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Dear Caroline,

RE NEW POWER LINE ROUTES AT COLESKOP WIND ENERGY FACILITY – AVIFAUNAL

WildSkies Ecological Services conducted the pre-construction bird monitoring, scoping and EIA level avifaunal assessments for the Coleskop Wind Energy Facility and various amendments during 2013-2018. The most recent report was submitted to EOH-CES in 2018 entitled: "Coleskop Wind Energy facility – Avifaunal Impact Assessment Report" (Smallie, 2018). During March 2019 EDF Renewables (formerly InnoWind) added two new power line routes for assessment and WildSkies was asked to provide avifaunal input.

Our previous report made the following findings:

- *Collision and electrocution of birds on overhead power lines on site is anticipated to be of HIGH significance. Both of these impacts can be mitigated successfully in our opinion to reduce the significance to LOW. In the case of bird collision, all power line linking turbines to the on-site switching substation must be buried underground. None of this power line may be above ground. The only permissible power line above ground is that shown in Figure 3 labeled 'internal overhead line' (approximately 1.5km long). To mitigate for collision of the relevant species with the 'internal overhead line', it is recommended that the earth wires on the spans identified as high risk be fitted with the best available (at the time of construction) Eskom approved anti bird collision line marking device. This should preferably be a dynamic device, i.e. one that moves as it is believed that these are more effective in reducing collisions, especially for bustards (see Shaw 2013), which are one of the key species (Ludwig's Bustard) in this area. It is recommended that a durable device be used as this area is clearly prone to a lot of strong wind and dynamic devices may be susceptible to mechanical failure. It will be either EDF or Eskom's responsibility to ensure that these line marking devices remain in working order for the full lifespan of the power line, as we cannot afford to have significant* *numbers of bird collisions on this new line. It is important that these devices are installed as soon as the conductors are strung, not only once the line is commissioned, as the conductors and earth wires pose a collision risk as soon as they are strung. The devices should be installed alternating a light and a dark colour to provide contrast against dark and light backgrounds respectively. This will make the overhead cables more visible to birds flying in the area. Eskom Distribution has a guideline for this work and this should be followed. Note that 100% of the length of each span needs to be marked (i.e. right up to each tower/pylon) and not the middle 60% as some guidelines recommend. This is based on a finding by Shaw (2013) that collisions still occur close to the towers or pylons. It is also recommended that the stay wires on the met masts on site be installed with these devices as soon as possible.*

- *In the case of bird electrocution, all power line linking turbines to the on-site substation must be buried underground. The 'internal overhead line' must be built on an Eskom approved bird-friendly pole structure which provides ample clearance between phases and phase-earth to allow large birds to perch on them in safety. Note that if on site power cannot be buried for any reason, this would represent a significant change to the risk posed by this facility, and the specialist will need an opportunity to revise these findings.*
- *The preferred option for the 132kv power line to the MTS Substation is Option 2 as it does not pass through the no-go area around the Verreaux's Eagle nests.*
- *A final avifaunal walk through should be conducted prior to construction to ensure that all the avifaunal aspects have been adequately managed and to ground truth the final layout of all infrastructure. This will most likely be done as part of the site specific Environmental Management Plan. This will also allow the development of specific management actions for the Environmental Control Officer during construction and training for relevant on site personnel if necessary.*

Figure 1 (originally Figure 16 in the previous report) shows the layout of these components relative to our avifaunal sensitivity map.

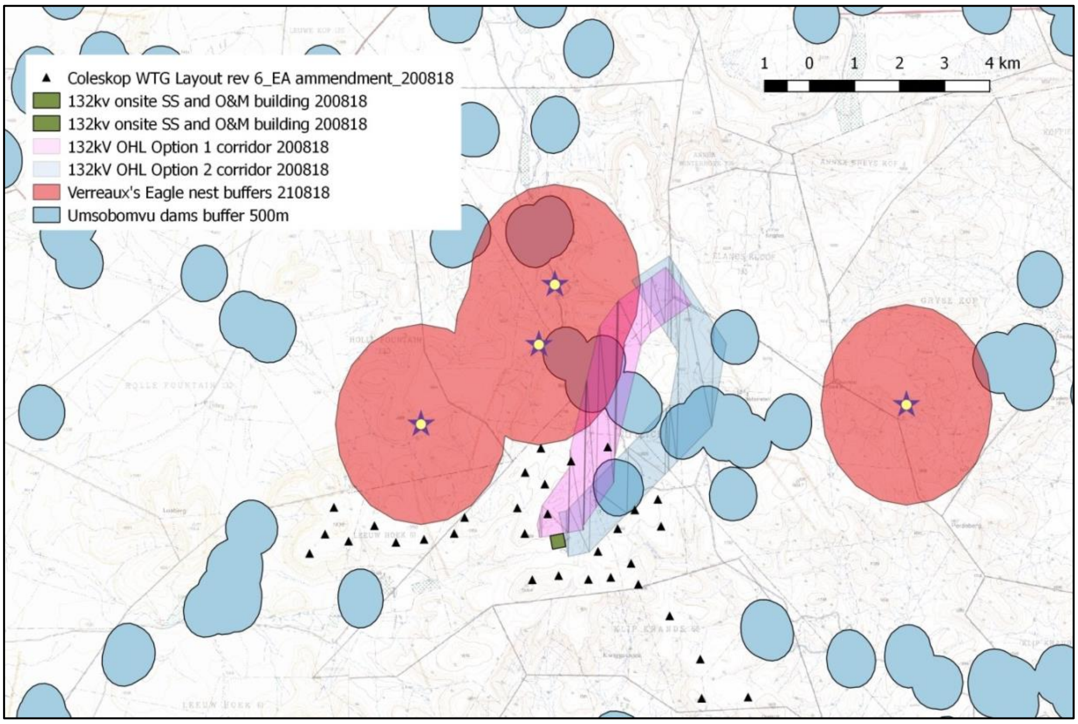

Figure 1. Original sensitivity mapping relative to the two new power line routes.

Our findings above remain unchanged by the two new power line routes and can be used for the Basic Assessment.

Please feel free to contact us if any further clarity is required.

Kind Regards

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Coleskop Wind Energy Facility

EDF Renewables

Avifaunal Impact Assessment report

September 2018

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Submitted to:
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EXECUTIVE SUMMARY

EDF Renewables (hereafter EDF) previously obtained environmental authorization (2017) for a wind farm and grid connection named Umsobomvu, located between Middleburg and Noupoort in the Eastern and Northern Cape provinces. EDF now propose to split this wind farm into three authorisations: Umsobomvu Wind Farm; Coleskop Wind Farm; and the Eskom Infrastructure MTS. The turbine model is also to be amended for each wind farm. EOH Coastal & Environmental Services (hereafter EOH-CES) was appointed by EDF to undertake the amendment process. WildSkies Ecological Services (Pty) Ltd (WildSkies) conducted the pre-construction bird monitoring and the original impact assessment and was appointed to update the impact assessment report and split it into the three projects Umsobomvu, Coleskop, and Eskom Infrastructure MTS. This report deals with the Coleskop site.

Pre-construction bird monitoring was conducted on the original site across four seasons, and comprised a total of 64 days on site by a team of two observers, plus several extra days surveying sensitive areas, and several specialist site visits. The main findings of this study are as follows:

- A total of 29 target bird species were identified at the outset of this programme on the basis of their conservation status and/or likely susceptibility to impacts of the proposed facility. This group of species comprises four ecological groups: raptors; large terrestrials; water birds; and a game bird. Of these 29 species, 19 were recorded on site including: 3 Endangered species (Taylor *et al*, 2015 – Martial Eagle, Tawny Eagle, Ludwig's Bustard); and 3 Vulnerable species (Lanner Falcon, Secretarybird, and Verreaux's Eagle).
- A total of 40 small bird species were recorded on site by walked transects. This species diversity peaked in spring and summer (33 and 30 species respectively), with lower species richness in winter and autumn. None of these species were Red Listed. Approximately 21 of these species are southern African endemic or near-endemics, with some being Karoo endemics.
- Thirteen large terrestrials and raptor species were recorded by drive transects, with a slight peak in species richness in autumn (5 species), and 4 species in each of the other seasons. The most abundant species recorded by this method was Lesser Kestrel, recorded only in summer as expected as it is a migrant.
- Over the full year a total of 142 bird species were recorded on site by all data collection methods. Spring showed the highest species richness (114 species) followed by summer (104) and autumn and winter (84 species each). Approximately 55 of these species can be considered southern African endemic or near-endemic species.

- Three pairs of Verreaux's Eagle were found to breed on or near site during this study. This is certainly the most important avifaunal aspect uncovered by this study. Most of the site is mountainous, with good availability of cliffs and rock lines on the mountain slopes and in the valleys.
- Ten target bird species were recorded flying on site, including 7 raptors, 2 large terrestrials, and a water bird. The majority of recorded flight was that of raptors, particularly Verreaux's Eagle. Almost half of all recorded flights were at Vantage Point 1, of Verreaux's Eagle. At VP1 and elsewhere on site, the majority of Verreaux's Eagle flight was recorded close to (1 to 1.5km from) a nest site. Other species recorded flying relatively frequently on site included Rock Kestrel, Jackal Buzzard, Booted Eagle and Lesser Kestrel. Both these species spent most of their flight time at rotor height, placing them at risk of collision with turbines once built.
- The species determined to be at most risk if the facility is constructed are: Verreaux's Eagle; Rock Kestrel; Lesser Kestrel; Jackal Buzzard; and Ludwig's Bustard (at risk from overhead power lines predominantly).
- A spatial 'collision risk index' for the site was created from the above flight data. Collision risk was highest close to (approximately 1 to 1.5km) Verreaux's Eagle nests, and over the valleys and steep valley sides. Collision risk was low on the top plateau. Flight activity of Verreaux's Eagles is not evenly distributed around nest sites, but rather follows topography.
- In a national context, this site is believed to be in a position of moderate to high sensitivity for avifauna. On site, two categories of sensitivity or constraints for development have been identified: HIGH and MEDIUM. The high sensitivity areas are identified on the basis of Verreaux's Eagle breeding sites, ridge edges, valleys and drainage lines. It is recommended that no turbines or other infrastructure be placed within the HIGH sensitivity areas. MEDIUM sensitivity areas are identified on the basis of farm dams, and can be considered soft buffer areas.
- Formal assessment of the possible impacts of the proposed facility on birds (as per criteria supplied by EOH-CES) resulted in the following findings:
    - Destruction of bird habitat is anticipated to be of HIGH significance pre-mitigation. Adherence to the recommendations of this report, in particular the sensitivity map, will reduce this to MEDIUM significance.
    - Disturbance if birds, particularly breeding Verreaux's Eagles could be of HIGH significance, but can be mitigated to LOW significance through adherence to the sensitivity map and other recommendations.
    - Displacement of birds is judged to be of MEDIUM significance, mitigated to LOW by adhering to the sensitivity map.

  - Collision of birds with turbines is judged to be of HIGH significance, mostly for Verreaux's Eagle. This can be mitigated to MEDIUM significance by avoiding placing turbines within the buffer areas identified around the eagle breeding sites.
  - Collision and electrocution of birds on overhead power lines will be of HIGH significance, but is reasonably easily mitigated to LOW significance. Note that if on site power cannot be buried for any reason, this would represent a significant change to the risk posed by this facility, and the specialist will need an opportunity to revise these findings.
  - The contribution that the Coleskop facility will make to the cumulative impacts of wind farms on birds in this area is judged to be of medium significance.
- The preferred option for the site access road is Option 1 to the south of site. Option 3 is not acceptable for avifauna as it passes too close to a Verreaux's Eagle breeding site, which could be disturbed by increased traffic on this road.
- The preferred option for the 132kv power line to the MTS Substation is Option 2 as it does not pass through the no-go area around the Verreaux's Eagle nests.
- A construction phase and post construction phase bird monitoring programme framework has been designed and presented in this report.

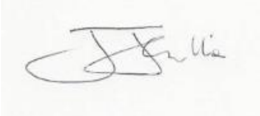
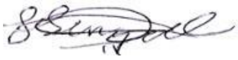
The following management recommendations are made for the management of risk to avifauna at this site:

- No infrastructure should be built in the areas identified as HIGH sensitivity in this report.
- All power line linking the turbines and linking turbine strings to the switching substation should be placed underground.
- There is a need to carefully manage the risk to Verreaux's Eagle at this site. The following actions will be required:
  - It may be necessary to avoid construction of certain infrastructure during Verreaux's Eagle breeding season (approximately May to October). This will depend on the final layout, construction timing and breeding status at the various nests. This must be determined by the avifaunal walk through prior to construction and once the infrastructure layout is final.
  - The effects of construction of the wind farm on the eagles must be monitored during construction. This will require a minimum of 3 site visits by a specialist during each eagle breeding season during construction. These site visits must determine breeding success at each nest and document eagle behaviour and reaction to construction as far as possible.

  - Once operational, the wind farm will have a 'duty of care' to monitor and document the effects of the operational phase of the facility on Verreaux's Eagle. This must include: thorough weekly turbine collision fatality searches; annual breeding status monitoring (3 site visits per season as above); and research into the eagles movement on and around site through the tracking of a sample of eagles (through the use of tracking devices fitted to one eagle from each pair).
  - If eagle turbine collision fatalities are recorded it will be necessary to mitigate this impact. It is recommended that the wind farm budget a suitable contingency amount for each year of operations so that identified mitigation measures can be implemented or further research can be undertaken to facilitate better understanding and mitigation.
- The post-construction bird monitoring programme outlined by this report should be implemented by a suitably qualified avifaunal specialist in accordance with the latest available best practice guidelines at the time (see Jenkins *et al*, 2015). As mentioned above this monitoring should include the grid connection power line.
- A final avifaunal walk through should be conducted prior to construction to ensure that all the avifaunal aspects have been adequately managed and to ground truth the final layout of all infrastructure. This will most likely be done as part of the site specific Environmental Management Plan. This will also allow the development of specific management actions for the Environmental Control Officer during construction and training for relevant on site personnel if necessary.
- The findings of post-construction monitoring should be used to measure the effects of this facility on birds. If significant impacts are identified the wind farm operator will have to identify and implement suitable mitigation measures.

If these recommendations are adhered to, this project can proceed in our opinion.

REPORT REVIEW & TRACKING

Document title	Coleskop Wind Energy Facility – Avifaunal Impact Assessment Report	
Client name & address	EOH Coastal & Environmental Services	
Status	Draft submitted to client	
Issue date	3 September 2018	
Lead author	Jon Smallie – SACNASP 400020/06	
Internal review	Luke Strugnell – SACNASP 400181/09	

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SPECIALIST DETAILS

Professional registration

The Natural Scientific Professions Act of 2003 aims to "Provide for the establishment of the South African Council of Natural Scientific Professions (SACNASP) and for the registration of professional, candidate and certified natural scientists; and to provide for matters connected therewith."

"Only a registered person may practice in a consulting capacity" – Natural Scientific Professions Act of 2003 (20(1)-pg 14)

Investigator:	Jon Smallie (*Pri.Sci.Nat)*
Qualification:	BSc (hons) Wildlife Science – University of Natal
	Msc Env Sc – University of Witwatersrand
Affiliation:	South African Council for Natural Scientific Professions
Registration number:	400020/06
Fields of Expertise:	Ecological Science
Registration:	Professional Member

Professional experience

Jon Smallie has been involved in bird interactions with energy infrastructure for 15 years. During this time he has completed impact assessments for more than 100 projects, at least thirty of which involved wind energy generation. He is a founding member of the Birds and Wind Energy Specialist Group and co-author of the best practice guidelines for wind energy and birds. A full Curriculum Vitae can be supplied on request.

Declaration of Independence

The specialist investigator (WildSkies Ecological Services) declares that:

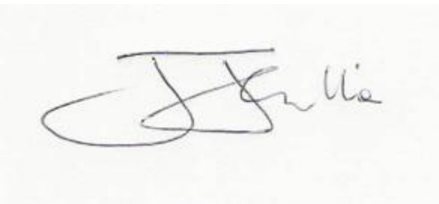
- We act as independent specialists for this project.
- We consider ourselves bound by the rules and ethics of the South African Council for Natural Scientific Professions.
- We do not have any personal or financial interest in the project except for financial compensation for specialist investigations completed in a professional capacity as specified by the Environmental Impact Assessment Regulations, 2006.
- We will not be affected by the outcome of the environmental process, of which this report forms part of.
- We do not have any influence over the decisions made by the governing authorities.

