AVIFAUNAL IMPACT ASSESSMENT

Prieska Power Reserve: Construction of Wind Electricity Generation Turbines and Associated Infrastructure, Prieska, Northern Cape

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EXECUTIVE SUMMARY

PRIESKA POWER RESERVE (PTY) LTD is a planning, managing, contracting, and financing facilitator for solar plants. It now also expands into wind energy and, in addition, also want to facilitate, at a much higher level, the establishment of downstream businesses.
Planned industries for the Power Reserve Hub proposal in the Prieska area is anticipated to be developed in phases:

- Phase 1: Development and construction of a PV plant with associated infrastructure;
- Phase 2: Development and construction of an industrial park for green hydrogen and ammonia production; and
- Phase 3: Development and construction of a wind energy facility (WEF) with associated infrastructure.

This Specialist Assessment Report deals with the potential impact of Phase 3, the development of a WEF with associated infrastructure, on avifauna.

1 AVIFAUNA

The SABAP2 data, combined with the result of the monitoring surveys, indicate that a total of 197 bird species could potentially occur within the broader area – Appendix 1 provides a comprehensive list of all the species. Of these, 22 species are classified as priority species for wind energy development. Nine (9) of these are South African Red List species.

2 SUMMARY OF FINDINGS AND CONCLUDING STATEMENT

The proposed Prieska Power Reserve WEF will have several potential impacts on priority avifauna. The impacts are the following:

- Displacement of priority species due to disturbance associated with construction of the WEF and associated infrastructure.
- Displacement of priority species due to habitat transformation associated with construction of the WEF and associated infrastructure.
- Displacement of priority species due to disturbance associated with construction of the overhead power lines.
- Mortality of priority species due to collisions with the turbines in the operation phase.
- Mortality of priority species due to collisions with the overhead lines
- Mortality of priority species due to electrocution on the overhead lines, collector substations and on-site substations
- Displacement of priority species due to disturbance associated with decommissioning of the WEF and associated infrastructure.
- Displacement of priority species due to disturbance associated with decommissioning of the overhead lines, collector substations and on-site substations.

2.1 Displacement of priority species due to disturbance associated with construction of the WEF and associated infrastructure.

It is inevitable that a measure of displacement will take place for all priority species during the construction phase of the WEF, due to the disturbance factor associated with the construction activities. This is likely to affect ground nesting species severely, as this could temporarily disrupt their reproductive cycle. Species which fall in this category are Ludwig's Bustard, Karoo Korhaan, Kori Bustard, Double-banded Courser, African Rock Pipit, Grey-winged Francolin, Northern Black Korhaan and Spotted Eagle-Owl. Some raptors might also be affected, e.g., Pale Chanting Goshawk which could potentially breed in the small *Senegalia mellifera* trees in the drainage lines.

Another major potential concern is the potential displacement of the estimated five (5) pairs of Verreaux's Eagles that breed within the PAOI, due to disturbance. The VE guidelines recommend a minimum no-disturbance buffer of 1km around Verreaux's Eagle nests (Ralston-Patton 2021) where no construction activities should take place.

Some species might be able to recolonise the area after the completion of the construction phase, but for some species this might only be partially the case, resulting in lower densities than before once the WEFs are operational, due to the disturbance factor of the operational turbines.

The impact is rated as **Medium** before and after mitigation.

The following mitigation measures are proposed:

- Construction activity should be restricted to the immediate footprint of the infrastructure as far as possible, and in particular to the proposed road network. Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species.
- Construction of new roads should only be considered if existing roads cannot be upgraded.
- Vehicle and pedestrian access to the site should be controlled and restricted as much as possible to prevent unnecessary disturbance of priority species.
- No construction activity should take place within 1km of any Verreaux's Eagle nests, except if there is already an existing road, and avoiding the 1km buffer would result in the construction of a new road.

2.2 Displacement of priority species due to habitat transformation associated with construction of the WEF and associated infrastructure.

The network of roads is likely to result in significant habitat fragmentation, and it could have an effect on the density of several species, particularly terrestrial species such as Ludwig's Bustard, Kori Bustard, Karoo Korhaan, Northern Black Korhaan, Double-banded Courser, Grey-winged Francolin and Africa Rock Pipit. Various species of raptors could also be affected. Given the current density of the proposed turbine layout and associated road infra-structure for the WEF development, it is not expected that any priority species will be permanently displaced from the development sites.

The impact is rated as **Medium** before and **Low** after mitigation.

The following mitigation measures are proposed:

- Vegetation must be rehabilitated to its former state where possible after construction.
- The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint is concerned.
- Formal live-bird monitoring should be resumed once the turbines have been constructed, as per the most recent edition of the Best Practice Guidelines (Jenkins et al. 2015). The purpose of this would be to establish if displacement of priority species has occurred and to what extent. The exact time when operational monitoring should commence, will depend on the construction schedule, and should commence when the first turbines start operating. The Best Practice Guidelines require that, as an absolute minimum, operational monitoring should be undertaken for the first two (preferably three) years of operation, and then repeated again in year 5, and again every five years thereafter for the operational lifetime of the facility.

2.3 Displacement of priority species due to disturbance associated with construction of the overhead power lines.

It is inevitable that a measure of displacement will take place for all priority species during the construction phase of the WEF, including the associated electricity infrastructure, due to the disturbance factor associated with the construction activities. This is likely to affect ground nesting species severely, as this could temporarily disrupt their reproductive cycle. Species which fall in this category are Ludwig's Bustard, Karoo Korhaan, Kori Bustard, Double-banded Courser, African Rock Pipit, Grey-winged Francolin, Northern Black Korhaan and Spotted Eagle-Owl. Some raptors might also be affected, e.g., Pale Chanting Goshawk which could potentially breed in the small *Senegalia mellifera* trees in the drainage lines.

Another major potential concern is the potential displacement of the estimated five (5) pairs of Verreaux's Eagles that breed within the PAOI, due to disturbance. The VE guidelines recommend a minimum no-disturbance buffer of 1km around Verreaux's Eagle nests (Ralston-Patton 2021) where no construction activities should take place. The exception to this would be in certain circumstances where a nest is located on or within 1km of an existing transmission line. In such an event, it is preferable to place any new powerlines next to the existing powerline, even if this means temporary disturbance of a pair of breeding eagles. By placing the new line next to an existing line, the creation of a new collision risk in a pristine area is avoided, and the collision risk that the new line poses is also mitigated to some extent through making both the lines more visible. The temporary, short- term disturbance of the eagles is less detrimental compared to the long-term collision risk that the new powerline will pose in a pristine area and the additional habitat fragmentation which it will cause. This particularly relevant for the construction of the proposed 132kV OHL and associated road, which may cause the temporary displacement of priority species using the existing Burchell - Cuprum 132kV line for roosting and nesting purposes, due to disturbance associated with the construction activities. The proposed 132kV OHL will run for a considerable distance next to the existing 132kV OHL and comes to within 700m of an existing Verreaux's Eagle nest.

The impact is rated as **Medium** before and after mitigation.

The following mitigation measures are proposed:

- Conduct a pre-construction inspection (avifaunal walk-through) to record the status of the priority species nests on the existing Burchell – Cuprum 132kV high voltage line. If a nest of a SCC is found to be occupied, the avifaunal specialist must consult with the contractor to find ways of minimising the potential disturbance to the breeding pair of birds during the construction period. This could include measures such as delaying some of the activities until after the breeding season.
- Construction activity should be restricted to the immediate footprint of the infrastructure as far as practically possible.
- Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species.
- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum.
- No construction activity should take place within 1km of any Verreaux's Eagle nests, except if there is already an existing OHL, and the new OHL is routed directly next to the existing OHL. In the latter instance, construction activity should be restricted to outside the breeding season i.e. from November to March, if possible.

2.4 Mortality of priority species due to collisions with the turbines in the operation phase.

The proposed WEF will pose a potential collision risk to several priority species which could occur regularly in the PAOI. Species exposed to this risk are large terrestrial species i.e., mostly bustards, korhaans, francolins and coursers, although bustards generally seem to be not as vulnerable to turbine collisions as was originally anticipated (Ralston-Paton & Camagu, 2019). Soaring priority species, i.e., raptors such as Pale Chanting Goshawk, Lanner Falcon, Booted Eagle, Greater Kestrel, White-backed Vulture, Lappet-faced Vulture and in particular, Verreaux's Eagle, are most at risk of collision mortality of all the priority species likely to occur regularly in the PAOI.

The impact is rated as **High** before and **Low** after mitigation.

The following mitigation measures are proposed:

- No turbines (including their rotor swept area) should be constructed within 200m around water points and 150m from the centre line of drainage lines to limit potential collision risk to priority species which are attracted to the surface water.
- All turbines must be curtailed from an hour before sunrise to an hour after sunset every day for the operational lifetime of the WEF, to eliminate the risk of priority species collisions, particularly to Verreaux's Eagle. This is a novel mitigation measure and has been agreed to by the proponent. See Appendix 4 for a detailed explanation of this proposed mitigation measure, including a monthly sunrise and sunset chart for Prieska, and the advantages over traditional anti-collision buffer zones.
- Carcass searches must be implemented to establish mortality rates, as per the most recent edition of the Best Practice Guidelines (Jenkins et al. 2015). The exact time when operational monitoring should commence, will depend on the construction schedule, and should commence when the first turbines starts operating. The Best Practice Guidelines require that, as an absolute minimum, operational monitoring should be undertaken for the first two (preferably three) years of operation, and then repeated again in year 5, and again every five years thereafter for the operational lifetime of the facility. If annual estimated collision rates indicate unsustainable mortality levels of priority species, i.e. if natural background mortality together with the estimated mortality caused by turbine collisions exceeds a critical mortality threshold as determined by the avifaunal specialist in consultation with other experts e.g. BLSA, additional measures will have to be implemented. This must be undertaken in consultation with a qualified avifauna specialist.

2.5 Mortality of priority species due to collisions with the overhead lines

Collisions are arguably the biggest threat posed by overhead lines to birds in southern Africa (Van Rooyen, 2004). Most heavily impacted upon are bustards, storks, cranes and various species of waterbirds, and to a lesser extent, vultures. These species are mostly heavy-bodied birds with limited manoeuvrability, which makes it difficult for them to take the necessary evasive action to avoid colliding with transmission lines (Van Rooyen, 2004; Anderson, 2001).
Using a controlled experiment spanning a period of nearly eight years (2008 to 2016), the EWT and Eskom tested the effectiveness of two types of line markers in reducing powerline collision mortalities of large birds on three 400kV transmission lines near Hydra substation in the Karoo. Marking was highly effective for Blue Cranes, with a 92% reduction in mortality, and large birds in general with a 56% reduction in mortality, but not for bustards, including the endangered Ludwig's Bustard. The two different marking devices were approximately equally effective, namely spirals and bird flappers, they found no evidence supporting the preferential use of one type of marker over the other (Shaw et al., 2017).

The impact is rated as **Medium** before and after mitigation.

The following mitigation measures are proposed:

- Use underground cables as much as possible for the medium voltage connections.
- All overhead lines must be marked with Eskom approved Bird Flight Diverters according to the latest official Eskom Engineering Instruction.

2.6 Mortality of priority species due to electrocution on the overhead lines, collector substations and on-site substations

Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen, 2000). The electrocution risk is largely determined by the design of the electrical hardware and the size of the bird.

Ideally the 33kV reticulation network should be placed underground where possible. If the lines have to run above ground, for technical reasons, the poles could potentially pose a serious electrocution risk to raptors, which could result in mortalities even more severe than turbine collisions, unless a bird-friendly design is used. Raptors and vultures are particularly at risk. Electrocutions within the proposed substations are possible, however the likelihood of this impact on the more sensitive Red List priority species is remote, as these species are unlikely to regularly utilise the infrastructure within the substation yard for perching or roosting.

The only priority species capable of bridging the clearance distances of the proposed 132kV power line infrastructure are White-backed Vultures and Lappet-faced Vultures, due to their size and gregarious nature. There is an established White-backed Vulture and Lappet-faced Vulture roost on this line ~25 km south-west of the PAOI (>100 birds). Based on interviews with landowners and personal observations, it is it seems that the numbers of White-backed Vultures and Lappet-faced Vultures are on the increase south of the Orange River in the Northern Cape during the non-breeding season (December to May). These birds establish temporary roosts on power lines, and it is entirely possible that the birds could on occasion roost on the proposed 33kV and 132kV powerlines. Depending on the proposed pole design, this could place them at risk of electrocution.

The impact is rated as **High** before and **Low** after mitigation.

The following mitigation measures are proposed:

- Construction of the power line using an approved bird friendly pole/tower design in accordance with the Eskom Distribution Technical Bulletin relating to bird friendly structures. The avifaunal specialist must sign off on the final design.
- The hardware within the proposed central collector substation yard is too complex to warrant any mitigation for electrocution at this stage. It is recommended that if on-going impacts are recorded once operational, site-specific mitigation (insulation) be applied reactively. This is an acceptable approach because Red List priority species are unlikely to frequent the switching station and substation and be electrocuted.

2.7 Displacement of priority species due to disturbance associated with decommissioning of the WEF and associated infrastructure.

The impact of displacement due to disturbance during this phase will be similar in nature and intensity as during the construction phase (see 3.3).

The impact is rated as **Medium** before and after mitigation.

The following mitigation measures are proposed:

- Activity should as far as possible be restricted to the footprint of the infrastructure.
- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical.
- Access to the rest of the property must be restricted.
- The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the footprint is concerned.
- Measures to control noise and dust should be applied according to current best practice in the industry

2.8 Displacement of priority species due to disturbance associated with decommissioning of the overhead lines, collector substations and on-site substations.

The impact of displacement due to disturbance during this phase will be similar in nature and intensity as during the construction phase (see 14.3).

The impact is rated as **Medium** before and after mitigation.

The following mitigation measures are proposed:

- Activity should as far as possible be restricted to the footprint of the infrastructure.
- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical.
- Access to the rest of the property must be restricted.
- The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the footprint is concerned.
- Measures to control noise and dust should be applied according to current best practice in the industry

2.9 Cumulative impacts

The total affected land parcel area taken up by authorised renewable energy projects within the 30km radius (all solar PV) is approximately 260km², although the actual area affected by the solar facilities is likely to be 20% or less of the land parcel area, i.e. ~52 km². The total area affected by the proposed Prieska Power Reserve WEF project equates to ~10 km². The combined area affected by authorised renewable energy developments within the 30 km radius around the proposed WEF, including the proposed WEF, thus equals ~62 km². Of this, the proposed WEF project constitutes ~16%. The contribution of the proposed WEF to the cumulative impact of the renewable energy projects is thus anticipated to be **medium** after mitigation.

The total area of natural habitat within the 30km radius around the proposed projects equates to about 2 691km² (excluding urban areas and irrigated agriculture). The total combined size of the area potentially affected by renewable energy projects will thus equate to ~2.3% of the available untransformed habitat in the 30km radius, should all the projects be constructed. However, each of these projects must still be subject to a competitive bidding process where only the most competitive projects will win a power purchase agreement required for the project to proceed to construction. The cumulative impact of all the proposed renewable energy projects is thus estimated to affect a maximum of ~2.3% or less of the available untransformed habitat, resulting in a **low** impact.

The table below is a table with a summarised assessment of the anticipated impacts.

Nature of the Impact	Rating prior to mitigation	Rating post mitigation
Displacement of priority species due to disturbance associated with construction of the WEF and associated infrastructure.	50 MEDIUM	40 MEDIUM
Displacement of priority species due to habitat transformation associated with construction of the WEF and associated infrastructure.	33 MEDIUM	27 LOW
Displacement of priority species due to disturbance associated with construction of the overhead power lines.	50 MEDIUM	40 MEDIUM
Mortality of priority species due to collisions with the turbines in the operation phase.	60 HIGH	22 LOW

Mortality of priority species due to collisions with the overhead lines	48 MEDIUM	30 MEDIUM
Mortality of priority species due to electrocution on the overhead lines, collector substations and on-site substations	60 HIGH	11 LOW
Displacement of priority species due to disturbance associated with decommissioning of the WEF and associated infrastructure.	50 MEDIUM	40 MEDIUM
Displacement of priority species due to disturbance associated with decommissioning of the overhead lines, collector substations and on-site substations	50 MEDIUM	40 MEDIUM
AVERAGE SIGNIFICANCE RATING	**50 MEDIUM**	**31 MEDIUM**

3 ENVIRONMENTAL SENSITIVITIES

The following environmental sensitivities were identified from an avifaunal perspective in the development area:

3.1 Surface water: 200/150 m turbine exclusion zone

No turbines (including their rotor swept areas) should be constructed within 200m around water points and 150m from the centre line of drainage lines to limit potential collision risk to priority species which are attracted to the surface water. Surface water in this semi-arid habitat is crucially important for priority avifauna, including nocturnal species e.g. Spotted Eagle-Owl, and some non-priority species. It is important to leave open space with no turbines for birds to access and leave the surface water area unhindered.

3.2 Verreaux's Eagle nests: 1km all infrastructure exclusion zone

A 1km all infrastructure exclusion zone must be implemented around the Verreaux's Eagle nests at the following localities:

- VE nest 2: -29.761014° 22.724252°
- VE nest 5: -29.821777° 22.767599°
- VE nest 6: -29.785307° 22.742258°
- VE nest 7 & 8: -29.782901° 22.777143°
- VE nest 18 & 19: -29.759758° 22.762227°
- VE nest 12 & 13: -29.830647° 22.774612°
- VE nest 30: -29.838815° 22.816784°
- VE nest 31: -29.835845° 22.817236°

This is to prevent the birds from being displaced from their nest due to disturbance associated with the construction activities at the WEF. Verreaux's Eagles are classified as regionally Vulnerable (Taylor *et al*. 2015).

See Figure (i) for the avifaunal sensitivities identified in the PAOI.

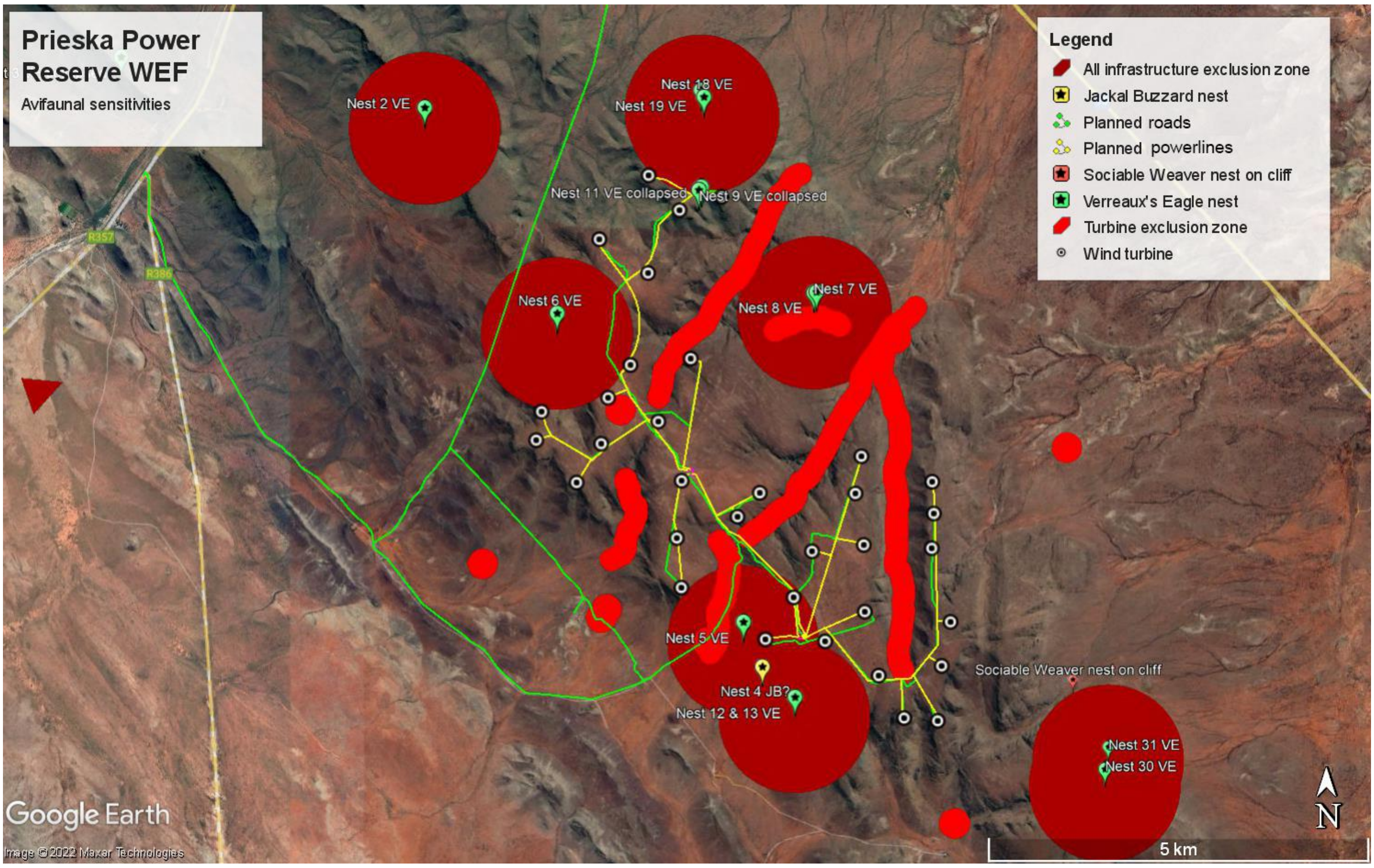


Figure (i): Avifaunal sensitivities identified in the PAOI.

4 CONCLUSIONS

The proposed Prieska Power Reserve WEF could have a range of potential pre-mitigation impacts on priority avifauna ranging from medium to high, which is expected to be reduced to medium and low with appropriate mitigation. No fatal flaws were discovered during the investigations. The development is therefore supported, provided the mitigation measures listed in this report are strictly applied.

CONTENTS

DETAILS OF THE SPECIALIST

Chris van Rooyen (Bird Specialist)

Chris has decades' experience in the management of wildlife interactions with electricity infrastructure. He was head of the Eskom-Endangered Wildlife Trust (EWT) Strategic Partnership from 1996 to 2007, which has received international acclaim as a model of co-operative management between industry and natural resource conservation. He is an acknowledged global expert in this field and has worked in South Africa, Namibia, Botswana, Lesotho, New Zealand, Texas, New Mexico and Florida. Chris also has extensive project management experience and has received several management awards from Eskom for his work in the Eskom-EWT Strategic Partnership. He is the author of 15 academic papers (some with co-authors), co-author of two book chapters and several research reports. He has been involved as ornithological consultant in numerous power line and wind generation projects. Chris is also co-author of the Best Practice for Avian Monitoring and Impact Mitigation at Wind Development Sites in Southern Africa, which is currently (2016) accepted as the industry standard. Chris also works outside the electricity industry and had done a wide range of bird impact assessment studies associated with various residential and industrial developments.

Albert Froneman (Bird and GIS Specialist)

Albert has an M. Sc. in Conservation Biology from the University of Cape Town and started his career in the natural sciences as a Geographic Information Systems (GIS) specialist at Council for Scientific and Industrial Research (CSIR). In 1998, he joined the Endangered Wildlife Trust where he headed up the Airports Company South Africa – EWT Strategic Partnership, a position he held until he resigned in 2008 to work as a private ornithological consultant. Albert's specialist field is the management of wildlife, especially bird related hazards at airports. His expertise is recognized internationally; in 2005 he was elected as Vice Chairman of the International Bird Strike Committee. Since 2010, Albert has worked closely with Chris van Rooyen in developing a protocol for pre-construction monitoring at wind energy facilities, and he is currently jointly coordinating pre-construction monitoring programmes at several wind farm facilities. Albert also works outside the electricity industry and had done a wide range of bird impact assessment studies associated with various residential and industrial developments.

Definitions	
Priority species	Species listed in the latest (2014) list of priority species for wind energy development.
Broader Area	The area covered by the 9 SABAP2 pentads where the project is located.
Project Site	The total area set aside for all planned turbines namely 1007.69 ha
Pentad	A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km.
Project Area of Impact (PAOI)	An aggregate area encompassing of a 1km buffer area around the turbine layout and a 2km buffer around the proposed 132kV OHL.

List of Abbreviations

BLSA	BirdLife South Africa
DFFE	Department of Forestry, Fisheries and Environment
EIA	Environmental Impact Assessment
IBA	Important Bird Area
NEMA	National Environmental Management Act 107 of 1998 (as amended)
NPAES	National Protected Areas Expansion Strategy
PAOI	Project Area of Impact
REDZ	Renewable Energy Development Zone
SABAP 2	South African Bird Atlas Project 2
SACNASP	South African Council for Natural and Scientific Professions
SANBI	South African National Biodiversity Institute
SCC	Species of Conservation Concern
SEA	Strategic Environment Assessment
SIP	Strategic Infrastructure Project
WEF	Wind Energy Facility

1. INTRODUCTION

PRIESKA POWER RESERVE (PTY) LTD is a planning, managing, contracting, and financing facilitator for solar plants. It now also expands into wind energy and, in addition, also want to facilitate, at a much higher level, the establishment of downstream businesses.

An opportunity arose in 2014 for PRIESKA POWER RESERVE (PTY) LTD when access was gained to leasable land about 10 km southeast of Prieska in the Northern Cape. Since then, PRIESKA POWER RESERVE (PTY) LTD has undertaken feasibility investigations for the flexible production of green hydrogen and ammonia from variable solar and wind energy. Prieska and surrounding areas proof to have extremely good solar and wind load factors. PRIESKA POWER RESERVE (PTY) LTD developed a model to utilise these load factors to produce green ammonia of which the hydrogen content is derived from the renewable energy sources, solar and wind (energy production).

Planned industries for the Power Reserve Hub proposal in the Prieska area is anticipated to be developed in phases:

- Phase 1: Development and construction of a PV plant with associated infrastructure;
- Phase 2: Development and construction of an industrial park for green hydrogen and ammonia production; and
- Phase 3: Development and construction of a wind energy facility (WEF) with associated infrastructure.

This Specialist Assessment Report deals with the potential impact of Phase 3, the development of a WEF with associated infrastructure, on avifauna.

The WEF will be constructed on sections of the following land portions, with the area set aside for turbines:

- Karabee 3/50 (289.44 ha); Jan-se-Plaas
- Karabee 9/50 (36.03 ha); Stoffelshoek
- Prieska's Poort (2/51) (19.53 ha); Prieska's Poort
- Prieska's Poort (11/51) (347.46 ha); Prieska's Poort
- Karabee 4(RE)/50 (84.38 ha); Wonderpan
- Karabee 8(RE)/50 (123.72 ha); Wonderpan
- T'Keikans Poort (12(RE)/71) (51.93 ha); Pienaar Boerderye
- RE of Erf 1, Prieska (55.20 ha); Municipal Land /Townlands

Prieska is in the Siyathemba Local Municipality in the Northern Cape Province. In the first phase of the wind turbine project, a total of 21 turbines will be erected, delivering 138.6 MW AC. The second phase will bring the erection of the other thirteen turbines and an additional 85.8 MW AC.

PRIESKA POWER RESERVE (PTY) LTD has appointed Green-Box Consulting as the independent environmental assessment practitioner to undertake the Environmental Impact Assessment (EIA) for the proposed facility. The EIA process is being undertaken in accordance with the requirements of the EIA Regulations of 2014 (as amended), promulgated in terms oof the National Environmental Management Act (NEMA: Act No. 107 of 1998). Green-Box Consulting has appointed Chris van Rooyen Consulting to assess the impact of the proposed facility on avifauna.

A summary of the key components of the proposed project is described below. It is important to note at the outset that the exact specifications of the proposed project components will be determined during the detailed engineering phase.

- The project is being developed with a maximum possible production capacity of 224 MW AC of electricity. The preferred project site includes approximately 1007.69 hectare of land in total with a footprint of 33.64 hectares.
- The wind facility will consist of the following components:

- Thirty-four (34) separate wind turbines and associated laydown areas of approximately 80 m x 125 m (0.96 ha) in size each
- Two electrical combiner substations
- Connection 132kV overhead powerline (OHL) that will run parallel to the existing Cuprum-Burchell line
- Access road
- Security towers and a utility building, with ablutions
- 33kV medium OHL network connecting the turbines with the combiner substations
- Laydown area, and
- Perimeter fencing and internal security

Please see Figures 1 and 2 for maps of the proposed development.

