Loxton Wind Energy Facility 1

Avifaunal Impact Assessment – EIA Phase

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Submitted to:

Loxton Wind Farm 1 (Pty) Ltd

Executive Summary

Loxton Wind Facility 1 (Pty) Ltd) is currently proposing the development of one of three commercial Wind Energy Facilities (WEFs) and associated infrastructure on a site located approximately 30km North of Loxton within the Ubuntu Local Municipality and the Pixley Ka Seme District Municipality in the Northern Cape Province. An SPV for each wind farm was established, namely Loxton Wind Facility 1 (Pty) Ltd, Loxton Wind Facility 2 (Pty) Ltd and Loxton Wind Facility 3 (Pty) Ltd. As part of the feasibility investigations towards the suitability of the site for wind farm development, WildSkies Ecological Services (Pty) Ltd conducted an avifaunal screening assessment for the site (WildSkies, 2020). The developer then refined the developable area on the basis of identified avifaunal constraints. This included running the VERA (Verreaux's Eagle Risk Assessment) model to identify high and medium risk areas around known Verreaux's Eagle nests. The developer then appointed WildSkies to conduct the necessary 12 months pre-construction bird monitoring for the developable area and undertake the Avifaunal Impact Assessment for the Environmental Authorisation application, managed by Arcus Consultancy Services South Africa (Pty) Ltd (Arcus).

This EIA Phase report presents findings from the four pre-construction monitoring Site Visits spanning a year of avifaunal monitoring. Data from various methodologies have been analysed and are presented for the full site (Loxton WEF 1 - 3) throughout the report, although this report is specifically concerned with Loxton WEF 1. Site Visits were conducted as follows:

- Site Set-up: 27 & 28th July 2021
- Site Visit 1: 29th July – 11th August 2021
- Site Visit 2: 19th October – 2nd November 2021
- Site Visit 3: 14th February – 2nd March 2022 (teams slightly staggered)
- Site Visit 4: 16th – 29th May 2022

We draw the following conclusions regarding the avifaunal community and potential impacts of the proposed wind farm:

- We classified three bird species as being at High risk should the projects proceed, and two species at Medium risk. High risk species include: Ludwig's Bustard (Endangered), Verreaux's Eagle (Vulnerable) and Jackal Buzzard (endemic, not Red Listed). Martial Eagle (Endangered) and Black Harrier (Endangered) were classified as Medium risk.
- Since the turbine model has not been finalised, we estimated bird fatalities using a 'typical rotor envelope' of 30 to 230m above ground. It is estimated that before mitigation approximately 3.41 bird fatalities could be recorded at the wind farm per year across the 20 target bird species recorded flying on site for a turbine rotor swept area of 30 – 230m. This includes: 0.66 Ludwig's

Bustards, 0.47 Verreaux's Eagles and 1.38 Jackal Buzzards. Although the preferred turbine model would result in a lower blade tip 25 – 35m above ground, for illustrative purposes we ran the calculation using a lower blade tip of 60m above ground (as a best case scenario). The fatality estimates could be reduced significantly with an increase in minimum blade height above ground as most bird flight was recorded closer to the ground than 60m. We strongly recommend that any opportunity to raise the lower blade tip as much as possible should be taken, as this could significantly reduce the bird collision risk.

Based on this assessed risk, we assessed the potential impacts on birds and made the following findings:

Impact	**Significance before mitigation**	**Significance after mitigation**
Construction phase		
Habitat destruction during construction	Moderate negative	Moderate negative
Disturbance of birds during construction	Low negative	Low negative
Operational phase		
Disturbance during operations	Low negative	Low negative
Displacement during operations	Low negative	Low negative
Collision with turbine blades	High negative	Moderate negative
Bird collision with turbine infrastructure during operations	High negative	Moderate negative
Bird electrocution during operations	High negative	Low negative
Decommissioning phase		
Disturbance of birds during decommissioning	Low negative	Low negative
Cumulative impacts		
Habitat destruction & bird fatality through turbine collision	High negative	Moderate negative

In addition to the avoidance measures already implemented for the overall site of three wind farms (which include No-Go nest buffers, some derived from the Verreaux's Eagle Risk Assessment model) that pertain to raptor nest buffers and bustard lekking areas, the following mitigation measures in terms of the developable site area are recommended:

- No wind turbines or overhead power lines should be placed within the identified No-Go areas. The High sensitivity areas should be avoided as far as possible with new infrastructure, in particular turbines. One proposed turbine is currently within the buffer area around the Ludwig's Bustard lek (classified as High sensitivity) and has been agreed to and approved by the specialist. Construction of this turbine and associated roads may be subject to a seasonal restriction (breeding season is variable dependent on rainfall and would need confirmation in the relevant year) if Ludwig's Bustard are found displaying in the these leks in the relevant construction year. An avifaunal specialist will need to survey for this.
- A pre-construction avifaunal walk down should be conducted to confirm final layout and identify any sensitivities that may arise between the conclusion of the EIA process and the construction phase. This can be done in any season, although May to October would be raptor breeding season and should be prioritised if possible.
- All human activities associated with construction, operation and decommissioning should be strictly managed according to generally accepted environmental best practice standards, so as to avoid any unnecessary impact on the receiving environment.
- Existing roads and tracks should be used as far as possible.
- Movement of all staff, vehicle and machinery activities should be strictly controlled at all times so as to ensure that the absolute minimum of surface area is impacted.
- Care should be taken not to introduce or propagate alien plant species/weeds during construction.
- Any underground cabling should follow roads at all times to reduce the impact on the habitat by grouping these linear infrastructures.
- A post-construction inspection must be conducted by an avifaunal specialist (at the start of operation phase monitoring) to confirm that all aspects have been appropriately handled and in particular that road and hard stand verges do not provide additional substrate for raptor prey species. It is essential that the new wind farm does not create favourable conditions for such mammals in high risk areas. We therefore recommend that within the first year of operations a full assessment of this aspect be made by the ornithologist contracted for post-construction monitoring. If such conditions have been created, case-specific solutions will need to be developed and implemented by the wind farm. It is strongly recommended that rodenticides not be used at the newly established Operation and Maintenance (O&M) buildings or around auxiliary infrastructure on the project site. While pest control of this nature may be effective, even so-called "environmentally friendly" rodenticides are toxic and pose significant secondary poisoning risk to predatory avifauna, especially owls.
- A bird fatality threshold and adaptive management plan has been designed for the project (Appendix 14). This policy should form an annexure of the operational EMP for the facility. This plan identifies the number of bird fatalities of priority species which will trigger a management

response, appropriate responses, and time lines for such responses. Fatalities of priority bird species are usually rare events (but with very high consequence) and it is difficult to analyse trends or statistics related to these fatalities as they occur. It is therefore important to have an adaptive management plan in place proactively to assist management.

- Following on from the above point, should the identified priority bird species fatality thresholds be exceeded in Year 1 and 2, an observer-led turbine Shutdown on Demand (SDOD) programme must be implemented on site. This programme must consist of a suitably qualified, trained and resourced team of observers present on site for all daylight hours 365 days of the year. This team must be stationed at vantage points with full visible coverage of all turbine locations. The observers must detect incoming priority bird species, track their flights, judge when they enter a turbine proximity threshold, and alert the control room to shut down the relevant turbine until the risk has reduced. A full detailed method statement or protocol must be designed by an ornithologist.
- The combination of hub height and rotor diameter must be optimised where technically feasible to maximise the lower blade tip height above ground. Raising the lower turbine blade tip height from a typical 30m above ground to 60m above ground (for example) will reduce collision risk for cranes, Ludwig's Bustards, Black Harrier and korhaans, which typically fly low over the ground. Raising the lower blade tip from 30 to 60m above ground as a mitigation measure benefits every target species (in terms of reduced predicted mortality). We strongly recommend that any opportunity to raise the lower blade tip as much as possible, should be taken as this could significantly reduce the bird collision risk.
- Turbine blades must be painted according to a protocol currently under development by the South African Wind Energy Association (SAWEA) from the outset. Painting one of the three rotor blades black reduces motion smear and may greatly reduce avian collision risk. Provision must be made by the developer for the resolution of any technical, warranty, and supplier challenges that this may present.
- Any residual impacts during the operational phase after all possible mitigation measures have been implemented will need to be mitigated off site by the developer. The developer/facility will need to address other sources of mortality of priority species in a measurable way so as to compensate for residual effects on the facility itself. This will need to be detailed in a Biodiversity Action Plan compiled by an ornithologist. Since most priority species for this project face considerable threat through overhead power lines across their range, a likely off-site mitigation measure could be the mitigation of power line impacts on Eskom's network. These are measurable and easily mitigated impacts which could result in a no nett loss or even nett gain scenario for priority bird species.
- No internal medium voltage power lines should be overhead unless approved by the avifaunal specialist prior to construction. All such cables should be buried along road verges. Only the 132kV collector lines and grid connection power line should be above ground.

- Any overhead conductors or earth wires should be fitted with an Eskom approved anti-bird collision line-marking device to make cables more visible to birds in flight and reduce the likelihood of collisions.
- The pole design of any overhead power line should be approved by an ornithologist in terms of the electrocution risk it may pose to large birds such as eagles.
- Should more than one power line be constructed in parallel with another either new or existing power line, the pylon structures should be staggered as per Pallett *et al*. (2022) to increase visibility to large, slow-moving species, especially bustards and cranes.
- The "during construction" and "post-construction" monitoring programme outlined in **Appendix 7** should be implemented according to the latest available version of the Best Practice Guidelines at the time. The findings from operational phase monitoring should inform an adaptive management programme to mitigate any impacts on avifauna to acceptable levels. In particular, any Verreaux's Eagle fatalities should be reported to Dr Megan Murgatroyd in order to close the feedback loop back to the VERA modelling performed for this site.

The Applicant (Loxton Wind Facility 1) has redesigned the developable area of the proposed Loxton WEF 1 to avoid the No-Go areas identified in this report. One proposed turbine (WTG42) is within the buffer area around the Ludwig's Bustard lek (classified as High sensitivity) and has been agreed to and approved by the specialist. Construction of this turbine and associated roads may be subject to a seasonal restriction if Ludwig's Bustard are found displaying in the these leks in the relevant construction year. An avifaunal specialist will need to survey for this. Increasing the minimum turbine blade height above ground from 30m to 60m can potentially reduce collision risk by as much as 75% for this species and for almost every other target species assessed, to varying degrees. Increasing minimum rotor swept height is strongly recommended.

Avifaunal impacts have been assessed in this document and have been mostly determined to be of Low or Moderate Negative significance post-mitigation, with the exception of habitat destruction and the impact of fatalities as a direct result of turbine and power line collisions, which remain at Moderate Negative post mitigation. Cumulative impacts will be of High negative significance pre-mitigation, and Moderate negative significance post mitigation.

According to available information consulted during this study to date, there are no fatal flaws from an avifaunal sensitivity perspective which should prevent the wind farm from proceeding.

Glossary of terms & abbreviations

The following terms and abbreviations are used in this study:

Endemic/Near endemic	Occurring only here; southern African endemics as taken from BirdLife South Africa Checklist (2022).
Priority Species	Priority species are those that this study focuses on in more detail. See 'SCC'
Red Listed – Globally	The latest global conservation status for the species as per IUCN (2022).
Red Listed – Regionally	The latest regional conservation status for the species as per Taylor *et al.* 2015.
EN	Endangered
IBA	Important Bird Areas
kV	Kilovolt (1000 volts)
LC	Least concern
NT	Near-threatened
Rec	Number of records
REDZ	Renewable Energy Development Zone
REDZ2	Renewable Energy Development Zone 2
SCC	Species of conservation concern. The term consistently used in this report to refer to an SCC is "priority species"
SSV	Site Sensitivity Verification
VERA	Verreaux's Eagle Risk Assessment (model)
VU	Vulnerable
WEF	Wind Energy Facility

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1. Introduction

The Applicant, Loxton Wind Facility 1 (Pty) Ltd, is proposing the development of a commercial Wind Energy Facility (WEF) and associated infrastructure on a site located approximately 30km north of Loxton within the Ubuntu Local Municipality and the Pixley Ka Seme District Municipality in the Northern Cape Province.

Two additional WEFs are concurrently being considered on the surrounding properties and are assessed by way of separate Impact Assessment processes contained in the 2014 Environmental Impact Assessment Regulations (GN No. R982, as amended) for listed activities contained in Listing Notices 1, 2 and 3 (GN R983, R984 and R985, as amended). These projects are known as Loxton WEF 2 and Loxton WEF 3.

A preferred project site with an extent of approximately 52 000 ha has been identified as a technically suitable area for the development of the three WEF projects. Loxton WEF 1 will comprise of up to 42 turbines, Loxton WEF 2 up to 62 turbines and Loxton WEF 3 up to 38 turbines. Loxton WEF 1 and Loxton WEF 3 will each have a contracted capacity of up to 240MW with a permanent footprint of up to 65 ha whereas Loxton WEF 2 will comprise of up to 62 turbines with a contracted capacity of up to 480 MW and permanent footprint of up to 110ha.

As part of the feasibility investigations towards the suitability of the site for wind farm development, WildSkies Ecological Services (Pty) Ltd conducted an Avifaunal Screening Assessment for the site (WildSkies, 2020). The developer then refined the developable area on the basis of identified avifaunal constraints. This included running the VERA (Verreaux's Eagle Risk Assessment) model to identify high and medium risk areas around known Verreaux's Eagle nests. The developer then appointed WildSkies to conduct the necessary 12 months pre-construction bird monitoring for the developable area and undertake the Avifaunal Impact Assessment for the Environmental Authorisation application, managed by Arcus Consultancy Services South Africa (Pty) Ltd (Arcus).

This document is the EIA Phase avifaunal impact assessment report for Loxton WEF 1, but presents data analysed from the 12 months of bird monitoring for all three relevant WEFs. While the spatial scope of our data collection presented here is larger than the developable area of the Loxton WEF 1 alone, the habitat, vegetation and resources concerned from an avian perspective are similar. The excellent mobility of birds as a whole warrants a study wider than within the strict boundary of the redesigned project site, and it is our opinion that this approach strengthens our confidence in the findings. The project area is presented below in **Figure 1**.

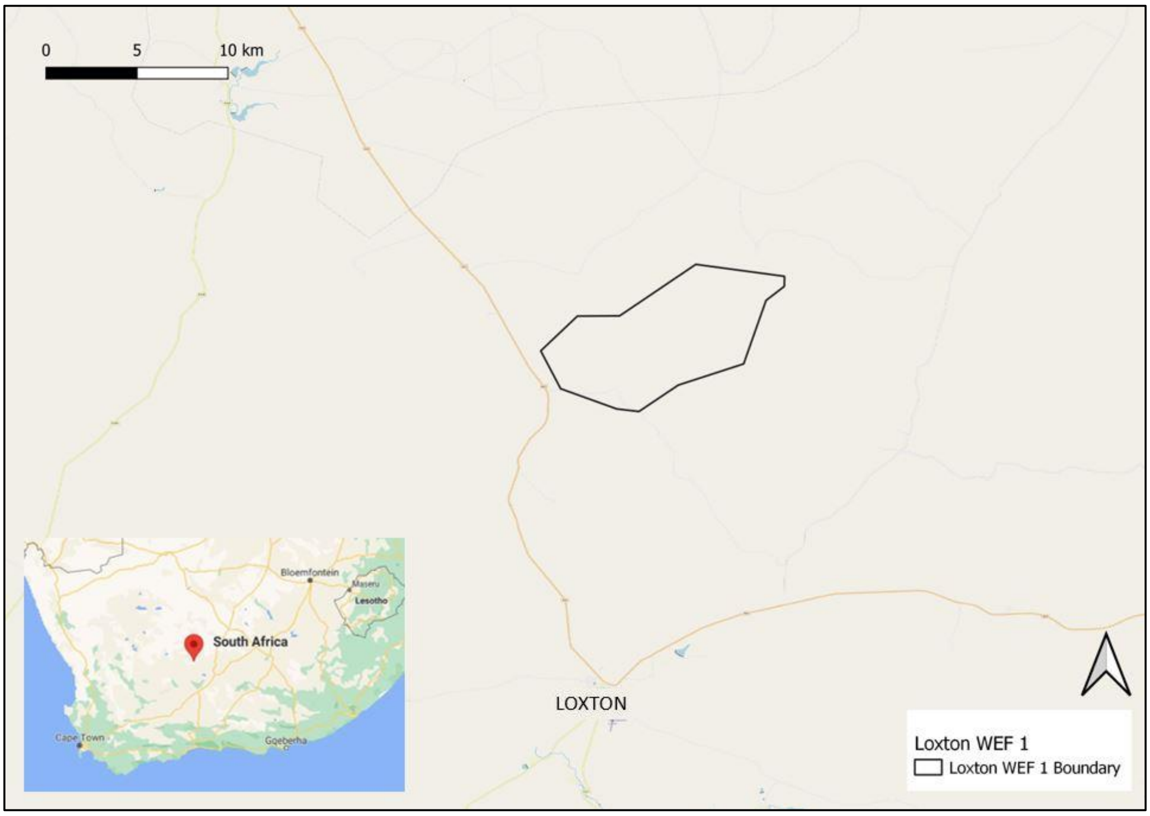

Figure 1. The position of the proposed Loxton WEF 1.

1.1 Project Description

The Loxton WEF 1 project site covers approximately 7 200 ha and comprises the following farm portions:

- Portion 12 of the Farm Rietfontein 572;
- Remaining Extent of Farm 582
- Remaining Extent of the Farm Saaidam No. 574;
- Remaining Extent of the Farm Springfontein No. 573

The Loxton WEF 1 project site is proposed to accommodate the following infrastructure, which will enable the wind farm to supply a contracted capacity of up to 240 MW:

- Up to 42 wind turbines with a maximum hub height of up to 160 m and a rotor diameter of up to 200 m;
- A transformer at the base of each turbine;
- Concrete turbine foundations with a permanent footprint 5.5 ha;
- Each turbine will have a crane hardstand of 70 m x 45 m. The permanent footprint for turbine hardstands will be up to 12ha.

- Each turbine will have a temporary blade hardstand of 80 m x 45 m. The temporary footprint for blade hardstands will be up to 14 ha.
- Temporary laydown areas (with a combined footprint of up to 23 ha) which will accommodate the boom erection, storage and assembly area;
- Battery Energy Storage System (with a footprint of up to 5 ha);
- Medium voltage (33 kV) cables/powerlines running from wind turbines to the facility substations. The routing will follow existing/proposed access roads and will be buried where possible.
- One on-site substations of up to 2 ha in extent to facilitate the connection between the wind farm and the electricity grid;
- Access roads to the site and between project components inclusive of stormwater infrastructure. A 15 m road corridor may be temporarily impacted upon during construction and rehabilitated to 6m wide after construction. The WEF will have a total road network of up to 50 km.
- A temporary site camp establishment and concrete batching plants (with a combined footprint of up to 2 ha); and
- Operation and Maintenance buildings (with a combined footprint of up to 2 ha) including a gate house, security building, control centre, offices, warehouses, parking bays, a workshop and a storage area.

The Electrical Grid Infrastructure (EGI) associated with the Loxton WEF considers a 300m wide corridor route from the Loxton Switching Station/Collector Station to the Gamma MTS. The EGI is located within the Central Strategic Powerline Corridor and therefore subject to a Basic Assessment process in accordance with GN 113 of 16 February 2018 listed under NEMA, 1998.

The EA applications for the wind farm project and grid connection infrastructure are being undertaken in parallel as they are co-dependent, i.e. one will not be developed without the other.

Figure 2 below shows the proposed turbine layout supplied by the proponent. Exact turbine specifications have not yet been confirmed.

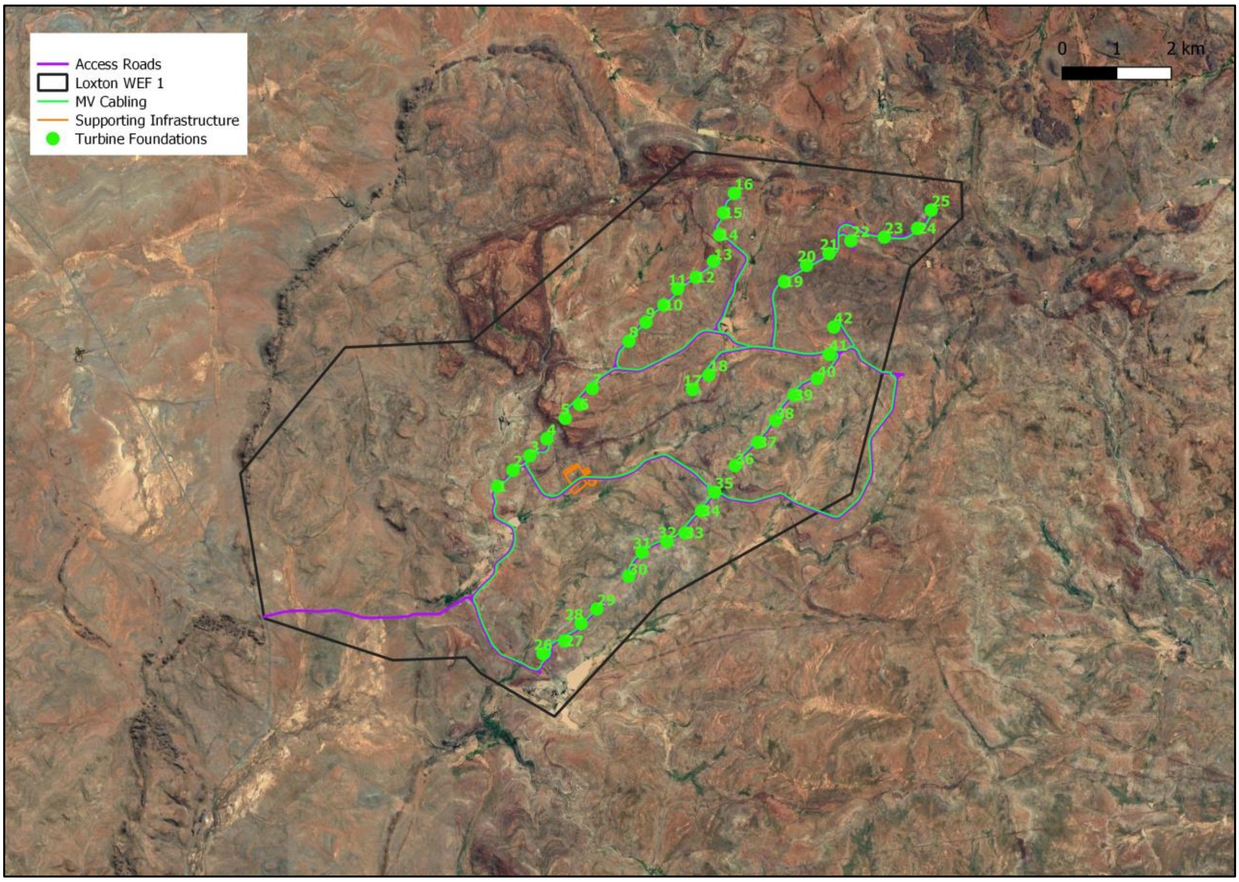

Figure 2. Indicative turbine layout (up to 38 turbine positions).

1.2 Literature review - background to potential wind energy facilities & birds

The first documented interaction between birds and wind farms was that of birds killed through collision with turbines, dating back to the 1970's. Certain sites in particular, such as Altamont Pass – California, and Tarifa – Spain, killed a lot of birds and focused attention on the issue. However it appears that sites such as these are the exception rather than the rule, with most facilities causing much lower fatality rates (Kingsley & Whittam, 2005; Rydell *et al.* 2012; Ralston-Paton *et al.* 2017; Perold *et al*. 2020). With time it became apparent that there are actually four ways in which birds can be affected by wind farms: 1) collisions – which is a direct mortality factor; 2) habitat alteration or destruction (less direct); 3) disturbance – particularly whilst breeding; and 4) displacement/barrier effects (various authors including Rydell *et al.* 2012). Whilst the impacts of habitat alteration and disturbance are probably fairly similar to those associated with other forms of development, collision and displacement/barrier effects are unique to wind energy. Associated infrastructure such as overhead power lines also has the potential to impact on birds. For example they pose a collision and possibly electrocution threat to certain bird species.

1.2.1 Collision of birds with turbine blades

Without doubt, the impact of bird collision with turbines has received the most attention to date amongst researchers, operators, conservationists, and the public. The two most common measures for collision fatality used to date are number of birds killed per turbine per year, and number of birds killed per megawatt installed per year. Rydell *et al.* (2012) reviewed studies from 31 wind farms in Europe and 28 in North America and found a range between 0 and 60 birds killed per turbine per year, with a median of 2.3. European average bird fatality rates were much higher at 6.5 birds per turbine per year compared to the 1.6 for North America. These figures include adjustment for detection (the efficiency with which monitors detect carcasses in different conditions) and scavenger bias (the rate at which birds are removed by scavengers between searches). These are important biases which must be accounted for in any study of mortality.

In South Africa, Ralston-Paton, Smallie, Pearson & Ramalho (2017) reviewed the results of operational phase bird monitoring at 8 wind farms ranging in size from 9 to 66 turbines and totalling 294 turbines (or 625MW). Hub height ranged from 80 to 115m (mean of 87.8m) and rotor diameter from 88 to 113m (mean of 102.4m). The estimated fatality rate at the wind farms (accounting for detection rates and scavenger removal) ranged from 2.06 to 8.95 birds per turbine per year. The mean fatality rate was 4.1 birds per turbine per year. This places South Africa within the range of fatality rates that have been reported for North America and Europe. The composition of the South African bird fatalities by family group was as follows: Unknown 5%; Waterfowl 3%; Water birds other 2%; Cormorants & Darters 1%; Shorebirds, Lapwings and gulls 2%; Large terrestrial birds 2%; Gamebirds 4%; Flufftails & coots 2%; Songbirds 26%; Swifts, swallows & martins 12%; Pigeons & doves 2%; Barbets, mousebirds & cuckoo's 1%; Ravens & crows 1%; Owls 1%; and Diurnal raptors 36%. Threatened species killed included Verreaux's Eagle *Aquila verreauxii* (5 - Vulnerable), Martial Eagle *Polemaetus bellicosus* (2 - Endangered), Black Harrier *Circus maurus* (5 - Endangered), and Blue Crane *Grus paradisea* (3 – Near-threatened). Although not Red Listed, a large number of Jackal Buzzard *Buteo rufofuscus* fatalities (24) were also reported. Ralston-Paton *et al.*'s review included the first year of operational monitoring at the first 8 facilities.

Perold *et al.* (2020) summarised the data on bird turbine collisions from 20 wind energy facilities across South Africa from 2014 to 2018. A total of 848 bird carcasses were recorded at a crude fatality rate of 1.0 ± 0.6 birds/turbine/year. When adjusted for biases, the fatality rate was 4.6 ± 2.9birds/turbine/year. This is slightly lower than rates reported in the northern hemisphere. One hundred and thirty species from 46 families were killed. Thirty-six percent of carcasses or 23 species were diurnal raptors, 30% were passerines, 11% waterbirds, 9% swifts, 5% large terrestrials, 4% pigeons and 1% other near-passerines. Species of conservation concern killed include: Cape Vulture *Gyps coprotheres* (10); Cape Cormorant *Phalacrocorax capensis* (1); Ludwig's Bustard *Neotis ludwigii* (1); Black Harrier (6); Martial Eagle (4); Southern Black Korhaan *Afrotis afra* (5); Secretarybird *Sagittarius serpentarius* (1); Blue Crane (8); Verreaux's Eagle (6); Lanner Falcon *Falco biarmicus* (6); Striped Flufftail *Sarothrura affinis* (1); Greater Flamingo *Phoenicopterus roseus* (1); and Agulhas Long-billed Lark *Certhilauda brevirostris* (1).

1.2.2 Loss or alteration of habitat during construction

The area of land directly affected by a wind farm and associated infrastructure is relatively small. As a result, in most cases habitat destruction or alteration in its simplest form (removal of natural vegetation) is unlikely to be of great significance. However, fragmentation of habitat can be an important factor for some smaller bird species. Construction and operation of a wind farm results in an influx of human activity to areas often previously relatively uninhabited (Kuvlesky *et al.* 2007). This disturbance could cause certain birds to avoid the entire site, thereby losing a significant amount of habitat (Langston & Pullan, 2003). In addition to this, birds are aerial species, spending much of their time above the ground. It is therefore simplistic to view the amount of habitat destroyed as the terrestrial land area only.

Ralston-Paton *et al.* (2017) did not review habitat destruction or alteration. From our own work to date, we have recorded a range of habitat destruction on 6 operational wind farms from 0.6 to 4% (mean of 2.4%) of the total site area (defined by a polygon drawn around the outermost turbines and other infrastructure) and 6.9 to 48.1ha (mean of 27.8ha) of aerial space (WildSkies, unpublished data).

1.2.3. Disturbance of birds

Disturbance effects can occur at differing levels and have variable levels of effect on bird species, depending on their sensitivity to disturbance and whether they are breeding or not. For smaller bird species, with smaller territories, disturbance may be absolute and the birds may be forced to move away and find alternative territories, with secondary impacts such as increased competition. For larger bird species, many of which are typically the subject of concern for wind farms, larger territories mean that they are less likely to be entirely displaced from their territory. For these birds, disturbance is probably likely to be significant only when breeding. Effects of disturbance during breeding could include loss of breeding productivity; temporary or permanent abandonment of breeding; or even abandonment of nest site.

Ralston-Paton *et al.* (2017) found no conclusive evidence of disturbance of birds at the sites reviewed. It may be premature to draw this conclusion after only one year as effects are likely to vary with time (Stewart *et al.* 2007) and statistical analysis was not as in depth as desired. At this stage in the industry, a simplistic view of disturbance has been applied whereby the presence or absence of active breeding at breeding sites of key species is used as the basis for findings.

1.2.4. Displacement & barrier effects

A barrier effect or displacement occurs when a wind energy facility acts as a barrier for birds in flight, which then avoid the obstacle and fly around it. This can reduce the collision risk, but will also increase the distance that the bird must fly. This has consequences for the birds' energy balance. Obviously the scale of this effect can vary hugely and depends on the scale of the facility, the species territory and movement patterns and the species reaction.

Ralston-Paton *et al.* (2017) reported that little conclusive evidence for displacement of any species was reported for the 8 wind farms in South Africa, although once again this is an early and possibly simplistic conclusion. Our own work on operational sites has provided no evidence for significant displacement of priority bird species (WildSkies, unpublished data).

1.2.5. Associated infrastructure

Infrastructure associated with wind energy facilities also has the potential to impact on birds, in some cases more than the turbines themselves. Overhead power lines pose a collision and possibly an electrocution threat to certain bird species (depending on the pole top configuration). Furthermore, the construction and maintenance of the power lines will result in some disturbance and habitat destruction. New access roads, substations and offices constructed will also have a disturbance and habitat destruction impact. Collision with power lines is one of the biggest single threats facing birds in southern Africa (van Rooyen 2004). Most heavily impacted upon are bustards, storks, cranes and various species of water birds (many of which occur in the area). 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 power lines (van Rooyen 2004, Anderson 2001). Unfortunately, many of the collision-sensitive species are considered threatened in southern Africa. The Red List species vulnerable to power line collisions are generally long living, slow reproducing species under natural conditions. 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 2004). The larger bird species (such as eagles) are most affected since they are most capable of bridging critical clearances on hardware. Ralston-Paton *et al.* (2017) did not review power line impacts at the 8 sites.

1.2.6. Mitigation

Possible mitigation measures for bird turbine collision include: increasing turbine visibility (for example through painting turbine blades; restriction of turbine operation during high risk periods; automated turbine shutdown on demand; human based turbine shutdown on demand; bird deterrents – both audible and visual; habitat management; habitat management; and offsets). Most of these suggested mitigation measures are largely untested. In South Africa, observer led Shutdown on Demand has recently shown promise at an operational wind farm in the Western Cape. It is likely that by the time of construction of the proposed project more experience on this mitigation will be available in country. Likewise with blade painting, a paper out of Norway recently showed significant promise for the effectiveness of this measure (May *et al*. 2020). A trial for this method is currently underway in SA, with Civil Aviation Authority approval (Arcus, pers comm).

Mitigation for habitat destruction typically consists of avoiding sensitive habitats during layout planning. A certain amount of habitat destruction is unavoidable. For disturbance, mitigation takes the form of allowing sufficient spatial and temporal protection for breeding sites of sensitive species. Mitigation of power line impacts is relatively well understood and effective, and is described in more detail later in this report. It is also essential that internal power line connecting turbines be buried beneath the ground.

The primary means of mitigating bird impacts at wind farms therefore remains avoidance through correct siting, both of the entire facility, and of the individual turbines themselves. This has already been done in detail for the full facility during the screening phase in which detailed No-Go areas for avifauna were used in developing the layout being assessed.

1.2.7. Contextualising wind energy impacts on birds

Several authors have compared causes of mortality of birds (American Bird Conservancy, 2012; Sibley Guides, 2012; National Shooting Sports Foundation 2012; Drewitt & Langston 2008) in order to contextualise possible mortality at wind farms. In most of these studies, apart from habitat destruction which is the number one threat to birds (although not a direct mortality factor) the top killers are collision with building windows and cats. Overhead power lines rank fairly high up, and wind turbines only far lower down the ranking. These studies typically cite absolute number of deaths and rarely acknowledge the numerous biases in this data. For example a bird that collides with a high-rise building window falls to a pavement and is found by a passer-by, whereas a bird colliding with a wind turbine falls to the ground which is covered in vegetation and seldom passed by anyone. Other biases include: the number of windows; kilometres of power line; or cats which are available to cause the demise of a bird, compared to the number of wind turbines. Biases aside the most important short coming of these studies is a failure to recognise the difference in species affected by the different infrastructure. Species such as those of concern at wind farms, and particularly Red List species in South Africa are unlikely to frequent tall buildings or to be caught by cats. Since many of these bird species are already struggling to maintain sustainable populations, we should be striving, where possible based on the merits of the specific scenario, to avoid all additional, new and preventable impacts on these species, and not permitting these impacts simply because they are smaller than those anthropogenic impacts already in existence.

1.3 Relevant treaties, conventions, policies, guidelines and legislation.

The legislation, conventions, policies etc. relevant to this specialist field and development include the following:

- The Convention on Biological Diversity (CBD): dedicated to promoting sustainable development. The Convention recognizes that biological diversity is about more than plants, animals and micro-organisms and their ecosystems – it is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live. It is an international convention signed by 150 leaders at the Rio 1992 Earth Summit. South Africa is a signatory to this convention and should therefore abide by its' principles.

- An important principle encompassed by the CBD is the precautionary principle which essentially states that where serious threats to the environment exist, lack of full scientific certainty should not be used a reason for delaying management of these risks. The burden of proof that the impact will *not* occur lies with the proponent of the activity posing the threat.

- The Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention): aims to conserve terrestrial, aquatic and avian migratory species throughout their range. It is an intergovernmental treaty, concluded under the aegis of the United Nations Environment Programme, concerned with the conservation of wildlife and habitats on a global scale. Since the Convention's entry into force, its membership has grown steadily to include 117 (as of 1 June 2012) Parties from Africa, Central and South America, Asia, Europe and Oceania. South Africa is a signatory to this convention.

- The Agreement on the Conservation of African-Eurasian Migratory Water birds (AEWA): is the largest of its kind developed so far under the CMS. The AEWA covers 255 species of birds ecologically dependent on wetlands for at least part of their annual cycle, including many species of divers, grebes, pelicans, cormorants, herons, storks, rails, ibises, spoonbills, flamingos, ducks, swans, geese, cranes, waders, gulls, terns, tropic birds, auks, frigate birds and even the South African penguin. The agreement covers 119 countries and the European Union (EU) from Europe, parts of Asia and Canada, the Middle East and Africa.

- The National Environmental Management – Biodiversity Act (Act 10 of 2004) - Threatened or Protected Species list (TOPS).

- The Provincial Nature Conservation Ordinance (Nature Conservation Ordinance 19 of 1974) identifies very few bird species as endangered, none of which are relevant to this study. Protected status is accorded to all wild bird species, except for a list of approximately 12 small passerine species, all corvids (crows and ravens) and all Mousebirds.

- The Civil Aviation Authority has certain requirements regarding the visibility of wind turbines to aircraft. It is our understanding that these may preclude certain mitigation measures for bird collisions, such as the painting of turbine blades in black. We await the release of data from a trial apparently underway in SA (Arcus, *pers. comm*) and the approval statement from the Authority.