- We do not object to or endorse the proposed developments, but aim to present facts and our best scientific and professional opinion with regard to the impacts of the development.
- We undertake to disclose to the relevant authorities any information that has or may have the potential to influence its decision or the objectivity of any report, plan, or document required in terms of the Environmental Impact Assessment Regulations, 2006.

Terms and Liabilities

- This report is based on four seasons of pre-construction bird monitoring on site, and other available information and data related to the site to be affected.
- The Precautionary Principle has been applied throughout this investigation.
- Additional information may become known or available during a later stage of the process for which no allowance could have been made at the time of this report.
- The specialist investigator reserves the right to amend this report, recommendations and conclusions at any stage should additional information become available.
- Information, recommendations and conclusions in this report cannot be applied to any other area without proper investigation.
- This report, in its entirety or any portion thereof, may not be altered in any manner or form or for any purpose without the specific and written consent of the specialist investigator as specified above.
- Acceptance of this report, in any physical or digital form, serves to confirm acknowledgment of these terms and liabilities.

Signed in September 2018 by Jon Smallie, in his capacity as avifaunal specialist for this project.



CONTENTS

1 INTRODUCTION

EDF Renewables (hereafter EDF) previously obtained environmental authorization (2017) for a wind farm and grid connection named Umsobomvu, located between Middleburg and Noupoort in the Eastern and Northern Cape provinces. EDF now propose to split this wind farm into three authorisations: Umsobomvu Wind Farm; Coleskop Wind Farm; and the Eskom Infrastructure MTS. The turbine model is also to be amended for each wind farm. EOH Coastal & Environmental Services (hereafter EOH-CES) was appointed by EDF to undertake the amendment process. WildSkies Ecological Services (Pty) Ltd (WildSkies) conducted the pre-construction bird monitoring and the original impact assessment and was appointed to update the impact assessment report and split it into the three projects Umsobomvu, Coleskop, and Eskom Infrastructure MTS. This report focuses on the Coleskop Wind Farm.

Typically a wind energy facility of this nature can be expected to impact on avifauna as follows: disturbance of birds; habitat destruction during construction and maintenance of the facility and associated infrastructure; displacement of birds from the area, or from flying over the area; collision of birds with turbine blades during operation; and collision and electrocution of birds on any overhead electrical infrastructure. The pre-construction bird monitoring carried out on site over four seasons collected the data required to assess the likelihood and significance of each of these impacts.

Topographically the site is mountainous and is varied in vegetation with open grassland on the higher ground, and thornveld in the lower lying and steeper areas. This presents a diverse habitat for use by birds. An approximate total of 254 bird species could occur in the broader area, based on what has been recorded in the study area by the first and second bird atlas projects (http://mybirdpatch.adu.org.za/). Pre-construction bird monitoring recorded a total of 142 species on the site itself. This is a relatively good diversity of species, reflecting the diversity of habitats in the broader study area.

1.1 Description of the proposed wind energy facility

The proposed facility will consist of the following:

- Up to 32 turbines.
- Each turbine will have a generating capacity of up to 5.5MW.
- Hub height assessed previously was up to 137m whilst rotor diameter was up to 132 metres. The new proposed model is of hub height up to 155m and rotor up to 165m.
- Ancillary infrastructure associated with the facility include:

- a site access road & internal access roads between turbines
- a temporary lay down area
- contractor's site office
- administration & warehouse buildings
- cabling between the turbines which will connect to an on-site substation
- An IPP Substation Area of 600m x 600m including MTS portion, located at (31°21'21.95"S; 24°49'21.88"E)

There is no alternative site for consideration for the overall wind energy facility. Alternatives exist within the site for the substation, turbine and road positioning. Figure 1 below shows the location and proposed layout of the Coleskop Wind Energy Facility. It is noted that several refinements to this layout have been undertaken by EDF during the year of pre-construction monitoring, as avifaunal risks were identified.

Figure 1. The location of the proposed Coleskop Wind Energy Facility.

1.2 Background to wind energy facilities and birds

The interaction between birds and wind farms first documented was that of birds killed through collisions 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). 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 that associated with other forms of development, collision and displacement/barrier effects are unique to wind energy.

Associated infrastructure such as overhead power lines also have 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 totaling 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 *Anthropoides paradiseus* (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* (2017) review included the first year of operational monitoring at the first 8 facilities. At least one more year has elapsed at each of these facilities and additional facilities have come on line. Where we are aware of this additional monitoring data and it is relevant to the Umsobomvu study we have cited it in the text.

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 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.

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.

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. 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 (several of which occur in the Coleskop 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. New access roads, substations and offices constructed will also have a disturbance and habitat destruction impact.

Ralston-Paton *et al* (2017) did not review power line impacts at the 8 sites. Our own experience has been of relatively few power line impacts at most sites, although monitoring of power lines has been much less frequent (quarterly) than at turbines (weekly).

1.2.6. Mitigation

Realistic mitigation measures for bird turbine collision include: increasing turbine visibility (for example through painting turbine blades; restriction of turbines during high risk periods; automated turbine shutdown on demand; human based turbine shutdown on demand; bird deterrents – both audible and visual; habitat management; and offsets. Most of these suggested mitigation measures are largely untested and/or impractical. For any mitigation to be undertaken during operation, budget will need to be available. This report strongly recommends that the wind farm operator make provision for a mitigation contingency budget so that if issues are encountered during operation, the best-suited and proven mitigation at that point in time can be implemented. This is discussed further in Section 4.

Mitigation for habitat destruction consists typically 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.

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.

2 METHODOLOGY

2.1 Terms of reference

The avifaunal specialist has conducted this assessment according to the terms of reference provided by EOH-CES for a study of this nature. The terms of reference are as follows:

- The existing environment must be described and the bird communities most likely to be impacted will be identified. Different bird micro-habitats must be described as well as the species associated with those habitats.
- Typical impacts that could be expected from the developments must be listed as well as the expected impact on the bird communities. Impacts must be quantified (if possible) and a full description of predicted impacts (direct and indirect) must be provided.
- Gaps in baseline data must be highlighted and discussed. An indication of the confidence levels must be given. The best available data sources must be used to predict the impacts including the results of the pre-construction monitoring and specialist studies that have been completed for previous EIA studies (if any) conducted at the site (or similar sites), and extensive use must be made of local knowledge, if available.
- The potential impact on the birds must be assessed and evaluated according to the requirements prescribed by the Environmental Assessment Practitioner.
- Practical mitigation measures must be recommended and discussed, including a post construction monitoring programme.
- Bird sensitive areas must be mapped in a sensitivity map for easy reference. Any no-go areas must be clearly indicated.

2.2 Project objectives

The aims of this study are as follows:

- To estimate the abundance of the priority species within the wind farm affected area. This will be used as a baseline against which to measure potential displacement and disturbance of these species due to the construction and operation of the WEF. This objective is reported on in Section 3.
- To document patterns of bird movement on site and flight behaviour that is relevant to understanding the risk of collision of these birds with wind turbines once constructed. This objective is achieved in Section 3.

- To identify potential risks of interaction between avifauna and the facility once constructed. This is achieved in Sections 4 and 5.
- To develop management recommendations for the mitigation of these risks. This could include providing spatial input into the final design (including the siting of turbines), construction and management strategy of the development. This is presented in Section 7.
- To develop a framework or outline for during construction and post construction bird monitoring at this site. This is presented in Section 6.

2.3 General approach

This study followed the following general steps. The detailed methodology is presented in Section 2.7:

- An extensive review of available international literature pertaining to bird interactions with wind energy facilities was undertaken in order to fully understand the issues involved and the current level of knowledge in this field. This international knowledge was then adapted to local conditions and species as far as possible in order to identify important or target species for this study.
- The various data sets listed below and the study area were examined to determine the likelihood of these relevant species occurring on or near the site.
- A pre-construction bird monitoring programme was conducted covering four seasons, in order to obtain the necessary data to make a more confident assessment of the impacts.
- The potential impacts of the proposed facility on these species were described.
- Sensitive areas within the proposed site, where the above impacts are likely to occur, were identified using various GIS (Geographic Information System) layers and Google Earth.
- Recommendations were made for the management and mitigation of impacts.

2.4 Data sources used

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

- The Southern African Bird Atlas Project 1 and 2 datasets were consulted using the Animal Demography Unit's *MyBirdPatch* web-based platform that enables the collection and curatorship of bird lists, for any defined area (http://mybirdpatch.adu.org.za/). An approximate total of 254 species have been recorded in the broader area within which the WEF is proposed.

- The Important Bird & Biodiversity Areas report (IBBA - Barnes 1998, Marnewick *et al,* 2015) was consulted to determine the location of the nearest IBA's and their importance for this study. The Platberg-Karoo Conservancy (SA037) IBA is located approximately 15km from the nearest proposed turbine location. This is discussed later in the report.
- The Co-ordinated Avifaunal Roadcount project (CAR – Young *et al*, 2003) data was consulted to obtain relevant data on large terrestrial bird report rates in the area where possible. The closest route, NK283 is located approximately ten kilometres north-west of the most northerly turbine location. Although this data would typically be useful for a project of this nature, pre-construction bird monitoring has collected far more comprehensive and site specific data, and this has been used in this report.
- The conservation status of all relevant bird species was determined using Taylor *et al* (2015) for regional and IUCN (2018) for global status.
- The latest vegetation classification of South Africa (Mucina & Rutherford, 2006) was consulted in order to determine which vegetation types occur on site.
- Google Earth Imagery was used extensively for planning purposes.
- Aerial photography from the Surveyor General was used.
- The recent document "Avian Wind Farm Sensitivity Map for South Africa: Criteria and Procedures Used" by Retief, Diamond, Anderson, Smit, Jenkins & Brooks (2011, 2014) was used for the species listing.
- Jenkins, Van Rooyen, Smallie, Harrison, Diamond, Smit-Robbinson & Ralston. 2015. Best practice guidelines for assessing and monitoring the impact of wind energy facilities on birds in southern Africa" Unpublished guidelines. Birdlife South Africa and Endangered Wildlife Trust.
- Various documentation on the Good Practice Wind website was used (www.project-gpwind.eu), particular guidance on assessment of impacts.
- The Birdlife International "Position statement on wind farms and bird' (2005).
- The Endangered Wildlife Trust and BirdLife South Africa "Position statement on wind farms and birds (2012) (www.birdlife.org.za).
- The BirdLife South Africa "Draft Terms of Reference for Avifaunal Impact Assessment at Wind Energy Facilities" 2013) (www.birdlife.org.za).
- Subsequent to the writing of the original impact assessment (Smallie 2015), BirdLife South Africa published "Verreaux's Eagle and Wind Farms: Guidelines for impact assessment, monitoring and mitigation. (2017). These guidelines have significant implications for this updated report as described in Section 4.

2.5 Relevant legislation

The legislation relevant to this specialist field and development include the following:

The Convention on Biological Diversity: 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.

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 African-Eurasian Waterbird Agreement. The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (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 - Threatened Or Protected Species list (TOPS). Examples of species occurring on this site and listed for protection by TOPS are: Lesser Kestrel, Tawny Eagle, Martial Eagle; African Marsh-Harrier, Blue Crane, Kori Bustard, and Ludwig's Bustard.

The Civil Aviation Authority's regulations are relevant to the issue of lighting of wind energy facilities, and to painting turbine blades, both of which are relevant to bird collisions with turbine blades.

The Eastern Capes' "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 Northern Cape Nature Conservation Act 9 of 2009 is relevant, and provides protection for most bird species.

2.6 Limitations & assumptions

Typically a study of avifauna at a site such as this would be heavily dependent on secondary data sources such as those listed in Section 2.4. In this case however, a significant amount of primary data was collected on site – rendering the above data sources useful only for preliminary planning. Limitations of this study then apply more to the primary data collection methods. A potential limitation exists in the quality and skill levels of the observers used. The data obtained can only be as good as those people capturing it. Experience with the observer team used on this project has shown that their bird identification and data capture skills are excellent.

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, 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 vantage point counts, it is extremely unlikely that two observers sitting in position for three hours 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 and flight height 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 perhaps only within 800 metres. Similarly birds are spotted more easily closer to the observers. 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 this 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 selection of vantage point positions is often challenging, and this site was no different. Because of the topography, road access and large size of the site, it was difficult to provide optimal coverage. Furthermore, new turbine positions were added in the far north and north-east late in this programme. Although these flat areas can be seen from existing vantage points, they are quite distant and our confidence in these areas is lower.

It is not possible to eliminate all risk of impacts of a proposed facility such as this on avifauna. In our South African landscape a vertical structure of 200 metres is almost unprecedented, multiple such structures even more so. Our best possible efforts can probably not ensure zero impact on birds. Studies such as this attempt to minimise the risk as far as possible, but it is probably unavoidable that the facilities will impact on birds, and perhaps in ways not yet understood.

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.

An overarching limitation is that since it is early days for wind energy in South Africa we have multiple and often quite different goals for this monitoring. This means that the pre-construction monitoring programme has not been as focused as it would possibly be for a project a few years into the future. Collecting diverse and substantial amounts of data is obviously an advantage on some levels, but perhaps may also dilute the focus somewhat.

The above limitations need to be stated as part of this study so that the reader fully understands the complexities. However they do not detract from the confidence that this author has in the findings of this study and subsequent management recommendations for this project. It has to be noted that the collection of vast amounts of data through pre-construction monitoring places us in a far better position to assess impacts than was the case a few years ago when only a very short once off site inspection was typically conducted.

2.7 Preparatory analysis

Due to their mobility, and the fact that one of the main possible impacts of the wind energy facility, that of bird collision, occurs whilst birds are mobile, the zone within which bird activity is relevant to the WEF is potentially far larger than the WEF itself. An important step in designing a monitoring programme is therefore defining this zone. Ideally this zone would encompass the likely range of all bird species likely to be affected by the WEF. However in the case of large birds of prey for example this could be tens of kilometres, and it is not considered feasible to monitor all of this.

Vegetation and the micro habitats available to birds on site are important in determining avifaunal abundance and movement on site. The vegetation on site has been described based on the work of Mucina & Rutherford (2006), and micro habitats available to birds were classified based on field work on site and the specialists' experience.

Determining the target species for this study, i.e. the most important species to be considered for the impact assessment, is a three step process. The first step is to determine which species occur or could occur in the area at significant abundances, and the importance of the study area for those species. Secondly, the recent document "A briefing document on best practice for pre-construction assessment of the impacts of onshore wind farms on birds" (Jordan & Smallie, 2010) was consulted to determine which groups of species could possibly be impacted on by wind farms. This document summarises which taxonomic groups of species have been found to be vulnerable to collision with wind turbines in the USA, UK, EU, Australia and Canada. The taxonomic groups that have been found to be vulnerable in two or more of these regions are as follows: Pelicaniformes (pelicans, gannets, cormorants); Ciconiiformes (storks, herons, ibises, spoonbills); Anseriformes (swans, ducks, geese); Falconiformes (birds of prey); Charadriiformes (gulls, terns, waders); Strigiformes (owls); Caprimulgiformes (nightjars); Gruiformes (cranes, bustards, rails); Galliformes (pheasants, grouse, francolins); and Passeriformes (songbirds). The third step is to consider the species conservation status or other reasons for protecting the species. This involved primarily consulting the Red List bird species (Taylor *et al*, 2015) as in Table 1. The recent document entitled "Avian Wind Farm Sensitivity Map for South Africa: Criteria and procedures used" (Retief, Diamond, Anderson, Smit, Jenkins & Brooks, 2011) combines all three above steps in order to identify sensitive areas of the country. The methods used by this project (Retief *et al*, 2011) are far more thorough and comprehensive than is possible during the scope of an EIA, and although the study was not intended to identify species for consideration in EIA's, it does serve as a useful resource, and in particular includes assessment of non-Red List bird species.

Two factors were considered in determining the monitoring effort: the facility size (in hectares and turbine number); and the perceived avifaunal sensitivity of the site. In addition the guidance offered in Jenkins *et al* (2014) was applied.

2.7 Data collection activities

2.7.1 Small terrestrial species

Although not traditionally the focus of wind farm–bird studies and literature, small terrestrial birds are an important component of this programme. Due to the rarity of many of our threatened bird species, it is anticipated that statistically significant trends in abundance and density may be difficult to observe. More common, similar species could provide early evidence for trends and point towards the need for more detailed future study. Given the large spatial scale of WEF's, these smaller species may also be particularly vulnerable to displacement and habitat level effects. Sampling these species is aimed at establishing indices of abundance for small terrestrial birds in the study area. These counts should be done when conditions are optimal. In this case this means the times when birds are most active and vocal, i.e. early mornings. A total of 14 walked transects (WT) of approximately 1 kilometre each were established in areas that are representative of the bird habitats available on the main site. These transects were conducted at first light and all bird species seen or heard, and their position relative to the transect line were recorded. For more detail on the exact methods of conducting walked transects see Jenkins *et al* (2015).