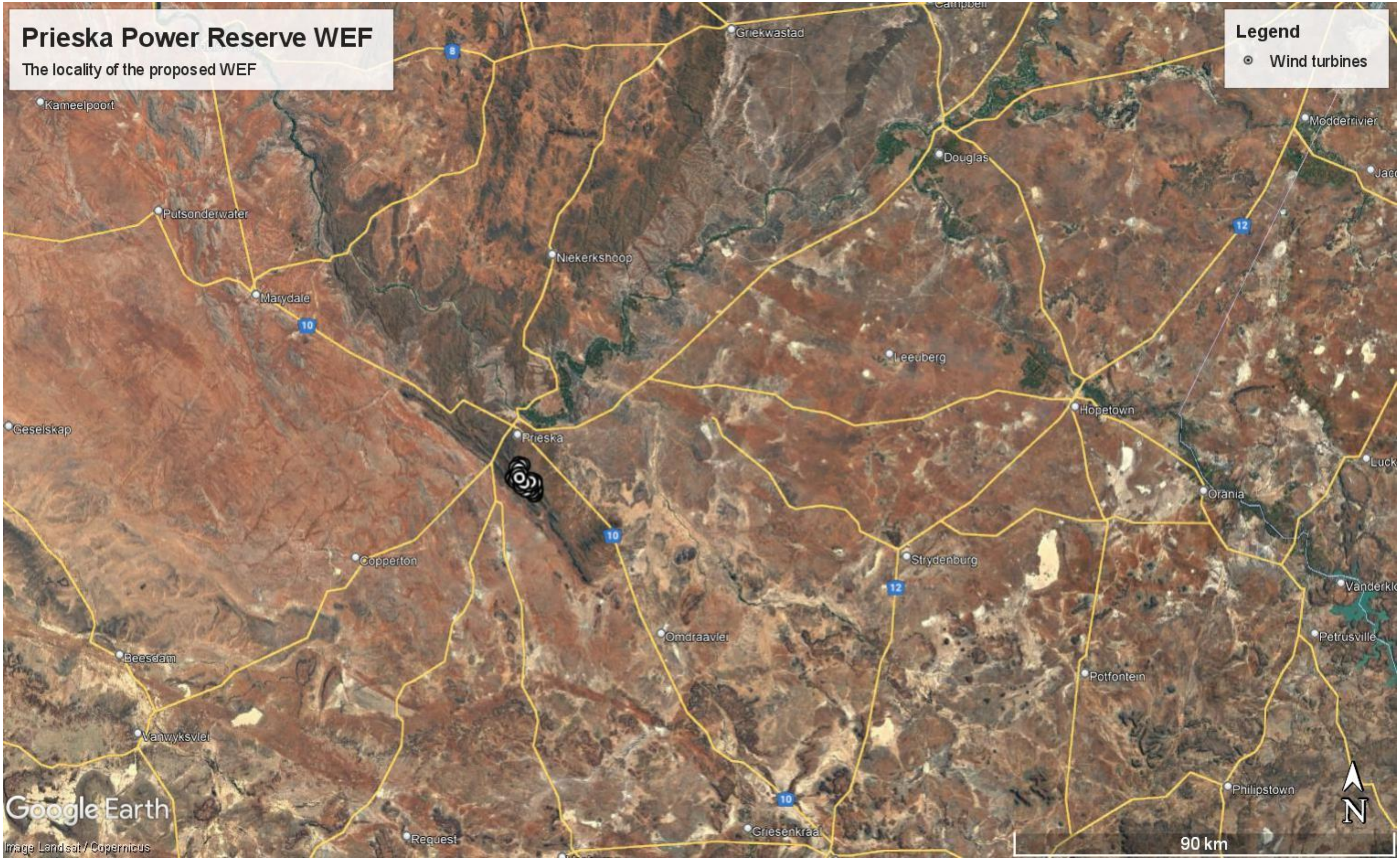


Figure 1: Locality map of the proposed WEF

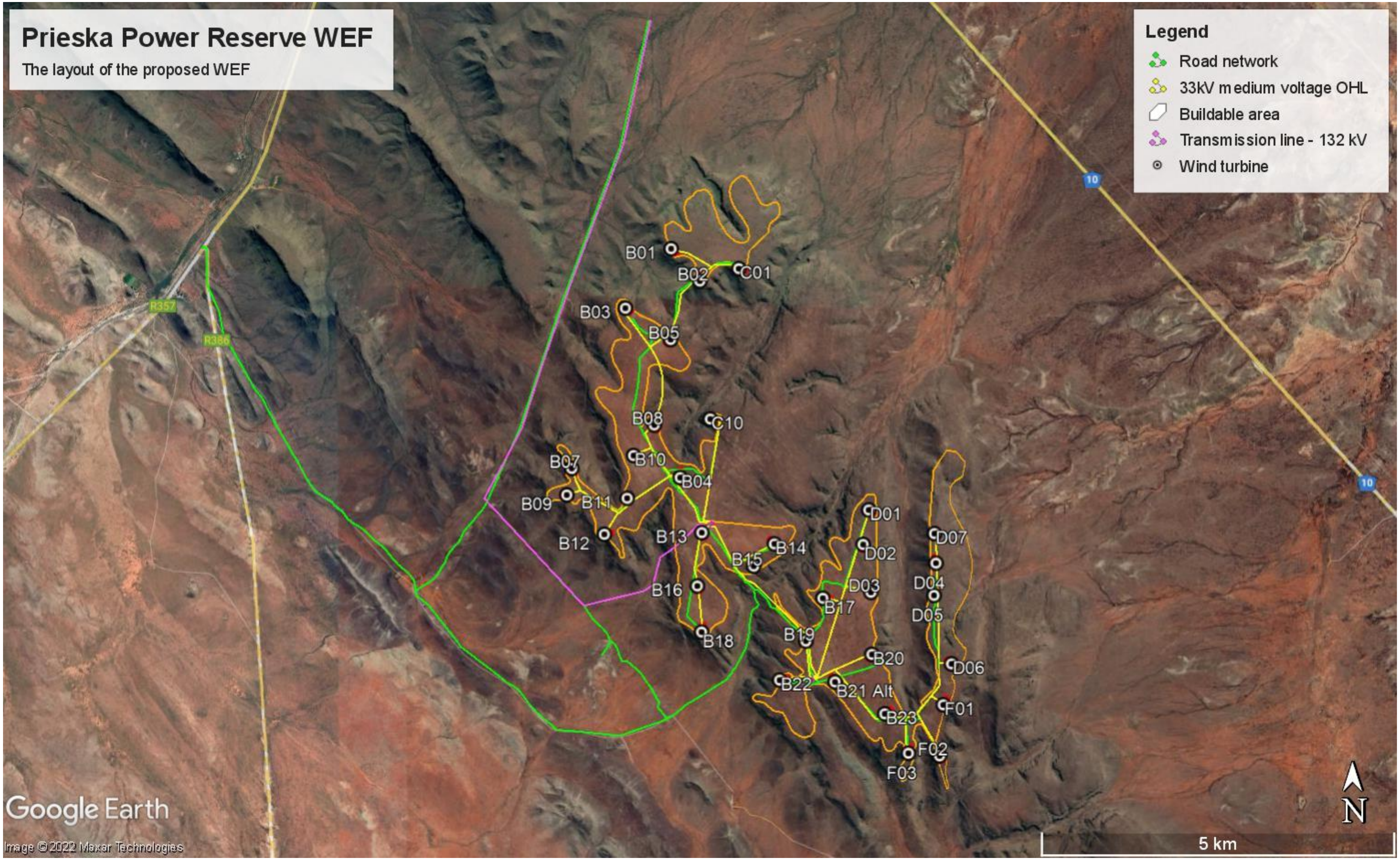


Figure 2: The layout of the proposed WEF

2 PROJECT SCOPE

The purpose of the specialist study is to determine the main issues and potential impacts of the proposed project based on existing information and field assessments. The terms of reference are as follows:

- Describe the affected environment from an avifaunal perspective
- Discuss gaps in baseline data and other limitations and describe the expected impacts associated with the wind energy facility and associated infrastructure
- Identify potential sensitive environments and receptors that may be impacted on by the proposed facility and the types of impacts that are most likely to occur.
- Determine the nature and extent of potential impacts during the construction, operational and decommissioning phases.
- Identify 'No-Go' areas, where applicable.
- Recommend mitigation measures to reduce the expected impacts to acceptable levels.
- Conclude with an impact statement whether the WEF and associated 132kV grid line is fatally flawed or may be authorised.

3 OUTLINE OF METHODOLOGY AND INFORMATION REVIEWED

The following information sources were consulted to conduct this study:

- The Project Area of Impact (PAOI) was defined as an aggregate area encompassing of a 1km buffer area around the turbine layout, and a 2km buffer around the proposed 132kV OHL.
- Bird distribution data from the Southern African Bird Atlas Project 2 (SABAP 2) was obtained (http://sabap2.adu.org.za/), in order to ascertain which species occur in the pentads where the proposed development is located. A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5' × 5'). Each pentad is approximately 8 × 7.6 km. A consolidated data set was obtained for a total of 9 pentads which overlaps with the development area, henceforth referred to as the B**roader Area**. The 9 pentad grid cells are the following: 2940_2240, 2940_2245, 2940_2250, 2945_2240, 2945_2245, 2945_2250, 2950_2240, 2950_2245, 2950_2250 (see Figure 33). A total of 59 full protocol lists (i.e. bird listing surveys lasting a minimum of two hours each) and 82 ad hoc protocol lists (surveys lasting less than two hours but still yielding valuable data) have been completed to date for the 9 pentads where the PAOI is located.
- An avifaunal scoping report compiled by Dr. D.J. van Niekerk provided valuable background information on the avifaunal community and habitat in the PAOI (Van Niekerk 2021).
- A classification of the vegetation types in the development area was obtained from the Atlas of Southern African Birds 1 (SABAP1), the 2018 National Vegetation Map compiled by the South African National Biodiversity Institute ((South African National Biodiversity Institute, 2018) and the scoping report compiled by Dr. D.J. van Niekerk (Van Niekerk 2021).
- The national threatened status of all priority species was determined with the use of the most recent edition of the Red List Book of Birds of South Africa, Lesotho and Swaziland (Taylor *et al.* 2015), and the latest authoritative summary of southern African bird biology (Hockey *et al.* 2005).
- The global threatened status of all priority species was determined by consulting the latest (2022.1) IUCN Red List of Threatened Species (http://www.iucnredlist.org/).
- The Important Bird and Biodiversity Areas of South Africa (Marnewick *et al.* 2015; http://www.birdlife.org.za/conservation/important-bird-areas) was consulted for information on potentially relevant Important Bird Areas (IBAs).
- Satellite imagery (Google Earth © 2022) was used in order to view the broader area on a landscape level and to help identify bird habitat on the ground.
- The South African National Biodiversity BGIS map viewer was used to determine the locality of the development area relative to National Protected Areas.

- The DFFE National Screening Tool (https://screening.environment.gov.za/) was used to determine the assigned avian sensitivity of the development area based on the relevant theme[1].
- The following sources were consulted to determine the investigation protocol that is required for the site:
  - Procedures for the Assessment and Minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of NEMA when applying for Environmental Authorisation (Gazetted October 2020)
  - The Protocol for the specialist assessment and minimum report content requirements for environmental impacts on avifaunal species where the output is 20MW or more (Government Gazette No 43110, 20 March 2020).
  - The Verreaux's Eagle Best Practice Guidelines Second edition (Ralston-Patton S. 2021. Verreaux's Eagles and Wind Farms. Guidelines for impact assessment, monitoring and mitigation. BirdLife South Africa, November 2021) henceforth referred to as "the VE guidelines".
- The main source of information on the avifaunal diversity and abundance at the project site and development area was a pre-construction monitoring programme implemented between March and November 2022 (see Section 7.1).

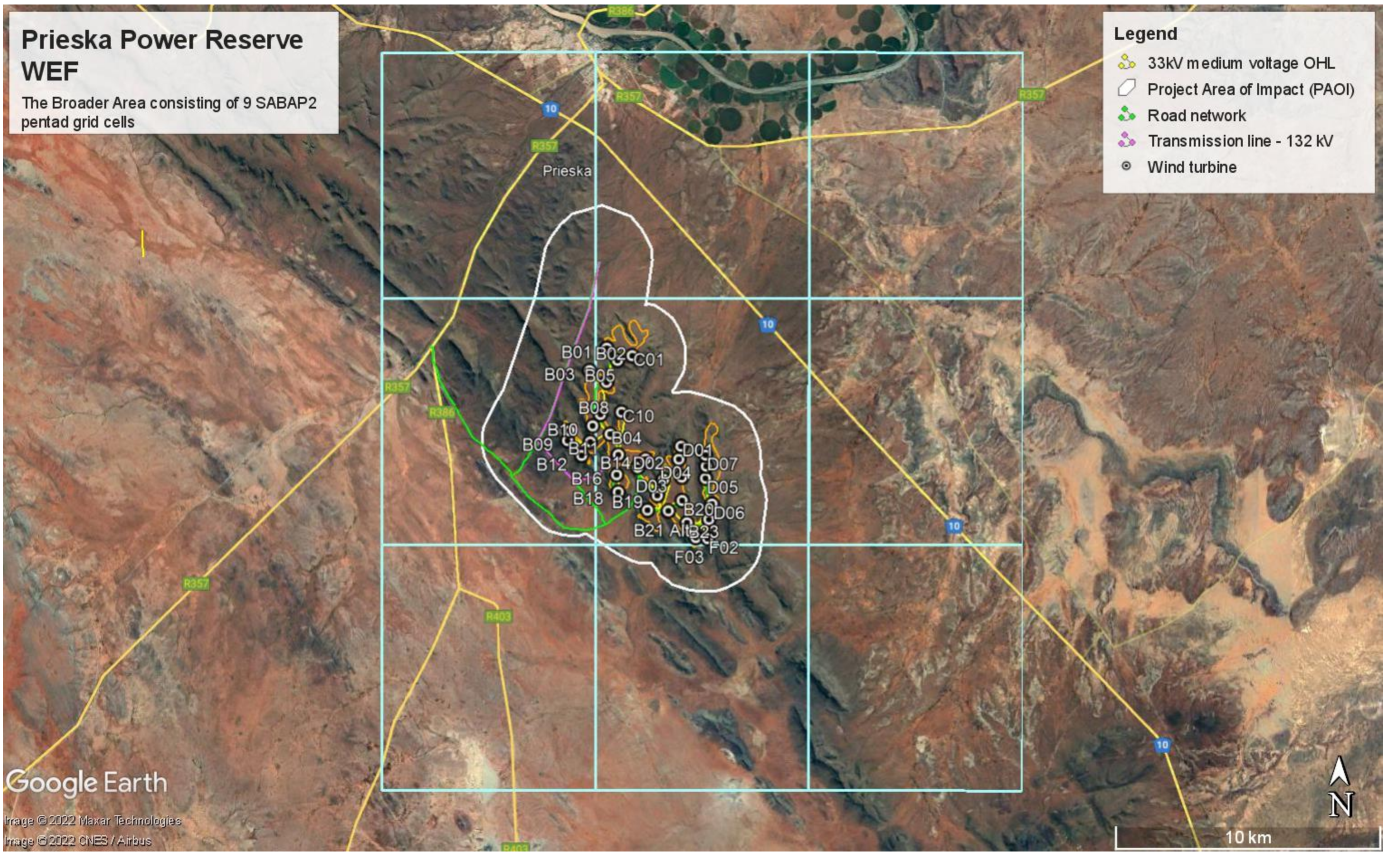


Figure 3: The Project Area of Impact (PAOI) and the Broader Area i.e. the area covered by the nine SABAP2 pentads.

4 ASSUMPTIONS AND LIMITATIONS

This study assumed that the sources of information used in this report are reliable. In this respect, the following must be noted:

- The focus of the study is primarily on the potential impacts on wind priority species, which act as umbrella species for all the avifauna. It is assumed that the proposed mitigation measures will benefit all the avifauna, not only the wind priority species, both as far as the WEF and associated grid infrastructure is concerned.
- The assessment of impacts is based on the baseline environment as it currently exists in the project site.

[1] The Avifauna Wind theme is only applicable to developments in Renewable Energy Development Zones (REDZ). Where the development is located outside a REDZ, the Terrestrial Animal Species theme is applicable.

- Conclusions in this study are based on experience of these and similar species in different parts of South Africa. Bird behaviour can never be entirely reduced to formulas that will be valid under all circumstances.
- The SABAP2 data is regarded as a reliable reflection of the avifauna which occurs in the area, but the data was also supplemented by data collected during pre-construction site surveys and previous work done for renewable energy projects in the area.
- The VE guidelines require a total of 72 hours of vantage point (VP) watches per year (Ralston - Patton 2021). If high and medium risk zones are avoided, monitoring can be completed in one year. In this instance, only 54 hours per VP per year was completed due to circumstances beyond the control of the specialists and the applicant. However, given the novel mitigation strategy that is proposed to eliminate the collision risk to all diurnal priority species, including Verreaux's Eagle (see Appendix 4), and the additional information which was available from the one pre-construction survey completed by Dr. Van Niekerk in 2021, we are of the opinion that the monitoring effort has been adequate. The monitoring effort meets the requirements of the wind/avifaunal protocol (Government Gazette No 43110, 20 March 2020).

5 LEGISLATIVE CONTEXT

There is no legislation pertaining specifically to the impact of wind energy facilities and associated electrical infrastructure on avifauna.

5.1 Agreements and conventions

Table 1 below lists agreements and conventions which South Africa is party to and which is relevant to the conservation of avifauna[2].

Table 1: Agreements and conventions which South Africa is party to and which is relevant to the conservation of avifauna.

Convention name	Description	Geographic scope
African-Eurasian Waterbird Agreement (AEWA)	The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) is an intergovernmental treaty dedicated to the conservation of migratory waterbirds and their habitats across Africa, Europe, the Middle East, Central Asia, Greenland and the Canadian Archipelago. Developed under the framework of the Convention on Migratory Species (CMS) and administered by the United Nations Environment Programme (UNEP), AEWA brings together countries and the wider international conservation community in an effort to establish coordinated conservation and management of migratory waterbirds throughout their entire migratory range.	Regional
Convention on Biological Diversity (CBD), Nairobi, 1992	The Convention on Biological Diversity (CBD) entered into force on 29 December 1993. It has 3 main objectives: The conservation of biological diversity The sustainable use of the components of biological diversity The fair and equitable sharing of the benefits arising out of the utilization of genetic resources.	Global
Convention on the Conservation of Migratory Species of Wild Animals, (CMS), Bonn, 1979	As an environmental treaty under the aegis of the United Nations Environment Programme, CMS provides a global platform for the conservation and sustainable use of migratory animals and their habitats. CMS brings together the States through which migratory animals pass, the Range States, and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range.	Global
Convention on the International Trade in Endangered Species of Wild	CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments. Its aim is	Global

[2] (BirdLife International (2016) Country profile: South Africa. Available from: http://www.birdlife.org/datazone/country/south_africa. Checked: 2016-04-02).

Flora and Fauna, (CITES), Washington DC, 1973	to ensure that international trade in specimens of wild animals and plants does not threaten their survival.	
Ramsar Convention on Wetlands of International Importance, Ramsar, 1971	The Convention on Wetlands, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.	Global
Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia	The Signatories will aim to take co-ordinated measures to achieve and maintain the favourable conservation status of birds of prey throughout their range and to reverse their decline when and where appropriate.	Regional

5.1 National legislation

5.1.1 Constitution of the Republic of South Africa, 1996

The Constitution of the Republic of South Africa provides in the Bill of Rights that: Everyone has the right –

(a) to an environment that is not harmful to their health or well-being; and

(b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that –

- (i) prevent pollution and ecological degradation;
- (ii) promote conservation; and
- (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

5.1.2 The National Environmental Management Act 107 of 1998 (NEMA)

The National Environmental Management Act 107 of 1998 (NEMA) creates the legislative framework for environmental protection in South Africa and is aimed at giving effect to the environmental right in the Constitution. It sets out a number of guiding principles that apply to the actions of all organs of state that may significantly affect the environment. Sustainable development (socially, environmentally and economically) is one of the key principles, and internationally accepted principles of environmental management, such as the precautionary principle and the polluter pays principle, are also incorporated. NEMA also provides that a wide variety of listed developmental activities, which may significantly affect the environment, may be performed only after an environmental impact assessment has been done and authorization has been obtained from the relevant authority. Many of these listed activities can potentially have negative impacts on bird populations in a variety of ways. The clearance of natural vegetation, for instance, can lead to a loss of habitat and may depress prey populations, while erecting structures needed for generating and distributing energy, communication, and so forth can cause mortalities by collision or electrocution.

NEMA makes provision for the prescription of procedures for the assessment and minimum criteria for reporting on identified environmental themes (Sections 24(5)(a) and (h) and 44) when applying for environmental authorisation. The Protocol for the specialist assessment and minimum report content requirements for environmental impacts on avifaunal species where the output is 20MW or more (Government Gazette No 43110, 20 March 2020).is applicable in the case of wind energy developments.

5.1.3 The National Environmental Management: Biodiversity Act 10 of 2004 (NEMBA) and the Threatened or Protected Species Regulations, February 2007 (TOPS Regulations)

The most prominent statute containing provisions directly aimed at the conservation of birds is the National Environmental Management: Biodiversity Act 10 of 2004 read with the Threatened or Protected Species Regulations, February 2007 (TOPS Regulations). Chapter 1 sets out the objectives of the Act, and they are aligned with the objectives of the Convention on Biological Diversity, which are the conservation of biodiversity, the sustainable use of its components, and the fair and equitable sharing of the benefits of the use of genetic resources. The Act also gives effect to CITES, the Ramsar Convention, and the Bonn Convention on Migratory Species of Wild Animals. The State is endowed with the trusteeship of biodiversity and has the responsibility to manage, conserve and sustain the biodiversity of South Africa.

5.2 Provincial Legislation

The current legislation applicable to the conservation of fauna and flora in the Northern Cape is the Northern Cape Nature Conservation Act No 9 of 2009. It provides for the sustainable utilisation of wild animals, aquatic biota and plants; the implementation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora; describes offences and penalties for contravention of the Act; provides for the appointment of nature conservators to implement the provisions of the Act; provides for the issuing of permits and other authorisations; and provides for matters connected therewith.

6 BASELINE ASSESSMENT

6.1 Important Bird Areas

There are no Important Bird Areas (IBA) located closely to the proposed WEF. The closest IBA to the project site is the Platberg-Karoo Conservancy IBA SA037 which is located ~120 km away at its closest point. It is therefore highly unlikely that the proposed WEF will have a negative impact on any IBA due to the distance from the project site.

6.2 DFFE National Screening Tool

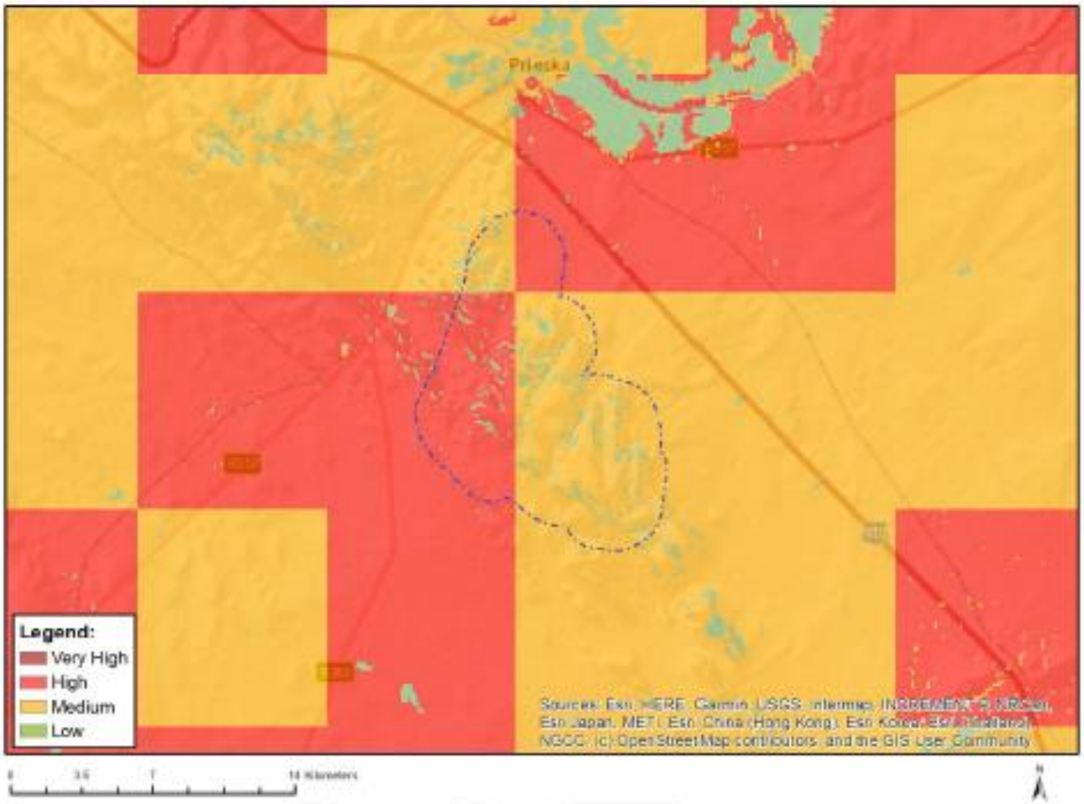
The project site and immediate environment is classified as **Medium and High** sensitivity for terrestrial animals according to the Terrestrial Animal Species Theme[3] (Figure 4). The High and Medium classification is linked to the potential occurrence of Ludwig's Bustard (Globally and Regionally Endangered), and Verreaux's Eagle (Regionally Vulnerable). The development site contains confirmed habitat for species of conservation concern (SCC) as defined in the Protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species (Government Gazette No 43855, 30 October 2020, namely listed on the IUCN Red List of Threatened Species or South Africa's National Red List website as Critically Endangered, Endangered or Vulnerable. The habitat for SCCs was confirmed during the surveys i.e. Ludwig's Bustard (Globally and Regionally Endangered), Lanner Falcon (Regionally Vulnerable), White-backed Vulture (Regionally Critically Endangered) and Lappet-faced Vulture (Globally and Regionally Endangered).

The following SCC were recorded during the pre-construction monitoring at the project site:

- Lanner Falcon
- Verreaux's Eagle
- Karoo Korhaan
- Ludwig's Bustard
- Tawny Eagle

[3] Note that the Avifaunal Wind theme in the Screening Tool is only applicable to developments in Renewable Energy Development Zones (REDZ).

MAP OF RELATIVE ANIMAL SPECIES THEME SENSITIVITY



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

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
	X		

Sensitivity Features:

Sensitivity	Feature(s)
High	Aves-Neotis ludwigii
High	Aves-Aquila verreauxii
High	Mammalia-Felis nigripes
Low	Subject to confirmation
Medium	Aves-Aquila verreauxii
Medium	Aves-Neotis ludwigii

Figure 4: The National Web-Based Environmental Screening Tool map of the PAOI, indicating sensitivities for the Terrestrial Animal Species theme. The High classification is linked to Ludwig's Bustard (*Neotis ludwigii*) and the Medium sensitivity classification is linked to Ludwig's Bustard (*Neotis ludwigii*) and Verreaux's Eagle (*Aquila verreauxii*).

Based on the results of the pre-construction monitoring, a classification of **High** sensitivity for avifauna is suggested for the whole PAOI.

See Appendix 6 for the Site Sensitivity Verification Report

6.3 Protected Areas

The project site does not fall within a formally protected area.

6.4 Biomes and vegetation types

The PAOI falls technically within the Nama Karoo biome (Mucina & Rutherford 2006), but the actual vegetation on the ground has more of an ecotonal character between Karoo and Savanna. The vegetation in the PAOI can best be described as shrubland dominated by *Rhigozum trichotomum* (Driedoring) with a well-developed grassy layer. *Senegalia mellifera* (Swarthaak) dominates along drainage lines and forms large shrubs and small trees. The topography in the PAOI is undulating. The most prominent topographical feature is the Doringberge Mountain range which runs through the middle of the PAOI in a north-westerly – south easterly orientation. The range contains many cliffs which are suitable breeding substrate for cliff-nesting priority avifauna.

The average annual rainfall Prieska area is ~200 mm with most rain falling from February to April (Mucina & Rutherford 2006). Temperatures range from an average high of ~35° in January to ~19° in June/July (https://www.meteoblue.com/).

6.5 Avifauna

The SABAP2 data, combined with the result of the monitoring surveys, indicate that a total of 197 bird species could potentially occur within the broader area – Appendix 1 provides a comprehensive list of all the species. Of these, 22 species are classified as priority species for wind energy development. Nine (9) of these are South African Red List species.

6.6 Environmental features relevant to avifauna

Whilst the distribution and abundance of the bird species in the development area are typical of the broad vegetation types and topographic features, it is also necessary to examine specific environmental features in the habitat in more detail as it may influence the distribution and behaviour of priority species. These are discussed in more detail below.