- The Species Environmental Assessment Guideline (SANBI, 2020) is applicable, this report adheres to the guideline.

- The "Best Practice Guidelines for Assessing and Monitoring the Impact of Wind Energy Facilities on Birds in Southern Africa" Guidelines by BirdLife South Africa & Endangered Wildlife Trust (Jenkins *et al*. 2015).

- The Best Practice Guidelines for Verreaux's Eagle and Wind Energy (BirdLife South Africa, 2017), and the more recent draft update of these: Verreaux's Eagles and Wind Farms (BirdLife South Africa, 2021).

- The DFFE Online Screening Tool is relevant and has been consulted, see **Appendix 13**.

1.4 Terms of Reference for the specialist study.

This report and monitoring programme follows the "Protocol For The Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Avifaunal Species by Onshore Wind Energy Generation Facilities where the Electricity Output is 20 Megawatts or More" (Government Gazette 43110, GN 320, 20 March 2020).

The following terms of reference are typical for a study of this nature:

- A description of the regional and local features,
- A field survey to search for sensitive areas, receptors or habitats and species of special concern,
- Mapping of the sensitive features,
- Assessing (identifying and rating) the potential impacts on the environment,
- Identification of relevant legislation and legal requirements; and
- Providing recommendations on possible mitigation measures and rehabilitation procedures/ management guidelines.

In addition, Arcus has supplied the following requirements:

Specialists are required to compile a single impact assessment report which meets the criteria of Appendix 6 of the NEMA EIA Regulations, 2014 (as amended) as well as other relevant protocols, guidelines, policies and/or plans.

The specialist report will include the specialist impact assessment of the proposed development. The terms of reference for specialist studies includes (but is not limited to):

- Site Visit
- Desktop Screening
- Mapping
- Sensitivity Analysis and/or modelling
- Submission of Shapefiles
- Defining the legal, planning and policy context,
- Description of the Baseline Environment
- Determination of potential impacts (direct, indirect, cumulative)
- Determination of residual risks
- Reporting
- Recommendation and input into project design
- Management Plan and/or Monitoring Programme
- Sensitivity Verification Reporting in terms of GN 320 of 20 March 2020 and/or a Compliance Statement in terms of GN 320 / GN 1150 of 20 March 2020
- Incorporate and address Public Comment following PPP

The Specialist Report must comply with the requirement of GN 43110 of NEMA: Environmental Themes Reporting Criteria and the Relevant Protocols Gazetted.

1.5 Details of the Specialist

See **Appendix 11** for details of the avifaunal specialist.

2. Methodology

2.1 The Project Area of Influence

Defining the Project Area of Influence (PAOI) was a three step process:

1. Screening and preliminary constraints surveys identified a list of priority bird species. The location of these species' sensitive receptors was mapped and considered.

2. Potential impacts on these species and receptors were identified.

3. The spatial scale at which these Impacts could take effect was examined.

The priority species lists and constraints mapping are shown in Section 3. The scale at which impacts could occur differs between bird species. Smaller resident species' range is confined more or less to the site itself, thereby confining the impact to the site, whilst the opposite is true for larger species. Verreaux's Eagle in particular is a wide ranging species, and mortality effects could impact on far off nest locations. We decided on a PAOI at multiple spatial scales as follows:

- For physically smaller bird species – the developable area itself
- For most larger large terrestrial and raptor species, an area of up to that monitored by driven transects (see Figure 3) and focal site checks during pre-construction bird monitoring

Figure 3 shows the PAOI.

2.2 General approach

The general approach to this study was as follows:

- An initial pre-feasibility or screening survey was conducted by WildSkies in October 2020 (WildSkies 2020). This included a survey for large eagle nests and other avifaunal constraints on site and within approximately six kilometres of site (based on the largest possible eagle nest buffer of 6km for Martial Eagle).
- The developable area was refined by the Applicant based on the findings of these early studies.
- Twelve months (four seasons) of pre-construction bird monitoring was initiated on site in July 2021 and completed in May 2022. Each seasonal Site Visit consisted of approximately 14 consecutive days (some changes were made to the developable area during the initial stage of

the programme) on site by a team of four skilled observers, to record data on bird species and abundance on and near site. These seasonal Site Visits covered: summer (when summer migrants are present); winter (when raptors breed and Blue Cranes flock); spring (when summer migrants are arriving on site and many species start to breed; and autumn (when summer migrants are leaving and many raptors are preparing to breed); we believe this sampling was sufficient to capture data representative of conditions on site.

- Site Visit dates were as follows:
  - Site Visit 1: 29th July – 11th August 2021
  - Site Visit 2: 19th October – 2nd November 2021
  - Site Visit 3: 14th February – 2nd March 2022 (teams slightly staggered)
  - Site Visit 4: 16th – 29th May 2022
- The final Pre-construction Bird Monitoring Progress Report (Site Visit 3) was compiled during March 2022 and submitted to the developer (WildSkies, 2022).
- During October 2022, the Avifaunal Impact Assessment Scoping Report was compiled for AEP.
- During March 2023 this current EIA Phase avifaunal impact assessment report was compiled.

2.3 Data sources consulted for this study

Various existing data sources have been used in the design and implementation of this study, including the following:

- The pre-feasibility avifaunal study findings (WildSkies, 2020).
- The pre-construction bird monitoring raw data and progress reports (WildSkies).
- The data captured by specialist site visits.
- The Southern African Bird Atlas Project 2 data, available at the pentad level (http://sabap2.adu.org.za/v1/index.php) (accessed at www.mybirdpatch.adu.org.za).
- The conservation status of all relevant bird species was determined using Taylor *et al.* (2015) & IUCN 2022.
- The vegetation classification of South Africa (Mucina & Rutherford, 2018) was consulted in order to determine which vegetation types occur on site.
- Aerial photography from the Surveyor General was used.
- The 'Avian Wind Farm Sensitivity Map' Criteria and procedures used. (Retief *et al.* 2011, updated 2014).
- The Important Bird Areas programme was consulted (Marnewick *et al*. 2015). No IBAs exist close enough to the site to be relevant.
- Two recent review reports entitled "Wind energy's impacts on birds in South Africa: a preliminary review of the results of operational monitoring at the first wind farms of the Renewable Energy

Independent Power Producer Procurement Programme Wind Farms in South Africa" (Ralston-Paton, Smallie, Pearson, & Ramalho, 2017), and "On a collision course: the large diversity of birds killed by wind farms in South Africa" (Perold *et al.* 2020) were consulted extensively.

- Coordinated Avifaunal Road count data for the area (accessed at www.car.adu.org.za). No monitored CAR routes exist within 50km of the proposed WEF.
- Coordinated Waterbird Count (CWAC) data for the area (accessed at www.cwac.adu.org.za). Two CWAC sites exist within 50km of the Loxton WEF.
- Comments on the scoping report were received from Ms Elsabe Swart and Mr Pieter Cloete (Northern Cape DAERL). These have been responded to previously, and also considered in the compilation of the mitigation section.

2.4 Primary data collection methods

The following sections describe the pre-construction bird monitoring data collection activities on site. For more detail on the exact methods of any of the below activities see Jenkins *et al.* (2015).

2.3.1. Sample counts of small terrestrial species

Although not traditionally the focus of wind farm–bird studies and literature, small terrestrial birds are an important component of any pre-construction bird monitoring programme. Due to the rarity of many of our threatened bird species, it is anticipated that statistically significant trends in abundance and density may be difficult to observe for these species. More common, similar species could provide early evidence for trends and point towards the need for more detailed future study. Given the large spatial scale of most wind farms, these smaller species may also be particularly vulnerable to displacement and habitat level effects. Sampling these species is aimed at establishing indices of abundance for small terrestrial birds in the study area. These counts should be done when conditions are optimal. In this case this means the times when birds are most active and vocal, i.e. early mornings. Transects were counted by two observers walking along a line recording all birds seen and heard within 200m either side. **Table 1** shows the number of transects conducted on site during the programme.

2.3.2. Counts of large terrestrial species & raptors

This is a very similar data collection technique to that above, the aim being to establish indices of abundance for large terrestrial species and raptors. These species are relatively easily detected from a vehicle, hence vehicle based or Driven Transects (DT) are conducted in order to determine the number of birds of relevant species in the study area. Transects were counted by driving slowly (40-50km/hr) along the transect scanning for birds. Every two kilometres or at suitable vantage points observers got out of the vehicle to stand and scan with binoculars. Detection of these large species is less dependent on their activity levels and calls, so these counts can be done later in the day. **Table 1** shows the number of transects conducted on site during the programme. These transects were each counted once on each Site Visit.

2.3.3. *Focal Site surveys & monitoring*

Focal Sites are surveyed at least once on each Site Visit, and comprise at least 15-20 minutes of observation for breeding activity around the nest of interest, or a count of the birds using a dam site. Four Verreaux's Eagle nests identified during screening (FS 1, 2, 3 & 5) were designated as Focal Sites. As monitoring progressed, four of the larger dams on site were identified as important for waterfowl counts (FS 6, 12, 13 & 16). Other raptor nests, a Hamerkop nest and arable land were also included as Focal Sites, and Ludwig's Bustard lekking activity was noted at what became FS 14 & 15 (see **Section 3.2.3**).

2.3.4 *Incidental Observations*

This monitoring programme comprises a significant amount of field time on site by the observers, much of it spent driving between the above activities. As such, it is important to record any other relevant information whilst on site. All other incidental sightings of priority species (and particularly those suggestive of breeding or important feeding or roosting sites or flight paths) within the broader study area were recorded. As far as possible, field teams attempted to avoid recording resident species in the same location on consecutive days, however some replication is highly probable, particularly between Site Visits.

2.3.5. *Direct observation of bird flight on site*

The aim of direct observation is to record bird flight activity on site. An understanding of this flight behaviour will help explain any future interactions between birds and the wind farm. Spatial patterns in bird flight movement may also be detected, which will allow for input into turbine placement. Direct observation was conducted through counts at a number of fixed Vantage Points (VPs) in the study area (**Table 1**) (**Figure 3**). These VPs provided coverage of a reasonable and representative proportion of the entire study area. VP's were identified using GIS (Geographic Information Systems), and then fine-tuned during the project setup, based on access and other factors such as viewsheds and representativity of habitats. Since these VPs aim at capturing both usage and behavioural data, they were positioned mostly on high ground to maximise visibility. The survey radius for VP counts is 2 kilometres (although large birds are sometimes detected further). Vantage Point counts were conducted by two observers and birds were recorded 360° around observers. Data should be collected during representative conditions, so the sessions were spread throughout the day, with each VP being counted over 'early to mid-morning', 'mid-morning to early afternoon', and 'mid-afternoon to evening'. Each VP session was 4 hours long, which is believed to be towards the upper limit of observer concentration span, whilst also maximising duration of data capture relative to the travel time to the Vantage Points. A maximum of two VP sessions were conducted per day, to avoid observer fatigue compromising data quality. For more detail on exact criteria recorded for each flying bird observed, see Jenkins *et al.* (2015). At least 48 hours of Vantage Point observation was collected per Vantage Point per year, with certain VPs receiving a total of 72 hours of observation in compliance with the Verreaux's Eagle guidelines and VERA model identified areas (BirdLife South Africa 2017, 2021).

One of the most important attributes of any bird flight event is its height above ground, since this will determine its risk of collision with turbine blades. Since it is possible that the turbine model (and hence the exact height of the rotor swept zone) could still change on this project, actual flight height was estimated rather than assigning flight height to broad bands (such as proposed by Jenkins *et al.* 2015). This 'raw' data will allow flexibility in assigning to classes later on depending on final turbine specifications.

It is not practical to record all bird species flying by this method, the method focuses rather on a pre-determined set of priority species, predominantly the physically large species and particularly Red Listed species, raptors and otherwise important species.

2.3.6. Control Site

A Control or Reference Site was monitored as part of this monitoring programme (Jenkins *et al.* 2015). At this site, two Vantage Points (12 hours per VP, per Site Visit), one Driven Transect and three Walked Transects were monitored in addition to the main site. The findings from the Control Site are not presented in this Scoping Report but are available for comparison post-construction where necessary.

Figure 3 shows the layout of these monitoring activities on site.

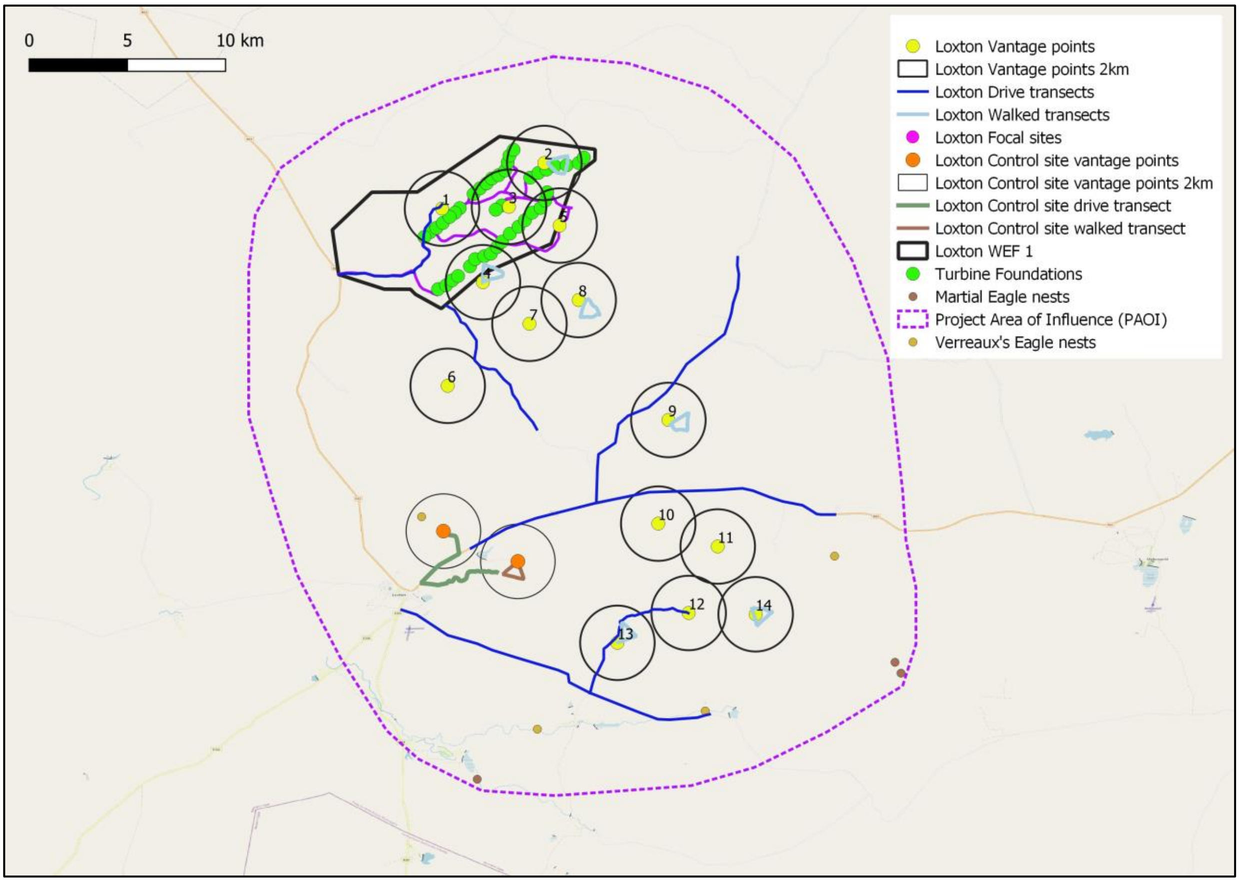

Figure 3. Layout of pre-construction bird monitoring activities in the study area (including PAOI).

The monitoring programme was slightly extended before the second Site Visit commenced, in response to VERA modelling which highlighted risk to Verreaux's Eagle. The monitoring schedule for the year has been summarised in **Table 1**.

Table 1. Summary of monitoring design over the four Site Visits.

Data Collection Method	Site Visit 1	Site Visit 2	Site Visit 3	Site Visit 4
Walked Transects	*18 km* *2a,b,c* *4a,b,c* *8a,b,c* *9a,b,c* *13a,b,c* *14a,b,c*	*18 km* *2a,b,c* *4a,b,c* *8a,b,c* *9a,b,c* *13a,b,c* *14a,b,c*	*18 km* *2a,b,c* *4a,b,c* *8a,b,c* *9a,b,c* *13a,b,c* *14a,b,c*	*18 km* *2a,b,c* *4a,b,c* *8a,b,c* *9a,b,c* *13a,b,c* *14a,b,c*
Driven Transects	81.4km DT 1- 6 (once)	81.4km DT 1- 6 (once)	81.4km DT 1- 6 (once)	77km DT 1- 6 (once)

				DT 2 partially driven - tracks waterlogged
Focal Sites	All	All	All excluding Verreaux's Eagle nests	All
Incidental Observations	All	All	All	All
Vantage Points	186 hours VP 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 & 14	204 hours VP 1, 2, 3, 4, 5, 6*, 7, 8, 9, 10*, 11*, 12*, 13* & 14* *VP observation increased from 12hr/VP to 18hr/VP for remainder of monitoring	204 hours VP 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 & 14	204 hours VP 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 & 14
# Days on site	12 (team of 4)	14 (team of 4)	14 (team of 4)	14 (team of 4)
Teams	DS & WM AB & JP	DS & WM AB & GDK	DS & WM AB & GDK	DS & WM AB & GDK

2.5 Limitations & Assumptions

Certain biases and challenges are inherent in the methods that have been employed to collect data in this programme. It is not possible to discuss all of them here, and some will only become evident with time and operational phase data, but the following are some of the key points:

- The presence of the observers on site is certain to have an effect on the birds itself. For example during walked transects, certain bird species will flush more easily than others (and therefore be detected), certain species may sit undetected, certain species may flee, and yet others may be inquisitive and approach the observers. Likewise with the vantage point counts, it is extremely unlikely that two observers sitting in position for four hours at a time will have no effect on bird flight. Some species may avoid the vantage point position, because there are people there, and others may approach out of curiosity. In almost all data collection methods large bird species will be more easily detected, and their position in the landscape more easily estimated. This is particularly relevant at the vantage points where a large eagle may be visible several kilometres away, but a smaller Rock Kestrel (*Falco rupicolus*) perhaps only within 800 metres. A particularly important challenge is that of estimating the height at which birds fly above the ground. With no reference points against which to judge, it is exceptionally difficult and subjective. It is for this reason that the flight height data has been treated cautiously by this report, and much of the analysis conducted using flights of all height. With time, and data from multiple sites it will be possible to tease out these relationships and establish indices or measures of these biases.

- The questions that one can ask of the data collected by this programme are almost endless. Most of these questions however become far more informative once post construction data has been collected and effects can be observed. For this reason some of the analysis in this report is relatively crude. The raw data has however been collected and will be stored until such time as more detailed analysis is possible and necessary.

- It is well known that the 2019-2021 period was a drought period in most of the country. As a result there is a risk that the data collected may not be perfectly typical of conditions in the area. Given that pre-construction bird monitoring for wind farms samples one year, and the wind farm will operate for at least 20 years (and may only be constructed five years from now), we will always face this challenge of greater variability in environmental conditions occurring during the project lifespan than during the impact assessment of the project. In general we would expect the abundance of certain bird species to decrease in drought periods, so the abundance data presented in this report should be considered a minimum. Fortunately towards the middle of the monitoring programme good rainfall fell in the study area and this would have influenced bird abundance and diversity for the better.

- Spotting and identifying birds whilst walking is a significant challenge, particularly when only fleeting glimpses of birds are obtained. As such, there is variability between observers' ability and hence the data obtained. The data is therefore by necessity subjective to some extent. In order to control for this subjectivity, the same pairs of observers has largely been used for the full duration of the project, and it is hoped this can be maintained for the post construction phase. Despite this subjectivity, and a number of assumptions that line transects rely on (for more details see Bibby *et al*. 2000), this field method returns the greatest amount of data per unit effort (Bibby *et al.* 2000) and was therefore deemed appropriate for the purposes of this programme. Likewise, in an attempt to maximise the returns from available resources, the walked transects were located close to each Vantage Point. This systematic selection may result in some as yet unknown bias in the data but it has numerous logistical benefits.

- No thresholds for fatality rates for priority species have been established in South Africa to date. This means that impact assessments need to make subjective judgements on the acceptability of the estimated predicted fatalities for each species.

3. Baseline Description & Results

3.1 Vegetation and habitat

Loxton WEF 1 is comprised entirely of the 'Eastern Upper Karoo', vegetation unit (**Figure 4**). Effectively, a number of micro habitats are available to birds in the area which includes: man-made dams, wetlands, streams/drainage lines, rocky ridges & small cliffs, limited grassland, Karoo shrubland and small areas of pasture/crops (**Figure 5**).

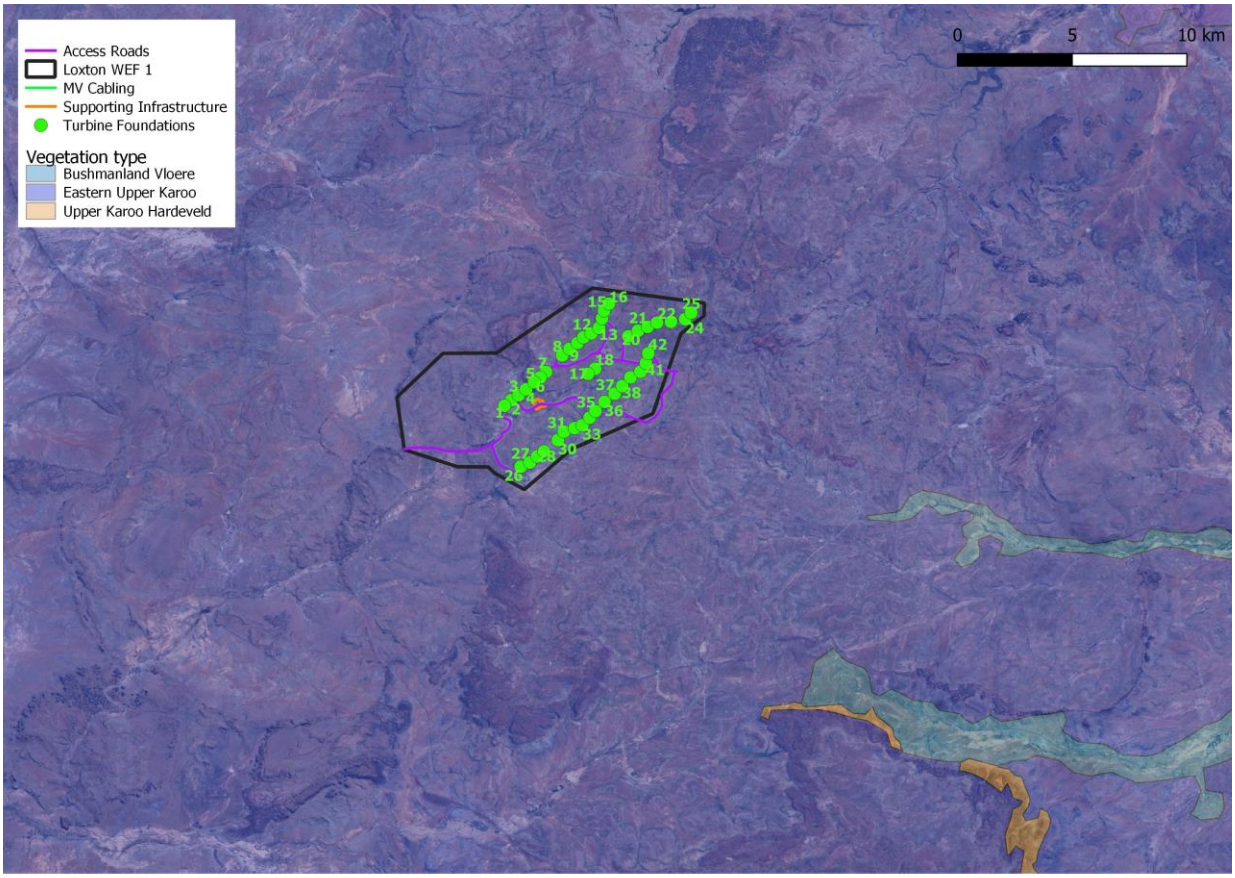

Figure 4. Vegetation units present on and surrounding Loxton WEF 1 (Mucina & Rutherford 2012).

3.1.1 Eastern Upper Karoo

Flats and gently sloping plains are found within the Eastern Upper Karoo vegetation unit, which is 'Least Threatened' and has the largest mapped area of all units in the country. The entire site is comprised of this vegetation unit. Dwarf microphyllous shrubs dominate this landscape and 'white' grasses (*Aristida* and *Eragrostis* species) are prominent after good summer rains. Karoo scrub species of *Pentzia*, *Eriocephalus*, *Rosenia* and *Lycium* are important taxa (Mucina & Rutherford 2012).

Beaufort Group sandstones and mudstones are common in this vegetation unit, and some Jurassic dolerites are also to be found. Mean annual precipitation ranges from 180 – 430mm per year (west to east), peaking in March, and frost incidence is relatively high (30 – 80 days per year).

Figure 5. Typical micro-habitats available to birds in the Loxton Wind Farm study area.

3.2 Avifaunal Community

Data from the various methodologies have been analysed for the 12 months of pre-construction avifaunal monitoring and are presented for the full site (Loxton WEF 1 - 3) throughout this report, although this report is specifically concerned with Loxton WEF 1. While the spatial scope of our data collection presented here is larger than the developable area of the Loxton WEF 1 alone, the habitat, vegetation and resources concerned from an avian perspective are similar. The excellent mobility of birds as a whole warrants a study wider than within the strict boundary of the redesigned project site, and it is our opinion that this approach strengthens our confidence in the findings. We present only the on-site findings and analyses most relevant to Loxton WEF 1 where it is applicable.

Throughout the year of avifaunal monitoring, observers identified 165 bird species on site across all methodologies, and incidentally. Totals per Site Visit were as follows: 95 species in Site Visit 1 (S1), 103 in S2, 145 in S3 and 125 in S4. The third Site Visit fell over the summer period and produced the greatest species list, as expected, when migrant species were present on site. The full species list is presented in **Table A1** in **Appendix 1**.

The South African Bird Atlas Project 2 (SABAP 2) has a relatively low reporting rate across the 16 pentads that span the site boundary, ranging between 0 – 13 full protocol cards submitted per pentad (some, if not most, of these cards have been contributed by our own monitors). The SABAP 2 assemblage of 164 reported species is essentially very similar to what our monitors have reported; this SABAP 2 dataset is thus not presented in addition to our comprehensive findings.

Eleven species observed to occur on the site are Red Listed: Martial Eagle (*Polemaetus bellicosus*), Ludwig's Bustard (*Neotis ludwigii*) and Black Harrier (*Circus maurus*) are Endangered; Verreaux's Eagle (*Aquila verreauxii*), Lanner Falcon (*Falco biarmicus*), Secretarybird (*Sagittarius serpentarius*) and Black Stork (*Ciconia nigra*) are Vulnerable, and Blue Crane (*Grus paradisea*), Karoo Korhaan (*Eupodotis vigorsii*), Sclater's Lark (*Spizocorys sclateri*) and African Rock Pipit (*Anthus crenatus*) are Near-Threatened. Twenty-four of the recorded species are either endemic or near endemic to South Africa, or endemic to South Africa, Lesotho and Eswatini.

3.2.1 Small terrestrial bird species

A total of 67 bird species was recorded on the Walked Transects on the site through the year. This included 811 records of 2 173 individual birds. Transects were completed at six of the Vantage Points on site, and totalled 18km per Site Visit, or 72km overall. An average of 30 birds per walked kilometre was calculated. **Table 2** shows the data for the full year for the 20 most abundant species. **Appendix 2** shows the full species set and the breakdown across the four Site Visits. In each case the number of birds, number of records, and number of birds per kilometre of transect are presented, although the index of birds per kilometre is relatively crude. However, since this will be used primarily to compare the effects of the facility on these species post-construction, this index is considered adequate at this stage. If more complex analysis is required during post-construction monitoring in order to demonstrate effects, the raw data is available for this purpose.

The most abundant species encountered on the Walked Transects were not surprisingly all species already known to be common in the area, such as: Grey-backed Sparrowlark (*Eremopterix verticalis*), Lark-like Bunting (*Emberiza impetuani*), Black-eared Sparrowlark (*Eremopterix australis*), Spike-heeled Lark (*Chersomanes albofasciata*) and Karoo Long-billed Lark (*Certhilauda subcoronata*). The former three species are very gregarious and were often encountered in numerous or large flocks. The latter two species were particularly vocal throughout the year, and many records were made of the birds by means of their far-reaching vocalisations alone.

Of the 67 species identified on the Walked Transects, one is endemic to South Africa, Lesotho and eSwatini - the Pied Starling (*Lamprotornis bicolor*) and a further ten are near-endemic to South Africa. These species include: Black-eared Sparrow-lark, Large-billed Lark (*Galerida magnirostris*), Sickle-winged Chat (*Emarginata sinuata*), Black-headed Canary (*Serinus alario*), Grey Tit (*Melaniparus afer*), Karoo Eremomela (*Eremomela gregalis*), Karoo Lark (*Calendulauda albescens*), Karoo Prinia (*Prinia maculosa*), Cloud Cisticola (*Cisticola textrix*) and Melodious Lark (*Mirafra cheniana*).

The small terrestrial bird community on site is as expected for a semi-arid Nama Karoo area. There are no particularly concerning species present on site that were detected by Walked Transects, although Near-threatened Sclater's Lark have been recorded on site as Incidental Observations (**Section 3.2.4**). This arid-adapted near-endemic species is a nomad in this region and its isolated populations are unpredictable in space and time (Peacock 2012). Sclater's Lark is relatively cryptic and unobtrusive when not calling, and is most typically noticed when drinking from a water source.

3.2.2 Large terrestrial species & raptors

A total of 12 large terrestrial and raptor species were recorded across the six Drive Transects totalling 321.2 kilometres on the site through the year. This included 287 individual birds from 64 records. The data for the full year collectively are shown in **Table 3**, whilst **Appendix 3** has the breakdown per Site Visit. In each case, the species' regional and global Red List and endemism status are shown. Five species are regionally Red Listed: Martial Eagle and Ludwig's Bustard are Endangered; Verreaux's Eagle and Black Stork are Vulnerable; and Karoo Korhaan is Near-threatened (Taylor *et al*. 2015). In terms of the number of individuals sighted, the most abundant species recorded by this method was the Lesser Kestrel, followed by Amur Falcon and Karoo Korhaan. The former two are highly gregarious species, often occurring in large flocks. Few records were made of each species, and only in the summer season (S3), when large numbers of birds were observed together in very high densities. Karoo Korhaan was typically recorded in pairs or trios throughout the year of monitoring, flushing readily upon driving or walking, or recorded by duetting vocalisations within and between pairs.

The large terrestrial birds and raptors are the most important sector of the avifauna on this site, with a number of regionally Red Listed species included. Most of the priority species for the site come from this sector (**Section 3.3**).

3.2.3 Focal Site surveys

The results of the Focal Site surveys are summarised in **Table 4** and photographs of the Focal Sites are shown in **Appendix 4**.

» *Nests*

Three Verreaux's Eagle nests (FS 1, 2 & 3) were located in the broader study area during the screening assessment (October 2020). According to the Best Practice Guidelines for Verreaux's Eagles (BLSA 2021), AEP designed out the Verreaux's Eagle nest restrictions; having taken them into account by means of VERA modelling (as per Murgatroyd *et al*. 2021) when considering the developable area of the WEF. An additional Verreaux's Eagle nest (FS 5) was located during pre-construction monitoring after VERA modelling had already been consulted, but will by default receive a 5.2km No-go buffer.

Two immature Martial Eagles were recorded roosting in tall *Eucalyptus* trees at the Aarfontein farmstead and at least one bird was regularly flushed from the area upon transit through the farm on the first Site Visit. No nest was found in these trees or any others in the vicinity upon closer inspection. However, as these eagles may reach sexual maturity from 4-5 years, but can retain their immature plumage until 7 years of age (Hockey *et al*. 2005), it is possible that this was a courting pair in the initial stages of pair-bonding. These birds were not observed during the following three Site Visits despite many passages through the farm. No-go buffers of 6km have been applied to three Martial Eagle nests in two territories in the far south of the study area. The current turbine layout for Loxton WEF 3 (the closest of the three projects to these nests) has taken this constraint into account.

On the first Site Visit, two active Jackal Buzzard nests were found; one at the Springfontein farmstead (FS 8), and one along the Pampoenpoort Road at FS 9).

The nest monitored at FS 4 was washed away in the summer period when the poplar tree in its drainage line experienced a wash-out. The identity of the raptor was not established, but the nest was reported to be apparently rather small to have belonged to a Verreaux's or Martial Eagle. It possibly belonged to an African Fish Eagle. Any buffer size for this nest, even if it were a Martial Eagle nest with a 6km buffer, would not have affected the current turbine layout as it is too far from the site boundary to be relevant.

» *Arable land*

The land use in the broader study area does not typically include much irrigated cropland, but rather livestock grazing. One small identified arable field was monitored as a Focal Site in the broader area, on the farm Biesiespoort (FS 17). This field has been buffered by 500m to protect against it being used as a crane or stork congregation area at some point in the future. No other arable land was specifically identified as important.

» *Dams*

Initially, no significant water bodies were present on the main site for at least the first half of the monitoring year. Substantial rainfall was received across the landscape between S2 and S3 and new water bodies were surveyed as Focal Sites for waterbird counts on the third and fourth Site Visits. These included the Biesiespoort, Saaidam, Rooipoort and Loxton Dams (FS 6, 12, 13 and 16). A small group of five Black Stork were using the a newly filled dam at Aarfontein (FS 7) and Saaidam Dams (FS 12) as roosting sites, and were seen transiting between them, or foraging in their vicinity, for a number of days. No significant sightings other than this were reported at any of the other water bodies, and counts consisted of the usual consignment of ducks, geese and a few small waders, none of which were present in large numbers.

Two CWAC (Coordinated Waterbird Count) sites are registered within 50km of the site, namely the Slangfontein Dam and the Sakrivierspoort Wetlands, although neither has been formally surveyed within the last 20 years. The data are thus not particularly relevant, however, notable records include maximum counts of 153 Greater Flamingo (*Phoenicopterus roseus*), 10 Maccoa Duck (*Oxyura maccoa*), 2 Yellow-billed Stork (*Mycteria ibis*) and single records of Western Osprey (*Pandion haliaetus*) and African Marsh Harrier (*Circus ranivorus*) made at the Sakrivierspoort Wetlands between 1995 and 1997.

» Leks

Male Ludwig's Bustards display grossly inflated light throat patches and give deep, booming calls during the mating season in an effort to attract females for breeding rights. Females select the most impressive male from the lekking stage and is then solely responsible for raising the young herself (Hockey *et al*. 2005). Ludwig's Bustard lekking behaviour was recorded in the north of the study area during summer (Site Visit 3), where far greater incidence of the species was recorded throughout the year, compared to the southern areas. One dense lek was observed between VPs 4 and 7 (FS 14), consisting of 13 adult birds, and a much looser group of at least 3 displaying adult males was noted to the extreme north east (FS 15). We have made use of topographical mapping to delineate No-go buffers around these leks as well as an additional 500m High sensitivity buffer to avoid disturbing lekking birds.

3.2.4 Incidental Observations of target bird species

A total of 28 species were recorded on the site as Incidental Observations, the summary of which is provided in **Table 5**; **Appendix 5** presents the findings per Site Visit. The most abundant species (by a significant margin) recorded by this method was Karoo Korhaan, with 101 records made of 256 birds. Ludwig's Bustard was the second most abundant species with 33 records of 70 birds. Eleven of the species recorded by this method are regionally Red Listed. These include three Endangered species (Ludwig's Bustard, Martial Eagle and Black Harrier); four Vulnerable species (Verreaux's Eagle, Lanner Falcon, Black Stork & Secretarybird); and four Near-threatened species (Blue Crane, Karoo Korhaan, Sclater's Lark & African Rock Pipit). Since these data are not the product of systematic data collection methods, they should be used cautiously and we do not discuss these findings any further here.