2.7.2. 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 transects (VT) were conducted in order to determine the number of birds of relevant species in the study area. Detection of these large species is less dependent on their activity levels and calls, so these counts can be done later in the day. Five VTs counts were established along suitable roads on the site, totalling approximately 46.5 kilometres. These transects were each counted once on each site visit. For more detail on the exact methods of conducting vehicle based transects see Jenkins *et al* (2015).

2.7.3. Focal site surveys & monitoring

Any particularly sensitive sites such as wetlands, dams, cliffs, and breeding sites are typically identified and monitored on each site visit. The eight focal sites identified on this site are all related to eagle breeding sites and potential cliff nesting habitat.

2.7.4. 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. It is important to maximise the benefit from this time on site by recording any other relevant information observed. 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 carefully plotted and documented. Where patterns in these observations are identified this may lead to additional focal site surveys in future.

2.7.5. *Direct observation of bird movements*

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

The aim of direct observation is to record bird flight activity on site. An understanding of this flight behaviour will help explain any future interactions between birds and the WEF. 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 six vantage points (VP) in the study area. These VP's provided coverage of a reasonable and representative proportion of the entire study area (total coverage being unnecessary and impractical given resource constraints). VP's were identified using GIS (Geographic Information Systems), and then fine-tuned during the project setup, based on access and other information. Since these VP's aim at capturing both usage and behavioural data, they were positioned mostly on high ground to maximise visibility. The survey radius for VP counts was two kilometres. VP counts were conducted by two observers, seated at the VP, taking care not to make their presence overtly obvious as to effect bird behaviour. Birds were recorded 360° around observers. Data was collected during representative conditions, so the sessions were spread throughout the day, with each VP being counted over 'early to mid-morning', 'mid to late morning', 'early to mid-afternoon', and 'mid-afternoon to evening'. Each session was three hours in duration, resulting in a total of 12 hours of observation conducted at each vantage point on each site visit. A maximum of two VP sessions were conducted per day, to avoid observer fatigue compromising data quality. For more detail on the exact criteria recorded for each flying bird observed, see Jenkins *et al* (2015).

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.

Spatial analysis of the bird flight data was conducted as follows:

A Viewshed Analysis of the two kilometre radius around each Vantage Point was undertaken to identify the areas that can actually be seen by the observers from the Vantage Point. This was done by using 20 metre contours to create a Triangular Irregular Network. Birds in flight above the ground surface can often be seen despite the ground itself not being visible. In order to account for this a point 65 metres above the ground was used to correspond with the lower edge of the rotor zone (for the proposed turbine model). The final viewshed then includes areas where birds 65 metres or more above the ground could be seen. Only data from areas deemed visible were displayed in the final figures. The recorded flight paths within this viewshed were vectorized to create lines for each flight record. A 100 x 100 metre grid was created of the relevant area. Each flight record or line was assigned a collision risk score as follows: The collision risk score for each record equals the flight height score multiplied by flight mode score multiplied by species conservation score, multiplied by number of birds recorded flying. Flight height scores were assigned as follows: 0 – 65 metres above ground = 1; 65 – 210 metres = 2; >210 metres = 1. Birds flying at rotor height (approximately 65 to 210 metres) are deemed to be at greater collision risk than those above or below this zone. Scores were assigned for flight mode as follows: direct commuting = 1; soaring or hovering = 2. Soaring and hovering are considered to be higher risk flight modes. A conservation score was assigned to each species as follows: common and non-threatened species = 1; 'Near-threatened' species and medium to large raptors = 2; 'Vulnerable' species = 3; and 'Endangered' species = 4. The results of this analysis were superimposed on the latest available turbine layout to determine collision risk at specific turbines.

2.8 Control sites

A suitable control site was identified approximately ten kilometres east of the main site. This site was chosen as it is one of the few areas at comparable altitude and with similar open plateau grassland to the Coleskop site. Activities on the control site consist of a single Vehicle Transect, two Vantage Points and six Walked Transects.

Figure 2 shows the layout of the above described monitoring activities on the original Umsobomvu site and Figure 3 shows the layout relative to the 'post-split' Coleskop project.

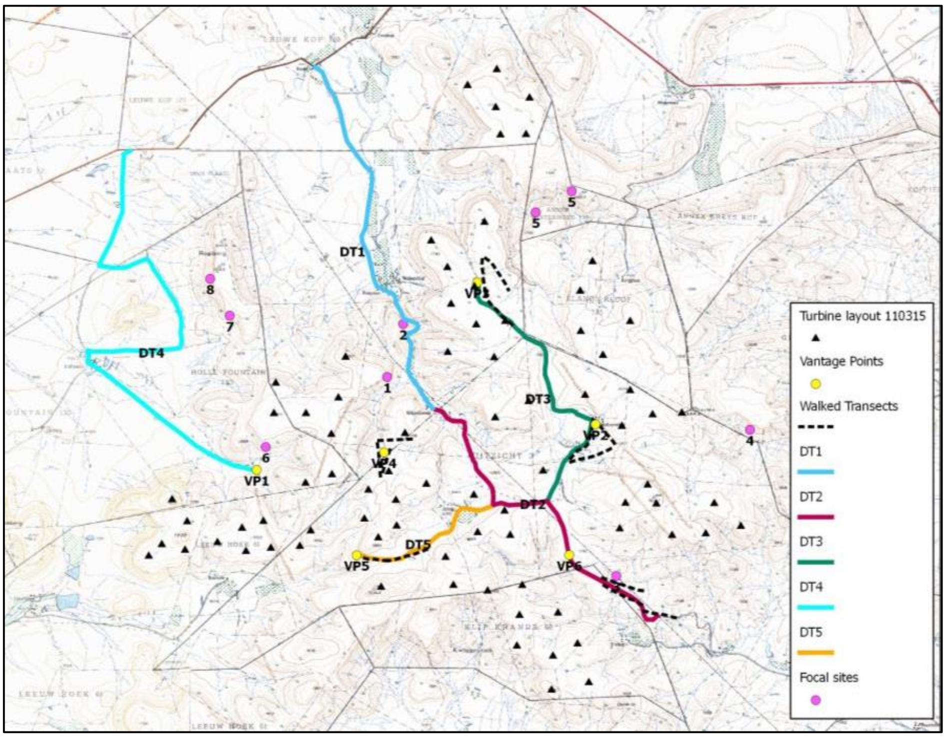


Figure 2. The layout of the pre-construction bird monitoring on the original Umsobomvu Wind Energy Facility site. Note that monitoring was conducted for the larger original Umsobomvu site and the turbine layout shown here is the original one.

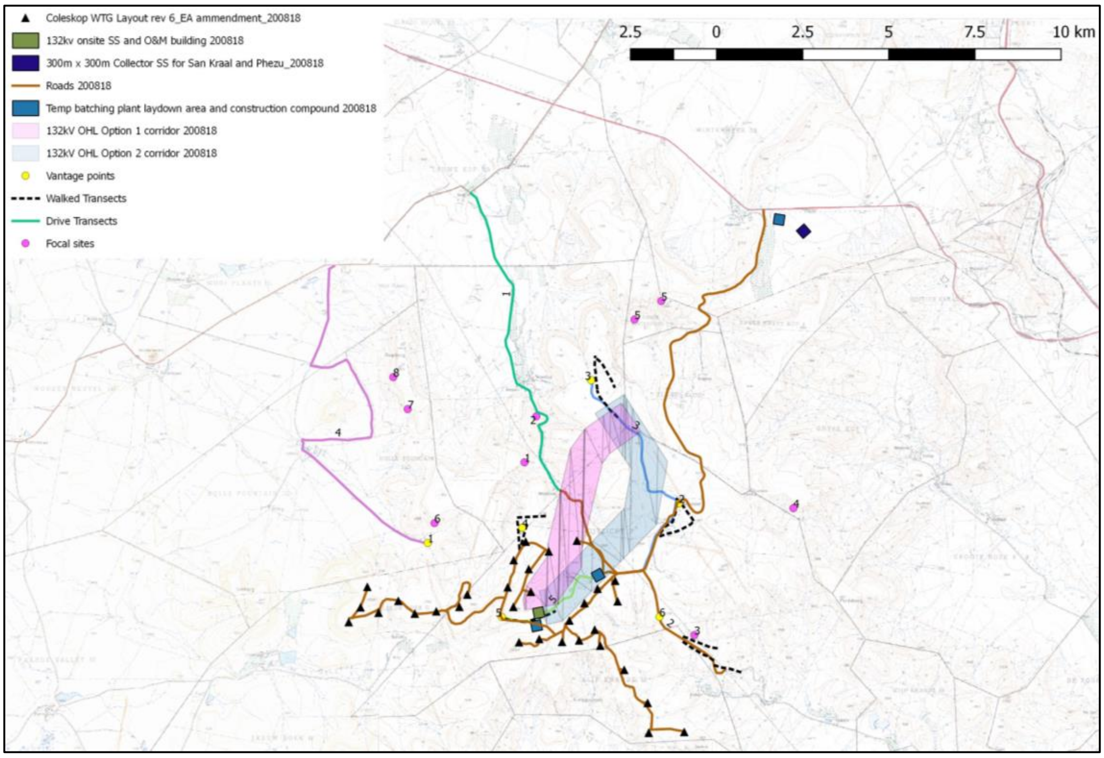


Figure 3. The layout of the pre-construction bird monitoring on the new Coleskop facility.

3 PRE CONSTRUCTION BIRD MONITORING RESULTS & DISCUSSION

The findings from the pre-construction bird monitoring programme have been reported on below. Since the original larger area was monitored as a unit, and birds are mobile, the larger original data set is report on. This data set is stronger when applied to each of the three applications than if all data were split into three. We have reported on specific findings where they differ notably between the three sites.

The monitoring programme has comprised of approximately 64 days on site by a skilled field team of two observers, and several additional days scouting new areas. The specialist has also conducted several site visits. The zone to be monitored was defined as approximately a buffer of two kilometres around the relevant properties, although drive transects extended further. Ideally this zone would encompass the likely range of all bird species likely to be affected by the WEF. However in the case of large birds of prey, and species such as cranes, bustards and Secretarybirds this could be tens of kilometres, and it is not considered feasible to monitor all of this.

3.1 Vegetation & habitat description

Vegetation is one of the primary factors determining bird species distribution and abundance in an area. The following description of the vegetation on the site (Mucina & Rutherford, 2006) focuses on the vegetation structure and not species composition. It is widely accepted within ornithological circles that vegetation structure is more important in determining bird species diversity. The affected area within which all the turbines are currently positioned is classified as “Besemkaree Koppies Shrubland”. The “Eastern Upper Karoo” vegetation type occurs in the low lying, flat areas of the project area and will be impacted on by access roads and power lines.

Field work revealed that the site is varied in vegetation with some open grassland on the higher ground and thornveld in the lower lying and steeper areas. The relevance of this vegetation classification to the avifauna of the area is that a variety of habitat is provided, which can accommodate both the species mostly dependent on shorter grassland, and those dependent on the taller thicket and woodland. This is reflected in the species composition for the study area, shown in Table 1 below and in Appendix 7.

The vegetation description partially describes the habitat available and hence the species likely to occur in the study area. However, more detail is required in order to understand exactly where within the study area certain species will occur and how suitable these areas are for the relevant species. The habitats available to birds at a small spatial scale are known as micro habitats. These micro habitats are formed by a combination of factors such as vegetation, land use, anthropogenic factors, topography and others. These micro habitats are typically important for judging the suitability of the site for relevant bird species. In this case the site is fairly uniform and there are few man made micro habitats. The identified micro habitats on the Coleskop site are therefore: grassland, rivers and drainage lines, wetlands, dams, thornveld, rocky ridges, and stands of exotic trees. Examples of these are shown in Figure 5, and species likely to utilise each habitat are shown in Table 1.

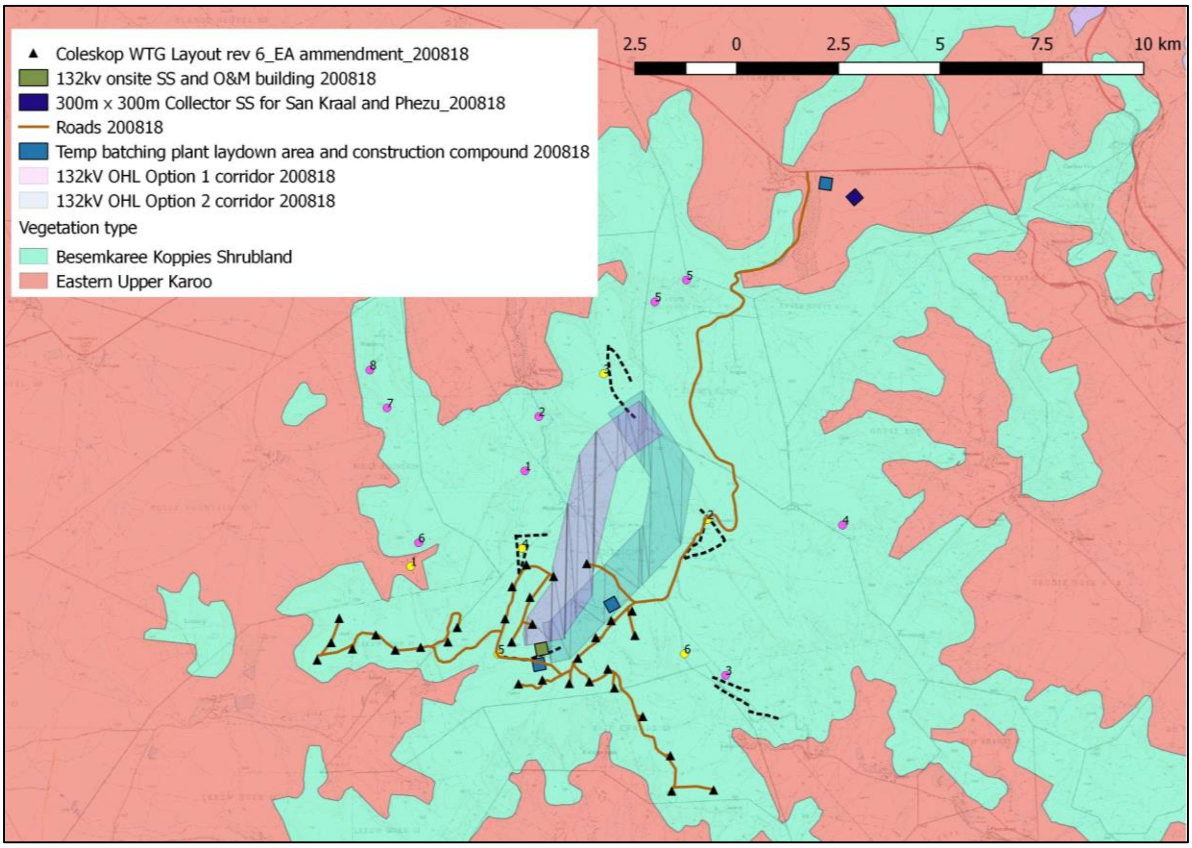


Figure 4. The vegetation composition of the Coleskop Wind Energy Facility site (Mucina & Rutherford, 2006).

Figure 5. Examples of bird micro habitats available on the Coleskop Wind Energy Facility site.

Note that this includes a far larger area than the current proposed Umsobomvu site.

3.2 Target species list

A total of 29 target bird species were identified as being of particular relevance on this site (Table 1) and formed the focus of the monitoring programme and this final preconstruction monitoring report. In each case the species' regional (Taylor *et al,* 2015) and global (IUCN 2018) conservation status is presented, and whether it has been confirmed on the site. Each species' preferred micro habitat is also presented.

This group of target species comprises species from mostly the 'large terrestrial'; 'raptor'; and 'water bird' ecological groups. One additional species, the Grey-winged Francolin *Scleroptila africana* is classed as a gamebird. In general terms, we can expect all bird species to be vulnerable to disturbance and habitat destruction impacts, particularly those breeding. The raptors and water birds are likely to be most susceptible to collision with turbines, based on frequent flights, and time spent in flight. The large terrestrials are generally expected to fly seldom, and low, but to be highly susceptible to collision when they do fly. These aspects are described in more detail later in this report.