6.6.0 Grassland/shrub

See description in 6.4 above. The priority species which could use this habitat are the following:

Species name	Scientific name	Reporting rate: SABAP2 Full protocol	Reporting rate: SABAP2 Ad hoc protocol	Global status	Regional status	Recorded during monitoring	Likelihood of occurrence in the PAOI
Black-chested Snake Eagle	*Circaetus pectoralis*	0.00	1.27	-	-		L
Black-winged Kite	*Elanus caeruleus*	13.73	2.53	-	-		M
Booted Eagle	*Hieraaetus pennatus*	5.88	2.53	-	-	x	H
Common Buzzard	*Buteo buteo*	7.84	1.27	-	-	x	M

Double-banded Courser	*Rhinoptilus africanus*	7.84	1.27	-	-	x	M
Greater Kestrel	*Falco rupicoloides*	0.00	2.53	-	-		L
Karoo Korhaan	*Eupodotis vigorsii*	9.80	8.86	-	NT	x	H
Kori Bustard	*Ardeotis kori*	7.84	5.06	NT	NT		M
Lanner Falcon	*Falco biarmicus*	5.88	2.53	-	VU	x	M
Lappet-faced Vulture	*Torgos tracheliotis*	0.00	0.00	EN	EN		M
Lesser Spotted Eagle	*Clanga pomarina*	0.00	1.27	-	-		L
Ludwig's Bustard	*Neotis ludwigii*	9.80	1.27	EN	EN	x	M
Northern Black Korhaan	*Afrotis afraoides*	33.33	15.19	-	-	x	H
Pale Chanting Goshawk	*Melierax canorus*	33.33	17.72	-	-	x	H
Spotted Eagle-Owl	*Bubo africanus*	9.80	1.27	-	-		M
Tawny Eagle	*Aquila rapax*	0.00	0.00	VU	EN	x	M
White-backed Vulture	*Gyps africanus*	0.00	0.00	CR	CR		M

6.6.1 Woodland

The drainage lines in the PAOI are characterised by dense clumps of *Senegalia mellifera* (Swarthaak) shrubs and low trees in the riparian zone, giving a distinct woodland character to the vegetation. The priority species which could use this habitat are the following:

Species name	Scientific name	Reporting rate: SABAP2 Full protocol	Reporting rate: SABAP2 Ad hoc protocol	Global status	Regional status	Recorded during monitoring	Likelihood of occurrence in the PAOI
Black-chested Snake Eagle	*Circaetus pectoralis*	0.00	1.27	-	-		L
Black-winged Kite	*Elanus caeruleus*	13.73	2.53	-	-		M
Common Buzzard	*Buteo buteo*	7.84	1.27	-	-	x	M
Kori Bustard	*Ardeotis kori*	7.84	5.06	NT	NT		M
Lanner Falcon	*Falco biarmicus*	5.88	2.53	-	VU	x	M
Lappet-faced Vulture	*Torgos tracheliotis*	0.00	0.00	EN	EN		M
Lesser Spotted Eagle	*Clanga pomarina*	0.00	1.27	-	-		L
Northern Black Korhaan	*Afrotis afraoides*	33.33	15.19	-	-	x	H
Pale Chanting Goshawk	*Melierax canorus*	33.33	17.72	-	-	x	H
Spotted Eagle-Owl	*Bubo africanus*	9.80	1.27	-	-		M
Tawny Eagle	*Aquila rapax*	0.00	0.00	VU	EN	x	M
White-backed Vulture	*Gyps africanus*	0.00	0.00	CR	CR		M

6.6.2 Surface water

The only source of permanent source of surface water in the PAOI are a few boreholes with water troughs. The PAOI also contains a number of ephemeral drainage lines which briefly flows after good rains. The priority species which could use this habitat are the following:

Species name	Scientific name	Reporting rate: SABAP2 Full protocol	Reporting rate: SABAP2 Ad hoc protocol	Global status	Regional status	Recorded during monitoring	Likelihood of occurrence in the PAOI
Black-chested Snake Eagle	*Circaetus pectoralis*	0.00	1.27	-	-		L
Verreaux's Eagle	*Aquila verreauxii*	9.80	3.80	-	VU	x	H
Booted Eagle	*Hieraaetus pennatus*	5.88	2.53	-	-	x	H
Common Buzzard	*Buteo buteo*	7.84	1.27	-	-	x	M
Kori Bustard	*Ardeotis kori*	7.84	5.06	NT	NT		M
Lanner Falcon	*Falco biarmicus*	5.88	2.53	-	VU	x	M
Lappet-faced Vulture	*Torgos tracheliotis*	0.00	0.00	EN	EN		M
Jackal Buzzard	*Buteo rufofuscus*	3.92	3.80	-	-	x	M
Lesser Spotted Eagle	*Clanga pomarina*	0.00	1.27	-	-		L
Pale Chanting Goshawk	*Melierax canorus*	33.33	17.72	-	-	x	H
Spotted Eagle-Owl	*Bubo africanus*	9.80	1.27	-	-		M
Tawny Eagle	*Aquila rapax*	0.00	0.00	VU	EN	x	M
White-backed Vulture	*Gyps africanus*	0.00	0.00	CR	CR		M

6.6.3 High voltage lines

There is one high voltage line, the Burchell – Cuprum 132kV powerline that bisects the PAOI in a north-south direction. Transmission lines are an important breeding substrate for raptors in the Karoo, due to the lack of large trees (Jenkins *et al.* 2013). There is an established White-backed Vulture and Lappet-faced Vulture roost on this line ~25 km south-west of the PAOI (>100 birds). Based on interviews with landowners and personal observations, it seems that the numbers of White-backed Vultures and Lappet-faced Vultures are on the increase south of the Orange River in the Northern Cape during the non-breeding season (December to May). These birds establish temporary roosts on power lines. The priority species that could use power lines for breeding and roosting in the PAOI are the following:

Species name	Scientific name	Reporting rate: SABAP2 Full protocol	Reporting rate: SABAP2 Ad hoc protocol	Global status	Regional status	Recorded during monitoring	Likelihood of occurrence in the PAOI
Black-chested Snake Eagle	*Circaetus pectoralis*	0.00	1.27	-	-		L
Verreaux's Eagle	*Aquila verreauxii*	9.80	3.80	-	VU	x	H

Black-winged Kite	*Elanus caeruleus*	13.73	2.53	-	-		M
Common Buzzard	*Buteo buteo*	7.84	1.27	-	-	x	M
Greater Kestrel	*Falco rupicoloides*	0.00	2.53	-	-		L
Lanner Falcon	*Falco biarmicus*	5.88	2.53	-	VU	x	M
Lappet-faced Vulture	*Torgos tracheliotis*	0.00	0.00	EN	EN		M
Jackal Buzzard	*Buteo rufofuscus*	3.92	3.80	-	-	x	M
Pale Chanting Goshawk	*Melierax canorus*	33.33	17.72	-	-	x	H
Tawny Eagle	*Aquila rapax*	0.00	0.00	VU	EN	x	M
White-backed Vulture	*Gyps africanus*	0.00	0.00	CR	CR		M

6.6.4 Ridges and mountains

The most prominent topographical feature of the PAOI is the Doringberge Mountain range which runs through the middle of the PAOI in a north-westerly – south easterly orientation. The range contains many cliffs which are suitable breeding substrate for cliff-nesting priority avifauna, including the Red List Verreaux's Eagle. **There are currently (2022) nine (9) confirmed, structurally functional Verreaux's Eagle nests within the PAOI, belonging to an estimated five (5) pairs of eagles.** There is also a nest which is suspected to belong to a Jackal Buzzard, and one belonging to White-necked Ravens. A further fourteen (14) confirmed structurally functional Verreaux's Eagle nests were recorded in a 50km radius outside the PAOI, six (6) unconfirmed Verreaux's Eagle nest sites which could not be investigated in detail, and two suspected African Fish Eagle nests. See Figure 5 for the location of nests in the PAOI.

The priority species that could use cliffs and ridges for breeding and/or roosting in the PAOI are the following:

Species name	Scientific name	Reporting rate: SABAP2 Full protocol	Reporting rate: SABAP2 Ad hoc protocol	Global status	Regional status	Recorded during monitoring	Likelihood of occurrence in the PAOI
Black-chested Snake Eagle	*Circaetus pectoralis*	0.00	1.27	-	-		L
African Fish Eagle	*Haliaeetus vocifer*	15.69	2.53	-	-		L
Verreaux's Eagle	*Aquila verreauxii*	9.80	3.80	-	VU	x	H
Booted Eagle	*Hieraaetus pennatus*	5.88	2.53	-	-	x	H
African Rock Pipit	*Anthus crenatus*	1.96	1.27	NT	NT		L
Lanner Falcon	*Falco biarmicus*	5.88	2.53	-	VU	x	M
Lappet-faced Vulture	*Torgos tracheliotis*	0.00	0.00	EN	EN		M
Grey-winged Francolin	*Scleroptila afra*	0.00	0.00	-	-	x	M
Jackal Buzzard	*Buteo rufofuscus*	3.92	3.80	-	-	x	M
Spotted Eagle-Owl	*Bubo africanus*	9.80	1.27	-	-		M
White-backed Vulture	*Gyps africanus*	0.00	0.00	CR	CR		M

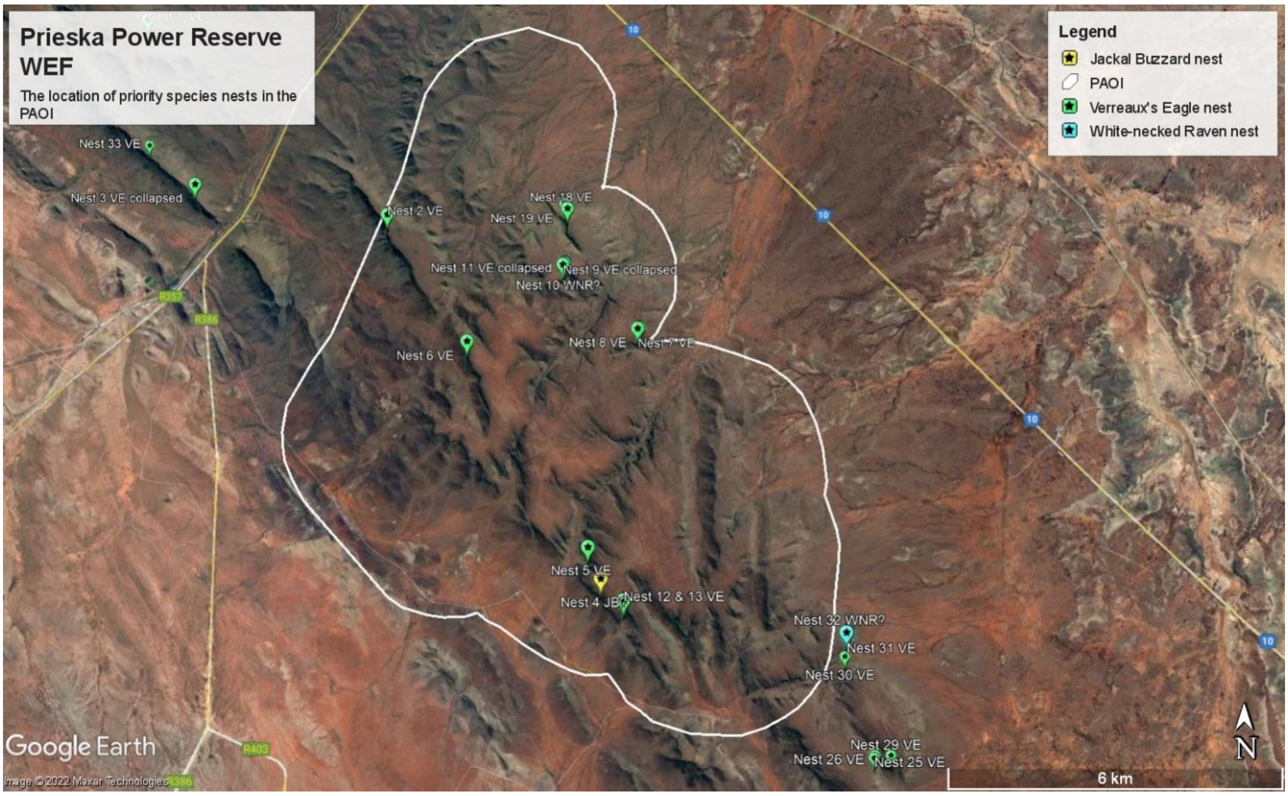


Figure 5: Confirmed priority species nests in the PAOI.

See Appendix 2 for photographic record of environmental features in the PAOI and immediate surroundings.

7 PRE-CONSTRUCTION MONITORING

7.1 Objectives

The objective of the pre-construction monitoring at the proposed Prieska Power Reserve Wind Energy Facility (WEF) was to gather baseline data over a period of one year on the following aspects pertaining to avifauna:

- The abundance and diversity of birds at the wind farm, and a suitable control site, to measure the potential displacement effect of the wind farm.
- Flight patterns of priority species at the wind farm site to assess the potential collision risk with the turbines.

7.2 Methods

The monitoring was designed according to the following best practice guidelines (hereafter referred to as the VE guidelines):

- The Verreaux's Eagle Best Practice Guidelines Second edition (Ralston-Patton S. 2021. Verreaux's Eagles and Wind Farms. Guidelines for impact assessment, monitoring and mitigation. BirdLife South Africa, November 2021).

Wind priority species were identified using the latest (November 2014) BirdLife SA (BLSA) list of priority species for wind farms.

The first monitoring survey was conducted at the proposed WEF site and a control site by field monitors during the following time envelopes:

- 08 – 12 March 2022
- 10 – 14 October 2022
- 24 – 28 October 2022

Additional dedicated nest searches in the PAOI and beyond were conducted in the following time envelopes:

- Late June/ early July 2022
- October 2022

7.2.0 Transect counts

Monitoring was conducted in the following manner:

- One (1) drive transect was identified totalling 9.49km on the development site and one drive transect in the control site, with a total length of 10.1km.
- One monitor travelling slowly (± 10km/h) in a vehicle recorded all birds on both sides of the transect. The observer stopped at regular intervals (every 500m) to scan the environment with binoculars. Drive transects were counted three times per sampling session.
- In addition, three (3) walk transects of 1km each were identified. The transects were counted four (4) times per survey. All birds were recorded during walk transects. Two walk transects were also identified at the control site.
- The following variables were recorded:
  - Species
  - Number of birds
  - Date
  - Start time and end time
  - Estimated distance from transect
  - Wind direction
  - Wind strength (estimated Beaufort scale)
  - Weather (sunny; cloudy; partly cloudy; rain; mist)
  - Temperature (cold; mild; warm; hot)
  - Behaviour (flushed; flying-display; perched; perched-calling; perched-hunting; flying-foraging; flying-commute; foraging on the ground) and
  - Co-ordinates (priority species only)

The aim with drive transects was primarily to record large priority species (i.e. raptors and large terrestrial species), while walk transects were primarily aimed at recording small passerines. The objective of the transect monitoring was to gather baseline data on the use of the site by birds in order to measure potential displacement by the wind and solar farm activities.

7.2.1 Vantage point counts

- Three (3) vantage points (VPs) were identified from which the majority of the wind buildable area could be observed, to record the flight altitude and patterns of priority species. One (1) VP was also identified on a suitable control site. The following variables were recorded for each flight:
  - Species
  - Number of birds
  - Date
  - Start time and end time
  - Wind direction
  - Wind strength (estimated Beaufort scale 1-7)

- Weather (sunny; cloudy; partly cloudy; rain; mist)
- Temperature (cold; mild; warm; hot)
- Flight altitude (high i.e. above rotor altitude; medium i.e. at rotor altitude; low i.e. below rotor altitude)
- Flight mode (soar; flap; glide; kite; hover) and
- Flight time (in 15 second intervals).

The objective of vantage point counts was to measure the potential collision risk with the turbines.

A total of six (8) potential focal points (FPs) of bird activity were identified and were being monitored. The focal points were all Verreaux's Eagle nests.
See Figure 6 for map of the Project Site indicating the location of the transects, vantage points and focal points.

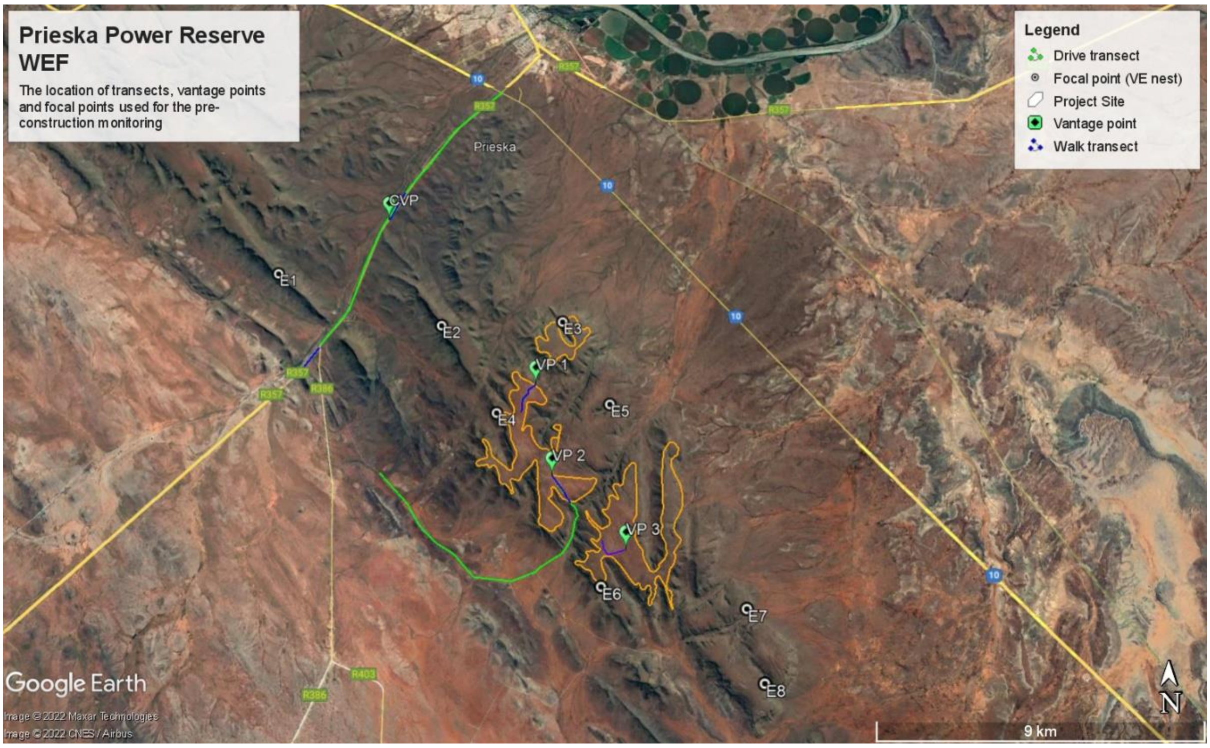


Figure 6: The area where monitoring was performed, with the position of VPs, focal points, drive transects, walk transects.

7.3 Results

7.3.0 Transect counts

The results of the transect counts are tabled in Table 2:

Table 2: The results of the transect counts (three surveys)

Turbine site	
Species composition	**Number**
All Species	81
Priority Species (9%)	7
Non-Priority Species	74
Total count	**Count**
Drive transects	1379
Walk transects	719
Total:	2098

Control site	
Species composition	**Number**
All Species	70
Priority Species (6%)	4
Non-Priority Species	66
Total count	**Count**
Drive transects	1370
Walk transects	1315
Total:	2685

Figures 2 and 3 present the priority species transect count data for the development site and the control site, presented as an Index of Kilometric Abundance (IKA = birds/km).

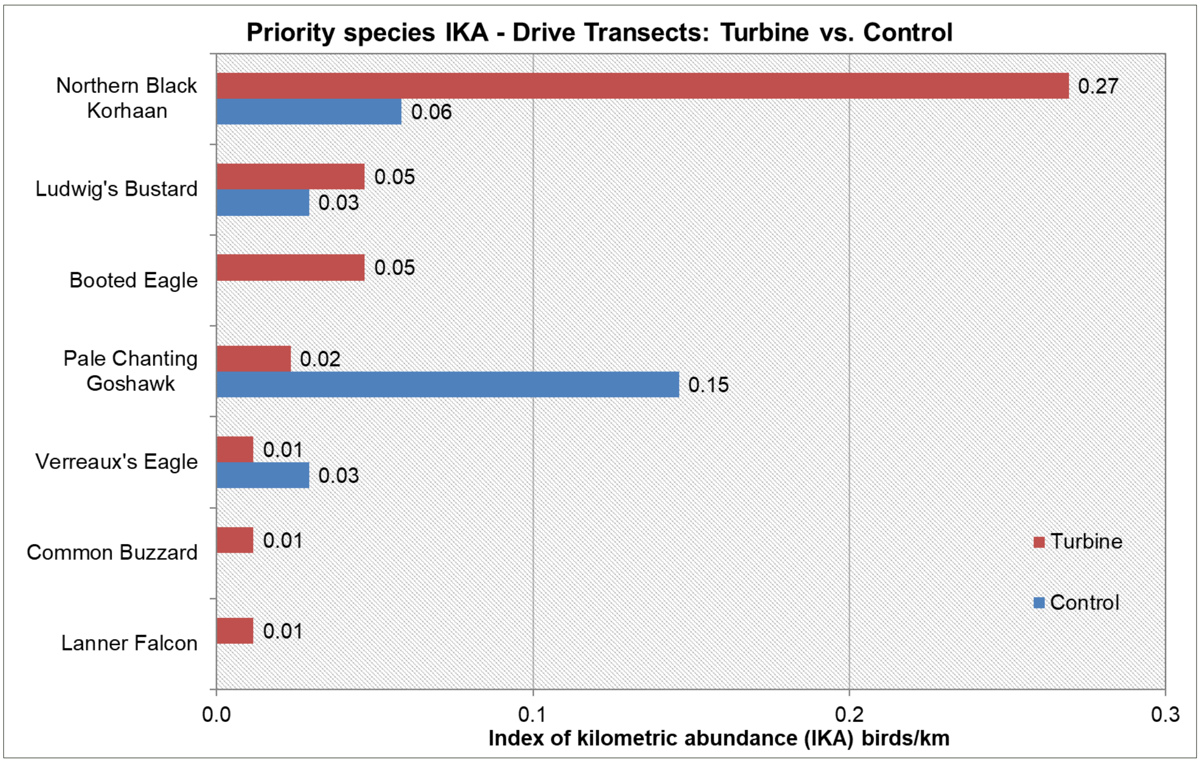


Figure 2: IKA for drive transect wind priority species at the development area vs. control site

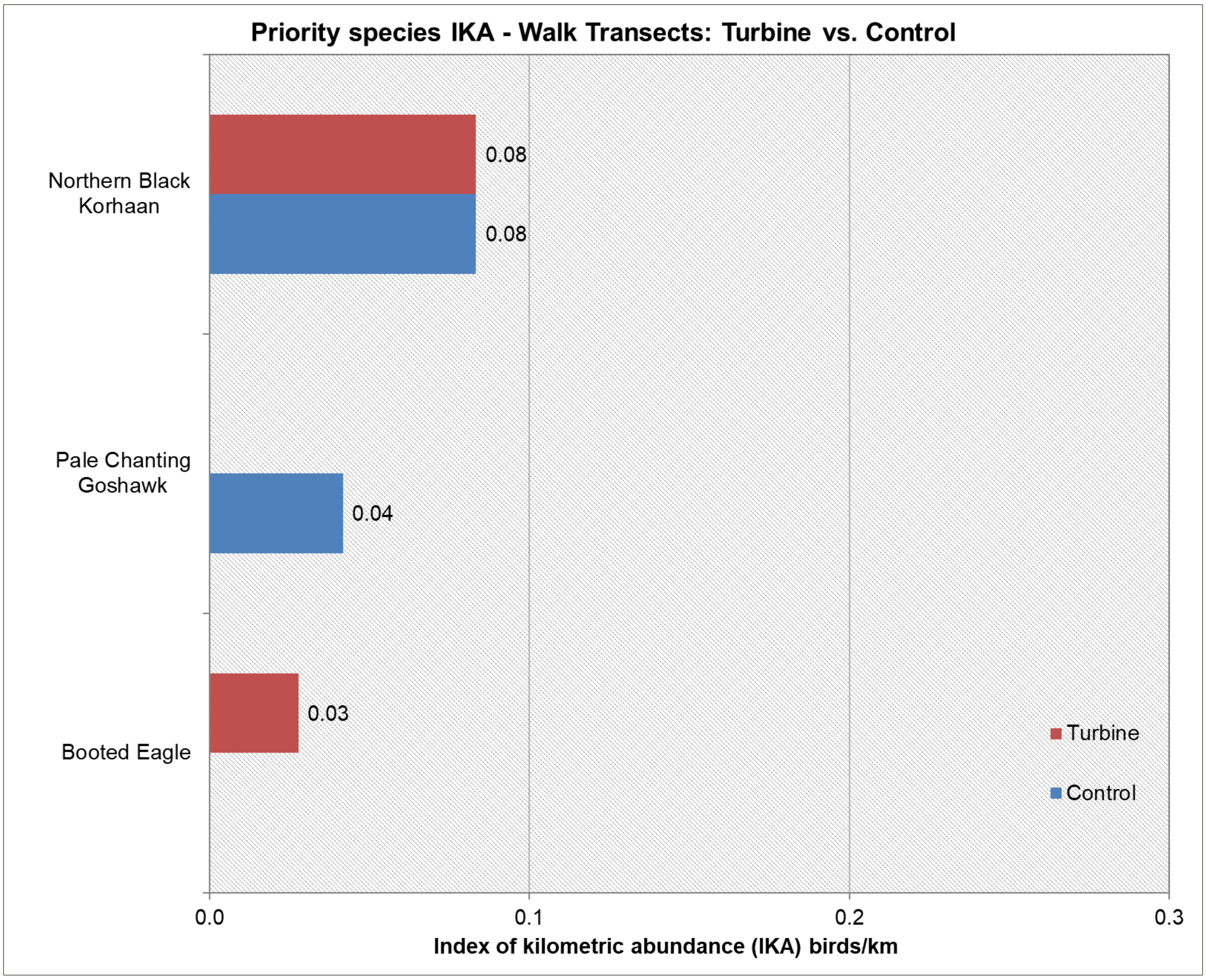


Figure 3: IKA for walk transects wind priority species at the development area vs. control site.

7.3.1 Focal points

The results of the focal point monitoring are tabled in Table 3:

Table 3: The results of the focal point monitoring conducted during three surveys

Focal Point Name	FP type	Territory occupied?
E 1	Verreaux's Eagle nest	Yes
E 2	Verreaux's Eagle nest	Yes
E 3	Verreaux's Eagle nest	Yes
E 4	Verreaux's Eagle nest	Yes
E 5	Verreaux's Eagle nest	Uncertain
E 6	Verreaux's Eagle nest	Yes
E 7	Verreaux's Eagle nest	Yes
E 8	Verreaux's Eagle nest	Yes

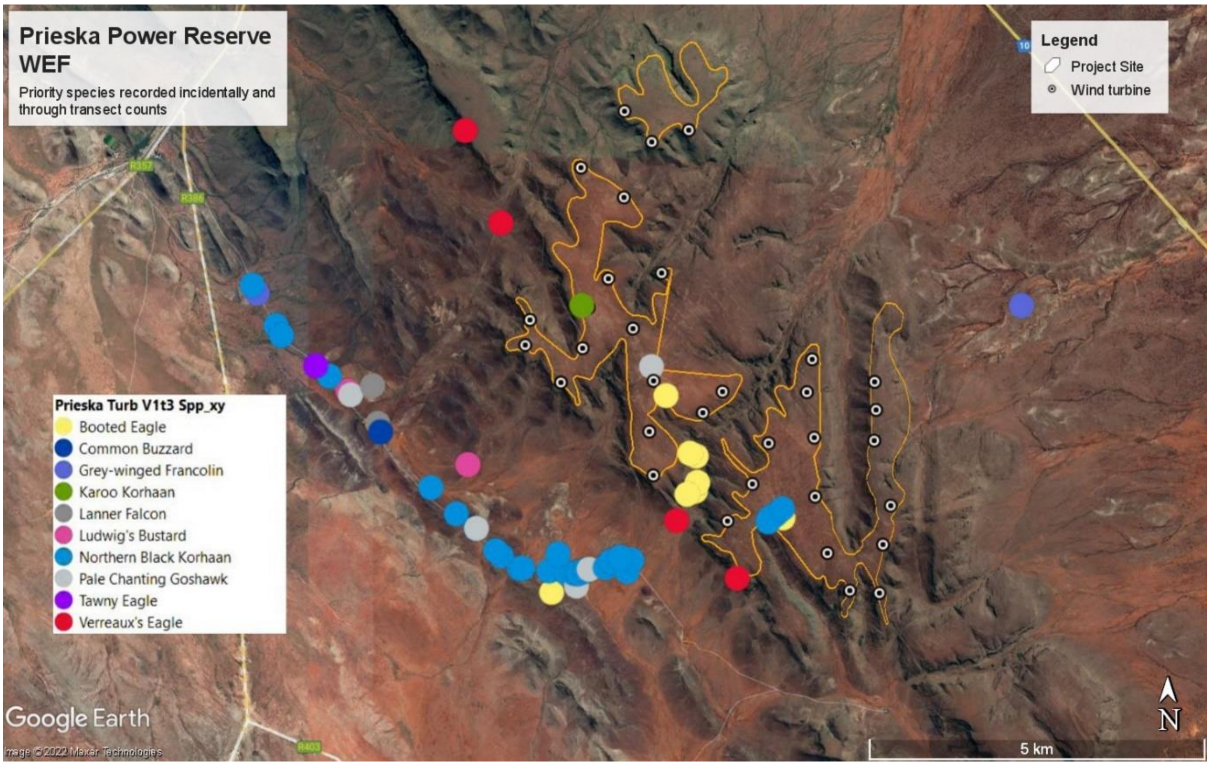
7.3.2 Incidental counts

Table 44 provides an overview of the incidental sightings of priority species during the three surveys. These are records obtained outside of formal transect and vantage point counts.

Table 4: Incidental sightings of priority species made in the course of the three surveys

Priority Species (Incidentals)		Survey 1	Survey 2	Survey 3	Grand Total
Northern Black Korhaan	*Afrotis afraoides*	5	3	4	**12**
Pale Chanting Goshawk	*Melierax canorus*	5	3	1	**9**
Verreaux's Eagle	*Aquila verreauxii*	0	3	6	**9**
Grey-winged Francolin	*Scleroptila afra*	0	1	5	**6**
Booted Eagle	*Hieraaetus pennatus*	2	2	0	**4**
Karoo Korhaan	*Eupodotis vigorsii*	0	0	2	**2**
Lanner Falcon	*Falco biarmicus*	2	0	0	**2**
Jackal Buzzard	*Buteo rufofuscus*	1	0	0	**1**
Tawny Eagle	*Aquila rapax*	0	0	1	**1**

Figure 4 shows the spatial distribution of the priority species recorded during transect counts and incidental sightings during three surveys.



7.3.3 Vantage points

Flight patterns of priority species were recorded for 162 hours (54 hours per VP) at 3 vantage points at the development site in three bands (high i.e. above rotor altitude; medium i.e. at rotor altitude; low i.e. below rotor altitude). Approximate flight altitude was visually judged by an observer with the aid of binoculars. Priority species were observed for a combined 1 hour and 33 minutes. The passage rate for priority species was 0.23 birds/hour, or approximately 3 birds per day.[4]

[4] Assuming 13 hours of daylight averaged over all seasons

Figure 4 presents the data gathered during vantage point watches at the development site.

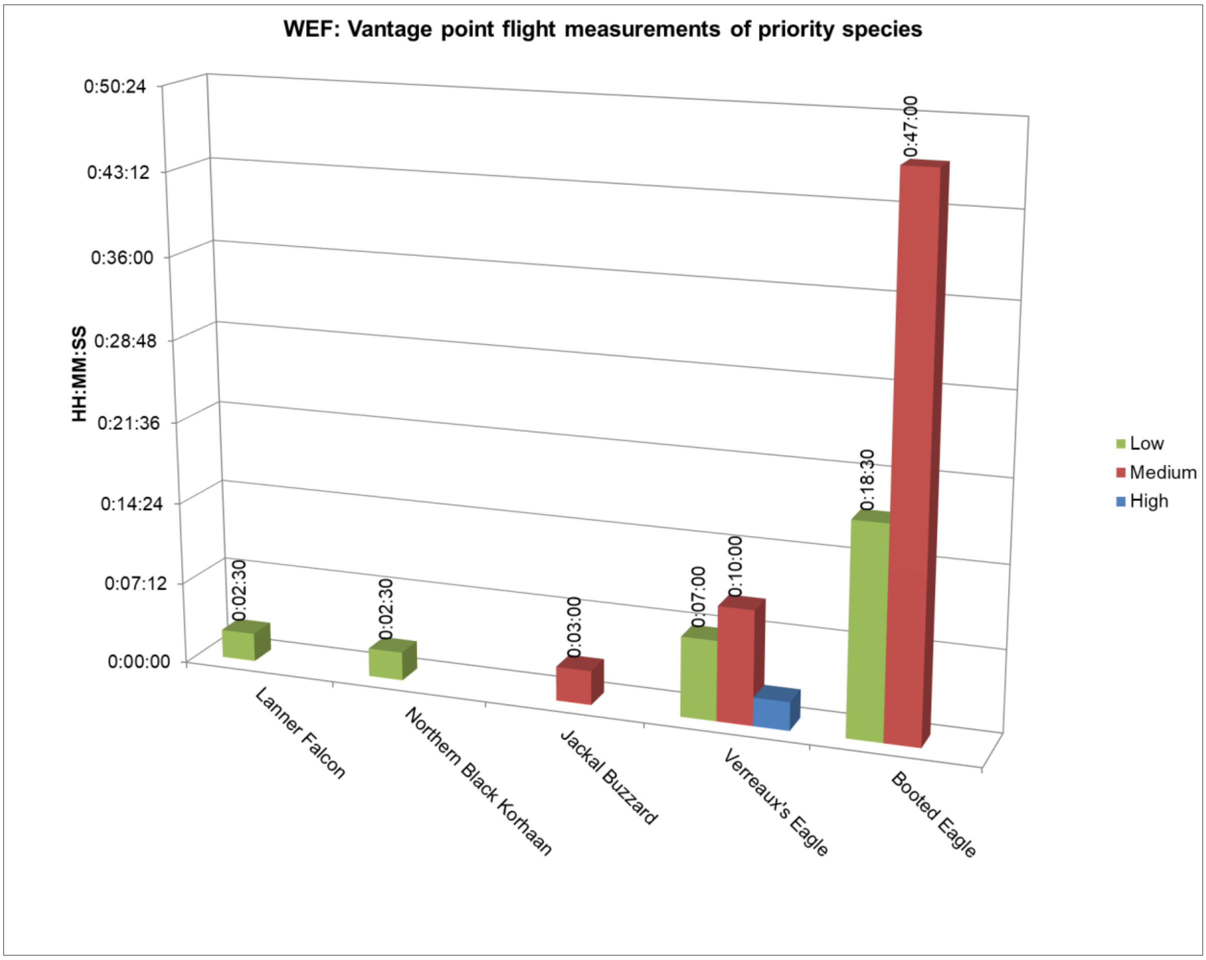


Figure 4: Flight time and altitude recorded for all individuals of priority species at the Project Site (162 hours of observation). Time is indicated in hours: minutes: seconds. Flight altitude is indicated as low (green = below rotor altitude), medium (red = within rotor altitude) and high (blue = above rotor altitude).