3.2.5 Bird flight activity on site

A total of 798 hours of bird flight observation were completed on site. Overall, 20 target bird species were recorded flying on the site during the Vantage Point surveys. These data are shown in **Table 6**, summarised for the full year, whilst the breakdown per Site Visit is shown in **Appendix 6**. Eight of these 20 species are regionally Red Listed (Taylor *et al.* 2015): Black Harrier, Ludwig's Bustard and Martial Eagle are Endangered; Verreaux's Eagle, Lanner Falcon, Black Stork and Secretarybird are all Vulnerable and Karoo Korhaan is Near-Threatened. Two species are regionally endemic or near-endemic: Karoo Korhaan and Jackal Buzzard. **Table 7** also presents each species' overall passage rate (birds/hour).

The species recorded flying most frequently on site during dedicated Vantage Point sessions was the Jackal Buzzard, with 135 individual birds recorded across 110 records. Ludwig's Bustard was the second most frequent flyer with 52 records of 78 birds. The third most frequent flyer was Karoo Korhaan, with 39 records of 74 birds. The spatial representation of all flight activity is discussed in **Section 3.2.7** and presented in **Figure 6.** Recorded target bird species flight paths at the site (all species, full year) and **Figure 7**.

3.2.6 Estimating turbine collision fatality rates

Crude turbine collision fatality rates were calculated for each bird species in order to estimate how many bird fatalities could occur at the proposed wind farms once operational. This was based on the species' passage rates (number of birds recorded flying per hour) recorded on site. Generally speaking, we expect those species which fly more often to be more susceptible to turbine collision. In order to calculate crude passage rates for each species, we assumed that the 2 kilometre radius around Vantage Points was approximately equal to the maximum distance over which sightings were made, and that the coverage was approximately circular. This meant that at each Vantage Point an area of 12.57km² was sampled ($A = \pi r^2$). Secondly, we assumed that the area of the wind farm directly presenting a collision risk is described by the area of each turbine's rotor zone multiplied by the number of turbines. We assumed a turbine model with a rotor swept area of 31 415.93m² (turbines with rotor diameter of 200m) and a layout of up to 42 turbines. This equates to a wind farm collision risk area of 1.3194km² (42 x 31 415.93m²). Thirdly, we assumed that the survey area around each of the Vantage Points was a representative sample of the area in which built turbines will operate. Fourthly we assumed that species passage rates calculated from our four Site Visits of sampling can be reasonably extrapolated to annual passage rates (by multiplying hourly passage rates by 12 x 365 in the case of resident diurnal species (12 daylight hours) and 12 x 365 x 0.5 in the case of migrants (present in the study area for only 6 months). We also assumed a 98% avoidance rate for these birds, i.e., 2% of birds passing through the rotor zone would collide with blades (as recommended by Scottish Natural Heritage guidance for species for which no established avoidance rate is available, www.project-gpwind.eu).

Fatality rates were calculated under two rotor swept area (RSA) scenarios:

- 1 - where RSA was 30m to 230m above ground. This is derived from the approximate lowest that the blade tip could be, and the maximum diameter rotor
- 2 – where RSA was 60 to 260m above ground (lower blade tip raised as a mitigation measure, in this case to maximum height, since most bird flight activity is <60m above ground)

These scenarios were used for illustrative purposes and do not commit the developer to specific turbine parameters. The turbine model has not yet been finalised but the application remains for a Hub Height up to 160m and Rotor Diameter up to 200m. Although the Applicant's preferred turbine model would *result in a lower blade tip 25 – 35m above ground, we also ran the calculation using a lower blade tip of 60m above ground as a best case scenario, as most bird flight was recorded closer to the ground than 60m.*

In both cases we believe that the estimated fatality rates are over-estimations for the following reasons: no consideration is given to actual turbine locations relative to actual flight path positions. However the species average passage rate was applied to the full turbine layout); and a relatively conservative avoidance rate of 98% was used; this is without the application of any mitigation measures.

Although the calculations we have made are not a Collision Risk Model (CRM-Scottish Natural Heritage) some of the principles and assumptions made are similar. In South Africa, one of the main reasons CRM is not often used is that we have not established accurate species-specific avoidance rates yet, and the model is so sensitive to these avoidance rates. For example, if we used a 99% avoidance rate it would halve the estimated number of fatalities calculated as described below. Our confidence in these estimates is therefore low, but the exercise is worthwhile nonetheless.

Scenario 1 – Rotor Swept Area of 30-230m

Using the above-described methods, it is estimated that approximately 3.41 fatalities could be recorded at the wind farm per year across the 20 target bird species recorded flying on site (**Table 7**).
This includes the following regionally Red Listed species fatalities:

- 0.66 Ludwig's Bustards;
- 0.47 Verreaux's Eagles;
- 0.08 Karoo Korhaans;
- 0.05 Martial Eagles;
- 0.02 Black Storks;
- 0.03 Lanner Falcons;
- 0.02 Secretarybirds and
- 0.01 Black Harriers.

Approximately 1.38 Jackal Buzzards (not Red Listed) could be killed per year.

Scenario 2 – Rotor Swept Area of 60-260m

When the lower blade tip is raised to 60m above ground, the fatality rates decreased as shown **Table 7**. A significant proportion of recorded bird flights was removed from analysis by raising the lower blade tip from 30 to 60m above ground. The species for which this arguably made the largest difference were Ludwig's Bustard (-75.44%) and Karoo Korhaan (-100%). The raising of the lower blade tip reduced collision risk for Common Buzzard by 38.46% and Jackal Buzzard by 19.17%. Increasing the overall height above ground of turbine blades had no predicted collision reduction for five species (Verreaux's Eagle, Booted Eagle, Black-chested Snake-eagle, Secretarybird and African Spoonbill) yet benefited every other target species (in terms of reduced predicted mortality) to some degree. We estimate that a total of approximately 2.28 fatalities could be recorded at the wind farm per year across the target bird species recorded flying on site under this Scenario (**Table 7**).

This includes the following regionally Red Listed species fatalities:

- 0.16 Ludwig's Bustards;
- 0.47 Verreaux's Eagles;
- 0.03 Martial Eagles;
- 0.01 Black Storks and
- 0.02 Secretarybirds

Approximately 1.12 Jackal Buzzards (not Red Listed) could be killed per year.

We strongly recommend that any opportunity to raise the lower blade tip as much as possible should be taken if technically possible as this could significantly reduce the bird collision risk. Human caused fatalities of Red Listed or otherwise threatened bird species are always cause for concern and should be avoided as far as possible. It is essential that all mitigation measures recommended in this report be implemented to ensure that these fatality rates are reduced where possible. It is also essential that an adaptive management approach be adopted, ensuring that the wind farm is prepared to respond timeously and effectively if unsustainable impacts are detected.

Table 2. Small passerine bird data from Walked Transects for all four Site Visits for the 20 most abundant species (see Appendix 2 for full dataset).

			FULL YEAR			Site Visit 1			Site Visit 2			Site Visit 3			Site Visit 4		
		Transect length (km)	72			18			18			18			18		
		# Species	67			31			30			47			35		
Common Name	**Scientific Name**	**Endemism**	**Birds**	**Rec**	**Birds /km**	**Birds**	**Rec**	**Birds /km**	**Birds**	**Rec**	**Birds /km**	**Birds**	**Rec**	**Birds /km**	**Birds**	**Rec**	**Birds /km**
Grey-backed Sparrow-Lark	*Eremopterix verticalis*		397	50	5.51				3	2	0.17	394	48	21.89			
Lark-like Bunting	*Emberiza impetuani*		391	65	5.43	7	4	0.39	17	12	0.94	349	42	19.39	18	7	1.00
Black-eared Sparrow-Lark	*Eremopterix australis*	NE	176	4	2.44				176	4	9.78						
Spike-heeled Lark	*Chersomanes albofasciata*		159	49	2.21	27	9	1.50	23	10	1.28	35	10	1.94	74	20	4.11
Karoo Long-billed Lark	*Certhilauda subcoronata*		107	84	1.49	16	15	0.89	20	19	1.11	44	30	2.44	27	20	1.50
African Pipit	*Anthus cinnamomeus*		99	50	1.38							96	47	5.33	3	3	0.17
Rufous-eared Warbler	*Malcorus pectoralis*		80	64	1.11	7	5	0.39	13	12	0.72	24	20	1.33	36	27	2.00
Large-billed Lark	*Galerida magnirostris*	NE	73	60	1.01	3	3	0.17	8	7	0.44	38	33	2.11	24	17	1.33
Cape Sparrow	*Passer melanurus*		71	30	0.99	30	9	1.67	12	9	0.67	12	4	0.67	17	8	0.94
Karoo Chat	*Emarginata schlegelii*		59	45	0.82	14	11	0.78	19	14	1.06	8	6	0.44	18	14	1.00
Sickle-winged Chat	*Emarginata sinuata*	NE	39	27	0.54	3	2	0.17	10	7	0.56	6	6	0.33	20	12	1.11
Black-headed Canary	*Serinus alario*	NE	38	6	0.53										38	6	2.11
Pied Crow	*Corvus albus*		33	18	0.46	17	10	0.94	7	5	0.39				9	3	0.50
Cape Bunting	*Emberiza capensis*		30	26	0.42	7	7	0.39	3	3	0.17	8	7	0.44	12	9	0.67
Karoo Scrub Robin	*Cercotrichas coryphoeus*		26	17	0.36	9	6	0.50	6	5	0.33	2	1	0.11	9	5	0.50
Wattled Starling	*Creatophora cinerea*		25	2	0.35							25	2	1.39			
Grey Tit	*Melaniparus afer*	NE	24	17	0.33	3	3	0.17	4	3	0.22	5	5	0.28	12	6	0.67
Speckled Pigeon	*Columba guinea*		23	4	0.32										23	4	1.28
Karoo Eremomela	*Eremomela gregalis*	NE	21	9	0.29	2	1	0.11	2	1	0.11	9	4	0.50	8	3	0.44
Desert Cisticola	*Cisticola aridulus*		20	19	0.28							14	13	0.78	6	6	0.33

**Regional Red List status according to Taylor* et al*. 2015 – most recent regional conservation status for species*

**Global Red List status according to IUCN 2022*

EN = Endangered; VU = Vulnerable; NT = Near-threatened; LC = Least Concern

***Endemism – whether the species is endemic (E) or near endemic (NE) to South Africa.*

E = Endemic; NE = Near-endemic; SLS = Endemic to South Africa, Lesotho & Swaziland; BNE = Breeding near endemic

Retief et al*. 2014 – the species ranking in terms of turbine collision risk – as per Avian Wind Farm Sensitivity Map*

(This key applies to all following species tables)

Table 3. Summary of large terrestrial & raptor species recorded on the Drive Transects at the site (see Appendix 3 for full dataset).

Common name	Taxonomic name	Red List: Regional, Global (Endemism)	Number of Birds	Number of Records	Birds/km
Lesser Kestrel	*Falco naumanni*		145	6	0.451
Amur Falcon	*Falco amurensis*		50	2	0.156
Karoo Korhaan	*Eupodotis vigorsii*	NT, LC	32	16	0.100
Pale Chanting Goshawk	*Melierax canorus*		18	13	0.056
South African Shelduck	*Tadorna cana*		18	7	0.056
Jackal Buzzard	*Buteo rufofuscus*	(NE)	13	11	0.040
Common Buzzard	*Buteo*		3	1	0.009
Martial Eagle	*Polemaetus bellicosus*	EN, VU	3	3	0.009
Verreaux's Eagle	*Aquila verreauxii*	VU, LC	2	2	0.006
Northern Black Korhaan	*Afrotis afraoides*		1	1	0.003
Ludwig's Bustard	*Neotis ludwigii*	EN, EN	1	1	0.003
Black Stork	*Ciconia nigra*	VU, LC	1	1	0.003

Table 4. Summary of Focal Site survey findings on site and in the broader study area.

Focal Site	Type	Status and findings
FS 1	**Loxton Tower Verreaux's Eagle nest**	• 2021: Active – nest-building witnessed • 2022: Active – nest-building witnessed
FS 2	**Grootkrans Verreaux's Eagle nest - cliff**	• 2021: Active – brooding adult present • 2022: No activity noted
FS 3	**Grootkop Verreaux's Eagle nest - cliff**	• 2021: Territory occupied – nest presumed active • 2022: Inaccessible due to heavy rains
FS 4	**Potentially African Fish Eagle nest**	• 2021: No activity noted, nest appeared relatively small, potentially that of an African Fish Eagle. • 2022: Tree fell down between S3 and S4 due to swollen river banks
FS 5	**Altona Verreaux's Eagle nest - tree**	• 2021: Active – chick present • 2022: Active – nest-building witnessed
FS 6	**Biesiespoort Dam**	• Assorted waterfowl present each Site Visit, including maximum counts of 60 Pied Avocet and 24 Black-necked Grebe
FS 7	**Martial Eagle potential roost - tree**	• Two immature birds recorded regularly and flushed from large *Eucalyptus* trees (S1). No further records were made of the species in this location. Five Black Storks roosting at newly filled dam (S3)
FS 8	**Springfontein Jackal Buzzard nest - tree**	• 2021 and 2022: Adult pair very active in area year-long, often foraging nearby with offspring
FS 9	**Pampoenpoort Rd Jackal Buzzard nest - tree**	• 2021: Active • 2022: Active
FS 10	**Grootkrans Hamerkop nest - cliff**	• 2021 & 2022 – Presumed inactive
FS 11	**Pale Chanting Goshawk nest - tree**	• 2021 and 2022: Pair very active in the area
FS 12	**Saaidam Dams (x2)**	• Unremarkable waterfowl, limited waders and aerial foragers present only from S3
FS 13	**Rooipoort Dam**	• Unremarkable waterfowl, aerial foragers present. Maximum count of 7 Pied Avocet

FS 14	**“Dense” or traditional Ludwig’s Bustard lek**	• 2022: 13 Adult birds present, 2 of which were displaying males (S3) • Adults birds commonly recorded in the area into S4 but no further displaying observed
FS 15	**“Loose” Ludwig’s Bustard lek**	• 2022: Five adult males displaying in the area, but dispersed (S3) • Adults birds commonly recorded in the area in S4 but no further displaying observed
FS 16	**Loxton Dam**	• 2022: Relatively good diversity of waterfowl species from S3 including South African Shelduck, Egyptian Geese and Pied Avocet present among a few other waterfowl species
FS 17	**Biesiespoort Arable land**	• 2022: Pair of Lanner Falcon, 3 Common Buzzard and an estimated 1 000 Wattled Starlings at a colony (S3)

Table 5. Summary of Incidental Observations of relevant bird species on the site (see Appendix 5 for full dataset).

Common Name	Scientific Name	Red List: Regional, Global (Endemism)	Number of Birds	Number of Records
Karoo Korhaan	*Eupodotis vigorsii*	NT, LC	256	101
Ludwig's Bustard	*Neotis ludwigii*	EN, EN	70	33
Pale Chanting Goshawk	*Melierax canorus*		39	34
Jackal Buzzard	*Buteo rufofuscus*	(NE)	38	34
Grey-winged Francolin	*Scleroptila africana*	(SLS)	22	6
Double-banded Courser	*Rhinoptilus africanus*		17	14
Northern Black Korhaan	*Afrotis afraoides*		12	8
Sclater's Lark	*Spizocorys sclateri*	NT, NT (NE)	12	3
Black Stork	*Ciconia nigra*	VU, LC	9	3
Grey-winged Francolin	*Scleroptila afra*		8	3
Verreaux's Eagle	*Aquila verreauxii*	VU, LC	6	6
Common Buzzard	*Buteo*		5	5
Secretarybird	*Sagittarius serpentarius*	VU, EN	5	3
Martial Eagle	*Polemaetus bellicosus*	EN, VU	5	5
Blue Crane	*Grus paradisea*	NT, VU	4	2
Spotted Eagle-Owl	*Bubo africanus*		4	4
Black Harrier	*Circus maurus*	EN, EN	3	3
Lanner Falcon	*Falco biarmicus*	VU, LC	3	3
African Rock Pipit	*Anthus crenatus*	NT, LC	3	3
Gabar Goshawk	*Micronisus gabar*		3	2
Rock Kestrel	*Falco rupicolus*		2	2
Rufous-breasted Sparrowhawk	*Accipiter rufiventris*		2	2
South African Shelduck	*Tadorna cana*		2	1
Cape Eagle-owl	*Bubo capensis*		2	2
Black-chested Snake-eagle	*Circaetus pectoralis*		2	1
Booted Eagle	*Hieraeetus pennatus*		1	1
African Harrier-Hawk	*Polyboroides typus*		1	1
Peregrine Falcon	*Falco peregrinus*		1	1

Table 6. Target bird species recorded during Vantage Point counts at the site (see Appendix 6 for full dataset).

Common Name	**Scientific Name**	**Red List: Regional, Global (Endemism)**	**Number of Birds**	**Number of Records**
Jackal Buzzard	*Buteo rufofuscus*	(NE)	135	110
Ludwig’s Bustard	*Neotis ludwigii*	EN, EN	78	52
Karoo Korhaan	*Eupodotis vigorsii*	NT, LC	74	39
Pale Chanting Goshawk	*Melierax canorus*		52	43
Verreaux’s' Eagle	*Aquila verreauxii*	VU, LC	46	41
South African Shelduck	*Tadorna cana*		21	10
Steppe Buzzard	*Buteo bueo*		14	13
Booted Eagle	*Hieraaetus pennatus*		7	7
Martial Eagle	*Polemaetus bellicosus*	EN, VU	6	6
Pied Avocet	*Recurvirostra avosetta*		6	2
Lanner Falcon	*Falco biarmicus*	VU, LC	5	5
Rock Kestrel	*Falco rupicolus*		4	4
Black Harrier	*Circus maurus*	EN, EN	4	4
Black Stork	*Ciconia nigra*	VU, LC	4	2
Black-chested Snake-eagle	*Circaetus pectoralis*		3	3
Secretarybird	*Sagittarius serpentarius*	VU, EN	2	1
Double-banded Courser	*Rhinoptilus africanus*		2	2
Greater Kestrel	*Falco rupicoloides*		1	1
Hamerkop	*Scopus umbretta*		1	1
African Spoonbill	*Platalea alba*		1	1

Table 7. Target bird species passage rates and estimated turbine collision fatalities at the site, calculated for up to 42 turbines.

	Scenario 1 (30-230m)		**Scenario 2 (60-260m)**		
Species	# flights	Ann. Fat. rate (98% avoid-ance)	# flights	Ann. Fat. rate (98% avoidance)	% Collision risk reduction
All target species	304	3.41	203	2.28	
Jackal Buzzard	120	1.38	97	1.12	19.17
Ludwig's Bustard	57	0.66	14	0.16	75.44
Verreaux's Eagle	41	0.47	41	0.47	0.00
Pale Chanting Goshawk	27	0.31	23	0.27	14.81
Common Buzzard	13	0.07	8	0.05	38.46
Karoo Korhaan	7	0.08	0	0.00	100.00
South African Shelduck	7	0.08	2	0.02	71.43
Pied Avocet	6	0.07	1	0.01	83.33
Booted Eagle	5	0.06	5	0.06	0.00
Black Stork	4	0.02	2	0.01	50.00
Martial Eagle	4	0.05	3	0.03	25.00
Black-chested Snake-eagle	3	0.03	3	0.03	0.00
Lanner Falcon	3	0.03	0	0.00	100.00
Rock Kestrel	2	0.02	1	0.01	50.00
Secretarybird	2	0.02	2	0.02	0.00
African Spoonbill	1	0.01	1	0.01	0.00
Black Harrier	1	0.01			100.00
Double-banded Courser	1	0.01			100.00

3.2.7 Spatial location of flight records

The spatial location of all target bird species flight records for the site, for the full year of pre-construction monitoring, can be seen below in **Figure 6**.

The flight path data for regionally Red Listed bird species only is presented in **Figure 7**, in order to eliminate the clutter created by more common species.

The most intense area of flight activity is fortunately away from the proposed turbines in the north-west. This flight activity was primarily that of Jackal Buzzard.

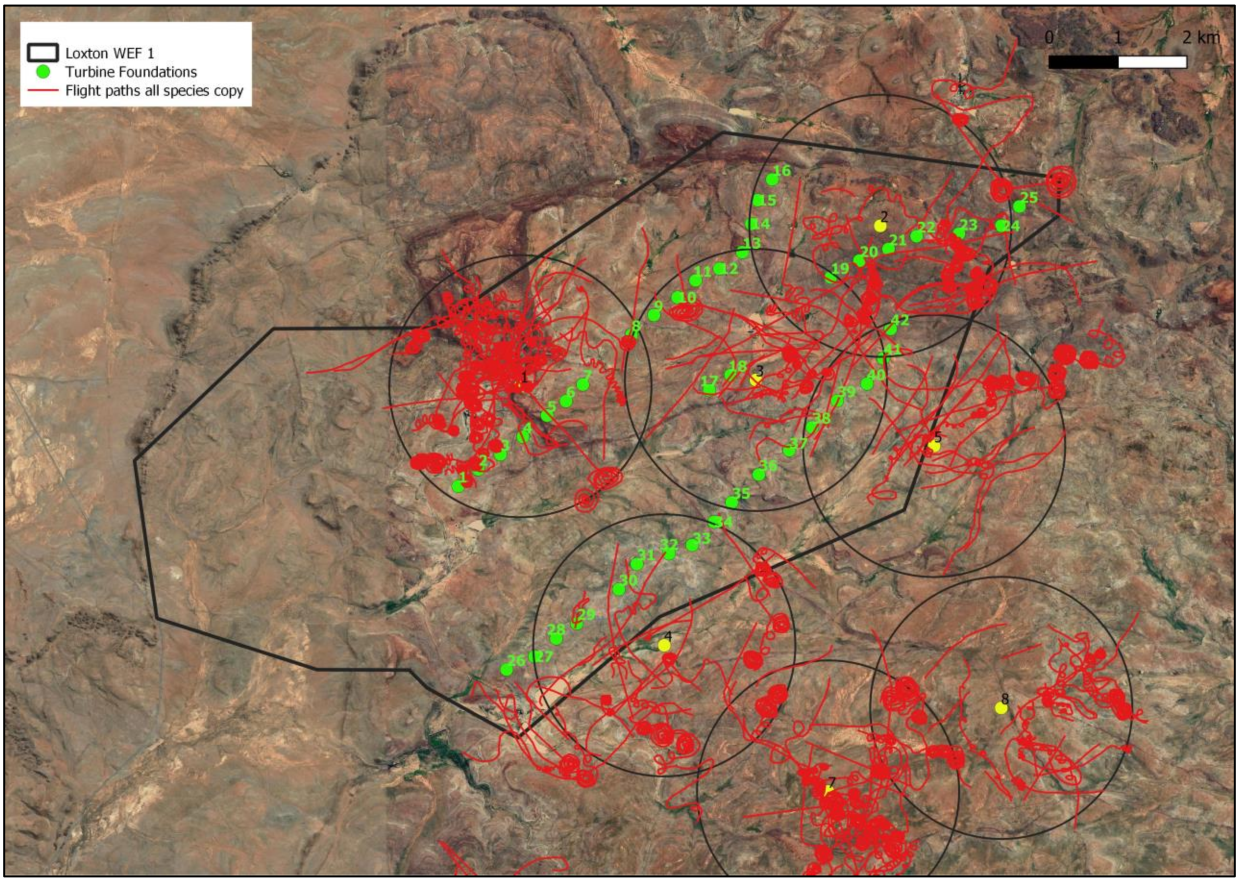

Figure 6. Recorded target bird species flight paths at the site (all species, full year).

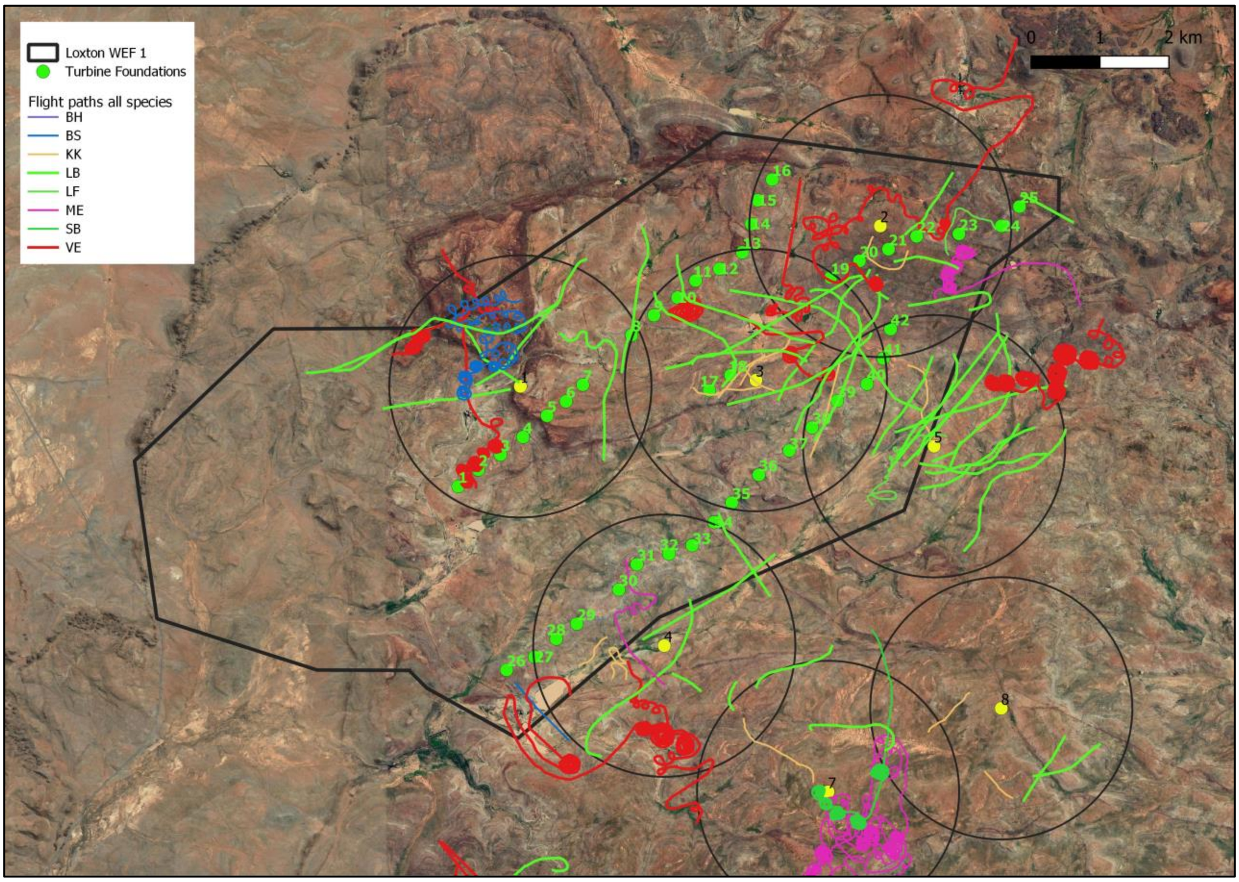

Figure 7. Regionally Red Listed species flight paths (full year).

3.3 Assessment of risk to priority bird species (Species of Conservation Concern)

Table 8 presents the seasonal presence of each priority species on the site and a qualitative assessment of the risk of each type of impact (pre-mitigation) occurring for each of the priority species if the proposed wind farm is built. Species are presented in descending order of regional conservation status. This assessment has been made on the basis of the data collected on site during this programme, reported on in **Section 3.2.** The proposed facility could pose risk to avifauna in six main ways: collision with turbines; collision with or electrocution on power lines; habitat destruction during construction; disturbance during construction and operation; and displacement from the site once operational. A discussion of each High and Medium risk species follows **Table 8**, in the order of risk category.

Table 8. Priority bird species (Species of Conservation Concern) assessment and risk profile for the site.

Common Name	Scientific Name	Red List: Regional, Global (Endemism)	Collision risk (Retief *et al.* 2014)	S1	S2	S3	S4	Specialist Risk Assessment	Likely impacts
Bustard, Ludwig's	*Neotis ludwigii*	EN, EN	14	√	√	√	√	**High**	Collision with turbines
Eagle, Martial	*Polemaetus bellicosus*	EN, VU	4	√	√	√	√	**Medium**	Collision with turbines
Harrier, Black	*Circus maurus*	EN, EN (NE)	6			√		**Medium**	Collision with turbines
Eagle, Verreaux's	*Aquila verreauxii*	VU, LC	3	√	√	√	√	**High**	Collision with turbines
Falcon, Lanner	*Falco biarmicus*	VU, LC	24	√		√	√	**Low**	Collision with turbines
Secretarybird	*Sagittarius serpentarius*	VU, EN	13	√	√		√	**Low**	Collision with turbines, Disturbance & Displacement
Stork, Black	*Ciconia nigra*	VU, LC	10		√	√		**Low**	Collision with turbines
Crane, Blue	*Grus paradisea*	NT, VU	11			√		**Low**	Collision with turbines, Disturbance & Displacement
Korhaan, Karoo	*Eupodotis vigorsii*	NT, LC	51	√	√	√	√	**Low**	Collision with turbines, Disturbance & Displacement
Lark, Sclater's	*Spizocorys sclateri*	NT, NT (NE)	50	√	√			**Low**	Collision with turbines
Pipit, African Rock	*Anthus crenatus*	NT, LC (SLS)	78			√	√	**Low**	Collision with turbines, Disturbance & Displacement
Buzzard, Jackal	*Buteo rufofuscus*	(NE)	43	√	√	√	√	**High**	Collision with turbines
Francolin, Grey-winged	*Scleroptila afra*	(SLS)	80	√	√	√		**Low**	Collision with turbines
Buzzard, Common	*Buteo buteo*		67		√	√		**Low**	Collision with turbines
Courser, Double-banded	*Rhinoptilus africanus*		72	√	√	√	√	**Low**	Collision with turbines, Disturbance & Displacement
Eagle, Black-chested Snake	*Circaetus pectoralis*		60	√		√	√	**Low**	Collision with turbines
Eagle, Booted	*Hieraaetus pennatus*		59	√	√	√		**Low**	Collision with turbines
Falcon, Amur	*Falco amurensis*		66			√		**Low**	Collision with turbines
Falcon, Peregrine	*Falco peregrinus*		49			√		**Low**	Collision with turbines
Goshawk, Pale Chanting	*Melierax canorus*		75	√	√	√	√	**Low**	Collision with turbines
Hawk, African Harrier-	*Polyboroides typus*		85	√		√	√	**Low**	Collision with turbines
Kestrel, Greater	*Falco rupicoloides*		95			√		**Low**	Collision with turbines

Kestrel, Lesser	*Falco naumanni*		64			√		**Low**	Collision with turbines
Korhaan, Northern Black	*Afrotis afraoides*		90	√	√	√	√	**Low**	Collision with turbines
Lark, Melodious	*Mirafra cheniana*		91			√		**Low**	Collision with turbines
Owl, Cape Eagle-	*Bubo capensis*		42	√			√	**Low**	Collision with turbines
Owl, Spotted Eagle-	*Bubo africanus*		98	√		√	√	**Low**	Collision with turbines
Sparrowhawk, Rufous-breasted	*Accipiter rufiventris*		101	√		√		**Low**	Collision with turbines

3.3.1 Ludwig's Bustard (High risk)

The Ludwig's Bustard is classified as regionally Endangered by Taylor *et al.* (2015). This physically large species is highly vulnerable to collision with overhead power lines (which leads us to believe it may be susceptible to collision with wind turbines), and is also likely to be affected by disturbance and habitat destruction. This species was listed as globally Endangered in 2010 because of potentially unsustainable power line collision mortality, exacerbated by the rapidly expanding power grid (Jenkins *et al.* 2011). Ludwig's Bustard is a wide-ranging bird endemic to the south-western region of Africa (Hockey *et al.* 2005). Ludwig's Bustards are both partially nomadic and migratory (Allan 1994, Shaw 2013, Shaw *et al*. 2015), with a large proportion of the population moving west in the winter months to the Succulent Karoo. In the arid and semi-arid Karoo environment, bustards are also thought to move in response to rainfall, so the presence and abundance of bustards in any one area are not predictable.

Ludwig's Bustard was classified as the 14th most at risk species in Retief's classification (2011, species list updated in 2014). Allan and Anderson (2010) rated the Ludwig's Bustard as the second most threatened (of 11 species), after the Denham's Bustard. Ludwig's Bustard is likely to be susceptible to four possible impacts associated with a wind farm: habitat destruction, disturbance, displacement and collision with turbine blades and power lines. In a recent update of their review work Ralston-Paton (2019) reports two Ludwig's Bustard fatalities at operational wind turbines in SA. This demonstrates that the species is susceptible to turbine collision. We also consider our experience to date with another bustard species, which has more operational wind farms in its range, the Denham's Bustard. At the operational Kouga Wind Farm, disturbance and displacement does not seem to have been significant (Strugnell 2016, 2017, Smallie 2018), since males are still displaying within 50 - 100m of operating turbines. To our knowledge only one turbine collision fatality has been recorded for this species at operational facilities to date at a wind farm in the Kouga area (Ralston-Paton *et al.* 2017; *pers obs*).

Bustard mortality is not sufficiently reduced by affixing bird diverters to power line earth wires. However, a recent study by Pallett *et al*. (2022) showed that staggering the pylon towers of parallel power lines increases the visibility of the infrastructure to bustards, and significantly reduces the number of fatal collisions. This mitigation could theoretically reduce mortality by up to 67% for new lines and is strongly recommended.

We recorded Ludwig's Bustard on the proposed site in all four Site Visits. The location of all recorded flight paths is presented in **Figure 8**. Flights were most frequently recorded in the viewsheds of VPs 3 and 5, and generally parallel to that of the proposed turbine strings. The overall passage rate for the species was 0.1 birds/hour and we estimated that Loxton WEF 1 could kill 0.66 birds per year under "Scenario 1", or 0.16 under "Scenario 2"). Increasing minimum turbine blade height to 60m above ground reduced the estimated collision risk by 75.44%. Lekking behaviour was noted at FS 14 and 15 and we conclude that the species favours the broader area for breeding behaviour at least in times of favourable conditions (after good rains). The species commutes across the landscape fairly regularly at Loxton WEF

1, albeit at a flight height generally below rotor swept area (<60m). We thus conclude the species is at High risk at the proposed site, especially if minimum blade height is unmitigated. The most effective strategies for minimising the impact of development for Ludwig's Bustards are most likely to be as follows:

- Avoiding the No-go turbine buffers around leks;
- Avoiding the High sensitivity buffers in the construction and decommissioning phases during the breeding season;
- Raising the lower rotor swept height of turbine blades and
- Complying with all power line mitigation measures detailed in this report (line-marking devices, pylon staggering, etc.)

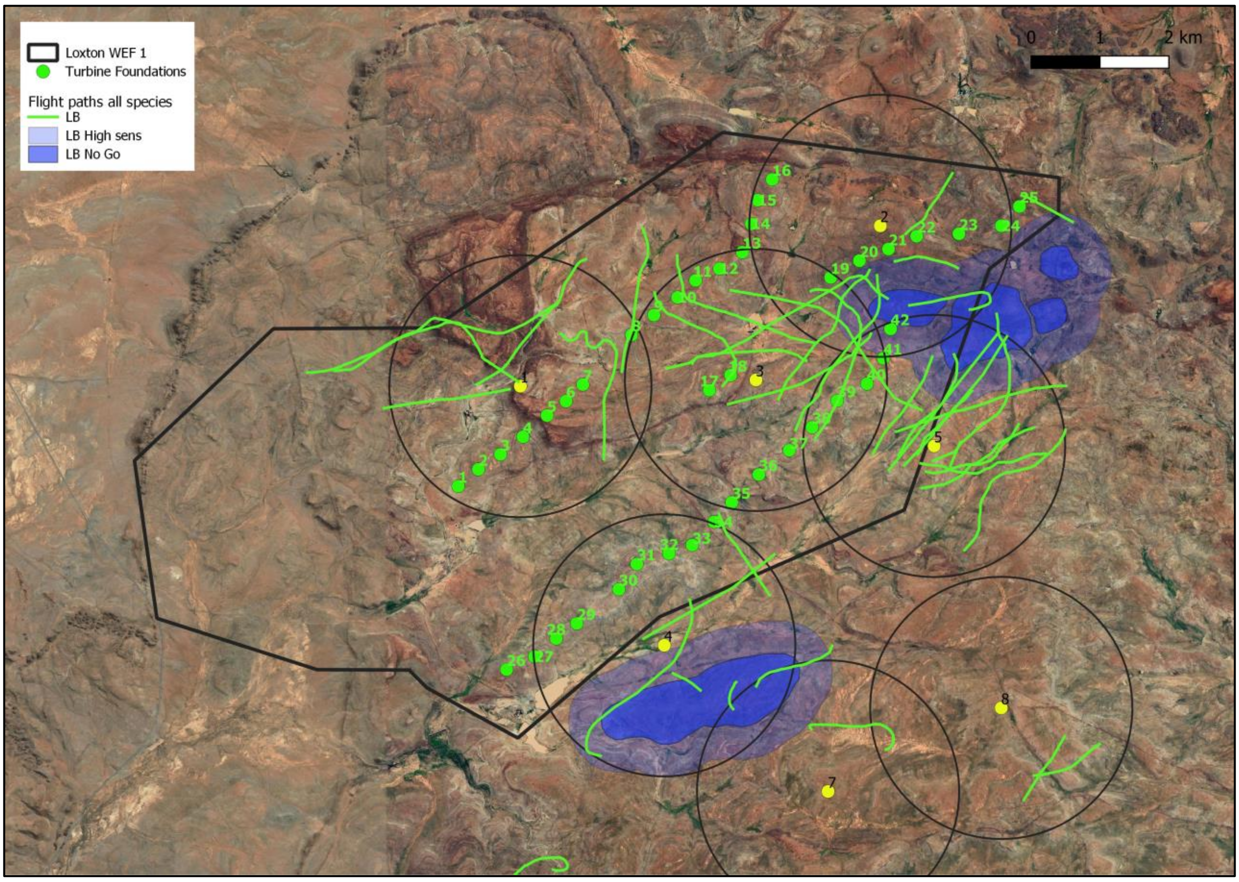

Figure 8. Ludwig's Bustard flight paths on site and identified lekking areas with buffers.

