnerable (VU) or protected. NEMBA also deals with endangered, threatened and otherwise controlled species, under the Threatened or Protected Species Regulations (ToPS). A ToPS permit is required for any activities involving the removal or destruction of any ToPS-listed species.

Protected species: any species which is of such high conservation value or national importance that it requires national protection. Species listed in this category include, among others, species listed in terms of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

4 RESULTS

4.1 REGIONAL VEGETATION

The study area is located in the Bushmanland Arid Grassland (NKb3; Table 4-1) and Bushmanland Basin Shrubland (NKb6; Table 4-2) vegetation type. The Bushmanland Arid Grassland vegetation type (Table 4-1) is present in the Northern Cape Province, extending from around Aggeneys in the west to Prieska in the east. Three of the four WEFs, namely Red Sands Northwest (Figure 4-1), Northeast (Figure 4-2) and Southwest (Figure 4-3), including the two solar facilities (Figure 4-5; Figure 4-6) are located in NKb3.

The southern border of the unit is formed by edges of the Bushmanland Basin while in the northwest this vegetation unit borders on desert vegetation (northwest of Aggeneys and Pofadder). The northern border (in the vicinity of Upington) and the eastern border (between Upington and Prieska) are formed with often intermingling units of Lower Gariep Broken Veld, Kalahari Karroid Shrubland and Gordonia Duneveld. Most of the western border is formed by the edge of the Namaqualand hills. From an avifaunal habitat Point of view, the primary sensitivity concern is related to the pans as well as the sparsely vegetated red dune habitats that permeate both vegetation types.

Table 4-1: Attributes of the Bushmanland Arid Grassland vegetation type (Mucina and Rutherford, 2006 as amended).

Name of vegetation type	Bushmanland Arid Grassland
Code as used in the Book	NKb3
Conservation Target (percent of area) from NSBA	21%
Protected (percent of area) from NSBA	0.4%
Remaining (percent of area) from NSBA	99.4%
Description of conservation status from NSBA	Least threatened
Description of the Protection Status from NSBA	Hardly protected
Area (sqkm) of the full extent of the Vegetation Type	45478.96
Name of the Biome	Nama-Karoo Biome
Name of Group (only differs from Bioregion in Fynbos)	Bushmanland Bioregion
Name of Bioregion (only differs from Group in Fynbos)	Bushmanland Bioregion

Table 4-2: Attributes of the Bushmanland Basin Shrubland vegetation type (Mucina and Rutherford, 2006 as amended).

Name of vegetation type	Bushmanland Basin Shrubland
Code as used in the Book	NKb6
Conservation Target (percent of area) from NSBA	21%
Protected (percent of area) from NSBA	%
Remaining (percent of area) from NSBA	99.5%
Description of conservation status from NSBA	Least threatened
Description of the Protection Status from NSBA	Not protected
Area (km^2) of the full extent of the Vegetation Type	34690.68
Name of the Biome	Nama-Karoo
Name of Bioregion	Bushmanland Bioregion

4

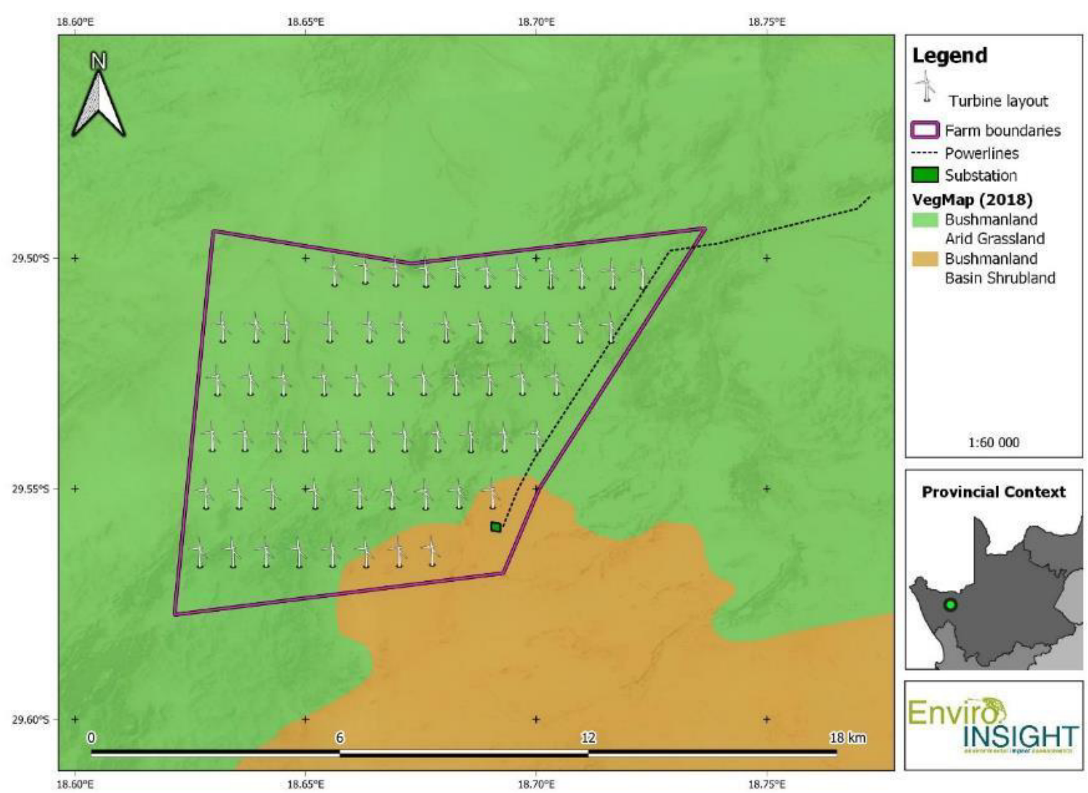

Figure 4-1: Regional vegetation types in relation to Red Sands Northwest WEF (SANBI, 2018).

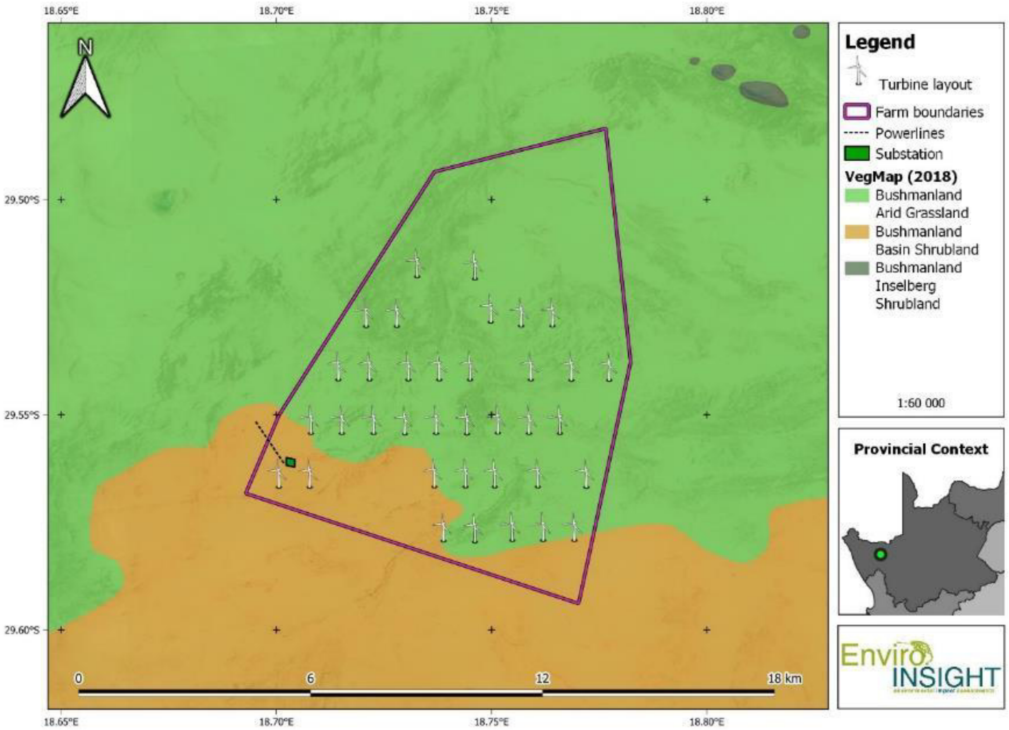

Figure 4-2: Regional vegetation types in relation to Red Sands Northeast WEF (SANBI, 2018).

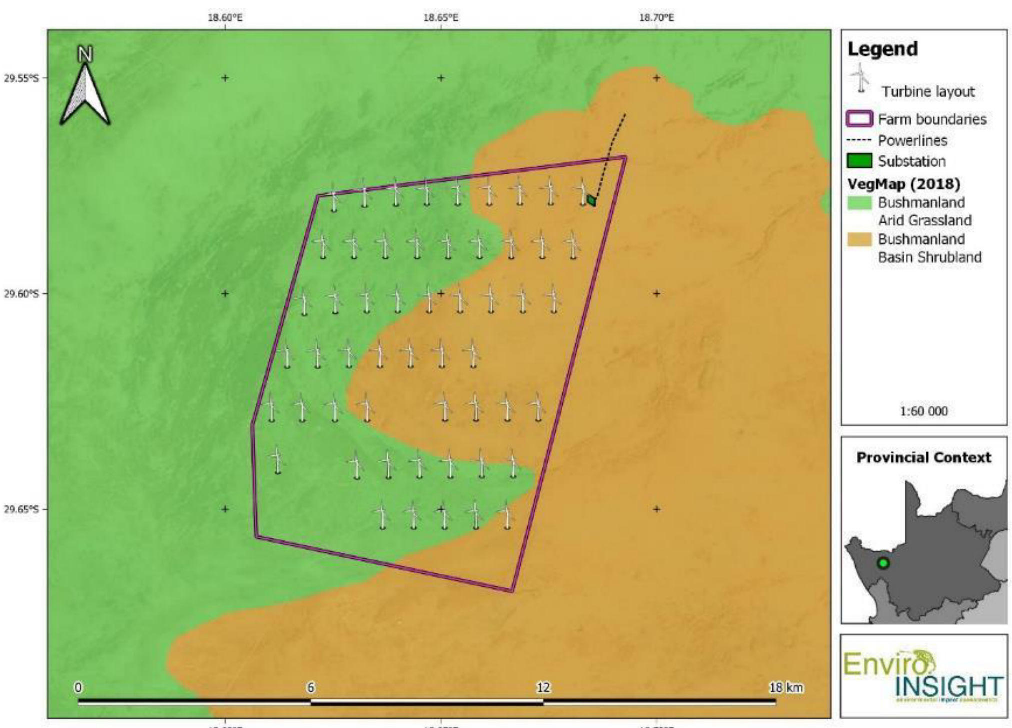

Figure 4-3: Regional vegetation types in relation to Red Sands Southwest WEF (SANBI, 2018)

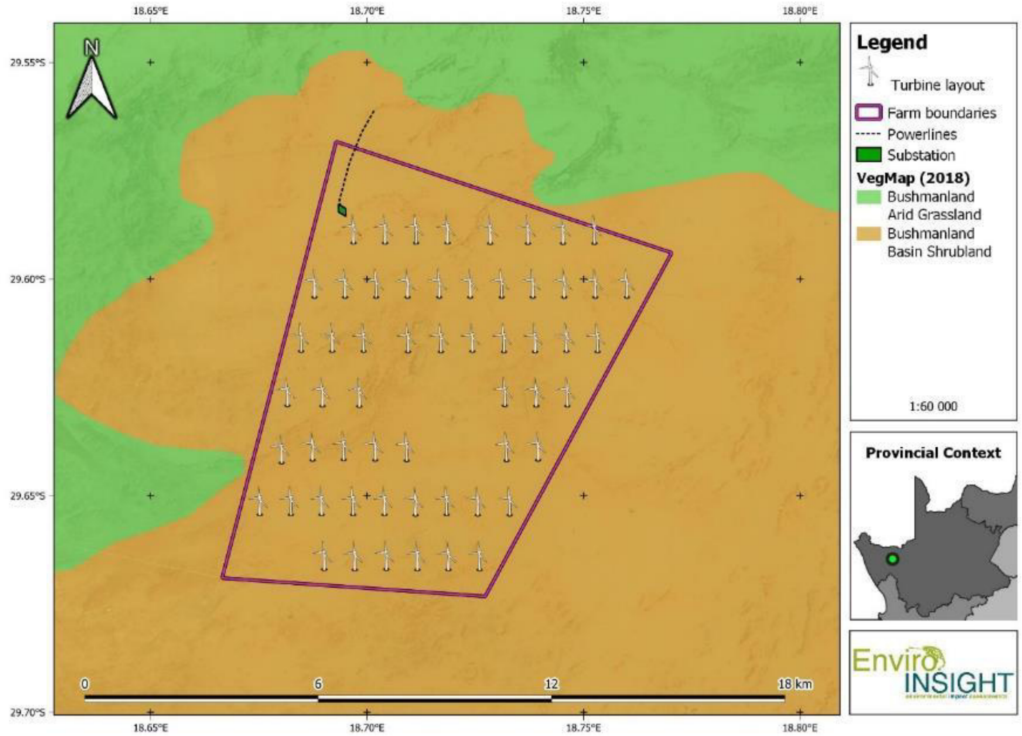

Figure 4-4: Regional vegetation types in relation to Red Sands Southeast WEF (SANBI, 2018).

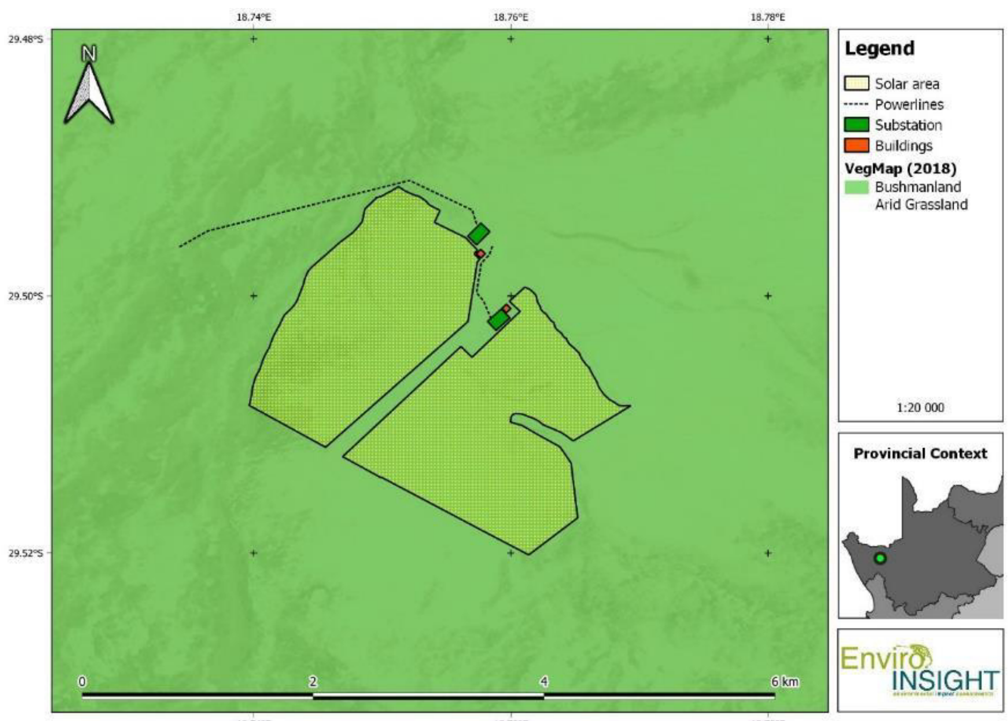

Figure 4-5: Regional vegetation types in relation to Red Sands Solar WEST (SANBI, 2018).

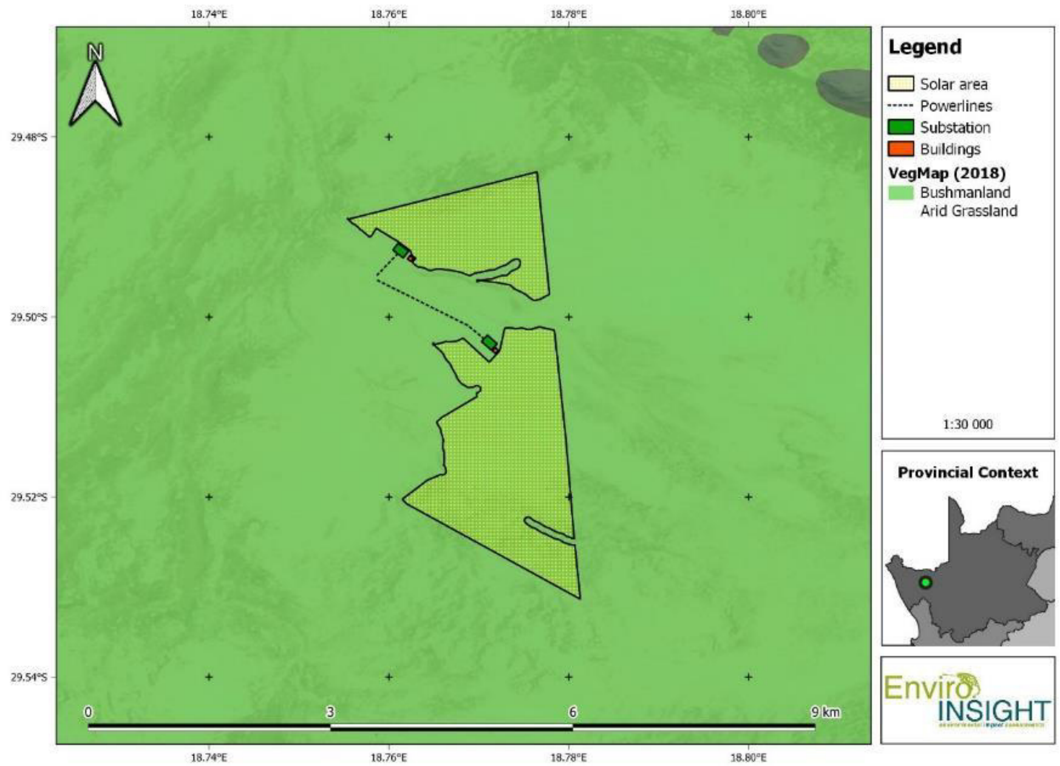

Figure 4-6: Regional vegetation types in relation to Red Sands Solar EAST (SANBI, 2018).