7.3.4 Site specific collision risk rating

A site-specific collision risk rating for each priority species recorded during VP watches was calculated to give an indication of the likelihood of an individual of the specific species to collide with the turbines at these sites. This was calculated taking into account the following factors:

- The duration of flights;
- The susceptibility to collisions, based on morphology (size) and behaviour (soaring, predatory, ranging behaviour, flocking behaviour, night flying, aerial display and habitat preference) using the ratings for priority species in the Avian Wind Farm Sensitivity Map of South Africa (Retief *et al.*, 2012); and
- The number of turbines.

This was done in order to gain some understanding of which species are likely to be most at risk of collision. The formula used is as follows[5]:

[5] It is important to note that the formula does not incorporate avoidance behaviour. This may differ between species and may have a significant impact on the size of the risk associated with a specific species. It is generally assumed that 95-98% of bird flights will successfully avoid the turbines (SNH, 2010).

Duration of flights (in decimal hours) x collision ratings in the Avian Wind Farm Sensitivity Map x number of turbines ÷100.

The results are presented in Table 55 and Figure 77 below.

Table 5: Site specific collision risk rating

Species	Duration of all flights (hr)	Avian Wind Farm Sensitivity Map collision susceptibility rating	Site specific collision risk rating
Northern Black Korhaan	0	60	0.00
Lanner Falcon	0	85	0.00
Jackal Buzzard	0.002	95	0.07
Verreaux's Eagle	0.007	115	0.27
Booted Eagle	0.033	85	0.94
Average	*0.01*	*88*	*0.26*

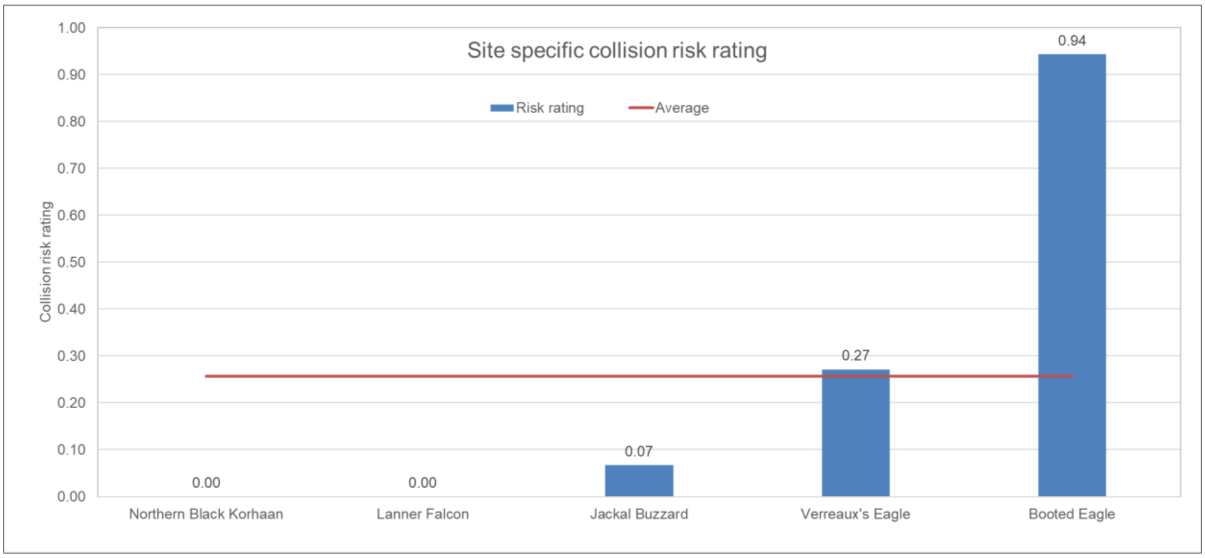


Figure 7: Site specific collision risk rating for priority species. The red line indicates the average collision risk rating for priority species, based on recorded flight behaviour in three surveys.

7.3.5 Spatial distribution of flights over the turbine area

Flight maps were prepared for the species with higher-than-average collision risk indices (Booted Eagle and Verreaux's Eagle), indicating the spatial distribution of flights observed from the various vantage points. This was done by overlaying a 400m x 400m grid over the survey area. The decision to use 400m x 400m resolution is to compensate for any inaccuracies by the observer drawing the line on a map, assuming that a margin of error up to 200m on both sides of the line is possible. Each grid cell was then given a weighting score (i.e., Very High; High; Medium; Low) taking into account the flight intensity i.e., the duration and distance of individual flight lines through a grid cell and the number of individual birds associated with each flight crossing the grid cell, in order to give an indication where the observed flight activity was most concentrated (see **Error! Reference source not found.**8 and **Error! Reference source not found.**9).

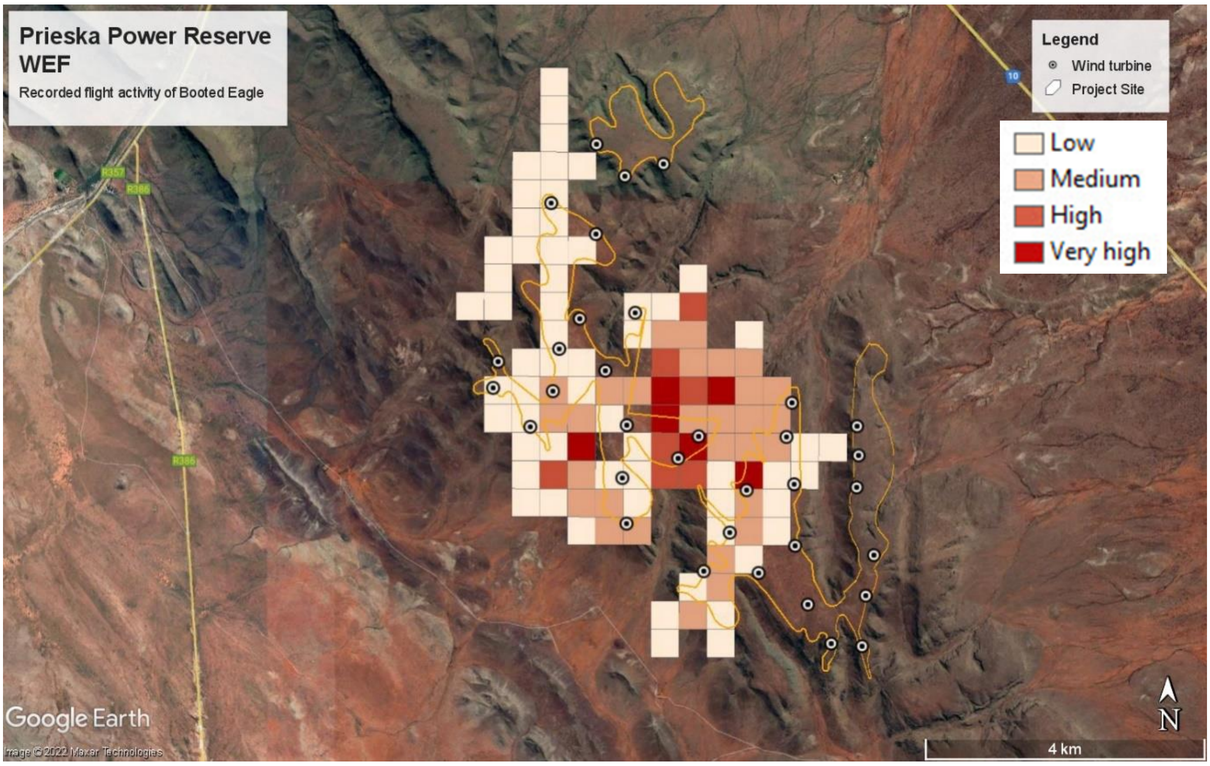


Figure 8: Recorded flight intensity of Booted Eagle

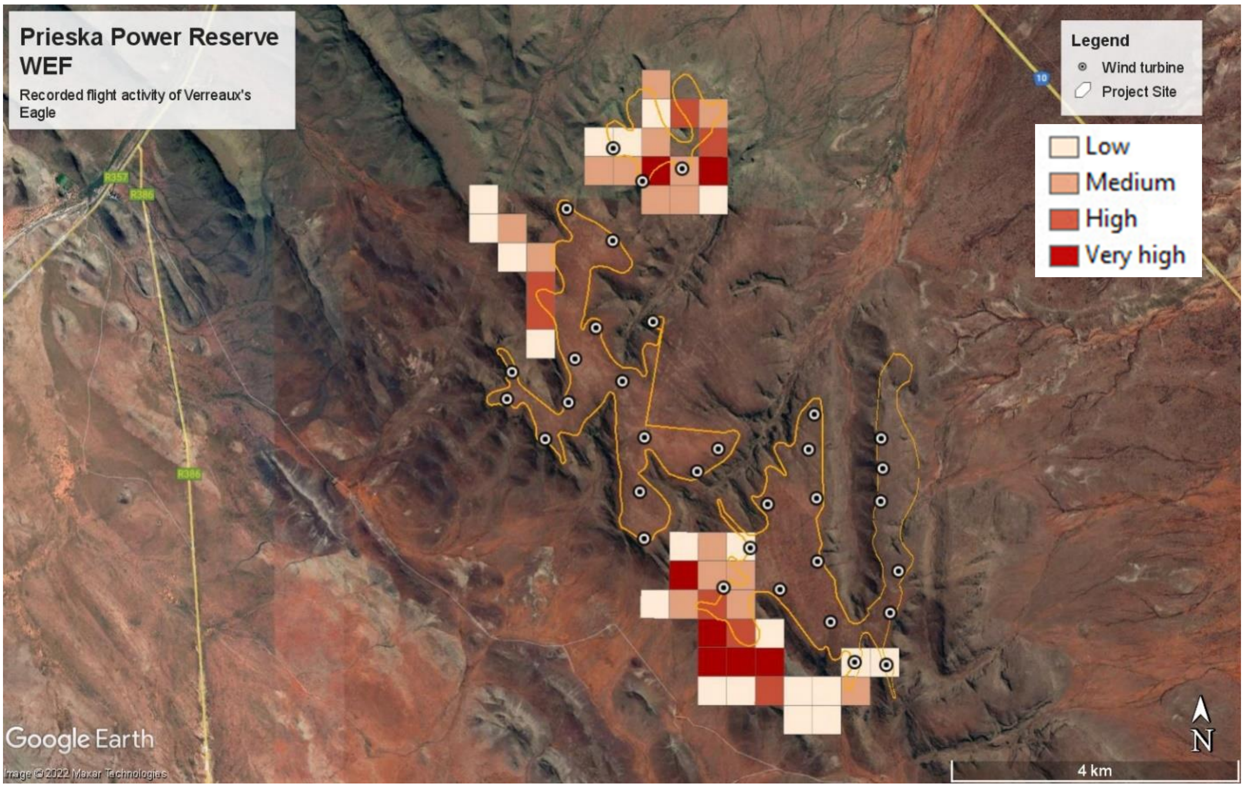


Figure 9: Recorded flight intensity of Verreaux's Eagle

8. SPECIALIST FINDINGS AND ASSESSMENT OF IMPACTS

8.1 Wind Energy Facility (WEF)

The proposed WEF could have several potential impacts on priority avifauna, which include the following:

- Displacement of priority species due to disturbance linked to construction activities in the construction phase.
- Displacement due to habitat transformation in the construction phase.
- Collision mortality caused by the wind turbines in the operational phase.
- Electrocution on the 33kV MV overhead lines in the operational phase.
- Collisions with the 33kV MV overhead lines in the operational phase.
- Displacement of priority species due to disturbance linked to dismantling activities in the decommissioning phase.

The above-mentioned impacts on priority avifauna are discussed in the sections below.

The effects of a WEF on birds are highly variable and depend on a wide range of factors, including the specification of the development, the topography of the surrounding land, the habitats affected and the number and species of birds present. With so many variables involved, the impacts of each WEF must be assessed individually. The principal areas of concern with regard to effects on birds are listed below. Each of these potential effects can interact with each other, either increasing the overall impact on birds or, in some cases, reducing a particular impact (for example where habitat loss or displacement causes a reduction in birds using an area which might then reduce the risk of collision):

It should be noted that the assessment is made on the *status quo* as it is currently on site. The possible change in land use in the Project Site is not taken into account because the extent and nature of future developments (not only wind energy development) are unknown at this stage. It is however highly unlikely that the land use will change in the foreseeable future due to climatic limitations.

8.1.1 Displacement of priority species due to disturbance linked to construction activities in the construction phase

The displacement of birds from areas within and surrounding WEFs due to visual intrusion and disturbance in effect can amount to habitat loss. Displacement may occur during both the construction and operation phases of WEFs and may be caused by the presence of the turbines themselves through visual, noise and vibration impacts, or as a result of vehicle and personnel movements related to site maintenance. The scale and degree of disturbance will vary according to site- and species-specific factors and must be assessed on a site-by-site basis (Drewitt & Langston, 2006).

Unfortunately, few studies of displacement due to disturbance are conclusive, often because of the lack of before- and-after and control-impact (BACI) assessments. Indications are that Great Bustard (*Otis tarda)* could be displaced by WEFs up to one kilometre from the facility (Langgemach, 2008). An Austrian study found displacement for Great Bustards up to 600m (Wurm & Kollar as quoted by Raab *et al.,* 2009). However, there is also evidence to the contrary; information on Great Bustard received from Spain points to the possibility of continued use of leks at operational WEFs (Camiña, 2012b). The same situation seems to prevail at WEFs in the Eastern Cape, where Denham's Bustard are still using WEF sites as leks.[6] Research on small grassland species in North America indicates that permanent displacement is uncommon and very species specific (e.g., see Stevens *et al.,* 2013, Hale *et al.,* 2014). There also seems to be little evidence for a persistent decline in passerine populations at WEF sites in the UK (despite some evidence of turbine avoidance), with some species, including Skylark, showing increased populations after WEF construction (see Pierce-Higgins *et al.,* 2012). Populations of Thekla Lark (*Galerida theklae)* were found to be unaffected by WEF developments in Southern Spain (see Farfan *et al*., 2009).

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[6] Personal communication by Wessel Rossouw, bird monitor based in Jeffreys Bay, from on personal observations in the Kouga municipal area.

The consequences of displacement for breeding productivity and survival are crucial to whether or not there is likely to be a significant impact on population size. However, studies of the impact of WEFs on breeding birds are also largely inconclusive or suggest lower disturbance distances, though this apparent lack of effect may be due to the high site fidelity and long life-span of the breeding species studied. This might mean that the true impacts of disturbance on breeding birds will only be evident in the longer term, when new recruits replace existing breeding birds. Few studies have considered the possibility of displacement for short-lived passerines (such as larks), although Leddy *et al.,* (1999) found increased densities of breeding grassland passerines with increased distance from wind turbines, and higher densities in the reference area than within 80m of the turbines. A review of minimum avoidance distances of 11 breeding passerines were found to be generally <100m from a wind turbine ranging from 14 – 93m (Hötker *et al.,* 2006). A comparative study of nine WEFs in Scotland (Pearce-Higgens *et al.,* 2009) found unequivocal evidence of displacement: Seven of the 12 species studied exhibited significantly lower frequencies of occurrence close to the turbines, after accounting for habitat variation, with equivocal evidence of turbine avoidance in a further two. No species were more likely to occur close to the turbines. Levels of turbine avoidance suggest breeding bird densities may be reduced within a 500m buffer of the turbines by 15– 53%, with Common Buzzard (*Buteo buteo)*, Hen Harrier (*Circus cyaneus)*, Golden Plover (*Pluvialis apricaria)*, Snipe (*Gallinago gallinago)*, Curlew (*Numenius arquata)* and Wheatear (*Oenanthe oenanthe)* most affected. In a follow-up study, monitoring data from WEFs located on unenclosed upland habitats in the United Kingdom were collated to test whether breeding densities of upland birds were reduced as a result of WEF construction or during WEF operation. Red Grouse (*Lagopus lagopus scoticus)*, Snipe (*Gallinago gallinago)* and Curlew (*Numenius arquata)* breeding densities all declined on WEFs during construction. Red Grouse breeding densities recovered after construction, but Snipe and Curlew densities did not. Post-construction Curlew breeding densities on WEFs were also significantly lower than reference sites. Conversely, breeding densities of Skylark (*Alauda arvensis)* and Stonechat (*Saxicola torquate)* increased on WEFs during construction. Overall, there was little evidence for consistent post-construction population declines in any species, suggesting that WEF construction can have greater impacts upon birds than WEF operation (Pierce-Higgens *et al.,* 2012).

It is inevitable that a measure of displacement will take place for all priority species during the construction phase of the WEF, due to the disturbance factor associated with the construction activities. This is likely to affect ground nesting species severely, as this could temporarily disrupt their reproductive cycle. Species which fall in this category are Ludwig's Bustard, Karoo Korhaan, Kori Bustard, Double-banded Courser, African Rock Pipit, Grey-winged Francolin, Northern Black Korhaan and Spotted Eagle-Owl. Some raptors might also be affected, e.g., Pale Chanting Goshawk which could potentially breed in the small *Senegalia mellifera* trees in the drainage lines.

Another major potential concern is the potential displacement of the estimated five (5) pairs of Verreaux's Eagles that breed within the PAOI, due to disturbance. **The VE guidelines recommend a minimum no-disturbance buffer of 1km around Verreaux's Eagle nests (Ralston-Patton 2021) where no construction activities should take place.**

Some species might be able to recolonise the area after the completion of the construction phase, but for some species this might only be partially the case, resulting in lower densities than before once the WEFs are operational, due to the disturbance factor of the operational turbines.

In summary, the following priority species are expected to be vulnerable to displacement due to disturbance:

Species name	Scientific name	Reporting rate: SABAP2 Full protocol	Reporting rate: SABAP2 Ad hoc protocol	Global status	Regional status	Wind priority	Recorded during monitoring	Likelihood of occurrence in the PAOI
Black-chested Snake Eagle	*Circaetus pectoralis*	0.00	1.27	-	-	x		L
Verreaux's Eagle	*Aquila verreauxii*	9.80	3.80	-	VU	x	x	H
Black-winged Kite	*Elanus caeruleus*	13.73	2.53	-	-	x		M
Booted Eagle	*Hieraaetus pennatus*	5.88	2.53	-	-	x	x	H
African Rock Pipit	*Anthus crenatus*	1.96	1.27	NT	NT	x		L
Double-banded Courser	*Rhinoptilus africanus*	7.84	1.27	-	-	x	x	M
Greater Kestrel	*Falco rupicoloides*	0.00	2.53	-	-	x		L
Karoo Korhaan	*Eupodotis vigorsii*	9.80	8.86	-	NT	x	x	H
Kori Bustard	*Ardeotis kori*	7.84	5.06	NT	NT	x		M
Lanner Falcon	*Falco biarmicus*	5.88	2.53	-	VU	x	x	M
Grey-winged Francolin	*Scleroptila afra*	0.00	0.00	-	-	x	x	M
Jackal Buzzard	*Buteo rufofuscus*	3.92	3.80	-	-	x	x	M
Ludwig's Bustard	*Neotis ludwigii*	9.80	1.27	EN	EN	x	x	M
Northern Black Korhaan	*Afrotis afraoides*	33.33	15.19	-	-	x	x	H
Pale Chanting Goshawk	*Melierax canorus*	33.33	17.72	-	-	x	x	H
Spotted Eagle-Owl	*Bubo africanus*	9.80	1.27	-	-	x		M
Tawny Eagle	*Aquila rapax*	0.00	0.00	VU	EN	x	x	M

8.1.2 Displacement due to habitat transformation in the construction phase

The scale of permanent habitat loss resulting from the construction of a WEF and associated infrastructure depends on the size of the project but, in general, it is likely to be small per turbine base. Typically, actual habitat loss amounts to 2–5% of the total development site (Fox *et al.,* 2006 as cited by Drewitt & Langston, 2006), though effects could be more widespread where developments interfere with hydrological patterns or flows on wetland or peatland sites (unpublished data). Some changes could also be beneficial. For example, habitat changes following the development of the Altamont Pass WEF in California led to increased mammal prey availability for some species of raptor (for example through greater availability of burrows for Pocket Gophers *Thomomys bottae* around turbine bases), though this may also have increased collision risk (Thelander *et al.,* 2003 as cited by Drewitt & Langston, 2006).

However, the results of habitat transformation may be more subtle, whereas the actual footprint of the WEF may be small in absolute terms, the effects of the habitat fragmentation brought about by the associated infrastructure (e.g., powerlines and roads) may be more significant. Sometimes Great Bustard can be seen close to or under powerlines, but a study done in Spain (Lane *et al.,* 2001 as cited by Raab *et al.,* 2009) indicates that the total observation of Great Bustard flocks was significantly higher further from powerlines than at control points. Shaw (2013) found that Ludwig's Bustard generally avoid the immediate proximity of roads within a 500m buffer. Bidwell (2004) found that Blue Cranes select nesting sites away from roads. This means that powerlines and roads also cause loss and fragmentation of the habitat used by the population in addition to the potential direct mortality. The physical encroachment increases the disturbance and barrier effects that contribute to the overall habitat fragmentation effect of the infrastructure (Raab *et* *al.,* 2010). It has been shown that fragmentation of natural grassland in Mpumalanga (in that case by afforestation) has had a detrimental impact on the densities and diversity of grassland species (Alan *et al.,* 1997).

The population displacement effect of wind turbines is observable across avian taxonomic orders, and has been recorded in raptors (Accipitriformes and Falconiformes), landfowl (Galliformes), shorebirds (Charadriiformes), waterfowl (Anseriformes), and songbirds (Passeriformes) (Marques et al., 2021).

The network of roads is likely to result in significant habitat fragmentation, and it could have an effect on the density of several species, particularly terrestrial species such as Ludwig's Bustard, Kori Bustard, Karoo Korhaan, Northern Black Korhaan, Double-banded Courser, Grey-winged Francolin and Africa Rock Pipit. Various species of raptors that could also be affected. Given the current density of the proposed turbine layout and associated road infra-structure for the WEF development, it is not expected that any priority species will be permanently displaced from the development sites.

In summary, the following priority species are expected to be vulnerable to potential displacement due to habitat transformation:

Species name	Scientific name	Reporting rate: SABAP2 Full protocol	Reporting rate: SABAP2 Ad hoc protocol	Global status	Regional status	Wind priority	Recorded during monitoring	Likelihood of occurrence in the PAOI
Black-chested Snake Eagle	*Circaetus pectoralis*	0.00	1.27	-	-	x		L
Verreaux's Eagle	*Aquila verreauxii*	9.80	3.80	-	VU	x	x	H
Black-winged Kite	*Elanus caeruleus*	13.73	2.53	-	-	x		M
Booted Eagle	*Hieraaetus pennatus*	5.88	2.53	-	-	x	x	H
African Rock Pipit	*Anthus crenatus*	1.96	1.27	NT	NT	x		L
Common Buzzard	*Buteo buteo*	7.84	1.27	-	-	x	x	M
Double-banded Courser	*Rhinoptilus africanus*	7.84	1.27	-	-	x	x	M
Greater Kestrel	*Falco rupicoloides*	0.00	2.53	-	-	x		L
Karoo Korhaan	*Eupodotis vigorsii*	9.80	8.86	-	NT	x	x	H
Kori Bustard	*Ardeotis kori*	7.84	5.06	NT	NT	x		M
Lanner Falcon	*Falco biarmicus*	5.88	2.53	-	VU	x	x	M
Lappet-faced Vulture	*Torgos tracheliotis*	0.00	0.00	EN	EN	x		M
Grey-winged Francolin	*Scleroptila afra*	0.00	0.00	-	-	x	x	M
Jackal Buzzard	*Buteo rufofuscus*	3.92	3.80	-	-	x	x	M
Lesser Spotted Eagle	*Clanga pomarina*	0.00	1.27	-	-	x		L
Ludwig's Bustard	*Neotis ludwigii*	9.80	1.27	EN	EN	x	x	M
Northern Black Korhaan	*Afrotis afraoides*	33.33	15.19	-	-	x	x	H
Pale Chanting Goshawk	*Melierax canorus*	33.33	17.72	-	-	x	x	H
Spotted Eagle-Owl	*Bubo africanus*	9.80	1.27	-	-	x		M
Tawny Eagle	*Aquila rapax*	0.00	0.00	VU	EN	x	x	M
White-backed Vulture	*Gyps africanus*	0.00	0.00	CR	CR	x		M

8.1.3 Collision mortality on wind turbines in the operational phase[7]

Wind energy generation has experienced rapid worldwide development over recent decades, as its environmental impacts are considered to be relatively lower than those caused by traditional energy sources, with reduced environmental pollution and water consumption (Saidur *et al.*, 2011). However, bird fatalities due to collisions with wind turbines have been consistently identified as a main ecological drawback to wind energy (Drewitt and Langston, 2006).

Collisions with wind turbines appear to kill fewer birds than collisions with other man-made infrastructures, such as powerlines, buildings or even traffic (Calvert *et al.,* 2013; Erickson *et al.,* 2005). Nevertheless, estimates of bird deaths from collisions with wind turbines worldwide range from 0 to almost 40 deaths per turbine per year (Sovacool, 2009). The number of birds killed varies greatly between sites, with some sites posing a higher collision risk than others, and with some species being more vulnerable (e.g., Hull *et al.,* 2013; May *et al.,* 2012a). These numbers may not reflect the true magnitude of the problem, as some studies do not account for detectability biases such as those caused by scavenging, searching efficiency and search radius (Bernardino *et al.,* 2013; Erickson *et al.,* 2005; Huso and Dalthorp, 2014). Additionally, even for low fatality rates, collisions with wind turbines may have a disproportionate effect on some species. For long-lived species with low productivity and slow maturation rates (e.g., raptors), even low mortality rates can have a significant impact at the population level (e.g., Carrete *et al.,* 2009; De Lucas *et al.,* 2012a; Drewitt and Langston, 2006). The situation is even more critical for species of conservation concern, which sometimes are most at risk (e.g., Osborn *et al.,* 1998).

High bird fatality rates at several WEFs have raised concerns among the industry and scientific community. High profile examples include the Altamont Pass Wind Resource Area (APWRA) in California because of high fatality of Golden eagles (*Aquila chrysaetos*), Tarifa in Southern Spain for Griffon vultures (*Gyps fulvus*), Smøla in Norway for White-tailed eagles (*Haliaatus albicilla*), and the port of Zeebrugge in Belgium for gulls (*Larus* sp.) and terns (*Sterna* sp.) (Barrios and Rodríguez, 2004; Drewitt and Langston, 2006; Everaert and Stienen, 2008; May *et al.,* 2012a; Thelander *et al.,* 2003). Due to their specific features and location, and characteristics of their bird communities, these WEFs have been responsible for a large number of fatalities that culminated in the deployment of additional measures to minimize or compensate for bird collisions. However, currently, no simple formula can be applied to all sites; in fact, mitigation measures must inevitably be defined according to the characteristics of each WEF and the diversity of species occurring there (Hull *et al.,* 2013; May *et al.,* 2012b). An understanding of the factors that explain bird collision risk and how they interact with one another is therefore crucial to proposing and implementing valid mitigation measures.

Species-specific factors

- Morphological features

Certain morphological traits of birds, especially those related to size, are known to influence collision risk with structures such as powerlines and wind turbines. Janss (2000) identified weight, wing length, tail length and total bird length as being collision risk determinant. Wing loading (ratio of body weight to wing area) and aspect ratio (ratio of wingspan squared to wing area) are particularly relevant, as they influence flight type and thus collision risk (Bevanger, 1994; De Lucas *et al.,* 2008; Herrera-Alsina *et al.,* 2013; Janss, 2000). Birds with high wing loading, such as the Griffon Vulture (*Gyps fulvus*), seem to collide more frequently with wind turbines at the same sites than birds with lower wing loadings, such as Common Buzzards (*Buteo buteo*) and Short-toed Eagles (*Circaetus gallicus*), and this pattern is not

[7] This section is based largely on a (2014) review paper by Ana Teresa Marques, Helena Batalha, Sandra Rodrigues, Hugo Costa, Maria João Ramos Pereira,Carlos Fonseca, Miguel Mascarenhas, Joana Bernardino. *Understanding bird collisions at wind farms: An updated review on the causes and possible mitigation strategies*. Biological Conservation 179 (2014) 40– 52.

related with their local abundance (Barrios and Rodríguez, 2004; De Lucas *et al.,* 2008). High wing-loading is associated with low flight manoeuvrability (De Lucas *et al.,* 2008), which determines whether a bird can escape an encountered object fast enough to avoid collision.

Information on the wing loading of the priority species potentially occurring at the PAOI was not available at the time of writing. However, based on general observations, and research on related species, it can be confidently assumed that priority species that could potentially be vulnerable to wind turbine collisions due to morphological features (high wing loading) are bustards, korhaans and vultures, making them less manoeuvrable (Keskin *et al.,* 2019).