3.3.2 Verreaux's Eagle (High risk)

The Verreaux's Eagle has recently been up-listed in regional conservation status to Vulnerable (Taylor *et al.* 2015) in recognition of the threats it is facing. It was ranked at 22 on the list developed by Retief *et al.* (2011), but has been upgraded to 3rd in the 2014 update of this list. This species tends to occupy remote mountainous areas largely unaffected by development (until the advent of wind energy in SA, that is). Early observations on constructed wind farms under monitoring indicate that this species is susceptible to collision with turbines (*pers. obs.*; Ralston-Paton *et al*. 2017; Perold *et al*. 2020).

There are four known Verreaux's Eagle nests within 12km of the southernmost boundary of the Loxton WEFs, although these are more than 12km from Loxton WEF 1. We recorded Verreaux's Eagle on site in all seasons. At Vantage Points, the passage rate recorded for Verreaux's Eagle was 0.05 birds/hour. We estimate based on the recorded passage rates that 0.47 Verreaux's Eagle fatalities could occur each year across the wind farm. **Figure 9** presents the location of flight paths for this species. Flights are dispersed throughout the site, despite the distance to known nests. This is possibly due to these resident pairs occasionally foraging further afield from nests, or it could be non-resident 'floater' eagles moving through the area. In order to comply with best practice requirements, the VERA (Verreaux's Eagle Risk Assessment) model was run for the WEF cluster and the output used in designing the layout (see **Appendix 9**). It cannot be ruled out that there are nests in the broader study area that have not been discovered, given the activity seen on site. Overall, we conclude that the species is at High risk at the proposed site.

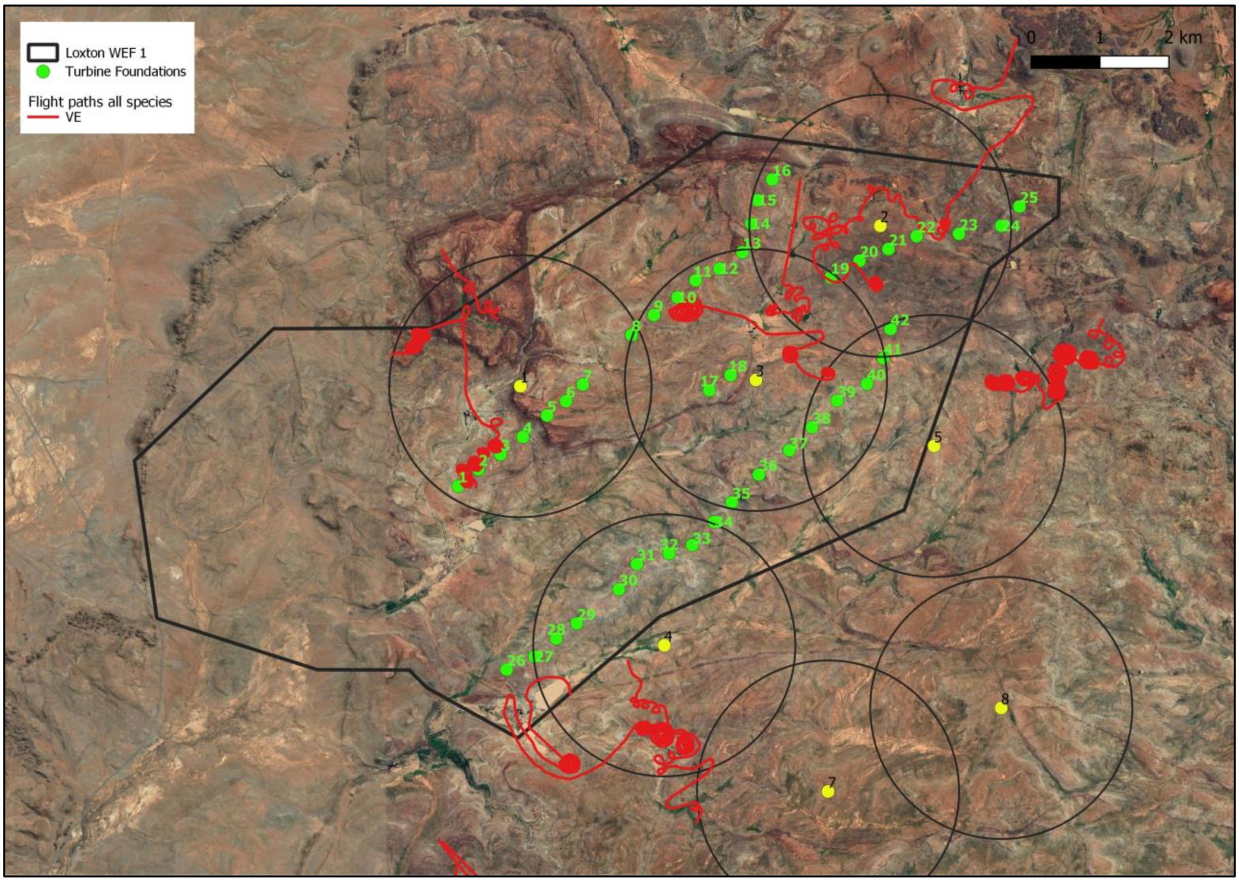

Figure 9. Verreaux's Eagle flight paths on site.

3.3.3 Jackal Buzzard (High risk)

The Jackal Buzzard is a fairly common species throughout South Africa and on this site. It is a generalist in terms of habitat, although does favour shorter vegetation. It hunts mostly in flight, meaning that a large proportion of its time is spent flying, and thereby at some risk of collision with vertical obstacles. Early observations on constructed wind farms under monitoring indicate that this species is highly susceptible to collision with turbines (*pers. obs*; Ralston-Paton *et al.* 2017; Perold *et al*. 2020).

On the proposed site we recorded the species by all methods and in all seasons. Vantage Points recorded the species at 0.15 birds/hour. The location of recorded flight paths is shown in **Figure 10**. We estimate that 1.38 Jackal Buzzard fatalities could occur per year, or reduced to 1.12 for "Scenario 2". A significant amount of activity was noted in the viewshed of VP 1 in close proximity to an active nest (FS 8). The pair foraged for approximately 6.5 hours over the year at this VP alone. Collision risk appears to be disproportionately greater in this area in particular. Due to its relatively common status this anticipated risk does not carry as much significance as it would if the species were Red Listed. However concern is growing for this species based on the number being killed at operational wind farms in SA. We conclude that this species is at High risk at the site. Given the disproportionate flight activity in the viewshed of VP1, it appears that the current 500m No-go buffer is inadequate to cover the preferred foraging areas of this pair.

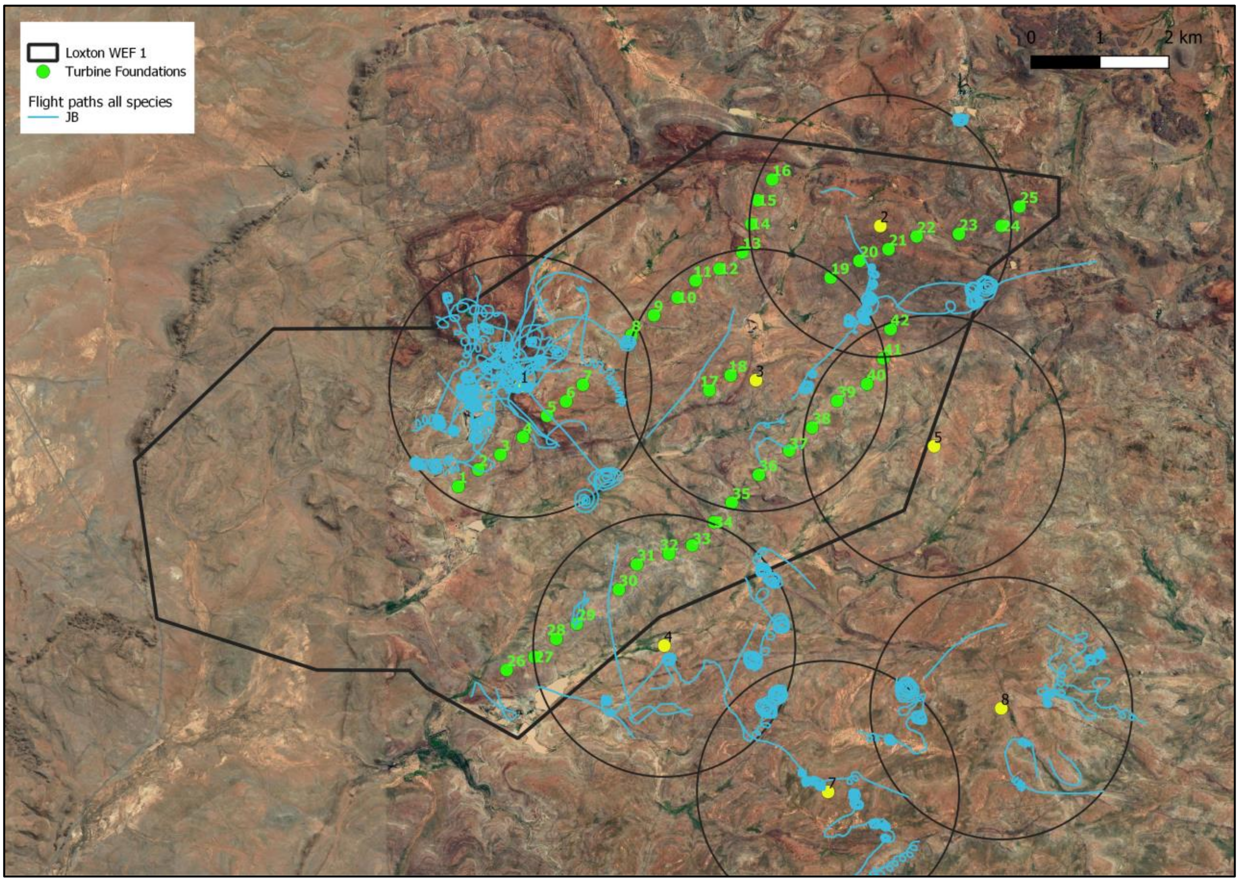

Figure 10. Jackal Buzzard flight paths on site.

3.3.4 *Martial Eagle (Medium risk)*

The Martial Eagle is classified as regionally and globally Endangered (Taylor *et al.* 2015, IUCN 2020). Martial Eagle has proven susceptible to collision with wind turbines (Ralston-Paton *et al*. 2017, Perold *et al*. 2020) particularly in close association with nests (Simmons & Martins, 2016). This is a wide-ranging species, which can best be protected from wind turbine collision risk close to its breeding sites.

No nests are known on or near the proposed Loxton WEF 1, although nests to the extreme south of the Loxton WEF Cluster have influenced the turbine layout there. **Figure 11** shows the location of recorded flight paths for the species. Flights were not observed particularly frequently, although observers recorded an immature individual foraging well within rotor swept zone for an hour during one Vantage Point session, showing that the area is at least extensively used at certain times.

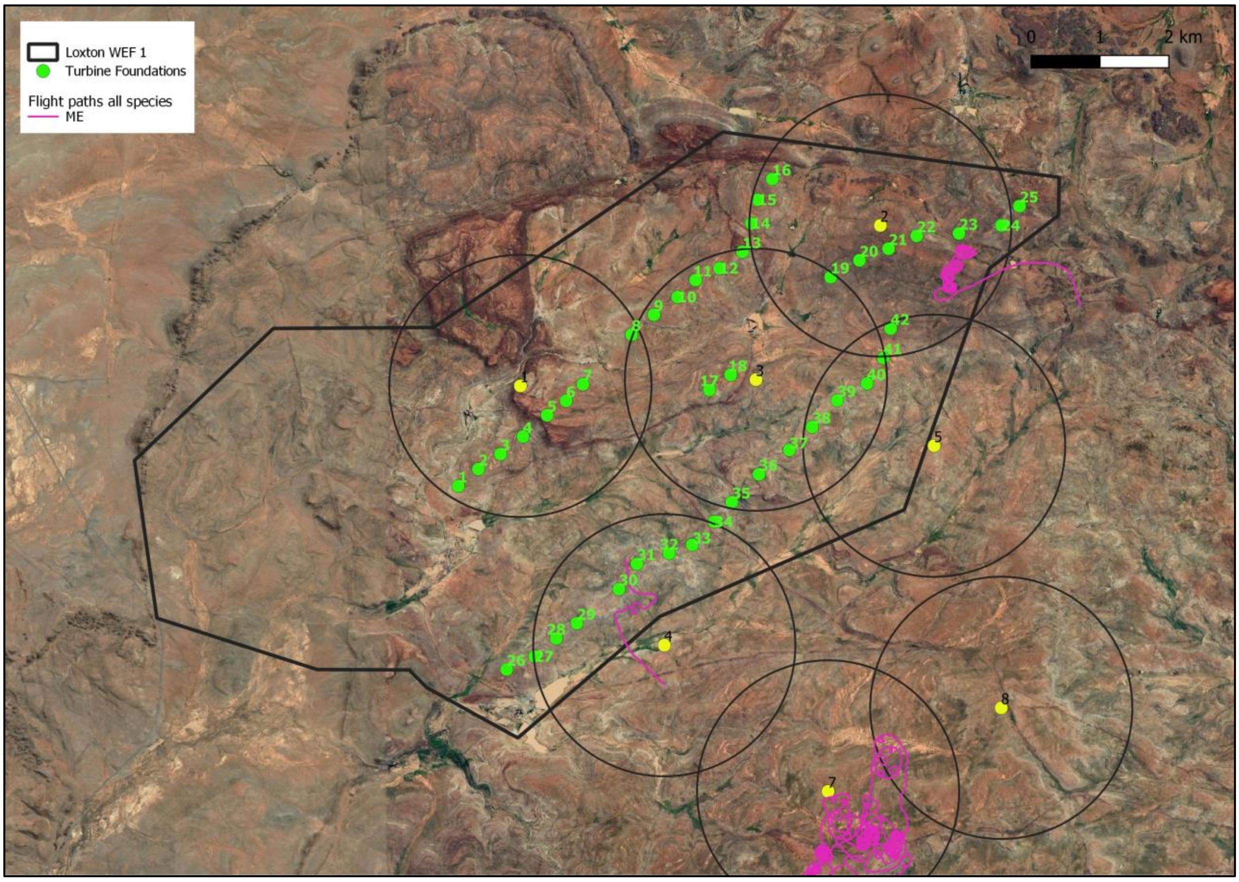

Figure 11. Martial Eagle flight paths on site.

Based on the passage rates recorded on site for the species we estimate that 0.05 Martial Eagles could collide with turbines on the wind farm per year under "Scenario 1" or 0.03 under "Scenario 2". Although this is a very low fatality rate, on a precautionary basis, given the extended length of time that these foraging bouts can represent in the area, we conclude that the species is at Medium risk at the site.

3.3.5 Black Harrier (Medium risk)

The Black Harrier is both regionally and globally Endangered as well as a South African endemic species (Taylor *et al.* 2015, IUCN 2020). It is currently suffering population declines due to an ongoing loss of mature individuals, with wind energy a contributing factor alongside habitat loss, landscape alteration and climate change. The population is estimated to be around 1 000 mature birds (IUCN 2020) and Cerventes *et al*. (2022) recently calculated their rate of decline to be 2.3% per year, with extinction possible within 100 years if 3-5 adult individuals are killed per year. With the advent of the extensive prospecting for wind energy in South Africa throughout the distribution of the species, this fatality rate may soon be reached or even exceeded.

We estimate that 0.01 Black Harriers could collide with turbines on the wind farm per year when all flight records are considered, reduced to 0 under Scenario 2. Although this is a low fatality rate, it should not be considered in isolation, as the risk along the species' migratory routes is a cumulative one. Flight paths were not documented for this species on official VP sessions at Loxton WEF 1, although Incidental Records were made further afield. This is a highly mobile migrant species and we precautionarily rate the risk as Medium at this site. Increasing rotor swept height above ground is predicted to greatly reduce collision risk for this species that typically forages at lower heights.

4. Avifaunal sensitivity of the site

4.1 Site Sensitivity Verification (SSV)

We conducted a Site Sensitivity Verification (SSV) exercise for the proposed project (see Appendix 13). We dispute the Screening Tool finding for the Avian Theme which designates the site as Low sensitivity and concur with the Tool's High sensitivity assessment of the Animal Species Theme for both highlighted avian species (Ludwig's Bustard and Verreaux's Eagle). We include Black Harrier and Martial Eagle in a category of at least Medium sensitivity.

4.2 National sensitivity

The "Avian Wind Farm Sensitivity map for South Africa" (Retief *et al.* 2011) and the Important Bird & Biodiversity Areas programme data (IBA - Marnewick *et al*. 2015) were consulted to determine the sensitivity of the project in national terms. **Figure 12** shows the position of the wind farm relative to the avian wind farm sensitivity map and the IBAs. The site falls mostly within the lowest two categories of sensitivities in terms of avifauna (darker colours indicate higher risk). For a full discussion on the methods used in producing this map see Retief *et al.* (2011, 2014). The site is not located in or close to any IBAs (Marnewick *et al.* 2015). The proposed site does not fall in a Renewable Energy Development Zone (REDZ/2), but is not situated far from an identified power corridor. Overall, it is our opinion that the proposed site falls in an area of Low sensitivity *overall, on a national scale* based on these factors (see also the Site Sensitivity Verification in Appendix 13 and referred to below). This statement serves to provide holistic context on the suitability of the location of the development on the basis of these consulted databases and does not consider individual species.

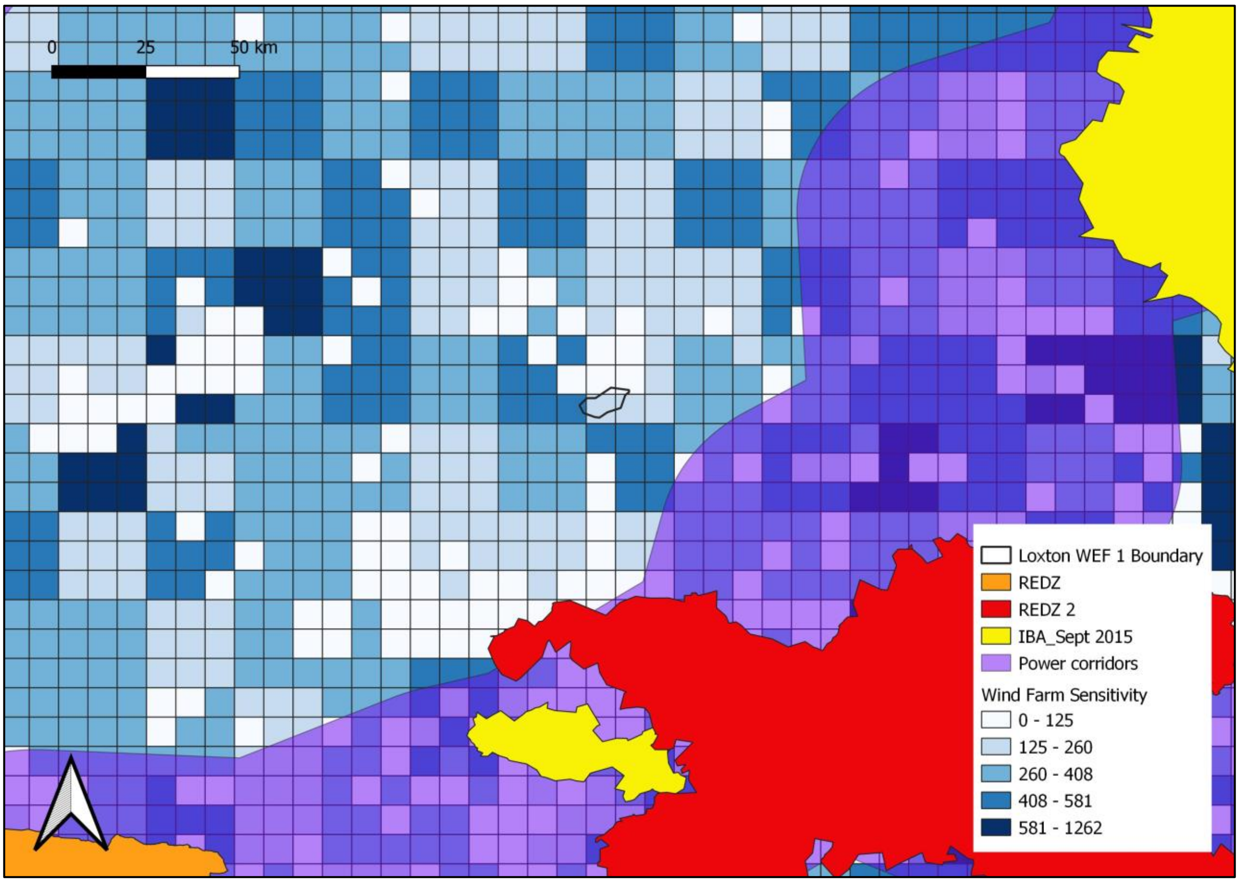

Figure 12. The position of Loxton WEF 1 relative to the Avian wind farm sensitivity map (Retief *et al.* 2011), Important Bird & Biodiversity Areas (Marnewick *et al.* 2015), and Renewable Energy Development Zones (REDZ/2).

4.3 Site Ecological Importance (SEI)

Site Ecological Importance is derived from combining Biodiversity Importance and Receptor Resilience. Biodiversity Importance is in turn derived from combining Conservation Importance and Functional Integrity.

Conservation Importance (CI) is defined as: "*The importance of a site for supporting biodiversity features of conservation concern present, e.g. populationsof IUCN threatened and Near Threatened species (CR, EN, VU and NT), Rare species, range-restricted species, globally significant populations of congregatory species, and areas of threatened ecosystem types,through predominantly natural processes.*"

Functional integrity (FI) of the receptor (e.g. the vegetation/fauna community or habitat type) is defned here as *A measure of the ecological condition of the impactreceptor as determined by its remaining intact and functional area, its connectivity to other natural areas and the degree of current persistent ecological impacts."*

Receptor Resilience (RR) is defined as*: 'The intrinsic capacity of the receptor to resist major damage from disturbance and/or to recover to its original state with limited or no human intervention.'*

In the case of the Loxton site, we score:

1. Conservation Importance as Medium (*Confirmed or highly likely occurrence of populations of NT species, threatened species (CR, EN, VU) listed under Criterion A only and which have more than 10 locations or more than 10 000 mature individuals.)*

2. Functional Integrity as Very High (*Very large (> 100 ha) intact area for any conservation status of ecosystem type or > 5 ha for CR ecosystem types. High habitat connectivity serving as functional ecological corridors, limited road network between intact habitat patches. No or minimal current negative ecological impacts with no signs of major past disturbance (e.g. ploughing*).

According to the figure below then this provides a Biodiversity Importance score of ' High'.

Biodiversity importance		Conservation importance				
		Very high	High	Medium	Low	Very low
Functional integrity	Very high	Very high	Very high	High	Medium	Low
	High	Very high	High	Medium	Medium	Low
	Medium	High	Medium	Medium	Low	Very low
	Low	Medium	Medium	Low	Low	Very low
	Very low	Medium	Low	Very low	Very low	Very low

Figure 13. Biodiversity Importance scoring table (extracted from SANBI 2022).

3. The Receptor Resilience is scored as Medium for the Loxton site.

Site ecological importance		Biodiversity importance				
		Very high	High	Medium	Low	Very low
Receptor resilience	Very low	Very high	Very high	High	Medium	Low
	Low	Very high	Very high	High	Medium	Very low
	Medium	Very high	High	Medium	Low	Very low
	High	High	Medium	Low	Very low	Very low
	Very high	Medium	Low	Very low	Very low	Very low

Figure 14. Site Ecological Importance scoring table (extracted from SANBI 2022).

4. This then produces a Site Ecological Importance of 'Very High' as per the above figure. The recommendation (SANBO 2022) for this class of SEI is: "*Avoidance mitigation wherever possible. Minimisation mitigation – changes to project infrastructure design to limit the amount of habitat impacted; limited development activities of low impact acceptable. Offset mitigation may be required for high impact activities.".* In our view the Loxton project has successfully achieved this.

In this case SEI cannot be mapped as birds are mobile and move across the entire site. On site avifaunal sensitivity has instead been mapped below.

4.4 On-site sensitivity: Avifaunal constraints

In terms of on-site avifaunal sensitivity, the table below summarises the factors considered. The constraints identified were classified according to a four-tier sensitivity classification method (No-Go, High, Medium, and Low).

Table 9. Avifaunal Sensitivity mapping factors.

Sensitivity class	Avifaunal factors considered	Recommendation
No-Go areas	**Verreaux's Eagle nest buffers.** Four Verreaux's Eagle nests are known within the area originally screened for the Loxton wind farms. The VERA model was run for three of these nests. The project was re-designed to exclude the High and Medium risk areas identified by VERA. The fourth nest was found only after VERA modelling had been run, and was provided with a buffer of 5.2km.	No wind turbines or overhead power lines should be placed within these areas Other infrastructure may be permitted on agreement with the specialist.
	Martial Eagle nest buffers. Three Martial Eagle nests from two territories occur in the broader study area, which was originally screened. To determine the size of the nest buffers	

	(in the absence of established guidance) we consulted the most recent and comprehensive nest tracking-based study of Martial Eagle breeding ecology that we are aware of (Van Eeden *et al.* 2017). This study was conducted in the Kruger National Park and determined a mean (n=6) home range size of 108km² implying a home range radius of 6km if a circular home range is assumed. We have therefore placed a 6km radius circular buffer around the Martial Eagle nesting sites.	
	Ludwig's Bustard Leks. Several lek areas were idenitified during the course of pre-construction bird monitoring. These areas were identified spatially, by delineating a polygon around the area within which male bustards were recorded displaying. These leks were all on slightly higher topography areas, i.e. low ridge lines. We have therefore made use of topographical mapping to delineate No-go buffers around these leks.	
	Jackal Buzzard nest. Two Jackal Buzzard nests were identified. These nests have received a 500m No-go turbine buffer.	
	Dams. Dams are important for general waterfowl, and are life-giving resources, particularly in arid to semi-arid environments. Dams are also important roosting sites for Blue Cranes which sleep at night in the shallows. The four largest and most reliable dams were buffered by 500m as a precaution against being used as roosts at some point in the future. All other dams were mapped (using the SANFEPA shape file) without a buffer, but should be avoided as far as possible.	
	Arable lands are an important source of food for cranes, particularly during winter. We precautionarily placed a 500m No-go buffer around the Biesiespoort arable land.	
	Wetlands. The National Wetland Map of the National Biodiversity Assessment (2018) was used to map the wetlands on site.	
High sensitivity	**Ludwig's Bustard Leks.** An additional 500m High sensitivity buffer was delineated around the above described lek no-go areas, to avoid disturbing lekking birds.	These areas should be avoided as far as possible with new infrastructure, in particular turbines. One proposed turbine is within the buffer area around the Ludwig's Bustard lek (classified as High sensitivity) and has been approved by the specialist. Construction of this turbine and associated roads may be subject to a seasonal restriction if Ludwig's Bustard are found displaying in the these leks in the relevant construction year. An

		avifaunal specialist will need to survey for this.
Medium sensitivity	The remainder of the site classifies as Medium sensitivity.	Infrastructure may enter these areas and remaining on existing infrastructure as far as possible (eg. roads).
Low sensitivity	Not applicable	

Figure 15 shows the above information consolidated into one map. This spatial information has already been considered in designing the current draft turbine layout. The current proposed turbine layout avoids all of the above described No-Go areas. One turbine exists within the High sensitivity area and is acceptable and agreed to by the specialist, subject to conditions.

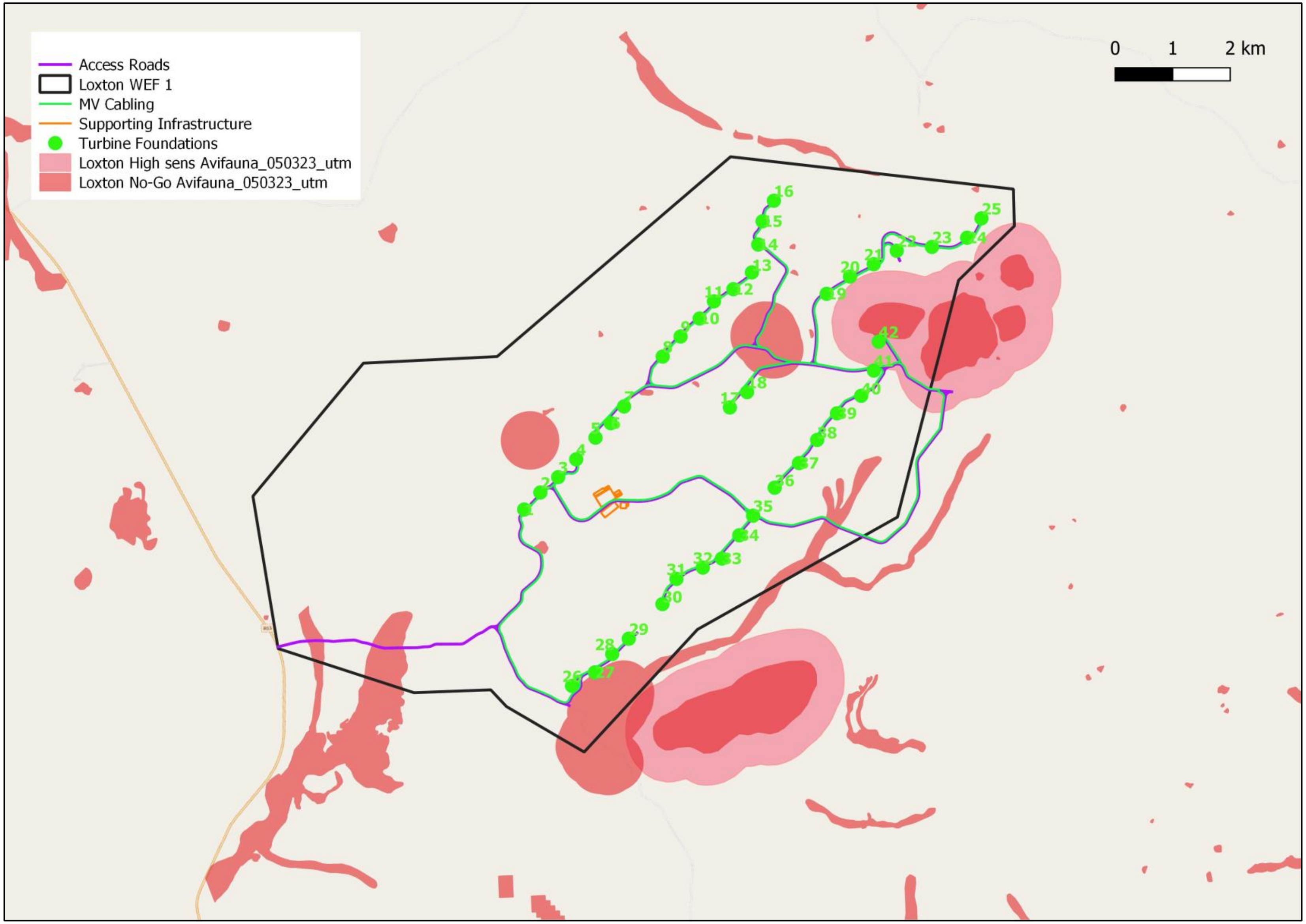

Figure 15. The avifaunal sensitivity map for Loxton WEF 1.

4.5 Application of the mitigation hierarchy

The avoidance of avifaunal risk at Loxton WEF 1 has been an iterative process resulting from ongoing communication between WildSkies and AEP. The degree to which mitigation or avoidance can make a material difference to avifaunal risk at a wind farm is higher earlier in the project. In the case of Loxton WEF 1, a significant amount of avifaunal risk avoidance has already been implemented. The various avoidance measures already applied have been summarised below for the full site of three wind farms (Loxton WEF 1 - 3):

- Raptor nests (Jackal Buzzard FS 8 & FS 9 – 500m)
- Ludwig's Bustard leks (FS 14 & 15)
- Wetlands, according to The National Wetland Map of the National Biodiversity Assessment (2018)
- Focal Site dams (FS 6, 12, 13 & 16 – 500m)
- Verreaux's Eagle nests (FS 1, 2, 3, & 5: No-go buffers identified by best practice and VERA)
- Martial Eagle nests (No-go buffers identified from literature)

5. Impact Assessment

In general terms, the proposed project lies in a wilderness area, little disturbed by anthropogenic factors. Very few if any vertical man-made structures exist in this landscape currently. Human presence and noise pollution are very low. The proposed project would therefore result in a significant change from the *status quo* for avifauna.

The avifaunal community is comprised perhaps most importantly of raptors and large terrestrials. The larger raptors' breeding sites have been avoided by placing large No-go buffers around nests in accordance with current Best Practice Guidelines. These species have however still been recorded flying outside of these areas and on site. Large terrestrials such as cranes, bustards and korhaans are more dispersed on site but spend less time in flight. We assess the impacts via Arcus methodology for three Phases of the development: Construction, Operation and Decommissioning. Mitigation measures are highlighted for each impact and are fully described in detail in **Section 7**. The explanation of Arcus assessment criteria is provided in **Appendix 8**.

5.1 Potential Construction Phase Impacts

Two impacts exist for the Construction Phase of development. These are detailed below:

Table 10. Assessment of destruction of habitat during construction.

Impact Phase: Construction phase					
Nature of the impact: Destruction of avifaunal habitat					
Description of Impact: With the current proposed layout of up to 38 turbines and associated infrastructure such as roads, laydown areas, collector substations etc, the wind farm will impact on natural habitat through its clearing for construction. Given the relatively undisturbed nature of vegetation on site, most of this is likely to be natural vegetation. This is a small proportion of the overall site extent, and the habitat is neither particularly unique, nor threatened, or in limited availability. However, the fragmented nature of the remaining habitat will experience an "edge effect", whereby an area greater than the exact footprint of construction is affected by the impact under consideration. Of course, the effect on the avifaunal community is not as simple as the surface area affected. In addition to surface area alteration, the effect of large, dispersed infrastructure projects such as wind farms on birds is likely to be far more complex through factors such as habitat fragmentation, disruption of territories and other factors. These effects have however proven extremely difficult to measure. Since this habitat destruction is largely unavoidable, and our confidence in the effectiveness of habitat rehabilitation is uncertain, we anticipate that the impact significance will remain unchanged by mitigation.					
Impact Status: Negative					
	E	**D**	**R**	**M**	**P**

Without Mitigation	Site	Long term	Recoverable	Moderate	Highly probable
Score	1	4	3	3	4
With Mitigation	Site	Long term	Recoverable	Low	Highly probable
Score	1	4	3	2	4
Significance Calculation	**Without Mitigation**			**With Mitigation**	
S=(E+D+R+M)*P	Moderate Negative Impact (40)			Moderate Negative Impact (36)	
Was public comment received?	Yes				
Has public comment been included in mitigation measures?	Yes				
Mitigation measures to reduce residual risk or enhance opportunities: Please see **Section 7**: Points 1, 2, 3, 4, 5, 6, 7 & 18					
Residual impact	The destruction of habitat is inevitable, and the significance remains at Moderate with mitigation.				