The pre-construction bird monitoring programme recorded 19 of these target species on site, including 3 Endangered species (Martial Eagle, Tawny Eagle *Aquila rapax*, and Ludwig's Bustard *Neotis ludwigii*); and 3 Vulnerable species (Lanner Falcon *Falco biarmicus*, Secretarybird *Sagittarius serpentarius* and Verreaux's Eagle). These species are discussed in more detail in Section 4.

Table 1. Target bird species for the Coleskop Wind Energy Facility pre-construction bird monitoring programme.

Common name	Taxonomic name	SABAP1	SABAP2	Regional status	Global status	TOPS list	Presence on Site	Preferred micro habitat
Stork, Black	*Ciconia nigra*	√	√	VU	LC	VU		Riverine, cliffs
Flamingo, Greater	*Phoenicopterus ruber*	√	√	NT	LC			Dams, pans
Flamingo, Lesser	*Phoenicopterus minor*	√		NT	NT			Dams, pans
Shelduck, South African	*Tadorna cana*	√	√				√	Dams, rivers
Secretarybird	*Sagittarius serpentarius*	√	√	VU	VU		√	Grassland, open woodland
Falcon, Lanner	*Falco biarmicus*	√	√	VU	LC		√	Generalist, open vegetation, cliffs
Falcon, Amur	*Falco amurensis*		√				√	Grassland
Kestrel, Rock	*Falco rupicolus*	√	√				√	Generalist
Kestrel, Lesser	*Falco naumanni*	√	√			VU	√	Generalist
Eagle, Verreaux's	*Aquila verreauxii*	√	√	VU	LC		√	Mountainous rocky areas
Eagle, Tawny	*Aquila rapax*	√		EN	LC	VU	√	Generalist
Eagle, Booted	*Aquila pennatus*	√	√				√	Generalist
Eagle, Martial	*Polemaetus bellicosus*	√	√	EN	VU	VU	√	Generalist
Snake-Eagle, Black-chested	*Circaetus pectoralis*		√					Generalist
Fish-Eagle, African	*Haliaeetus vocifer*		√					Open water sources
Buzzard, Jackal	*Buteo rufofuscus*	√	√				√	Generalist
Buzzard, Steppe	*Buteo vulpinus*	√	√				√	Generalist
Goshawk, Southern Pale Chanting	*Melierax canorus*						√	Generalist

Marsh-Harrier, African	*Circus ranivorus*	√		EN	LC	Protected		Grassland, wetland
Harrier, Black	*Circus maurus*	√		EN	EN			Grassland, wetland, Fynbos
Harrier-Hawk, African	*Polyboroides typus*	√	√				√	Generalist
Francolin, Grey-winged	*Scleroptila africanus*	√	√				√	Grassland
Crane, Blue	*Anthropoides paradiseus*	√	√	NT	VU	EN	√	Grassland, Karoo, dams
Bustard, Kori	*Ardeotis kori*	√		NT	NT	VU		Grassland, Open woodland
Bustard, Ludwig's	*Neotis ludwigii*	√	√	EN	EN	VU	√	Grassland, Karoo
Korhaan, Karoo	*Eupodotis vigorsii*	√	√	NT	LC		√	Grassland, Karoo
Korhaan, Blue	*Eupodotis caerulescens*	√	√	NT	NT	VU	√	Grassland, Karoo
Korhaan, Northern Black	*Eupodotis afra*	√					√	Karoo, grassland

Regional status = As per Taylor *et al,* 2015; Global status as per IUCN 2018.
EN = Endangered; VU = Vulnerable; NT = Near-threatened; LC = Least concern;

3.3 Small terrestrial species

A total of 40 small bird species were recorded by walked transects during this programme (see Appendix 1). Species richness peaked in spring (33 species) and summer (30 species). Lower species richness was recorded during winter and autumn (26 species each). The most abundant species on site as recorded by this method (and noting that more conspicuous species are more easily recorded) were Grey-backed Cisticola *Cisticola subruficapilla*, Cape Bunting *Emberiza capensis*, Pied Starling *Lamprotornis bicolor*, Lark-like Bunting *Emberiza impetuani* and Karoo Scrub-Robin *Erythropygia coryphaeus*. None of the species recorded by this method are regionally Red Listed. Approximately 21 of the small species are Southern African endemics or near-endemics, with quite a few of these being Karoo endemics. These species are highlighted in Appendix 1.

This group of species will predominantly be at risk of habitat destruction or alteration, disturbance and displacement on site if the facility is built. Certain species may also be at risk of collision with turbines, in particular species which spend a lot of time in flight (such as swallows and swifts) and/or do aerial breeding displays (such as certain larks).

3.4 Large terrestrial species & raptors

A total of 13 target bird species were recorded by Drive Transects (see Appendix 2). A slight peak in species richness was recorded in autumn (5 species), with 4 species being recorded in each of the remaining three seasons. The species recorded at the highest abundance was the Lesser Kestrel *Falco naumannii*, but this was recorded only in summer, as it is a migrant species. Other significant records include: Verreaux's Eagle (5 records of single birds); Cape Vulture *Gyps coprotheres* (1 record of 4 birds); and Booted Eagle *Hieraaetus pennatus* (2 records of single birds). Five of the thirteen species are Red Listed: Verreaux's Eagle (Vulnerable); Blue Crane (Near-threatened); Cape Vulture (Endangered); Lanner Falcon (Vulnerable) and Secretarybird (Vulnerable).

These large species are the species of most concern with regard to the risk posed by the proposed facility. Most of these species could be susceptible to collision with turbines and overhead power lines. This aspect is discussed in more detail in Section 3.6. Certain of these species also breed on site, such as (most importantly) the Verreaux's Eagle. Breeding species will be at risk of disturbance whilst breeding, displacement and habitat destruction. Young birds may also be at greater risk of collision with obstacles such as turbines and power lines.

3.5 Focal sites

A total of 8 Focal Sites were identified at the outset of this monitoring programme. All of these were identified as potential breeding habitat for raptors and other sensitive species. The location of these sites can be seen in Figure 2. Focal Site 3 is a large nest on the Eskom Transmission Hydra/Poseidon 400kV power line running through site. The remaining 7 Focal Sites were all areas of cliff nesting habitat identified as having the potential to house breeding Verreaux's Eagles and other species. Each of these sites was visited at least once (but often several times) in each season, in order to survey the areas and determine whether any relevant bird species are nesting there. Details on the findings of each visit to these Focal Sites are presented in Appendix 3. The most important of these findings are described below:

- Focal Site 1 holds a Verreaux's Eagle nest. This nest was not used in the 2014 breeding season. It is believed that this nest could be an alternate nest (i.e. used by the same breeding pair of birds, in alternate seasons) to that at FS 2, due to its proximity (approx. 1.3km).
- At Focal Site 2 a pair of Verreaux's Eagle bred, with a chick being recorded on the nest during spring.
- At Focal Site 3, only one record of a single adult Martial Eagle sitting on the power line approximately 800m from the nest was made during the year. It is concluded that this nest was not used this season, or in any seasons in the recent past.
- At Focal Site 4 a Verreaux's Eagle nest was located and a chick was seen on the nest during spring.
- Focal Site 5 was determined to hold an old disused Hamerkop nest.
- At Focal Site 6 a Verreaux's Eagle chick was successfully raised and recorded as flying in spring.
- At Focal Site 7 no large nests were recorded.
- At Focal Site 8 a Verreaux's Eagle nest was found, and one adult was recorded once in vicinity, but the nest did not appear to be used in the 2014 season.

In total then three pairs of Verreaux's Eagle were determined to be active on and near the proposed site. This is the most important avifaunal aspect uncovered by this body of work on site. There is a risk that breeding of these birds could be disturbed during either construction or operation of the facility, resulting in breeding failure (with consequent reduced recruitment of birds to the population) or even breeding site abandonment (with greater long term effects). The presence of breeding sites also theoretically heightens the risk of collision of birds. Adult flight activity is likely to be higher close to the nest due to seasonal nest building, breeding displays, mating, provisioning of chicks and other activities. Fledglings will also be susceptible to collisions whilst learning to fly before dispersing from the territory. The most common form of management of risk such as this is to avoid the construction of new infrastructure too close to these nests. These exclusion areas are commonly referred to as buffer areas, and are the subject of more discussion in Section 6.

3.6 Incidental observations

A total of 17 target bird species were recorded incidentally, comprising of 80 records of 136 individual birds (see Appendix 4). The species recorded most frequently was Verreaux's Eagle (15 records), followed by Jackal Buzzard (10 records) and Lesser Kestrel, Booted Eagle and Rock Kestrel *Falco rupicolus* (7 records each). Care must be taken not to attach too much importance to these sightings as they are not the product of systematic sampling and various biases exist in the data. An example of such a bias is that visibility is so much better for observers in the open areas, so we would expect more records there. Interestingly, two additional important species were recorded, despite not previously being identified as likely to occur in the area (Cape Vulture); or as likely target species (African Black Duck *Anas sparsa*).

In addition, where possible, eagle potential mammalian prey species were recorded in order to provide some insight into prey abundance distribution on site. A total of 11 records were made of 5 prey species: Rock Hyrax *Procavia capensis*; Bat-eared Fox *Otocyon megalotis*; Yellow Mongoose *Cynictis penicillata*; Ground Squirrel *Xerus inauris*; and Suricate *Suricata suricatta*. With the exception of 1 record, all these records were on the lower ground, and rocky slopes of the site, not on the top plateau. Although by no means a comprehensive study this does provide some indication that possibly prey is more abundant on the mountain sides and lower ground. This would support the finding in Section 3.6.2 that Verreaux's Eagle flight activity was far lower on the top flatter plateau.

Over the full year a total of 142 bird species were recorded on site by all data collection methods. This full data set is presented in Appendix 5. A peak in species richness was recorded in spring (114 species), followed by summer (104 species), autumn and winter each with 84 bird species. Of these 142 bird species, 9 are currently classified as regionally Red Listed by Taylor *et al* (2015). These include 4 Endangered, 3 Vulnerable, and 2 Near-threatened species. Approximately 55 of the recorded species are endemic or near-endemic to southern Africa (Hockey *et al,* 2005), and approximately 11 can be considered Karoo endemics. These include the following species: Karoo Long-billed Lark *Certhilauda subcoronata*; Karoo Chat *Cercomela schlegelii*; Mountain Chat *Oenanthe monticola*; Ludwig's Bustard; Northern Black Korhaan *Afrotis afraoides*; Layard's Titbabbler *Sylvia layardi*; African Rock Pipit *Anthus crenatus*; Sickle-winged Chat *Cercomela sinuata*; Spike-heeled Lark *Chersomanes albofasciata* and Karoo Korhaan. An endemic species is one which is restricted to that area and is found nowhere else in the world, and a near endemic is mostly restricted to the area.

South Africa has a high degree of endemism, with approximately 165 of the 960 species being endemic or near-endemic.

3.7 Direct observation of bird movements

3.6.1 Quantitative data analysis

Pre-construction bird monitoring recorded a total of 113 flight records of 10 target bird species (7 raptors, 2 large terrestrials and a water bird). Of these records, 109 were raptors, 2 of which were large terrestrials and 2 were water birds. Of a total of 96 three hour Vantage Point sessions, totaling 288 hours of observation, 50 sessions recorded no target bird species flight at all. These data are presented in Table 2.

For the following section, the data from Vantage Point 1 is excluded from the analysis, on the basis that Vantage Point 1 overlooks an active Verreaux's Eagle nest, on the lower ground away from the turbine layout, and is not comparable to the rest of the site (see Section 3.6.2).

Examination of the remaining data reveals that 61 records were made, including 57 raptors and the same 4 other species as above. Of the 80 observation sessions, 48 recorded no relevant flight activity. A peak in flight activity was recorded in summer (20 raptor records, 8 blank sessions), followed by autumn (17 raptor records, 13 blank sessions); spring (13 raptor records, 11 blank sessions). The species recorded most frequently flying on site was Rock Kestrel, followed by Verreaux's Eagle and Jackal Buzzard. Booted Eagle, Lesser Kestrel and South African Shelduck *Tadorna cana* were also recorded multiple times, whilst the remaining species were recorded only once. Verreaux's Eagle, Jackal Buzzard and Booted Eagle all had a mean flight height within rotor zone (approximately 65 to 210 metres above ground, based on a hub height of up to 140m and rotor diameter up to 132m), and spent the majority of their flying time at rotor zone. Rock Kestrel flew predominantly below rotor zone.

Significant differences between Verreaux's Eagle passage rates at the 6 Vantage Points were found (Kruskal-Wallis ANOVA : VP Kruskal-Wallis test: $H(5, N=617) = 103.52$ $p < 0.001$). Figure 6 shows the results of the test. Vantage Point 1 had far higher passage rates as explained above in this section.

Table 2. Summary data of recorded target bird species flight activity on the Coleskop site (excluding VP1).

Species	Ecological group	n	Total flight duration	Mean height above ground (m)	Mean flight duration	% flight duration below rotor	% flight duration within rotor	% flight duration above rotor
Rock Kestrel	Raptor	17	00:35:00	23.2	00:02:04	100.0	0.0	0.0
Verreaux's Eagle	Raptor	16	00:39:45	106.9	00:02:29	8.8	70.4	20.8
Jackal Buzzard	Raptor	10	00:25:00	83.5	00:02:30	20.0	76.0	4.0
Booted Eagle	Raptor	7	00:18:00	168.3	00:02:34	27.8	55.6	16.7
Lesser Kestrel	Raptor	5	00:21:30	17.0	00:04:18	100.0	0.0	0.0
SA Shelduck	Water bird	2	00:00:45	40.0	00:00:22	33.3	66.7	0.0
Blue Crane	Large terrestrial	1	00:03:00	600.0	00:04:00	0.0	0.0	100.0
Lanner Falcon	Raptor	1	00:12:00	20.0	00:12:00	0.0	100.0	0.0
Ludwig's Bustard	Large terrestrial	1	00:01:00	30.0	00:01:00	100.0	0.0	0.0
Martial Eagle	Raptor	1	00:02:00	30.0	00:02:00	100.0	0.0	0.0

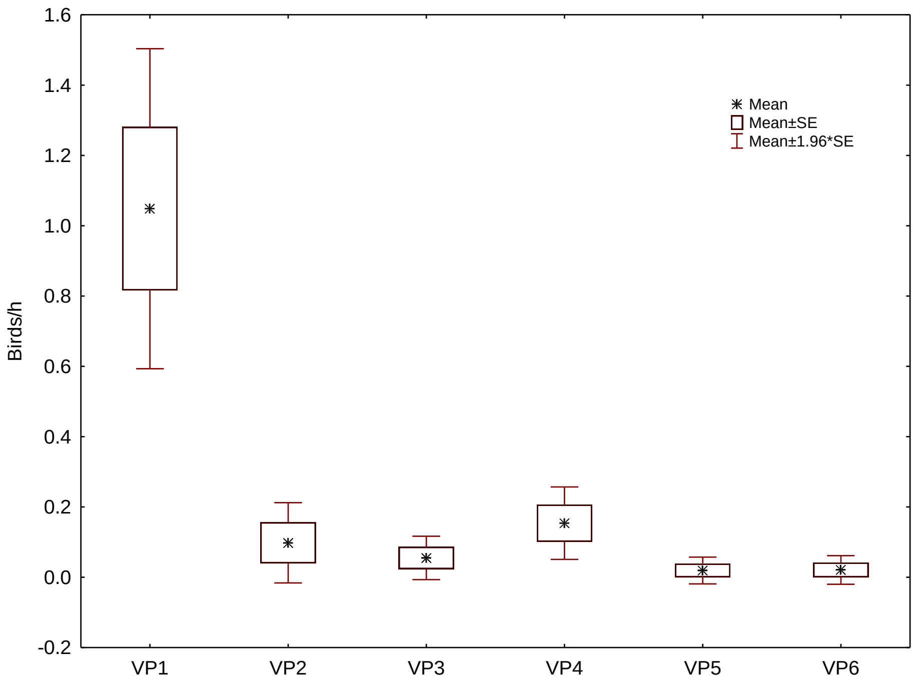


Figure 6. Passage rates for Verreaux's Eagle *Aquila verreauxii* across the six vantage points.