4.2 PROTECTED AREAS AND IMPORTANT BIRD AREAS

The Red Sands Solar and WEF is not located in an Important Bird Area (IBA) or protected area but is situated in between the and the Haramoep Black Mountain Mine (approximately 31 km to the North East) and the Bitterputs Conservation Area which is approximately 42 km south east of the study area with the Marietjie van Niekerk Nature Reserve being situated approximately 20 km to the west. The Mattheus Cat Conservation Area is also situated relatively close to the Project PAOI.

The Bitterputs Conservation Area (SA036) is an arid landscape which consists of extensive sandy and gravel plains covered with sparse, perennial desert grassland. A few large salt pans are a unique habitat type in this IBA. The conservation area falls within the Bushmanland Bioregion and the Nama Karoo Biome. Three vegetation types are present: the Bushmanland Vloere (salt pans), Bushmanland Arid Grassland and Bushmanland Sandy Grassland. The ecosystem status for the entire area is Least Concern.

The Haramoep Black Mountain IBA is characterised by large sand dunes following the course of the Koa River although dominated by the sparsely vegetated gravel plains that are prevalent in the region. The IBA falls within the Bushmanland Bioregion and three biomes (Desert, Nama Karoo and Succulent Karoo) are represented. Seven vegetation types are present, of which one is Endangered. One Endangered and two Vulnerable habitat units within these are considered irreplaceable. Approximately 90% of the land is natural and utilised for ranching and disturbance and overgrazing is prevalent.

Both IBAs are some of a few sites protecting both the globally threatened Red Lark (*Calendulauda burra)*, which inhabits the red sand dunes and sandy plains where there is mixed cover of grasses and dwarf shrubs, and the near-threatened Sclater's Lark (*Spizocorys sclater)i*. The sites also hold 16 of the 23 Namib-Karoo biome-restricted assemblage species and a host of other arid-zone birds. Other priority species, including globally threatened species, within this IBA include Ludwig's Bustard (*Neotis ludwigii),* Kori Bustard (*Ardeotis kor)i*, Karoo Korhaan (*Eupodotis vigorsii)*, Secretarybird (*Sagittarius serpentarius)* and Lanner Falcon (*Falco biarmicus)*. Restricted-range and biome-restricted species are Stark's Lark (*Spizocorys starki)*, Karoo Long-billed Lark (*Certhilauda subcoronata)*, Black-eared Sparrow-lark (*Eremopterix australis)*, Tractrac Chat (*Cercomela tractrac)*, Sickle-winged Chat (*C. sinuate)*, Karoo Chat *C. schlegelii*, Karoo Eremomela *Eremomela gregalis*, Cinnamon-breasted Warbler (*Euryptila subcinnamomea)* and Black-headed Canary (*Serinus alario)*.

There has been a c. 75% loss of optimal habitat for the Red Lark over the past 100 years. The disappearance of this species from ranches where dune grassland has been replaced by ephemerals is probably linked to the reduction in grass awns for nesting, shelter and invertebrate and plant foods.

There is a serious threat from climate change and it is predicted that temperatures will increase and rainfall decrease sharply in arid areas such as Bushmanland. Locally resident endemic larks, in particular, are at risk. Increased CO_2 can lead to the increase of C3 plants (shrubs) at the expense of C4 plants (mainly grasses), causing a shift in vegetation diversity and structure and making the habitat unsuitable for some species. It is expected that the Red Lark will not meet the challenge of global warming (BirdLife International, 2021).

Currently no part of these IBAs are formally conserved and no conservation actions have been implemented. Bitterputs falls within the Central Astronomy Advantage Area, which has restrictions on activities that can take place in it. This could result in some protection for the IBA. The IBAs in relation to the Project footprint is shown as Figure 4-7.

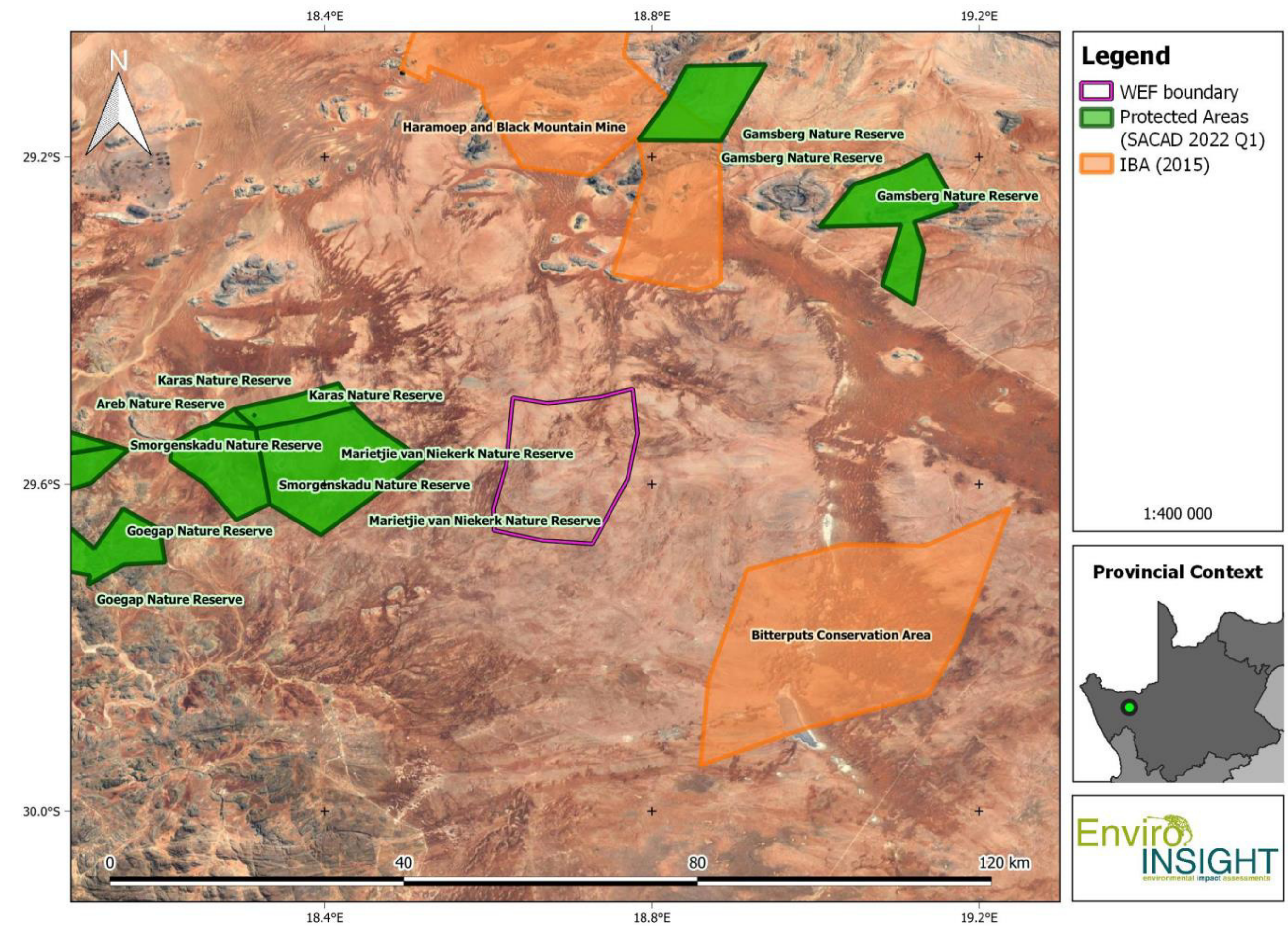

Figure 4-7: Red Sands Solar and WEF in relation to the adjacent IBAs

4.3 CRITICAL BIODIVERSITY AREAS

The following CBA information has been extracted and mapped Verbatim from the Enviro-Insight Terrestrial Biodiversity survey conducted as part of the BA application process.

The Northern Cape CBA Map (2016) identifies biodiversity priority areas, called Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs), which, together with protected areas, are important for the persistence of a viable representative sample of all ecosystem types and species as well as the long-term ecological functioning of e landscape as a whole (Holness & Oosthuysen, 2016). Priorities from existing plans such as the Namakwa District Biodiversity Plan, the Succulent Karoo Ecosystem Plan, National Estuary Priorities, and the National Freshwater Ecosystem Priority Areas were incorporated. Targets for terrestrial ecosystems were based on established national targets, while targets used for other features were aligned with those used in other provincial planning processes.

Critical biodiversity areas (CBA's) are terrestrial and aquatic features in the landscape that are critical for retaining biodiversity and supporting continued ecosystem functioning and services. The primary purpose of CBA's is to inform land-use planning in order to promote sustainable development and protection of important natural habitat and landscapes. Biodiversity priority areas are described as follows:

- Critical biodiversity areas (CBA's) are areas of the landscape that need to be maintained in a natural or near-natural state in order to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services. In other words, if these areas are not maintained in a natural or near-natural state then biodiversity conservation targets cannot be met. Maintaining an area in a natural state can include a variety of biodiversity-compatible land uses and resource uses. For CBA's the impact on biodiversity of a change in land-use that results in a change from the desired ecological state is most significant locally at the point of impact through the direct loss of a biodiversity feature (e.g. loss of a populations or habitat). All FEPA prioritized wetlands and rivers have a minimum category of CBA1, while all FEPA prioritised wetland clusters have a minimum category of CBA2.
- Ecological support areas (ESA's) are areas that are not essential for meeting biodiversity representation targets/thresholds but which nevertheless play an important role in supporting the ecological functioning of critical biodiversity areas and/or in delivering ecosystem services that support socio-economic development, such as water provision, flood mitigation or carbon sequestration. The degree of restriction on land use and resource use in these areas may be lower than that recommended for critical biodiversity areas. For ESA's a change from the desired ecological state is most significant elsewhere in the landscape through the indirect loss of biodiversity due to a breakdown, interruption or loss of an ecological process pathway (e.g. removing a corridor results in a population going extinct elsewhere or a new plantation locally results in a reduction in stream flow at the exit to the catchment which affects downstream biodiversity). All natural non-FEPA wetlands and larger rivers have a minimum category of ESA.

According to the CBA Map, the study area is mainly located in the category "Other Natural Areas". CBA1 is located on Red Sands Southwest WEF (Figure 4-11), while ESAs are located on Red Sands Northwest (Figure 4-8), Northeast (Figure 4-9) and Southeast (Figure 4-10). The CBA1 is listed due to recorded presence of a listed unknown threatened species, but this was not picked up in the screening report. Accordingly, it is assumed that the threatened species is avifauna, as no plant or animal species was flagged by the screening report or recorded during the site surveys. Fourteen turbines are located within the CBA1, and only small areas within this will be transformed for development. The ESA are due to the large rivers running through the site and other natural non-FEPA Wetlands. It must be noted that for the purpose of this report, avifauna and aquatic biodiversity is excluded. Where relevant, ecosystem services related to aquatic systems, or avifauna habitats may be included in the discussion, but the relevant assessments must be referred to for more details on impacts and mitigation measures.

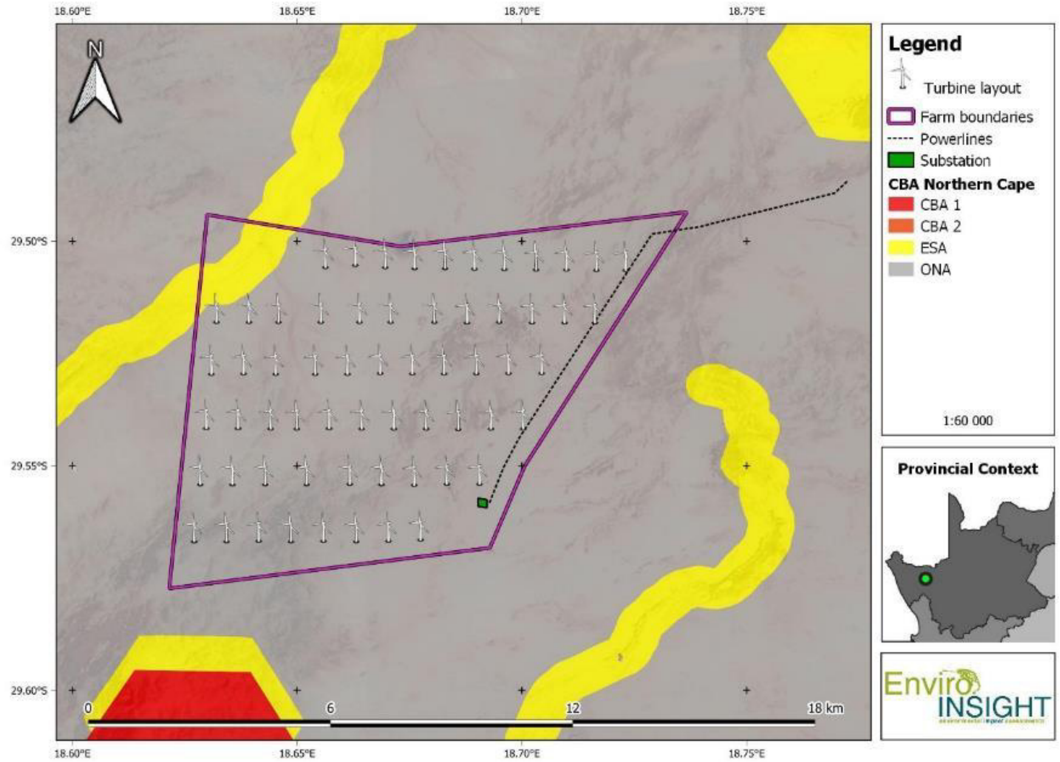

Figure 4-8: Red Sands Northwest WEF in relation to the Northern Cape Critical Biodiversity Areas (2016).

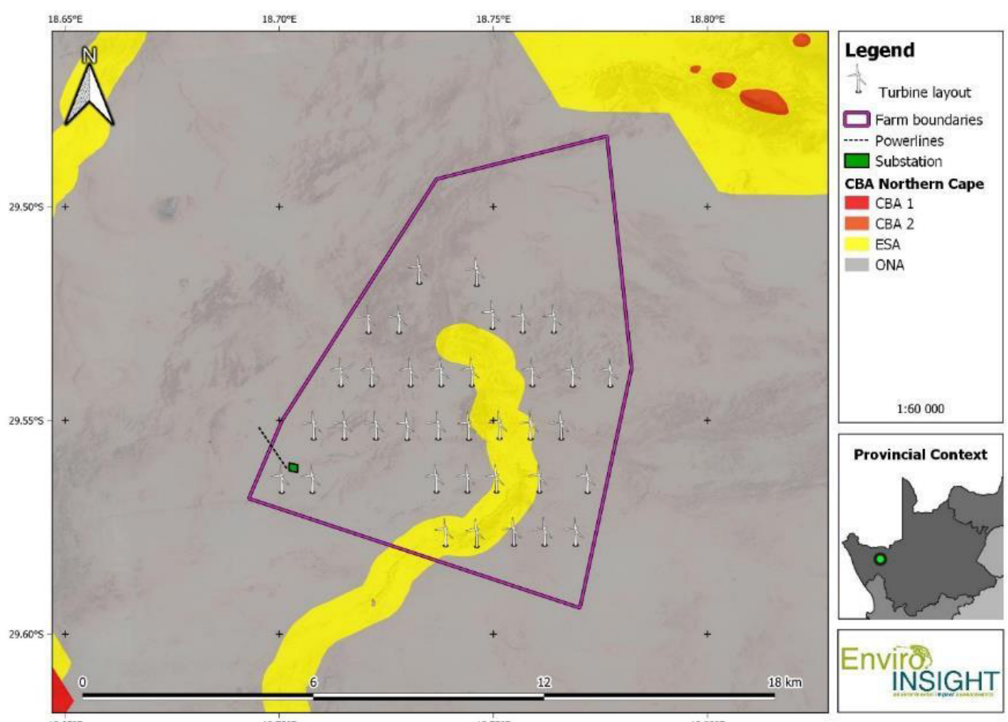

Figure 4-9: Red Sands Northeast WEF in relation to the Northern Cape Critical Biodiversity Areas (2016).

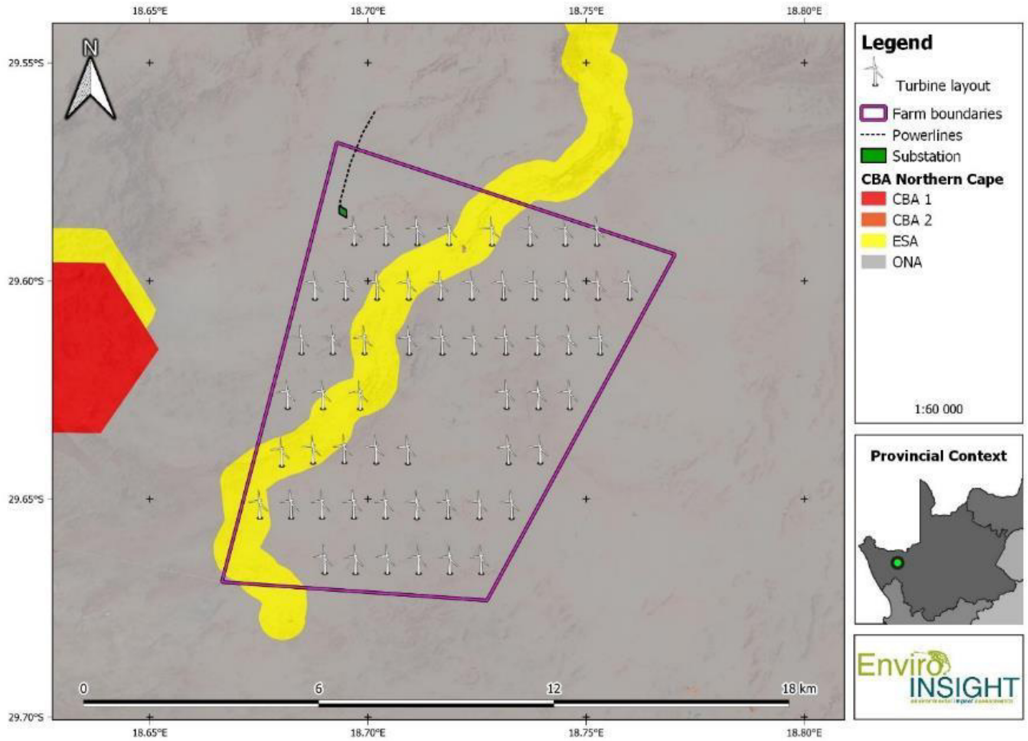

Figure 4-10: Red Sands Southeast WEF in relation to the Northern Cape Critical Biodiversity Areas (2016).