Table 11. Assessment of disturbance of birds during construction.

Impact Phase: Construction phase					
Nature of the impact: Disturbance of birds					
Description of Impact: Effects of disturbance on birds are particularly likely during breeding and could include loss of breeding productivity; temporary or permanent abandonment of breeding; or even abandonment of nest site. The avoidance measures (in the form of large No-go buffers) already taken to protect the various eagle nests and their breeding have reduced the significance of this impact.					
Impact Status: Negative					
	E	**D**	**R**	**M**	**P**
Without Mitigation	Local	Short term	Reversible	Low	Probable
Score	2	2	1	2	3
With Mitigation	Local	Short term	Reversible	Low	Probable
Score	2	2	1	2	3
Significance Calculation	**Without Mitigation**			**With Mitigation**	
S=(E+D+R+M)*P	Low Negative Impact (21)			Low Negative Impact (21)	
Was public comment received?	Yes				

Has public comment been included in mitigation measures?	Yes
Mitigation measures to reduce residual risk or enhance opportunities: Please see **Section 7**: Points 1, 2, 3, 4, 5, 6, 7 & 18	
Residual impact	The disturbance of birds is somewhat inevitable, although the most sensitive receptors have already been protected through impact avoidance, through the application of no-go buffers

5.2 Potential Operational Phase impacts

We have identified five main impacts for the Operational Phase of the project, described below

Table 12. Assessment of disturbance of birds during operational phase.

Impact Phase: Operational phase					
Nature of the impact: Disturbance of birds					
Description of Impact: The indications from operational wind farms are that this impact may be of fairly low importance, although it is acknowledged that a longer term or more detailed means of measuring this impact may be required. The impact of human-induced disturbance during the operational phase of the development is likely to be less severe than during the construction phase.					
Impact Status: Negative					
	E	**D**	**R**	**M**	**P**
Without Mitigation	Local	Long term	Reversible	Low	Probable
Score	2	4	1	2	3
With Mitigation	Local	Long term	Reversible	Low	Probable
Score	2	4	1	2	3
Significance Calculation	**Without Mitigation**			**With Mitigation**	
S=(E+D+R+M)*P	Low Negative Impact (27)			Low Negative Impact (27)	
Was public comment received?	Yes				
Has public comment been included in mitigation measures?	Yes				
Mitigation measures to reduce residual risk or enhance opportunities: Please see **Section 7**: Points 3, 8 & 18					
Residual impact	The disturbance of birds is somewhat inevitable, although the most sensitive receptors have already been protected through impact avoidance, through the application of no-go buffers				

Table 13. Assessment of displacement of birds during operational phase.

Impact Phase: Operational phase					
Nature of the impact: Displacement of birds					
Description of Impact: As for disturbance above, the indications from operational wind farms are that this impact may be of fairly low importance, although it is acknowledged that a longer term or more detailed means of measuring this impact may be required. Birds may be displaced from using the landscape for breeding, foraging and commuting purposes due to the loss of habitat, increased noise pollution and human presence. This may reduce population size or force individuals into subop-timal habitat.					
Impact Status: Negative					
	E	**D**	**R**	**M**	**P**
Without Mitigation	Local	Long term	Reversible	Low	Probable
Score	2	4	1	2	3
With Mitigation	Local	Long term	Reversible	Low	Probable
Score	2	4	1	2	3
Significance Calculation	**Without Mitigation**			**With Mitigation**	
S=(E+D+R+M)*P	Low Negative Impact (27)			Low Negative Impact (27)	
Was public comment received?	Yes				
Has public comment been included in miti-gation measures?	Yes				
Mitigation measures to reduce residual risk or enhance opportunities: Please see **Section 7**: Points 3, 8 & 18					
Residual impact	The displacement of birds is somewhat inevitable, although the most sensi-tive receptors have already been protected through impact avoidance, through the application of no-go buffers				

Table 14. Assessment of bird collision with turbines during operational phase.

Impact Phase: Operational phase
Nature of the impact: Bird collision with turbine blades
Description of Impact: Turbine collisions have been discussed in depth in the literature section of this report. They represent the greatest risk to avifauna at this development. Turbine blades are not always visible to birds flying at rotor swept height and evasive action is not always possible. Striking a moving blade almost certainly results in death or serious injury. In the case of resident species, or those that occupy home ranges on a fairly permanent basis, fatalities represent the loss of individuals in the greater study area, both directly (due to fatalities themselves) as well as indirectly (due to the

loss of breeding potential, particularly between monogamous pairs). Human caused fatalities of regionally Red Listed or otherwise threatened bird species are always cause for concern and should be avoided as far as possible. The estimated fatalities we have predicted are therefore of some concern for the relevant species. There are currently no established thresholds for acceptable impacts on bird species in South Africa. To establish these thresholds would require complex modelling incorporating accurate information on many factors for each species (including population size, age-specific fatality rates, breeding productivity, etc). Such modelling and information are not available in South Africa at present. In the absence of this information, we are forced to make a somewhat subjective decision as to the acceptability of the estimated annual fatalities.
Impact Status: Negative

	E	D	R	M	P
Without Mitigation	National	Long term	Irreversible	High	Highly probable
Score	4	4	5	4	4
With Mitigation	National	Long Term	Irreversible	Moderate	Probable
Score	4	4	5	3	3
Significance Calculation	**Without Mitigation**		**With Mitigation**		
S=(E+D+R+M)*P	High Negative Impact (68)		Moderate Negative Impact (48)		
Was public comment received?	Yes				
Has public comment been included in mitigation measures?	Yes				
Mitigation measures to reduce residual risk or enhance opportunities: Please see **Section 7**: Points 3, 8, 10, 11, 12, 13 & 18					
Residual impact	There is some uncertainty around the effectiveness of bird-turbine collision mitigation at this stage in SA. As a result the significance remains at Moderate post mitigation.				

Table 15. Assessment of collision of birds with overhead lines during operational phase.

Impact Phase: Operational phase					
Nature of the impact: Bird collision with overhead power lines					
Description of impact: Collision with power line infrastructure has been discussed in depth in the literature section of this report. Unmitigated, it represents a high risk to avifauna at this development, particularly to bustards, storks, cranes and flamingos (collision). Large-bodied birds often lack the manoeuvrability to avoid poorly-marked power lines in flight when commuting in the landscape. This impact is relatively easily mitigated, however, our understanding from recent literature is that mitigation such as power line pylon staggering is not 100% effective and partial losses may still occur.					
Impact Status: Negative					
	E	D	R	M	P

Without Mitigation	National	Long term	Irreversible	High	Highly probable
Score	4	4	5	4	4
With Mitigation	National	Long Term	Irreversible	Moderate	Probable
Score	4	4	5	3	3
Significance Calculation	**Without Mitigation**			**With Mitigation**	
S=(E+D+R+M)*P	High Negative Impact (68)			Moderate Negative Impact (48)	
Was public comment received?	Yes				
Has public comment been included in mitigation measures?	Yes				
Mitigation measures to reduce residual risk or enhance opportunities: Please see **Section 7**: Points 1, 2, 3, 5, 6, 7, 8, 13, 14, 15, 17 & 18					
Residual impact	The line marking devices recommended to be installed on the overhead line earth wires are not 100% effective, particularly for bustards. As a result the significance remains at Moderate post mitigation.				

Table 16. Assessment of bird electrocution on overhead lines during operational phase.

Impact Phase: Operational phase					
Nature of the impact: Bird electrocution on overhead lines					
Description of Impact: 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. This is particularly true for raptors with larger wingspans such as Verreaux's and Martial Eagles. In a treeless landscape such as the proposed site the risk is exaggerated as the birds will certainly perch on pylons if available and may also nest on them. Once correctly installed, such infrastructure should not pose any danger to perching birds and no fatalities will occur.					
Impact Status: Negative					
	E	**D**	**R**	**M**	**P**
Without Mitigation	National	Long term	Irreversible	High	Highly probable
Score	4	4	5	4	4
With Mitigation	National	Long Term	Irreversible	Moderate	Improbable
Score	4	4	5	3	1
Significance Calculation	**Without Mitigation**			**With Mitigation**	
S=(E+D+R+M)*P	High Negative Impact (68)			Low Negative Impact (16)	

Was public comment received?	Yes
Has public comment been included in mitigation measures?	Yes
Mitigation measures to reduce residual risk or enhance opportunities: Please see **Section 7**: Points 1, 13, 16 & 18	
Residual impact	Mitigation for this impact should be 100% effective if the overhead lines are designed correctly.

5.3 Potential Decommissioning Phase impacts

We identify one main impact for the Decommissioning Phase, described below.

Table 17. Assessment of disturbance of birds during decommissioning phase.

Impact Phase: Decommissioning phase					
Nature of the impact: Disturbance of birds					
Description of Impact: Effects of disturbance on birds are particularly likely during breeding and could include loss of breeding productivity; temporary or permanent abandonment of breeding; or even abandonment of nest site. The avoidance measures (in the form of large No-go buffers) already taken to protect the various eagle nests and their breeding have reduced the significance of this impact.					
Impact Status: Negative					
	E	**D**	**R**	**M**	**P**
Without Mitigation	Local	Short term	Reversible	Low	Probable
Score	2	2	1	2	3
With Mitigation	Local	Short term	Reversible	Low	Probable
Score	2	2	1	2	3
Significance Calculation	**Without Mitigation**			**With Mitigation**	
S=(E+D+R+M)*P	Low Negative Impact (21)			Low Negative Impact (21)	
Was public comment received?	Yes				
Has public comment been included in mitigation measures?	Yes				
Mitigation measures to reduce residual risk or enhance opportunities: Please see **Section 7**: Points 3 & 5					

Residual impact	The disturbance of birds is somewhat inevitable, although the most sensitive receptors have already been protected through impact avoidance, through the application of no-go buffers

5.4 Cumulative Impacts of wind energy facilities on birds in this area

We received the below information from Arcus on renewable energy applications projects within a 35km radius (and a little further) of the Loxton 1 project (see **Figure 16** & **Table 18**). There are 12 wind energy applications in the broader area to the south of the Loxton project. **Not all of these are within 35km, but we nonetheless consider them below as they are part of the same landscape and present similar risks to avifauna.**

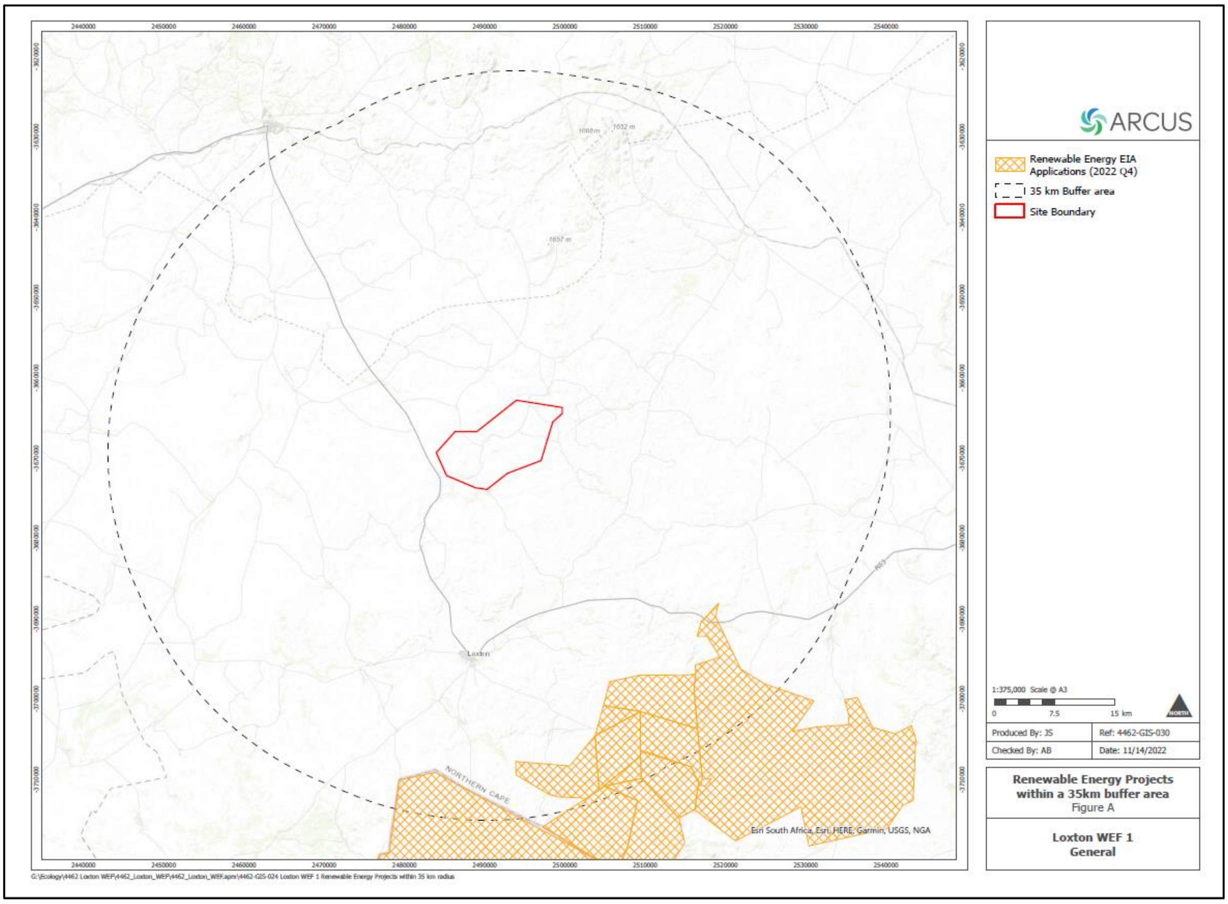

Figure 16. Approved renewable energy projects within 35km of the proposed project (figure provided by Arcus).

Table 18. Approved renewable energy projects within 30km of the proposed project.(Information provided by Arcus).

Project name	Details
Hoogland North WEF 1 (Redcap/Enel)	Approx 14km south of Loxton WEF 3; **Number of Turbines upto 60**; Installed capacity - up to a maximum of 420MW; Hub height – 80 to 150 m; Rotor Diameter - 100 m to 195 m; Blade radius – 50 m to 97.5 m blade / radius); Rotor top tip height: 130 m to 247.5 m (maximum based on 150 m hub + 97.5m blade = 247.5m)

Hoogland North WEF 2 (Redcap/Enel)	Approx 16km south of Loxton WEF 3; **Number of Turbines upto 60**; Installed capacity - up to a maximum of 420MW; Hub height – 80 to 150 m; Rotor Diameter - 100 m to 195 m; Blade radius – 50 m to 97.5 m blade / radius); Rotor top tip height: 130 m to 247.5 m (maximum based on 150 m hub + 97.5m blade = 247.5m)
Hoogland South WEF 3 (Redcap/Enel)	Approx 58km south of Loxton WEF 3; **number of Turbines upto 58**; Installed capacity - up to a maximum of 420MW; Hub height – 80 to 150 m; Rotor Diameter - 100 m to 195 m; Blade radius – 50 m to 97.5 m blade / radius); Rotor top tip height: 130 m to 247.5 m (maximum based on 150 m hub + 97.5m blade = 247.5m)
Hoogland South WEF 4 (Redcap Enel)	Approx 52km south of Loxton WEF 3; **Number of Turbines upto 58**; Installed capacity - up to a maximum of 420MW; Hub height – 80 to 150 m; Rotor Diameter - 100 m to 195 m Blade radius – 50 m to 97.5 m blade / radius); Rotor top tip height: 130 m to 247.5 m (maximum based on 150 m hub + 97.5m blade = 247.5m;
Nuweveld North WEF (Redcap Enel)	Approx 26km South of Loxton WEF 3; **Number of Turbines upto 35**; Installed capacity - up to a maximum of 280MW; Hub height – 80 to 150 m; Rotor Diameter - 110 m to 195 m; Blade radius – 50 m to 97.5 m blade / radius); Rotor top tip height: 140 m to 245 m (maximum based on 150 m hub + 95m blade = 245m)
Nuweveld East WEF (Redcap Enel)	Approx 37km South of Loxton WEF 3; **Number of Turbines upto 35**; Installed capacity - up to a maximum of 280MW; Hub height – 80 to 150 m; Rotor Diameter - 110 m to 195 m; Blade radius – 50 m to 97.5 m blade / radius); Rotor top tip height: 140 m to 245 m (maximum based on 150 m hub + 95m blade = 245m)
Nuweveld West WEF (Redcap Enel)	Approx 31km South East of Loxton WEF 3; **Number of Turbines upto 35**; Installed capacity - up to a maximum of 280MW; Hub height – 80 to 150 m; Rotor Diameter - 110 m to 195 m; Blade radius – 50 m to 97.5 m blade / radius); Rotor top tip height: 140 m to 245 m (maximum based on 150 m hub + 95m blade = 245m)
Taaibos North (WKN)	1-2km South Loxton WEF 3; **Number of Turbines upto 33**; Installed capacity - up to a maximum of 270MW; Hub height – upto 200m; Rotor Diameter - 240m; Blade radius – upto 120m blade / radius); Rotor top tip height: upto 320 (maximum based on 200m hub + 120m blade = 320m)
Taaibos South (WKN)	10-11km South Loxton WEF 3; **number of Turbines upto 40**; Installed capacity - up to a maximum of 270MW; Hub height – upto 200m; Rotor Diameter - 240m; Blade radius – upto 120m blade / radius); rotor top tip height: upto 320 (maximum based on 200m hub + 120m blade = 320m
Soutrivier North (WKN)	14km SSE of Loxton WEF 3; **Number of Turbines upto 31**; Installed capacity - up to a maximum of 270MW; Hub height – upto 200m; Rotor Diameter - 240m; Blade radius – upto 120m blade / radius); rotor top tip height: upto 320 (maximum based on 200m hub + 120m blade = 320m)
Soutrivier Central (WKN)	28km SSE of Loxton WEF 3; **Number of Turbines upto 32**; Installed capacity - up to a maximum of 270MW; Hub height – upto 200m; Rotor Diameter - 240m; Blade radius – upto 120m blade / radius); Rotor top tip height: upto 320 (maximum based on 200m hub + 120m blade = 320m)
Soutrivier South (WKN)	25km SE of Loxton WEF 3; **Number of Turbines upto 31**; Installed capacity - up to a maximum of 270MW; Hub height – upto 200m; Rotor Diameter - 240m; Blade radius – upto 120m blade / radius); rotor top tip height: upto 320 (maximum based on 200m hub + 120m blade = 320m)

The above projects combined could result in up to 508 wind turbines in addition to those planned at the Loxton wind farm cluster (142 - Loxton WEF 1 up to 42 turbines, Loxton WEF 2 up to 62 turbines, Loxton WEF 3 up to 38 turbines). This could bring the total number of turbines in this area to 650.

A cumulative impact, in relation to an activity, means the past, current and reasonable foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant, but may be significant when added to the existing and reasonable foreseeable impacts eventuating from similar or diverse activities (as defined by NEMA EIA Reg 1).

The cumulative impacts of wind energy on avifauna in the Loxton area area have been carefully assessed according to the guidance in the DEA (DEAT (2004) Cumulative Effects Assessment, Integrated Environmental Management, Information Series 7, Department of Environmental Affairs and Tourism (DEAT), Pretoria); and the IFC guidelines (Good Practice Handbook - Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets".

Specifically, the steps suggested by the above two sets of guidance have been undertaken to assess the cumulative impacts as follows:

Table 19. Steps taken to assess the cumulative impacts of renewable energy on birds in this area.

Step	**Approach**
1. Define and assess the impacts of the proposed project	This has been done in Section 5 of this report.
2. Identify and obtain details for all operational and authorised overhead power lines and wind farms (within 35km radius of the proposed project).	This has been done above, Figure 16 and Table 18
3. Identify impacts of the proposed project which are also likely or already exist at the other projects.	The above listed wind farm applications if constructed will result in the destruction of habitat and will also kille birds through collision with turbines. These are the two impacts common to all the above projects and Loxton 1, and of most significance.
4. Obtain reports and data for other projects.	WildSkies worked on many of the above projects and we have the reports.
5. As far as possible quantify the effect of all projects on key bird species local populations (will need to be defined and estimated).	Combined with Step 6 below
6. Express the likely impacts associated with the proposed project as a proportion of the overall impacts on key species.	At Loxton we estimate that approximately 2 hectares of ground surface area will be altered or destroyed per turbine (in total including turbine, hard stands, roads etc). Given the

	relatively undisturbed nature of vegetation on the site, most of this is likely to be natural vegetation. This is a small proportion of the overall site extent, and the habitat is neither particularly unique, nor in limited availability. We concluded that the significance of this impact is Low negative pre mitigation. Since this habitat destruction is largely unavoidable, we anticipate that the impact significance will remain unchanged by mitigation as Low Negative. However, considering all applications, a total of up to 1300ha could be transformed by 650 turbines. The number of bird fataliites through collision with turbines has been estimated at the Loxton projects, and most of the others. Although these estimates are mostly fairly low for each project, the cumulative impact across all projects is cause for concern.
7. A reasoned overall opinion will be expressed on the suitability of the proposed development against the above background (i.e. whether the receiving environment can afford to accommodate additional similar impacts). This will include a cumulative impact assessment statement.	Considering what we know, we judge the impact of habitat destruction by renewable energy facilities in this area to be of High significance. The current project contributes <10% of the potential impact that we are aware of.

The Cumulative Impacts have been assessed and populated in a cumulative impact summary table below as per the Arcus prescribed methodology.

Table 20. Cumulative impacts table.

Cumulative Impact: Name of impact					
Description of Cumulative Impact: The cumulative impacts of most significance are that of habitat destruction during construction, and bird fatalities through collision with turbines during operations.					
Impact Status: Negative					
	E	**D**	**R**	**M**	**P**
Without Enhancement	National	Long term	Recoverable	High	Highly probable
Score	4	4	3	4	4
With Enhancement	Regional	Long term	Recoverable	Moderate	Probable
Score	3	4	3	3	3
Significance Calculation	**Without Enhancement**			**With Enhancement**	

S=(E+D+R+M)*P	High Negative Impact (60)	Moderate Negative Impact (39)
Can Impacts be Enhanced?	The fatality impact can be mitigated at each wind farm. The habitat destruction impact cannot be enhanced, it is inevitable. Although the current farming land use on these properties appears not to impact on biodiversity, this is not always the case. Grazing regimes, veld management, pesticide use, problem animal control, fencing, water management and other practices all take their toll on biodiversity. There is an opportunity to enhance the natural habitat on projects through input into these management practices, perhaps through a biodiversity stewardship approach.	
Enhancement: Described above		
Residual impact	The destruction of habitat is inevitable, and the significance remains at Moderate with mitigation.	

Overall, we conclude that the cumulative impact of wind energy in this area will cause whole-scale changes to the avifauna environment within the greater Loxton area. However, given the limited grid availability at the Gamma MTS, and within the Hydra Cluster, it is unlikely that full allocation of turbines within a 35 km radius of the Loxton WEF will be achieved.

6. Consideration and assessment of alternatives

The NEMA requires the consideration and assessment of feasible and reasonable alternatives in the EIA process. Alternatives can include: Location of the proposed activity; Type of activity; Layout alternatives; Technology alternatives; and No-Go alternative.

6.1 Layout alternatives

No macro alternatives regarding turbine layout, other than the No-Go option, have been assessed in this specialist report. The site and layouts considered and assessed in this report are the Applicant's preferred alternatives. Site alternatives were screened out of the project scope in the Screening Phase (see **Section 4.1**). Micro-siting of the proposed infrastructure will be required as the project progresses, and will result in a preferred layout that minimises the predicted negative impacts.

6.2 The No-go alternative

The No-Go alternative will result in the *status quo* persisting on site. The *status quo* is mixed farming land use. This land use is not entirely without impacts on avifauna. Birds are subject to a number of mortality factors such as agrochemical poisoning (accidental), fence entanglement, road kill, power line electrocution and collision, disturbance of breeding, subsistence hunting, snaring and others. Habitat is also occasionally altered or destroyed through the creation of new arable lands, other construction, burning regimes, livestock overgrazing and other factors. Although these impacts all affect the avifaunal community on site, they do not appear to have pushed key species towards extinction in most cases. Furthermore, these impacts would not be replaced by the proposed project, they would all still persist in addition to the new impacts associated with the wind farm. The No-Go alternative therefore has much lower impacts on avifauna than the proposed project, and would be preferred from an avifaunal perspective. However, we determine that since the No-go constraints/buffers have already been taken into account for Loxton WEF 1, and with the recommended mitigation measures implemented going forward, it is our opinion that the Applicant's preference for developing the project is also acceptable.

7. Management & mitigation of identified impacts

Although extensive avoidance (see **Section 4**) of impacts has already been applied on this project via a Screening and Constraints Phase, and now a Scoping Phase, we recommend the following additional mitigation measures be applied to manage and further reduce the significance of impacts on birds. These mitigation measures apply to the three phases of construction, operations and decommissioning, and in many cases a particular measure applies to more than one of these phases. The Impact Assessment tables in **Section 5** detail which measures apply to each identified impact/phase.

- No wind turbines or overhead power lines should be placed within the identified No-Go areas. The High sensitivity areas should be avoided as far as possible with new infrastructure, in particular turbines. One proposed turbine is currently within the buffer area around the Ludwig's Bustard lek (classified as High sensitivity) and has been agreed to and approved by the specialist. Construction of this turbine and associated roads may be subject to a seasonal restriction (breeding season is variable dependent on rainfall and would need confirmation in the relevant year) if Ludwig's Bustard are found displaying in the these leks in the relevant construction year. An avifaunal specialist will need to survey for this.
- A pre-construction avifaunal walk down should be conducted to confirm final layout and identify any sensitivities that may arise between the conclusion of the EIA process and the construction phase. This can be done in any season, although May to October would be raptor breeding season and should be prioritised if possible.
- All human activities associated with construction, operation and decommissioning should be strictly managed according to generally accepted environmental best practice standards, so as to avoid any unnecessary impact on the receiving environment.
- Existing roads and tracks should be used as far as possible.
- Movement of all staff, vehicle and machinery activities should be strictly controlled at all times so as to ensure that the absolute minimum of surface area is impacted.
- Care should be taken not to introduce or propagate alien plant species/weeds during construction.
- Any underground cabling should follow roads at all times to reduce the impact on the habitat by grouping these linear infrastructures.
- A post-construction inspection must be conducted by an avifaunal specialist (at the start of operation phase monitoring) to confirm that all aspects have been appropriately handled and in particular that road and hard stand verges do not provide additional substrate for raptor prey species. It is essential that the new wind farm does not create favourable conditions for such mammals in high risk areas. We therefore recommend that within the first year of operations a full assessment of this aspect be made by the ornithologist contracted for post-construction monitoring. If such conditions have been created, case-specific solutions will need to be

developed and implemented by the wind farm. It is strongly recommended that rodenticides not be used at the newly established Operation and Maintenance (O&M) buildings or around auxiliary infrastructure on the project site. While pest control of this nature may be effective, even so-called “environmentally friendly” rodenticides are toxic and pose significant secondary poisoning risk to predatory avifauna, especially owls.

- A bird fatality threshold and adaptive management plan has been designed for the project (Appendix 14). This policy should form an annexure of the operational EMP for the facility. This plan identifies the number of bird fatalities of priority species which will trigger a management response, appropriate responses, and time lines for such responses. Fatalities of priority bird species are usually rare events (but with very high consequence) and it is difficult to analyse trends or statistics related to these fatalities as they occur. It is therefore important to have an adaptive management plan in place proactively to assist management.
- Following on from the above point, should the identified priority bird species fatality thresholds be exceeded in Year 1 and 2, an observer-led turbine Shutdown on Demand (SDOD) programme must be implemented on site. This programme must consist of a suitably qualified, trained and resourced team of observers present on site for all daylight hours 365 days of the year. This team must be stationed at vantage points with full visible coverage of all turbine locations. The observers must detect incoming priority bird species, track their flights, judge when they enter a turbine proximity threshold, and alert the control room to shut down the relevant turbine until the risk has reduced. A full detailed method statement or protocol must be designed by an ornithologist.
- The combination of hub height and rotor diameter must be optimised where technically feasible to maximise the lower blade tip height above ground. Raising the lower turbine blade tip height from a typical 30m above ground to 60m above ground (for example) will reduce collision risk for cranes, Ludwig’s Bustards, Black Harrier and korhaans, which typically fly low over the ground. Raising the lower blade tip from 30 to 60m above ground as a mitigation measure benefits every target species (in terms of reduced predicted mortality). We strongly recommend that any opportunity to raise the lower blade tip as much as possible, should be taken as this could significantly reduce the bird collision risk.
- Turbine blades must be painted according to a protocol currently under development by the South African Wind Energy Association (SAWEA) from the outset. Painting one of the three rotor blades black reduces motion smear and may greatly reduce avian collision risk. Provision must be made by the developer for the resolution of any technical, warranty, and supplier challenges that this may present.
- Any residual impacts during the operational phase after all possible mitigation measures have been implemented will need to be mitigated off site by the developer. The developer/facility will need to address other sources of mortality of priority species in a measurable way so as to compensate for residual effects on the facility itself. This will need to be detailed in a Biodiversity

Action Plan compiled by an ornithologist. Since most priority species for this project face considerable threat through overhead power lines across their range, a likely off-site mitigation measure could be the mitigation of power line impacts on Eskom's network. These are measurable and easily mitigated impacts which could result in a no nett loss or even nett gain scenario for priority bird species.

- No internal medium voltage power lines should be overhead. All such cables should be buried along road verges. Only the 132kV collector lines and grid connection power line should be above ground.
- Any overhead conductors or earth wires should be fitted with an Eskom approved anti-bird collision line-marking device to make cables more visible to birds in flight and reduce the likelihood of collisions.
- The pole design of any overhead power line should be approved by an ornithologist in terms of the electrocution risk it may pose to large birds such as eagles.
- Should more than one power line be constructed in parallel with another either new or existing power line, the pylon structures should be staggered as per Pallett *et al*. (2022) to increase visibility to large, slow-moving species, especially bustards and cranes.
- The "during construction" and "post-construction" monitoring programme outlined in **Appendix 7** should be implemented according to the latest available version of the Best Practice Guidelines at the time. The findings from operational phase monitoring should inform an adaptive management programme to mitigate any impacts on avifauna to acceptable levels. In particular, any Verreaux's Eagle fatalities should be reported to Dr Megan Murgatroyd in order to close the feedback loop back to the VERA modelling performed for this site.

Note: this is a rapidly evolving field and as more wind farms become operational, the learning curve steepens in terms of mitigation of risks to birds. A number of new technology options are possibly on the horizon, including: blade illumination; radar technology; and acoustic deterrents. The project must keep abreast of these developments and implement if deemed necessary and reasonable as per the adaptive management plan contained in this report.

8. Conclusion & Recommendations

We draw the following conclusions regarding the avifaunal community and potential impacts of the proposed wind farm:

- We classified three bird species as being at High risk should the projects proceed, and two species at Medium risk. High risk species include: Ludwig's Bustard (Endangered), Verreaux's Eagle (Vulnerable) and Jackal Buzzard (endemic, not Red Listed). Martial Eagle (Endangered) and Black Harrier (Endangered) were classified as Medium risk.
- Since the turbine model has not been finalised, we estimated bird fatalities using a 'typical rotor envelope' of 30 to 230m above ground. It is estimated that before mitigation approximately 3.41 bird fatalities could be recorded at the wind farm per year across the 20 target bird species recorded flying on site for a turbine rotor swept area of 30 – 230m. This includes: 0.66 Ludwig's Bustards, 0.47 Verreaux's Eagles and 1.38 Jackal Buzzards. Although the preferred turbine model would result in a lower blade tip 25 – 35m above ground, for illustrative purposes we ran the calculation using a lower blade tip of 60m above ground (as a best case scenario). The fatality estimates could be reduced significantly with an increase in minimum blade height above ground as most bird flight was recorded closer to the ground than 60m. We strongly recommend that any opportunity to raise the lower blade tip as much as possible should be taken, as this could significantly reduce the bird collision risk.

Based on this assessed risk, we assessed the potential impacts on birds and made the following findings:

Impact	**Significance before mitigation**	**Significance after mitigation**
Construction phase		
Habitat destruction during construction	Moderate negative	Moderate negative
Disturbance of birds during construction	Low negative	Low negative
Operational phase		
Disturbance during operations	Low negative	Low negative
Displacement during operations	Low negative	Low negative
Collision with turbine blades	High negative	Moderate negative
Bird collision with turbine infrastructure during operations	High negative	Moderate negative
Bird electrocution during operations	High negative	Low negative
Decommissioning phase		
Disturbance of birds during decommissioning	Low negative	Low negative
Cumulative impacts		
Habitat destruction & bird fatality through turbine collision	High negative	Moderate negative

In addition to the avoidance measures already implemented for the overall site of three wind farms (which include No-Go nest buffers, some derived from the Verreaux's Eagle Risk Assessment model) that pertain to raptor nest buffers and bustard lekking areas, the following mitigation measures in terms of the developable site area are recommended:

- No wind turbines or overhead power lines should be placed within the identified No-Go areas. The High sensitivity areas should be avoided as far as possible with new infrastructure, in particular turbines. One proposed turbine is currently within the buffer area around the Ludwig's Bustard lek (classified as High sensitivity) and has been agreed to and approved by the specialist. Construction of this turbine and associated roads may be subject to a seasonal restriction (breeding season is variable dependent on rainfall and would need confirmation in the relevant year) if Ludwig's Bustard are found displaying in the these leks in the relevant construction year. An avifaunal specialist will need to survey for this.
- A pre-construction avifaunal walk down should be conducted to confirm final layout and identify any sensitivities that may arise between the conclusion of the EIA process and the construction phase. This can be done in any season, although May to October would be raptor breeding season and should be prioritised if possible.
- All human activities associated with construction, operation and decommissioning should be strictly managed according to generally accepted environmental best practice standards, so as to avoid any unnecessary impact on the receiving environment.
- Existing roads and tracks should be used as far as possible.
- Movement of all staff, vehicle and machinery activities should be strictly controlled at all times so as to ensure that the absolute minimum of surface area is impacted.
- Care should be taken not to introduce or propagate alien plant species/weeds during construction.
- Any underground cabling should follow roads at all times to reduce the impact on the habitat by grouping these linear infrastructures.
- A post-construction inspection must be conducted by an avifaunal specialist (at the start of operation phase monitoring) to confirm that all aspects have been appropriately handled and in particular that road and hard stand verges do not provide additional substrate for raptor prey species. It is essential that the new wind farm does not create favourable conditions for such mammals in high risk areas. We therefore recommend that within the first year of operations a full assessment of this aspect be made by the ornithologist contracted for post-construction monitoring. If such conditions have been created, case-specific solutions will need to be developed and implemented by the wind farm. It is strongly recommended that rodenticides not be used at the newly established Operation and Maintenance (O&M) buildings or around auxiliary infrastructure on the project site. While pest control of this nature may be effective, even so-

called “environmentally friendly” rodenticides are toxic and pose significant secondary poisoning risk to predatory avifauna, especially owls.