Figure 7 shows results of the test of the differences between the remaining 5 vantage points (excluding VP1). Once again significant differences in Verreaux's Eagle passage rates were found between the vantage points (Kruskal-Wallis ANOVA by Ranks; Birds/h Independent (grouping) variable: VP: Kruskal-Wallis test: H (4, N= 514) =10.11 p <0.05 Exclude condition: v2='VP1'). Vantage Points 5 and 6 showed much lower passage rates than VP2 and VP4. As explained in section 3.6.2 the higher passage rates observed from VP4 are likely due to the presence of the nest site at Focal Site 1.

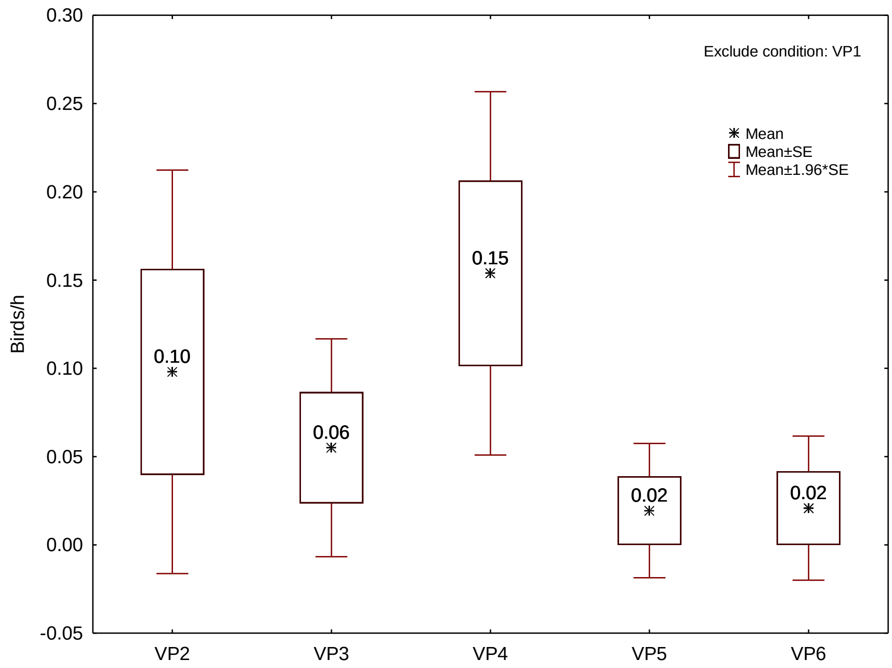


Figure 7. Verreaux's Eagle *Aquila verreauxii* passage rates at VP2 to VP6.

It is important to understand that the passage rates presented above are not only those flights through the rotor zone of proposed turbine locations, but rather all recorded flights irrespective of their location relative to turbines. The Verreaux's Eagle passage rates range from 0.02 to 0.15 birds/hour across the five vantage points presented in Figure 7. Without more experience of built wind farms in Verreaux's Eagle habitat it is difficult to contextualize these passage rates. The best we can do is to compare passage rates with other sites where WildSkies has conducted pre-construction bird monitoring. Three such sites have been monitored to date. Average passage rates ranged from 0.032 to 0.2 birds per hour at these sites. The Umsobomvu site therefore fits within this range of values.

3.6.2 Spatial data analysis

The position of the six vantage points on site has been shown in Figures 8 to 12. These figures show the calculated collision risk index for target species at each vantage point, relative to original (pre-split) turbine layout. Each grid cell has been categorised and coloured according to the collision risk index for that cell. Darker colours represent greater collision risk. In these figures the area within which a bird in flight would be visible (from approximately 65m above ground) from the VP position are shown in a beige colour. The individual characteristics of the vantage points are described in more detail below:

Vantage Point 1 was deliberately placed on the lower ground on the western fringe of the site, to collect data on the active breeding pair of Verreaux's Eagle located at Focal Site 6, approximately 600m from the VP position. This Vantage Point was by far the busiest in terms of flight activity recorded, predominantly that of the Verreaux's Eagles. This data has not been used formally in the analysis with the other vantage points but has been used separately to detect patterns in flight activity. One such pattern is that this species' flight activity is far greater closer to the nest. Since we were not able to place vantage points at each Verreaux's Eagle nest, we would need to extrapolate this finding to other nests, with the assumption that the other pairs of eagles fly in a similar pattern. The implication that this finding has for the proposed layout and management of risk to this species is described in more detail in Section 6.

Vantage Point 2 is situated on relatively high ground to the east of the site. Visibility is best to the south and west from this site, with poor visibility to the north-east

Vantage Point 3 is in the far north of the site, on a flattish plateau-like area. It has good visibility all round.

Vantage Point 4 is in the centre of the site, on the large open plateau. It has good visibility all round. This vantage point has captured a reasonable amount of Verreaux's Eagle flight activity, presumably that of the pair which bred at Focal Site 1 (Figure 2). This pair appears to fly predominantly in and above the 'Visserskloof' valley. Little flight activity up on to or above the plateau was recorded.

Vantage Point 5 is in the west of the site, and has best visibility to the west and south. It has limited visibility to the east due to high ground.

Vantage Point 6 covers the southern most parts of the site.

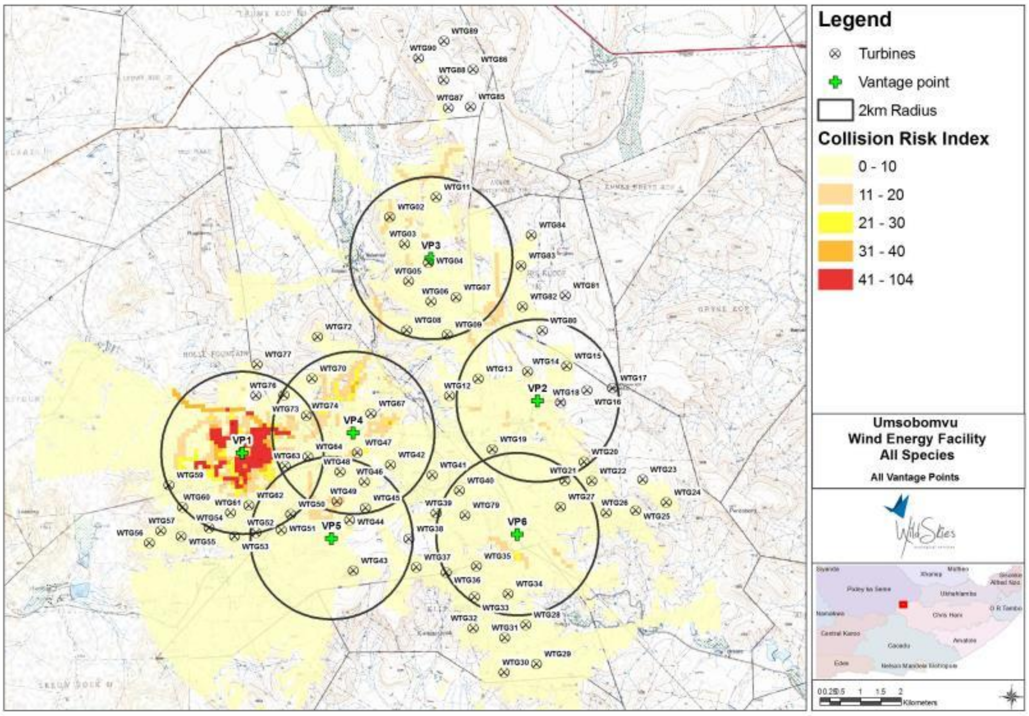


Figure 8. Layout of the 6 vantage points and the calculated collision risk index for the site (all target bird species included)(original pre-split turbine layout shown).

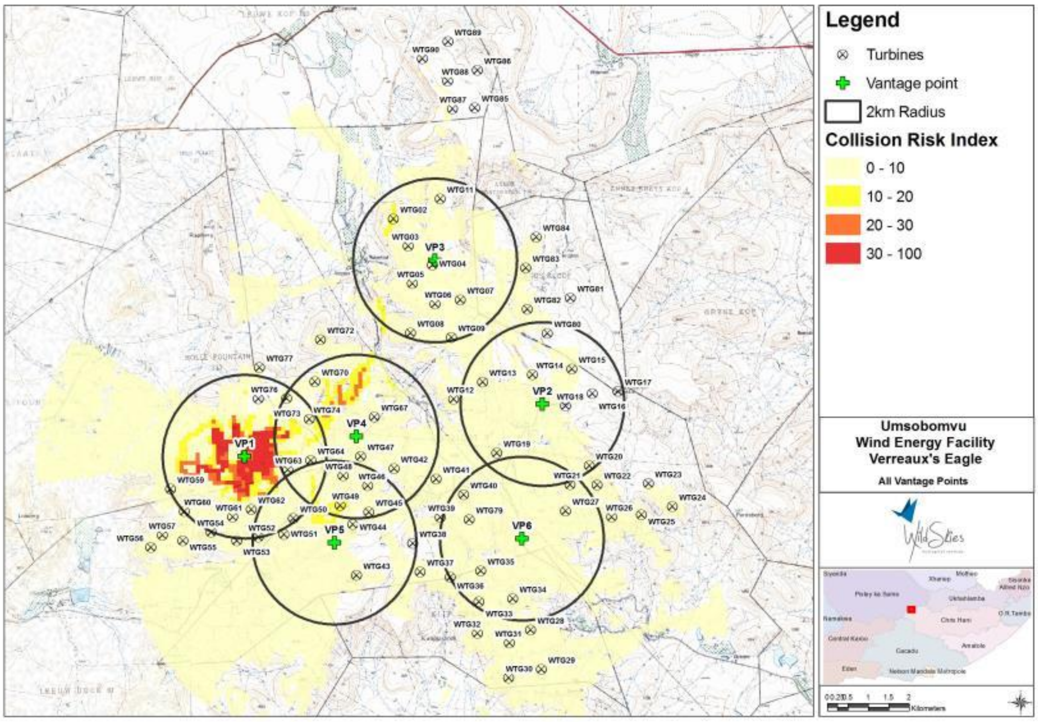


Figure 9. Layout of the 6 vantage points and the calculated collision risk index for the site (Verreaux's Eagle *Aquila verreauxii* only) (original pre-split turbine layout shown).

Two findings are immediately evident from Figures 8 and 9: Firstly, collision risk is far greater close to VP1 than for the remainder of the site. This is not surprising, since this VP was specifically located to view an active Verreaux's Eagle nest site and home range. It is clear that flight activity for this species is far greater close to (within 1 to 1.5km) the nest site. The second finding is that Verreaux's Eagle flight activity is responsible for most of the collision risk index results on site. Once again this is strongly biased by data from VP1.

Data from VP1 was then excluded from further spatial analysis, in order to examine more carefully the collision risk index calculated from data collected at the other vantage points, which are more representative of conditions on site. Figures 10 and 11 show the findings once the data from VP1 is excluded. Figure 10 shows the data from all species, whilst Figure 11 shows Verreaux's Eagle data only. Overall, collision risk is far lower across the site once the data from VP1 is excluded. One area still stands out as being of far higher collision risk than the remainder of the site. This area is to the north-west of VP4. This area is also home to pair of Verreaux's Eagle which bred at FS 1 (see Figure 3) during the 2014 season. The identification of this area as higher collision risk serves once again to highlight the fact that collision risk for Verreaux's Eagle is higher closer to nest sites. It is also important to note that collision risk is higher on the steeper ground and into the valley, rather than on top of the plateau on the flatter higher ground. This has important implications for the placement of wind turbines.

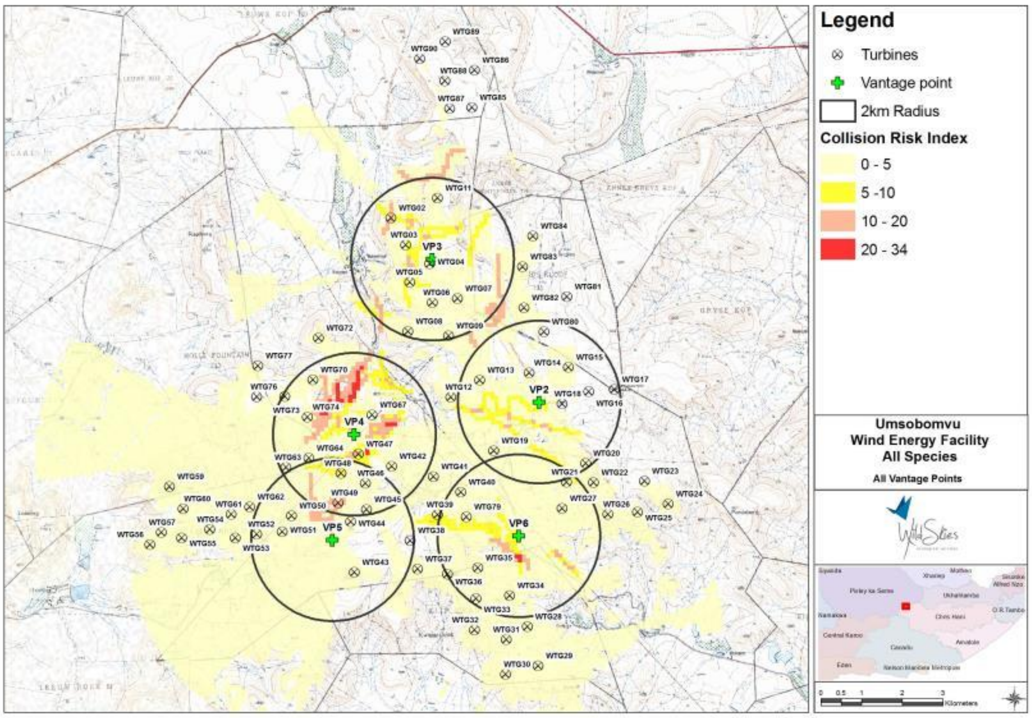


Figure 10. Layout of the 5 vantage points on site (excluding VP1), with the calculated collision risk index for the site (all target bird species included) (original pre-split turbine layout shown).

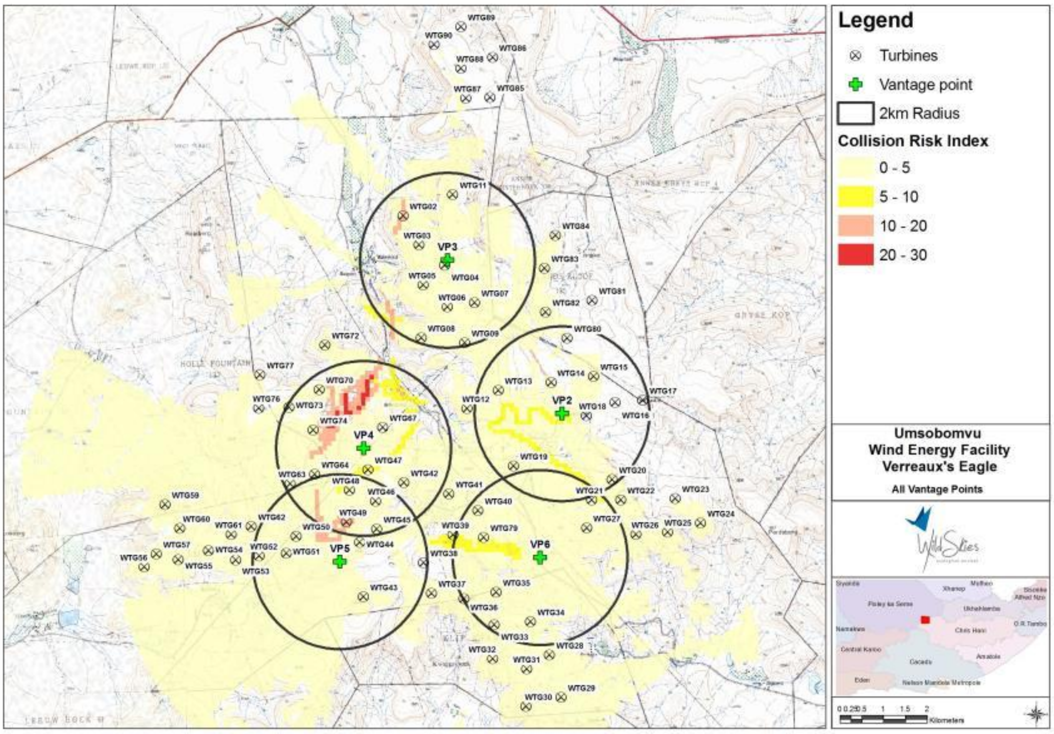


Figure 11. Layout of the 5 vantage points on site (excluding VP1) with the calculated collision risk index for the site (Verreaux's Eagle *Aquila verreauxii* only) (original pre-split turbine layout shown).