- Sensorial perception

Birds are assumed to have excellent visual acuity, but this assumption is contradicted by the large numbers of birds killed by collisions with man-made structures (Drewitt and Langston, 2008; Erickson *et al.,* 2005). A common explanation is that birds collide more often with these structures in conditions of low visibility, but recent studies have shown that this is not always the case (Krijgsveld *et al.,* 2009). The visual acuity of birds seems to be slightly superior to that of other vertebrates (Martin, 2011; McIsaac, 2001). Unlike humans, who have a broad horizontal binocular field of 120°, some birds have two high acuity areas that overlap in a very narrow horizontal binocular field (Martin, 2011). Relatively small frontal binocular fields have been described for several species that are particularly vulnerable to powerline collisions, such as vultures (Gyps sp.) cranes and bustards (Martin and Katzir, 1999; Martin *et al.*, 2010; Martin, 2012, 2011; O'Rourke *et al.,* 2010). Furthermore, for some species, their high-resolution vision areas are often found in the lateral fields of view, rather than frontally (e.g., Martin *et al.,* 2010; Martin, 2012, 2011; O'Rourke *et al.,* 2010). Finally, some birds tend to look downwards when in flight, searching for conspecifics or food, which puts the direction of flight completely inside the blind zone of some species (Martin *et al.,* 2010; Martin, 2011).

Some of the regularly occurring priority species in the PAOI have high resolution vision areas found in the lateral fields of view, rather than frontally, e.g., the bustards. The exceptions to this are the priority raptors which all have wider binocular fields, although as pointed out by Martin (2011, 2012), this does not necessarily result in these species being able to avoid obstacles better.

- Phenology

Recent studies have shown that, within a WEF, raptor collision risk and fatalities are higher for resident than for migrating birds of the same species. An explanation for this may be that resident birds generally use the WEF area several times, while a migrant bird crosses it just once (Krijgsveld *et al.,* 2009). However, other factors like bird behaviour are certainly relevant. Katzner *et al.,* (2012) showed that Golden Eagles performing local movements fly at lower altitudes, putting them at a greater risk of collision than migratory eagles. Resident eagles flew more frequently over cliffs and steep slopes, using low altitude slope updrafts, while migratory eagles flew more frequently over flat areas and gentle slopes where thermals are generated, enabling the birds to use them to gain lift and fly at higher altitudes.

South Africa is at the end of the migration path for summer migrants; therefore, the phenomenon of migratory flyways where birds are concentrated in large numbers for a limited period of time, e.g., the African Rift Valley or Mediterranean Red Sea flyways, is not a feature of the landscape. The migratory priority species which could occur in the PAOI with some regularity, e.g., Booted Eagle, will behave much the same as the resident birds once they arrive in the area. The same is valid for local migrants such as the Ludwig's Bustard. It is expected that, for the period when they are present, these species will be exposed to the same risks as resident species.

- Bird behaviour

Flight type seems to play an important role in collision risk, especially when associated with hunting and foraging strategies. Kiting flight (hanging in the wind with almost motionless wings), which is used in strong winds and occurs in rotor swept zones, has been highlighted as a factor explaining the high collision rate of Red-tailed Hawks (*Buteo jamaicensis*) at APWRA (Hoover and Morrison, 2005), and could also be a factor in contributing to the high collision rate for Jackal Buzzards in South Africa (Ralston-Paton & Camagu, 2019). The hovering behaviour exhibited by Common Kestrels (*Falco tinnunculus*) when hunting may also explain the fatality levels of this species at WEFs in the Strait of Gibraltar (Barrios and Rodríguez, 2004). This may also explain the high mortality rate of Rock Kestrels (*Falco rupicolus*) at WEFs in South Africa (Ralston-Paton & Camagu, 2019). Kiting and hovering are associated with strong winds, which often produce unpredictable gusts that may suddenly change a bird's position (Hoover and Morrison, 2005). Additionally, while birds are hunting and focused on prey, they might lose track of wind turbine positions (Krijgsveld *et al.,* 2009; Smallwood *et al.,* 2009). In the case of raptors, aggressive interactions may play an important role in turbine fatalities, in that birds involved in these interactions are momentarily distracted, putting them at risk. At least one eye-witness account of a Martial Eagle getting killed by a turbine in South Africa in this fashion is on record (Simmons & Martins, 2016)

Social behaviour may also result in a greater collision risk with wind turbines due to a decreased awareness of the surroundings. Several authors have reported that flocking behaviour increases collision risk with powerlines as opposed to solitary flights (e.g., Janss, 2000). However, caution must be exercised when comparing the particularities of WEFs with powerlines, as some species appear to be vulnerable to collisions with powerlines but not with wind turbines, e.g., indications are that bustards, which are highly vulnerable to powerline collisions, are not prone to wind turbine collisions – a Spanish database of over 7 000 recorded turbine collisions contains no Great Bustards (*Otis tarda*) (A. Camiña, 2012a). Similarly, in South Africa, few collisions with wind turbines have been reported to date, all Ludwig's Bustards (Ralston-Paton & Camagu, 2019). No Denham's Bustards (*Neotis denhami)* turbine fatalities have been reported to date, despite the species occurring at several WEF sites.

The priority species which could occur with some regularity in the PAOI can be classified as either terrestrial species, soaring species or occasional long-distance fliers. Terrestrial species spend most of the time foraging on the ground. They do not fly often and when they do, they generally fly for short distances at low to medium altitude. At the PAOI, Ludwig Bustard, Kori Bustard, Northern Black Korhaan, Karoo Korhaan and Grey-winged Francolin are included in this category. Occasional long-distance fliers generally behave as terrestrial species but can and do undertake long distance flights on occasion. Species in this category are Ludwig's Bustard, Double-banded Courser and Kori Bustard [8]. Soaring species spend a significant time on the wing in a variety of flight modes including soaring, kiting, hovering and gliding at medium to high altitudes. These include all the raptors and vultures which could occur, including the Red List Verreaux's Eagle, White-backed Vulture, Lappet-faced Vulture, Tawny Eagle and Lanner Falcon. Based on the time spent potentially flying at rotor height, soaring species are likely to be at greater risk of collision.

- Avoidance behaviours

Two types of avoidance have been described (Furness *et al.*, 2013): 'macro-avoidance' - whereby birds alter their flight path to keep clear of the entire WEF (e.g., Desholm and Kahlert, 2005; Plonczkier and Simms, 2012; Villegas-Patraca *et al.,* 2014), and 'micro-avoidance' - whereby birds enter the WEF but take evasive actions to avoid individual wind turbines (Band *et al.,* 2007). This may differ between species and may have a significant impact on the size of

[8] Blue Crane were not recorded at the sites, but the species occurs in the greater area.

the risk associated with a specific species. It is generally assumed that 95-98% of birds will successfully avoid the turbines (SNH, 2010).

It is anticipated that most birds in the PAOI will avoid the wind turbines, as is generally the case at all WEFs (SNH, 2010). Exceptions already mentioned are raptors that engage in hunting which might serve to distract them and place them at risk of collision, birds engaged in display behaviour or inter- and intraspecific aggressive interaction. Complete macro-avoidance of the WEF is unlikely for any of the priority species likely to occur in the PAOI**.**

- Bird abundance

Some authors suggest that fatality rates are related to bird abundance, density or utilization rates (Carrete *et al.,* 2012; Kitano and Shiraki, 2013; Smallwood and Karas, 2009), whereas others point out that, as birds use their territories in a non-random way, fatality rates do not depend on bird abundance alone (e.g., Ferrer *et al.,* 2012; Hull *et al.,* 2013). Instead, fatality rates depend on other factors such as differential use of specific areas within a WEF (De Lucas *et al.,* 2008). For example, at Smøla, White-tailed Eagle flight activity is correlated with collision fatalities (Dahl *et al.,* 2013). In the APWRA, Golden Eagles, Red-tailed Hawks and American Kestrels (*Falco spaverius*) have higher collision fatality rates than Turkey Vultures (*Cathartes aura*) and Common Raven (*Corvus corax*), even though the latter are more abundant in the area (Smallwood *et al.,* 2009), indicating that fatalities are more influenced by each species' flight behaviour and turbine perception. Also, in southern Spain, bird fatality was higher in the winter, even though bird abundance was higher during the pre-breeding season (De Lucas *et al.,* 2008).

The abundance of priority species in the PAOI will fluctuate depending on the season of the year, and especially in response to rainfall e.g., Ludwig's Bustard and Double-banded Courser. In the case of vultures, the observed pattern for the area is an influx of White-backed Vultures and Lappet-faced Vultures during the non-breeding season i.e. between November and April. The PAOI has a dense resident population of Verreaux's Eagles which maintains a year-round presence at the site.

Site-specific factors

- Landscape features

Susceptibility to collision can also heavily depend on landscape features at a WEF site, particularly for soaring birds that predominantly rely on wind updrafts to fly. Some landforms such as ridges, steep slopes and valleys may be more frequently used by some birds, for example for hunting or during migration (Barrios and Rodríguez, 2004; Drewitt and Langston, 2008; Katzner *et al.,* 2012; Thelander *et al.,* 2003). In APWRA, Red-tailed Hawk fatalities occur more frequently than expected by chance at wind turbines located on ridge tops and swales, whereas Golden Eagle fatalities are higher at wind turbines located on slopes (Thelander *et al.,* 2003). Other birds may follow other landscape features, such as peninsulas and shorelines, during dispersal and migration periods. Kitano and Shiraki (2013) found that the collision rate of White-tailed Eagles along a coastal cliff was extremely high, suggesting an effect of these landscape features on fatality rates.

The most significant landscape features from a collision risk perspective at the PAOI are the many ridges and valleys which are used extensively by a variety of raptors for slope soaring, but most importantly by the Red List Verreaux's Eagle, which puts them potentially at risk of collisions with the turbines. Also important are the ground dams, drinking troughs and the drainage lines (when flowing). Surface water attracts many birds, including Red List species such as White-backed Vulture, Lappet-faced Vulture, Lanner Falcon and occasionally, Verreaux's Eagle.

- Flight paths

For territorial raptors like Golden Eagles (and Verreaux's Eagles – see Ralston-Patton, 2017), foraging areas are preferably located near to the nest, when compared to the rest of their home range. For example, in Scotland 98% of Golden Eagle movements were registered at ranges less than 6km from the nest, and the core areas were located within a 2 - 3km radius (McGrady *et al.,* 2002). These results, combined with the terrain features selected by Golden Eagles to forage such as areas close to ridges, can be used to predict the areas used by the species to forage (McLeod *et al.,* 2002), and therefore provide a sensitivity map and guidance to the development of new WEFs (Bright *et al.,* 2006).

BirdLife South Africa (BLSA) initially recommended a 3 km buffer around Verreaux's Eagle nest sites, based on the radius of the mean 90% utilisation distributions, calculated from GPS tracking data collected data from a small number of Verreaux's Eagles in the Cederberg (two individuals) and Sandveld (three individuals) (Ralston-Patton 2021). This data was also derived from a short period, representing only 21 days during part of the annual cycle (pre-breeding season). Further justification was that 3 km is roughly half the mean inter-nest distance averaged across sites in South Africa (excluding the Ghaap plateau). Nevertheless, more recent data suggests that these buffers were inadequate. In fact, 9 of 14 (64%) adult Verreaux's Eagle collisions have taken place beyond 3 km of nests and an analysis of the spatial use of Verreaux's Eagle indicates that **collision risk potential remains high well beyond 3 km** (Murgatroyd et al., 2021). Drawing on the work of Murgatroyd *et al.* (2021) BLSA currently recommends a precautionary buffer of 5.2 km. Alternatively, the Verreaux's Eagle Risk Assessment (VERA) could be implemented. VERA is a collision risk potential (CRP) model that predicts collision risk based on site-specific variables defined by the local topography and the location of nests. By accounting for the primary static variables which impact habitat selection, this model provides a more realistic assessment of risk compared to circular nest buffers. In comparison, the VERA model correctly predicted 79% of adult collision mortalities, compared to 50% using a 5.2km buffer. (Ralston-Patton 2021).

Based on the number of recorded nests, it is estimated that there are at least five active Verreaux's Eagle territories that overlap with the PAOI. In the absence of effective mitigation, there is a high risk of collisions with the proposed wind turbines due to the expected high flight activity in the PAOI. In order to eliminate the risk of collisions to these birds, a novel mitigation strategy is proposed which is believed to be more effective than any of the buffer zones that are currently proposed in the VE guidelines (see Appendix 4)

- Food availability

Factors that increase the use of a certain area or that attract birds, like food availability; also play a role in collision risk. For example, the high density of raptors at the APWRA and the high collision fatality due to collision with turbines is thought to result, at least in part, from high prey availability in certain areas (Hoover and Morrison, 2005; Smallwood *et al.,* 2001). This may be particularly relevant for birds that are less aware of obstructions such as wind turbines while foraging (Krijgsveld *et al.,* 2009; Smallwood *et al.,* 2009). It is thought that the mortality of three Verreaux's Eagles in 2015 at a WEF site in South Africa may have been linked to the availability of food (Smallie, 2015).

The habitat at the PAOI supports a healthy population of Rock Hyrax (Dassie) *Procavia capensis*, which is the staple diet of Verreaux's Eagles. Dassies only live where there are outcrops of rock such as rocky koppies [hillocks], cliffs or piles of large rocks or boulders. The availability of food is definitely a contributing factor to the dense population of Verreaux's Eagle in the PAOI.

- Summary

The proposed WEF will pose a potential collision risk to several priority species which could occur regularly in the PAOI. Species exposed to this risk are large terrestrial species i.e., mostly bustards, korhaans, francolins and coursers, although bustards generally seem to be not as vulnerable to turbine collisions as was originally anticipated (Ralston-Paton & Camagu, 2019). Soaring priority species, i.e., raptors such as Pale Chanting Goshawk, Lanner Falcon, Booted Eagle, Greater Kestrel, White-backed Vulture, Lappet-faced Vulture and in particular, Verreaux's Eagle, are most at risk of collision mortality of all the priority species likely to occur regularly in the PAOI.

In summary, the following priority species could be at risk of collisions with the turbines in the PAOI:

Species name	Scientific name	Reporting rate: SABAP2 Full protocol	Reporting rate: SABAP2 Ad hoc protocol	Global status	Regional status	Wind priority	Recorded during monitoring	Likelihood of occurrence in the PAOI
African Fish Eagle	*Haliaeetus vocifer*	15.69	2.53	-	-	x		L
Black-chested Snake Eagle	*Circaetus pectoralis*	0.00	1.27	-	-	x		L
Black-winged Kite	*Elanus caeruleus*	13.73	2.53	-	-	x		M
Booted Eagle	*Hieraaetus pennatus*	5.88	2.53	-	-	x	x	H
Common Buzzard	*Buteo buteo*	7.84	1.27	-	-	x	x	M
Double-banded Courser	*Rhinoptilus africanus*	7.84	1.27	-	-	x	x	M
Greater Kestrel	*Falco rupicoloides*	0.00	2.53	-	-	x		L
Grey-winged Francolin	*Scleroptila afra*	0.00	0.00	-	-	x	x	M
Jackal Buzzard	*Buteo rufofuscus*	3.92	3.80	-	-	x	x	M
Karoo Korhaan	*Eupodotis vigorsii*	9.80	8.86	-	NT	x	x	H
Kori Bustard	*Ardeotis kori*	7.84	5.06	NT	NT	x		M
Lanner Falcon	*Falco biarmicus*	5.88	2.53	-	VU	x	x	M
Lappet-faced Vulture	*Torgos tracheliotis*	0.00	0.00	EN	EN	x		M
Lesser Spotted Eagle	*Clanga pomarina*	0.00	1.27	-	-	x		L
Ludwig's Bustard	*Neotis ludwigii*	9.80	1.27	EN	EN	x	x	M
Northern Black Korhaan	*Afrotis afraoides*	33.33	15.19	-	-	x	x	H
Pale Chanting Goshawk	*Melierax canorus*	33.33	17.72	-	-	x	x	H
Spotted Eagle-Owl	*Bubo africanus*	9.80	1.27	-	-	x		M
Tawny Eagle	*Aquila rapax*	0.00	0.00	VU	EN	x	x	M
Verreaux's Eagle	*Aquila verreauxii*	9.80	3.80	-	VU	x	x	H
White-backed Vulture	*Gyps africanus*	0.00	0.00	CR	CR	x		M

8.1.4 Displacement of priority species due to disturbance linked to construction activities in the decommissioning phase

The impact of displacement due to disturbance during this phase will be similar in nature and intensity as during the construction phase (see 8.1.2).

8.2 Impacts associated with the electricity infrastructure

The following potential impacts on priority avifauna, associated with the overhead lines and other electrical infrastructure, could materialise:

- Mortality due to electrocution of priority species in the on-site and combiner substations, and on the overhead lines.
- Mortality due to collisions with the overhead lines.
- Displacement of priority species due to disturbance associated with to the construction and decommissioning of the proposed overhead lines and associated infrastructure.

8.2.1 Electrocution on the overhead lines, in the on-site substations and in the combiner substations in the operational phase

Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen, 2000). The electrocution risk is largely determined by the design of the electrical hardware and the size of the bird.

Ideally the 33kV reticulation network should be placed underground where possible. If the lines have to run above ground, for technical reasons, the poles could potentially pose a serious electrocution risk to raptors, which could result in mortalities even more severe than turbine collisions, unless a bird-friendly design is used. Raptors and vultures are particularly at risk. Electrocutions within the proposed substations are possible, however the likelihood of this impact on the more sensitive Red List priority species is remote, as these species are unlikely to regularly utilise the infrastructure within the substation yard for perching or roosting.

The only priority species capable of bridging the clearance distances of the proposed 132kV power line infrastructure are White-backed Vultures and Lappet-faced Vultures, due to their size and gregarious nature. There is an established White-backed Vulture and Lappet-faced Vulture roost on this line ~25 km south-west of the PAOI (>100 birds). Based on interviews with landowners and personal observations, it is it seems that the numbers of White-backed Vultures and Lappet-faced Vultures are on the increase south of the Orange River in the Northern Cape during the non-breeding season (December to May). These birds establish temporary roosts on power lines, and it is entirely possible that the birds could on occasion roost on the proposed 33kV and 132kV powerlines. Depending on the proposed pole design, this could place them at risk of electrocution.

In summary, the following priority species are potentially vulnerable to electrocution on the electrical infrastructure:

Species name	Scientific name	Reporting rate: SABAP2 Full protocol	Reporting rate: SABAP2 Ad hoc protocol	Global status	Regional status	Wind priority	Recorded during monitoring	Likelihood of occurrence in the PAOI
African Fish Eagle	*Haliaeetus vocifer*	15.69	2.53	-	-	x		L
Black-chested Snake Eagle	*Circaetus pectoralis*	0.00	1.27	-	-	x		L
Black-winged Kite	*Elanus caeruleus*	13.73	2.53	-	-	x		M
Booted Eagle	*Hieraaetus pennatus*	5.88	2.53	-	-	x	x	H
Common Buzzard	*Buteo buteo*	7.84	1.27	-	-	x	x	M
Greater Kestrel	*Falco rupicoloides*	0.00	2.53	-	-	x		L

Jackal Buzzard	*Buteo rufofuscus*	3.92	3.80	-	-	x	x	M
Lanner Falcon	*Falco biarmicus*	5.88	2.53	-	VU	x	x	M
Lappet-faced Vulture	*Torgos tracheliotis*	0.00	0.00	EN	EN	x		M
Lesser Spotted Eagle	*Clanga pomarina*	0.00	1.27	-	-	x		L
Pale Chanting Goshawk	*Melierax canorus*	33.33	17.72	-	-	x	x	H
Spotted Eagle-Owl	*Bubo africanus*	9.80	1.27	-	-	x		M
Tawny Eagle	*Aquila rapax*	0.00	0.00	VU	EN	x	x	M
Verreaux's Eagle	*Aquila verreauxii*	9.80	3.80	-	VU	x	x	H
White-backed Vulture	*Gyps africanus*	0.00	0.00	CR	CR	x		M

8.2.2 Collisions with the overhead lines in the operational phase

Collisions are arguably the biggest threat posed by overhead lines to birds in southern Africa (Van Rooyen, 2004). Most heavily impacted upon are bustards, storks, cranes and various species of waterbirds, and to a lesser extent, vultures. These species are mostly heavy-bodied birds with limited manoeuvrability, which makes it difficult for them to take the necessary evasive action to avoid colliding with transmission lines (Van Rooyen, 2004; Anderson, 2001). In a PhD study, Shaw (2013) provides a concise summary of the phenomenon of avian collisions with transmission lines:

"The collision risk posed by power lines is complex and problems are often localised. While any bird flying near a power line is at risk of collision, this risk varies greatly between different groups of birds, and depends on the interplay of a wide range of factors (APLIC, 1994). Bevanger (1994) described these factors in four main groups – biological, topographical, meteorological and technical. Birds at highest risk are those that are both susceptible to collisions and frequently exposed to power lines, with waterbirds, gamebirds, rails, cranes and bustards usually the most numerous reported victims (Bevanger, 1998; Rubolini et al., 2005; Jenkins et al., 2010).

The proliferation of man-made structures in the landscape is relatively recent, and birds are not evolved to avoid them. Body size and morphology are key predictive factors of collision risk, with large-bodied birds with high wing loadings (the ratio of body weight to wing area) most at risk (Bevanger, 1998; Janss, 2000). These birds must fly fast to remain airborne, and do not have sufficient manoeuvrability to avoid unexpected obstacles. Vision is another key biological factor, with many collision-prone birds principally using lateral vision to navigate in flight, when it is the lower-resolution, and often restricted, forward vision that is useful to detect obstacles (Martin & Shaw, 2010; Martin, 2011; Martin et al., 2012). Behaviour is important, with birds flying in flocks, at low levels and in crepuscular or nocturnal conditions at higher risk of collision (Bevanger, 1994). Experience affects risk, with migratory and nomadic species that spend much of their time in unfamiliar locations also expected to collide more often (Anderson, 1978; Anderson, 2002). Juvenile birds have often been reported as being more collision-prone than adults (e.g., Brown et al., 1987; Henderson et al., 1996).

Topography and weather conditions affect how birds use the landscape. Power lines in sensitive bird areas (e.g., those that separate feeding and roosting areas, or cross flyways) can be very dangerous (APLIC, 1994; Bevanger, 1994). Lines crossing the prevailing wind conditions can pose a problem for large birds that use the wind to aid take-off and landing (Bevanger, 1994). Inclement weather can disorient birds and reduce their flight altitude, and strong winds can result in birds colliding with power lines that they can see but do not have enough flight control to avoid (Brown et al., 1987; APLIC, 2012).

The technical aspects of power line design and siting also play a big part in collision risk. Grouping similar power lines on a common servitude, or locating them along other features such as tree lines, are both approaches thought to reduce risk (Bevanger, 1994). In general, low lines with short span lengths (i.e., the distance between two adjacent pylons) and flat conductor configurations are thought to be the least dangerous (Bevanger, 1994; Jenkins et al., 2010). On many higher voltage lines, there is a thin earth (or ground) wire above the conductors, protecting the system from lightning strikes. Earth wires are widely accepted to cause the majority of collisions on power lines with this *configuration because they are difficult to see, and birds flaring to avoid hitting the conductors often put themselves directly in the path of these wires (Brown et al., 1987; Faanes, 1987; Alonso et al., 1994a; Bevanger, 1994)."*

From incidental record keeping by the Endangered Wildlife Trust (EWT), it is possible to give a measure of what species are generally susceptible to powerline collisions in South Africa (see Figure 100 below).

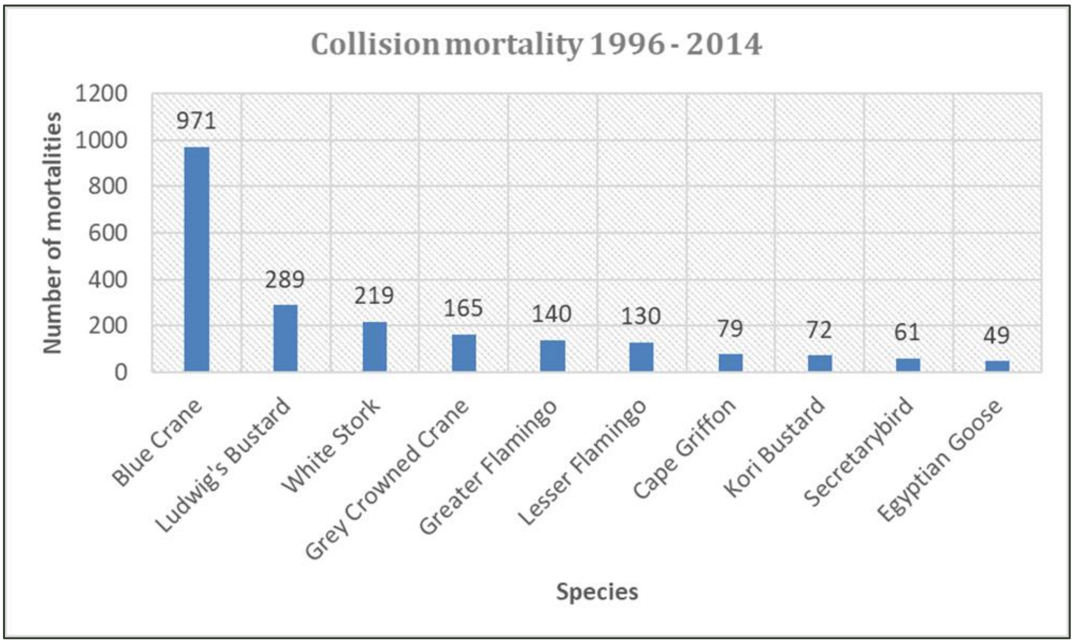

Figure 10: The top 10 collision prone bird species in South Africa, in terms of reported incidents contained in the Eskom / Endangered Wildlife Trust (EWT) Strategic Partnership central incident register 1996 - 2014 (EWT unpublished data)

Powerline collisions are generally accepted as a key threat to bustards (Raab *et al*., 2009; Raab *et al*., 2010; Jenkins & Smallie, 2009; Barrientos *et al*., 2012; Shaw, 2013). In a recent study, carcass surveys were performed under high voltage transmission lines in the Karoo for two years, and low voltage distribution lines for one year (Shaw, 2013). Ludwig's Bustard was the most common collision victim (69% of carcasses), with bustards generally comprising 87% of mortalities recovered. Total annual mortality was estimated at 41% of the Ludwig's Bustard population, with Kori Bustards also dying in large numbers (at least 14% of the South African population killed in the Karoo alone). Karoo Korhaan was also recorded, but to a much lesser extent than Ludwig's Bustard. The reasons for the relatively low collision risk of this species probably include their smaller size (and hence greater agility in flight) as well as their more sedentary lifestyles, as local birds are familiar with their territory and are less likely to collide with power lines (Shaw, 2013).

Several factors are thought to influence avian collisions, including the manoeuvrability of the bird, topography, weather conditions and powerline configuration. An important additional factor that previously has received little attention is the visual capacity of birds; i.e., whether they are able to see obstacles such as powerlines, and whether they are looking ahead to see obstacles with enough time to avoid a collision. In addition to helping explain the susceptibility of some species to collision, this factor is key to planning effective mitigation measures. Recent research provides the first evidence that birds can render themselves blind in the direction of travel during flight through voluntary head movements (Martin & Shaw, 2010). Visual fields were determined in three bird species, representative of families known to be subject to high levels of mortality associated with powerlines i.e., Kori Bustards, Blue Cranes *Anthropoides paradiseus* and White Storks *Ciconia ciconia*. In all species the frontal visual fields showed narrow and vertically long binocular fields typical of birds that take food items directly in the bill under visual guidance. However, these species differed markedly in the vertical extent of their binocular fields and in the extent of the blind areas which project above and below the binocular fields in the forward-facing hemisphere. The importance of these blind areas is that when in flight, head movements in the vertical plane (pitching the head to look downwards) will render the bird blind in the direction of travel. Such movements may frequently occur when birds are scanning below them (for foraging or roost sites, or for conspecifics). In bustards and cranes pitch movements of only 25° and 35°, respectively, are sufficient to render the birds blind in the direction of travel; in storks, head movements of 55° are necessary. That flying birds can render themselves blind in the direction of travel has not been previously recognised and has important implications for the effective mitigation of collisions with human artefacts including wind turbines and powerlines. These findings have applicability to species outside of these families especially raptors (A*ccipitridae*) which are known to have small binocular fields and large blind areas similar to those of bustards and cranes, and are also known to be vulnerable to powerline collisions.

Despite doubts about the efficacy of line marking to reduce the collision risk for bustards (Jenkins *et al*., 2010; Martin *et al.,* 2010), there are numerous studies which prove that marking a line with PVC spiral type Bird Flight Diverters (BFDs) generally reduce mortality rates (e.g. Bernardino *et al.,* 2018; Sporer *et al.,* 2013; Barrientos *et al*., 2011; Jenkins *et al*., 2010; Alonso & Alonso, 1999; Koops & De Jong, 1982), including to some extent for bustards (Barrientos *et al*., 2012; Hoogstad, 2015 pers.comm). Beaulaurier (1981) summarised the results of 17 studies that involved the marking of earth wires and found an average reduction in mortality of 45%. Barrientos *et al.* (2011) reviewed the results of 15 wire marking experiments in which transmission or distribution wires were marked to examine the effectiveness of flight diverters in reducing bird mortality. The presence of flight diverters was associated with a decrease of 55–94% in bird mortalities. Koops and De Jong (1982) found that the spacing of the BFDs was critical in reducing the mortality rates - mortality rates are reduced up to 86% with a spacing of 5m, whereas using the same devices at 10m intervals only reduces the mortality by 57%. Barrientos *et al*. (2012) found that larger BFDs were more effective in reducing Great Bustard collisions than smaller ones. Line markers should be as large as possible, and highly contrasting with the background. Colour is probably less important as during the day the background will be brighter than the obstacle with the reverse true at lower light levels (e.g., at twilight, or during overcast conditions). Black and white interspersed patterns are likely to maximise the probability of detection (Martin *et al*., 2010).

Using a controlled experiment spanning a period of nearly eight years (2008 to 2016), the EWT and Eskom tested the effectiveness of two types of line markers in reducing powerline collision mortalities of large birds on three 400kV transmission lines near Hydra substation in the Karoo. Marking was highly effective for Blue Cranes, with a 92% reduction in mortality, and large birds in general with a 56% reduction in mortality, but not for bustards, including the endangered Ludwig's Bustard. The two different marking devices were approximately equally effective, namely spirals and bird flappers, they found no evidence supporting the preferential use of one type of marker over the other (Shaw *et al*., 2017).

Ideally, the 33kV reticulation network should be underground where possible, except in areas where the lines might have to run above ground, for technical reasons. In these instances, the line could potentially pose a collision risk to various species.