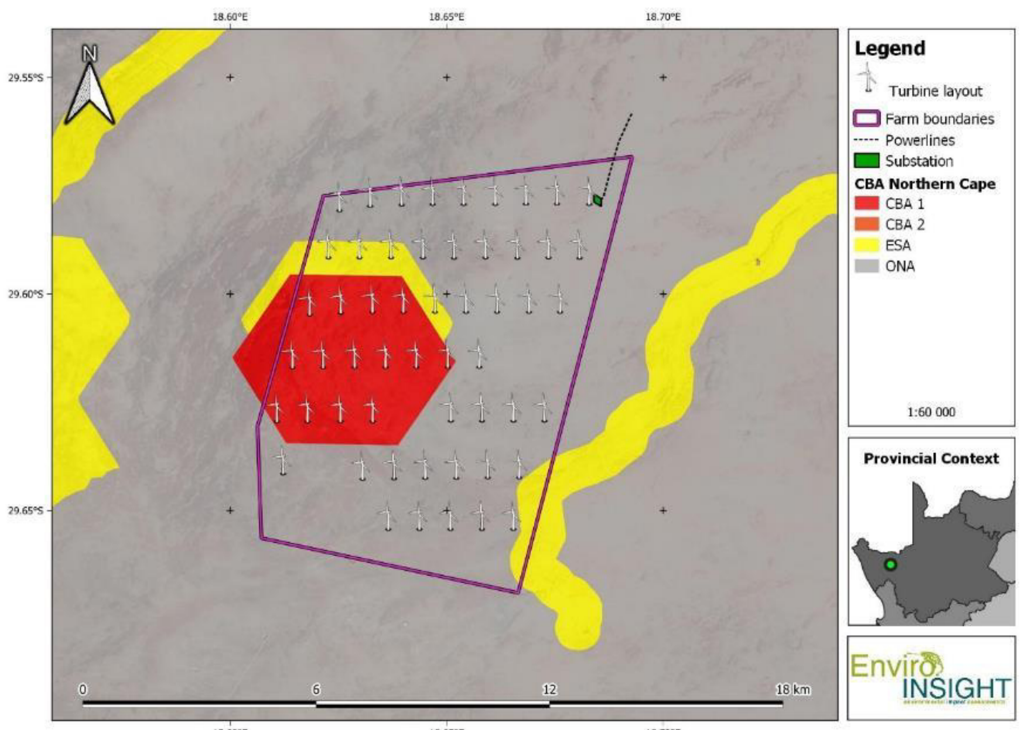

Figure 4-11: Red Sands Southwest WEF in relation to the Northern Cape Critical Biodiversity Areas (2016).

4.4 FLAGSHIP SPECIES FOR THE REGION

Flagship species are defined as species that may be highly conspicuous, readily identifiable, of high conservation value (SCC), of high tourism value or are endemic to the region. The Northern Cape is home to the South African (and Northern Cape Province) endemic Red Lark. It is a highly range restricted species that occurs on red dune (Nama Grassland as defined by the habitat delineation) habitat that provides a variety of sandy substrate and vegetation requirements, including annual grasses, perennial grasses and sparse woody vegetation. This species is currently poorly represented within existing protected areas across its range and is threatened by habitat loss and fragmentation primarily through intensive stock farming activities and most recently, renewable energy developments.

This province hosts significant populations of arid-adapted large terrestrial birds which have been recorded (and are expected) within the PAOI such as Kori Bustard, Ludwig's Bustard and Karoo Korhaan. Additional "flagship" bird species include Martial Eagle, Verreaux's Eagle, Secretary Bird, with occasional incursions within the PAOI such as Lappet-faced Vulture (incidental sightings) and indeed, other vulture species.

4.5 DESCRIPTION OF MAJOR BIRD HABITATS

A delineation to avifaunal habitats was coupled with the Terrestrial Ecology Report submitted by Enviro-Insight as part of the BA application and will be addressed in the sensitivity section below. The primary avifaunal habitats are described in tabular formats below with accompanying representative photographs. Sensitivity will largely be based upon "Avifaunal value" which relates to species diversity, endemism and the presence of topographical features or primary habitat units with the intrinsic ability to sustain certain avifaunal assemblages (with specific reference to SCC), their food supply and breeding habits. It is apparent throughout the study area that most of the habitats are generic in their ability to support general avifaunal species and Red-Listed / SCC with little differentiation. However, unique geological (such as red dunes) geographical or topographical features exist which may cause the areas these areas to be buffered from proposed development. Due to the high diversity and density of the above mentioned Red-Listed species recorded during the survey, (including regionally and globally listed Endangered and Vulnerable birds), the PAOI as a whole is considered to be an area of avifaunal importance and the BA will be strongly associated with Guidelines at a policy level, prioritising avoidance mitigation and the monitoring of avifaunal SCC.

4.5.1 Pans and Drainage Lines

<table>
<tr><th>Photographs</th><th>Watercourses and Drainage Lines</th></tr>
<tr><td>
</td><td>Classification: Ephemeral and endorheic drainage lines
Hydrology: With avoidance, limited major hydrological impacts are expected from the development.
Geomorphology: Channels varying in width and depth from large multi-channeled sandy gullies to shallow narrow channels with seasonally inundated pans with large surface areas.
Vegetation: Vegetation varies depending on current levels of disturbance (especially biosphere effects around pans), channel width and depth, where larger deep-rooted trees line larger channels with lower shrub layers characterising smaller drainage line systems.

Avifaunal Characteristics:
Avifaunal assemblages differed depending on the classification of the pan and drainage line systems as well as the season. Most of the drainage line systems are seasonally ephemeral or dry while the pans inundate seasonally. Thus, most of the bird associations are linked to the prevailing vegetation and soil types within the delineated drainage line habitats or standing water. In summary, drainage lines with taller shrub and tree layers showed a much higher diversity of passerine species as well as sand-associates and ground-dwelling birds. Species of conservation concern such as Red Lark and Sclater’s lark were observed in varying densities.

The seasonal drainage lines and accompanying riparian trees are linear dispersal corridors for terrestrial bird species. Much higher species diversity (as well as a unique composition) was observed in this habitat and therefore, these systems are classified to be of high avifaunal importance. The drainage lines act as important flight corridors for passerines and raptors between foraging and roosting sites.</td></tr>
</table>

4.5.2 Sandy Grassland

Photographs	Nama Grassland
 	**Classification:** Sandy Grassland **Hydrology:** No major hydrological impacts are expected from the development. **Geomorphology:** Undulating sandy grassy habitat with fewer flat areas and variable basal layer. **Vegetation:** Vegetation varies depending on slope and depth of topsoil and is characterized by grassland dominated and interspersed by negligible succulent/ Nama/ scrub (in varying ratios) karroid vegetation **Avifaunal Characteristics:** The sandy grassland habitats show a reduced structural complexity and vegetation which provides for a more generic species diversity albeit often higher densities of avifauna. The habitat contains features that provide suitable foraging habitat for Ludwig's Bustard (*Neotis ludwigii*), Kori Bustard (*Ardeotis kori*) and Secretary bird (*Sagittarius serpentarius*). However, the habitat is characterised by a much-reduced rocky substrate and a higher prevalence of grassed red sand infusions which provides infused and highly localized portions of optimal habitat for Red Larks. .

4.5.3 Shrubland

Photographs	Shrubland
 	**Classification:** Shrubland **Hydrology:** No major hydrological impacts are expected from the development **Geomorphology:** Undulating semi-succulent karroid habitat with large extents of flat terrain. **Vegetation:** Vegetation varies depending on soil quality but is mostly comprised of karroid shrub interspersed with grassy patches **Avifaunal Characteristics:** The localised high population densities of small mammals such as rodents, springhares and hares within the PAOI as well as the regional linkage to the drainage line habitats, elevates the importance of this habitat for avifauna. The rocky habitats do not provide structural complexity which provides for an increase in species diversity and often showed lower densities of avifauna due to the lack of prey species that are found in this habitat. However, the habitat vegetation provides suitable foraging habitat for the Ludwig's Bustard (*Neotis ludwigii*), Kori Bustard (*Ardeotis kori*) and Secretary bird (*Sagittarius serpentarius*).

4.6 OBSERVED AND EXPECTED AVIFAUNA

4.6.1 Total species composition and abundance

The study area supports a relatively low diversity and abundance of avifauna, which is to be expected in an arid area like the Aggeneys region. A total of 62 species have been observed to date, as shown in Appendix 1. This low diversity is predominantly due to a number of factors including:

- High regional aridity which reduces the overall species diversity;
- Somewhat generic habitat types (albeit with some highly sensitive habitat such as red sands and temporary pans within the PAOI).
- Climate change which is characterised by lower rainfall and increased temperatures.
- A lack of standing water.

It must be noted that stochastic high rainfall events (especially after the prolonged drought periods) and other atypical prevailing influences (persistent cold) may have influenced the local avifaunal assemblage densities which were often recorded as being very high.

4.6.2 Priority species list

A list of expected and observed priority species (Retief *et al.* 2012) in the project area is provided in Table 4-3. A total of 23 priority species are expected to occur on and surrounding the study area, of which 14 have been recorded.

It is clear from Table 4-3 that numerous priority avifauna species occur within the PAOI and can be expected to interact with the proposed development. The recorded mortality incidence due to priority species colliding with turbines from regional developments such as the Khobab WEF (which is located just over 100 km away) over 2 years is considered to be of low concern due to a very small number (four) of threatened and identified priority species being killed (Chris van Rooyen Consulting, 2020). The four priority species mortalities were one incidence each of the Near Threatened Karoo Korhaan and priority species Spotted Eagle Owl with two Greater Kestrel mortalities. This was deemed not to be ecologically significant. However, and as with all proposed Solar and WEF developments, it is vital to consider the context within which these species are observed in the current study, as congregatory behaviour, nesting behaviour and foraging behaviour may differ from that at the adjacent existing WEF facility. Indeed, Van Rooyen (2020) suggests that displacement effects of the WEF are more significant than direct mortality which can greatly affect habitat specific species such as Red Lark and Ludwig's Bustard. Consequently, all applicable data of priority species observed within the monitoring seasons of field surveys allowed for careful evaluation of potential impacts and application of suitable mitigation measures to reduce these impacts where possible.

Table 4-3: Priority avifauna species list (both expected and recorded as defined by Ralston-Paton et al 2017) for the study area.

Common name	Taxonomic name	Priority species rank	Global Status	Regional Status	Observed
Snake Eagle, Black-chested	*Circaetus pectoralis*	60	LC	LC	YES
Buzzard, Jackal	*Buteo rufofuscus*	43	LC	LC	NO
Courser, Burchell's	*Cursorius rufus*	69	LC	VU	YES
Courser, Double-banded	*Rhinoptilus africanus*	72	LC	LC	YES
Eagle, Booted	*Aquila pennatus*	59	LC	LC	NO
Eagle, Martial	*Polemaetus bellicosus*	4	EN	EN	YES
Eagle-Owl, Spotted	*Bubo africanus*	98	LC	LC	NO
Falcon, Lanner	*Falco biarmicus*	24	LC	VU	YES
Kestrel, Greater	*Falco rupicoloides*	95	LC	LC	YES
Kestrel, Lesser	*Falco naumanni*	64	LC	LC	YES
Korhaan, Karoo	*Eupodotis vigorsii*	51	LC	NT	YES
Korhaan, Northern Black	*Afrotis afraoides*	90	LC	LC	YES
Vulture, Lappet-faced	*Torgoa tracheliotos*	19	EN	EN	YES
Lark, Red	*Calendulauda burra*	40	VU	VU	NO
Lark, Sclater's	*Spizocorys sclateri*	50	NT	NT	NO
Ludwig's Bustard	*Neotis ludwigii*	14	EN	EN	YES

According to the literature, 14 Red-Listed species are known to occur in the region with nine species confirmed during the completed surveys, representing a very high success rate given a single year study period. Of the expected species and according to Taylor *et al.* (2015), two of the species are Endangered, seven of the species are Vulnerable and four are Near-Threatened. For the current study, it was deemed unnecessary that all SCC should be discussed in intensive detail unless deemed highly relevant to the proposed development. However, all relevant SCC are described in brief (Table 4-4). Three selected relevant species that are possibly susceptible to the proposed development were discussed below in greater detail, which include specific (Guideline-based) recommendations for monitoring and mitigation. Photographic evidence of SCC observed during the current study is provided in Figure 4-12.

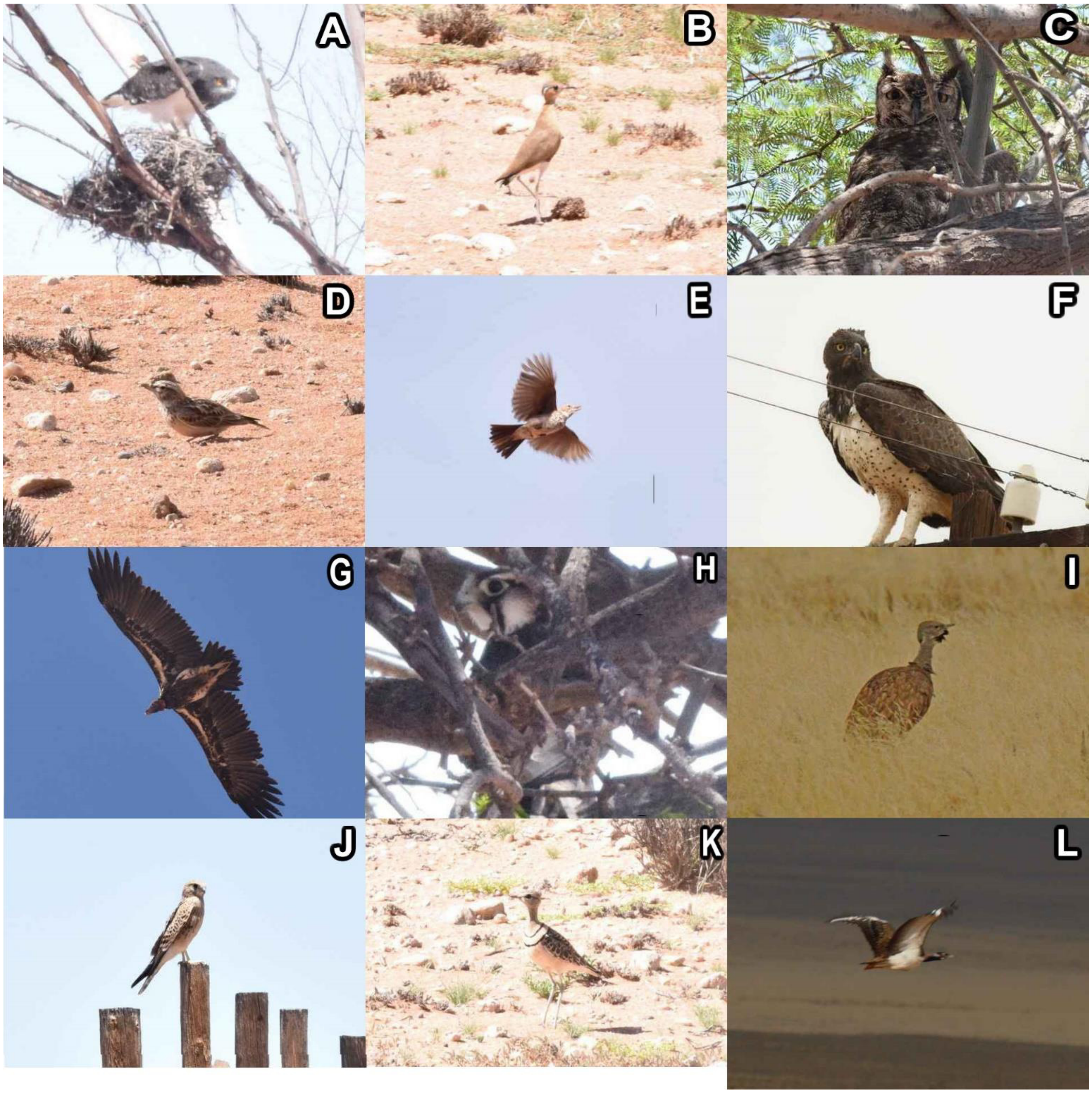

Figure 4-12: Avifauna Priority and SCC observed within the proposed Red Sands Solar and WEF PAOI[4].

[4] A = Black-chested Snake Eagle; B = Burchell's Courser; C = Spotted Eagle Owl, D = Sclater's Lark; E = Red Lark; F = Martial Eagle; G= Lappet-faced Vulture, H = Lanner Falcon; I = Karoo Korhaan; J= Greater Kestrel; K- Double-banded Courser; L= Ludwig's Bustard.

Table 4-4: Summary of avifauna species of conservation concern of known distribution, previously recorded in or adjacent to the study area pentads.