Figures 12 and 13 show the collision risk relative to the new proposed Coleskop turbine layout. None of the current turbine positions are in high collision risk areas.

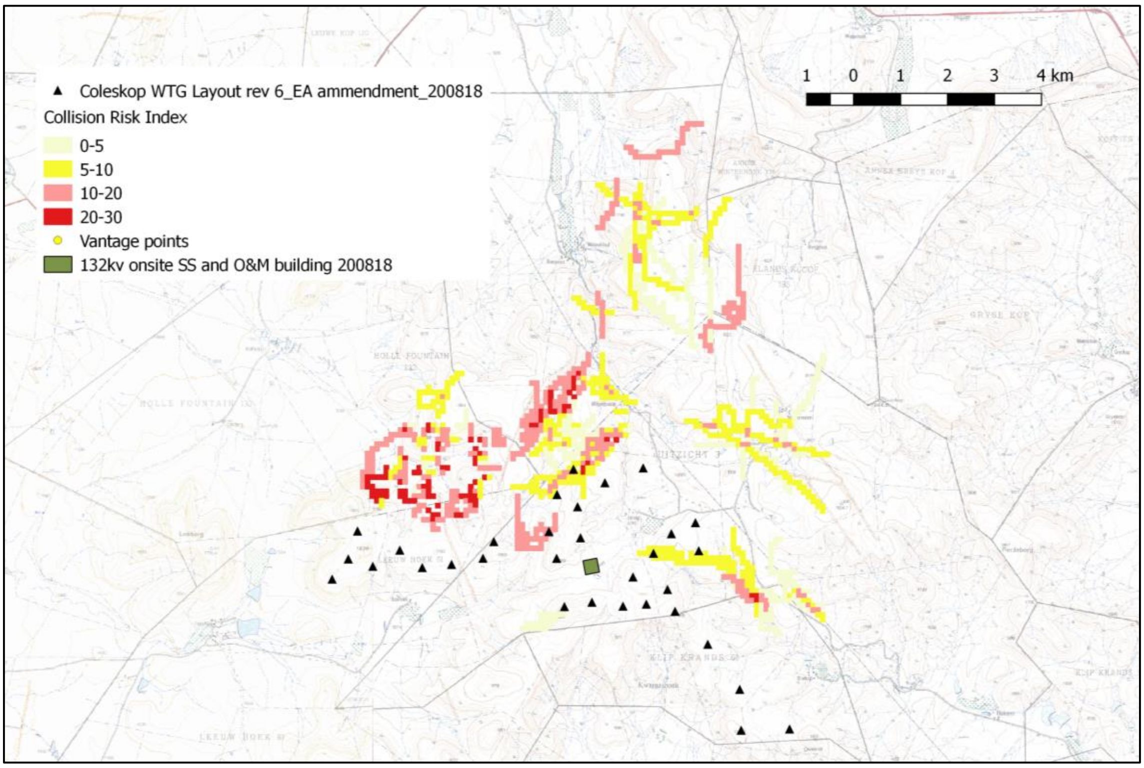


Figure 12. Collision risk index superimposed on the new Coleskop turbine layout resulting from the project split (all priority species).

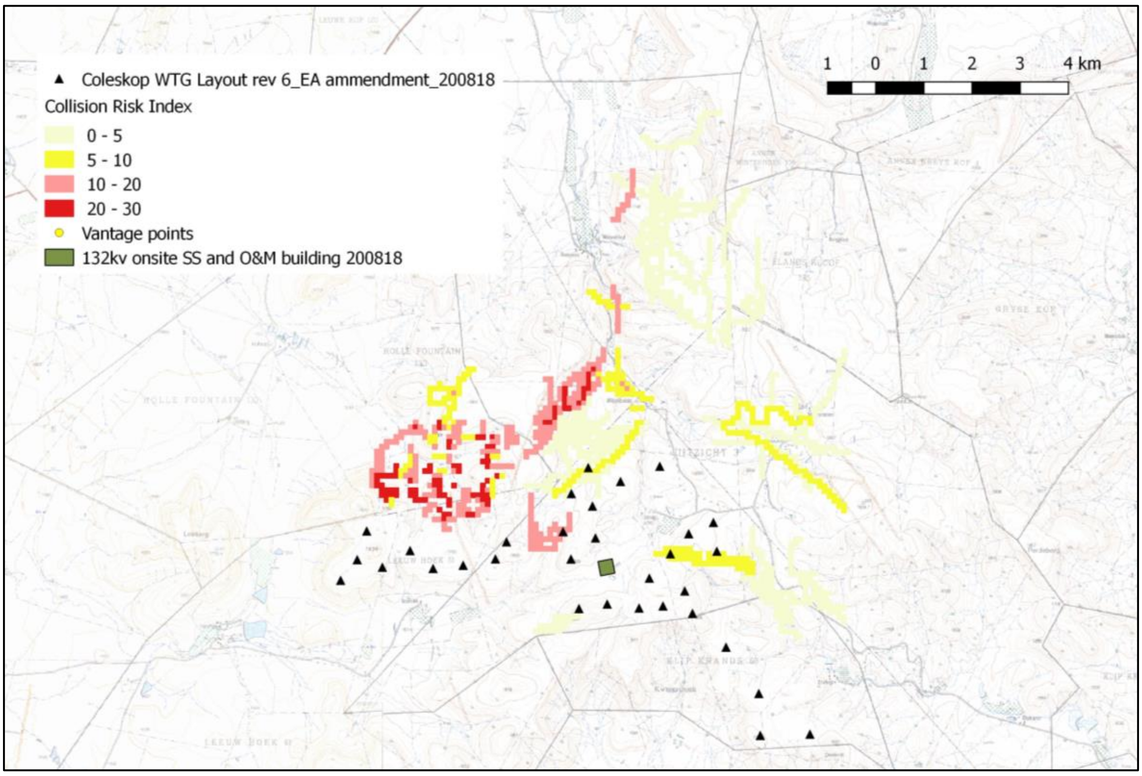


Figure 13. Collision risk index superimposed on the new Coleskop turbine layout resulting from the project split (Verreaux's Eagle *Aquila verreauxii* only).

Since the placement of vantage points aimed to sample the site and does not provide an absolute coverage, it is important to apply the principles learnt at these two vantage points to the rest of the site. The only pattern that has been learnt from this data is that the majority of flight activity on site is that of Verreaux's Eagle, and that most of this flight activity occurs close to nest sites (within 1-1.5km) and over the lower, steeper ground, not on the plateau. An important finding is that this flight activity is not surprisingly unequally distributed around the nest sites, not in a perfect circle. The application of a circular buffer area centred on the nest site would then seem to be of less benefit to the eagles, than a more refined approach which takes topography into account. Based on the data at hand to date we would conclude that the areas used most frequently by this species correspond to the steeper and lower ground closest to the nest sites.

Importantly, the collision risk over most of the site would appear to be low. Certain higher risk areas have been identified, particularly for Verreaux's Eagle, but these can be protected in the layout planning (see Section 6).

4 ASSESSMENT OF RISK OF INTERACTION OF SPECIES

In order to assess the risk of birds interacting with the proposed wind energy facility a risk matrix has been utilised (after Allan, 2006; Smallie, 2011), whereby the following equation is used:

Risk of interaction = Probability of interaction x Severity of interaction

In this case the probability of interaction is in simple terms the outcomes of this monitoring programme combined with general knowledge and understanding of the species and its likelihood of interacting with the facility. Useful sources in making this assessment include: Jordan & Smallie (2010) and Retief *et al* (2011, 2014). Jordan and Smallie (2010) examined literature on the families of species affected elsewhere in the world by wind farms in order to identify families of birds which could be affected in South Africa. Retief *et al* scored a suite of South Africa bird species for a number of factors believed to be relevant to the species risk of interaction with wind farms, such as behavioural and morphological factors. Combining these scores they arrived at a final risk score per species and a list of 210 species believed most at risk.

The severity of interaction is the importance of the species involved, i.e. the implications of impacting on these species. This is based on the species conservation status (Taylor *et al*, 2015; IUCN 2018). These aspects are described in more detail below:

4.1 Probability of interaction

Based on the data emanating from the above described monitoring programme it is possible to now make an informed qualitative assessment of the importance of this site for the target species in order to narrow our focus down to species and interactions that are of most importance for this project. This is achieved through assessing each species in terms of how it utilises the site and how it could interact with the proposed facility.

Birds can utilise a site such as Coleskop in five ways: breeding, perching, roosting, foraging and overflying. *Breeding* is one of the most important forms of utilisation. Breeding is often the aspect of birds life history that they are most specialised in, requiring certain substrate and other conditions to be correct in order to breed. As a result, breeding habitat is probably the form of habitat most under threat for most threatened bird species in South Africa. The breeding phase is also a time when birds are particularly susceptible to disturbance, and any number of factors could result in failed breeding attempt. Once young birds are hatched they are also susceptible to impacts, particularly when recently fledged as their inexperience in flight renders them more at risk of collision with obstacles.

Raptors in particular spend a fair proportion of their time *perching* on various substrate such as trees, poles, fences, rocks, and any others suitable. Certain species hunt from the perch, whilst others merely rest on perches. Perch availability is therefore an important factor determining the distribution of various bird species. Most bird species *roost* at night in trees, cliffs or in the shallows of dams – all in an attempt to escape predation. Most large raptors roost at their nest site, whilst smaller gregarious raptors roost communally in trees or on overhead cables. Communal roosting is an important feature in determining the sensitivity of a site for birds since the congregation of numerous birds increases the likelihood of impacts occurring. Also – roosts are typically entered and exited in poor light conditions at the start and the end of the day, when the risk of collision with obstacles is greatest. Due to their energy needs, most birds spend most of their time *foraging*. This is done in a number of different ways by different groups of birds. The likelihood of bird species foraging over an area depends on the presence of their food source or prey in that area and the favourability of other factors such as topography and water availability. Of course almost all birds can and do fly. In the context of this project though we mean those species recorded flying for long durations, in large numbers or frequently, i.e. those species at risk of collision with obstacles on site. On certain sites birds may *commute* across the site, without actually utilising the site itself for anything else, and would still therefore be at risk of collision.

The likely interactions between birds and the proposed facility include: habitat destruction as a result of construction of wind turbines, roads, substations and power lines; disturbance of birds as a result of these activities and operation of the facility; displacement of birds from the site; collision and electrocution of birds with/on overhead power lines; and collision of birds with wind turbine blades. Any *destruction or alteration of natural habitat* will have some negative effect on the various bird species present. However, many species will tolerate this and there will be little impact, so for many of the target species this is not considered to be significant. For species that may be breeding on site (i.e. the site provides breeding habitat in addition to foraging) this could be far more serious. These species have been identified in Table 3. The situation with *disturbance of birds* is almost identical to that above for habitat destruction. Once again the species most likely to be affected in this regard are the species that breed on site. *Displacement* refers to the scenario whereby a bird is forced to stop using a site or traversing it. This may result in a loss of habitat, or if the species was merely commuting across the site and now has to fly further around the site this may come with energetic costs to the bird. Key species in this regard are probably the large raptors and breeding species again. Breeding birds need to provide food for their young and are therefore already under pressure in terms of their energy balance. Any added travel distance could compromise the adults' well-being or its care for its young. *Power line collisions* are a significant threat posed to many bird species by overhead power lines. A collision occurs when a bird in flight does not see the cables, or sees them too late for effective evasive action. The bird is typically killed by the impact with the cable, or the subsequent impact with the ground. Most heavily impacted upon are bustards, storks, cranes and various species of water birds. 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). It is also important to note that any stay wires on met masts on site would pose a similar collision risk to an overhead power line. Although this monitoring programme did not detect such collisions on the Coleskop site, Martin (pers.comm) has previously recorded a Denham's Bustard collision with such stay wires at a met mast, demonstrating that this is a real risk. *Electrocutions of birds* on overhead lines are an important cause of unnatural mortality of raptors and storks. It has attracted plenty of attention in Europe, USA and South Africa (APLIC 1994; Alonso & Alonso 1999; van Rooyen & Ledger 1999). 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). Most at risk are the physically larger species such as eagles and vultures, which have more chance of bridging these clearances. *Bird collisions* with human developed infrastructure such as wind turbines have been well documented over the years (for e.g. Drewitt & Langston, 2008). Since the first birds were found under wind turbines it has more or less been assumed that the birds collided with turbine blades because they did not see them. Although vision certainly has a lot to do with the collision, it seems likely that various other factors also play a part. In recent research on bird vision (Martin, 2011; Martin & Shaw, 2010) suggest that birds may have reduced visual acuity in front of them when in flight, or in the case of vultures even be blind for a significant portion of their frontal vision.

Once again, Table 3 presents the assessment results for each species. A final probability score of 1 to 5 is assigned to each species based on the above information.

4.2 Severity of interaction

Regional conservation status (Taylor *et al,* 2015) was taken as the primary index of severity of interaction, the assumption being that impacting on a threatened species is more severe than impacting on a common species. Although not all Red Listed currently, it is generally agreed in ornithological circles that almost all raptors (in particular the larger ones) require as much protection as possible. Scores were assigned to species as follows: Common and non-threatened species = 1; Most large to medium raptors, certain korhaans and Near-threatened species = 2; Vulnerable species = 3; and Endangered = 4 (as per regional status).

4.3 Risk of interaction

The final risk score was obtained by multiplying the probability (1 to 5) and severity scores (1 to 4) to give a final risk score ranging between 0 and 15 (see final column in Table 3). These scores were then classed into High (10-15); Medium (5-9) and Low (0-4), or red, orange and yellow. One species was identified as being at HIGH risk at the Coleskop site, the Verreaux's Eagle. Five species have been identified as being at MEDIUM risk: the Lanner Falcon; Rock Kestrel; Lesser Kestrel; Jackal Buzzard; and Ludwig's Bustard. These species are described in more detail below:

Table 3. Target bird species for the Coleskop site. Each species form of utilisation of the site, likely interactions between each species and the facility, and final risk score for the species is presented. Walked transect data is not included as it focuses on small species only, few of which are target bird species for this study.