In summary, the following priority species could be vulnerable to collisions with the overhead lines:

Species name	Scientific name	Reporting rate: SABAP2 Full protocol	Reporting rate: SABAP2 Ad hoc protocol	Global status	Regional status	Wind priority	Recorded during monitoring	Likelihood of occurrence in the PAOI
Grey-winged Francolin	*Scleroptila afra*	0.00	0.00	-	-	x	x	M
Lappet-faced Vulture	*Torgos tracheliotis*	0.00	0.00	EN	EN	x		M
Ludwig's Bustard	*Neotis ludwigii*	9.80	1.27	EN	EN	x	x	M
Northern Black Korhaan	*Afrotis afraoides*	33.33	15.19	-	-	x	x	H
Verreaux's Eagle	*Aquila verreauxii*	9.80	3.80	-	VU	x	x	H
White-backed Vulture	*Gyps africanus*	0.00	0.00	CR	CR	x		M

8.2.3 Displacement of priority species due to disturbance associated with the construction and decommissioning of the proposed overhead lines

It is inevitable that a measure of displacement will take place for all priority species during the construction phase of the WEF, including the associated electricity infrastructure, due to the disturbance factor associated with the construction activities. This is likely to affect ground nesting species severely, as this could temporarily disrupt their reproductive cycle. Species which fall in this category are Ludwig's Bustard, Karoo Korhaan, Kori Bustard, Double-banded Courser, African Rock Pipit, Grey-winged Francolin, Northern Black Korhaan and Spotted Eagle-Owl. Some raptors might also be affected, e.g., Pale Chanting Goshawk which could potentially breed in the small *Senegalia mellifera* trees in the drainage lines.

Another major potential concern is the potential displacement of the estimated five (5) pairs of Verreaux's Eagles that breed within the PAOI, due to disturbance. The VE guidelines recommend a minimum no-disturbance buffer of 1km around Verreaux's Eagle nests (Ralston-Patton 2021) where no construction activities should take place. The exception to this would be in certain circumstances where a nest is located on or within 1km of an existing transmission line. In such an event, it is preferable to place any new powerlines next to the existing powerline, even if this means temporary disturbance of a pair of breeding eagles. By placing the new line next to an existing line, the creation of a new collision risk in a pristine area is avoided, and the collision risk that the new line poses is also mitigated to some extent through making both the lines more visible. The temporary, short- term disturbance of the eagles is less detrimental compared to the long-term collision risk that the new powerline will pose in a pristine area and the additional habitat fragmentation which it will cause. This particularly relevant for the construction of the proposed 132kV OHL and associated road, which may cause the temporary displacement of priority species using the existing Burchell - Cuprum 132kV line for roosting and nesting purposes, due to disturbance associated with the construction activities. The proposed 132kV OHL will run for a considerable distance next to the existing 132kV OHL and comes to within 700m of an existing Verreaux's Eagle nest. Ideally, construction activities should take place outside the breeding season, i.e. from November to March.

In summary, the following priority species could be vulnerable to displacement due to disturbance associated with the construction and decommissioning of the electrical infrastructure:

Species name	Scientific name	Reporting rate: SABAP2 Full protocol	Reporting rate: SABAP2 Ad hoc protocol	Global status	Regional status	Wind priority	Recorded during monitoring	Likelihood of occurrence in the PAOI
Black-chested Snake Eagle	*Circaetus pectoralis*	0.00	1.27	-	-	x		L
Black-winged Kite	*Elanus caeruleus*	13.73	2.53	-	-	x		M
African Rock Pipit	*Anthus crenatus*	1.96	1.27	NT	NT	x		L
Double-banded Courser	*Rhinoptilus africanus*	7.84	1.27	-	-	x	x	M
Greater Kestrel	*Falco rupicoloides*	0.00	2.53	-	-	x		L
Grey-winged Francolin	*Scleroptila afra*	0.00	0.00	-	-	x	x	M
Jackal Buzzard	*Buteo rufofuscus*	3.92	3.80	-	-	x	x	M
Karoo Korhaan	*Eupodotis vigorsii*	9.80	8.86	-	NT	x	x	H
Kori Bustard	*Ardeotis kori*	7.84	5.06	NT	NT	x		M
Lanner Falcon	*Falco biarmicus*	5.88	2.53	-	VU	x	x	M
Lappet-faced Vulture	*Torgos tracheliotis*	0.00	0.00	EN	EN	x		M
Ludwig's Bustard	*Neotis ludwigii*	9.80	1.27	EN	EN	x	x	M
Northern Black Korhaan	*Afrotis afraoides*	33.33	15.19	-	-	x	x	H
Pale Chanting Goshawk	*Melierax canorus*	33.33	17.72	-	-	x	x	H
Tawny Eagle	*Aquila rapax*	0.00	0.00	VU	EN	x	x	M
Verreaux's Eagle	*Aquila verreauxii*	9.80	3.80	-	VU	x	x	H
White-backed Vulture	*Gyps africanus*	0.00	0.00	CR	CR	x		M

9. IMPACT RATING

9.1 Determination of Significance of Impacts

Direct, indirect and cumulative impacts of the issues identified through the EIA process were assessed in terms of the following criteria:

- The nature, which includes a description of what causes the effect, what will be affected and how it will be affected.

- The extent, wherein it is indicated whether the impact will be
  - 1 = site only
  - 2 = local
  - 3 = regional
  - 4 = national
  - 5 = international

- The duration, wherein is indicated whether:
  - 1 = the lifetime of the impact will be of a very short duration (0–1 years)
  - 2 = the lifetime of the impact will be of a short duration (2-5 years)
  - 3 = medium-term (5–15 years)
  - 4 = long term (> 15 years)

- 5 = permanent

- The consequences (magnitude), quantified on a scale from 0-10, where:
  - 0 = small and will have no effect on the environment
  - 2 = minor and will not result in an impact on processes
  - 4 = low and will cause a slight impact on processes
  - 6 = moderate and will result in processes continuing but in a modified way
  - 8 = high (processes are altered to the extent that they temporarily cease)
  - 10 = very high and results in complete destruction of patterns and permanent cessation of processes.

- The probability of occurrence, which describes the likelihood of the impact actually occurring. Probability is estimated on a scale of 1–5, where:
  - 1 = very improbable (probably will not happen)
  - 2 = improbable (some possibility, but low likelihood)
  - 3 = probable (distinct possibility)
  - 4 = highly probable (most likely)
  - 5 is definite (impact will occur regardless of any prevention measures)

- The significance, which is determined through a synthesis of the characteristics described above and is assessed as low, medium or high

- The status, which is described as either positive, negative or neutral.

- The degree to which the impact can be reversed.

- The degree to which the impact may cause irreplaceable loss of resources.

- The degree to which the impact can be mitigated.

The significance is calculated by combining the criteria in the following formula:
S = (E+D+M)P
S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The significance weightings for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
- 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
- 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

9.2 Impact Assessment

The impact assessments are summarised in the tables below.

9.2.1 Construction Phase

Nature: Displacement of priority species due to disturbance during construction phase associated with the construction of the WEF		
	Without mitigation	**With mitigation**
Extent	Site (1)	Site (1)
Duration	Very short (1)	Very short (1)
Magnitude	High (8)	Moderate (6)
Probability	Definite (5)	Definite (5)
Significance	**MEDIUM (50)**	**MEDIUM (40)**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	To some extent	
Mitigation: • Construction activity should be restricted to the immediate footprint of the infrastructure as far as possible, and in particular to the proposed road network. Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species. • Construction of new roads should only be considered if existing roads cannot be upgraded. • Vehicle and pedestrian access to the site should be controlled and restricted as much as possible to prevent unnecessary disturbance of priority species. • No construction activity should take place within 1km of any Verreaux's Eagle nests, except if there is already an existing road, and avoiding the 1km buffer would result in the construction of a new road. In the latter instance, construction activities should ideally take place outside the breeding season i.e. from November to March.		
Residual Risks: Due to the nature of the construction activities, it is inevitable that temporary displacement of priority species will happen as a result. While this can be mitigated to some extent, the significance of the residual impacts will remain at a medium level.		

Nature: Displacement of priority species linked to habitat loss in the construction phase due to the construction of the WEF		
	Without mitigation	**With mitigation**
Extent	Site (1)	Site (1)
Duration	Long term (4)	Long term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**MEDIUM (33)**	**LOW (27)**

Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	To some extent	

Mitigation:

- Vegetation must be rehabilitated to its former state where possible after construction.
- The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint is concerned.
- Formal live-bird monitoring should be resumed once the turbines have been constructed, as per the most recent edition of the Best Practice Guidelines (Jenkins *et al*. 2015). The purpose of this would be to establish if displacement of priority species has occurred and to what extent. The exact time when operational monitoring should commence, will depend on the construction schedule, and should commence when the first turbines start operating. The Best Practice Guidelines require that, as an absolute minimum, operational monitoring should be undertaken for the first two (preferably three) years of operation, and then repeated again in year 5, and again every five years thereafter for the operational lifetime of the facility.

Residual Risks:

Due to the nature of the infrastructure, it is highly likely that long term partial displacement of priority species will happen, particularly as a result of the habitat fragmentation caused by the associated road network. The habitat transformation can be limited to some extent through mitigation measures, to keep the significance of the residual impacts at a low level.

Nature: Displacement of priority species due to disturbance associated with construction of the overhead power lines.

	Without mitigation	**With mitigation**
Extent	Site (1)	Site (1)
Duration	Very short (1)	Very short (1)
Magnitude	High (8)	Moderate (6)
Probability	Definite (5)	Definite (5)
Significance	**MEDIUM (50)**	**MEDIUM (40)**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	To some extent	

Mitigation:

- Conduct a pre-construction inspection (avifaunal walk-through) to record the status of the priority species nests on the existing Burchell – Cuprum 132kV high voltage line. If a nest of a SCC is found to be occupied, the avifaunal specialist must consult with the contractor to find ways of minimising the potential disturbance to the breeding pair of birds during the construction period. This could include measures such as delaying some of the activities until after the breeding season.
- Construction activity should be restricted to the immediate footprint of the infrastructure as far as practically possible.
- Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species.
- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum.

• No construction activity should take place within 1km of any Verreaux's Eagle nests, except if there is already an existing OHL, and the new OHL is routed directly next to the existing OHL. In the latter instance, construction activities should ideally take place outside the breeding season i.e. from November to March.
Residual Risks: Due to the nature of the construction activities, it is inevitable that temporary displacement of priority species will happen as a result. While this can be mitigated to some extent, the significance of the residual impacts will remain at a medium level.

9.2.2 Operational Phase

Nature: Mortality of priority species due to collisions with the turbines in the operation phase.		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Regional (3)
Duration	Long term (4)	Long term (4)
Magnitude	High (8)	Low (4)
Probability	Highly probable (4)	Probable (2)
Significance	**HIGH (60)**	**LOW (22)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	High
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	

Mitigation:

- No turbines (including their rotor swept areas) should be constructed within 200m around water points and 150m from the centre line of drainage lines to limit potential collision risk to nocturnal priority species (e.g., Spotted Eagle Owl) which are attracted to the surface water.
- All turbines must be curtailed from an hour before sunrise to an hour after sunset every day for the operational lifetime of the WEF, to eliminate the risk of priority species collisions, particularly to Verreaux's Eagle. This is a novel mitigation measure and has been agreed to by the proponent. See Appendix 4 for a detailed explanation of this proposed mitigation measure, including a monthly sunrise and sunset chart for Prieska, and the advantages over traditional anti-collision buffer zones.
- Carcass searches must commence to establish mortality rates, as per the most recent edition of the Best Practice Guidelines (Jenkins *et al*. 2015). The exact time when operational monitoring should commence, will depend on the construction schedule, and should commence when the first turbines starts operating. The Best Practice Guidelines require that, as an absolute minimum, operational monitoring should be undertaken for the first two (preferably three) years of operation, and then repeated again in year 5, and again every five years thereafter for the operational lifetime of the facility. If annual estimated collision rates indicate unsustainable mortality levels of priority species, i.e. if natural background mortality together with the estimated mortality caused by turbine collisions exceeds a critical mortality threshold as determined by the avifaunal specialist in consultation with other experts e.g. BLSA, additional measures will have to be implemented. This must be undertaken in consultation with a qualified avifauna specialist.

Residual Impacts:

It is not possible to completely eliminate the risk of turbine collisions, but through mitigation measures, particularly blanket daylight curtailment, it could be reduced to a low level.

Nature: Mortality of priority species due to collisions with the overhead lines		
	Without mitigation	**With mitigation**
Extent	Local (2)	Local (2)
Duration	Long term (4)	Long term (4)
Magnitude	Medium (6)	Low (4)
Probability	Highly Probable (4)	Probable (3)
Significance	**48 MEDIUM**	**30 MEDIUM**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	

Mitigation:

- Use underground cables as much as possible for the medium voltage connections.
- All overhead lines must be marked with Eskom approved Bird Flight Diverters according to the latest official Eskom Engineering Instruction.

Residual Risks:

The residual risk of collision will still be present for Ludwig's Bustard, but significantly reduced for other species.

Nature: Mortality of priority species due to electrocution on the overhead lines, collector substations and on-site substations		
	Without mitigation	**With mitigation**
Extent	Regional (3)	Regional (3)
Duration	Long term (4)	Long term (4)
Magnitude	High (8)	Low (4)
Probability	Highly probable (4)	Very improbable (1)
Significance	**60 HIGH**	**11 LOW**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	

Mitigation:

- Construction of the power line using an approved bird friendly pole/tower design in accordance with the Distribution Technical Bulletin relating to bird friendly structures. The avifaunal specialist must sign off on the final design.
- The hardware within the proposed central collector substation yard is too complex to warrant any mitigation for electrocution at this stage. It is recommended that if on-going impacts are recorded once operational, site-specific mitigation (insulation) be applied reactively. This is an acceptable approach because Red List priority species are unlikely to frequent the switching station and substation and be electrocuted.

Residual Risks:

The residual risk of electrocution will be low once mitigation is implemented.

9.2.3 Decommissioning Phase

Nature: Displacement of priority species due to disturbance associated with decommissioning of the WEF and associated infrastructure.		
	Without mitigation	**With mitigation**
Extent	Site (1)	Site (1)
Duration	Very short (1)	Very short (1)
Magnitude	High (8)	Moderate (6)
Probability	Definite (5)	Definite (5)
Significance	**50 MEDIUM**	**40 MEDIUM**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes, but to a limited extent	

Mitigation:

- Activity should as far as possible be restricted to the footprint of the infrastructure.
- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical.
- Access to the rest of the property must be restricted.
- The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the footprint is concerned.
- Measures to control noise and dust should be applied according to current best practice in the industry

Residual Risks:

The residual risk of displacement will be reduced but remain at a medium level after mitigation, if the proposed mitigation is implemented.

Nature: Displacement of priority species due to disturbance associated with decommissioning of the overhead lines, collector substations and on-site substations		
	Without mitigation	**With mitigation**
Extent	Site (1)	Site (1)
Duration	Very short (1)	Very short (1)
Magnitude	High (8)	Moderate (6)
Probability	Definite (5)	Definite (5)
Significance	**50 MEDIUM**	**40 MEDIUM**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes, but to a limited extent	

Mitigation:

- Activity should as far as possible be restricted to the footprint of the infrastructure.

• Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical. • Access to the rest of the property must be restricted. • The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the footprint is concerned. • Measures to control noise and dust should be applied according to current best practice in the industry
Residual Risks: The residual risk of displacement will be reduced but remain at a medium level after mitigation, if the proposed mitigation is implemented.

The impacts are summarized, and a comparison made between pre-and post-mitigation phases as shown in Table 6 below. The rating of environmental issues associated with different parameters prior to, and post mitigation of a proposed activity was averaged.

Table 6: Comparison of summarised impacts on environmental parameters

Nature of the Impact	Rating prior to mitigation	Rating post mitigation
Displacement of priority species due to disturbance associated with construction of the WEF and associated infrastructure.	50 MEDIUM	40 MEDIUM
Displacement of priority species due to habitat transformation associated with construction of the WEF and associated infrastructure.	33 MEDIUM	27 LOW
Displacement of priority species due to disturbance associated with construction of the overhead power lines.	50 MEDIUM	40 MEDIUM
Mortality of priority species due to collisions with the turbines in the operation phase.	60 HIGH	22 LOW
Mortality of priority species due to collisions with the overhead lines	48 MEDIUM	30 MEDIUM
Mortality of priority species due to electrocution on the overhead lines, collector substations and on-site substations	60 HIGH	11 LOW
Displacement of priority species due to disturbance associated with decommissioning of the WEF and associated infrastructure.	50 MEDIUM	40 MEDIUM
Displacement of priority species due to disturbance associated with decommissioning of the overhead lines, collector substations and on-site substations	50 MEDIUM	40 MEDIUM
AVERAGE SIGNIFICANCE RATING	**50 MEDIUM**	**31 MEDIUM**

10. ENVIRONMENTAL SENSITIVITIES

The following environmental sensitivities were identified from an avifaunal perspective in the development area:

10.1 Surface water: 200/150 m turbine exclusion zone

No turbines (including their rotor swept areas) should be constructed within 200m around water points and 150m from the centre line of drainage lines to limit potential collision risk to priority species which are attracted to the surface water. Surface water in this semi-arid habitat is crucially important for priority avifauna, including nocturnal species e.g. Spotted Eagle-Owl, and some non-priority species. It is important to leave open space with no turbines for birds to access and leave the surface water area unhindered.

10.2 Verreaux's Eagle nests: 1km all infrastructure exclusion zone

A 1km all infrastructure exclusion zone must be implemented around the Verreaux's Eagle nests at the following localities:

- VE nest 2: -29.761014° 22.724252°
- VE nest 5: -29.821777° 22.767599°
- VE nest 6: -29.785307° 22.742258°
- VE nest 7 & 8: -29.782901° 22.777143°
- VE nest 18 & 19: -29.759758° 22.762227°
- VE nest 12 & 13: -29.830647° 22.774612°
- VE nest 30: -29.838815° 22.816784°
- VE nest 31: -29.835845° 22.817236°

This is to prevent the birds from being displaced from their nest due to disturbance associated with the construction activities at the WEF. Verreaux's Eagles are classified as regionally Vulnerable (Taylor *et al*. 2015).

See Figure 11 for the avifaunal sensitivities identified in the PAOI.

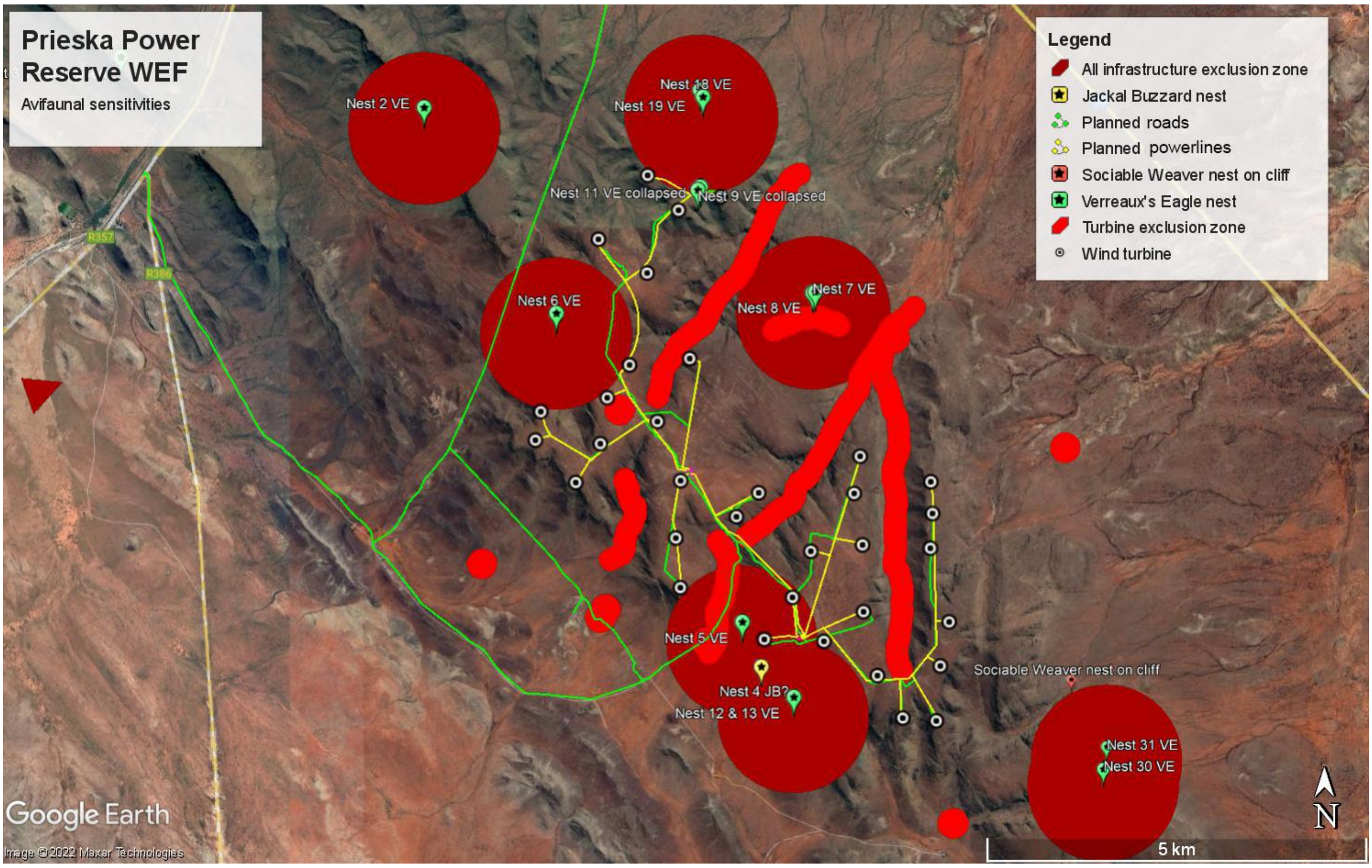

Figure 11: Avifaunal sensitivities identified in the PAOI.

11. CUMULATIVE IMPACTS

Cumulative effects are commonly understood to be impacts from different projects that combine to result in significant change, which could be larger than the sum of all the individual impacts. The assessment of cumulative effects therefore needs to consider all renewable energy projects within a 30 km radius that have received an EA at the time of starting the environmental impact process, as well as the proposed Prieska Power Reserve WEF project. There are currently six renewable energy projects authorised within a 30 km radius around the proposed WEF. The locality of renewable projects (affected properties) which are authorised are listed in Table 7 and shown in Figure 12.

Table 7: Renewable energy projects that have been approved within a 30km radius around the proposed PV 1 project (Source: Department of Forestry, Fisheries and the Environment).

Project name	Applicant	DFFE Ref. No.	Phase
The Proposed Construction of A 75mw Photovoltaic Power Plant and Its Associated Infrastructure on A Portion of The Remaining Extent of Erf 1 Prieska Within the Siyathemba Local Municipality, Northern Cape Province	Kala-Hari Survey Solutions and Products cc	14/12/16/3/3/2/345	Approved
Proposed Bosjesmansberg solar energy facility site near Copperton, Siyathemba Local Municipality, Northern Cape	Networx Renewables (Pty) Ltd	14/12/16/3/3/2/579	Approved
The proposed 2MW Mahoebe solar energy facility and associated infrastructure on portion 19 of the farm De Hoek 32, Northern Cape	Mahoebe Eiendomme BPK	14/12/16/3/3/1/1475	Approved
Proposed 75MW IPMS Solar power plant in Prieska, Northern Cape	IPMS Consulting (Pty) Ltd	14/12/16/3/3/1/981	Approved
Proposed Bosjesmansberg solar energy facility site near Copperton, Siyathemba Local Municipality, Northern Cape	Networx Renewables (Pty) Ltd	14/12/16/3/3/2/579/1	Approved
115 MW Camel Thorn Photovoltaic Solar Energy Facility on the Remaining Extent of Portion 2 of the Farm Karabee 50 east of Prieska within the Siyathemba Local Municipality, Northern Cape	Camel Thorn Solar Power Plant (RF) (Pty) Ltd	14/12/16/3/3/2/937	Approved

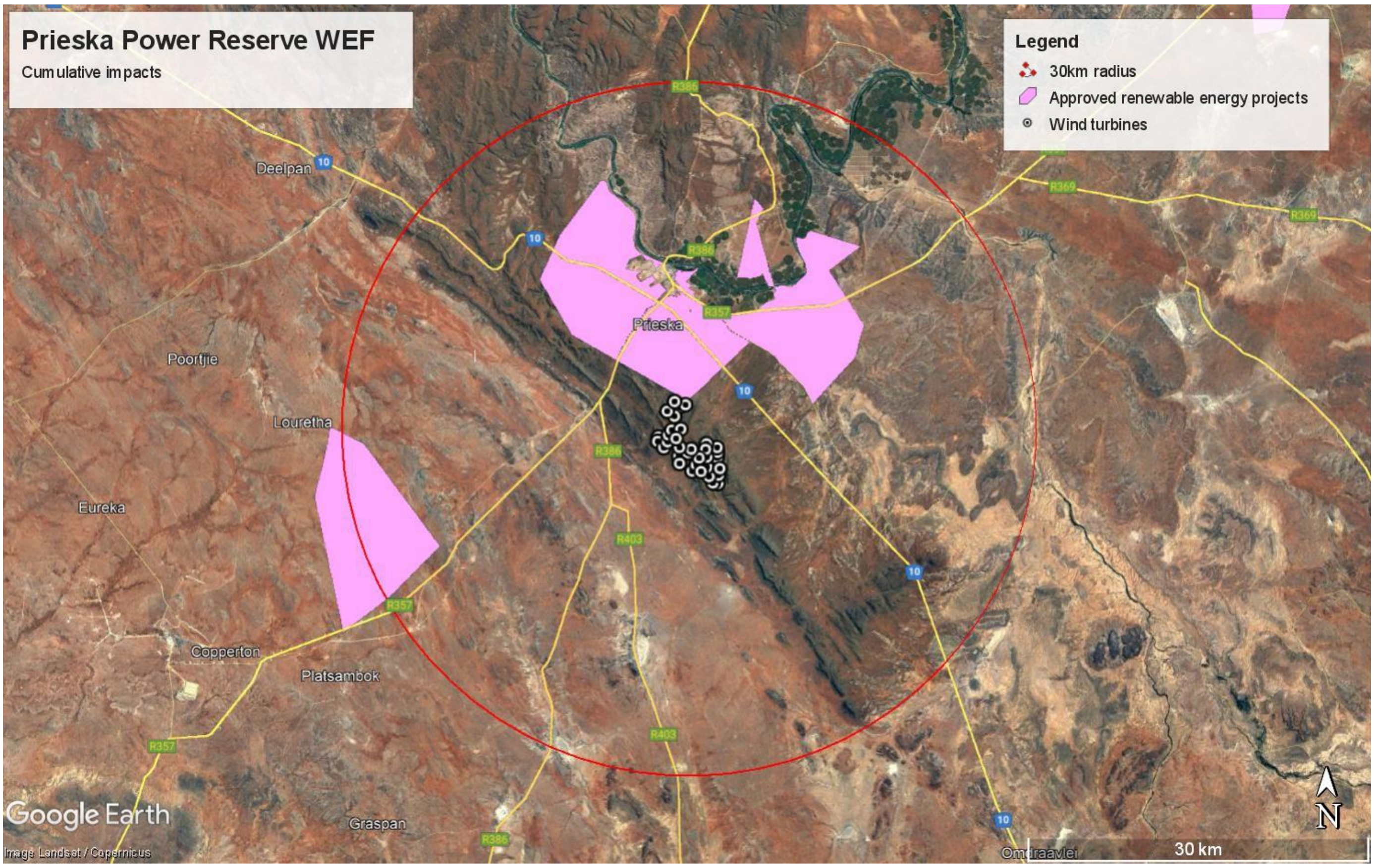

Figure 12: Approved Renewable Energy Projects within a 30km radius around the proposed WEF

The total affected land parcel area taken up by authorised renewable energy projects within the 30km radius (all solar PV) is approximately 260km², although the actual area affected by the solar facilities is likely to be 20% or less of the land parcel area, i.e. ~52 km². The total area affected by the proposed Prieska Power Reserve WEF project equates to ~10 km². The combined area affected by authorised renewable energy developments within the 30 km radius around the proposed WEF, including the proposed WEF, thus equals ~62 km². Of this, the proposed WEF project constitutes ~16%. The contribution of the proposed WEF to the cumulative impact of the renewable energy projects is thus anticipated to be **medium** after mitigation.

The total area of natural habitat within the 30km radius around the proposed projects equates to about 2 691km² (excluding urban areas and irrigated agriculture). The total combined size of the area potentially affected by renewable energy projects will thus equate to ~2.3% of the available untransformed habitat in the 30km radius, should all the projects be constructed. However, each of these projects must still be subject to a competitive bidding process where only the most competitive projects will win a power purchase agreement required for the project to proceed to construction. The cumulative impact of all the proposed renewable energy projects is thus estimated to affect a maximum of ~2.3% or less of the available untransformed habitat, resulting in a **low** impact.

12. NO-GO ALTERNATIVE

The no-go alternative will result in the current *status quo* being maintained as far as the avifauna is concerned. The low human population in the area is definitely advantageous to avifauna. The no-go option would therefore eliminate any additional impact on the ecological integrity of the proposed development site as far as avifauna is concerned. The no-go option will be to the advantage of the avifauna in the short to medium term, but perhaps less so in the longer term, given the expected impact of climate change on avifauna in the longer term

13. ENVIRONMENTAL MANAGEMENT PROGRAMME

For each anticipated impact, management recommendations for the design, construction, and operational phase (where appropriate) are included in the project EMPr (see Appendix 3).

14. SUMMARY OF FINDINGS AND CONCLUDING STATEMENT

The proposed Prieska Power Reserve WEF will have several potential impacts on priority avifauna. The impacts are the following:

- Displacement of priority species due to disturbance associated with construction of the WEF and associated infrastructure.
- Displacement of priority species due to habitat transformation associated with construction of the WEF and associated infrastructure.
- Displacement of priority species due to disturbance associated with construction of the overhead power lines.
- Mortality of priority species due to collisions with the turbines in the operation phase.
- Mortality of priority species due to collisions with the overhead lines
- Mortality of priority species due to electrocution on the overhead lines, collector substations and on-site substations
- Displacement of priority species due to disturbance associated with decommissioning of the WEF and associated infrastructure.
- Displacement of priority species due to disturbance associated with decommissioning of the overhead lines, collector substations and on-site substations.

14.1 Displacement of priority species due to disturbance associated with construction of the WEF and associated infrastructure.