Species	Global Conservation Status[5]	National Conservation Status[6]	Preferred Habitat	Potential likelihood of occurrence on study area and potential risk posed from the WEF
Ardeotis kori (Kori Bustard)	Near Threatened	Near Threatened	Primary upland grassland, desert savanna and karoo with foraging and roosting particularly on rocky/ hilly terrain.	**Moderate**: Moderate densities throughout the region and PAOI but surprisingly low densities within the study area. The species is likely to be a breeding resident within or adjacent to the study area. A large bodied species, it is highly susceptible to WEF development activities.
Spizocorys sclateri (Sclater's lark)	Near Threatened	Near Threatened	Dry shrubland, karroid drainage lines and karoo shrubveld	**Confirmed**: High densities throughout the region but uncommon in the study area The species is likely to be a breeding resident within or adjacent to the study area. A localised low flying passerine, it is not highly susceptible to WEF development activities but is threatened by habitat loss
Calendulauda burra (Red lark)	Vulnerable	Vulnerable	Red dune open shrubland/ grassy duneveld	**Confirmed**: Low densities throughout the region but locally common in the study area The species is likely to be a breeding resident within or adjacent to the study area. A localised low flying passerine, it is susceptible to WEF development activities (high display flights) but is more threatened by habitat loss.
Aquila verreauxii (Verreaux's' Eagle)	-	Vulnerable	Mountainous areas or areas with prominent outcrops with a high prey base (e.g. hyrax)	**Regionally confirmed, absent from study area**: Frequent foraging resident throughout the PAOI but far less frequent within the study areas due to the large distances to the mountainous preferred habitats and a general lack of localised abundant prey. Localised areas exhibiting high abundance of hyraxes and rock rabbits should be considered highly sensitive to the species. The species is susceptible to poisoning events and WEF facilities with a low risk from proposed activities.
Polemaetus bellicosus (Martial Eagle)	Endangered	Endangered	Open bushveld, desert savanna and karoo with adequate roosting and foraging potential.	**Confirmed:** A rare breeding resident and foraging visitor dependent on adequate food supply and roosts. No breeding pair nesting within the proposed Solar and WEF boundary were recorded but limited sightings in terms of foraging activity

[5] IUCN 2021
[6] Taylor et al. 2015

Species	Global Conservation Status[5]	National Conservation Status[6]	Preferred Habitat	Potential likelihood of occurrence on study area and potential risk posed from the WEF
				on the development footprint area. Typically, the species would exhibit a Low to Moderate risk.
Torgos tracheliotos (Lappet-faced Vulture)	Endangered	Endangered	Open bushveld, desert savanna and karoo with adequate roosting and foraging potential.	**Confirmed:** A rare foraging visitor dependent on adequate food supply and roosts. Stochastic records and well out of home range.
Ciconia nigra (Black Stork)	-	Vulnerable	Breeds on steep cliffs within mountain ranges; forages on ephemeral wetlands, pastures and agricultural fields. .	**Unlikely**: A highly irregular to rare foraging visitor dependent on the wetland systems located throughout the study area and potentially vulnerable to the proposed development activities. The proposed Solar and WEF is not situated adjacent to large tracts of the preferred habitat of the species.
Falco biarmicus (Lanner Falcon)	-	Vulnerable	Varied, but prefers to breed in mountainous areas.	**Confirmed:** A fairly common foraging migrant recorded in the current study and expected periodically to occur. Not highly vulnerable to the proposed activities.
Neotis ludwigii (Ludwig's Bustard)	Endangered	Endangered	Primary upland grassland, desert savanna and karoo with foraging and roosting particularly on rocky/ hilly terrain.	**Confirmed:** High densities throughout the study areas. The species is likely to be a breeding resident within or adjacent to the study area. A large bodied species, it is highly susceptible to Solar and WEF development activities as shown by direct interactions with the existing powerlines in the region.
Sagittarius serpentarius (Secretarybird)	Endangered	Vulnerable	Prefers open grassland or lightly wooded habitat although forages extensively in open karroid savannah.	**Moderate to Highly Likely:** Irregular low-density resident which is most likely of lower risk to the proposed development activities given ground foraging habitats. In addition, persistent long term regional drought may have significantly decimated local prey sources (especially snakes) thus further reducing the likelihood of persisting local populations of significant densities.
Eupodotis vigorsii (Karoo Korhaan)	Near threatened	Near threatened	Karroid habitats, large saline pans and shallow impoundments.	**Confirmed:** Common resident occurring near areas with drainage lines (including ephemeral) and open areas. Individually susceptible to Solar and WEF development activities but as a species is considered low risk.

Species	Global Conservation Status[5]	National Conservation Status[6]	Preferred Habitat	Potential likelihood of occurrence on study area and potential risk posed from the WEF
Falco naumanni (Lesser Kestrel)	Near Threatened	Least Concern	Widespread species prefers open grassland or lightly wooded habitat although forages extensively in open karroid savannah. Roosts collectively in locations with tall trees.	**Confirmed:** Regular migrant of fluctuating seasonal density which is most likely of lower risk to the proposed development activities due to most pressures occurring with breeding grounds and migration routes.

4.7 PRECONSTRUCTION MONITORING MAIN RESULTS

4.7.1 Walked and Driven Transects counts

During the walked transects, the total number of individual birds (per species) were recorded regardless of if they are listed as priority or not. Notable Priority Species recorded during walked transects included Ludwig's Bustards that were often flushed from foraging positions as well as Double-banded Coursers, Lesser Kestrel, Northern Black Korhaans and Karoo Korhaans. The main focus of drive transects were the recording of large birds and raptors. Ludwig's Bustards, raptors and korhaans and Red Lark were the most frequently recorded priority species. On some sample days, the observers returned at night and priority species were recorded (such as owls, coursers and thick knees). For walked transects, a total of 926 individual bird contacts were recorded (Appendix 3) of which 31 contacts and eight species are priority (Table 4-5). For driven transects, a total of 625 individual bird contacts were recorded (Appendix 3) of which 90 contacts and 11 species are priority (Table 4-6). The combined Index of Kilometric Abundance for walked and driven transects (IKA = birds/km) was calculated for each priority species as an average of 0,11 with individual sampling results shown below. This is considered to be a very low-risk numeric value and represents tha sparse, ecologically sub optimal habitat of the PAOI. The overall (priority and non-priority) IKA is 1,46 which is a significantly higher risk value. However, a wholly insignificant fraction of all observations occurred at rotor sweep height which thus shows a strong data set (based on density of observations) interpreted as a low risk of significant collision mortality.

4.7.2 Vantage Points

The Vantage Point data collection appeared to provide the richest avifaunal observations with 2636 total contacts of which 129 were priority species. Priority species recorded during VP surveys were divided into three flight height categories (Low 0 to 50 m, Medium 50 to 150 m and High with all observations of birds flying more than 150 m). The collated data capture is indicated in Appendix 2.

A total of 324 hours of bird flight observation were completed at the 9 Vantage Points on site during the year. Nine (9) priority species were recorded during VP watches in the WEF (Table 4-5 and Table 4-6). The list of non-priority species observed is shown as Appendix 2.). In order to gain some understandings of which species are likely to be most at risk of collision, the collisions risk ratings are discussed below.

Table 4-5: Per season priority species recorded during Walked Transects and Drive Transects.

	Drive Transects										Walk Transects												
Priority Species	**CDT**	**DT1**	**DT2**	**DT3**	**DT4**	**DT5**	**DT6**	**DT7**	**DT8**	**DT9**	**CWT**	**WT1**	**WT2**	**WT3**	**WT4**	**WT5**	**WT6**	**WT7**	**WT8**	**WTC**	**WTL1**	**Random**	**Total**
Winter '21				1	3		5	3				2					1					55	70
Double-banded Courser												2										7	9
Greater Kestrel							4															3	7
Karoo Korhaan				1	3		1	2									1					19	27
Lanner Falcon																						2	2
Ludwig's Bustard								1														17	18
Martial Eagle																						2	2
Northern Black Korhaan																						3	3
Spotted Eagle-Owl																						2	2
Spring '21	3	3			2					3		1					3					10	25
Greater Kestrel	3																					4	7
Karoo Korhaan		3			1												2					4	10
Lesser Kestrel												1											1
Ludwig's Bustard										2												1	3
Northern Black Korhaan					1					1							1					1	4
Summer '22	8	1	1	5	1	1	1		1	1	2							3				36	61
Black-chested Snake Eagle	1																					4	5
Burchell's Courser																						2	2
Double-banded Courser				1					1		1												3
Greater Kestrel	4	1	1	1	1		1															3	12
Karoo Korhaan				2		1												2				17	22
Lanner Falcon										1												3	4
Ludwig's Bustard																		1				2	3
Martial Eagle	1																					3	4
Northern Black Korhaan	2			1							1											2	6
Autumn '22	11	1		10	5	1	8	4	2	5	1	2		2	1		8	4			1	94	160
Burchell's Courser		1															6					22	29
Double-banded Courser																						1	1

Greater Kestrel	8			5	3	1		2	2	2							1	2	26
Karoo Korhaan	2			2	2		4	2		1			2		2			31	48
Lanner Falcon																		2	2
Ludwig's Bustard	1			3			4					2				4		32	46
Martial Eagle																		2	2
Northern Black Korhaan										2	1			1				2	6
Total	**22**	**5**	**1**	**16**	**11**	**2**	**14**	**7**	**3**	**9**	**3**	**5**	**2**	**1**	**12**	**7**	**1**	**195**	**316**

Table 4-6: Per season priority species recorded at vantage points during the surveys.

Priority Species	Vantage Points									Total
	CVP	VP1	VP2	VP3	VP4	VP5	VP6	VP7	VP8	
Winter '21	3		2	5	3	1	6	11	3	34
Double-banded Courser						1				1
Greater Kestrel	1			1	2					4
Karoo Korhaan	2		2	4	1		5	8	2	24
Ludwig's Bustard								3	1	4
Northern Black Korhaan							1			1
Spring '21			3		1	3	2	1	3	13
Double-banded Courser					1	2	1			4
Greater Kestrel						1				1
Karoo Korhaan			2						3	5
Lesser Kestrel								1		1
Northern Black Korhaan			1				1			2
Summer '22	4	1	3	4	2	1	8	2	3	28
Burchell's Courser						1				1
Double-banded Courser									1	1
Greater Kestrel	2				2					4
Karoo Korhaan	2	1	1	4			4	1	2	15
Northern Black Korhaan			2				4	1		7
Autumn '22	10	9	2	13	5	7	3	1	4	54
Burchell's Courser	7			11						18
Greater Kestrel		7			3	2	2	1		15
Karoo Korhaan	2	1	2	2	2				4	13
Martial Eagle		1								1
Northern Black Korhaan	1					5	1			7
Total	**17**	**10**	**10**	**22**	**11**	**12**	**19**	**15**	**13**	**129**

Ludwig's Bustards were recorded 37 times (74 individuals although this is not an absolute count) of which zero sightings were above 80 metres (rotor height). Due to its abundance and conservation status, the Ludwig's Bustard is a priority species of concern since it may be prone to collision at certain times (e.g., when commuting between roosting and feeding sites, following rainfall events, invertebrate outbreaks (locusts) or commuting after farming activities which increase food availability). Surprisingly and as mentioned, the species has not been observed flying at rotor height during the survey period. In the majority of observations, Ludwig's Bustards were mostly observed close to drainage lines, adjacent to roadsides, and in adjacent livestock. On multiple occasions, the observers' presence flushed some birds (presumably breeding pairs and/ or breeding pairs with a juvenile). Flights were most often generally very low (less than 50 m height) and short distanced although on numerous occasions, individuals would take flight and leave the vicinity (+/- 2 km). Red Larks were recorded 57 times (63 specimens although this is not an absolute count) of which five sightings were above 80 metres. The species is discussed in further detail below but the presence of this species is of significant concern with the implications to be discussed within the Impact Analysis below. Martial Eagles were recorded on 9 occasions of which three sightings were over 80 metres. Given the lack of the nest within the PAOI, this is deemed to be a low density (foraging flights only) and the species is of lesser concern than other developments in close proximity to an active nest in order to gain some understanding of which species are likely to be most at risk of collision, the collisions risk rating for each priority species recorded during VP watches are discussed below.

4.7.3 Focal Sites

The pan, drainage line and dune systems scattered throughout much of the project study area contained a relatively high density (and higher diversity) of passerines, Ludwig's Bustards and Red Larks.

4.7.4 Nest Survey

Nest sites were searched for during the surveys which included windmills, trees, pylons, bridges and masts, representing most potential roost and nesting sites for raptors. Water bodies were potential roost and nesting sites for multiple species, but the high degree of seasonality and above average rainfall conditions was optimal to being representative of optimal breeding habitat for water associates. No significant breeding habitat was recorded during the survey although Ludwig's Bustard is considered a resident and to be breeding on site although no nests have been located.

4.8 COLLISION RISK SUMMARY

1. All heights above ground for contacts were recorded for this analysis. For the pre-construction monitoring, three risk levels were defined considering the species characteristics and the risk behaviours, based upon Retief et al. (2012):
   - **High probability** movements of priority species at rotor swept height and presenting behaviours with potential to increase collision risk with rotating blades.
   - **Medium probability-** movements of priority species at rotor swept height or presenting collision risk behaviours;
   - **Low probability-** movements of sensitive species (regardless of the height or type of flight) and movements of non-priority species at rotor swept height or presenting collision risk behaviours.
2. Although the actual recorded numbers through rotor zones was much lower, in order to obtain the fatality rate, a precautionary number of 20% (of flights through the rotor zones) was applied for all flights for all priority species. The actual annual rotor zones passages based on observations are also expressed. As stated, the vast majority of all observations were recorded well below the anticipated rotor sweep height of 62.5 metres. However, the species observed at moderate to high-risk altitudes (50 to 150 metres) included:

   - Pied Crow (most frequent)
   - Martial Eagle
   - Karoo Korhaan (infrequent)
   - Northern Black Korhaan
   - Namaqua Sandgrouse
   - Greater Kestrel

- Eastern Clapper Lark
- Black-chested Snake Eagle
- Rock Kestrel
- Ludwig's Bustard

Of these observations, most observations were recorded below rotor sweep height with the following species sighted over 62.5 metres:

- Ludwig's Bustard
- Lappet-faced Vulture
- Martial Eagle
- Martial Eagle
- Pied Crow
- Greater Kestrel
- Red Lark
- Northern Black Korhaan

Overall, the vast majority of species observed above turbine sweep height was considered to be of very low significance. It was possible that most of the species are temporary foraging visitors (hence the frequent observations at lower heights) due to the highly unusual amount of rainfall that fell in 2022. However, the precautionary principle would suggest that all priority species be allocated a higher significance in regards to mitigation measures for the Solar and WEF.

3. It was assumed that the 2km radius around vantage points was approximately equal to the maximum distance over which sightings were made, and that the coverage was approximately circular. This meant that at each vantage point an area of 12.57 km² was sampled ($A = \pi r2$).
4. It was assumed that the collision risk area is described by the area of each turbines rotor zone x # turbines. Using the measurement of a 175 m rotor diameter, and the current proposed layout of 207 turbines, this equals a wind farm collision risk area of 4 978 933.482 m² or 4978.933 km² (207 x turbine area m²).
5. Passage rates calculated from four seasons of sampling can be extrapolated to annual passage rates (by multiplying hourly passage rates by 12 x 365 in the case of resident species).
6. A 98% avoidance rate was assumed for passing birds as recommended by Scottish Natural Heritage guidance for species for which no established specific avoidance rate is available, www.project-gpwind.eu.

The individual risk ratings for the priority species are considered low, as very few high-altitude flights were recorded for the Priority Species and or Species of Conservation Concern. While this assumption is correct in theory, it should be noted that multiple published scientific studies indicate that a rotor sweep area do not automatically translate into an increased or decreased collision risk. Therefore, it can be surmised that turbine dimensions play an insignificant role in the magnitude of the collision risk in general, relative to other factors such as prevailing wind speed, topography, turbine location, bird species morphology and a species' inherent ability to avoid the turbines and may only be relevant in combination with other factors, specifically prevailing wind speed and direction.

The below calculations yielded an overall predicted facility collision fatality of 2,54 birds based on the actual observational data and 16.49 birds based on a 10% rotor flight assumption. It is important to repeat that this is a collision risk model replicated in other surveys, and its value is mostly in comparison with other sites and projects. The absolute numbers of predicted fatalities should be used in context. Despite some species such as Ludwig's Bustard being highly susceptible to powerline collisions, caution must be exercised when comparing the relative risks related to solar and/or wind farms with risks associated with power lines. Indications are that Ludwig's Bustards are not prone to wind turbine collisions and overall, given the very large size of the WEF and large numbers of turbines, these mortality numbers are within acceptable limits.

Table 4-7: Selected bird species crude passage rates and crude predicted fatality at the Red Sands Solar and WEF.

Priority Species	Number of birds	Hourly passage rate at VP	Annual passage rate at VP	Actual passage rate through rotor zone	Annual passage rate through rotor zone (10% assumption)	Actual annual fatality rate (98% avoidance)	Predicted (20% assumption) annual fatality rate (98% avoidance)
Ludwig's Bustard	74	0,22839	1000,37037	2,25	100,037	0,04	2,0007
Lappet-faced Vulture	38	0,117283	513,70370	42.705	51,3703	0,85	1,02740
Jackal Buzzard	3	0,009259	40,555555	Negligible	4,05555	Negligible	0,08111
Martial Eagle	9	0,027777	121,66666	Negligible	12,16666	Negligible	0,24333
Greater Kestrel	79	0,243827	1067,9629	15.77	106,7962	0,355	2,13592
Lanner Falcon	8	0,024691	108,14814	Negligible	10,81481	Negligible	0,21629
Lesser Kestrel	2	0,006172	27,037037	Negligible	2,7037	Negligible	0,05407
Karoo Korhaan	164	0,506172	2217,0370	Negligible	221,7037	Negligible	4,43407
Black-chested Snake Eagle	5	0,0154320	67,592592	54,074	6,75925	1,0814	0,13518
Courser, Burchell's	50	0,1543209	675,92592	Negligible	67,5925	Negligible	1,35185
Courser, Double-banded	19	0,0586419	256,85185	Negligible	25,6851	Negligible	0,51370
Sclater's Lark	60	0,1851851	811,11111	Negligible	81,1111	Negligible	1,62222
Red Lark	63	0,1944444	851,66666	6,75	85,16666	0,13	1,70333
Northern Black Korhaan	36	0,1111111	486,66666	4,51	48,66666	0,09	0,97333
Totals						2,54	16,49

4.9 WEF AND SOLAR SITE SENSITIVITY

Each demarcated sensitive feature was evaluated for the degree of sensitivity based on the complete 12-month data set and presented as Figure 4-13. There is an important presence of a number (mainly two) SCC in the study area, recorded regularly and widespread through the proposed WEF area. In addition, there are several raptors utilising the PAOI, some of them priority species and/or of conservation concern, such as the Martial Eagle, Lanner Falcon, Pale-chanting Goshawk and Black-winged Kite. Areas of drainage lines and natural vegetation which are vital to maintaining populations of habitat obligate sensitive species (such as Red Lark) are deemed to have some probability of collision consistently throughout the year. Furthermore, natural drainage line vegetation represents an important habitat to maintain natural geohydrological processes of the PAOI. A 50 m buffer around these areas must be considered NO-GO where no turbines and associated infrastructure may be located.

A 200 m buffer is also applied around seasonally inundated watercourses in the PAOI, as these features attract birds under certain conditions and could be the only locations were certain sensitive species such as the ducks, herons, storks and water birds (and flamingos under rare circumstances) are likely to occur. These areas must be avoided by the developer where no solar panels, turbines and associated infrastructure may be located. A single pan system is indicated which is prone to stochastic use by Lappet-faced vultures which requires a 500-metre buffer. Several of the proposed turbine positions and associated infrastructure (including solar) coincide with areas currently demarcated as Medium sensitive features within the prescribed buffers and consequently were subjected to the mitigation hierarchy, including mitigation measures and avoidance. The layout was carefully re-evaluated in order to mitigate against negative interaction with priority species such as Red Lark and Ludwig's Bustard.