- A bird fatality threshold and adaptive management plan has been designed for the project (Appendix 14). This policy should form an annexure of the operational EMP for the facility. This plan identifies the number of bird fatalities of priority species which will trigger a management response, appropriate responses, and time lines for such responses. Fatalities of priority bird species are usually rare events (but with very high consequence) and it is difficult to analyse trends or statistics related to these fatalities as they occur. It is therefore important to have an adaptive management plan in place proactively to assist management.
- Following on from the above point, should the identified priority bird species fatality thresholds be exceeded in Year 1 and 2, an observer-led turbine Shutdown on Demand (SDOD) programme must be implemented on site. This programme must consist of a suitably qualified, trained and resourced team of observers present on site for all daylight hours 365 days of the year. This team must be stationed at vantage points with full visible coverage of all turbine locations. The observers must detect incoming priority bird species, track their flights, judge when they enter a turbine proximity threshold, and alert the control room to shut down the relevant turbine until the risk has reduced. A full detailed method statement or protocol must be designed by an ornithologist.
- The combination of hub height and rotor diameter must be optimised where technically feasible to maximise the lower blade tip height above ground. Raising the lower turbine blade tip height from a typical 30m above ground to 60m above ground (for example) will reduce collision risk for cranes, Ludwig’s Bustards, Black Harrier and korhaans, which typically fly low over the ground. Raising the lower blade tip from 30 to 60m above ground as a mitigation measure benefits every target species (in terms of reduced predicted mortality). We strongly recommend that any opportunity to raise the lower blade tip as much as possible, should be taken as this could significantly reduce the bird collision risk.
- Turbine blades must be painted according to a protocol currently under development by the South African Wind Energy Association (SAWEA) from the outset. Painting one of the three rotor blades black reduces motion smear and may greatly reduce avian collision risk. Provision must be made by the developer for the resolution of any technical, warranty, and supplier challenges that this may present.
- Any residual impacts during the operational phase after all possible mitigation measures have been implemented will need to be mitigated off site by the developer. The developer/facility will need to address other sources of mortality of priority species in a measurable way so as to compensate for residual effects on the facility itself. This will need to be detailed in a Biodiversity Action Plan compiled by an ornithologist. Since most priority species for this project face considerable threat through overhead power lines across their range, a likely off-site mitigation measure could be the mitigation of power line impacts on Eskom’s network. These are

measurable and easily mitigated impacts which could result in a no nett loss or even nett gain scenario for priority bird species.

- No internal medium voltage power lines should be overhead. All such cables should be buried along road verges. Only the 132kV collector lines and grid connection power line should be above ground.
- Any overhead conductors or earth wires should be fitted with an Eskom approved anti-bird collision line-marking device to make cables more visible to birds in flight and reduce the likelihood of collisions.
- The pole design of any overhead power line should be approved by an ornithologist in terms of the electrocution risk it may pose to large birds such as eagles.
- Should more than one power line be constructed in parallel with another either new or existing power line, the pylon structures should be staggered as per Pallett *et al*. (2022) to increase visibility to large, slow-moving species, especially bustards and cranes.
- The "during construction" and "post-construction" monitoring programme outlined in **Appendix 7** should be implemented according to the latest available version of the Best Practice Guidelines at the time. The findings from operational phase monitoring should inform an adaptive management programme to mitigate any impacts on avifauna to acceptable levels. In particular, any Verreaux's Eagle fatalities should be reported to Dr Megan Murgatroyd in order to close the feedback loop back to the VERA modelling performed for this site.

The Applicant (Loxton Wind Facility 1) has redesigned the developable area of the proposed Loxton WEF 1 to avoid the No-Go areas identified in this report. One proposed turbine is within the buffer area around the Ludwig's Bustard lek (classified as High sensitivity) and has been approved by the specialist. Construction of this turbine and associated roads may be subject to a seasonal restriction if Ludwig's Bustard are found displaying in the these leks in the relevant construction year. An avifaunal specialist will need to survey for this. Increasing the minimum turbine blade height above ground from 30m to 60m can potentially reduce collision risk by as much as 75% for this species and for almost every other target species assessed, to varying degrees. Increasing minimum rotor swept height is strongly recommended.

Avifaunal impacts have been assessed in this document and have been mostly determined to be of Low or Moderate Negative significance post-mitigation, with the exception of habitat destruction and the impact of fatalities as a direct result of turbine and power line collisions, which remain at Moderate Negative post mitigation. Cumulative impacts will be of High negative significance pre-mitigation, and Moderate negative significance post mitigation.

According to available information consulted during this study to date, there are no fatal flaws from an avifaunal sensitivity perspective which should prevent the wind farm from proceeding.

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Appendix 1. Bird species recorded on the site

Table A1. List of all bird species identified on the site throughout the year of monitoring

	Common Name	Scientific Name	Red Data (Regional, Global)*	Endemism**	Collision Risk (Retief *et al.* 2014)	Site Visit 1	Site Visit 2	Site Visit 3	Site Visit 4
1	**Bustard, Ludwig's**	***Neotis ludwigii***	**EN, EN**		**14**	**1**	**1**	**1**	**1**
2	**Eagle, Martial**	***Polemaetus bellicosus***	**EN, VU**		**4**	**1**	**1**	**1**	**1**
3	**Harrier, Black**	***Circus maurus***	**EN, EN**	**NE**	**6**			**1**	
4	**Eagle, Verreaux's**	***Aquila verreauxii***	**VU, LC**		**3**	**1**	**1**	**1**	**1**
5	**Falcon, Lanner**	***Falco biarmicus***	**VU, LC**		**24**	**1**		**1**	**1**
6	**Secretarybird**	***Sagittarius serpentarius***	**VU, EN**		**13**	**1**	**1**		**1**
7	**Stork, Black**	***Ciconia nigra***	**VU, LC**		**10**		**1**	**1**	
8	**Crane, Blue**	***Grus paradisea***	**NT, VU**		**11**			**1**	
9	**Korhaan, Karoo**	***Eupodotis vigorsii***	**NT, LC**		**51**	**1**	**1**	**1**	**1**
10	**Lark, Sclater's**	***Spizocorys sclateri***	**NT, NT**	**NE**	**50**	**1**	**1**		
11	**Pipit, African Rock**	***Anthus crenatus***	**NT, LC**	**SLS**	**78**			**1**	**1**
12	Avocet, Pied	*Recurvirostra avosetta*				1	1	1	1
13	Barbet, Acacia Pied	*Tricholaema leucomelas*				1	1	1	1
14	Batis, Pririt	*Batis pririt*				1	1	1	1
15	Bee-eater, European	*Merops apiaster*					1	1	
16	Bishop, Southern Red	*Euplectes orix*				1	1	1	1
17	Bokmakierie	*Telophorus zeylonus*				1	1	1	1
18	Bulbul, African Red-eyed	*Pycnonotus nigricans*				1	1	1	1
19	Bunting, Cape	*Emberiza capensis*				1	1	1	1
20	Bunting, Cinnamon-breasted	*Emberiza tahapisi*						1	
21	Bunting, Lark-like	*Emberiza impetuani*				1	1	1	1

22	Buttonquail, Common (Kurrichane)	*Turnix sylvaticus*						1	
23	Buzzard, Common (Steppe)	*Buteo buteo*			67		1	1	
24	Buzzard, Jackal	*Buteo rufofuscus*		NE	43	1	1	1	1
25	Canary, Black-headed	*Serinus alario*		NE		1		1	1
26	Canary, Black-throated	*Crithagra atrogularis*				1	1	1	1
27	Canary, Cape	*Serinus canicollis*					1	1	1
28	Canary, White-throated	*Crithagra albogularis*				1	1	1	1
29	Canary, Yellow	*Crithagra flaviventris*				1	1	1	1
30	Chat, Ant-eating	*Myrmecocichla for-micivora*				1	1	1	1
31	Chat, Familiar	*Oenathe familiaris*				1	1	1	1
32	Chat, Karoo	*Emarginata schlegelii*				1	1	1	1
33	Chat, Sickle-winged	*Emarginata sinuata*		NE		1	1	1	1
34	Chat, Tractrac	*Emarginata tractrac*				1			
35	Cisticola, Cloud	*Cisticola textrix*		NE				1	
36	Cisticola, Desert	*Cisticola aridulus*						1	1
37	Cisticola, Grey-backed	*Cisticola subruficapilla*					1	1	1
38	Cisticola, Zitting	*Cisticola juncidis*						1	
39	Coot, Red-knobbed	*Fulica cristata*				1			1
40	Cormorant, Reed	*Microcarbo africanus*					1	1	1
41	Courser, Double-banded	*Rhinoptilus africanus*			72	1	1	1	1
42	Crombec, Long-billed	*Sylvietta rufescens*				1	1	1	1
43	Crow, Cape	*Corvus capensis*						1	
44	Crow, Pied	*Corvus albus*				1	1	1	1
45	Dove, Cape Turtle (Ring-necked)	*Streptopelia capicola*				1	1	1	1
46	Dove, Laughing	*Spilopelia senegalensis*				1	1	1	1
47	Dove, Namaqua	*Oena capensis*				1	1	1	1

48	Dove, Red-eyed	*Streptopelia semitor-quata*					1	1	1
49	Dove, Rock	*Columba livia*				1	1	1	1
50	Duck, Yellow-billed	*Anas undulata*				1		1	1
51	Eagle, Black-chested Snake	*Circaetus pectoralis*			60	1		1	1
52	Eagle, Booted	*Hieraaetus pennatus*			59	1	1	1	
53	Egret, Western Cattle	*Bubulcus ibis*					1		
54	Eremomela, Karoo	*Eremomela gregalis*		NE		1	1	1	1
55	Eremomela, Yellow-bel-lied	*Eremomela icteropygialis*				1	1	1	1
56	Falcon, Amur	*Falco amurensis*			66			1	
57	Falcon, Peregrine	*Falco peregrinus*			49			1	
58	Finch (Weaver), Scaly-feathered	*Sporopipes squamifrons*					1	1	1
59	Finch, Red-headed	*Amadina erythrocephala*					1	1	1
60	Firefinch, Red-billed	*Lagonosticta senegala*						1	
61	Fiscal, Southern (Com-mon)	*Lanius collaris*				1	1	1	1
62	Flycatcher, Chat	*Melaenornis infuscatus*					1	1	1
63	Flycatcher, Fairy	*Stenostira scita*		NE			1	1	1
64	Francolin, Grey-winged	*Scleroptila afra*		SLS	80	1	1	1	
65	Goose, Egyptian	*Alopochen aegyptiaca*				1	1	1	1
66	Goose, Spur-winged	*Plectropterus gambensis*						1	1
67	Goshawk, Gabar	*Micronisus gabar*							1
68	Goshawk, Pale Chant-ing	*Melierax canorus*			75	1	1	1	1
69	Grebe, Little	*Tachybaptus ruficollis*						1	1
70	Greenshank, Common	*Tringa nebularia*				1	1	1	1
71	Guineafowl, Helmeted	*Numida meleagris*							1
72	Hamerkop	*Scopus umbretta*							1

73	Hawk, African Harrier-	*Polyboroides typus*			85	1		1	1
74	Heron, Black-headed	*Ardea melanocephala*				1		1	1
75	Heron, Grey	*Ardea cinerea*						1	1
76	Heron, Squacco	*Ardeola ralloides*							1
77	Hoopoe, African	*Upupa africana*					1	1	1
78	Ibis, African Sacred	*Threskiornis aethiopicus*				1	1	1	1
79	Ibis, Hadeda (Hadada)	*Bostrychia hagedash*				1	1	1	1
80	Kestrel, Greater	*Falco rupicoloides*			95			1	
81	Kestrel, Lesser	*Falco naumanni*			64			1	
82	Kestrel, Rock	*Falco rupicolus*				1	1	1	1
83	Korhaan, Northern Black	*Afrotis afraoides*			90	1	1	1	1
84	Lapwing, Blacksmith	*Vanellus armatus*				1	1		1
85	Lapwing, Black-winged	*Vanellus melanopterus*						1	
86	Lapwing, Crowned	*Vanellus coronatus*						1	1
87	Lark, Black-eared Spar-row-	*Eremopterix australis*		NE		1	1	1	1
88	Lark, Eastern Clapper	*Mirafra fasciolata*						1	1
89	Lark, Grey-backed Spar-row	*Eremopterix verticalis*				1	1	1	1
90	Lark, Karoo	*Calendulauda albescens*		NE		1	1	1	1
91	Lark, Karoo Long-billed	*Certhilauda subcoronata*				1	1	1	1
92	Lark, Large-billed	*Galerida magnirostris*		NE		1	1	1	1
93	Lark, Melodious	*Mirafra cheniana*		NE	91			1	
94	Lark, Red-capped	*Calandrella cinerea*				1	1	1	1
95	Lark, Sabota	*Calendulauda sabota*				1	1	1	1
96	Lark, Spike-heeled	*Chersomanes albofas-ciata*				1	1	1	1
97	Martin, Brown-throated	*Riparia paludicola*						1	
98	Martin, Rock	*Ptyonoprogne fuligula*				1	1	1	1

99	Moorhen, Common	*Gallinula chloropus*					1	1	1
100	Mousebird, Red-faced	*Urocolius indicus*				1	1	1	1
101	Mousebird, White-backed	*Colius colius*				1	1	1	1
102	Neddicky	*Cisticola fulvicapilla*				1			1
103	Nightjar, Rufous-cheeked	*Caprimulgus rufigena*						1	
104	Owl, Cape Eagle-	*Bubo capensis*			42	1			1
105	Owl, Spotted Eagle-	*Bubo africanus*			98	1		1	1
106	Penduline-tit, Cape	*Anthoscopus minutus*						1	1
107	Pigeon, Speckled	*Columba guinea*				1	1	1	1
108	Pipit, African	*Anthus cinnamomeus*				1	1	1	1
109	Pipit, Nicholson's	*Anthus similis*				1		1	1
110	Plover, Kittlitz’s	*Charadrius pecuarius*				1	1	1	1
111	Plover, Three-banded	*Charadrius tricollaris*				1	1	1	1
112	Prinia, Karoo	*Prinia maculosa*		NE		1	1	1	1
113	Quail, Common	*Coturnix coturnix*						1	1
114	Quail-finch, African	*Ortygospiza atricollis*						1	1
115	Quelea, Red-billed	*Quelea quelea*						1	
116	Raven, White-necked	*Corvus albicollis*				1	1	1	1
117	Robin, Karoo Scrub	*Cercotrichas coryphoeus*				1	1	1	1
118	Robin-chat, Cape	*Cossypha caffra*					1	1	1
119	Sandgrouse, Namaqua	*Pterocles namaqua*				1	1	1	1
120	Shelduck, South African	*Tadorna cana*				1	1	1	1
121	Shoveler, Cape	*Spatula smithii*						1	1
122	Shrike, Lesser Grey	*Lanius minor*						1	
123	Sparrow, Cape	*Passer melanurus*				1	1	1	1
124	Sparrow, House	*Passer domesticus*				1	1	1	1
125	Sparrow, Southern Grey-headed	*Passer diffusus*				1	1	1	1

126	Sparrowhawk, Rufous-breasted	*Accipiter rufiventris*			101	1		1	
127	Spoonbill, African	*Platalea alba*							1
128	Spurfowl, Cape	*Pternistis capensis*		NE		1			
129	Starling, Cape Glossy (Cape)	*Lamprotornis nitens*				1			
130	Starling, Pale-winged	*Onychognathus nabouroup*				1		1	1
131	Starling, Pied	*Lamprotornis bicolor*		SLS		1	1	1	1
132	Starling, Red-winged	*Onychognathus morio*							1
133	Starling, Wattled	*Creatophora cinerea*				1		1	1
134	Stilt, Black-winged	*Himantopus himantopus*				1	1	1	1
135	Stint, Little	*Calidris minuta*						1	
136	Stonechat, African	*Saxicola torquatus*				1	1	1	1
137	Sunbird, Dusky	*Cinnyris fuscus*					1	1	1
138	Sunbird, Malachite	*Nectarinia famosa*						1	
139	Swallow, Barn	*Hirundo rustica*					1	1	1
140	Swallow, Greater Striped	*Cecropis cucullata*					1	1	
141	Swallow, Pearl-breasted	*Hirundo dimidiata*					1	1	
142	Swallow, Red-breasted	*Cecropis semirufa*						1	
143	Swallow, South African Cliff	*Petrochelidon spilodera*		BNE			1		
144	Swallow, White-throated	*Hirundo albigularis*					1	1	
145	Swift, African Black	*Apus barbatus*						1	
146	Swift, Alpine	*Tachymarptis melba*				1			1
147	Swift, Common	*Apus apus*						1	
148	Swift, Horus	*Apus horus*					1		
149	Swift, Little	*Apus affinis*				1	1	1	1
150	Swift, White-rumped	*Apus caffer*					1	1	

151	Teal, Cape	*Anas capensis*						1	1
152	Teal, Red-billed	*Anas erythrorhyncha*							1
153	Thick-knee, Spotted	*Burhinus capensis*					1	1	1
154	Thrush, Karoo	*Turdus smithi*		NE			1	1	1
155	Tit, Grey	*Melaniparus afer*		NE		1	1	1	1
156	Tit-Babbler (Warbler), Layard’s	*Sylvia layardi*		NE		1	1	1	1
157	Wagtail, Cape	*Motacilla capensis*				1	1	1	1
158	Warbler, Cinnamon-breasted	*Euryptila subcinnamomea*		NE		1	1	1	1
159	Warbler, Rufous-eared	*Malcorus pectoralis*				1	1	1	1
160	Waxbill, Common	*Estrilda astrild*					1	1	
161	Weaver, Cape	*Ploceus capensis*		NE				1	1
162	Weaver, Southern Masked	*Ploceus velatus*				1	1	1	1
163	Wheatear, Capped	*Oenanthe pileata*						1	1
164	Wheatear, Mountain	*Myrmecocichla monticola*				1	1	1	1
165	White-eye, Cape	*Zosterops virens*		NE		1	1	1	1
					TOTALS:	**95**	**103**	**145**	**124**

‘1’ denotes presence, not abundance. Rec = Number of Records

**Regional Red List status according to Taylor* et al. *2015 – most recent regional conservation status for species*

**Global Red List status according to IUCN 2022*

EN = Endangered; VU = Vulnerable; NT = Near-threatened; LC = Least Concern

***Endemism – whether the species is endemic (E) or near endemic (NE) to South Africa.*

E = Endemic; NE = Near-endemic; SLS = Endemic to South Africa, Lesotho & Swaziland; BNE = Breeding near endemic

Retief et al. *2014 – the species ranking in terms of turbine collision risk – as per Avian Wind Farm Sensitivity Map*

(This key applies to all following species tables)

Appendix 2. Small passerine bird species recorded on the site

Table A 2. Walked Transect data for the site: all species

			FULL YEAR			S1			S2			S3			S4		
		Transect length (km)	72			18			18			18			18		
		# species	67			31			30			47			35		
Common Name	**Scientific Name**	**Ende-mism***	**Birds**	**Rec**	**Birds /km**	**Birds**	**Rec**	**Birds /km**	**Birds**	**Rec**	**Birds /km**	**Birds**	**Rec**	**Birds /km**	**Birds**	**Rec**	**Birds /km**
Grey-backed Sparrow-Lark	*Eremopterix verticalis*		397	50	5.51				3	2	0.17	394	48	21.89			
Lark-like Bunting	*Emberiza impetuani*		391	65	5.43	7	4	0.39	17	12	0.94	349	42	19.39	18	7	1.00
Black-eared Sparrow-Lark	*Eremopterix australis*	NE	176	4	2.44				176	4	9.78						
Spike-heeled Lark	*Chersomanes albofas-ciata*		159	49	2.21	27	9	1.50	23	10	1.28	35	10	1.94	74	20	4.11
Karoo Long-billed Lark	*Certhilauda subcoronata*		107	84	1.49	16	15	0.89	20	19	1.11	44	30	2.44	27	20	1.50
African Pipit	*Anthus cinnamomeus*		99	50	1.38							96	47	5.33	3	3	0.17
Rufous-eared Warbler	*Malcorus pectoralis*		80	64	1.11	7	5	0.39	13	12	0.72	24	20	1.33	36	27	2.00
Large-billed Lark	*Galerida magnirostris*	NE	73	60	1.01	3	3	0.17	8	7	0.44	38	33	2.11	24	17	1.33
Cape Sparrow	*Passer melanurus*		71	30	0.99	30	9	1.67	12	9	0.67	12	4	0.67	17	8	0.94
Karoo Chat	*Emarginata schlegelii*		59	45	0.82	14	11	0.78	19	14	1.06	8	6	0.44	18	14	1.00
Sickle-winged Chat	*Emarginata sinuata*	NE	39	27	0.54	3	2	0.17	10	7	0.56	6	6	0.33	20	12	1.11
Black-headed Canary	*Serinus alario*	NE	38	6	0.53										38	6	2.11
Pied Crow	*Corvus albus*		33	18	0.46	17	10	0.94	7	5	0.39				9	3	0.50
Cape Bunting	*Emberiza capensis*		30	26	0.42	7	7	0.39	3	3	0.17	8	7	0.44	12	9	0.67
Karoo Scrub Robin	*Cercotrichas coryphoeus*		26	17	0.36	9	6	0.50	6	5	0.33	2	1	0.11	9	5	0.50
Wattled Starling	*Creatophora cinerea*		25	2	0.35							25	2	1.39			
Grey Tit	*Melaniparus afer*	NE	24	17	0.33	3	3	0.17	4	3	0.22	5	5	0.28	12	6	0.67

Speckled Pigeon	*Columba guinea*		23	4	0.32										23	4	1.28
Karoo Eremomela	*Eremomela gregalis*	NE	21	9	0.29	2	1	0.11	2	1	0.11	9	4	0.50	8	3	0.44
Desert Cisticola	*Cisticola aridulus*		20	19	0.28							14	13	0.78	6	6	0.33
Common Quail	*Coturnix coturnix*		20	13	0.28							13	10	0.72	7	3	0.39
Yellow Canary	*Crithagra flaviventris*		18	9	0.25				3	3	0.17	2	1	0.11	13	5	0.72
South African Shelduck	*Tadorna cana*		18	6	0.25	6	2	0.33				7	2	0.39	5	2	0.28
Pied Starling	*Lamprotornis bicolor*	SLS	18	3	0.25	18	3	1.00									
Yellow-bellied Ere-momela	*Eremomela icteropygialis*		17	10	0.24	2	1	0.11	4	3	0.22	4	1	0.22	7	5	0.39
White-throated Canary	*Crithagra albogularis*		17	7	0.24	5	3	0.28	1	1	0.06	6	1	0.33	5	2	0.28
Barn Swallow	*Hirundo rustica*		16	9	0.22				2	1	0.11	14	8	0.78			
Common Buttonquail	*Turnix sylvaticus*		11	7	0.15							11	7	0.61			
Egyptian Goose	*Alopochen aegyptiaca*		11	6	0.15	2	1	0.11	2	2	0.11	6	2	0.33	1	1	0.06
Layard's Warbler	*Curruca layardi*		9	9	0.13	1	1	0.06	3	3	0.17	2	2	0.11	3	3	0.17
Sabota Lark	*Calendulauda sabota*		9	7	0.13	5	3	0.28				4	4	0.22			
Ring-necked Dove	*Streptopelia capicola*		8	6	0.11	2	1	0.11	2	2	0.11				4	3	0.22
Mountain Wheatear	*Myrmecocichla monticola*		8	5	0.11				2	2	0.11	5	2	0.28	1	1	0.06
Karoo Lark	*Calendulauda albescens*	NE	7	6	0.10				3	3	0.17	1	1	0.06	3	2	0.17
Cape Wagtail	*Motacilla capensis*		7	4	0.10	5	3	0.28							2	1	0.11
Namaqua Sandgrouse	*Pterocles namaqua*		7	4	0.10	2	1	0.11	2	2	0.11	3	1	0.17			
Black-throated Canary	*Crithagra atrogularis*		7	3	0.10	7	3	0.39									
Capped Wheatear	*Oenanthe pileata*		6	6	0.08							6	6	0.33			
Familiar Chat	*Oenanthe familiaris*		6	5	0.08	3	3	0.17				2	1	0.11	1	1	0.06
Quailfinch	*Ortygospiza atricollis*		6	3	0.08							4	2	0.22	2	1	0.11
Chat Flycatcher	*Melaenornis infuscatus*		4	4	0.06				3	3	0.17	1	1	0.06			
Dusky Sunbird	*Cinnyris fuscus*		4	3	0.06				1	1	0.06	3	2	0.17			
African Black Swift	*Apus barbatus*		4	1	0.06							4	1	0.22			
Cape Canary	*Serinus canicollis*		4	1	0.06							4	1	0.22			
Karoo Prinia	*Prinia maculosa*	NE	3	3	0.04							2	2	0.11	1	1	0.06
Namaqua Dove	*Oena capensis*		3	2	0.04				3	2	0.17						
White-necked Raven	*Corvus albicollis*		3	2	0.04				1	1	0.06	2	1	0.11			

Pale-winged Starling	*Onychognathus nabouroup*		3	1	0.04	3	1	0.17									
Southern Masked Weaver	*Ploceus velatus*		3	1	0.04							3	1	0.17			
Eastern Clapper Lark	*Mirafra fasciolata*		2	2	0.03							2	2	0.11			
Blacksmith Lapwing	*Vanellus armatus*		2	1	0.03	2	1	0.11									
Bokmakierie	*Telophorus zeylonus*		2	1	0.03							2	1	0.11			
Common Waxbill	*Estrilda astrild*		2	1	0.03							2	1	0.11			
Grey-backed Cisticola	*Cisticola subruficapilla*		2	1	0.03							2	1	0.11			
Long-billed Crombec	*Sylvietta rufescens*		2	1	0.03										2	1	0.11
Red-headed Finch	*Amadina erythrocephala*		2	1	0.03										2	1	0.11
African Spoonbill	*Platalea alba*		1	1	0.01										1	1	0.06
Ant-eating Chat	*Myrmecocichla for-micivora*		1	1	0.01				1	1	0.06						
Cape Penduline Tit	*Anthoscopus minutus*		1	1	0.01										1	1	0.06
Cloud Cisticola	*Cisticola textrix*	NE	1	1	0.01							1	1	0.06			
Kittlitz's Plover	*Charadrius pecuarius*		1	1	0.01	1	1	0.06									
Melodious Lark	*Mirafra cheniana*	NE	1	1	0.01							1	1	0.06			
Red-breasted Swallow	*Cecropis semirufa*		1	1	0.01							1	1	0.06			
Rock Martin	*Ptyonoprogne fuligula*		1	1	0.01	1	1	0.06									
Southern Fiscal	*Lanius collaris*		1	1	0.01	1	1	0.06									
Three-banded Plover	*Charadrius tricollaris*		1	1	0.01	1	1	0.06									
Zitting Cisticola	*Cisticola juncidis*		1	1	0.01							1	1	0.06			

Appendix 3. Large terrestrial & raptor data recorded on Drive Transects on the site

Table A 3. Driven Transect data for the site

				FULL YEAR			Site Visit 1		Site Visit 2		Site Visit 3		Site Visit 4	
			Transect length (km)	**321.2**			**81.4**		**81.4**		**81.4**		**77**	
			# Species	**12**			**7**		**4**		**10**		**5**	
Common Name	**Taxonomic Name**	**Red List: Regional, Global**	**Endemism**	**Birds**	**Records**	**Birds/km**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**
Lesser Kestrel	*Falco naumanni*			145	6	0.451					145	6		
Amur Falcon	*Falco amurensis*			50	2	0.156					50	2		
Karoo Korhaan	*Eupodotis vigorsii*	NT, LC		32	16	0.100	13	5	14	8	1	1	4	2
Pale Chanting Goshawk	*Melierax canorus*			18	13	0.056	4	2	5	4	8	6	1	1
South African Shelduck	*Tadorna cana*			18	7	0.056	6	2	2	1	6	2	4	2
Jackal Buzzard	*Buteo rufofuscus*		NE	13	11	0.040	3	3	3	2	2	2	5	4
Common Buzzard	*Buteo buteo*			3	1	0.009					3	1		
Martial Eagle	*Polemaetus bellicosus*	EN, VU		3	3	0.009	2	2			1	1		
Verreaux's Eagle	*Aquila verreauxii*	VU, LC		2	2	0.006	1	1					1	1
Northern Black Korhaan	*Afrotis afraoides*			1	1	0.003					1	1		
Ludwig's Bustard	*Neotis ludwigii*	EN, EN		1	1	0.003	1	1						
Black Stork	*Ciconia nigra*	VU, LC		1	1	0.003					1	1		

Appendix 4. Focal Site photographs

Figure A 1. Example of nest Focal Sites in the broader study area

Appendix 5. Incidental Observation data recorded on the site

Table A 4. Incidental Observations of target bird species on site

			FULL YEAR		Site Visit 1		Site Visit 2		Site Visit 3		Site Visit 4	
		# Species	**35**		**21**		**28**		**21**		**19**	
Common Name	**Scientific Name**	**Red List: Regional, Global (Endemism)**	**Birds**	**Records**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**
Karoo Korhaan	*Eupodotis vigorsii*	NT, LC	256	101	86	37	51	19	36	16	83	29
Ludwig's Bustard	*Neotis ludwigii*	EN, EN	70	33	2	1	9	7	35	16	24	9
Pale Chanting Goshawk	*Melierax canorus*		39	34	15	13	10	8	5	5	9	8
Jackal Buzzard	*Buteo rufofuscus*	(NE)	38	34	14	11	3	3	12	12	9	8
Grey-winged Francolin	*Scleroptila africana*	(SLS)	22	6	13	2	9	4				
Double-banded Courser	*Rhinoptilus africanus*		17	14	4	3	4	3	5	4	4	4
Northern Black Korhaan	*Afrotis afraoides*		12	8	4	2	2	2	5	3	1	1
Sclater's Lark	*Spizocorys sclateri*	NT, NT (NE)	12	3	4	2	8	1				
Black Stork	*Ciconia nigra*	VU, LC	9	3					9	3		
Grey-winged Francolin	*Scleroptila afra*		8	3					8	3		
Verreaux's Eagle	*Aquila verreauxii*	VU, LC	6	6	3	3	1	1	2	2		
Common Buzzard	*Buteo buteo*		5	5					5	5		
Secretarybird	*Sagittarius serpentarius*	VU, EN	5	3	3	2					2	1
Martial Eagle	*Polemaetus bellicosus*	EN, VU	5	5	4	4			1	1		
Blue Crane	*Grus paradisea*	NT, VU	4	2					4	2		
Spotted Eagle-Owl	*Bubo africanus*		4	4	2	2			1	1	1	1
Black Harrier	*Circus maurus*	EN, EN	3	3					3	3		
Lanner Falcon	*Falco biarmicus*	VU, LC	3	3					3	3		
African Rock Pipit	*Anthus crenatus*	NT, LC	3	3					1	1	2	2
Gabar Goshawk	*Micronisus gabar*		3	2							3	2
Rock Kestrel	*Falco rupicolus*		2	2			1	1			1	1
Rufous-breasted Sparrowhawk	*Accipiter rufiventris*		2	2	1	1			1	1		

South African Shelduck	*Tadorna cana*		2	1	2	1						
Cape Eagle-owl	*Bubo capensis*		2	2	1	1					1	1
Black-chested Snake-eagle	*Circaetus pectoralis*		2	1					2	1		
Booted Eagle	*Hieraeetus pennatus*		1	1					1	1		
African Harrier-Hawk	*Polyboroides typus*		1	1					1	1		
Peregrine Falcon	*Falco peregrinus*		1	1					1	1		

Appendix 6. Bird flight activity data for priority species on the site

Table A 5. Flight activity summary from Vantage Point surveys on site

			FULL YEAR			Site Visit 1		Site Visit 2		Site Visit 3		Site Visit 4	
						Jul-Aug 2021		Oct-Nov 2021		Feb 2022		May 2022	
		# Hours	**798**			**186**		**204**		**204**		**204**	
		# Species	**20**			**10**		**10**		**15**		**13**	
Common Name	**Scientific Name**	**Red List: Regional, Global (Endemism)**	**Birds**	**Rec**	**Birds/hr**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**	**Birds**	**Rec**
Jackal Buzzard	*Buteo rufofuscus*	(NE)	135	110	0.169	20	18	23	20	72	53	20	19
Ludwig's Bustard	*Neotis ludwigii*	EN, EN	78	52	0.098	2	1	23	19	14	11	39	21
Karoo Korhaan	*Eupodotis vigorsii*	NT, LC	74	39	0.093	22	10	12	7	23	13	17	9
Pale Chanting Goshawk	*Melierax canorus*		52	43	0.065	14	11	12	12	16	11	10	9
Verreaux's' Eagle	*Aquila verreauxii*	VU, LC	46	41	0.058			11	11	23	20	12	10
South African Shelduck	*Tadorna cana*		21	10	0.026	2	1	2	1	7	4	10	4
Steppe Buzzard	*Buteo buteo*		14	13	0.018					14	13		
Booted Eagle	*Hieraaetus pennatus*		7	7	0.009	1	1	1	1	5	5		
Martial Eagle	*Polemaetus bellicosus*	EN, VU	6	6	0.008	2	2	1	1	1	1	2	2
Pied Avocet	*Recurvirostra avosetta*		6	2	0.008							6	2
Lanner Falcon	*Falco biarmicus*	VU, LC	5	5	0.006	1	1			3	3	1	1
Rock Kestrel	*Falco rupicolus*		4	4	0.005	1	1	2	2	1	1		
Black Harrier	*Circus maurus*	EN, EN	4	4	0.005					4	4		
Black Stork	*Ciconia nigra*	VU, LC	4	2	0.005					4	2		
Black-chested Snake-eagle	*Circaetus pectoralis*		3	3	0.004	1	1			1	1	1	1
Secretarybird	*Sagittarius serpentarius*	VU, EN	2	1	0.003			2	1				
Double-banded Courser	*Rhinoptilus africanus*		2	2	0.003							2	2
Greater Kestrel	*Falco rupicoloides*		1	1	0.001					1	1		
Hamerkop	*Scopus umbretta*		1	1	0.001							1	1

African Spoonbill	*Platalea alba*		1	1	0.001							1	1

Appendix 7. Construction and post-construction bird monitoring framework

The work done to date on the proposed site has established a baseline understanding of the distribution, abundance and movement of key bird species on and near the site. However this is purely the 'before' baseline and aside from providing input into turbine micro-siting, it is not very informative until compared to post-construction data. The following programme has therefore been developed to meet these needs. It is recommended that this programme be implemented by the wind farm if constructed. The findings from operational phase monitoring should inform an adaptive management programme to mitigate any impacts on avifauna to acceptable levels. In particular, any Verreaux's Eagle fatalities should be reported to Dr Megan Murgatroyd in order to close the feedback loop back to the VERA modelling performed for this site.

During construction monitoring

It will be necessary to monitor the breeding status and productivity of the nesting raptors during all breeding seasons during construction. This can be done by a minimum of 3 specialist visits to the nest site per breeding season, or close enough to observe the birds without disturbing them. Detailed requirements as follows:

- Independent avifaunal specialist to make 3 visits to nest site in each breeding season (May to October) during construction.
- Breeding status & productivity to be determined.
- Any response by eagles to construction disturbance to be documented.

Operational phase monitoring

The intention with operational phase bird monitoring is to repeat as closely as possible the methods and activities used to collect data pre-construction. This work will allow the assessment of the impacts of the proposed facility and the development of active and passive mitigation measures that can be implemented in the future where necessary. One very important additional component needs to be added, namely mortality estimates through carcass searches under turbines. The following programme has therefore been developed to meet these needs, and should start as soon as possible after the operation of the first phase of turbines (not later than 3 months):

Note that this framework is an interim draft. The most up-to-date version of the Best Practice Guidelines (Jenkins *et al.* 2015) should inform the programme design at the time.

Live bird monitoring

Note that due to the construction of the wind farm and particularly new roads it may be necessary to update the location of the below monitoring activities from those used pre-construction.

- The 18 walked transects of 1km each that have been done during pre-construction monitoring on the site should be continued.
- The 6 vehicle-based road count routes on the site should be continued, and conducted once on each Site Visit.
- The Focal Sites on the site should be monitored. If any sensitive species are found breeding on site in future these nest sites should be defined as focal sites.
- All other incidental sightings of priority species (and particularly those suggestive of breeding or important feeding or roosting sites or flight paths) within the broader study area should be carefully plotted and documented.
- The Vantage Points already established on the overall site should be used to continue data collection post-construction. The exact positioning of these may need to be refined based on the presence of new turbines and roads. A total of 72 hours direct observation per Vantage Point should be conducted per year.
- The activities at the Control Site should be continued, i.e. 2 Vantage Points, 3 Walked Transects, 1 Vehicle Based transect, and Focal Sites.

Bird Fatality estimates

This is now an accepted component of the post-construction monitoring program and the newest guidelines (Jenkins *et al*. 2015) will be used to design the monitoring program. It is important that in addition to searching for carcasses under turbines, an estimate of the detection (the success rate that monitors achieve in finding carcasses) and scavenging rates (the rate at which carcasses are removed and hence not available for detection) is also obtained (Jenkins *et al*. 2015). Both of these aspects can be measured using a sample of carcasses of birds placed out in the field randomly. The rate at which these carcasses are detected and the rate at which they decay or are removed by scavengers should also be measured.