It is inevitable that a measure of displacement will take place for all priority species during the construction phase of the WEF, due to the disturbance factor associated with the construction activities. This is likely to affect ground nesting species severely, as this could temporarily disrupt their reproductive cycle. Species which fall in this category are Ludwig's Bustard, Karoo Korhaan, Kori Bustard, Double-banded Courser, African Rock Pipit, Grey-winged Francolin, Northern Black Korhaan and Spotted Eagle-Owl. Some raptors might also be affected, e.g., Pale Chanting Goshawk which could potentially breed in the small *Senegalia mellifera* trees in the drainage lines.

Another major potential concern is the potential displacement of the estimated five (5) pairs of Verreaux's Eagles that breed within the PAOI, due to disturbance. The VE guidelines recommend a minimum no-disturbance buffer of 1km around Verreaux's Eagle nests (Ralston-Patton 2021) where no construction activities should take place.

Some species might be able to recolonise the area after the completion of the construction phase, but for some species this might only be partially the case, resulting in lower densities than before once the WEFs are operational, due to the disturbance factor of the operational turbines.

The impact is rated as **Medium** before and after mitigation.

The following mitigation measures are proposed:

- Construction activity should be restricted to the immediate footprint of the infrastructure as far as possible, and in particular to the proposed road network. Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species.
- Construction of new roads should only be considered if existing roads cannot be upgraded.

- Vehicle and pedestrian access to the site should be controlled and restricted as much as possible to prevent unnecessary disturbance of priority species.
- No construction activity should take place within 1km of any Verreaux's Eagle nests, except if there is already an existing road, and avoiding the 1km buffer would result in the construction of a new road. In the latter instance, construction activities should take place outside the breeding season i.e. from November to March, if possible.

14.2 Displacement of priority species due to habitat transformation associated with construction of the WEF and associated infrastructure.

The network of roads is likely to result in significant habitat fragmentation, and it could have an effect on the density of several species, particularly terrestrial species such as Ludwig's Bustard, Kori Bustard, Karoo Korhaan, Northern Black Korhaan, Double-banded Courser, Grey-winged Francolin and Africa Rock Pipit. Various species of raptors that could also be affected. Given the current density of the proposed turbine layout and associated road infra-structure for the WEF development, it is not expected that any priority species will be permanently displaced from the development sites.

The impact is rated as **Medium** before and **Low** after mitigation.

The following mitigation measures are proposed:

- Vegetation must be rehabilitated to its former state where possible after construction.
- The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint is concerned.
- Formal live-bird monitoring should be resumed once the turbines have been constructed, as per the most recent edition of the Best Practice Guidelines (Jenkins et al. 2015). The purpose of this would be to establish if displacement of priority species has occurred and to what extent. The exact time when operational monitoring should commence, will depend on the construction schedule, and should commence when the first turbines start operating. The Best Practice Guidelines require that, as an absolute minimum, operational monitoring should be undertaken for the first two (preferably three) years of operation, and then repeated again in year 5, and again every five years thereafter for the operational lifetime of the facility.

14.3 Displacement of priority species due to disturbance associated with construction of the overhead power lines.

It is inevitable that a measure of displacement will take place for all priority species during the construction phase of the WEF, including the associated electricity infrastructure, due to the disturbance factor associated with the construction activities. This is likely to affect ground nesting species severely, as this could temporarily disrupt their reproductive cycle. Species which fall in this category are Ludwig's Bustard, Karoo Korhaan, Kori Bustard, Double-banded Courser, African Rock Pipit, Grey-winged Francolin, Northern Black Korhaan and Spotted Eagle-Owl. Some raptors might also be affected, e.g., Pale Chanting Goshawk which could potentially breed in the small Senegalia mellifera trees in the drainage lines.

Another major potential concern is the potential displacement of the estimated five (5) pairs of Verreaux's Eagles that breed within the PAOI, due to disturbance. The VE guidelines recommend a minimum no-disturbance buffer of 1km around Verreaux's Eagle nests (Ralston-Patton 2021) where no construction activities should take place. The exception to this would be in certain circumstances where a nest is located on or within 1km of an existing transmission line. In such an event, it is preferable to place any new powerlines next to the existing powerline, even if this means temporary disturbance of a pair of breeding eagles. By placing the new line next to an existing line, the creation of a new collision risk in a pristine area is avoided, and the collision risk that the new line poses is also mitigated to some extent through making both the lines more visible. The temporary, short- term disturbance of the eagles is less detrimental compared to the long-term collision risk that the new powerline will pose in a pristine area and the additional habitat fragmentation which it will cause. This particularly relevant for the construction of the proposed 132kV OHL and associated road, which may cause the temporary displacement of priority species using the existing Burchell - Cuprum 132kV line for roosting and nesting purposes, due to disturbance associated with the construction activities. The proposed 132kV OHL will run for a considerable distance next to the existing 132kV OHL and comes to within 700m of an existing Verreaux's Eagle nest. In the latter instance, construction activities should take place outside the breeding season i.e. from November to March, if possible.

The impact is rated as **Medium** before and after mitigation.

The following mitigation measures are proposed:

- Conduct a pre-construction inspection (avifaunal walk-through) to record the status of the priority species nests on the existing Burchell – Cuprum 132kV high voltage line. If a nest of a SCC is found to be occupied, the avifaunal specialist must consult with the contractor to find ways of minimising the potential disturbance to the breeding pair of birds during the construction period. This could include measures such as delaying some of the activities until after the breeding season.
- Construction activity should be restricted to the immediate footprint of the infrastructure as far as practically possible.
- Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species.
- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum.
- No construction activity should take place within 1km of any Verreaux's Eagle nests, except if there is already an existing OHL, and the new OHL is routed directly next to the existing OHL. In the latter instance, construction activities should take place outside the breeding season i.e. from November to March, if possible.

14.4 Mortality of priority species due to collisions with the turbines in the operation phase.

The proposed WEF will pose a potential collision risk to several priority species which could occur regularly in the PAOI. Species exposed to this risk are large terrestrial species i.e., mostly bustards, korhaans, francolins and coursers, although bustards generally seem to be not as vulnerable to turbine collisions as was originally anticipated (Ralston-Paton & Camagu, 2019). Soaring priority species, i.e., raptors such as Pale Chanting Goshawk, Lanner Falcon, Booted Eagle, Greater Kestrel, White-backed Vulture, Lappet-faced Vulture and in particular, Verreaux's Eagle, are most at risk of collision mortality of all the priority species likely to occur regularly in the PAOI.

The impact is rated as **High** before and **Low** after mitigation.

The following mitigation measures are proposed:

- No turbines (including their rotor swept area) should be constructed within 200m around water points and 150m from the centre line of drainage lines to limit potential collision risk to nocturnal priority species, e.g. Spotted Eagle-Owl, which are attracted to the surface water.
- All turbines must be curtailed from an hour before sunrise to an hour after sunset every day for the operational lifetime of the WEF, to eliminate the risk of priority species collisions, particularly to Verreaux's Eagle. This is a novel mitigation measure and has been agreed to by the proponent. See Appendix 4 for a detailed explanation of this proposed mitigation measure, including a monthly sunrise and sunset chart for Prieska, and the advantages over traditional anti-collision buffer zones.

- Carcass searches must be implemented to establish mortality rates, as per the most recent edition of the Best Practice Guidelines (Jenkins et al. 2015). The exact time when operational monitoring should commence, will depend on the construction schedule, and should commence when the first turbines starts operating. The Best Practice Guidelines require that, as an absolute minimum, operational monitoring should be undertaken for the first two (preferably three) years of operation, and then repeated again in year 5, and again every five years thereafter for the operational lifetime of the facility. If annual estimated collision rates indicate unsustainable mortality levels of priority species, i.e. if natural background mortality together with the estimated mortality caused by turbine collisions exceeds a critical mortality threshold as determined by the avifaunal specialist in consultation with other experts e.g. BLSA, additional measures will have to be implemented. This must be undertaken in consultation with a qualified avifauna specialist.

14.5 Mortality of priority species due to collisions with the overhead lines

Collisions are arguably the biggest threat posed by overhead lines to birds in southern Africa (Van Rooyen, 2004). Most heavily impacted upon are bustards, storks, cranes and various species of waterbirds, and to a lesser extent, vultures. These species are mostly heavy-bodied birds with limited manoeuvrability, which makes it difficult for them to take the necessary evasive action to avoid colliding with transmission lines (Van Rooyen, 2004; Anderson, 2001).
Using a controlled experiment spanning a period of nearly eight years (2008 to 2016), the EWT and Eskom tested the effectiveness of two types of line markers in reducing powerline collision mortalities of large birds on three 400kV transmission lines near Hydra substation in the Karoo. Marking was highly effective for Blue Cranes, with a 92% reduction in mortality, and large birds in general with a 56% reduction in mortality, but not for bustards, including the endangered Ludwig's Bustard. The two different marking devices were approximately equally effective, namely spirals and bird flappers, they found no evidence supporting the preferential use of one type of marker over the other (Shaw et al., 2017).

The impact is rated as **Medium** before and after mitigation.

The following mitigation measures are proposed:

- Use underground cables as much as possible for the medium voltage connections.
- All overhead lines must be marked with Eskom approved Bird Flight Diverters according to the latest official Eskom Engineering Instruction.

14.6 Mortality of priority species due to electrocution on the overhead lines, collector substations and on-site substations

Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen, 2000). The electrocution risk is largely determined by the design of the electrical hardware and the size of the bird.

Ideally the 33kV reticulation network should be placed underground where possible. If the lines have to run above ground, for technical reasons, the poles could potentially pose a serious electrocution risk to raptors, which could result in mortalities even more severe than turbine collisions, unless a bird-friendly design is used. Raptors and vultures are particularly at risk. Electrocutions within the proposed substations are possible, however the likelihood of this impact on the more sensitive Red List priority species is remote, as these species are unlikely to regularly utilise the infrastructure within the substation yard for perching or roosting.

The only priority species capable of bridging the clearance distances of the proposed 132kV power line infrastructure are White-backed Vultures and Lappet-faced Vultures, due to their size and gregarious nature. There is an established White-backed Vulture and Lappet-faced Vulture roost on this line ~25 km south-west of the PAOI (>100 birds). Based on interviews with landowners and personal observations, it is it seems that the numbers of White-backed Vultures and Lappet-faced Vultures are on the increase south of the Orange River in the Northern Cape during the non-breeding season (December to May). These birds establish temporary roosts on power lines, and it is entirely possible that the birds could on occasion roost on the proposed 33kV and 132kV powerlines. Depending on the proposed pole design, this could place them at risk of electrocution.

The impact is rated as **High** before and **Low** after mitigation.

The following mitigation measures are proposed:

- Construction of the power line using an approved bird friendly pole/tower design in accordance with the Eskom Distribution Technical Bulletin relating to bird friendly structures. The avifaunal specialist must sign off on the final design.
- The hardware within the proposed central collector substation yard is too complex to warrant any mitigation for electrocution at this stage. It is recommended that if on-going impacts are recorded once operational, site-specific mitigation (insulation) be applied reactively. This is an acceptable approach because Red List priority species are unlikely to frequent the switching station and substation and be electrocuted.

14.7 Displacement of priority species due to disturbance associated with decommissioning of the WEF and associated infrastructure.

The impact of displacement due to disturbance during this phase will be similar in nature and intensity as during the construction phase (see 14.1).

The impact is rated as **Medium** before and after mitigation.

The following mitigation measures are proposed:

- Activity should as far as possible be restricted to the footprint of the infrastructure.
- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical.
- Access to the rest of the property must be restricted.
- The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the footprint is concerned.
- Measures to control noise and dust should be applied according to current best practice in the industry

14.8 Displacement of priority species due to disturbance associated with decommissioning of the overhead lines, collector substations and on-site substations.

The impact of displacement due to disturbance during this phase will be similar in nature and intensity as during the construction phase (see 14.3).

The impact is rated as **Medium** before and after mitigation.

The following mitigation measures are proposed:

- Activity should as far as possible be restricted to the footprint of the infrastructure.
- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical.

- Access to the rest of the property must be restricted.
- The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the footprint is concerned.
- Measures to control noise and dust should be applied according to current best practice in the industry

14.9 Cumulative impacts

The total affected land parcel area taken up by authorised renewable energy projects within the 30km radius (all solar PV) is approximately 260km², although the actual area affected by the solar facilities is likely to be 20% or less of the land parcel area, i.e. ~52 km². The total area affected by the proposed Prieska Power Reserve WEF project equates to ~10 km². The combined area affected by authorised renewable energy developments within the 30 km radius around the proposed WEF, including the proposed WEF, thus equals ~62 km². Of this, the proposed WEF project constitutes ~16%. The contribution of the proposed WEF to the cumulative impact of the renewable energy projects is thus anticipated to be **medium** after mitigation.

The total area of natural habitat within the 30km radius around the proposed projects equates to about 2 691km² (excluding urban areas and irrigated agriculture). The total combined size of the area potentially affected by renewable energy projects will thus equate to ~2.3% of the available untransformed habitat in the 30km radius, should all the projects be constructed. However, each of these projects must still be subject to a competitive bidding process where only the most competitive projects will win a power purchase agreement required for the project to proceed to construction. The cumulative impact of all the proposed renewable energy projects is thus estimated to affect a maximum of ~2.3% or less of the available untransformed habitat, resulting in a **low** impact.

15 POST CONSTRUCTION PROGRAMME

The new procedures and minimum criteria for reporting on identified environmental themes in terms of Sections 24(5)(a) and (h) and 44 of NEMA came into force in March 2020. According to these regulations, a detailed post-construction monitoring programme must be included as part of the bird specialist study. See APPENDIX F for a proposed programme.

16 CONCLUSIONS

The proposed Prieska Power Reserve WEF could have a range of potential pre-mitigation impacts on priority avifauna ranging from medium to high, which is expected to be reduced to medium and low with appropriate mitigation. No fatal flaws were discovered during the investigations. The development is therefore supported, provided the mitigation measures listed in this report are strictly applied.

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APPENDIX 1: SABAP 2 SPECIES LIST FOR THE BROADER AREA

Species name	Scientific name	Reporting rate: SABAP2 Full protocol	Reporting rate: SABAP2 Ad hoc protocol	Global status	Regional status	Wind priority	Recorded during monitoring
Abdim's Stork	*Ciconia abdimii*	7.84	2.53	-	NT		
African Fish Eagle	*Haliaeetus vocifer*	15.69	2.53	-	-	x	
African Black Duck	*Anas sparsa*	1.96	0.00	-	-		
African Darter	*Anhinga rufa*	3.92	0.00	-	-		
Black-chested Snake Eagle	*Circaetus pectoralis*	0.00	1.27	-	-	x	
Black-winged Kite	*Elanus caeruleus*	13.73	2.53	-	-	x	
African Palm Swift	*Cypsiurus parvus*	19.61	0.00	-	-		
Booted Eagle	*Hieraaetus pennatus*	5.88	2.53	-	-	x	x
Common Buzzard	*Buteo buteo*	7.84	1.27	-	-	x	x
African Reed Warbler	*Acrocephalus baeticatus*	23.53	1.27	-	-		
African Rock Pipit	*Anthus crenatus*	1.96	1.27	NT	NT	x	
African Sacred Ibis	*Threskiornis aethiopicus*	19.61	1.27	-	-		
African Stonechat	*Saxicola torquatus*	5.88	0.00	-	-		
Double-banded Courser	*Rhinoptilus africanus*	7.84	1.27	-	-	x	x
Acacia Pied Barbet	*Tricholaema leucomelas*	68.63	10.13	-	-		x
Ashy Tit	*Melaniparus cinerascens*	15.69	0.00	-	-		
Banded Martin	*Riparia cincta*	1.96	0.00	-	-		
African Hoopoe	*Upupa africana*	9.80	2.53	-	-		x
African Pipit	*Anthus cinnamomeus*	13.73	3.80	-	-		x
Greater Kestrel	*Falco rupicoloides*	0.00	2.53	-	-	x	
Black-faced Waxbill	*Brunhilda erythronotos*	3.92	0.00	-	-		
Black-headed Heron	*Ardea melanocephala*	9.80	0.00	-	-		
Blacksmith Lapwing	*Vanellus armatus*	27.45	2.53	-	-		
African Red-eyed Bulbul	*Pycnonotus nigricans*	54.90	5.06	-	-		x
Grey-winged Francolin	*Scleroptila afra*	0.00	0.00	-	-	x	x
Black-winged Stilt	*Himantopus himantopus*	7.84	0.00	-	-		
Alpine Swift	*Tachymarptis melba*	7.84	1.27	-	-		x
Ant-eating Chat	*Myrmecocichla formicivora*	21.57	10.13	-	-		x
Bradfield's Swift	*Apus bradfieldi*	1.96	1.27	-	-		
Brown-crowned Tchagra	*Tchagra australis*	3.92	0.00	-	-		
Brown-hooded Kingfisher	*Halcyon albiventris*	23.53	1.27	-	-		
Brown-throated Martin	*Riparia paludicola*	29.41	3.80	-	-		
Brubru	*Nilaus afer*	7.84	1.27	-	-		
Barn Swallow	*Hirundo rustica*	27.45	8.86	-	-		x
Burchell's Coucal	*Centropus burchellii*	9.80	1.27	-	-		
Black-chested Prinia	*Prinia flavicans*	76.47	12.66	-	-		x
Black-throated Canary	*Crithagra atrogularis*	23.53	1.27	-	-		x
Cape Penduline Tit	*Anthoscopus minutus*	1.96	0.00	-	-		
Bokmakierie	*Telophorus zeylonus*	35.29	5.06	-	-		x
Cape Shoveler	*Spatula smithii*	5.88	0.00	-	-		
Jackal Buzzard	*Buteo rufofuscus*	3.92	3.80	-	-	x	x

Species name	Scientific name	Reporting rate: SABAP2 Full protocol	Reporting rate: SABAP2 Ad hoc protocol	Global status	Regional status	Wind priority	Recorded during monitoring
Buffy Pipit	*Anthus vaalensis*	0.00	0.00	-	-		x
Cape Teal	*Anas capensis*	5.88	1.27	-	-		
Cape Bunting	*Emberiza capensis*	9.80	1.27	-	-		x
Cape Crow	*Corvus capensis*	0.00	0.00	-	-		x
Cape Weaver	*Ploceus capensis*	3.92	0.00	-	-		
Cape White-eye	*Zosterops virens*	1.96	0.00	-	-		
Cape Robin-Chat	*Cossypha caffra*	37.25	2.53	-	-		x
Cape Sparrow	*Passer melanurus*	60.78	11.39	-	-		x
Cape Starling	*Lamprotornis nitens*	43.14	8.86	-	-		x
Cape Turtle Dove	*Streptopelia capicola*	35.29	12.66	-	-		x
Cape Wagtail	*Motacilla capensis*	35.29	1.27	-	-		x
Capped Wheatear	*Oenanthe pileata*	1.96	2.53	-	-		x
Cardinal Woodpecker	*Dendropicos fuscescens*	7.84	0.00	-	-		x
Common House Martin	*Delichon urbicum*	1.96	1.27	-	-		
Common Myna	*Acridotheres tristis*	3.92	2.53	-	-		
Chat Flycatcher	*Melaenornis infuscatus*	15.69	12.66	-	-		x
Common Sandpiper	*Actitis hypoleucos*	1.96	0.00	-	-		
Common Scimitarbill	*Rhinopomastus cyanomelas*	7.84	1.27	-	-		
Common Starling	*Sturnus vulgaris*	1.96	0.00	-	-		
Chestnut-vented Warbler	*Curruca subcoerulea*	45.10	6.33	-	-		x
Common Waxbill	*Estrilda astrild*	15.69	0.00	-	-		
Cinnamon-breasted Bunting	*Emberiza tahapisi*	0.00	0.00	-	-		x
Common Buttonquail	*Turnix sylvaticus*	7.84	2.53	-	-		x
Karoo Korhaan	*Eupodotis vigorsii*	9.80	8.86	-	NT	x	x
Diederik Cuckoo	*Chrysococcyx caprius*	3.92	0.00	-	-		
Common Quail	*Coturnix coturnix*	5.88	2.53	-	-		x
Common Swift	*Apus apus*	0.00	0.00	-	-		x
Crested Barbet	*Trachyphonus vaillantii*	31.37	5.06	-	-		x
Crowned Lapwing	*Vanellus coronatus*	21.57	1.27	-	-		x
Desert Cisticola	*Cisticola aridulus*	19.61	5.06	-	-		x
Kori Bustard	*Ardeotis kori*	7.84	5.06	NT	NT	x	
Dusky Sunbird	*Cinnyris fuscus*	52.94	6.33	-	-		x
Eastern Clapper Lark	*Mirafra fasciolata*	19.61	3.80	-	-		x
Egyptian Goose	*Alopochen aegyptiaca*	45.10	7.59	-	-		x
Giant Kingfisher	*Megaceryle maxima*	5.88	0.00	-	-		
Glossy Ibis	*Plegadis falcinellus*	1.96	0.00	-	-		
Golden-tailed Woodpecker	*Campethera abingoni*	3.92	0.00	-	-		
Goliath Heron	*Ardea goliath*	3.92	0.00	-	-		
Lanner Falcon	*Falco biarmicus*	5.88	2.53	-	VU	x	x
European Bee-eater	*Merops apiaster*	15.69	1.27	-	-		x
Grey Heron	*Ardea cinerea*	15.69	1.27	-	-		
Fairy Flycatcher	*Stenostira scita*	3.92	0.00	-	-		x
Familiar Chat	*Oenanthe familiaris*	49.02	3.80	-	-		x
Grey-backed Sparrow-Lark	*Eremopterix verticalis*	1.96	2.53	-	-		

Species name	Scientific name	Reporting rate: SABAP2 Full protocol	Reporting rate: SABAP2 Ad hoc protocol	Global status	Regional status	Wind priority	Recorded during monitoring
Fawn-colored Lark	*Calendulauda africanoides*	15.69	10.13	-	-		x
Fiscal Flycatcher	*Melaenornis silens*	39.22	1.27	-	-		x
Hamerkop	*Scopus umbretta*	3.92	0.00	-	-		
Greater Striped Swallow	*Cecropis cucullata*	45.10	3.80	-	-		x
Grey Tit	*Melaniparus afer*	0.00	0.00	-	-		x
Grey-backed Cisticola	*Cisticola subruficapilla*	21.57	1.27	-	-		x
Lappet-faced Vulture	*Torgos tracheliotis*	0.00	0.00	EN	EN	x	
Hadada Ibis	*Bostrychia hagedash*	45.10	5.06	-	-		x
Helmeted Guineafowl	*Numida meleagris*	25.49	6.33	-	-		x
House Sparrow	*Passer domesticus*	37.25	8.86	-	-		x
Karoo Prinia	*Prinia maculosa*	3.92	1.27	-	-		
Lesser Spotted Eagle	*Clanga pomarina*	0.00	1.27	-	-	x	
Karoo Thrush	*Turdus smithi*	39.22	1.27	-	-		
Ludwig's Bustard	*Neotis ludwigii*	9.80	1.27	EN	EN	x	x
Kalahari Scrub Robin	*Cercotrichas paena*	39.22	8.86	-	-		x
Karoo Chat	*Emarginata schlegelii*	5.88	2.53	-	-		x
Karoo Long-billed Lark	*Certhilauda subcoronata*	11.76	7.59	-	-		x
Karoo Scrub Robin	*Cercotrichas coryphoeus*	49.02	11.39	-	-		x
Large-billed Lark	*Galerida magnirostris*	0.00	0.00	-	-		x
Lark-like Bunting	*Emberiza impetuani*	35.29	11.39	-	-		x
Lesser Honeyguide	*Indicator minor*	1.96	1.27	-	-		
Northern Black Korhaan	*Afrotis afraoides*	33.33	15.19	-	-	x	x
Lesser Swamp Warbler	*Acrocephalus gracilirostris*	19.61	1.27	-	-		
Levaillant's Cisticola	*Cisticola tinniens*	9.80	0.00	-	-		
Little Egret	*Egretta garzetta*	1.96	0.00	-	-		
Little Grebe	*Tachybaptus ruficollis*	11.76	0.00	-	-		
Laughing Dove	*Spilopelia senegalensis*	76.47	25.32	-	-		x
Layard's Warbler	*Curruca layardi*	1.96	1.27	-	-		x
Lesser Grey Shrike	*Lanius minor*	11.76	3.80	-	-		x
Little Swift	*Apus affinis*	33.33	7.59	-	-		x
Marico Sunbird	*Cinnyris mariquensis*	1.96	1.27	-	-		
Marsh Warbler	*Acrocephalus palustris*	1.96	0.00	-	-		
Long-billed Crombec	*Sylvietta rufescens*	31.37	1.27	-	-		x
Long-billed Pipit	*Anthus similis*	0.00	0.00	-	-		x
Mountain Wheatear	*Myrmecocichla monticola*	11.76	5.06	-	-		x
Namaqua Warbler	*Phragmacia substriata*	19.61	1.27	-	-		
Namaqua Dove	*Oena capensis*	49.02	12.66	-	-		x
Namaqua Sandgrouse	*Pterocles namaqua*	15.69	6.33	-	-		x
Orange River White-eye	*Zosterops pallidus*	43.14	3.80	-	-		
Neddicky	*Cisticola fulvicapilla*	13.73	1.27	-	-		x
Pale Chanting Goshawk	*Melierax canorus*	33.33	17.72	-	-	x	x
Pearl-breasted Swallow	*Hirundo dimidiata*	1.96	0.00	-	-		
Pearl-spotted Owlet	*Glaucidium perlatum*	7.84	0.00	-	-		
Spotted Eagle-Owl	*Bubo africanus*	9.80	1.27	-	-	x	

Species name	Scientific name	Reporting rate: SABAP2 Full protocol	Reporting rate: SABAP2 Ad hoc protocol	Global status	Regional status	Wind priority	Recorded during monitoring
Pied Kingfisher	*Ceryle rudis*	7.84	2.53	-	-		
Pale-winged Starling	*Onychognathus nabouroup*	27.45	10.13	-	-		x
Pin-tailed Whydah	*Vidua macroura*	11.76	0.00	-	-		
Pied Crow	*Corvus albus*	60.78	16.46	-	-		x
Pygmy Falcon	*Polihierax semitorquatus*	25.49	6.33	-	-		
Quailfinch	*Ortygospiza atricollis*	3.92	0.00	-	-		
Pied Starling	*Lamprotornis bicolor*	1.96	3.80	-	-		x
Red-billed Firefinch	*Lagonosticta senegala*	5.88	0.00	-	-		
Pririt Batis	*Batis pririt*	29.41	6.33	-	-		x
Red-billed Teal	*Anas erythrorhyncha*	3.92	0.00	-	-		
Red-backed Shrike	*Lanius collurio*	1.96	1.27	-	-		x
Red-billed Quelea	*Quelea quelea*	43.14	3.80	-	-		x
Red-eyed Dove	*Streptopelia semitorquata*	45.10	5.06	-	-		
Red-capped Lark	*Calandrella cinerea*	3.92	0.00	-	-		x
Red-crested Korhaan	*Lophotis ruficrista*	21.57	5.06	-	-		x
Red-knobbed Coot	*Fulica cristata*	9.80	0.00	-	-		
Red-necked Falcon	*Falco chicquera*	1.96	0.00	-	-		
Reed Cormorant	*Microcarbo africanus*	17.65	1.27	-	-		
Rock Dove	*Columba livia*	9.80	1.27	-	-		
Red-faced Mousebird	*Urocolius indicus*	35.29	7.59	-	-		x
Red-headed Finch	*Amadina erythrocephala*	9.80	0.00	-	-		x
Rock Kestrel	*Falco rupicolus*	9.80	1.27	-	-		x
Rock Martin	*Ptyonoprogne fuligula*	50.98	2.53	-	-		x
Sand Martin	*Riparia riparia*	1.96	0.00	-	-		
Rufous-eared Warbler	*Malcorus pectoralis*	29.41	7.59	-	-		x
Sabota Lark	*Calendulauda sabota*	45.10	16.46	-	-		x
Sickle-winged Chat	*Emarginata sinuata*	1.96	0.00	-	-		
Scaly-feathered Weaver	*Sporopipes squamifrons*	35.29	5.06	-	-		x
Short-toed Rock Thrush	*Monticola brevipes*	3.92	6.33	-	-		x
Sociable Weaver	*Philetairus socius*	68.63	41.77	-	-		x
South African Shelduck	*Tadorna cana*	21.57	1.27	-	-		x
Southern Fiscal	*Lanius collaris*	64.71	12.66	-	-		x
Southern Pochard	*Netta erythrophthalma*	3.92	0.00	-	-		
Southern Red Bishop	*Euplectes orix*	37.25	5.06	-	-		
Southern Grey-headed Sparrow	*Passer diffusus*	21.57	1.27	-	-		x
Southern Masked Weaver	*Ploceus velatus*	62.75	16.46	-	-		x
Southern Yellow-billed Hornbill	*Tockus leucomelas*	0.00	0.00	-	-		x
Tawny Eagle	*Aquila rapax*	0.00	0.00	VU	EN	x	x
Spotted Flycatcher	*Muscicapa striata*	1.96	1.27	-	-		
Spotted Thick-knee	*Burhinus capensis*	3.92	0.00	-	-		
Spur-winged Goose	*Plectropterus gambensis*	15.69	2.53	-	-		
Stark's Lark	*Spizocorys starki*	1.96	0.00	-	-		
Striated Heron	*Butorides striata*	1.96	0.00	-	-		
Swallow-tailed Bee-eater	*Merops hirundineus*	23.53	1.27	-	-		

Species name	Scientific name	Reporting rate: SABAP2 Full protocol	Reporting rate: SABAP2 Ad hoc protocol	Global status	Regional status	Wind priority	Recorded during monitoring
Speckled Pigeon	*Columba guinea*	50.98	7.59	-	-		x
Spike-heeled Lark	*Chersomanes albofasciata*	21.57	11.39	-	-		x
Tractrac Chat	*Emarginata tractrac*	1.96	0.00	-	-		
Three-banded Plover	*Charadrius tricollaris*	13.73	1.27	-	-		x
Wattled Starling	*Creatophora cinerea*	21.57	1.27	-	-		x
Western Barn Owl	*Tyto alba*	9.80	0.00	-	-		x
Western Cattle Egret	*Bubulcus ibis*	7.84	1.27	-	-		
White-backed Mousebird	*Colius colius*	56.86	2.53	-	-		x
White-breasted Cormorant	*Phalacrocorax lucidus*	15.69	2.53	-	-		
White-browed Sparrow-Weaver	*Plocepasser mahali*	58.82	25.32	-	-		x
White-faced Whistling Duck	*Dendrocygna viduata*	19.61	2.53	-	-		
White-fronted Bee-eater	*Merops bullockoides*	13.73	0.00	-	-		
White-necked Raven	*Corvus albicollis*	1.96	0.00	-	-		x
White-rumped Swift	*Apus caffer*	31.37	5.06	-	-		x
White-throated Canary	*Crithagra albogularis*	27.45	2.53	-	-		x
White-throated Swallow	*Hirundo albigularis*	17.65	0.00	-	-		
Yellow Canary	*Crithagra flaviventris*	33.33	7.59	-	-		x
Yellow-bellied Eremomela	*Eremomela icteropygialis*	37.25	1.27	-	-		x
Yellow-billed Duck	*Anas undulata*	9.80	0.00	-	-		
Yellow-billed Kite	*Milvus aegyptius*	3.92	5.06	-	-		x
Zitting Cisticola	*Cisticola juncidis*	15.69	1.27	-	-		
Verreaux's Eagle	*Aquila verreauxii*	9.80	3.80	-	VU	x	x
White-backed Vulture	*Gyps africanus*	0.00	0.00	CR	CR	x	

APPENDIX 2: HABITAT IN THE PAOI

Figure 1: A typical mixture of grassland, shrubland, ridges and valleys in the PAOI.