Common name	Ecological group	Severity score	Method which recorded species			Form of utilisation of site	Theoretical interactions with facility	Probability score	Collision risk score
			Driven Transect	Incid. Obs.	Vantage Point				
Stork, Black	Water bird	3				None	-	-	-
Stork, White	Large terrestrial	2				None	-	-	-
Flamingo, Greater	Water bird	2				None	-	-	-
Flamingo, Lesser	Water bird	2				None	-	-	-
Shelduck, South African	Water bird	1			√	Foraging, commuting	Collision with turbines & power lines	1	1
Secretarybird	Large terrestrial	3	√	√		Foraging, commuting	Collision with turbines & power lines, habitat destruction	1	3
Falcon, Lanner	Raptor	3	√	√	√	Foraging, commuting, perching, roosting	Collision with turbines & power lines, habitat destruction	1	3
Falcon, Amur	Raptor	1				None recorded, although likely in certain seasons	Collision with turbines & power lines, habitat destruction	1	2
Kestrel, Rock	Raptor	2	√	√	√	Foraging, perching, roosting, likely breeding	Collision with turbines & power lines, disturbance, displacement, habitat destruction	4	8
Kestrel, Lesser	Raptor	2	√	√	√	Foraging, perching, commuting	Collision with turbines & power lines, habitat destruction	3	6
Eagle, Verreaux's	Raptor	3	√	√	√	Foraging, perching, roosting, commuting, breeding	Collision with turbines & power lines, disturbance, displacement, habitat destruction	4	12

Eagle, Tawny	Raptor	4		√		Foraging, commuting	Collision with turbines & power lines, habitat destruction	1	4
Eagle, Booted	Raptor	2	√	√	√	Foraging, perching, commuting	Collision with turbines & power lines, habitat destruction	2	4
Eagle, Martial	Raptor	4		√	√	Foraging, commuting	Collision with turbines & power lines, habitat destruction	1	4
Snake-Eagle, Black-chested	Raptor	2				None	-	-	-
Fish-Eagle, African	Raptor	2				None	-	-	-
Buzzard, Jackal	Raptor	2	√	√	√	Foraging, commuting, perching, roosting, likely breeding	Collision with turbines & power lines, disturbance, displacement, habitat destruction	4	8
Buzzard, Steppe	Raptor	2			√	Foraging, commuting, perching, roosting	Collision with turbines & power lines, habitat destruction	2	4
Goshawk, Southern Pale Chanting	Raptor	2	√	√		Foraging, commuting, perching, roosting	Collision with turbines & power lines, habitat destruction	1	2
Marsh-Harrier, African	Raptor	4				None	-	-	-
Harrier, Black	Raptor	4				None	-	-	-
Harrier-Hawk, African	Raptor	2		√		Foraging, commuting, perching, roosting	Collision with turbines & power lines, habitat destruction	1	2
Francolin, Grey-winged	Large terrestrial	1	√	√		Foraging, perching, roosting, breeding	Collision with turbines & power lines, disturbance, habitat destruction	1	1
Crane, Blue	Large terrestrial	2	√	√	√	Foraging, commuting	Collision with turbines & power lines, disturbance, habitat destruction	2	4
Bustard, Kori	Large terrestrial	2				None	-	-	-
Bustard, Ludwig's	Large terrestrial	4		√	√	Foraging, commuting	Collision with turbines & power lines, disturbance, habitat destruction	2	8
Korhaan, Karoo	Large terrestrial	2				None	-	-	-
Korhaan, Blue	Large terrestrial	2				None	-	-	-
Korhaan, Northern Black	Large terrestrial	2	√	√		Foraging, commuting, perching, breeding	Collision with turbines & power lines, disturbance, habitat destruction	2	4

C = collision with either turbines or power lines, E = electrocution on power lines, D = disturbance, HD = habitat destruction, DISPL = displacement

These species are best understood in their respective families:

Accipitridae family:

Eagles are large, powerfully built raptors with a strong beak and head. Most eagles are larger than any other raptors, excluding vultures. Eagles' eyes are extremely powerful, having several times the visual acuity of humans, which makes them able to spot prey from long distances. Eagles in general are one of the groups of birds most affected by wind farms, with Golden Eagle *Aquila chrysaetos* (most closely related to Verreaux's*)*; White-tailed Sea Eagle *Haliaeetus albicilla*; Bald Eagle *Haliaeetus leucocephalus*; Wedge-tailed Eagle *Aquila audax*; and White-bellied Sea Eagle *Haliaeetus leucogaster* all having been documented as colliding with turbines around the world (various authors). Large, heavy bird species such as eagles, which spend time soaring are considered to be particularly at risk of collision with wind turbines. Their slow breeding and long lifespan also make them susceptible to mortality factors such as wind turbines (Drewitt & Langston 2008, Herera Alsina *et al* 2013).

Verreaux's Eagle (High risk – 3rd most at risk species as per Retief et al 2011/2014)

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. Approximately 400 – 2 000 pairs exist in the Western, Northern and Eastern Cape (Hockey *et al*. 2005). These eagles can exist at quite high density compared to other eagle species, with some territories as small as 10km² in the Karoo (Davies, 2010 – www.africanraptors.org) and 10.3km² in the Matopos in Zimbabwe (Steyn, 1989). Davies found a range of territory size from 10 to 50km², with an average size of 24km² in the Karoo of South Africa, and nests were approximately 2 kilometres apart on average. The furthest recorded flight from the nest for food was 7 kilometres, although it is almost certain that they will fly further when required (Davies, 2010). Analysis of how much rock line was within 3 territories proved informative, with each pair defending approximately 52km of linear rock line (Davies 2010). In the Matopos in Zimbabwe territories ranged from 5.8 to 14km², with nests 1.3 to 4.5km apart (in Steyn, 1989). Some of these territories were roughly circular whilst others were irregular. This species tends to occupy remote mountainous areas largely unaffected by development (until the advent of wind energy in SA that is). A pair can typically use several alternate nests in different seasons, varying from a few metres to 2.5km apart (in Steyn, 1989). Davies recognizes wind farms as a 'new and worrying' threat, although the main threat to the species to date is considered to be the loss of prey populations (Rock Hyrax). Juveniles disperse from their home ranges 4 months after fledging and are not allowed to return to these territories by the adults. There is a suspected high mortality rate amongst juveniles due to the difficult in finding suitable territories.

This species is likely to be susceptible to four possible impacts: habitat destruction, disturbance, displacement and collision with turbine blades and power lines. 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). Mitigation of the risk to these eagles is discussed more in Section 6.

Rock Kestrel (Medium risk -111th most at risk species as per Retief et al 2011/2014)

Kestrels are a group of birds that distinguishable by their flight behaviour. They typical hover approximately 10 to 30 metres above the ground whilst hunting and swoop down onto prey. Importantly kestrels do not require moving air or wind to fly, being able to fly even in stationary air. This has implications for their wind turbine collision risk profile, as they can occur and hunt almost anywhere on a site, and in any conditions.

The Rock Kestrel is a relatively common species throughout most of South Africa. It can forage over most open habitat types but breeds in cliff terrain, although it has also been recorded breeding on man-made structures, such as Eskom transmission lines. This species has been recorded flying frequently and for long durations on the Coleskop site. Its flight behaviour, alternating hovering with soaring makes it theoretically highly susceptible to collision with turbines. It is considered likely to breed on or near the site, although no nests have been found so far.

This species is likely to be susceptible to four possible impacts: habitat destruction, disturbance, displacement and collision with turbine blades and power lines. 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). The sensitivity map in Section 7 will provide some protection for the species at its roosting and breeding sites in the valleys and on cliffs.

Lesser Kestrel (Medium risk – 64th most at risk species as per Retief et al 2011/2014)

This migrant species is considered locally common in its core area of South Africa, which consists mostly of the Highveld in the Eastern Cape, Limpopo, Free State and North-west Province. It is also found in the Northern Cape and much of the Karoo. The global population is estimated to be between 50 000 and 60 000 birds (Birdlife International 2000). It is normally present in South Africa between October and March, with a peak in January to February. It's a highly gregarious species, and roosts communally, normally in large trees, often in small towns, including Middelburg (approximately 20km south-east of site).

This species is likely to be susceptible to four possible impacts: habitat destruction, disturbance, displacement and collision with turbine blades and power lines. This is a challenging species to mitigate for, as it could fly all over the site and is not confined to certain areas. The species' abundance in any area is also highly erratic inter annually.

Jackal Buzzard (Medium risk – 44th most at risk species as per Retief et al 2011/2014)

The Jackal Buzzard is a fairly common species throughout South Africa which tends to be resident in a particular area, as is the case on this site where at least one pair probably resides in the broader area. 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. On this site this species has been recorded frequently by all data collection methods and is suspected to breed somewhere close by. Due to its relatively common status this anticipated risk does not carry as much significance as it would if the species were regionally Red Listed.

This species is likely to be susceptible to four possible impacts: habitat destruction, disturbance, displacement and collision with turbine blades and power lines. 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). The most appropriate mitigation for this species is to site turbines correctly, but it is a species which flies all over the site and is not confined to certain areas. The sensitivity map in Section 7 will provide some protection for the species at its roosting and breeding sites in the valleys and on cliffs.

Otididae family:

Ludwig's Bustard (Medium risk -13th most at risk species as per Retief et al 2011/2014)

The Ludwig's Bustard is classified as Endangered by Taylor *et al* (2015) and its population and range has decreased over the last few decades due to habitat destruction and disturbance. 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. Ludwig's Bustard was classified as the 14th most at risk species in Retief's classification (2011, species list updated in 2014). Ludwig's Bustard is a wide-ranging bird endemic to the south-western region of Africa (Hockey *et al.* 2005). This species was listed as globally Endangered in 2010 because of potentially unsustainable collision mortality, exacerbated by the current lack of proven mitigation and the rapidly expanding power grid (Jenkins *et al.* 2011, BirdLife International 2013). 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. Therefore, collisions are also largely unpredictable, and vary greatly between seasons and years (Shaw 2013, *Shaw et al* 2015). While there is no evidence yet of population-level declines resulting from power line collision mortality, detailed range-wide power line surveys estimate that tens of thousands of bustards (from a total South African population of approximately 114,000 birds – Shaw *et al* 2015) die annually on the existing power grid in this country, which is of grave concern given that they are likely to be long-lived and slow to reproduce. It seems likely that there will be a threshold power line fatality load at which population declines will become apparent, but it is not possible to accurately predict what this will be, and such effects will probably only be noticed when it is too late to do anything about it (Shaw 2013, Shaw *et al*, 2015). Therefore, extreme caution is necessary in the planning of any new power lines and other overhead infrastructure in the range of this species.

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: habitat destruction, disturbance, displacement and collision with turbine blades and power lines. Raab *et al* (2009) state that up until their publication at least no known instance of collision of Great Bustard with wind turbine exists (2009), probably because they fly too low. This is an important finding of the current Coleskop study, where the mean flight height above ground for the species was 30.0m and it spent 100% of its recorded flight duration below rotor height. Ralston Paton *et al* (2017) do not report any wind turbine collision fatalities for this species.

5 IMPACT ASSESSMENT

The potential impacts of the proposed Coleskop wind farm and associated infrastructure are as follows (see Table 4). These impacts have been formally assessed and rated according to the criteria (supplied by EOH-CES and shown in Appendix 1).

5.1 Destruction of bird habitat during construction of the facility

This impact is anticipated to be of HIGH significance pre mitigation, particularly on the basis of the breeding pairs of Verreaux's Eagles on site, and probable impacts on their territories. A certain amount of habitat destruction is inevitable for the construction of roads and turbines. However by adhering to the sensitivity map (Section 6), it is possible to reduce the significance of this impact to MEDIUM.

5.2 Disturbance of birds

This is rated as HIGH significance, on account of the breeding pairs of Verreaux's Eagles on and near site. Mitigation is in the form of the sensitivity map in Section 6. Buffer areas have been identified around nest sites, within which no infrastructure should be built. In addition, it is recommended that the access road option to the south be selected (Option 1) for use as this will ensure that heavy vehicles, equipment and machinery movement close to nest sites is minimized. Option 3 should not be used. By adhering to the recommendations of this report it is believed that this can be mitigated to LOW significance.

There is a need to carefully manage the risk to Verreaux's Eagle at this site. The following actions will be required:

- It may be necessary to avoid construction of certain infrastructure during Verreaux's Eagle breeding season (approximately May to October). This will depend on the final layout, construction timing and breeding status at the various nests. This must be determined by the avifaunal walk through prior to construction and once the infrastructure layout is final.
- The effects of construction of the wind farm on the eagles must be monitored during construction. This will require a minimum of 3 site visits by a specialist during each eagle breeding season during construction. These site visits must determine breeding success at each nest and document eagle behaviour and reaction to construction as far as possible.

- Once operational, the wind farm will have a 'duty of care' to monitor and document the effects of the operational phase of the facility on Verreaux's Eagle. This must include: thorough weekly turbine collision fatality searches; annual breeding status monitoring (3 site visits per breeding season as above); and research into the eagles movement on and around site through the tracking of a sample of eagles (through the use of tracking devices fitted to one eagle from each pair).
- If eagle turbine collision fatalities are recorded it will be necessary to mitigate this impact. It is recommended that the wind farm budget a suitable contingency amount for each year of operations so that identified mitigation measures can be implemented or further research can be undertaken to facilitate better understanding and mitigation.

5.3 Displacement of birds from the site and barrier effects

Displacement of birds is judged to be of MEDIUM significance pre mitigation, but can be reduced to LOW significance by adhering to the sensitivity map in Section 6.

5.4 Collision of birds with turbine blades

Collision of birds with turbines is judged to be of HIGH significance pre mitigation, as the bird species most at risk are regionally Red List species. However this can be reduced to MEDIUM significance by adhering to the sensitivity map in Section 6 and by the impact avoidance measures already implemented in terms of turbine micro siting.

5.5 Collision & electrocution on internal overhead power lines

Collision and electrocution of birds on overhead power lines on site is anticipated to be of HIGH significance. Both of these impacts can be mitigated successfully in our opinion to reduce the significance to LOW. In the case of bird collision, all power line linking turbines to the on-site switching substation must be buried underground. None of this power line may be above ground. The only permissible power line above ground is that shown in Figure 3 labeled 'internal overhead line' (approximately 1.5km long). To mitigate for collision of the relevant species with the 'internal overhead line', it is recommended that the earth wires on the spans identified as high risk be fitted with the best available (at the time of construction) Eskom approved anti bird collision line marking device. This should preferably be a dynamic device, i.e. one that moves as it is believed that these are more effective in reducing collisions, especially for bustards (see Shaw 2013), which are one of the key species (Ludwig's Bustard) in this area. It is recommended that a durable device be used as this area is clearly prone to a lot of strong wind and dynamic devices may be susceptible to mechanical failure. It will be either EDF or Eskom's responsibility to ensure that these line marking devices remain in working order for the full lifespan of the power line, as we cannot afford to have significant numbers of bird collisions on this new line. It is important that these devices are installed as soon as the conductors are strung, not only once the line is commissioned, as the conductors and earth wires pose a collision risk as soon as they are strung. The devices should be installed alternating a light and a dark colour to provide contrast against dark and light backgrounds respectively. This will make the overhead cables more visible to birds flying in the area. Eskom Distribution has a guideline for this work and this should be followed. Note that 100% of the length of each span needs to be marked (i.e. right up to each tower/pylon) and not the middle 60% as some guidelines recommend. This is based on a finding by Shaw (2013) that collisions still occur close to the towers or pylons. It is also recommended that the stay wires on the met masts on site be installed with these devices as soon as possible.

In the case of bird electrocution, all power line linking turbines to the on-site substation must be buried underground. The 'internal overhead line' must be built on an Eskom approved bird-friendly pole structure which provides ample clearance between phases and phase-earth to allow large birds to perch on them in safety. Note that if on site power cannot be buried for any reason, this would represent a significant change to the risk posed by this facility, and the specialist will need an opportunity to revise these findings.

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

The proposed Coleskop wind farm is situated in an area of the country where several such projects are either under assessment or already authorised. To our knowledge, at least one other project is already operational (the Noupoort Wind Farm approximately 7km east of Noupoort) and several others are proposed. In such areas, where multiple facilities may be built, it is important to consider the overall or cumulative impact of these facilities on birds. Consideration of each project in isolation may not adequately judge the effect that projects will have on avifauna when combined.

The International Finance Corporation (IFC) recognises Cumulative Impact Assessment (CIA) and management as essential in risk management. However CIA is also "One of the biggest risk management challenges currently facing project developers in emerging markets…". Challenges include: a lack of basic baseline data, uncertainty associated with anticipated developments, limited government capacity, and absence of strategic regional, sectoral, or integrated resource planning schemes. Considerable debate exists as to whether CIA should be incorporated into good practice of Environmental and Social Impact Assessment, or whether it requires a separate stand-alone process.

As a minimum, according to the IFC, developers should assess whether their projects could contribute to cumulative impacts or be impacted upon by other projects. The IFC recommend that developers conduct a Rapid Cumulative Impact Assessment (RCIA) either as part of the EIA or separately. This RCIA should follow 6 steps: 1 & 2 – scoping; 3 - baseline determination; 4 - assessment of the contribution of the development under evaluation to the predicted cumulative impacts; 5 - evaluation off the significance of predicted cumulative impacts to the viability or sustainability of the affected environmental components; 6 - design and implementation of mitigation measures to manage the development's contribution to the cumulative impacts and risks (see the "Good Practice Handbook - Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets". International Finance Corporation).

Additional challenges specific to the Coleskop wind farm area and avifauna include:

- The difficulty in defining which projects to include in a Cumulative Impact Assessment (CIA). Not all the projects in the area have obtained environmental authorisation, or authorisation from the Department of Energy, so may never materialise. The question is which projects should be considered then, only those authorised, or those successful bidders, or those that have reached financial close.
- The difficulty in defining the spatial extent of a CIA, bearing in mind that some of the relevant bird species move hundreds of kilometres across the landscape and could theoretically be affected by developments within this entire range.

The IFC step wise approach is useful to follow for this study, and has been elaborated on below:

Steps 1 & 2: The Coleskop study has achieved these through the scoping of issues and identification of aspects worthy of attention. It is assumed that these aspects will be similar on the other project sites in similar topography and vegetation.

Step 3: Although baseline information has been obtained on the relevant bird species for the Coleskop site, obtaining relevant, detailed data on baseline conditions on all the other facilities in the general area is not possible at this stage. This information is not readily available publicly, so assumptions need to be made about which species will be affected by these other facilities.

Step 4: requires a judgment of the contribution that the Coleskop site makes to the predicted cumulative impacts. In our opinion, with respect to the key species listed as most important for this area, the Coleskop site makes a significant contribution to impacts in the area, on account of its size, and available open habitat on site (which is attractive to key Red List bird species).