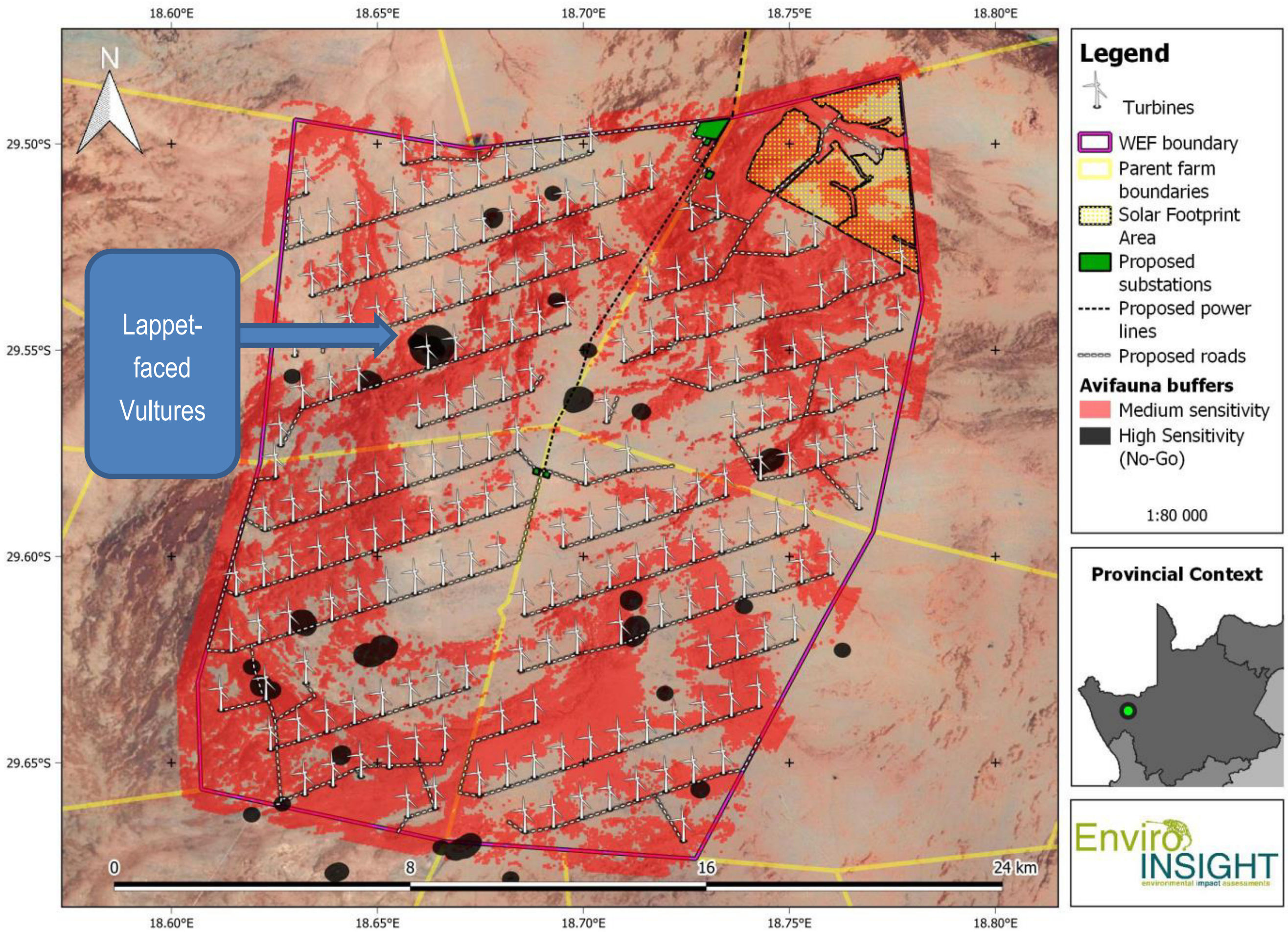

Figure 4-13: Overall Avifauna Sensitivity Buffers with preferred turbine and solar panel placements overlaid with 500 metre buffered pan indicated (due to stochastic presence of vultures).

Figure 4-14: Lappet-faced vultures drinking from the large north-western impoundment within the PAOI.

5 POTENTIAL IMPACTS

5.1 BACKGROUND TO INTERACTIONS BETWEEN WIND ENERGY FACILITIES, POWER LINES AND BIRDS

The effects of a wind farm on birds are highly variable and depend on a wide range of factors including the design and specification of the development, the topography of the surrounding land, the habitats affected and the number and species of birds present.

Typical potential impacts include (but are not necessarily limited to):

- Habitat loss (including foraging and breeding) and fragmentation due to displacement (avoidance of disturbance);
- Collision mortality with turbines;
- Collision and electrocution with above-ground power transmission lines. In some cases, collision can be associated with polarised light pollution and waterbird species mistaking large PV panels areas as wetlands or other waterbodies, a case known as the “lake effect” (as per Jenkins *et al*. 2017).
- Disturbance of flight/migratory pathways; and
- Disturbance due to lights, noise, machinery movements and maintenance operations.

These potential impacts are assessed in the BA phase of the project with specific reference to priority species and other non-priority species at high risk of negative impact from the proposed facility.

Table 5-1: Habitat loss and fragmentation impacts during the construction phase.

Impact: Habitat loss and fragmentation Access roads and turbine or infrastructure construction may necessitate the removal of foraging and roosting habitat, destruction or disturbance of bird breeding habitats, bird roosts and sensitive avifaunal habitats such as migratory routes. This will occur during the construction phase and sensitive areas include tall emergent trees, flight paths to the mountain ranges, the river and associated riparian vegetation, free standing water (impoundments) and drainage lines across the PAOI.			
Issue	Nature of impact	Extent	No-Go Areas
Habitat destruction due to construction of infrastructure.	Negative, especially species utilising watercourses for foraging and breeding, as well as migratory pathways.	Local	Watercourses, including the river, wetlands and all drainage lines.
Description of expected significance of impact: The relatively small operational footprint of the development may reduce the overall expected significance of the impact although the impact can potentially be high and long-lasting. However, if no-go areas are avoided and the necessary buffers against infrastructure applied, the impact should be medium to low. As far as possible all roads must utilise and upgrade existing farm roads to avoid further destruction of habitat.			
Gaps in knowledge and recommendations for further study Areas that might be important for avifaunal activity, especially migratory pathways may change over time in response to infrastructure establishment and subsequent monitoring.			

Table 5-2: Collision mortality with turbines and panels

Impact: Avifauna mortalities due to collision with turbines and panels This impact will occur during the operational phase due to avifauna collision with the blades of the turbines or due to barometric trauma suffered by avifauna caused by difference in air pressure created by the turning of wind turbine blades. This will be especially relevant during times of migration when avifauna move through the area between summer and winter breeding sites and there is a higher abundance of avifauna in the area.			
Issue	Nature of impact	Extent	No-Go Areas
Mortalities suffered due to collision with turbines.	Negative and highly relevant for migratory species that traverse	Local, but can be more extensive for species that migrate through the region.	Large emergent trees, water bodies including large rivers, and all drainage lines and areas with heavily vegetated wetlands. Based on observations, the Drainage lines (leading to

	through the area.		pans) seems to act as migratory pathways and this area must be subject to buffering. Areas shown to have high recorded densities of bird activity.

Description of expected significance of impact:

The impact can potentially be highly significant and will persist during the life of project, but if no-go areas are avoided and the necessary buffers applied the impact may be reduced to medium/ low. This impact can be significantly reduced if mitigation measures are followed, which included no development in Very High and High bird sensitivity areas and implementing appropriate buffers in no-go areas.

Gaps in knowledge and recommendations for further study:

The post construction monitoring form the neighbouring Kangnas have not yet been made available. Future monitoring must be coupled with these data in order to provide a comparative analysis for regional impacts which will assist with the assessment and monitoring of cumulative impacts.

Table 5-3: Disturbance of flight/migratory pathways.

Impact: Disturbance of flight/migratory pathways

Turbines placed along or close to flight pathways used for migration can cause a large number of collision-related mortalities on birds moving through the area during times of small-scale migration and seasonal migration between winter / summer roosts

Issue	Nature of impact	Extent	No-Go Areas
Disturbance of bird migration pathways.	Negative, but should be low if pathways are avoided.	Regional.	The entire river section must have a 100m buffer around and anywhere in this buffer will be considered a No-Go Area.

Description of expected significance of impact:

This impact could be extremely high, but easily reduced if the buffer around the river is strictly enforced.

Gaps in knowledge and recommendations for further study:

Migration in birds are poorly understood, and times of the year when these events occur can be unpredictable. It is also not established whether birds will follow the exact same pathway year after year.

Table 5-4: Disturbance due to lights, noise, machinery movements and maintenance operations.

<table>
<tr><td colspan="4">Impact: Disturbance due to lights, noise, machinery movements and maintenance operations

Can have a negative effect on avifauna behaviour by affecting foraging activity and flight paths used. Artificial lights can attract insects which will entice nocturnal species (owls, nightjars etc) to feed in the area leading to a higher chance of mortalities due to collision or barotrauma. High noise levels could disturb breeding birds which could lead to abandonment of eggs or fledglings.</td></tr>
<tr><td>Issue</td><td>Nature of impact</td><td>Extent</td><td>No-Go Areas</td></tr>
<tr><td>Increased noise, lighting and disturbance during operation</td><td>Negative, but can be reduced to acceptable levels</td><td>Local</td><td>All bodies of water including the river</td></tr>
<tr><td colspan="4">Description of expected significance of impact:
This impact could be high, but easily reduced if high intensity lights are not used and only the compulsory civil aviation lighting is employed, noise levels are within the accepted standards and machinery are fitted with dampers, where required.</td></tr>
<tr><td colspan="4">Gaps in knowledge and recommendations for further study:
In certain areas the use of artificial lights will be unavoidable, and these include areas where offices or operational and maintenance buildings will be constructed. Placement of these buildings is currently unknown, but it is recommended that these are constructed in areas away from watercourses.</td></tr>
</table>

5.2 IMPACT ASSESSMENT

5.2.1 Construction Phase

Impacts associated with the loss of bird foraging habitat due to construction activity (Table 5-5) can be mitigated by avoiding avifaunal specific sensitive areas and their associated buffers, such as the local drainage lines, impoundments, smaller watercourses, pans, koppies, sandy dunes and areas associated with infrastructure and/or large trees which will ultimately reduce the spatial extent of this impact and limit it to a once-off event. The overall severity of the impact can be reduced to being insignificant if avoidance mitigation is applied related to the positioning of the turbines and supporting infrastructure and minimisation mitigation is applied.

Table 5-5: Consolidation table of impacts due to habitat destruction during construction phase.

<table>
<tr><td colspan="3">Nature: Habitat destruction during construction phase</td></tr>
<tr><td></td><td>Without mitigation</td><td>With mitigation</td></tr>
<tr><td>Extent</td><td>2</td><td>1</td></tr>
<tr><td>Duration</td><td>4</td><td>3</td></tr>
</table>

Magnitude	8	3
Probability	5	4
Significance	**High (70)**	**Low (28)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Low
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	

Bird roosts varied from artificial structures such as windmills to the pan areas and impacts associated with the destruction or disturbance of such roosts (Table 5-6) can be mitigated by avoiding habitat features that could act as potential bird roosts as highlighted below. This impact can potentially be eliminated if mitigation measures are applied across the area.

Table 5-6: Consolidation table of impacts due to the destruction or disturbance of bird roosts during the construction phase.

Nature: The destruction or disturbance of bird roosts during the construction phase		
	Without mitigation	**With mitigation**
Extent	2	1
Duration	2	2
Magnitude	8	4
Probability	5	3
Significance	**(42)**	**Low (24)**
Status (positive or negative)	Negative	Negative
Reversibility	No	Yes
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	

Impacts due to bird mortalities during the operational phase are practically unavoidable for any Solar and WEF, but with the appropriate mitigation measures these impacts can be minimised. Although the overall bird activity (especially average height flights) qualifies the proposed WEF boundary as a Low-Risk Area for bird/ turbine collisions, there are certain times of the year (and day) when it appears that large flocks of birds (such as bustards and large birds of prey) move through the area. If mitigation measures are followed and sensitive areas avoided the current WEF will have a Low-Medium mortality impact on the local bird populations (Table 5-7).

Table 5-7: Consolidation table of impacts from bird mortalities during the operational phase.

Nature: Bird mortalities during the operational phase		
	Without mitigation	**With mitigation**
Extent	3	3
Duration	4	4

Magnitude	10	6
Probability	5	3
Significance	**High (85)**	**Medium (39)**
Status (positive or negative)	Negative	Negative
Reversibility	No	No
Irreplaceable loss of resources?	Yes	Potentially
Can impacts be mitigated?	Partially	

Migratory pathways of birds cannot be changed and the resulting impacts are unavoidable. However, severity of the impacts can be reduced with appropriate mitigation measures. Very few discernible migratory flight pathways were able to be established which could be explained by the lack of distinguishing geographic features in the landscape, such as large rivers or a mountain range. However, the sandy western habitats represent a highly sensitive habitat feature which should allow for limited construction in this area (Table 5-8). If this is strictly applied there could be an adequate avoidance of any migratory pathways and minimal impact during migratory events and indeed, flight events that occur daily.

Table 5-8: Consolidation table of impacts due to disruption of bird migratory pathways during the operational phase.

Nature: Disruption of bird migratory pathways during the operational phase		
	Without mitigation	**With mitigation**
Extent	3	3
Duration	4	3
Magnitude	8	2
Probability	5	2
Significance	**High (75)**	**Low (16)**
Status (positive or negative)	Negative	Negative
Reversibility	No	Yes
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	

5.2.2 Operational Phase

Table 5-9: Wind Related Bird mortalities during the operational phase.

Nature: Bird mortalities during the operational phase due to vehicle collisions, collisions with infrastructure and/or combustion.		
	Without mitigation	**With mitigation**
Extent	3	3
Duration	4	4

Magnitude	10	6
Probability	5	3
Significance	**High (85)**	**Medium (39)**
Status (positive or negative)	Negative	Negative
Reversibility	No	No
Irreplaceable loss of resources?	Yes	Potentially
Can impacts be mitigated?	Partially	

Table 5-10: Solar related bird mortalities during the operational phase.

Nature: Bird mortalities during the operational phase due to vehicle collisions, collisions with infrastructure (fences) and/or combustion.		
	Without mitigation	**With mitigation**
Extent	3	3
Duration	4	4
Magnitude	10	6
Probability	5	3
Significance	**High (85)**	**Medium (39)**
Status (positive or negative)	Negative	Negative
Reversibility	No	No
Irreplaceable loss of resources?	Yes	Potentially
Can impacts be mitigated?	Partially	

Mitigation Measures

Impacts due to bird mortalities during the operational phase are practically unavoidable for any large facility, but with the appropriate mitigation measures these impacts can be minimised. It is likely that most of the avifaunal populations will be largely displaced from the majority of the Solar project infrastructure, although significant risks are associated with the likelihood of project vehicles flushing birds into fencing infrastructure as well as collisions of large bodied species with powerlines. Wind turbine collisions remain a high risk. Although the current overall bird activity qualifies the proposed solar development boundary as a low-density area, there are certain times of the year (and day) when it appears that large flocks of birds (such as storks, korhaans, bustards and large birds of prey) are far more prevalent. All powerline infrastructure must be fitted with approved bird diverters in order to provide visibility for large-bodied birds. In all areas where service road intersect with semi natural or natural habitat, all fences must be set back at least (strictly) 75 metres from the edge of every service road in order to allow for vulnerable species such as cranes and korhaans to obtain adequate height after being flushed by vehicle traffic. Through the essential elimination of habitat, this will limit any chance of vulnerable species foraging on verge side vegetation and causing subsequent fence collisions. Finally and for the WEF, it is deemed necessary to raise the rotor sweep length to at least 80 metres by either raising the hub or reducing the turbine blade length. This will dramatically reduce the predicted collision mortality rate to and mitigate the fact that the WEF is comprised of a very high turbine density.

Table 5-11: Loss of Bird Foraging Habitat.

Nature: Loss of Bird Foraging Habitat		
	Without mitigation	**With mitigation**
Extent	3	3
Duration	4	3
Magnitude	8	2
Probability	5	2
Significance	**High (75)**	**Low (16)**
Status (positive or negative)	Negative	Negative
Reversibility	No	Yes
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	

Mitigation Measures

Impacts associated with the loss of bird foraging habitat due to operations can be mitigated by avoiding avifaunal specific sensitive areas and their associated buffers, such as the local drainage lines, impoundments, smaller watercourses, and pans. A green buffer should be maintained around all habitats with a SEI designated as High or above.

Table 5-12: Disruption of bird migratory pathways during the operational phase.

Nature: Disruption of bird migratory pathways during the operational phase		
	Without mitigation	**With mitigation**
Extent	3	3
Duration	4	3
Magnitude	8	2
Probability	5	2
Significance	**High (75)**	**Low (16)**
Status (positive or negative)	Negative	Negative
Reversibility	No	Yes
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	

Mitigation Measures

Migratory pathways of birds cannot be changed and the resulting impacts are unavoidable. However, severity of the impacts can be reduced with appropriate mitigation measures. Some significant discernible migratory flight pathways were able to be established which could be explained by large areas of generic habitats punctuated by some distinguishing geographic features in the landscape, such as large ridges, large impoundments, wetlands and drainage lines. The linear drainage line habitats must be buffered by a minimum of 50 metres from the edge of the demarcated wetland.

Table 5-13: The attraction of some novel bird species due to the development of a solar farm with associated infrastructure such as lake effect, perches, nest and shade opportunities.

Nature: The attraction of some novel bird species due to the development of a solar farm with associated infrastructure such as lake effect perches, nest and shade opportunities may cause both damage to the infrastructure through acidic defecation by certain species but also draw birds closer to infrastructure and cause significant direct mortality risks.		
	Without mitigation	**With mitigation**
Extent	3	3
Duration	4	3
Magnitude	8	2
Probability	5	2
Significance	**High (75)**	**Low (16)**
Status (positive or negative)	Negative	Negative
Reversibility	No	Yes
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	

Mitigation Measures

Essentially, all habitat attractants should be eliminated so that avifaunal populations will not embedded themselves within the infrastructure over time. This includes bird diverters, perch deterrents and the application of Non-polarising white tape can be used around and/or across panels to minimise reflection which can attract aquatic birds and insects (food) as panels mimic reflective surfaces of waterbodies.