Fatality searches should be conducted as follows:

- The area surrounding the base of turbines should be searched (up to a radius equal to 75% of the maximum height of turbine) for collision victims.
- All turbines on the wind farm should be searched at least once a week (Monday to Friday).
- Any suspected collision casualty should be comprehensively documented (for more detail see Jenkins *et al*. 2015).
- A team of carcass searchers will need to be employed and these carcass searchers will work on site every day searching the turbines for mortalities.
- It is also important that associated infrastructure such as power lines and wind masts be searched for collision victims according to similar methods.

The most up to date version of the Best Practice Guidelines (Jenkins *et al*. 2015) should inform the programme design at the time.

The above programme should be reported on, quarterly, to the wind farm operator, who should submit these reports to the Department of Foresty, Fisheries and the Environment, Endangered Wildlife Trust and BirdLife South Africa. These reports should include a comparison of actual measured fatality rates with those predicted by this study.

Appendix 8. Arcus Impact Assessment Methodology

IMPACT ASSESSMENT METHODOLOGY

The purpose of the assessment of impacts in an EIA is to evaluate the likely extent and overall significance that a potential impact may have on an identified receptor or resource. Another important aspect of the assessment of impacts is to quantify those impacts that are not scientific-based or evidence-based and include the opinions of others (i.e., the involvement and comment from I&APs).

A successful assessment of the potential significance of impacts will include the description and development of measures that will be taken to avoid, minimise or compensate for any adverse environmental impacts, to enhance positive impacts, and to report the significance of residual impacts that occur following mitigation.

A 7-step approach for the determination of significance of potential impacts was developed by Arcus to align with the requirements of Appendix 3 of the EIA Regulations, 2014 (as amended). The approach is both objective and scientific based to allow appointed specialists and EAPs to retain independence throughout the assessment process.

Arcus has adapted this 7-step approach from standard ranking metrics such as the Hacking Method, Crawford Method etc. The Arcus 7-step approach complies with the method provided in the EIA guideline document (GN 654 of 2010) and considers international EIA Regulatory reporting standards such as the newly amended European Environmental Impact Assessment (EIA) Directive (2014/52/EU).

The 7-Step approach for determining the significance of impacts pre, and post mitigation, is described below:

- **Step 1:** Predict potential impacts by means of an appraisal of:
    - Site Surveys,
    - Project-related components and infrastructure,
    - Activities related with the project life-cycle,
    - The nature and profile of the receiving environment and potential sensitive environmental features and attributes,
    - Input received during public participation from all stakeholders, and
    - The relevant legal framework applicable to the proposed development
- **Step 2**: Determination of whether the potential impacts identified in **Step 1** will be *direct* (caused by construction, operation, decommissioning or maintenance activities on the proposed development site or immediate surroundings of the site), *indirect* (not immediately observable or do not occur on the proposed development site or immediate surroundings of the site), *residual* (those impacts which remain after post mitigation) and *cumulative* (the combined impact of the project when considered in conjunction with similar projects in proximity).

- **Step 3:** Description and determination of the significance of the predicted impacts in terms of the criteria below to ensure a consistent and systematic basis for the decision-making process. Significance is numerically quantified on the basis score of the following impact parameters:

1. ***Extent* (E)** of the impact: The geographical extent of the impact on a given environmental receptor.
2. ***Duration* (D)** of the impact: The length of permanence of the impact on the environmental receptor.
3. ***Reversibility* (R) of the impact**: The ability of the environmental receptor to rehabilitate or restore after the activity has caused environmental change
4. ***Magnitude* (M)** of the impact: The degree of alteration of the affected environmental receptor.
5. ***Probability* (P)** of the impact: The likelihood of the impact actually occurring.

A widely accepted numerical quantification of significance is the formula:

S=(E+D+R+M)*P

Where: *Significance=(Extent+Duration+Reversibility+Magnitude) * Probability*

The following has also been considered when determining the significance of a potential impact.

6. **Nature (N)** of the impact: A description of what causes the effect, what will be affected, and how it will be affected.
7. **Status (S)** of the impact: described as either positive, negative or neutral
8. **Cumulative impacts**.
9. Inclusion of **Public comment.**

The significance of environmental impacts is determined and ranked by considering the criteria presented in **Table 1** below. All criteria are rank according to 'Very Low', 'Low', 'Moderate', 'High' and 'Very High' and are assigned scores of 1 to 5 respectively.

Defining the significant in terms of the impact criteria.

Impact Criteria	Definition	Score	Criteria Description
Extent (E)	Site	1	Impact is on the site only
	Local	2	Impact is localized inside the activity area
	Regional	3	Impact is localized outside the activity area
	National	4	Widespread impact beyond site boundary. May be defined in various ways, e.g. cadastral, catchment, topographic
	International	5	Impact widespread far beyond site boundary. Nationally or beyond
Duration (D)	Immediate	1	On impact only
	Short term	2	Quickly reversible, less than project life. Usually up to 5 years.
	Medium term	3	Reversible over time. Usually between 5 and 15 years.
	Long term	4	Longer than 10 years. Usually for the project life.
	Permanent	5	Indefinite

Impact Criteria	Definition	Score	Criteria Description
Magnitude (M)	Very Low	1	No impact on processes
	Low	2	Qualitative: Minor deterioration, nuisance or irritation, minor change in species/habitat/diversity or resource, no or very little quality deterioration. Quantitative: No measurable change; Recommended level will never be exceeded.
	Moderate	3	Qualitative: Moderate deterioration, discomfort, Partial loss of habitat /biodiversity /resource or slight or alteration. Quantitative: Measurable deterioration; Recommended level will occasionally be exceeded.
	High	4	Qualitative: Substantial deterioration death, illness or injury, loss of habitat /diversity or resource, severe alteration or disturbance of important processes. Quantitative: Measurable deterioration; Recommended level will often be exceeded(e.g. pollution)
	Very High	5	Permanent cessation of processes
Reversibility (R)	Reversible	1	Recovery which does not require rehabilitation and/or mitigation.
	Recoverable	3	Recovery which does require rehabilitation and/or mitigation.
	Irreversible	5	Not possible, despite action. The impact will still persist, and no mitigation will remedy or reverse the impact.
Probability (P)	Improbable	1	Not likely at all. No known risk or vulnerability to natural or induced hazards
	Low Probability	2	Unlikely; low likelihood; Seldom; low risk or vulnerability to natural or induced hazards
	Probable	3	Possible, distinct possibility, frequent; medium risk or vulnerability to natural or induced hazards.
	Highly Probable	4	Highly likely that there will be a continuous impact. High risk or vulnerability to natural or induced hazards
	Definite	5	Definite, regardless of prevention measures.

The *significance* (s) of potential impacts identified according to the criteria above has been colour coded for the purpose of comparison. This colour coding will be used in impact tables.

Significance is deemed Negative (-)			Significance is deemed Positive (+)		
0 - 30	31 - 60	61 - 100	0 - 30	31 - 60	61 - 100
Low	Moderate	High	Low	Moderate	High

- **Step 4:** Determination of practical and reasonable mitigation measures based on specialists' inputs and field observations following the mitigation hierarchy (avoid, minimise, manage, mitigate, or rehabilitate).

- **Step 5:** Evaluation of predicted residual impacts after implementation of mitigation measures.

- **Step 6:** Determination of the significance of the impact taking into consideration the predicted residual impacts after implementation of mitigation measures.

- **Step 7:** Based on an acceptable significance of the impact, determination of the need and desirability of the proposed development and an opinion as to whether the development should proceed or not.

The Assessment of the significance of potential impacts is then populated in an Impact Summary Table.

IMPACT SUMMARY TABLE

Please copy the below table into your reports for any impact assessments required.

Impact Phase: Detail if the impact will take place during Construction/ Operation/Decommissioning					
Nature of the impact: Name of impact					
Description of Impact: Detailed description of impact xxxx …					
Impact Status: Detail of the impact is Positive, Neutral or Negative					
	E	**D**	**R**	**M**	**P**
Without Mitigation	Local	Medium Term	x	x	x
Score	2	3	x	x	x
With Mitigation	Site	Short Term	x	x	x
Score	1	2	x	x	x
Significance Calculation	**Without Mitigation**		**With Mitigation**		
S=(E+D+R+M)*P	Moderate Negative Impact (42)		Low Negative Impact (25)		
Was public comment received?	YES/NO. If yes, provide a bullet summary of main concerns.				

Has public comment been included in mitigation measures?	YES/NO, if NO then WHY? If YES then HOW/WHERE
Mitigation measures to reduce residual risk or enhance opportunities: *List and describe* *Aaa* *Aaa* *Aaa* *Aaa* *Aaaa* …	
Residual impact	*Describe the impact.*

ASSESSMENT OF CUMULATIVE IMPACTS

In relation to an activity, cumulative impact means *"the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant, but may be significant when added to the existing and reasonably foreseeable impacts eventuating from similar or diverse activities"* (NEMA EIA Reg GN R982 of 2014).

Specialists are required to assess cumulative impacts associated with similar developments within a 35km radius of the proposed developments. The purpose of the cumulative assessment is to test if such impacts are relevant to the proposed developments in the proposed locations (i.e. whether the addition of the proposed project in the area will increase the impact). In this regard, specialist studies considered whether the construction of the proposed development will result in:

- Unacceptable risk
- Unacceptable loss
- Complete or whole-scale changes to the environment or sense of place
- Unacceptable increase in impact

Cumulative Impacts will be assessed and populate in a cumulative impact summary table.

Please copy the below table into your reports for any impact assessments required.

Cumulative Impact: Name of impact					
Description of Cumulative Impact: Detailed description of cumulative impact xxxx …					
Impact Status: Detail of the impact is Positive, Neutral or Negative					
	E	**D**	**R**	**M**	**P**
Without Enhancement	Local	Medium Term	x	x	x
Score	2	3	x	x	x
With Enhancement	Site	Short Term	x	x	x

Score	1	2	x	x	x
Significance Calculation	**Without Enhancement**			**With Enhancement**	
S=(E+D+R+M)*P	Moderate Negative Impact (42)			Low Negative Impact (25)	
Can Impacts be Enhanced?	YES/NO and HOW/WHY				
Enhancement: *List and describe* *Aaa* *Aaa* *Aaa* *Aaa* *Aaaa* …					
Residual impact	*Describe the impact.*				

Appendix 9. Verreaux's Eagle Risk Assessment (VERA) report

Verreaux's Eagle Risk Assessment
Site: Loxton
Developer: Atlantic Renewable Energy Partners (Pty) Ltd
Processed on: 2020 November 16

Project background: 3 Verreaux's eagle nests have been located during pre-application site screening around the proposed development area. This document outlines the Verreaux's Eagle Risk Assessment (VERA) modelling which has been used to predict collision risk for Verreaux's eagle at the development, using these nest locations.

Model background: The VERA model is built from 57,285 at-risk GPS fix locations from 15 Verreaux's eagles each tracked between 18–895 days each, equivalent to a total of 13.6 bird-years of tracking data. For each nest, the VERA model calculates the collision risk potential on a 90x90m resolution in a 12km buffer around the nest location, nests within 1.5km of each other are treated as alternative nests of the same pair. The model takes into account the distance from the nest, distance to all other conspecific nests within 12km of a given nest, topographic slope, elevation and distance to slope. The model gives collision risk potential as a probability (a continuous value between zero and one). Collision risk potential is then re-classified as high, medium or low using model derived (Youden) thresholds calculated by cross-validating the results on territories of tracked eagles.

Model thresholds: The impacts of using different model thresholds can be checked using predictions from tracked eagles (Fig. 1) and from operational developments where collisions have occurred (Fig. 2).

<u>High collision risk potential area:</u> The high risk area is the area predicted to be most intensively used by eagles; for tracked eagles it incorporates 73% of the area used (Fig.1 – dashed line). 50% (7 of 14) of the known collisions have occurred in this area (Fig. 2 – dashed line). Development of wind turbines should not occur in these areas.

<u>Medium collision risk potential:</u> The medium risk area is also likely to be used by eagles; for tracked eagles it represents an additional 12% of the area used, thus protection of the high and medium risk areas can be expected to offer protection to 85% of an eagle's home range (Fig. 1 – dotted line). 79% (11 of 14) of the known collisions have occurred in the medium and high risk areas combined (Fig. 2 – dotted line). Development in this area should be avoided where possible and only proceed with additional specialist input.

<u>Low collision risk potential:</u> The low risk area (with ordinal risk predictions less 0.13) is the area predicted to be least used by eagles and development here poses the lowest risk to eagles within the 12km buffer. However this area is not without risk, and three collisions have occurred at operational wind energy sites, within areas that would be predicted to be low risk.

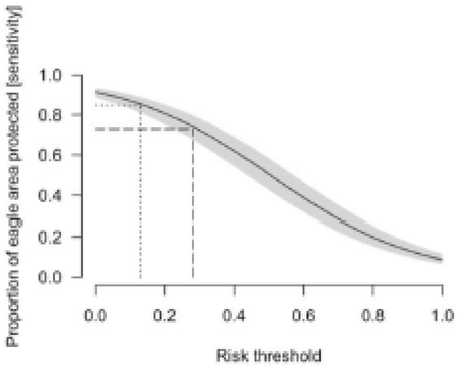


Figure 1. Proportion of the area used by tracked Verreaux's eagles which is protected along a gradient of thresholds used to classify collision risk, this is calculated on a 90x90 m cell basis and is equivalent to the model 'sensitivity'. Lines represent two risk thresholds; i.e. if a risk threshold of 0.13 is applied (dotted line) then 0.85 of the area used by eagles is protected (covered by medium and high risk areas), if a higher threshold of 0.28 (dashed line) is applied then 0.73 of the area used by eagles is protected (covered by high risk only).

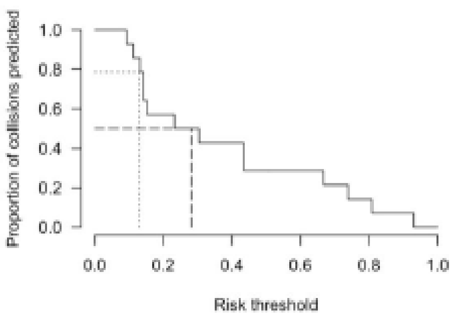


Figure 2. Proportion of known Verreaux's eagles collisions (n=14) correctly predicted by the model along a gradient of risk thresholds. 0.79 collisions were above the medium risk threshold (dotted line), while 0.5 were in the area considered to be high risk (dashed line).

VERA modelling report | compiled by FitzPatrick Institute of African Ornithology & HawkWatch International
Page 1 of 2

Model results: The collision risk estimates are dependent on accurate information on nest locations and will only be reliable if all nest locations have been found and provided for this analysis. Recommendations are intended to minimise collision risk to resident adult eagles but will not be relevant to non-breeding eagles using the area. The modelling methods used here are currently being compiled for scientific publication and may be subject to further refinements. The final published VERA model may differ from the one used here, but it is unlikely to significantly change the overall patterns of risk outlined in this report.

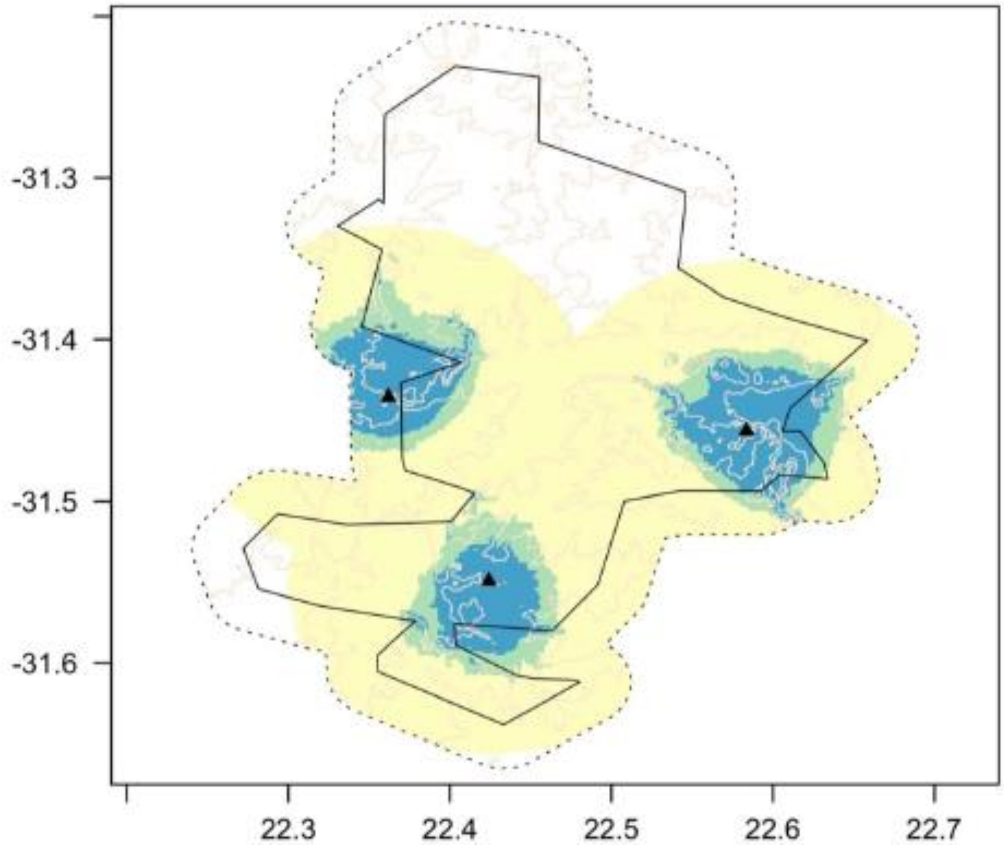
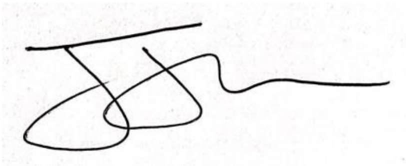


Figure 3. Verreaux's eagle collision risk potential for Loxton development. Solid line [development boundary/farms], dotted line [area surveyed for nests]. Verreaux's eagle nest locations are shown by triangles. Collision risk potential is represented in high risk [blue]; medium risk [green] and low risk [yellow]. White areas within the area surveyed for nests are more than 12km from a known nest and also considered low risk.

Appendix 10. Specialist Declaration

I, _____J SMALLIE______________________________, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the Specialist: ____  ______________________

Name of Company: ____WILDSKIES ECOLOGICAL SERVICES______________________

Date: _____10 OCTOBER 2022_____________________

Appendix 11. Specialist CV

JONATHAN JAMES SMALLIE
WildSkies Ecological Services (2011/131435/07)
Curriculum Vitae

Background
Date of birth: 20 October 1975
Qualifications: BSC – Agriculture (Hons) (completed 1998)
University of Natal – Pietermaritzburg
MSC – Environmental Science (completed 2011)
University of Witwaterstrand
Occupation: Specialist avifaunal consultant
Profession registration: South African Council for Natural Scientific Professions

Contact details
Cell number: 082 444 8919
Fax: 086 615 5654
Email: jon@wildskies.co.za
Postal: 36 Utrecht Avenue, Bonnie Doon, East London, 5210
ID #: 7510205119085

Professional experience
IFC PS6 experience:
Amakhala Emoyeni Wind Farm – in collaboration with Simon Hulka (IFC) designed and implemented an operational phase monitoring programme and Biodiversity Monitoring & Mitigation Plan; Golden Valley Wind Farm – in collaboration with Leon Bennun (The Biodiversity Consultancy - TBC) compiled a Critical Habitat Assessment and Biodiversity Action Plan for the wind farm; Jeffrey's Bay Wind Farm – in collaboration with TBC compiled a Biodiversity Management Plan for the wind farm.

Renewable energy:

Post construction bird monitoring for wind energy facilities:
Dassieklip (Caledon) –initiated in April 2014 (2yrs); Dorper Wind Farm (Molteno) – initiated in July 2014 (5yrs); Jeffreys Bay Wind Farm – initiated in August 2014 (4yrs); Kouga Wind Farm – started Feb 2015 (2yrs); Cookhouse Wind Farm – started March 2015 (1yr); Grassridge Wind Farm – initiated in April 2015 (2yrs); Chaba Wind Farm – initiated December 2015 (1yr); Amakhala Emoyeni 01 Wind Farm initiated August 2016 (5yrs) – IFC funded project; Gibson Bay Wind Farm – initiated March 2017 (4yrs); Nojoli Wind Farm initiated March 2017 (4yrs); Sere Wind Farm (2yrs); Golden Valley Wind Farm (started Sep 2021 – 1 yr).

Pre-construction bird monitoring & EIA for wind energy facilities:
Golden Valley 1; Middleton; Dorper; Qumbu; Ncora; Nqamakhwe; Ndakana; Thomas River; Peddie; Mossel Bay; Hluhluwe; Richards Bay; Garob; Outeniqua; Castle; Wolf; Inyanda-Roodeplaat; Dassiesridge; Great Kei; Bayview; Grahamstown; Bakenskop; Umsobomvu; Stormberg; Zingesele; Oasis; Gunstfontein; Naumanii; Golden Valley Phase 2; Ngxwabangu; Hlobo; Woodstock; Scarlet Ibis; Albany; Golden Valley 1 2nd monitoring; Umtathi Emoyeni; Serenje Zambia; Unika 1 Zambia; Impofu East, West, and North; Nuweveld East, West and North; Elands Wind Farm; Ingwe Wind Farm; Hoogland Wind Farm; Cradock

Wind Farm Cluster; Canyon Springs Wind Farm; Loxton Wind Farm; Taaibos Wind Farm; Aberdeen Wind Farm.

Screening studies for wind energy facilities:
Tarkastad Wind Farm; Quanti Wind Farm; Ruitjies Wind Farm; Beaufort West Wind Farm; Success Wind Farm; Cradock Wind Farm; Britstown Wind Farm; Clanwilliam Wind Farm; Ebenhezer Wind Farm.

Avifaunal walk through for wind energy facilities:
Garob Wind Farm; Golden Valley 1 wind farm; Nxuba Wind Farm.

Pre-construction bird monitoring and EIA for Solar energy facilities:
Bonnievale Solar Energy Facility; Dealesville Solar Energy Facility; Rooipunt Solar Energy Facility; De Aar Solar Energy Facility; Noupoort Solar Energy Facility, Aggeneys Solar Energy Facility; Eskom Concentrated Solar Power Plant; Bronkhorstspruit Solar Photovoltaic Plant; De Aar Solar Energy Facility; Paulputs Solar Energy Facility; Kenhardt Solar Energy Facility; Wheatlands Solar Energy Facility; Nampower CSP project; Dwaalboom PV; Slurry PV; De Hoek PV; Suikerbekkie PV; Springhaas PV.

Other Electricity Generation:
Port of Nqura Power Barge EIA; Tugela Hydro-Electric Scheme; Mmamabula West Coal Power Station (Botswana).

Electricity transmission & distribution:
Overhead transmission power lines (>132 000 kilovolts):
Oranjemund Gromis 220kv; Perseus Gamma 765kv; Aries Kronos 765kv; Aries Helios 765kv; Perseus Kronos 765kv; Helios Juno 765kv; Borutho Nzelele 400kv; Foskor Merensky 275kv; Kimberley Strengthening; Mercury Perseus 400kV; Eros Neptune Grassridge 400kV; Kudu Juno 400kV; Garona Aries 400kV; Perseus Hydra 765Kv; Tabor Witkop 275kV; Tabor Spencer 400kV; Moropule Orapa 220kV (Botswana); Coega Electrification; Majuba Venus 765kV; Gamma Grassridge 765kV; Gourikwa Proteus 400KV; Koeberg Strengthening 400kV; Ariadne Eros 400kV; Hydra Gamma 765kV; Zizabona transmission – Botswana; Maphutha Witkop 400kv; Makala B 400kv; Aggeneis Paulputs 400kv; Northern Alignment 765kv; Kappa Omega 765kv; Isundu 400kv and Substation; Senakangwedi B Integration; Oranjemund Gromis;

Overhead distribution power lines (<132 000 kilovolts):
Kanoneiland 22KV; Hydra Gamma 765kV; Komani Manzana 132kV; Rockdale Middelburg 132kV; Irenedale 132 kV; Zandfontein 132kV; Venulu Makonde 132 kV; Spencer Makonde 132 kV; Dalkeith Jackal Creek 132Kv; Glen Austin 88kV; Bulgerivier 132kV; Ottawa Tongaat 132kV; Disselfontein 132kV; Voorspoed Mine 132kV; Wonderfontein 132kV; Kabokweni Hlau Hlau 132kV; Hazyview Kiepersol 132kV; Mayfern Delta 132kV; VAAL Vresap 88kV; Arthursview Modderkuil 88kV; Orapa, AK6, Lethakane substations and 66kV lines (Botswana); Dagbreek Hermon 66kV; Uitkoms Majuba 88kV; Pilanesberg Spitskop 132kV; Qumbu PG Bison 132kV; Louis Trichardt Venetia 132kV; Rockdale Middelburg Ferrochrome 132kV; New Continental Cement 132KV; Hillside 88kV; Marathon Delta 132kV; Malelane Boulder 132kV; Nondela Strengthening 132kV; Spitskop Northern Plats 132kV; West Acres Mataffin 132kV; Westgate Tarlton Kromdraai 132kV; Sappi Elliot Ugie 132kV; Melkhout Thyspunt 132kV; St Francis Bay 66kv; Etna Ennerdale 88kv; Kroonstad 66kv; Firham Platrand; Paradise Fondwe 132kv; Kraal Mafube 132kv; Loeriesfontein 132kv; Albany Mimosa 66kv; Zimanga 132kv; Grootpan Brakfontein; Mandini Mangethe; Valkfontein Substation; Sishen Saldanha; Corinth Mzongwana 132kv; Franklin Vlei 22kv; Simmerpan Strengthening; Ilanga Lethemba 132kv; Cuprum Burchell Mooidraai 132; Oliphantskop Grassridge 132;

Risk Assessments on existing power lines:
Hydra-Droerivier 1,2 & 3 400kV; Hydra-Poseidon 1,2 400kV; Butterworth Ncora 66kV; Nieu-Bethesda 22kV; Maclear 22kV (Joelshoek Valley Project); Wodehouse 22kV (Dordrecht district); Burgersdorp Aliwal North Jamestown 22kV; Cradock 22kV; Colesberg area 22kV; Loxton self build 11kV; Kanoneiland 22kV; Stutterheim Municipality 22kV; Majuba-Venus 400kV; Chivelston-Mersey 400kV; Marathon-Prairie 275kV; Delphi-Neptune 400kV; Ingagane – Bloukrans 275kV; Ingagane – Danskraal 275kV; Danskraal – Bloukrans 275kV

Avifaunal "walk through" (EMP's):
Kappa Omega 765kv; Rockdale Marble Hall 400kv*;* Beta Delphi 400kV; Mercury Perseus 765kV; Perseus 765kV Substation; Beta Turn 765kV in lines; Spencer Tabor 400kV line; Kabokweni Hlau Hlau 132kV; Mayfern Delta 132Kv; Eros Mtata 400kV; Cennergi Grid connect 132kV; Melkhout Thyspunt 132kv; Imvubu Theta 400kv; Outeniqua Oudshoorn 132kv; Clocolan Ficksburg 88kv.

Strategic Environmental Assessments for Master Electrification Plans:
Northern Johannesburg area; Southern KZN and Northern Eastern Cape; Northern Pretoria; Western Cape Peninsula

Other electrical infrastructure work
Investigation into rotating Bird Flapper saga – Aberdeen 22Kv; Special investigation into faulting on Ariadne-Eros 132kV; Special investigation into Bald Ibis faulting on Tutuka Pegasus 275kV; Special investigation into bird related faulting on 22kV Geluk Hendrina line; Special investigation into bird related faulting on Camden Chivelston 400kV line

Water sector:
Umkhomazi Dam and associated tunnel and pipelines; Rosedale Waste Water Treatment Works; Lanseria Outfall Sewer; Lanseria Wastewater Treatment Works;

Wildlife airport hazards:
Kigali International Airport – Rwanda; Port Elizabeth Airport – specialist study as part of the EIA for the proposed Madiba Bay Leisure Park; Manzini International Airport (Swaziland); Polokwane International Airport; Mafekeng International Airport; Lanseria Airport. Namibia Airports Company – wildlife hazard management plans for three airports.

Conservation planning:
East Cape Biodiversity Strategy & Action Plan – avifaunal input; City of Ekurhuleni Biodiversity Plan – avifaunal input.

Other sectors:
Submarine telecommunications cables project; Lizzard Point Golf Estate – Vaaldam; Lever Creek Estates housing development; East Cape Biodiversity Strategy and Action Plan 2017; Cathedral Peak Road diversion; Dube Tradeport; East London Transnet Ports Authority Biodiversity Management Plan; Leazonia Feedlot; Carisbrooke Quarry; Senekal Sugar Development; Frankfort Paper Mill;

Employment positions held to date:

- August 1999 to May 2004: Eastern Cape field officer for the South African Crane Working Group of the Endangered Wildlife Trust

- May 2004 to November 2007: National Field officer for Eskom-EWT Strategic Partnership and Airports Company SA – EWT Strategic Partnership (both programmes of Endangered Wildlife Trust)
- November 2007 to August 2011: Programme Manager – Wildlife & Energy Programme – Endangered Wildlife Trust
- August 2011 to present: Independent avifaunal specialist – Director at WildSkies Ecological Sevices (Pty) Ltd

Relevant achievements:

- Recipient of BirdLife South Africa's Giant Eagle Owl in 2011 for outstanding contribution to bird conservation in SA
- Founded and chaired for first two years – the Birds and Wind Energy Specialist Group (BAWESG) of the Endangered Wildlife Trust & BirdLife South Africa.

Conferences attended & presented at:

- 2021. African Conference on Linear Infrastructure and Environment
- 2018. Raptor Research Foundation conference, Kruger National Park.
- 2019. Conference on Wind Energy and Wildlife, Stirling, Scotland.
- 2017. Conference on Wind Energy and Wildlife, Estoril, Portugal.
- 2012-2020. Windaba Conference. Various attendance.
- May 2011. Conference of Wind Energy and Wildlife, Trondheim, Norway.
- March 2011. Chair and facilitator at Endangered Wildlife Trust – Wildlife & Energy Programme – "2011 Wildlife & Energy Symposium", Howick, SA
- September 2010 – Raptor Research Foundation conference, Fort Collins, Colorado. Presented on the use of camera traps to investigate Cape Vulture roosting behaviour on transmission lines
- May 2010 - Wind Power Africa 2010. Presented on wind energy and birds
- October 2008. Session chair at Pan-African Ornithological Conference, Cape Town, South Africa
- March 27 – 30 2006: International Conference on Overhead Lines, Design, Construction, Inspection & Maintenance, Fort Collins Colorado USA. Presented a paper entitled "Assessing the power line network in the Kwa-Zulu Natal Province of South Africa from a vulture interaction perspective".
- June 2005: IASTED Conference at Benalmadena, Spain – presented a paper entitled "Impact of bird streamers on quality of supply on transmission lines: a case study"
- May 2005: International Bird Strike Committee 27th meeting – Athens, Greece. Presented a paper entitled Bird Strike Data analysis at SA airports 1999 to 2004.
- 2003: Presented a talk on "Birds & Power lines" at the 2003 AGM of the Amalgamated Municipal Electrical Unions – in Stutterheim - Eastern Cape
- September 2000: 5th World Conference on Birds of Prey in Seville, Spain.

Papers & publications:

- Jenkins, A.R., Van Rooyen, C.S., Smallie, J., Harrison, J.A., Diamond, M., Smit-Robinson, H.A. & Ralston, S. 2015. "Best practice guidelines for assessing and monitoring the impact of wind energy facilities on birds in southern Africa" Unpublished guidelines
- Ralston-Paton, S., Smallie, J., Pearson, A., & Ramalho, R. 2017. Wind energy's impacts on birds in South Africa: a preliminary review of the results of operational monitoring at the first wind farms of the Renewable Energy Independent Power Producer Procurement Programme Wind Farms in South Africa. BirdLife South Africa Occasional Report Series No. 2. BirdLife South Africa, Johannesburg, South Africa.

- Prinsen, H.A.M., J.J. Smallie, G.C. Boere, & N. Pires. (compilers), 2011. Guidelines on how to avoid or mitigate impacts of electricity power grids on migratory birds in the African-Eurasian Region. CMS Technical Series Number XX. Bonn, Germany.
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- Jenkins, A.R., Shaw, J.M., Smallie, J.J., Gibbons, B., Visagie, R. & Ryan, P.G. 2011. Estimating the impacts of power line collisions on Ludwig's Bustards *Neotis ludwigii*. Bird Conservation International.
- Jordan, M., & Smallie, J. 2010. A briefing document on best practice for pre-construction assessment of the impacts of onshore wind farms on birds. Endangered Wildlife Trust , Unpublished report
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- Smallie, J.J., Diamond, M., & Jenkins, A.R. 2008. Lighting up the African continent – what does this mean for our birds? Pp 38-43. In Harebottle, D.M., Craig, A.J.F.K., Anderson, M.D., Rakotomanana, H., & Muchai. (eds). Proceedings of the 12th Pan-african Ornithological Congress. 2008. Cape Town. Animal Demography Unit. ISBN (978-0-7992-2361-3)
- Van Rooyen, C., & Smallie, J.J. 2006. The Eskom –EWT Strategic Partnership in South Africa: a brief summary. Nature & Faunae Vol 21: Issue 2, p25
- Smallie, J. & Froneman, A. 2005. Bird Strike data analysis at South African Airports 1999 to 2004. Proceedings of the 27th Conference of the International Bird Strike Committee, Athens Greece.
- Smallie, J. & Van Rooyen, C. 2005. Impact of bird streamers on quality of supply on transmission lines: a case study. Proceedings of the Fifth IASTED International Conference on Power and Energy Systems, Benalmadena, Spain.
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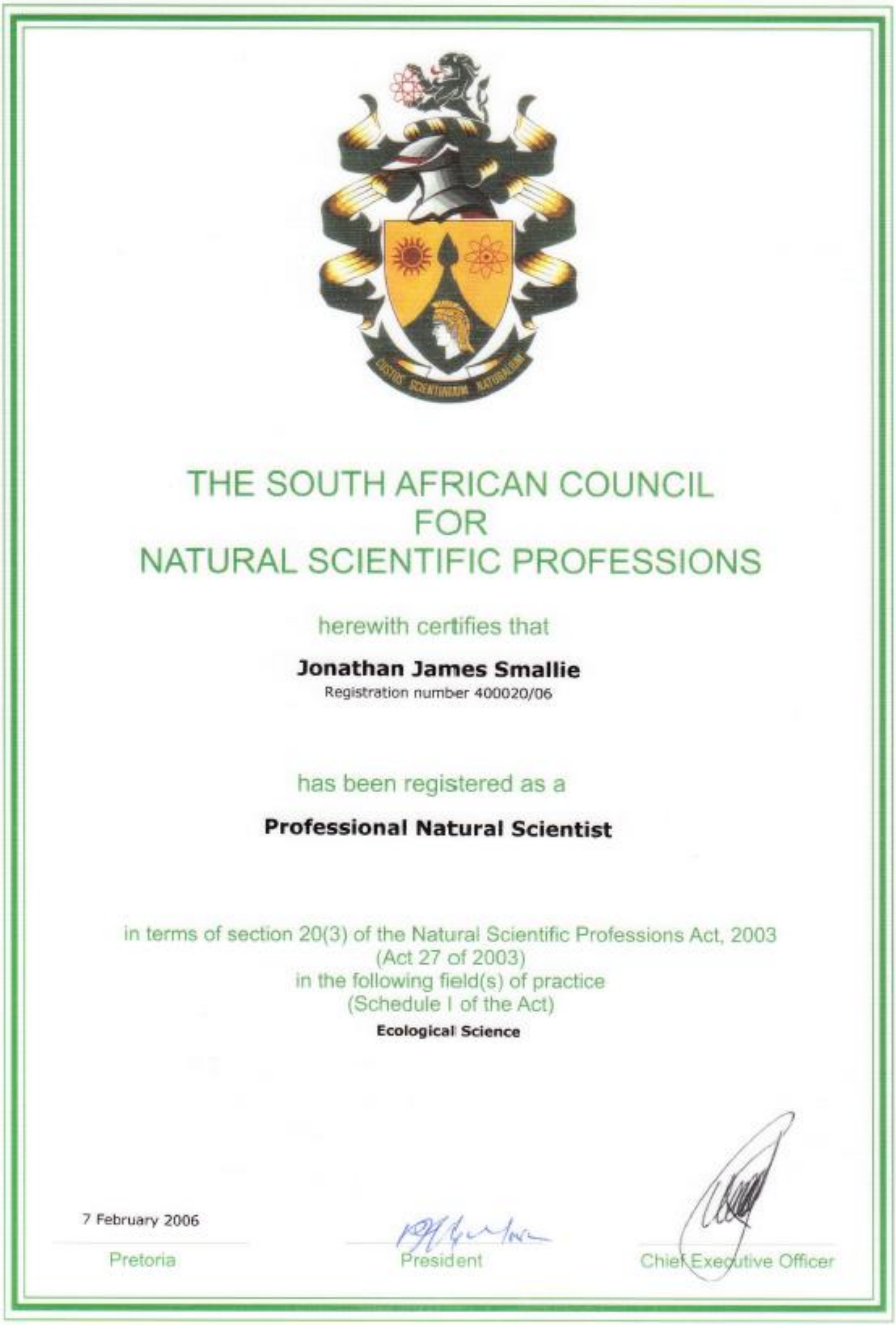
- Van Rooyen, C. Jenkins, A. De Goede, J. & Smallie J. 2003. Environmentally acceptable ways to minimise the incidence of power outages associated with large raptor nests on Eskom pylons in the Karoo: Lessons learnt to date. Project number 9RE-00005 / R1127 Technology Services International. Johannesburg. South Africa
- Smallie, J. J. & O'Connor, T. G. (2000) Elephant utilization of *Colophospermum mopane*: possible benefits of hedging. African Journal of Ecology 38 (4), 352-359.