Figure 2: The proposed 132kV grid connection will run next to the existing Burchell - Cuprum 132kV powerline for most of the way.

APPENDIX 3: ENVIRONMENTAL MANAGEMENT PROGRAMME

Environmental Management Programme (EMPr): WEF

Management Plan for the Planning and Design Phase

Impact	Mitigation/Management Objectives and Outcomes	Mitigation / Management Actions	Monitoring		
			Methodology	*Frequency*	*Responsibility*
Avifauna: Mortality due to collisions with the turbines					
Mortality of priority avifauna due to collisions with the wind turbines	Prevent mortality of priority avifauna	The results of the pre-construction monitoring must guide the lay-out of the turbines, especially as far as proposed no-turbine zones are concerned. No turbines must be constructed in the buffer zones which were identified based on the results of the pre-construction monitoring, with a specific view to limiting the risk of collisions to a variety of birds, including several Red Data species.	1. Design the facility with 200m turbine exclusion zones (including rotor swept areas) around dams and water troughs, and 150m buffers around major drainage lines. 2. Implement a 1km all infrastructure exclusion zone around the following Verreaux's Eagle nests: • VE nest 2: -29.761014° 22.724252° • VE nest 5: -29.821777° 22.767599° • VE nest 6: -29.785307° 22.742258° • VE nest 7 & 8: -29.782901° 22.777143° • VE nest 18 & 19: -29.759758° 22.762227° • VE nest 12 & 13: -29.830647° 22.774612° • VE nest 30: -29.838815° 22.816784° • VE nest 31: -29.835845° 22.817236°	Once-off during the planning phase.	Project Developer
Avifauna: Mortality due to electrocution					
Electrocution of raptors on the internal 33kV poles	Prevent electrocutions	1. Use underground cabling as much as is practically possible. 2. Where the use of overhead lines is unavoidable due to technical reasons, the Avifaunal Specialist must be consulted to ensure that a raptor friendly pole design is used, and that appropriate mitigation is	1. Design the facility with underground cabling where possible. 2. Consult with Avifaunal Specialist during the design phase of the overhead lines.	Once-off during the planning phase.	Project Developer

		implemented pro-actively for complicated pole structures e.g. insulation of live components to prevent electrocutions on terminal structures and pole transformers.			

Management Plan for the Construction Phase (Including pre- and post-construction activities)

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	*Frequency*	*Responsibility*
Avifauna: Displacement due to disturbance					
The noise and movement associated with the construction activities at the development footprint will be a source of disturbance which would lead to the displacement of avifauna from the area	Prevent unnecessary displacement of priority avifauna by ensuring that contractors are aware of the requirements of the Construction Environmental Management Programme (CEMPr.)	A site-specific Construction EMPr (CEMPr) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted. All contractors are to adhere to the CEMPr and must apply good environmental practice during construction. The CEMPr must specifically include the following: 1. Driving only allowed on designated roads. 2. Maximum use of existing roads. New roads only to be constructed if existing roads cannot be used. 3. Measures to control noise and dust according to latest best practice. 4. Restricted access to the rest of the property. 5. Strict application of all recommendations in the botanical specialist report pertaining to the limitation and rehabilitation of the footprint. 6. No construction activity should take place within 1km of any Verreaux's Eagle nests, except if there is already an existing road, and avoiding the 1km buffer would result in the construction of a new road. 7. No construction activity should take place within 1km of any Verreaux's Eagle nests, except if there is already an existing OHL, and the new OHL is routed directly next to the existing OHL. In the latter instance, construction activities should take place outside the breeding season i.e. from November to March, if possible. 8. Conduct a pre-construction inspection (avifaunal walk-through) to record the status of the priority species nests on the existing Burchell – Cuprum 132kV high voltage line. If a nest of a SCC is found to be occupied, the avifaunal specialist must consult with the	1. Implementation of the CEMPr. Oversee activities to ensure that the CEMPr is implemented and enforced via site audits and inspections. Report and record any non-compliance. 2. Ensure that construction personnel are made aware of the impacts relating to off-road driving. 3. Construction access roads must be demarcated clearly. Undertake site inspections to verify. 4. Monitor the implementation of noise control mechanisms via site inspections and record and report non-compliance. 5. Ensure that the construction area is demarcated clearly and that construction personnel are made aware of these demarcations. Monitor via site inspections and report non-compliance. 6. Ensure that the construction area is demarcated clearly and that construction personnel are made aware of these demarcations. Monitor via site inspections and report non-compliance. 7. Ensure that the construction area is demarcated clearly and that construction personnel are made aware of these demarcations. Monitor via site inspections and report non-compliance. 8. Appoint an avifaunal specialist to do the walk-through.	1. Weekly 2. Monthly 3. Monthly 4. Monthly 5. Monthly 6. Monthly 7. Monthly 8. Once-off	1. Contractor and ECO 2. Contractor and ECO 3. Contractor and ECO 4. Contractor and ECO 5. Contractor and ECO 6. Contractor and ECO 7. Contractor and ECO 8. Facility operator

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	*Frequency*	*Responsibility*
		contractor to find ways of minimising the potential disturbance to the breeding pair of birds during the construction period. This could include measures such as delaying some of the activities until after the breeding season.			
Avifauna: Displacement due to habitat transformation					
Total or partial displacement of avifauna due to habitat transformation associated with the vegetation clearance and the presence of the wind turbines and associated infrastructure.	Prevent unnecessary displacement of avifauna by ensuring that the rehabilitation of transformed areas is implemented by an appropriately qualified rehabilitation specialist, according to the recommendations of the biodiversity specialist study.	1. Vegetation must be rehabilitated to its former state where possible after construction. 2. The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint is concerned. 3. Formal live-bird monitoring should be resumed once the turbines have been constructed, as per the most recent edition of the Best Practice Guidelines (Jenkins et al. 2015). The purpose of this would be to establish if displacement of priority species has occurred and to what extent. The exact time when operational monitoring should commence, will depend on the construction schedule, and should commence when the first turbines start operating. The Best Practice Guidelines require that, as an absolute minimum, operational monitoring should be undertaken for the first two (preferably three) years of operation, and then repeated again in year 5, and again every five years thereafter for the operational lifetime of the facility.	1. Appointment of rehabilitation specialist to oversee the rehabilitation process.	1. Once-off	1. Facility operator

Management Plan for the Operational Phase

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	*Frequency*	*Responsibility*
Avifauna: Mortality due to collisions with the wind turbines					
Bird collisions with the wind turbines	Prevention of collision mortality on the wind turbines.	1. All turbines must be curtailed from an hour before sunrise to an hour after sunset **every day** for the operational lifetime of the WEF, to eliminate the risk of priority species collisions, particularly to Verreaux's Eagle. Curtailment to start once the first turbines start turning in the test phase. See the daily curtailment start and stop times below: • Month / Start / Stop • 01 January 04:31 20:32 • 15 January 04:42 20:33 • 01 February 04:57 20:27 • 15 February 05:09 20:17 • 01 March 05:19 20:03 • 15 March 05:28 19:47 • 01 April 05:38 19:27 • 15 April 05:47 19:11 • 01 May 05:56 18:55 • 15 May 06:05 18:45 • 01 June 06:15 18:37 • 15 June 06:21 18:36 • 01 July 06:24 18:40 • 15 July 06:22 18:46 • 01 August 06:14 18:56 • 15 August 06:03 19:04 • 01 September 05:45 19:13 • 15 September 05:28 19:20 • 01 October 05:08 19:29 • 15 October 04:52 19:37 • 01 November 04:35 19:49 • 15 November 04:25 20:01 • 01 December 04:20 20:14 • 15 December 04:22 20:24 • 31 December 04:30 20:32 2. Carcass searches must be implemented to establish mortality rates, as per the most recent edition of the Best Practice Guidelines (Jenkins et al. 2015). The exact time when operational monitoring should commence, will depend on the construction	1. Operator to implement curtailment daily according to the predetermined schedule 2. Appoint Avifaunal Specialist to compile operational monitoring plan, including live bird monitoring and carcass searches. 3. Implement operational monitoring plan. 4. Design and implement mitigation measures if mortality thresholds are exceeded. 5. Avifaunal Specialist to compile quarterly and annual progress reports detailing the results of the operational monitoring and progress with any recommended mitigation measures.	1. Daily 2. Once-off 3. Years 1,2, 5 and every five years after that for the duration of the operational lifetime of the facility. 4. As and when required 5. Quarterly and annually	1. Facility operator 2. Facility operator 3. Facility operator 4. Facility operator 5. Facility operator and Avifaunal Specialist

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	*Frequency*	*Responsibility*
		schedule, and should commence when the first turbines start operating. The Best Practice Guidelines require that, as an absolute minimum, operational monitoring should be undertaken for the first two (preferably three) years of operation, and then repeated again in year 5, and again every five years thereafter for the operational lifetime of the facility. If annual estimated collision rates indicate unsustainable mortality levels of priority species, i.e. if natural background mortality together with the estimated mortality caused by turbine collisions exceeds a critical mortality threshold as determined by the avifaunal specialist in consultation with other experts e.g. BLSA, additional measures will have to be implemented. This must be undertaken in consultation with a qualified avifauna specialist.			
Avifauna: Mortality due to collisions and electrocutions on the overhead lines					
Bird electrocutions on the overhead lines	Prevention of electrocution mortality on the overhead lines.	1. Conduct regular inspections of the overhead lines to look for carcasses.	1. Carcass searchers under the supervision of the Avifaunal Specialist. 2. Design and implement mitigation measures if mortality thresholds are exceeded. 3. Compile quarterly and annual progress reports detailing the results of the operational monitoring and progress, with any recommended mitigation measures.	1. At least once every two months.	1. Facility operator

Management Plan for the Decommissioning Phase

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	*Frequency*	*Responsibility*
Avifauna: Displacement due to disturbance					
The noise and movement associated with the dismantling activities at the development footprint will be a source of disturbance which would lead to the displacement of avifauna from the area	Prevent unnecessary displacement of priority avifauna by ensuring that contractors are aware of the requirements of the Environmental Management Programme (EMPr.)	A site-specific EMPr must be implemented, which gives appropriate and detailed description of how dismantling activities must be conducted. All contractors are to adhere to the EMPr and must apply good environmental practice during dismantling. The EMPr must specifically include the following: 1. Driving only allowed on designated roads. 2. Maximum use of existing roads. New roads only to be constructed if existing roads cannot be used. 3. Measures to control noise and dust according to latest best practice. 4. Restricted access to the rest of the property. 5. Strict application of all recommendations in the botanical specialist report pertaining to the limitation and rehabilitation of the footprint.	1. Implementation of the EMPr. Oversee activities to ensure that the EMPr is implemented and enforced via site audits and inspections. Report and record any non-compliance. 2. Ensure that personnel are made aware of the impacts relating to off-road driving. 3. Access roads must be demarcated clearly. Undertake site inspections to verify. 4. Monitor the implementation of noise control mechanisms via site inspections and record and report non-compliance. 5. Ensure that the dismantling area is demarcated clearly and that personnel are made aware of these demarcations. Monitor via site inspections and report non-compliance.	1. Weekly 2. Monthly 3. Monthly 4. Monthly 5. Monthly	1. Contractor and ECO 2. Contractor and ECO 3. Contractor and ECO 4. Contractor and ECO 5. Contractor and ECO

APPENDIX 4: CURTAILMENT STRATEGY

The iconic Verreaux's Eagle (*Aquila verreauxii*; previously known as the Black Eagle) is found across much of Africa, including South Africa and a number of wind farms have been proposed within its range. BirdLife South Africa analysed 57 avifaunal impact assessment and monitoring reports for wind farms - 65% of those studied reported the presence of Verreaux's Eagles at, or near to, a proposed wind farm. Between 2015 and 2020, at least 22 Verreaux's Eagles collision fatalities were recorded at wind energy developments in South Africa, with an additional 6 fatalities incurred on associated electrical infrastructure. The conservation status, behaviour and distribution of Verreaux's Eagles, together with the recorded effects of wind farms on other eagle species further afield, suggest that poorly planned wind farms could negatively affect the species. It is therefore not surprising that the Verreaux's Eagle is considered to be a priority for impact assessment and monitoring at wind energy facilities in South Africa (Ralston-Patton 2021).

The proponent of the Prieska Power Reserve WEF has agreed to an innovative mitigation strategy in order to minimise the risk of priority avifauna mortality caused by collisions with the wind turbines. This is specifically aimed at Verreaux's Eagles but will benefit all diurnal priority avifauna**. The strategy entails the curtailment of all wind turbines every day from an hour before dawn throughout the day to an hour after dusk, for the operational life of the wind farm, to minimise the risk of eagles colliding with the turbines.** The strategy is based on the assumption that Verreaux's Eagle flight activity is restricted to daylight hours (see Murgatroyd *et al.* 2021). As a pre-cautionary measure, the curtailment is extended to an hour outside dawn and dusk as well, as eagles are sometimes active pre-dawn and during dusk, especially in windy conditions (personal observation). The table below indicates the curtailment windows for the whole year, based on the sunrise and sunset times for Prieska (https://www.weatheravenue.com/en/africa/za/northern-cape/prieska-sunrise.html). The curtailment will be implemented as soon as turbine testing starts.

Bi-weekly curtailment windows based on the sunrise and sunset times at Prieska, Northern Cape		
Month	**Start**	**Stop**
01 January	04:31	20:32
15 January	04:42	20:33
01 February	04:57	20:27
15 February	05:09	20:17
01 March	05:19	20:03
15 March	05:28	19:47
01 April	05:38	19:27
15 April	05:47	19:11
01 May	05:56	18:55
15 May	06:05	18:45
01 June	06:15	18:37
15 June	06:21	18:36
01 July	06:24	18:40
15 July	06:22	18:46
01 August	06:14	18:56
15 August	06:03	19:04

Bi-weekly curtailment windows based on the sunrise and sunset times at Prieska, Northern Cape		
Month	**Start**	**Stop**
01 September	05:45	19:13
15 September	05:28	19:20
01 October	05:08	19:29
15 October	04:52	19:37
01 November	04:35	19:49
15 November	04:25	20:01
01 December	04:20	20:14
15 December	04:22	20:24
31 December	04:30	20:32

This mitigation method is likely to be more effective than traditional buffer-based methods such as circular nest buffers or the Verreaux's Eagle Risk Assessment (VERA) method as it effectively eliminates the risk for the entire period that the birds could potentially be exposed to the collision risk posed by the turning turbines.

References:

- Ralston-Patton S. 2021. Verreaux's Eagles and Wind Farms. Guidelines for impact assessment, monitoring and mitigation. BirdLife South Africa, November 2021.
- Murgatroyd, M., Bouten, W. and 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.

APPENDIX 5: OPERATIONAL MONITORING PLAN

1 INTRODUCTION

The avifaunal post-construction monitoring at the proposed wind energy facility must be conducted in accordance with the latest version (2015) of the *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa* (Jenkins *et al*., 2015)[9].

2 AIM OF POST-CONSTRUCTION MONITORING

The avifaunal post construction monitoring aims to assess the impact of the proposed WEF by comparing pre- and post- construction monitoring data and to measure the extent of bird fatalities caused by the WEF. Post-construction monitoring is therefore necessary to:

- Confirm as far as possible what the actual impacts of the WEF are on avifauna; and
- Determine what mitigation is required if need be (adaptive management).

The proposed post-construction monitoring can be divided into three categories:

- Habitat classification;
- Quantifying bird numbers and movements (replicating baseline pre-construction monitoring); and
- Quantifying bird mortalities.

Post-construction monitoring will aim to answer the following questions:

- How has the habitat available to birds in and around the WEF changed?
- How has the number of birds and species composition changed?
- How have the movements of priority species changed?
- How has the WEF affected priority species' breeding success?
- How many birds collide with the turbines at the WEF? And are there any patterns to this?
- What mitigation is necessary to reduce the impacts on avifauna?

3 TIMING

Post-construction monitoring should commence as soon as possible after the first turbines become operational to ensure that the immediate effects of each facility on resident and passing birds are recorded, before they have time to adjust or habituate to the developments. However, it should be borne in mind that it is also important to obtain an understanding of the impacts of the facilities as they would be over the lifespan of the facilities. Over time the habitat within each WEF may change, birds may become habituated to, or learn to avoid the facilities. It is therefore necessary to monitor over a longer period than just an initial one year.

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[9] Jenkins, A.R., Van Rooyen, C.S., Smallie, J.J., Anderson, M.D., & A.H. Smit. 2015. Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa. Produced by the Wildlife & Energy Programme of the Endangered Wildlife Trust & BirdLife South Africa.

4 DURATION

Monitoring should take place in Year 1 and 2 of the operational phase of each proposed WEF, and then repeated in Year 5 and every five years after that. After the first year of monitoring, the programme should be reviewed in order to incorporate significant findings that may have emerged. This may entail the revision of the number of turbines to be searched, and the size of the search plots, depending on the outcome of the first year of monitoring. If significant impacts are observed, i.e., exceeding predetermined thresholds, and mitigation is required, the matter should be taken up with the operator to discuss potential mitigation. In such instances the scope of monitoring could be reduced to focus only on the impacts of concern.

5 HABITAT CLASSIFICATION

Any observed changes in bird numbers and movements at each WEF may be linked to changes in the available habitat. The avian habitats available must be mapped once a year for the first two years, then in year 5 and thereafter in 5-yearly intervals.

6 BIRD NUMBERS AND MOVEMENTS

In order to determine if there are any impacts relating to displacement and/or disturbance, all methods used to estimate bird numbers and movements during baseline monitoring must be applied as far as is practically possible in the same way to post-construction work in order to ensure maximum comparability of these two data sets. This includes sample counts of small terrestrial species, counts of large terrestrial species and raptors, focal site surveys and vantage point surveys according to the current best practice.

7 COLLISIONS

The collision monitoring must have three components:

- Experimental assessment of search efficiency and scavenging rates of bird carcasses on the respective sites.
- Regular searches in the immediate vicinity of the WEF turbines for collision casualties (see Section 9).
- Estimation of collision rates.

8 SEARCHER EFFICIENCY AND SCAVENGER REMOVAL

The value of surveying the area for collision victims is only valid if some measure of the accuracy of the survey method is developed. The probability of a carcass being detected and the rate of removal / decay of the carcass must be accounted for when estimating collision rates. This must be addressed in the form of searcher and scavenger trails which must be conducted by the avifaunal specialists at least twice a year during each year of post-construction monitoring in order to arrive at an estimated annual collision mortality rate.

9 COLLISION VICTIM SURVEYS

9.1 Aligning carcass search protocols

The carcass search protocol must be agreed upon between the bat and bird specialists to constitute an acceptable compromise between the current best practice guidelines for bird and bat monitoring.

Daily carcass searches must begin as early in the mornings as possible to reduce carcass removal by scavengers. A carcass searcher must walk in straight line transects, 6m apart, covering 3m on each side. A team of searchers and one supervisor must be trained to implement the carcass searches. The searchers must have a vehicle available for transport per site. The supervisor must assist with the collation of the data at each site and to provide the data to the specialist in electronic format on a weekly basis. The specialists must ensure that the supervisor is completely familiar with all the procedures concerning the management of the data. The following must be made available online to specialist on a weekly basis:

- Carcass fatality data (entered into Excel spreadsheets);
- Pictures of any carcasses, properly labelled;
- GPS tracks of the search plots walked;
- Turbine search interval spreadsheets.

When a carcass is found, it must be bagged, labelled and kept refrigerated for species confirmation by the avifaunal specialist.

9.2 Estimation of collision rates

Observed mortality rates need to be adjusted to account for searcher efficiency and scavenger removal. There have been many different formulas proposed to estimate mortality rates. The available methodologies must be investigated, and an appropriate method will be applied. The current method which is used widely is the GenEst method.

10 DELIVERABLES

10.1 Annual report

An operational monitoring report must be completed at the end of each year of operational monitoring. As a minimum, the report must attempt to answer the following questions:

- How has the habitat available to birds in and around each WEF changed?
- How has the number birds and species composition changed?
- How have the movements of priority species changed?
- How has each WEF affected priority species' breeding success?
- What are the likely drivers of any changes observed?
- How many, and which species of birds collided with the turbines and associated infrastructure? And are there any patterns to this?
- What is the significance of any impacts observed?
- What mitigation measures are required to reduce the impacts?

10.2 Quarterly reports

Concise quarterly reports must be compiled by the avifaunal specialist for the WEF operator with basic statistics and recommendations for the management of impacts that need to be addressed.

APPENDIX 6: SITE SENSITIVITY VERIFICATION

Prior to commencing with the specialist assessment in accordance with Appendix 6 of the National Environmental Management Act (Act 107 of 1998, as amended) (NEMA) Environmental Impact Assessment (EIA) Regulations of 2014, a site sensitivity verification was undertaken in order to confirm the current land use and environmental sensitivity of the proposed project area as identified by the National Web-Based Environmental Screening Tool (Screening Tool)..

The details of the site sensitivity verification (SSV) are noted below:

Date of Site Visits	08 – 12 March 2022
Supervising Specialist Name	Albert Froneman
Professional Registration Number	MSc Conservation Biology (SACNASP Zoological Science Registration number 400177/09)
Specialist Affiliation / Company	Chris van Rooyen Consulting

METHODOLOGY

The following methods were used to compile the SSV report:

- The Project Area of Impact (PAOI) was defined as an aggregate area encompassing of a 1km buffer area around the turbine layout, and a 2km buffer around the proposed 132kV OHL.
- Bird distribution data from the Southern African Bird Atlas Project 2 (SABAP 2) was obtained (http://sabap2.adu.org.za/), in order to ascertain which species occur in the pentads where the proposed development is located. A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5' × 5'). Each pentad is approximately 8 × 7.6 km. A consolidated data set was obtained for a total of 9 pentads which overlaps with the development area, henceforth referred to as the B**roader Area**. The 9 pentad grid cells are the following: 2940_2240, 2940_2245, 2940_2250, 2945_2240, 2945_2245, 2945_2250, 2950_2240, 2950_2245, 2950_2250 (see Figure 33). A total of 59 full protocol lists (i.e. bird listing surveys lasting a minimum of two hours each) and 82 ad hoc protocol lists (surveys lasting less than two hours but still yielding valuable data) have been completed to date for the 9 pentads where the PAOI is located.
- An avifaunal scoping report compiled by Dr. D.J. van Niekerk provided valuable background information on the avifaunal community and habitat in the PAOI (Van Niekerk 2021).
- A classification of the vegetation types in the development area was obtained from the Atlas of Southern African Birds 1 (SABAP1), the 2018 National Vegetation Map compiled by the South African National Biodiversity Institute ((South African National Biodiversity Institute, 2018) and the scoping report compiled by Dr. D.J. van Niekerk (Van Niekerk 2021).
- The national threatened status of all priority species was determined with the use of the most recent edition of the Red List Book of Birds of South Africa, Lesotho and Swaziland (Taylor *et al.* 2015), and the latest authoritative summary of southern African bird biology (Hockey *et al.* 2005).
- The global threatened status of all priority species was determined by consulting the latest (2022.1) IUCN Red List of Threatened Species (http://www.iucnredlist.org/).
- The Important Bird and Biodiversity Areas of South Africa (Marnewick *et al.* 2015; http://www.birdlife.org.za/conservation/important-bird-areas) was consulted for information on potentially relevant Important Bird Areas (IBAs).
- Satellite imagery (Google Earth © 2022) was used in order to view the broader area on a landscape level and to help identify bird habitat on the ground.
- The South African National Biodiversity BGIS map viewer was used to determine the locality of the development area relative to National Protected Areas.

- The DFFE National Screening Tool (https://screening.environment.gov.za/) was used to determine the assigned avian sensitivity of the development area based on the relevant theme[10].
- The following sources were consulted to determine the investigation protocol that is required for the site:
    - Procedures for the Assessment and Minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of NEMA when applying for Environmental Authorisation (Gazetted October 2020)
    - The Protocol for the specialist assessment and minimum report content requirements for environmental impacts on avifaunal species where the output is 20MW or more (Government Gazette No 43110, 20 March 2020).
    - The Verreaux's Eagle Best Practice Guidelines Second edition (Ralston-Patton S. 2021. Verreaux's Eagles and Wind Farms. Guidelines for impact assessment, monitoring and mitigation. BirdLife South Africa, November 2021) henceforth referred to as "the VE guidelines".

NATURAL ENVIRONMENT AND HABITAT TYPES

- **Grassland/Shrubland**

The PAOI falls within the Nama Karoo Biome (Mucina & Rutherford 2006), but the vegetation on site is an ecotone between Karoo and Savanna. The vegetation in the PAOI can be described as shrubland dominated by *Rhigozum trichotomum* (Driedoring) and a well-developed grassy layer. *Senegalia mellifera* (Swarthaak) dominates along drainage lines and forms large shrubs and small trees. The topography in the PAOI is flat, but mountainous terrain is present towards the west and south of the PAOI. The average annual rainfall in the Prieska area is ~200 mm with most rain falling from February to April (Mucina & Rutherford 2006). Temperatures range from an average daytime high of about 35° Celsius in January to about 19° Celsius in June/July (https://www.meteoblue.com/). See Figures 1 and 2.

Whilst the distribution and abundance of bird species in the development area are typical of the broad vegetation type, it is also necessary to examine bird habitats in more detail as it may influence the distribution and behaviour of priority species. The various other habitat types within the PAOI are discussed below.

Figure 1: Grassland habitat with low shrubs at the PAOI.

[10] The Avifauna Wind theme is only applicable to developments in Renewable Energy Development Zones (REDZ). Where the development is located outside a REDZ, the Terrestrial Animal Species theme is applicable.

- **Woodland**

The drainage lines in the PAOI are characterised by dense clumps of *Senegalia mellifera* (Swarthaak) shrubs and low trees in the riparian zone, giving a distinct woodland character to the vegetation. Many bird species can potentially utilize this habitat for roosting and nesting (Figure 2).

Figure 2: Woodland habitat along a drainage line at the PAOI.

- **Ridges**

The most prominent topographical feature of the PAOI is the Doringberge Mountain range which runs through the middle of the PAOI in a north-westerly – south easterly orientation. The range contains many cliffs which are suitable breeding substrate for cliff-nesting priority avifauna, including the Red List Verreaux's Eagle. **There are currently (2022) nine (9) confirmed, structurally functional Verreaux's Eagle nests within the PAOI, belonging to an estimated five (5) pairs of eagles.**

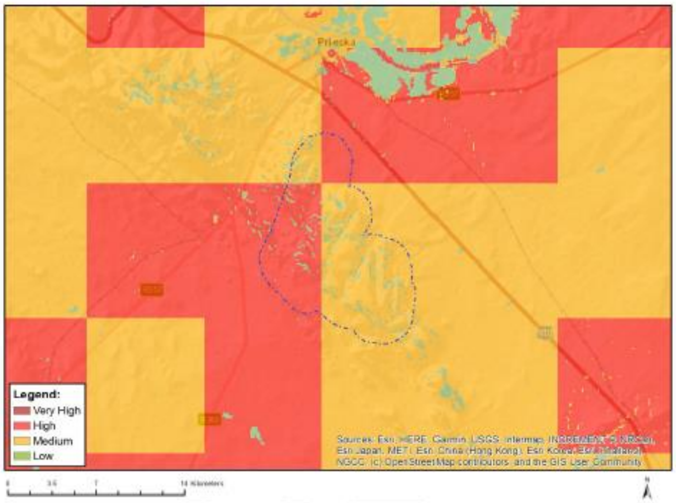
Figure 3: A ridge at the PAOI containing an active Verreaux's Eagle nest.

RESULTS AND CONCLUSION OF SITE ASSESSMENT

The project site and immediate environment is classified as **Medium and High** sensitivity for terrestrial animals according to the Terrestrial Animal Species Theme[11] (Figure 4). The High and Medium classification is linked to the potential occurrence of Ludwig's Bustard (Globally and Regionally Endangered), and Verreaux's Eagle (Regionally Vulnerable). The development site contains confirmed habitat for species of conservation concern (SCC) as defined in the Protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species (Government Gazette No 43855, 30 October 2020, namely listed on the IUCN Red List of Threatened Species or South Africa's National Red List website as Critically Endangered, Endangered or Vulnerable.

The habitat for SCCs was confirmed during the surveys i.e. Ludwig's Bustard (Globally and Regionally Endangered), Lanner Falcon (Regionally Vulnerable), White-backed Vulture (Regionally Critically Endangered) and Lappet-faced Vulture (Globally and Regionally Endangered), Lanner Falcon and Verreaux's Eagle were recorded during the site sensitivity verification surveys.

MAP OF RELATIVE ANIMAL SPECIES THEME SENSITIVITY



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

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
	X		

Sensitivity Features:

Sensitivity	Feature(s)
High	Aves-Neotis ludwigii
High	Aves-Aquila verreauxii
High	Mammalia-Felis nigripes
Low	Subject to confirmation
Medium	Aves-Aquila verreauxii
Medium	Aves-Neotis ludwigii

Figure 4: The National Web-Based Environmental Screening Tool map of the PAOI, indicating sensitivities for the Terrestrial Animal Species theme. The High classification is linked to Ludwig's Bustard (*Neotis ludwigii*) and the Medium sensitivity classification is linked to Ludwig's Bustard (*Neotis ludwigii*) and Verreaux's Eagle (*Aquila verreauxii*).

Based on the results of the pre-construction monitoring, a classification of **High** sensitivity for avifauna is suggested for the whole PAOI.

[11] Note that the Avifaunal Wind theme in the Screening Tool is only applicable to developments in Renewable Energy Development Zones (REDZ).