Table 5-14: Chemical pollution: Chemicals being used to keep the PV panels clean from dust (suppressants) etc.

Nature: Chemical pollution: Chemicals being used to keep the PV panels clean from dust (suppressants) etc.		
	Without mitigation	**With mitigation**
Extent	3	3
Duration	4	3
Magnitude	8	2
Probability	5	2
Significance	**High (75)**	**Low (16)**
Status (positive or negative)	Negative	Negative
Reversibility	No	Yes
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	

Mitigation Measures

The application of strict chemical control protocols as per the EMPr.

5.3 CUMULATIVE IMPACTS

There are a number of proposed, approved and implemented renewable energy facilities within the PAOI as shown in Figure 5-1 and any impacts anticipated from the proposed Red Sands Solar and WEF will add to these existing impacts. As such, the results obtained during this preconstruction survey and from the subsequent impact analysis should be considered in conjunction with the impacts created by the regional developments. There is a large amount of renewable energy development within the region, raises the possibility of significant cumulative impacts concerning collision risk, habitat loss and fragmentation and loss of suitable habitat for threatened species.

The following current impacts will be exacerbated through increased WEF development regionally;

- Habitat loss: The destruction of highly sensitive habitat (for example sandy substrates for Red Lark) will potentially increase. The Red Lark exists within a narrow ecological and distributional belt and loss of its ecologically specific habitat may be highly significant.
- Road-kills: Many birds are commonly killed on roads, especially nocturnal species such as Spotted Eagle-Owl.
- Regional saturation of turbines: This has implications for several priority species, both in terms of collision mortality for some species, especially Bustards and Raptors, and displacement due to transformation of habitats
- Powerlines: Numerous existing and new power lines are significant threats to large terrestrial priority species in the region as powerlines may kill significant numbers of all large terrestrial bird species.

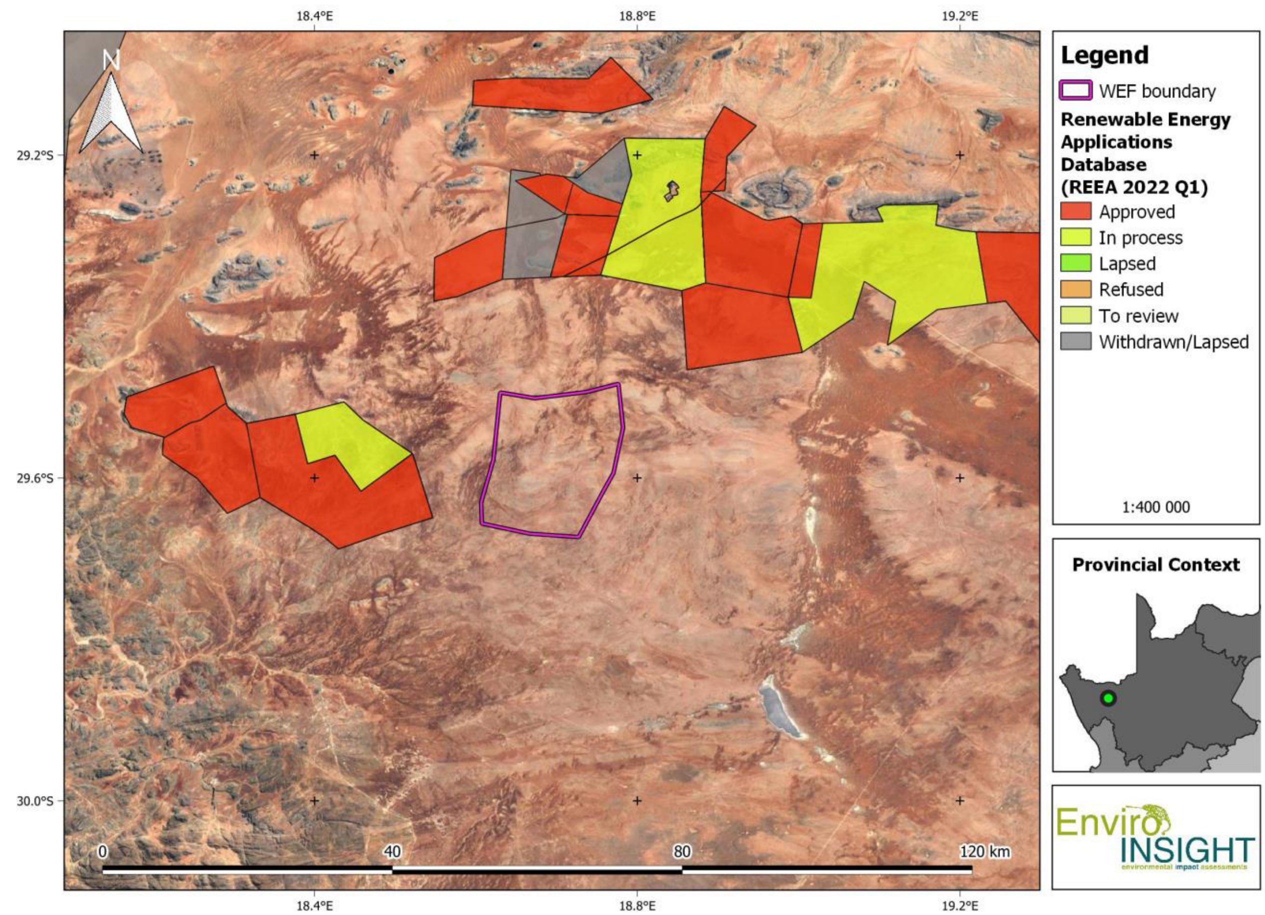

Figure 5-1: Local and regional renewable energy applications and operations

Table 5-15: Cumulative impact of the project and other projects in the area.

Nature: Cumulative impact of the project and other projects in the area		
	Overall impact of the proposed project considered in isolation	***Cumulative impact of the project and other projects in the area***
Extent	1	4
Duration	4	4
Magnitude	4	8
Probability	4	5
Significance	**Medium (36)**	**High (80)**
Status (positive or negative)	Negative	Negative

Reversibility	No	No
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	Possibly

5.4 MITIGATION OF IMPACTS

Due to the global demand for renewable energy, a strong research emphasis has been placed on describing and defining mitigation measures to negate or minimise the negative impacts associated with such facilities. In particular, much research is focused on bird-turbine collisions prevention/minimisation at wind energy facilities (see May *et al.*, 2015; Gartman *et al.*, 2016 a & b; May *et al.*, 2020; McClure *et al.*, 2021). New mitigation measures range from simple (e.g., painting one turbine blade black; May *et al.*, 2020) to complex (detecting approaching birds with cameras and artificial intelligence to slow turbines down; McClure *et al.*, 2021). However, by far the best mitigation option remains the first step of the mitigation hierarchy which is "avoidance". Consequently, all attempts will be made to avoid potential impacts arising from the proposed Solar and WEF through the application of necessary buffers for sensitive areas, where placement of turbines may not occur. Additional remaining impacts will be minimised through the application of known and previously tested mitigation measures (e.g., May *et al.*, 2015). Finally, there is strong support from the developer to apply experimental minimisation mitigation measures (e.g., painting of one blade) and to utilise the facility to generate important research data.

Alternative additional mitigation measures may include change of the current land use to minimise attraction for priority species. Since development and construction go hand in hand with high ambient and stochastic noise levels (machinery) and habitat loss, it is possible for bird species and bird individuals to be displaced from the surrounding environment. It is essentially true for large species that require extensive home ranges, and those species that are inherently shy or unobtrusive by nature (e.g., raptors). Displacement will be the response of raptors to the disturbance activity, for example when a bird changes its behaviour or takes flight by aborting its activity prior to the disturbance or being unsuccessful in completing its current activity (Ruddock & Whitfield 2007). Reactions are likely to differ between species and between individuals of the same species (Rogers & Smith 1995; Rogers & Schwikert 2002). Reactions are also positively correlated to the magnitude and frequency of a particular disturbance event. For the proposed Solar and WEF as well as the cumulative impacts, it cannot be predicted to a 100% confidence to what degree these activities will affect the Priority Species, but it must be stated that many bird species will become accustomed, or have the ability to learn and adapt, to constant occurring disturbance events of low magnitude (e.g. vehicle noise) and turbine operation, unless they are directly affected (e.g. their physical habitat is affected). Collision with turbines and associated infrastructure (including powerlines, fences surrounding solar panels and situated near roads) is the most significant impact for the species in the region.

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

5.5 SUMMARY OF PROPOSED MITIGATION MEASURES

It is deemed possible, through the application of appropriate mitigation measures, to restrict the impact of on priority species through collisions with the turbines to a low level of significance. The following mitigation measures are proposed:

Habitat destruction: Apply necessary buffers for roost and foraging sites and other sensitive bird habitat features, avoiding the construction of turbines and access roads in these areas. Roads must utilise or upgrade existing farm roads as far as possible.

Bird mortality: Avoid placement of turbines near sensitive bird breeding and roosting habitats. The application of adaptive mitigation measures (e.g., shutdown on demand retrofitting), according to post-construction monitoring results (counted strikes of threatened species) must be informed by environmental correlates of avifaunal activity and/or strikes. It is vital to understand that significant bird mortality for ground dwelling species such as Ludwig's Bustard and Karoo Korhaan will occur, not because of turbine collision, but as a result of collision with supporting infrastructure. Therefore, mitigation measures must be applied to powerlines and fences.

Bird collisions with turbines and solar panels: Increase turbine cut in speed as this has been shown to reduce collisions. The risk is not considered to be high, and the annual collision risk is estimated at less than 5 birds per year. The fatality rates post-construction will provide additional data and the risk model can be adjusted accordingly. Advanced Radar-based shutdown on demand must be considered as a retrofit where turbines transcend recommended buffers if permanent populations of Martial Eagles and Vultures establish within the PAOI (which currently do not exist). The minimum sweep height must be raised to 80 metres which will required by either raising of the hub height pr shortening of the blade turbine length.

Avoidance: It is recommended that limited development (including the full rotor swept zone of wind turbines) takes place in High sensitivity areas. Minimise impacts to natural and artificial wetlands and water bodies by implementing the appropriate buffer areas where no development may take place. This includes a 200 m no-go buffer proposed around water points (500 metres from the largest seasonal impoundment within the Project Footprint) as they serve as focal points for bird activity.

General Mitigation Measures for Wind Energy

- Formal post construction monitoring must be resumed once the turbines have been activated, as per the most recent edition of the best practice guidelines (Jenkins et al. 2015). The exact scope and nature of the post-construction monitoring will be informed on an ongoing basis by the result of the monitoring through a process of an establishment of available new technology and adaptive management. The purpose of this would be to establish if and to what extent displacement of priority species has occurred through the altering of flight patterns post-construction, and to search for and identify carcasses at turbines (mortality).
- Post-construction monitoring should be undertaken as per the EMPr. The exact scope, nature and frequency of the post-construction monitoring will be informed on an ongoing basis by the results of the monitoring through a process of adaptive management.
- If turbines are to be lit at night, lighting should be kept to a minimum and should preferably not be white light. Flashing strobe lights should be used where possible (provided this complies with Civil Aviation Authority regulations).
- Lighting of the wind farm (for example security lights) should be kept to a minimum. Lights should be directed downwards (provided this complies with Civil Aviation Authority regulations).

General Mitigation Measures for Solar Energy

Due to the global demand for renewable energy, a strong research emphasis has been placed on describing and defining mitigation measures to negate or minimise the negative impacts associated with such facilities. In particular, much research is focused on bird impacts prevention/minimisation at solar facilities (see TBC 2021). New mitigation measures range from simple (e.g., buffering of habitats) to complex (retrofitting of panels to avoid Lake Effect Impacts). However, by far the best mitigation option remains the first step of the mitigation hierarchy which is "avoidance". Consequently, all attempts will be made to avoid potential impacts arising from the proposed development through the application of necessary buffers for sensitive areas, where placement of panel infrastructure may not occur. Additional remaining impacts will be minimised through the application of known and previously tested mitigation measures.

Alternative additional mitigation measures may include change of the current land use to minimise attraction for priority species. Since development and construction go hand in hand with high ambient and stochastic noise levels (machinery) and habitat loss, it is possible for bird species and bird individuals to be displaced from the surrounding environment. It is essentially true for large species that require extensive home ranges, and those species that are inherently shy or unobtrusive by nature (e.g., raptors). However, it is far more likely that collision with powerlines is the most significant impact for the species in the region.

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

5.6 SPECIES SPECIFIC RISK ANALYSIS AND RECOMMENDED MITIGATIONS

Ultimately, it is suggested that the morphological and behavioural; characteristics of a given bird species traits of birds, especially those related to size, wing beat, manoeuvrability, flight pattern and hunting/ foraging behaviour, are known to influence the relative collision risk with structures such as power lines and wind turbines. Larger bird species often need to use thermal and updrafts to gain altitude, particularly for long distance flights. Thermal updrafts (thermals) and orographic lift (slope updraft) will affect the relative risk per species. The relatively flat nature of the survey area dictates that the overall topography related risks are low, However, some higher risk species have been identified and described below.

5.6.1 Ludwig's Bustard (*Neotis ludwigii*)

Ludwig's Bustards are globally and regionally listed as Endangered (BirdLife International 2012b and Taylor,*et. al.* 2015) which is cause for a significant evaluation of the species in relation to the proposed development. Actual counts were carried out during the pre-construction monitoring process although and monitoring data suggest that a permanent (albeit seasonal) population including breeding pairs persist for prolonged periods within the study area. Multiple and frequent sightings were recorded. The species is highly migratory and localised development may not represent a fatal flaw. However, the fact that sub-adults and juveniles are encountered in the study area provides strong anecdotal evidence of residential breeding behaviour which may have significance ramifications for the Cumulative Impact Assessment.

It must be stated that some local landowners stated that Ludwig's bustards have increased in density over the last five years within the region but not within the Project footprint, with the significant exception of 2022. There are a number of possible explanations for the observed increase in density in 2022:

- This species, as a nomad, may show localised and temporal increases as part of natural population dynamics due to climatic fluctuations. 2022 experienced a highly unusual amount of rainfall in 2022 over an extended period of time. This caused an activation of the seed bank within the PAOI and subsequently, a large amount of fodder was available for avifaunal species including Ludwig's Bustard.
- The lack of smaller (and less visible) powerlines within much of the study area allowing for localised lower mortality rates; and

This species is almost certainly resident and at risk to the creation of large, turbines in combination with non-marked powerlines may cause collision of birds which could significantly reduce local and regional populations. In addition, large-scale increases in fencing combined with a high volume of large maintenance trucks may cause drastic declines in bustard numbers due to flushing displacements, collisions and entanglements. The presence of this species must form a significant focal point of the mitigation measures.

On a final note, concerning monitoring of the species (and possible mitigations), it is vital to highlight that fact that as an Endangered species, Ludwig's bustard demands higher degrees of auditing and monitoring attention than other Red-Listed birds (a fact supported by multiple publications including Visser *et. al.* 2018 and Scott *et. al.* 2012). It is also vital to highlight that presence or absence over time for a nomadic species is difficult to predict and spatial/ temporal population reductions may or may not be development-induced. For example, another prolonged drought may all but exclude local colonisation which will be immediately reversed with the onset of more unusual heavy rains. Although it is highly feasible that the development may be directly responsible for local population reductions, comprehensive and continuous data collection is required to monitor the situation on site and apply appropriate mitigation measures and far more significant weighting and value should be applied to the Cumulative Impact Assessment.

5.6.2 Red Lark (*Calendulauda burra*)

This species is highly range range-restricted (Figure 5-2) and is listed as IUCN Vulnerable (Taylor *et al.*, 2015). The species was observed frequently during the assessment period albeit within a highly restricted habitat preference. Significant populations (breeding and foraging) within the PAOI have been confirmed. Even though the species exhibits a specific breeding behaviour (display flights of up to 20 metres as described in Hockey *et. al.* 2005), it has been deemed to have a relatively low risk of collision and thus is not considered a fatal flaw to the project. However, care must be taken as some individuals were observed displaying up to 60 metres (wind assisted). The species prefers the open sandy habitats, in particular open sandy karroid dunes and grassland, particularly on dune crests and dune side slopes. The species is considered as a regular breeding resident in the region. Avoidance based mitigation is the primary mitigation measure and must be based upon the aforementioned delineated sensitivity. However as multiple solar panels and turbines fall within the delineated high sensitivity area for Red Lark and large-scale avoidance may not be possible, additional small-scale micro sighting is required. Turbines and panel infrastructure should be placed away from dune crests and side slopes. In addition, and affected turbines, dune habitat should be removed, fenced or artificially vegetated to a prescribed radius of 100 metres in order to ensure no breeding behaviour (and therefore, mating displays leading to potential collision) will not take place within range of the rotor sweep zone.