Courses & training:

- Successfully completed a 5 day course in High Voltage Regulations (modules 1 to 10) conducted by Eskom – Southern Region
- Successfully completed training on, and obtained authorization for, live line installation of Bird Flappers



CUSTOS SCIENTIARUM NATURALIUM

THE SOUTH AFRICAN COUNCIL
FOR
NATURAL SCIENTIFIC PROFESSIONS

herewith certifies that

Jonathan James Smallie
Registration number 400020/06

has been registered as a

Professional Natural Scientist

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

7 February 2006

Pretoria	President	Chief Executive Officer

Appendix 12. Compliance with Government Gazette 43110 (GN 320, 20 March 2020)

Requirements for Avifauna Specialist Assessment Report as per GN 320, 20 March 2020	Section where this has been addressed in the Specialist Report
6.2.1. the SACNASP registration number of the avifaunal specialist preparing the assessment and their curriculum vitae;	**Section 1.5, Appendix 11**
6.2.2. a signed statement of independence by the specialist;	**Appendix 10**
6.2.3. a description of the study area including a map of all the aspects identified in the duration, dates and seasons of the site investigation and the relevance of the season to the outcome of the assessment;	**Section 2.1 & Section 2.3**
6.2.4. the outcome of the reconnaissance study and the resultant site specific pre-application avifaunal monitoring;	**Section 3**
6.2.5. a description of the methodology used to undertake the site specific pre-application avifaunal monitoring program inclusive of the equipment used;	**Section 2.3**
6.2.6. a map showing the Global Positioning System (GPS) coordinates for each of the monitoring points for both the preferred site as well as the control site;	**Figure 3 (Section 2.3)**
6.2.7. the monitoring intervals for both sites;	**Section 2.1**
6.2.8. where relevant, a map showing the areas to be avoided;	**Section 4.2**
6.2.9. fatality prediction for target species and general species on the preferred site;	**Section 3.2.6 (Table 7)**
6.2.10. a map showing the existing renewable energy facilities within a 10km radius of the proposed development;	**Not applicable (Section 5.4)**
6.2.11. where relevant, the outcomes of the cumulative impact assessment;	**Not applicable**
6.2.12. a discussion based on the pre-application monitoring of the expected impact of the proposed development on avifaunal species;	**Sections 3, 4 & 8.**
6.2.13. a substantiated statement from the avifauna specialist, indicating the acceptability or not of the proposed development and a recommendation on the approval, or not, of the proposed development;	**Executive Summary, Section 8**
6.2.14. any conditions to which this statement is subjected;	**Executive Summary, Section 4.2, Appendix 7**
6.2.15. a detailed post construction monitoring programme;	**Appendix 7**
6.2.16. the outcomes of the post-construction monitoring, including data and specialists reports, must be uploaded onto the national bird monitoring database, to be accessed at	**Website not operational**

https://www.environment.gov.za/birddatabase, once operational;	
6.2.17. where required, proposed mitigation measures or any monitoring requirements for inclusion in the Environmental Management Programme (EMPr); and	**Appendix 7**
6.2.18. a description of the assumptions made and any uncertainties or gaps in knowledge or data.	**Section 2.4**

Appendix 13. Site Sensitivity Verification

Introduction

In accordance with GN 320 and GN 1150 (20 March 2020) of the NEMA EIA Regulations of 2014 (as amended), prior to commencing with a specialist assessment, a Site Sensitivity Verification (SSV) must be undertaken to confirm the current land use and environmental sensitivity of the proposed project area as identified by the National Web-Based Environmental Screening Tool (i.e., Screening Tool).

We examined the Screening Tool output (dated 05 October 2022) and found the following:

- The Animal Theme is classed as High sensitivity (**Figure A 2**), with Verreaux's Eagle, Ludwig's Bustard and Black-footed Cat (*Felis nigripes*) highlighted. Riverine Rabbit (*Bunolagus monticularis*) and Karoo Dwarf Tortoise (*Chersobius boulengeri*) are highlighted as Medium sensitivity.
- The Avian Theme is classified as Low sensitivity (**Figure A 3**). No bird species are highlighted.
- The Terrestrial Biodiversity Theme is classified as Very High sensitivity (**Figure A 4**). This is due to the presence of Critical Biodiversity Areas 1 and 2 and FEPA Subcatchments on site, as well as the Protected Areas Expansion Strategy being relevant.

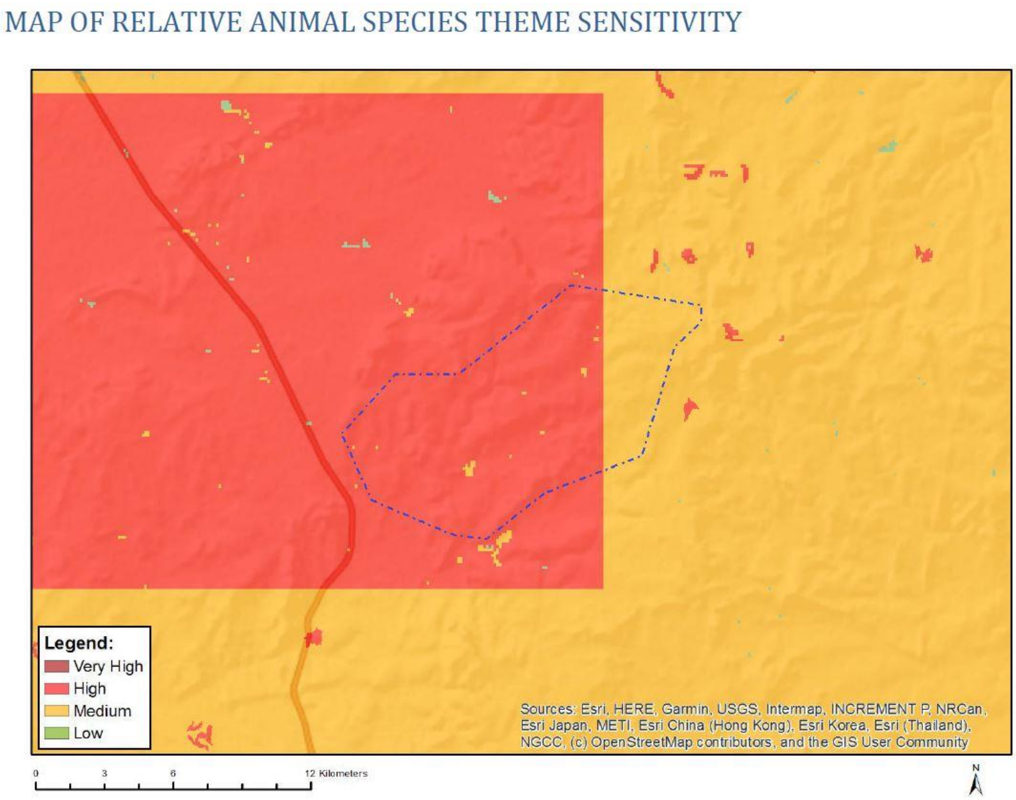


Figure A 2. DFFE Screening Tool output for Animal Species Theme.

MAP OF RELATIVE AVIAN (WIND) THEME SENSITIVITY

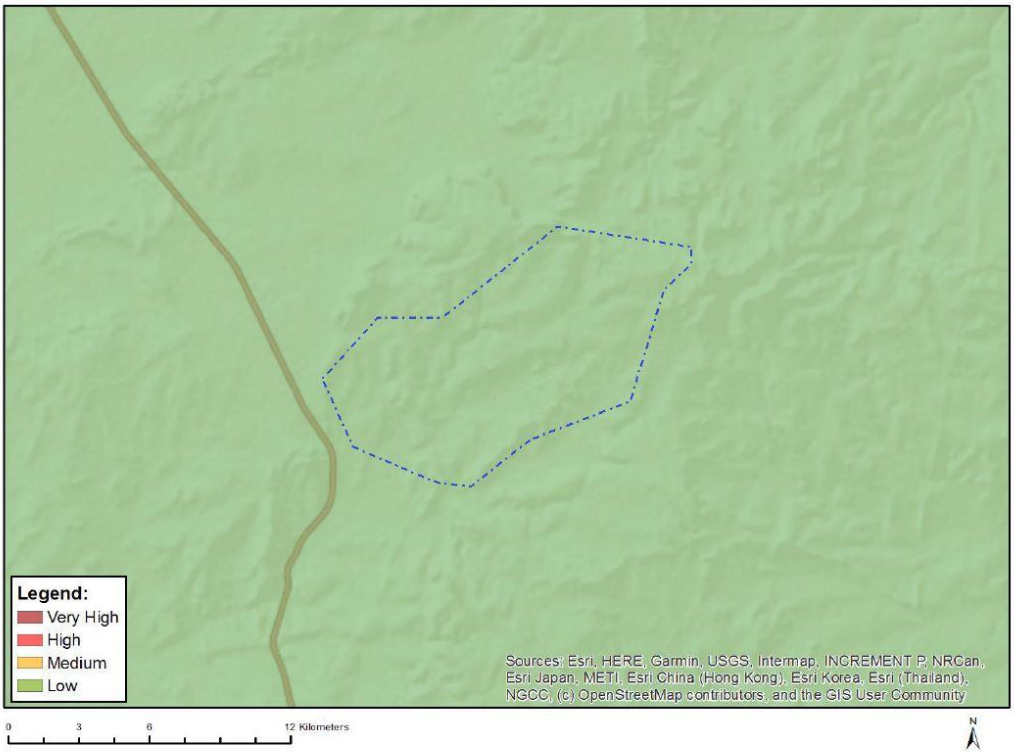


Figure A 3. DFFE Screening tool output for Avian Theme.

MAP OF RELATIVE TERRESTRIAL BIODIVERSITY THEME SENSITIVITY

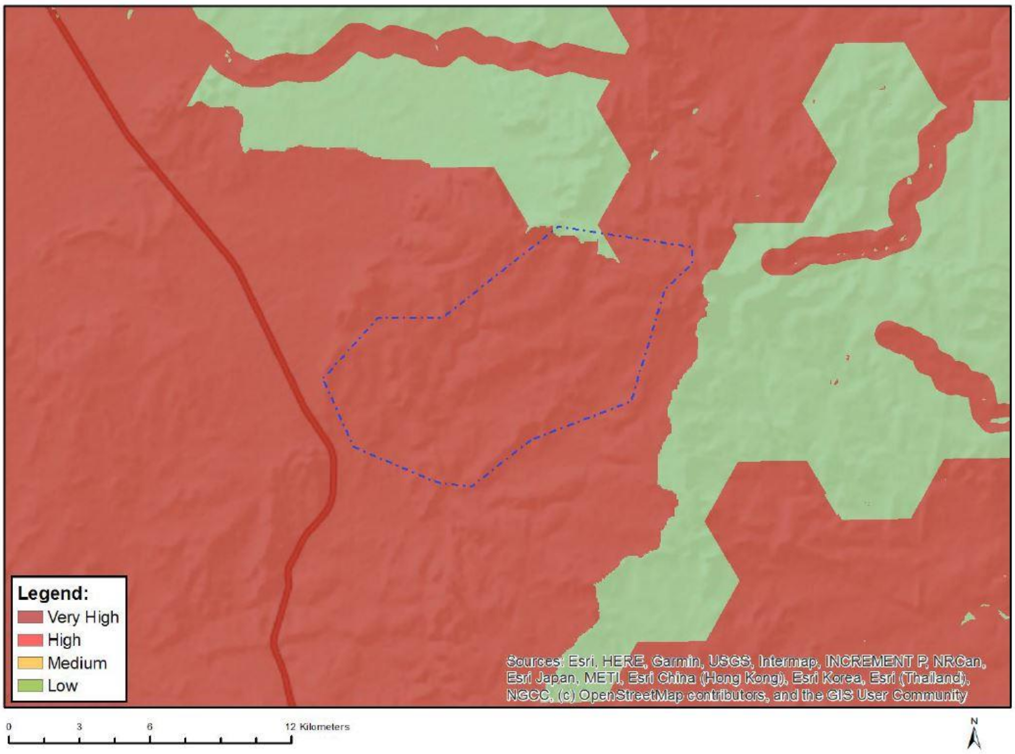


Figure A 4. DFFE Screening Tool output for Terrestrial Biodiversity Theme.

Site Sensitivity Verification Framework

We base this SSV on both a desktop analysis of the various avifaunal databases consulted in the Screening and Scoping Phases (e.g.: IUCN, SABAP, CWAC, CAR) as well as our comprehensive work on site as part of the 12-month pre-construction monitoring. Our on-site methodologies align with "The Best Practice Guidelines for Assessing and Monitoring the Impact of Wind Energy Facilities on Birds in Southern Africa" Guidelines by BirdLife South Africa & Endangered Wildlife Trust (Jenkins *et al*. 2015), "The Best Practice Guidelines for Verreaux's Eagle and Wind Energy" (BirdLife South Africa, 2017), and the more recent draft update of these: "Verreaux's Eagles and Wind Farms" (BirdLife South Africa, 2021).

The on-site findings for the avian SCC highlighted by the Screening Tool are discussed throughout this report, but particularly in **Section 3.3.1** and **3.3.2**. Some key points are revised below:

- **Ludwig's Bustard (*Neotis ludwigii*)**

Ludwig's Bustard is Globally and Regionally listed as Endangered (Retief *et al*. 2014, IUCN 2022) and was classified as the 14th most at risk species in terms of turbine collision, in Retief's classification (2011, species list updated in 2014). It is likely to be susceptible to four possible impacts associated with a wind farm: habitat destruction, disturbance, displacement and collision with turbine blades and power lines. We recorded the species on the site in all four seasons, and lekking behaviour (breeding display, **Figure A5**) was documented in the summer, which coincided with good rains. These leks indicate that breeding is very likely to occur on site; they have been buffered as per **Section 4.2**. We estimate that approximately 0.59 bustards may be killed by turbines per year under the Applicant's preferred turbine model, but this could be reduced to 0.15 bustards per year by raising the lower rotor swept height to 60m; a "best case scenario".

Figure A5. Distant photograph of part of the Focal Site 14 lek where up to 13 adult birds were recorded, two of which were displaying males, one pictured far left

- **Verreaux's Eagle (*Aquila verreauxii*)**

Verreaux's Eagle has recently been up-listed in regional conservation status to Vulnerable (Taylor *et al.* 2015) in recognition of the threats it is facing. It has been upgraded to 3rd in the 2014 update of the risk rankings for wind energy (Retief *et al*. 2014). Early observations on constructed wind farms under monitoring indicate that this species is susceptible to collision with turbines (*pers. obs*.; Ralston-Paton *et al*. 2017; Perold *et al*. 2020). We recorded Verreaux's Eagle on site in all seasons and estimated based on the recorded passage rates that 0.43 Verreaux's Eagle fatalities could occur each year across the wind farm regardless of minimum blade height (of up to 60m). VERA modelling has been conducted and the Applicant's preferred turbine layout currently avoids any No-go constraints for the species, although non-resident, non-breeding and juvenile birds are likely to also utilise the landscape relief outside of these buffers which coincides with optimal turbine placement (i.e. ridges).

Figure A6. A pair of adult Verreaux's Eagles perched near their nest at Focal Site 3

Table A6. On-site confirmation of species of conservation concern (SCC) and likely impacts at Loxton WEF 1

Taxonomy	Red List: Regional, Global* (Endemism**)	Collision risk rank (Retief *et al.* 2014)	S1: Winter 2021	S2: Spring 2021	S3: Summer 2022	S4: Autumn 2022	Specialist Risk Assessment	Likely impacts
Bustard, Ludwig's *Neotis ludwigii*	EN, EN	14	√	√	√	√	**High**	Collision with turbines
Eagle, Martial *Polemaetus bellicosus*	EN, VU	4	√	√	√	√	**Medium**	Collision with turbines
Harrier, Black *Circus maurus*	EN, EN (NE)	6			√		**Medium**	Collision with turbines
Eagle, Verreaux's *Aquila verreauxii*	VU, LC	3	√	√	√	√	**High**	Collision with turbines
Falcon, Lanner *Falco biarmicus*	VU, LC	24	√		√	√	**Low**	Collision with turbines
Secretarybird *Sagittarius serpentarius*	VU, EN	13	√	√		√	**Low**	Collision with turbines, Disturbance & Displacement
Stork, Black *Ciconia nigra*	VU, LC	10		√	√		**Low**	Collision with turbines
Crane, Blue *Grus paradisea*	NT, VU	11			√		**Low**	Collision with turbines, Disturbance & Displacement
Korhaan, Karoo *Eupodotis vigorsii*	NT, LC	51	√	√	√	√	**Low**	Collision with turbines, Disturbance & Displacement
Lark, Sclater's *Spizocorys sclateri*	NT, NT (NE)	50	√	√			**Low**	Collision with turbines
Pipit, African Rock *Anthus crenatus*	NT, LC (SLS)	78			√	√	**Low**	Collision with turbines, Disturbance & Displacement

Regional Red List status according to Taylor* et al. *2015 *Global Red List status according to IUCN 2022. EN = Endangered; VU = Vulnerable; NT = Near-threatened; LC = Least Concern.Endemism – whether the species is endemic (E) or near endemic (NE) to SA. E = Endemic; NE = Near-endemic; SLS = Endemic to SA, Lesotho & Swaziland; BNE = Breeding near endemic. Retief* et al. *2014 – the species ranking in terms of turbine collision risk – as per Avian Wind Farm Sensitivity Map*

Site Sensitivity Verification outcome

There are currently no published national acceptable thresholds for estimated avian fatality at wind energy facilities with which to compare our findings for the SCC confirmed on site. However, we confirm the presence of 11 avian SCC and specify the nature of impacts likely to be of concern (**Table A6**).

We dispute the Screening Tool finding for the Avian Theme which designates the site as Low sensitivity and concur with the Tool's High sensitivity assessment of the Animal Species Theme for both highlighted avian species (Ludwig's Bustard and Verreaux's Eagle). We include Black Harrier and Martial Eagle in a category of at least Medium sensitivity.

Appendix 14. Priority bird species Fatality threshold and Adaptive Management Plan.

Species Fatality Thresholds

Section 3.3 identifies five species as being at High or Medium risk at the proposed wind farm through turbine collision (i.e., direct mortality): Ludwig's Bustard, Verreaux's Eagle & Jackal Buzzard at High; and Martial Eagle and Black Harrier at Medium risk. In Section 3.2.6. we estimated that at the proposed wind farm the following turbine collision fatalities could occur annually for these five species before any mitigation is applied: 0.66 Ludwig's Bustards; 0.47 Verreaux's Eagles; 1.38 Jackal Buzzards; 0.05 Martial Eagles and 0.01 Black Harriers.

It is important to assess whether these fatality rates are acceptable to these five species, or in other words whether these species populations can sustain these fatality levels. For each high risk bird species above, we calculated an estimated fatality threshold for the wind farm. Threshold setting was informed by firstly calculating an annual fatality rate for each species, using Potential Biological Removal (PBR) (Wade 1998, Dillingham & Fletcher, 2008, 2011). The PBR method estimates a level of mortality which if exceeded would likely compromise the long-term viability of the species' population. Secondly an estimate of annual, non-project related fatalities due to human derived effects for each priority species is calculated. In simple terms we calculated how many anthropogenic fatalities each species could 'afford' annually, and then how many anthropogenic fatalities are already occurring annually prior to the addition of the proposed project. This leaves an estimate of how many fatalities a new project (such as the proposed wind farm) could sustainably cause. The PBR value indicates a crisis point for the population and therefore if additional mortality due to human derived effects is close to or exceeds the PBR then it is likely that the population cannot sustain further fatalities.

'Crisis point' fatality rate estimation

The PBR approach is considered an appropriate approach when limited information on species population biology is available. The PBR is calculated using the annual recruitment rate which is calculated from the maximum annual population growth rate, based on mean annual adult survival and age of first breeding. A conservative estimate of population size is used and recovery factors are assigned to species based on a sliding scale developed by Dillingham and Fletcher (2008), whereby 'Critically Endangered', 'Endangered' and 'Vulnerable' species receive a factor of 0.1 whilst 'Near-threatened' species receive a factor of 0.3, and other species receive a factor of 0.5. Calculating the Potential Biological Removal rate requires three pieces of biological information:

1) an estimate of population size for the relevant 'reference' population (ideally the biogeographic population);
2) age at first breeding; and
3) adult survival rate.

The PBR is calculated for an appropriate Unit of Analysis (UoA) for each species. Ludwig's Bustard, Black Harrier, and Jackal Buzzard have global populations that are principally restricted to South Africa and its' neighbours and so from an ecological and conservation perspective this biogeographically defined, global population was selected as the most appropriate UoA population. Martial Eagle and Verreaux's Eagle have a widespread breeding distribution across sub-Saharan Africa and therefore determining the extent of biogeographical populations was not possible. The national population was therefore used as a spatially relevant conservation unit (UoA) for these species.

Age of first breeding for each species was obtained from available literature (referenced for each species in Table 1). In cases where a range in age was cited (for example 3 to 5 years), the more conservative or older age was used. Adult survival rate was obtained from available literature where possible. For some species we could not obtain a species specific survival rate and so estimated this based on ecologically similar and similar sized species.In some cases, the necessary information was estimated (always stated for transparency).

The PBR output is obviously sensitive to these input factors. For example, if any of the species population sizes are actually larger than estimated, this would mean the population could sustain more fatalities. However, in the next step, where existing anthropogenic factors are estimated it becomes clear that for most of these species the existing anthropogenic impacts are already so high that even larger populations would not sustain them. Table 2 shows the results of the PBR results for each priority species. The full calculation is shown in Table 3. For Martial Eagle, Black Harrier, Verreaux's Eagle and Ludwig's Bustard the proposed project's annual fatality threshold is zero fatalities. For Jackal Buzzard the project threshold is 10 fatalities per annum.

Summary PBR analysis.

Common Name	Taxonomic name	Status	Global popn	Unit of Analysis	Popn estimate in UoA (used to calculate Nmin)	Mean Adult Survival rate	Age at first breeding	Recovery value (F)	PBR	Reference for demographic info	Project threshold
Ludwig's Bustard	*Neotis ludwigii*	EN, EN	114000	Global population	114000	0.7	3	0.1	1213.84	Population estimate Shaw 2013, adult survival rate & age of first breeding estimated based on similar species	0
Verreaux's Eagle	*Aquila verreauxii*	VU, LC	n/a	South African population	10000	0.9	7	0.1	38.66	Population estimate Taylor et al 2015; adult survival rate & age of first breeding estimated based on similar species	0
Jackal Buzzard	*Buteo rufofuscus*	LC	20000	Global population	20000	0.85	3	0.5	823.32	Popn estimate - own crude estimate. Adult survival rate based on similar sized species in Newton et al, 2016. Age of first breeding based on literature for similar size species	10
Martial Eagle	*Polemaetus bellicosus*	EN, EN	16000	South African population	800	0.93	7	0.1	2.74	Popn estimate (Taylor et al, 2015). Adult survival rate & age of first breeding (Hockey *et al*, 2005).	0
Black Harrier	*Circus maurus*	EN, EN	1000	Global population	1000	0.8	3	0.1	9.19	(Taylor et al, 2015). (Simmons pers comm).	0

Fatalities from human derived sources

To estimate how many annual fatalities already result from human derived effects other than the proposed project we used the below described reasoning:

Ludwig's Bustard

Collision with overhead lines is cited as the main threat to this species, although hunting, poisoning and disturbance are also threats (Taylor *et al,* 2015). Collision with power lines is a significant threat (e.g. Shaw *et al* 2010, 2107). Shaw (2013) estimated that 36 556 Ludwig's Bustards collide with power lines annually in South Africa. In a separate long term monitoring study, Shaw *et al* (2017) recorded 412 Ludwig's Bustard collision fatalities under 109km of power line over 8 years. This equates to approximately 0.47 bustard fatalities/km/year. Extrapolating this fatality rate to the number of kilometres of overhead power line in Ludwig's Bustard range comfortably confirms an estimate of tens of thousands of fatalities per year. The calculated PBR value for Ludwig's Bustard is 1 213.84 birds per year (Table 1). The estimated fatality rate by Shaw 2013 (on power lines alone) far exceeds this value. The PBR value and available evidence of human derived effects therefore indicates that the assessed Ludwig's Bustard population cannot sustain additional mortality from human derived sources, and that a zero-fatality threshold should be implemented for wind energy in South Africa. Accordingly, a zero-fatality threshold for Ludwig's Bustard at the proposed project is considered necessary to adequately contribute to the safeguarding of the South African population.

Verreaux's Eagle

Taylor *et al* (2015) list persecution by stock farmers as the primary threat to this species, with drowning in reservoirs and depletion of prey base (Rock Hyrax) also of concern. Electrocution and collision on power lines are also mentioned. Of these, power line mortality provides the best available data. Data from the EWT-Eskom for the Karoo region shows 29 Verreaux's Eagle fatalities reported in 24 years. This is only one region of SA, and reports are the product of chance detection not thorough survey. This crude data equates to 1.21 eagle fatalities per year on power lines in the Karoo. It is likely that the South African fatality rate is several times higher than this fatality rate. The calculated PBR value for Verreaux's Eagle is 38.66 birds per year (across SA, all sources of mortality). The PBR value and available evidence of human derived effects therefore indicates that the assessed Verreaux's Eagle population cannot sustain additional mortality from human derived sources, and that a zero-fatality threshold should be implemented at all operational wind farms in South Africa. Accordingly, a zero-fatality threshold for Verreaux's Eagle at the proposed project is considered necessary to adequately contribute to the safeguarding of the South African population. This means that the estimated annual fatality rate of 0.47 Verreaux's Eagles at each of the proposed wind farms is not acceptable, and mitigation must be implemented.

Jackal Buzzard

Little is known about the anthropogenic threats to Jackal Buzzard, but they are thought to include poisoning, drowning in reservoirs and power lines. As a medium sized raptor, Jackal Buzzard is less susceptible to power line impacts than larger species. Data from the Endangered Wildlife Trust-Eskom Strategic partnership (EWT-Eskom) for the Karoo region shows 3 electrocution fatalities for the species in 24 years. Considering that these data are the product of chance detection and not systematic survey, it is probable that not all fatalities are found. However even taking this into account, a conservative extrapolation to the remainder of South Africa would suggest that in the region of 50 or fewer birds are killed by power lines each year. No literature exists on other threats to this species. Perold *et al* (2020) collated bird fatality data from 16 operational wind farms during the period 2014 to 2018. Fatality data from a combined total of 1101 turbine years was examined and included 81 Jackal Buzzard fatalities, for an unadjusted fatality rate of 0.07 Jackal Buzzards per turbine per year. Operational wind farms therefore currently account for approximately 10% of the calculated PBR value for Jackal Buzzard of 823.32 birds per year. Based on the available evidence, expert judgement and the PBR rate, an annual fatality threshold at the proposed project of 10 Jackal Buzzards is considered necessary to adequately contribute to the safeguarding of the global population.

Martial Eagle

Taylor *et al* (2015) list the following threats to Martial Eagle: direct persecution, poisoning, drowning in reservoirs, habitat alteration, nest site disturbance and electrocution on power lines. Of these, power line mortality provides the best available data. Data from the EWT-Eskom for the Karoo region shows 26 Martial Eagle fatalities reported in 24 years. This is only one region of SA, and reports are the product of chance detection not thorough survey. This crude data equates to 1.08 eagle fatalities per year on power lines in the Karoo. It is likely that the South African fatality rate is several times higher than this fatality rate. The calculated PBR value for Martial Eagle is 2.74 birds per year (across SA, all sources of mortality). The PBR value and available evidence of human derived effects indicates that the assessed Martial Eagle population cannot sustain additional mortality from human derived sources, and that a zero-fatality threshold should be implemented at all operational wind farms in South Africa. Accordingly, a zero-fatality threshold for Martial Eagle at the proposed projects is considered necessary to adequately contribute to the safeguarding of the South African population. This means that the estimated annual fatality rate of 0.05 Martial Eagles is not acceptable, and mitigation must be implemented.

Black Harrier

Taylor *et al* (2015) describes the main threats to Black Harrier as habitat loss and fire. Contrasting with these indirect impacts on the population, wind farms may represent one of the first widespread threats to adult survival. The calculated PBR rate for Black Harrier is 9 fatalities annually. If these were all allocated to wind energy (assuming no other threats), this would require each wind farm in South Africa to have less than one fatality per year to remain below the PBR value. On this basis, a zero fatality threshold for Black Harrier at the proposed project is considered necessary to adequately contribute to the safeguarding of the global population.

Adaptive management plan

The adaptive management plan aims to manage the impact of the proposed facility on birds to the extent that the impacts are acceptable and sustainable for the species populations.

It is important for the project to have an adaptive management plan in place before operations, so that once operational, managements' response to any bird fatalities is clearly structured. Fatalities of Red Listed birds are typically rare events, but each with high consequence. As a result trends and patterns are often not evident at a level useful for decision making. At the proposed project, fatality thresholds have been set for the high risk bird species. Adaptive management will be triggered when these thresholds are exceeded.

Adaptive management strategies should follow a set of clear sequential actions, specifically:

1. Conduct a review to determine the primary reasons why a threshold was exceeded.
2. Review the effectiveness of existing mitigation in light of the findings and determine whether a revised mitigation strategy is required and if so design revised mitigation.
3. If needed, define a revised threshold or limit of acceptable change.
4. Define the actions that will be taken if the new threshold or limit of acceptable change is exceeded.

This process is iterative, and the breaching of successive thresholds should be matched by an increase in the measures to protect and promote the viability of priority bird populations. If thresholds are repeatedly exceeded, despite mitigation efforts, off set options will need to be considered. Adaptive management responses are not limited to exceeded thresholds and may be triggered in response to other events such as:

- Evidence of an increased risk to a population from other non-project sources. For example, evidence of increased persecution during the operational phase of the wind farm may lead to reassigning a priority bird with an annual fatality threshold to a zero fatality threshold.
- An elevated risk situation, such as a temporary and unforeseen abundance of a risk species on site. For example, increased livestock/wildlife around turbines may result in an observed increase in raptor activity in the area.
- A near-miss incident, in which no fatality occurred but existing mitigation failed to prevent the risk. For example a raptor present on site and observed flying through rotor airspace.

The Adaptive Management Plan for the project described here provides a clear procedure and timeframe for evaluating fatalities and responding to exceeded thresholds. Following the framework allows the project to clearly demonstrate its' safeguarding record for priority birds.
Fatality thresholds at the project fall into four different categories:

1. Zero fatality thresholds for priority birds
2. Annual fatality thresholds for priority birds (threshold >zero)
3. Extreme event thresholds – for unforeseen once off situations
4. Elevated risk situations

Adaptive management response strategies for each threshold category are described below.

Adaptive management response strategies for threshold categories.

Species Category	Species	Annual Fatality Threshold	Reporting process for recorded fatality	Management response
Zero fatality threshold species	Ludwig's Bustard, Verreaux's Eagle, Martial Eagle, Black Harrier	0	Fatality reported by field search team to avifaunal specialist within 24hrs of discovery. Incident Report compiled by specialist & submitted to site management within 48hrs.	Meeting/call held within 1 week of incident. Details & timing of any adaptive management response agreed & documented.
Annual Fatality Threshold species	Jackal Buzzard	10	Thresholds assessed at 6-months and 12 months based on species specific corrected fatality rate estimate results.	Appropriate adaptive management for an exceeded threshold agreed at management meeting within 1 month of the completing of a semi-annual report.
Extreme Event Thresholds	Any species	For practical reasons, such as the need for a quick decision in the field to minimize the scale of this type of extreme event the threshold is set to a single fatality event that exceeds 10 individuals of one or more species.	A threshold is set to manage the risk of multiple-fatalities occurring as a single fatality event e.g. resulting from migratory activity or extreme weather. This type of event may be particularly relevant to species that occur in flocks.	The Adaptive management protocol for exceeding extreme event thresholds follows the same procedure as for zero-fatality thresholds.
Elevated Risk Situations	Any species	If site staff observe an increase in priority bird activity that could result in exceeded thresholds, even if no fatalities have occurred For e.g. a severe hailstorm kills numerous lambs and attracts raptors to feed.	Site should inform Avifaunal specialist immediately. Specialist should assess the maximum number of birds at risk and estimate how long the risk is likely to persist and likelihood of fatalities during this period. Specialist should then arrange a call/meeting with site management within 48 hours of the event.	Meeting to agree on any necessary action necessary to reduce immediate risk of fatalities along with a timescale for implementing the action. In this situation (even if no fatalities occurred) an incident report should be completed to

Species Category	Species	Annual Fatality Threshold	Reporting process for recorded fatality	Management response
				document details of the elevated risk situation, the action taken and the outcome of the action
Near-miss Incidents	Any species	All near-miss incidents involving a priority species observed by fatality search teams or any site staff should be reported to site management/avifaunal specialist following the same procedure and timescales as for Elevated Risk Situations.		

Common Name	Status	Population estimate in UoA (This column has been used to calculate Nmin)	Mean Adult Survival rate	Mean age at first breeding	Zp (at the lower 60th percentile)	CVn	ZpCVn	Nmin	F =0.1	F =0.3	F =0.5	F =1.0	sa	sa-s+a+1	s-sa-a-1^2	4sa^2	s-sa-a-1^2 -4sa^2	sqrt. s-sa-a-1^2 - 4sa^2	Ymax	Rmax	PBR F = 0.1	PBR F = 0.3	PBR F = 0.5	PBR F = 1.0
Ludwig's Bustard	EN, EN	114000	0.7	3	-0.842	0.1	-0.0842	104794.20	0.1	0.3	0.5	1	2.1	5.4000	29.1600	25.2000	3.9600	1.9900	1.2317	0.2317	1213.84	3641.53	6069.22	12138.44
Jackal Buzzard	LC	20000	0.85	3	-0.842	0.1	-0.0842	18384.95	0.1	0.3	0.5	1	2.55	5.7000	32.4900	30.6000	1.8900	1.3748	1.1791	0.1791	164.66	493.99	823.32	1646.64
Martial Eagle	EN, EN	800	0.93	7	-0.842	0.1	-0.0842	735.40	0.1	0.3	0.5	1	6.51	13.5800	184.4164	182.2800	2.1364	1.4616	1.0744	0.0744	2.74	8.21	13.68	27.36
Verreaux's Eagle	VU, LC	10000	0.9	7	-0.842	0.1	-0.0842	9192.47	0.1	0.3	0.5	1	6.3	13.4000	179.5600	176.4000	3.1600	1.7776	1.0841	0.0841	38.66	115.99	193.31	386.62
Black Harrier	EN, EN	1000	0.8	3	-0.84	0.1	-0.0842	919.2474	0.1	0.3	0.5	1	2.4	5.6	31.36	28.8	2.56	1.6	1.2	0.2	9.192474	27.57742	45.96237	91.92474