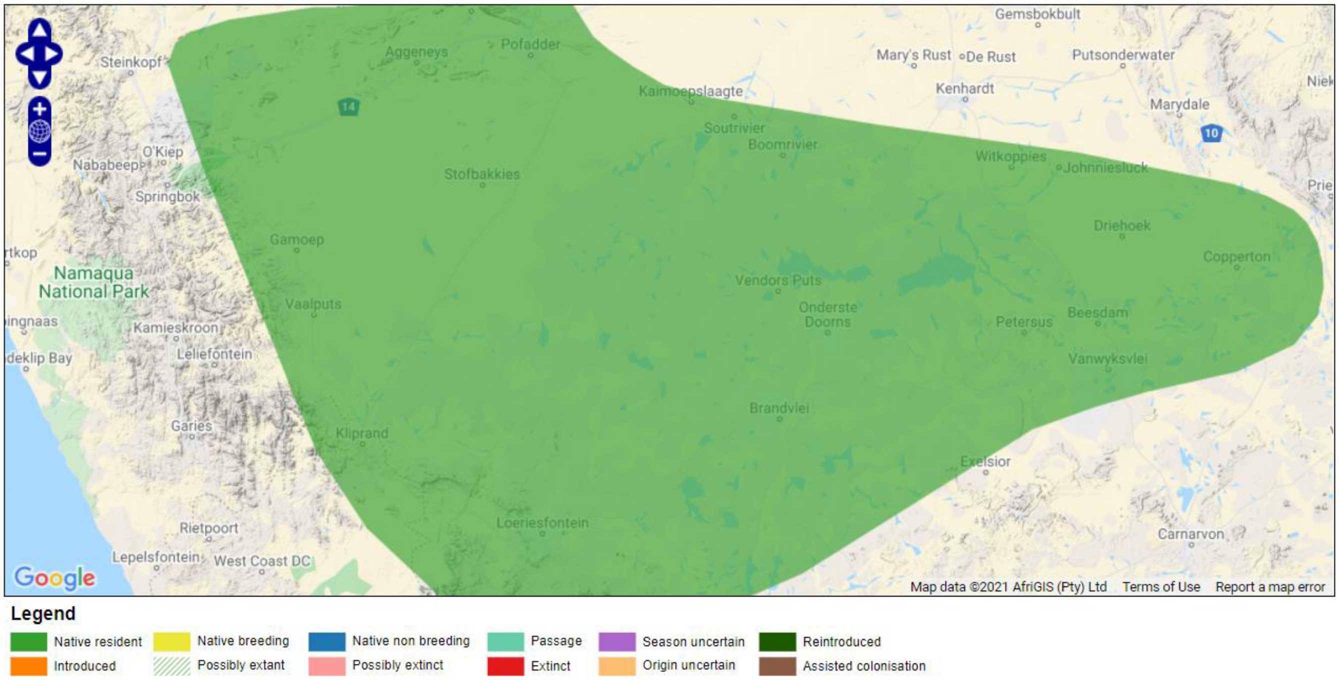

Figure 5-2: Red lark (Calendulauda burra) distribution map (BirdLife International, 2021b).

5.6.3 Raptors and Vultures

For the purposes of the report and given some ecological similarities within the affected groups and specifically for the Red Sands Solar and WEF project, all raptors and vultures of special conservation concern will be addressed together.

Affected Species, Threatened Status and Habitat Requirements

The Martial Eagle (*Polemaetus bellicosus*) is listed as globally Endangered (IUCN 2021) and has been subject to rapid declines in during the last 10 years owing to habitat loss and poisoning (Taylor et al., 2015). Although subject to degradation and development specific impacts such as deforestation, transport collision, power line electrocution and poisoning, the main threat in the region is the loss of large and medium-sized mammal populations which comprise the primary food source of the species. Martial Eagles utilise a variety of environments represented in the study areas but rely on emergent forests for breeding purposes. No individuals were located during the survey.

Lappet-faced Vulture (*Torgos tracheliotos*). Due to large-scale drastic declines in recent years, Lappet-faced Vultures are listed as Globally Endangered (IUCN 2021) meaning that the species are in imminent danger of extinction. Within the study area, Lappet-faced Vultures have been classified as locally vagrant but were observed on a single occasion in significant numbers within a seasonal pan by the IUCN (2021). Due to climate change and other factors, it appears that vulture ranges are expanding west and the frequency of occurrence of multiple vulture species may increase over time.

Although there exists excellent habitat for these species within the study area, their significance of their presence (permanent or otherwise) within the PAOI must be assessed. For breeding habitat along the major rivers as wells as essential roosting habitat wherever there are tall trees. The high density of depressions and waterholes, providing drinking water and "bathing stations" utilised during post-foraging, combine to characterise the natural/ semi natural and disturbed natural portions of the study area and the surrounding habitats as optimal habitat for a resident breeding population of this “category” of SCC. However, there is a tangible and significant absence of viable populations of medium and large mammals within much of the study area have rendered the habitat partially inadequate as foraging habitat which serves to limit the presence of the species to comparatively low densities.

Methods Applied for Future Species Assessment

Habitat Mapping Verification. Given the predicted low population densities of these species, it is anticipated that individuals may not be observed during a future study period. Therefore, and regardless of observational success, predicted habitats for the species must be mapped using a structural habitat map and this must be carried out prior to the commencement of fieldwork to increase the chances of successful observation through the identification of target areas. In addition, on-site habitat verification must take place to enable supervised classification of potential vulture and raptor habitat (using GIS algorithms) which allows for delineations of areas qualifying as IFC Critical Habitat under Criteria 1.

Random (ad hoc) and periodic visual surveys. Walking and driving transects, periodic horizon and “sky scans” should be undertaken to search for soaring raptor species. In addition, particular attention must be devoted to suitable roosting, foraging and nesting habitat of the target species.

Potential Impact and Mitigation

Disturbance to either large raptors or vultures refers to the disruption of a foraging, breeding or roosting bird caused by human-induced activities which will include unacceptable mortalities. Since the proposed operations go hand in hand with high ambient and stochastic disturbance levels (machinery and especially fire) as well as other impacts such as collisions, dust, poison and habitat loss, it is possible for bird species and bird individuals to be displaced from the surrounding environment. It is especially true for large species that require extensive home ranges, and those species that are inherently shy or unobtrusive by nature (e.g. raptors). Displacement from suitable breeding habitat will be the primary response of eagles to the anticipated disturbance, for example when a bird changes its behaviour or takes flight (and abandoning offspring) by aborting its activity during a disturbance. In the case of foraging, the disturbance will apply, when the individual raptor or vulture is unsuccessful in completing its current activity (Ruddock & Whitfield 2007). Reactions are likely to differ between species and between individuals of the same species (Rogers & Smith 1995; Rogers & Schwikert 2002). Reactions are also positively correlated to the magnitude and frequency of a particular disturbance event. It is currently unknown to what degree these activities will affect the vultures, eagles and their prey, but reactions can be estimated based on previous studies. Disturbances and possible subsequent displacement are further aggravated by an increased loss of suitable foraging, breeding and roosting habitat.

Discussions, Mitigations and Recommendations

It is the opinion of the specialists that all vulture and large raptor species represent an extremely pertinent issue for discussion given the potential implications for mitigation measures and subsequent limitations to the development. As a significant point of reference, the IFC PS 6 (GN 2019) guidance notes specifically refer to the fact that wide-ranging species are either included or excluded from automatically classifying a habitat as Critical if aggregation, recruitment, the proximity to conservation areas and other specific habitat features do or do not apply.

It is the opinion of the specialist that even with stochastically high rainfall events (as seen in 2022), significant prey recruitment within the PAOI is unlikely to increase (thus causing a possible increase in regional raptor and vulture densities). Therefore, and apart from the commencement of further monitoring studies, two specific mitigation measures are suggested:

1. 1.Set-back areas or buffer zones are allocated to sensitive or important habitat features to alleviate the effect of directly mortalities based upon attraction to such areas. The choice of an appropriate set-back distance is complex since different species and even different taxon groups demand different ecological requirements. Thus, and as a precautionary principle, it is recommended that the two identified seasonally inundated pans within the Project footprint be buffered by 500 metres.
2. All carcasses within the area must be subjected to a strict monitoring and removal management system where searching, collecting and destroying of carcasses be carried out within a 24-hour mortality period.

6 MONITORING REQUIREMENTS

The following outlines a general monitoring plan (EMP) structure.

	Title: SCC community monitoring
Stressor	Project Activities, Climatic Changes
Receptor(s)	Avifauna SCC diversity and densities in each habitat type
Variables	Presence/absence of bird species of conservation concern, including observed breeding behaviour, proportion of SCC species present per sample site, species richness and densities.
Sampling Method	• Vantage Point counts – 3 x Three hour counts (morning, midday and evening) to be conducted at each monitoring plot • Drive Transects (species lists) – all species seen to be recorded along set transects to be driven during dawn till pre 10 am; and • Walked Transects (species lists) – all species heard and seen to be recorded along set transects to be walked at dawn chorus
Sampling Frequency	• Annual wet and dry season surveys; and • Continuous observations by ECO.
Sampling Site(s)	(All existing VPs, DTs and WTs)
Change and Action Thresholds	Loss/decrease in any SCC parameter, unnatural decline (cannot be explained by stochastic weather changes) in species densities and/or richness. Similarly, positive changes (e,g, unusual presence in high densities of nomadic species such as Ludwig's Bustard or establishment of SCC breeding population such as Secretary Bird) in species densities and/or richness that indicate disturbance. Rapid surveys of greater surrounding area should be conducted to attempt to determine cause of change detected.
Data Analysis	All variables acquired should be statistically and graphically compared to the available data and the original targeted baseline data. Photographs should be taken of as many SCC observed in the field.
Reporting requirements	Annual reporting presenting data analysis results and mapping indicating locations of change. Specific reporting on negative change detection not directly attributable to Project activities (Turbine Operation) and their cause. All reporting to be accompanied by GIS shapefiles and any original photographs.

	TITLE: Collision and mortality monitoring
Stressor(s)	Avifauna-Turbine and PV panel collisions (incidents)
Receptor(s)	Avifauna community composition, density and distribution
Variables	Species, geographical location and date of every avifaunal mortality
Sampling Method	• For powerlines: Weekly surveys before dawn (prior to scavenger activity) by driving slowly along the servitudes and documenting each collision kill location and species (a georeferenced photograph as evidence is required). • For turbine and solar panel location sites: daily inspection on foot of cleared areas for birds killed during the operation process. Location and species must be recorded (a georeferenced photograph as evidence is also required).
Sampling Frequency	Weekly for powerlines, daily for turbines and Solar Panel Locations
Sampling Site(s)	Along the entire powerline network on the PAOI. All operational turbines.

Collision Action Thresholds	Collision frequency and intensity (#kills per species per unit time) will need to be assessed per species by specialist. However, any non-specific collision concentrations (> 10 kills per month clustering in a stretch of powerline or a specific turbine) must initiate investigation and corrective measures (including temporary suspension of operations, additional mitigation infrastructure).
Data Analysis	Geospatial analysis of density and dispersion of avifaunal mortalities highlighting the core areas of mortalities so that corrective measures can be implemented. Time-series and trend analysis to accompany evaluation to inform on temporal fluctuations (e.g. seasonality) and steer adaptive management. Cumulative species-specific summary statistics to be calculated.
Reporting requirements	• Bi-annual reporting of faunal avifaunal mortalities associated with collision data highlighting locations where corrective measures are to be taken (if necessary).

	TITLE: Carcass monitoring
Stressor(s)	Avifauna- Livestock deaths (incidents)
Receptor(s)	Avifauna (large scavengers and raptors) community composition, density and distribution
Variables	Avifaunal species attracted, geographical location of every livestock mortality
Sampling Method	• Monitoring of livestock herds, especially during lambing/ birthing season • A thermal drone with a large radius must patrol target areas during the night in order to pick up the heat signature of large bodied animals in a state of decomposition.
Sampling Frequency	Three-times weekly for herds, daily during birthing season
Sampling Site(s)	General PAOI and livestock locations
Collision Action Thresholds	General and unusually high presence of large scavenging and predatory species (vultures and raptors)
Data Analysis	Geospatial analysis of density and dispersion of livestock mortalities highlighting the core areas of mortalities so that corrective measures can be implemented. Monitoring of increased species of scavengers and raptors, numbers of carcasses removed and destroyed
Reporting requirements	• Annual reporting of faunal livestock mortalities and numbers of carcasses located (including locations) associated with presence of vultures and large raptors.

7 CONCLUSIONS

The study area is located in a region dominated by natural (albeit highly disturbed) sandy grassland and shrubland karoo vegetation types. Several drainage lines and small dams as well as small to large natural pans can be found scattered across the study area with most being mostly dry with some seasonal flow/ inundation.

Fourteen priority species were recorded during the initial surveys, including Martial Eagle, Ludwig's Bustard, Lanner Falcon, Red Lark and Black-winged Kite. Of these, the Ludwig's Bustard was the most concerning large bird species and was observed flying near the rotor sweep area, albeit infrequently.

At the commencement of the survey, the PAOI was characterised by extremely typical arid conditions with expected very low densities of priority species. However, the onset of a stochastic extreme rainfall event (wet season) atypically transformed the

PAOI where it is possible that unusually high densities (and perhaps diversity) of avifaunal assemblages were recorded. This reduces the concern regarding large nomadic species such as bustards, large wide foraging raptors such as Martial Eagle and vultures seeking water sources.

It was the occurrence of several passerine species that might potentially be affected by collision was confirmed, namely endemic and/or range-restricted larks (Red Lark and Sclater's Lark representing the highest profile and frequently observed) which are widespread species in the area. These species are considered to have a "Vulnerable and Near threatened" conservation status respectively. As habitat obligates, the potential impact on these passerines may be mitigated via avoidance.

7.1 PROFESSIONAL OPINION

The addition of the proposed Red Sands Solar and WEF does indicate moderately significant impacts to the receiving environment via the risk to Priority Species (such as Red Lark and Ludwig's Bustard) as well as the Cumulative Impacts need to be considered and provision made within the EMPr for this development. The overall predicted fatality rates (actual and assumed) were **significantly low** given the extremely large size of the PAOI and large numbers of turbines.

Although previous impact assessments and monitoring programs for existing local Solar and WEFs indicated that not all impacts can be mitigated to acceptable levels, medium significance post-mitigation should be interpreted that more can be done to avoid critically important species-specific (especially Red Lark impacts as is the case for the impacts discussed within this statement). This is mainly because impact assessments regarding solar and wind developments have been poorly understood since their inception and the impacts (especially cumulative impacts) of wind developments may have highly significant consequences if mitigation and monitoring is not implemented correctly. It is still the opinion of the consultants that the impacts associated with WEF projects are far preferable (from an environmental impact perspective) to extractive and/ or non-renewable alternatives. It must be related that this report must be considered in context with the greater EIA process. In addition, while striving to maintain the highest standards of mitigation and monitoring as well as the commissioning of a highly detailed preconstruction micro sighting assessment, developments such as the Red Sands Solar and WEF be encouraged within designated areas.

The presence of nesting Red Lark within the PAOI is of particular concern. Avoidance mitigation must be implemented in conjunction with the aforementioned micro sighting. Thus, the author sees no reason why an Environmental Authorisation (EA) should not be granted on the following conditions:

- All recommended buffering (500m, 200m and 100m habitat dependent) be strictly adhered to.
- Turbines within Red Lark habitat should not breach the 62.5 metre rotor sweep height.
- Micro sighting of turbine placement must occur preconstruction supervised by a specialist zoologist in order to mitigate habitat loss for Red Lark.
- All recommended mitigation measures be applied preconstruction, post construction and operations.
- The EMPr be updated every three years in order to revaluate the potential distributional population changes of species such as Martial Eagles and Vultures. Thus, retrofitted mitigations such as AI, radar and camera technology may have to be applied.

8 REFERENCES

BirdLife International. 2020. *Polemaetus bellicosus*. *The IUCN Red List of Threatened Species* 2020: e.T22696116A172287822. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T22696116A172287822.en.

BirdLife International (2021[a]) Important Bird Areas factsheet: Bitterputs Conservation Area. Downloaded from http://www.birdlife.org.

BirdLife International (2021[b]) Species factsheet: *Calendulauda burra*. Downloaded from http://www.birdlife.org.

BirdLife International (2021[c]) Species factsheet: *Polemaetus bellicosus*. Downloaded from http://www.birdlife.org

Del Hoyo, J., Elliott, A. AND Sargatal, J. 1992. Handbook of the birds of the world. 1992 – 2011 editions, Lynx Editions, Barcelona.

Drewitt, A.L. and Langston, R.H., 2006. Assessing the impacts of wind farms on birds. Ibis, 148, pp.29-42.

Gartman, V., Bulling, L., Dahmen, M., Geißler, G., & Köppel, J. (2016a). Mitigation measures for wildlife in wind energy development, consolidating the state of knowledge—part 1: planning and siting, construction. *Journal of Environmental Assessment Policy and Management*, 18(03), 1650013.

Gartman, V., Bulling, L., Dahmen, M., Geißler, G., & Köppel, J. (2016b). Mitigation measures for wildlife in wind energy development, consolidating the state of knowledge—Part 2: Operation, decommissioning. *Journal of Environmental Assessment Policy and Management*, 18(03), 1650014.

Gill, F. & Donsker, D. (Eds). 2019. IOC World Bird List (v9.2). doi: 10.14344/IOC.ML.9.2.

Harebottle, D.M, and Harrison, J.A. 1999. Coordinated Waterbird Counts (CWAC): Guidelines for the completion of the Site Data Collection Form. http://cwac.birdmap.africa/forms.php

Harrison, J.A., Allan, D.G., Underhill, L.G., Herremans, M., Tree, A.J., Parker, V., & Brown, C.J. (eds). (1997) *The Atlas of Southern African Birds*. BirdLife South Africa, Johannesburg.

Hockey P., Dean, W., Ryan, P., Maree S. & Brickman, B. (2005). *Roberts - Birds of Southern Africa* 7th ed. Trustees of the John Voelcker Bird Book Fun/ Africa Geographic Books. 1296 p.

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

Jenkins, A.R., van Rooyen, C.S., Smallie, J.J., Harrison, J.A., Diamond, M., Smit-Robinson, H.A. & Ralston, S. (2015) *Best-Practice Guidelines for Assessing and Monitoring the Impact of Wind-Energy Facilities on Birds in Southern Africa*.

Malan, G. (2009) *Raptor Survey and Monitoring – a Field Guide for African Birds of Prey*. Briza Publications, Pretoria, South Africa.

Marnewick, M., Retief, E., Theron, N., Wright, D., & Anderson, T. (2015). Important Bird and Biodiversity Areas of South Africa. BirdLife South Africa. Johannesburg.

May, R., Reitan, O., Bevanger, K., Lorentsen, S. H., & Nygård, T. (2015). Mitigating wind-turbine induced avian mortality:

Sensory, aerodynamic and cognitive constraints and options. *Renewable and Sustainable Energy Reviews*, 42, 170-181.

May, R., Nygård, T., Falkdalen, U., Åström, J., Hamre, Ø., & Stokke, B. G. (2020). Paint it black: Efficacy of increased wind turbine rotor blade visibility to reduce avian fatalities. Ecology and evolution, 10(16), 8927-8935.

McClure, C. J., Rolek, B. W., Dunn, L., McCabe, J. D., Martinson, L., & Katzner, T. (2021). Eagle fatalities are reduced by automated curtailment of wind turbines. *Journal of Applied Ecology*, 58(3), 446-452.

Mucina, L. & Rutherford, M.C. (eds). (2006, as amended). *The Vegetation of South Africa, Lesotho and Swaziland*. South African National Biodiversity Institute, Pretoria.

Murgatroyd, M., Bouten, W., & Amar, A. (2021). A predictive model for improving placement of wind turbines to minimise collision risk potential for a large soaring raptor. *Journal of Applied Ecology*, 58 (4), 857-868.

Perold, V., Ralston-Paton, S. & Ryan, P. (2020): On a collision course? The large diversity of birds killed by wind turbines in South Africa, Ostrich, DOI: 10.2989/00306525.2020.1770889.

Ralston-Paton, S. (2017). Verreauxs' Eagle and Wind Farms: Guidelines for impact assessment, monitoring, and mitigation. BirdLife South Africa Occasional papers, Johannesburg.

Ralston-Paton, S., Smallie J., Pearson A., and Ramalho R. (2017). Wind energy's impacts on birds in South Africa: A preliminary review of the results of operational monitoring at the first wind farms of the Renewable Energy Independent Power Producer Procurement Programme in South Africa. BirdLife South Africa Occasional Report Series No. 2. BirdLife South Africa, Johannesburg, South Africa.

Retief, E.F., Diamond, M., Anderson, M.D., Smit, H.A., Jenkins, A., Brooks, M. & Simmons, R. (2012). *Avian Wind Farm Sensitivity Map for South Africa.*

SABAP2 (South African Bird Atlas Project). Visited April 2021. http://vmus.adu.org.za/

Sinclair, I. & Ryan, P. 2010. Birds of Africa south of the Sahara: a comprehensive illustrative field guide. 2nd Ed. Struik Publishers. Cape Town.

South African National Biodiversity Institute. (2018) Beta Vegetation Map of South Africa, Lesotho and Swaziland (File Geodatabase) [File geodatabase] 2018. Available from the Biodiversity GIS website (http://bgis.sanbi.org/SpatialDataset/Detail/670).

Sutherland, W.J. 2006 Ecological Census Techniques: A Handbook. Cambridge University Press, New Jork.

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, South Africa.

Young, D.J., Harrison, J.., Navarro, R.A., Anderson, M.A. & Colahan, B.D. (eds). (2003) Big Birds on Farms: Mazda CAR Report 1993-2001. Avian Demography Unit, Cape Town. Young, D.J., Harrison, J.., Navarro, R.A., Anderson, M.A. & Colahan, B.D. (eds). (2003) Big Birds on Farms: Mazda CAR Report 1993-2001. Avian Demography Unit, Cape Town.

9 APPENDIX

9.1 APPENDIX 1: EXPECTED AVIFAUNA SPECIES LIST

Avifauna recorded and predicted to potentially occur within the study area according to SABAP1 and SABAP2.

#	Common Name	Scientific Name	Observed on Site	First species for SABAP Pentads
1	Acacia Pied Barbet	*Tricholaema leucomelas*		
2	African Pipit	*Anthus cinnamomeus*	X	
3	Alpine Swift	*Tachymarptis melba*		
4	Ant-eating Chat	*Myrmecocichla formicivora*	X	
5	Barn Swallow	*Hirundo rustica*		
6	Black-chested Prinia	*Prinia flavicans*		
7	Black-chested Snake Eagle	*Circaetus pectoralis*	X	
8	Black-eared Sparrow-Lark	*Eremopterix australis*	X	
9	Black-headed Canary	*Serinus alario*	X	
10	Black-winged Stilt	*Himantopus himantopus*		
11	Bokmakierie	*Telophorus zeylonus*	X	
12	Burchell's Courser	*Cursorius rufus*	X	
13	Cape Bunting	*Emberiza capensis*		
14	Cape Crow	*Corvus capensis*		
15	Cape Penduline Tit	*Anthoscopus minutus*	X	
16	Cape Sparrow	*Passer melanurus*	X	
17	Cape Turtle Dove	*Streptopelia capicola*	X	
18	Cape Wagtail	*Motacilla capensis*		
19	Capped Wheatear	*Oenanthe pileata*	X	
20	Chat Flycatcher	*Melaenornis infuscatus*	X	
21	Common Quail	*Coturnix coturnix*	X	
	Common Swift	*Apus apus*	X	X
22	Crowned Lapwing	*Vanellus coronatus*	X	
23	Double-banded Courser	*Rhinoptilus africanus*	X	
24	Dusky Sunbird	*Cinnyris fuscus*	X	
	Eastern Clapper Lark	*Mirafra fasciolata*	X	X
25	Egyptian Goose	*Alopochen aegyptiaca*		
26	Familiar Chat	*Oenanthe familiaris*	X	
27	Greater Kestrel	*Falco rupicoloides*	X	
28	Grey Tit	*Melaniparus afer*		
	Grey-backed Cisicola	*Cisticola subruficapilla*	X	X
29	Grey-backed Sparrow-Lark	*Eremopterix verticalis*	X	
30	House Sparrow	*Passer domesticus*		

	Jackal Buzzard	*Buteo rufofuscus*	X	X
31	Karoo Chat	*Emarginata schlegelii*	X	
32	Karoo Eremomela	*Eremomela gregalis*	X	
33	Karoo Korhaan	*Eupodotis vigorsii*	X	
34	Karoo Long-billed Lark	*Certhilauda subcoronata*		
35	Karoo Prinia	*Prinia maculosa*	X	
36	Karoo Scrub Robin	*Cercotrichas coryphoeus*		
37	Kori Bustard	*Ardeotis kori*		
38	Lanner Falcon	*Falco biarmicus*	X	
	Lappet-faced Vulture	*Torgos tracheliotos*	X	X
39	Large-billed Lark	*Galerida magnirostris*	X	X
40	Lark-like Bunting	*Emberiza impetuani*	X	
	Laughing Dove	*Spilopelia senegalensis*	X	X
41	Lesser Kestrel	*Falco naumanni*	X	X
42	Little Grebe	*Tachybaptus ruficollis*	X	
43	Little Swift	*Apus affinis*	X	
44	Ludwig's Bustard	*Neotis ludwigii*	X	
45	Martial Eagle	*Polemaetus bellicosus*	X	
46	Mountain Wheatear	*Myrmecocichla monticola*	X	
47	Namaqua Dove	*Oena capensis*	X	
48	Namaqua Sandgrouse	*Pterocles namaqua*	X	
49	Nicholson's Pipit	*Anthus nicholsoni*		
50	Northern Black Korhaan	*Afrotis afraoides*	X	
51	Pale Chanting Goshawk	*Melierax canorus*	X	
52	Pale-winged Starling	*Onychognathus nabouroup*		
53	Pied Avocet	*Recurvirostra avosetta*		
54	Pied Crow	*Corvus albus*	X	
55	Red Lark	*Calendulauda burra*	X	
56	Red-capped Lark	*Calandrella cinerea*		
57	Red-headed Finch	*Amadina erythrocephala*	X	
58	Rock Kestrel	*Falco rupicolus*	X	
59	Rock Martin	*Ptyonoprogne fuligula*	X	
60	Rufous-eared Warbler	*Malcorus pectoralis*	X	
61	Sabota Lark	*Calendulauda sabota*	X	
62	Scaly-feathered Weaver	*Sporopipes squamifrons*	X	
63	Sclater's Lark	*Spizocorys sclateri*	X	
64	Sickle-winged Chat	*Emarginata sinuata*		
65	Sociable Weaver	*Philetairus socius*		
66	South African Shelduck	*Tadorna cana*		
67	Southern Fiscal	*Lanius collaris*	X	
68	Southern Double-collared Sunbird	*Cinnyris chalybeus*		

69	Speckled Pigeon	*Columba guinea*	X	
70	Spike-heeled Lark	*Chersomanes albofasciata*	X	
71	Spotted Eagle-Owl	*Bubo africanus*	X	
72	Spotted Thick-knee	*Burhinus capensis*	X	
	Spur-winged Goose	*Plectropterus gambensis*	X	X
73	Stark's Lark	*Spizocorys starki*	X	
74	Three-banded Plover	*Charadrius tricollaris*		
75	Tractrac Chat	*Emarginata tractrac*	X	
76	Verreaux's Eagle	*Aquila verreauxii*		
77	Wattled Starling	*Creatophora cinerea*		
78	Western Barn Owl	*Tyto alba*	X	
	White-rumped Swift	*Apus caffer*	X	X
79	White-throated Canary	*Crithagra albogularis*		
80	Yellow Canary	*Crithagra flaviventris*	X	
	Total	88	62	10

9.2 APPENDIX 2: NON-PRIORITY SPECIES CONTACT DATA PER SEASON (WALKED TRANSECT)

Non-Priority Species	Drive Transects										Walk Transects												
	CDT	DT1	DT2	DT3	DT4	DT5	DT6	DT7	DT8	DT9	CWT	WT1	WT2	WT3	WT4	WT5	WT6	WT7	WT8	WTC	WTL1	Random	Total
Winter '21		6		9	7	3	16	8				1		1	2	7	7	15	4	24	3	18	131
Ant-eating Chat				1	3							1					2				2		9
Black-headed Canary																		5					5
Cape Sparrow							2									2		1		8			13
Dusky Sunbird																		1					1
Grey-backed Sparrow-lark																		2					2
Namaqua Sandgrouse																	1			4		6	11
Pied Crow				3			4								1			4	1	1			14
Red Lark							1										1					2	4
Rufous-eared Warbler					1			2															3
Sclater's Lark																3	2					5	10
Speckled Pigeon							1													3			4
Spike-heeled Lark		6		5	3	3	7	6						1	1	2	1	2	3	7	1	3	51
Spotted Eagle-Owl																						1	1
Tractrac Chat							1													1			2
Yellow Canary																						1	1
Spring '21	7	7	6	6	2	2	22	2	2	22		7	6	3		2	3	13	3		2	10	127
Ant-eating Chat										2													2
Cape Sparrow		7	3	1			2										1						14
Chat Flycatcher	1											2											3
Crowned Lapwing																						1	1
Grey-backed Sparrow-lark				3			8																11
Lark-like Bunting					1							2	2										5

Namaqua Dove										1											1
Namaqua Sandgrouse																		1			1
Pied Crow	2			1						3		1	3							1		11
Red Lark				1	1							1					2		1		2	8
Rock Martin							6														2	8
Sclater's Lark										7								3				10
Southern Fiscal																					1	1
Spike-heeled Lark	2		3			2	6	2	2	9			1	3		2		3	1	1		37
Spotted Eagle-Owl																					1	1
Spotted Thick-knee																					2	2
Tractrac Chat	2											1						1				4
White-rumped Swift																		5	1		1	7
Summer '22	9	5	4	16		7	56	27	11	46	36	11	5	5	17	39	25	43	55	4	60	481
Ant-eating Chat	2			2			3			1												8
Bokmakierie																					1	1
Cape Sparrow	1					2				5	12	1				2		2				25
Capped Wheatear				1																		1
Common Swift			3				2			2	2					10	3	8	30			60
Greater Kestrel						1																1
Grey-backed Sparrow-lark				3			23	8	4	13	3	5	1		9	4	4	1	2	1		81
Karoo Chat	1	1					1									2						5
Lappet-faced Vulture																					36	36
Lark-like Bunting									5			1							2			8
Mountain Wheatear																					1	1
Namaqua Dove																					4	4
Namaqua Sandgrouse							10	13			7	2			5	7	3	22	16			85
Pied Crow	3	2		2		2				7			1									17

Red Lark											1						1		3		5	10
Rock Kestrel																					1	1
Scaly-feathered Finch							4															4
Sclater's Lark																11		5				16
Southern Fiscal																					1	1
Speckled Pigeon								4		6												10
Spike-heeled Lark	2	2	1	3		2	3	2		6	6			5	1			3		3		39
Spotted Eagle-Owl																					4	4
Spotted Thick-knee																					2	2
Spur-winged Goose																					3	3
Stark's Lark				4			10		2	6	2	2	3		2	3	14	2	2			52
Tractrac Chat				1																		1
White-rumped Swift											3											3
Yellow Canary																					2	2
Autumn '22	43	10	14	18	16	13	14	21	14	64	61	137	7	6	96	1	4	181	47	12	117	896
Ant-eating Chat	3		1	3			3	4		6		2							1	4	5	32
Black-eared Sparrow-Lark	4			1	1	8	1	1	1		14	10			34				23		4	102
Cape Penduline Tit				1																		1
Cape Sparrow	1							1		2	20								1		9	34
Cape Turtle Dove	1				1			1	1													4
Capped Wheatear						1												1	1		1	4
Chat Flycatcher												2										2
Common Quail																					4	4
Dusky Sunbird	2				1			1														4
Familiar Chat	3		2																		1	6
Grey-backed Cisticola	3	2					2															7

Grey-backed Sparrow-lark	5			1	2		1	2	2		17				48			147	3				228
Jackal Buzzard	1																					2	3
Karoo Chat	1		2					1	1					2				4			1		12
Karoo Eremomela					1																		1
Karoo Prinia								1															1
Lark-like Bunting		1	1	2	2		1											1	2		1		11
Laughing Dove	1																						1
Mountain Wheatear																						1	1
Namaqua Dove	3	1	2		1			1	2			8										3	21
Namaqua Sandgrouse	1	1	1	3	3			3	2	4	1	30			3			3	8		6	54	123
Pale Chanting Goshawk	1																					2	3
Pied Crow	5	1	3	1	1		2		2					1			1	1				1	19
Red Lark	3	3					2	1	1	2	1								3			7	23
Red-headed Finch																						7	7
Rock Martin											3											1	4
Rufous-eared Warbler										1					1								2
Sabota Lark																		1					1
Sclater's Lark													6					2					8
Southern Fiscal																						1	1
Speckled Pigeon	1							1		37	2	84										10	135
Spike-heeled Lark		1		3	2	2	2	2	1	12	3		1	1	2		2	3	5			1	43
Spotted Eagle-Owl																						1	1
Spotted Thick-knee																						1	1
Stark's Lark														2	8	1		18					29
Tractrac Chat	4		2	2	1	2			1			1					1						14
Western Barn Owl																						1	1
Yellow Canary				1				1															2

Total	59	28	24	49	25	25	108	58	27	132	97	156	18	15	115	49	39	252	109	24	21	205	1635

9.3 APPENDIX 3: NON-PRIORITY SPECIES CONTACT DATA PER SEASON (VANTAGE POINT)

	Vantage Points									
Non-Priority Species	**CVP**	**VP1**	**VP2**	**VP3**	**VP4**	**VP5**	**VP6**	**VP7**	**VP8**	**Total**
Winter '21	44	20	11	13	10	11	19	25	94	247
Ant-eating Chat		2						2		4
Cape Sparrow	4		2	1				6	9	22
Chat Flycatcher									5	5
Grey-backed Sparrow-lark	5					6				11
Karoo Chat									2	2
Namaqua Sandgrouse	16			5	1			11	29	62
Pied Crow	12	4	3	2	6	1	2	3	16	49
Red Lark			1							1
Scaly-feathered Finch									8	8
Speckled Pigeon			1		1					2
Spike-heeled Lark	6	10	2	2	2	3	17		13	55
Tractrac Chat	1	4	2	3		1		3	2	16
Yellow Canary									10	10
Spring '21	52	7	13	5	7	10	15	18	42	169
African Pipit			1							1
Ant-eating Chat		3						1	1	5
Black-eared Sparrow-Lark	8		1							9
Black-headed Canary	1									1
Cape Sparrow	3			1		5	2	3	13	27
Capped Wheatear								3		3
Chat Flycatcher									4	4
Grey-backed Sparrow-lark	7									7
Karoo Chat			1					2		3
Lark-like Bunting		2	2			2		1	4	11
Little Swift	1									1
Namaqua Sandgrouse	2						1			3
Pied Crow	4		2	1	5		2	1	3	18

Mobile: Sam - 072 437 1742
Mobile: Luke - 083 784 1997
Email: info@enviro-insight.co.za
Website: www.enviro-insight.co.za

Red Lark						1			3	4
Rock Martin	2									2
Rufous-eared Warbler	3								3	6
Speckled Pigeon	8									8
Spike-heeled Lark	5	2	5	3		2	9	3	9	38
Stark's Lark								1		1
Tractrac Chat	6		1					2	2	11
White-rumped Swift	2				2					4
Yellow Canary							1	1		2
Summer '22	83	61	62	81	87	47	119	68	53	661
Ant-eating Chat		3	4			2			1	10
Black-eared Sparrow-Lark	4									4
Black-headed Canary	5									5
Bokmakierie									1	1
Cape Sparrow		2	1	2					6	11
Capped Wheatear			1						1	2
Chat Flycatcher			1						1	2
Common Swift	15	28	12	53	53	10	41	3	3	218
Greater Kestrel							2			2
Grey-backed Sparrow-lark	26	11	4	1	6	7	21	28	9	113
Karoo Chat		1	1							2
Lappet-faced Vulture									2	2
Lark-like Bunting	4	2	4		1		4	7	6	28
Namaqua Dove	1			3						4
Namaqua Sandgrouse	13	11	17	16	19	2	22	24	7	131
Pied Crow		1	4			9	10		4	28
Red Lark			7					1	1	9
Rock Kestrel							1			1
Rufous-eared Warbler	1								1	2
Scaly-feathered Finch								3	4	7
Spike-heeled Lark		2	3	3	6	9	7	2	1	33
Stark's Lark	6		2	3	2	8	11		3	35
Tractrac Chat			1						2	3

White-rumped Swift	8									8
Autumn '22	180	113	574	67	73	35	33	75	280	1430
Ant-eating Chat		6	5	5		1		1		18
Black-eared Sparrow-Lark	32		31				1	16	18	98
Cape Sparrow	3									3
Capped Wheatear				3				2	4	9
Common Quail						4				4
Eastern Clapper Lark							1			1
Grey-backed Sparrow-lark	100	60	493	25	14	3		2	79	776
Karoo Chat				3						3
Lark-like Bunting		2	1					2		5
Mountain Wheatear				2						2
Namaqua Dove								3		3
Namaqua Sandgrouse	29	21	11	14	56	25	13	35	136	340
Pied Crow	2	5	2	5	2		12	2	6	36
Red Lark			2						2	4
Red-headed Finch								3		3
Rock Kestrel		1								1
Rufous-eared Warbler	5		3						3	11
Sabota Lark									2	2
Scaly-feathered Finch									8	8
Sclater's Lark			12	4						16
Southern Fiscal									1	1
Speckled Pigeon							2	4		6
Spike-heeled Lark		5		2	1		4	5	9	26
Stark's Lark	9	13	12	4		2			7	47
Tractrac Chat			2						5	7
Total	**359**	**201**	**660**	**166**	**177**	**103**	**186**	**186**	**469**	**2507**