Step 5: The overall cumulative effect of wind energy facilities on birds in this area, is likely to be of MEDIUM significance prior to mitigation in our opinion.

Step 6: It is recommended that each project within this broader area ensures that no effort is spared in mitigating impacts on avifauna. It is hoped that if each project provides sufficient mitigation, the overall cumulative impact can be reduced. There are strong grounds for a strategic cumulative avifaunal impact assessment to be conducted for the greater Noupoort Middelburg area as soon as possible. It is recommended that the Department of Environmental Affairs implement such a study.

Table 4. Formal assessment of impacts according to criteria supplied by EOH-CES (see Appendix 1 for details).

Phase	Impact description	Type	Extent	Magnitude	Duration	Probability	Confidence	Reversibility	Significance	Type post mitigation	Extent post mitigation	Magnitude post mitigation	Duration post mitigation	Probability post mitigation	Confidence post mitigation	Reversibility post mitigation	Significance post mitigation
Construction	Destruction or alteration of bird habitat	Negative – multiple species affected	Local	Medium	Long term	Definite	Certain	Irreversible	High	Negative	Local	Medium	Long term	Definite	Certain	Irreversible	Medium
Construction & operational	Disturbance of birds, particularly whilst breeding	Negative – particularly breeding Verreaux's Eagle	Local	Medium	Construction period	Probable	Unsure	Reversible	High	Negative	Local	Low	Construction period	Probable	Unsure	Reversible	Low
Operational	Displacement of birds from the site	Negative – multiple species but particularly Verreaux's Eagle	Local	Medium	Long term	Probable	Unsure	Reversible	Medium	Negative	Local	Low	Long term	Probable	Unsure	Reversible	Low
Operational	Collision of birds with the turbine blades	Negative – Verreaux's Eagle, Rock Kestrel, Jackal Buzzard, Lesser	Local-regional	Medium	Long term	Probable	Unsure	Irreversible	High	Negative	Local-regional	Medium	Long term	Probable	Unsure	Irreversible	Medium

		Kestrel, Lanner Falcon, Ludwig's Bustard															
Operational	Collision and electrocution of birds on overhead power lines	Negative – Ludwig's Bustard, Blue Crane, Verreaux's Eagle	Local-regional	Medium-high	Long term	Probable	Unsure	Irreversible	High	Negative	Local-regional	Low	Long term	Probable	Unsure	Irreversible	Low

6 EFFECT OF PROJECT AMENDMENT/SPLIT ON AVIFAUNAL IMPACTS RATING

As described elsewhere in this report, the following changes have been made to this project:

1. The previously authorised Umsobomvu Wind Farm has been split into two applications: Umsobomvu Wind Farm; and Coleskop Wind Farm. The 400kV grid connection power line has also been split out into a separate application.
2. The authorised turbine model of up to 137m hub height and 132m rotor diameter has been changed to hub up to 155m and rotor up to 165m. This means that the rotor zone would previously have spanned from 71m to 203m above ground. With the new amendment the rotor zone would span from 72.5m to 237.5m above ground.

At the same time as the above amendments, the turbine layout has been amended to accommodate larger Verreaux's Eagle nest site buffers. This has resulted in the relocation and loss of several turbines.

It is necessary to now assess whether these changes affect our previous findings with respect to avifaunal impact significance. Point 1 above makes no material difference to our previous findings. The following section describes the effects of Point 2 above:

The original study (Smallie, 2015) made the following findings with respect to the impacts on avifauna:

1. Habitat destruction will be of HIGH significance, mitigated to MEDIUM. Unchanged by proposed amendment.
2. Disturbance of birds will be of HIGH significance, mitigated to LOW. Unchanged by proposed amendment.
3. Displacement of birds will be of MEDIUM significance, mitigated to LOW. Unchanged by proposed amendment.
4. Collision of birds with turbine blades will be of HIGH significance, and can be mitigated to MEDIUM significance. See below discussion for any change
5. Collision and electrocution of birds with and on the internal overhead power line will be of HIGH significance, but can be mitigated to LOW significance. Unchanged by proposed amendment.

Impacts 1, 2, 3, and 5 will not be affected at all by the current proposed amendment to turbine model. Impact 4 is the only impact which could potentially be affected, and we examine it in more detail below:

Two aspects of the proposed change are relevant, the change in height above ground, and the change in overall risk area presented by the rotor.

a. Change in height above ground of rotor

Smallie (2015) identified 5 bird species as being at most risk of collision with turbine blades at the original Umsobomvu site, based on flight activity data collected on site over four seasons of pre-construction bird monitoring. These are presented in Table 5 below.

Table 5. Top priority (for turbine collision) bird species identified by Smallie 2015.

Species	Original finding – Smallie, 2015	Implications of proposed amendment (change in height of rotor zone only)
Rock Kestrel	The Rock Kestrel was found to fly at an average height above ground of 23.2m. 100% of flight duration was below rotor zone.	The new proposed lower blade tip of 72.5m above ground is only 1.5m higher than previously assessed so 100% of flight would still be below rotor. No change to findings is warranted.
Verreaux's Eagle	Verreaux's Eagle flew at an average height above ground of 106.9m and spent 70% of flight time within rotor zone, 9% below and 21% above rotor height.	No change since the average flight height is contained within both the original and proposed rotor zones.
Lesser Kestrel	Lesser Kestrel flew at a mean height of 17m above ground and spent 100% of flight time below rotor zone.	The new proposed lower blade tip of 72.5m above ground is only 1.5m higher than previously assessed so 100% of flight would still be below rotor. No change to findings is warranted.
Jackal Buzzard	Jackal Buzzard flew at an average height of 84m, and spent 76% of its flight time within rotor zone, 20% below and 4% above.	No change since the average flight height is contained within both the original and proposed rotor zones.
Ludwig's Bustard	Ludwig's Bustard flew at a mean height of 30m above ground and spent 100% of its flight time below rotor height.	The new proposed lower blade tip of 72.5m above ground is only 1.5m higher than previously assessed so 100% of flight would still be below rotor. No change to findings is warranted.

For all five species we judge that the change in turbine model will not change the turbine collision risk. We conclude that the change in turbine blade height above ground does not materially change the collision risk posed to birds and hence would not affect our original findings (Smallie, 2015).

b. Change in overall risk window presented by rotor

The turbine envelope authorised originally had a 137m rotor diameter and presented a collision risk window of 14 741.14m² per turbine. The proposed change to a 165m rotor diameter will increase the collision risk window presented by each turbine to 21 382.46m². This represents an increase in the per turbine area of collision risk window of 45% if the increase in rotor zone is evenly distributed across the heights at which birds fly. However this is not the case. As illustrated in Figure 14 below, since the lower tip of the proposed new rotor remains relatively unchanged, most of the change comes at the upper blade tip, which is above the height at which we recorded most bird flights. None of the priority species recorded flying on site had average flight heights anywhere near the upper blade tip height of 203 to 237.5m (See Table 5).

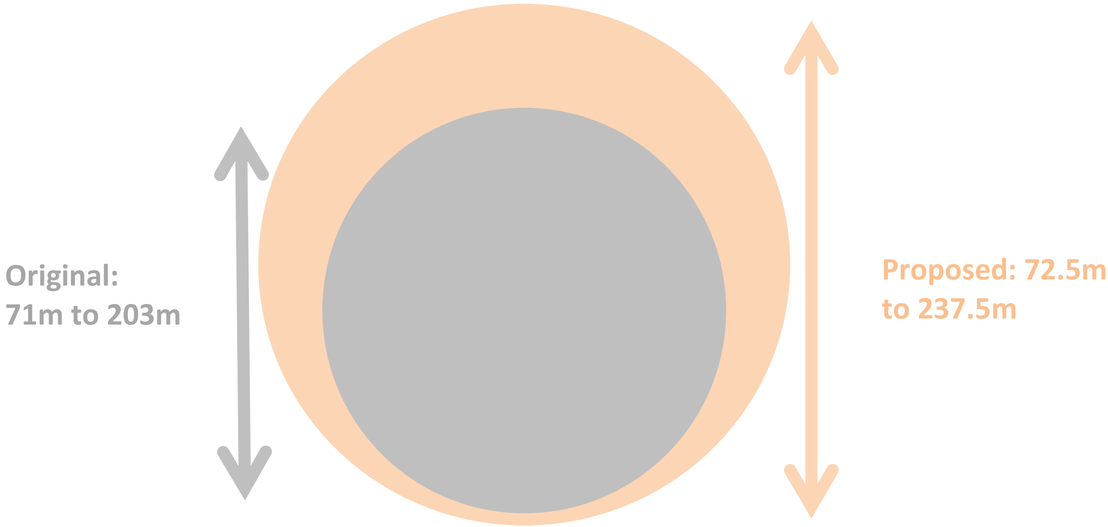


Figure 14. Indicative diagram of the original and proposed rotor swept areas. Not to scale.

We conclude then that the actual realized per turbine increase in collision risk to the relevant bird species flying on the Coleskop site will not be significant.

Unrelated to the above points 'a' and 'b', this amendment has provided an opportunity to micro site turbines to avoid Verreaux's Eagle nest buffer areas. At the Umsobomvu/Coleskop combined site 12 turbines have been removed from the layout and 2 moved out of the eagle buffer. In our view these were the 14 highest collision risk turbines and removing or moving them makes a significant difference (for the better) to the overall bird collision risk at the site.

The effect on bird collision risk as a result of the proposed amendment is in our view a net decrease in risk. The decrease is however not sufficient in our view to warrant a change in the significance findings of the original EIA assessment as they are categorical (i.e. the difference does not warrant a reduction from Medium to Low).

7 SENSITIVITY ANALYSIS

The primary means of minimising the potential impacts identified for a wind energy facility is typically the optimal placement of the proposed infrastructure. In order to achieve this, a sensitivity or constraints analysis is prepared for the site. This has been done below in Sections 6.1 and 6.2.

Avifaunal sensitivity for a project of this nature may be viewed at two spatial levels:

7.1 National & regional level

At the national level two bird conservation initiatives are particularly relevant to this exercise: the BirdLife South Africa-Endangered Wildlife Trust "Avian wind farm sensitivity map for South Africa" (Retief *et al*, 2011, 2014); and the Important Bird and Biodiversity Areas (IBBA) programme of BirdLife South Africa (Barnes, 1998; Marnewick *et al,* 2015). The sensitivity map (Retief *et al*, 2011, 2014) consolidated multiple avifaunal spatial data sources for a list of priority species in order to categorise pentads (9 x 9 kilometre grid cells – as shown in Figure 15) across South Africa according to their risk of bird- wind farm interactions. The darker grid cells indicate higher risk and the lighter coloured cells indicate lower risk. It is clear from Figure 15 that the proposed site is mostly classed in the lower sensitivity categories (but close to higher sensitivity pentads). It should be noted that since the primary data sources used to develop this map were the SABAP1 and 2, the map is affected by how well the areas of the country were covered by atlasing effort. It is therefore possible that areas of seemingly low sensitivity are actually data deficient. Exercises such as this map will certainly be over ruled by actual data collected by pre-construction monitoring on site, but are useful to provide perspective at this level.

The closest IBBA to the Coleskop site is the Platberg Karoo Conservancy IBA, the boundary of which lies approximately 15 kilometres to the north-west. This IBBA was declared on the basis of it holding vital populations of two Globally Threatened species, the Lesser Kestrel and the Blue Crane. The Karoo population of Blue Crane is really the only strong population remaining on natural vegetation in southern Africa. Lesser Kestrels are known to roost in both De Aar and Phillipstown. Other important threatened species that the area is important for include Tawny and Martial Eagles, Kori and Ludwig's Bustard, Pallid and Black Harriers, Blue Korhaan, Greater Flamingo, Black Stork, Secretarybird, South African Shelduck and Lanner Falcon (Taylor *et al,* 2015). Although most of these threatened species are physically large, a host of small terrestrial species also call this area home, including: Karoo Long-billed Lark, Karoo Lark, Karoo Chat, Tractrac Chat, Sickle-winged Chat, Layards Titbabbler, Namaqua Warbler, Pale-winged Starling, and Black-headed Canary. Many of these smaller species rely upon riverine woodland (e.g. Karoo Lark), thicket found mostly on slopes, and/or rocky slopes and outcrops (e.g. Karoo Long-billed Lark, Karoo Chat).

Based on these two data sources then, the Coleskop site is in an area of moderate to high sensitivity at the national scale.

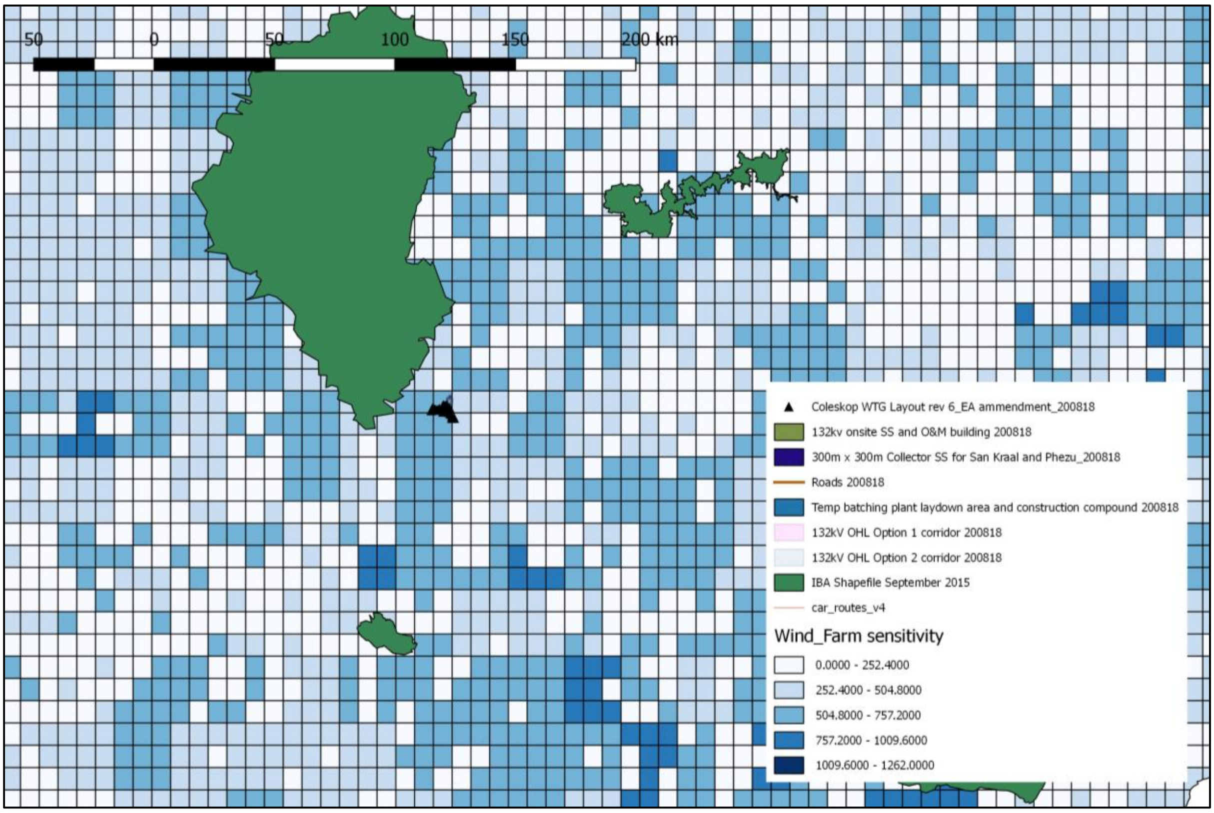


Figure 15. The proposed Coleskop Wind Energy Facility site relative to the Avian Wind Farm Sensitivity Map and Important Bird & Biodiversity Areas.

Dark colours indicate higher sensitivity or risk and light colours indicate lower sensitivity.

7.2 Local on- site constraints

The below description of avifaunal constraints on site is the most recent of a series of communications with the developer through the pre-construction bird monitoring programme. It is noted that significant improvements were made to the turbine layout, based on avifaunal input, prior to the tabling of this most recent layout under assessment. EDF has already revised the layout to reflect sensitive areas identified by the avifaunal specialist, and these changes are not reflected in Figure 16. An example is a string of turbines which was positioned on the narrow ridge called Rooiberg to the north-west of site. This string was removed from the layout on the basis of identified avifaunal risk, and the inability to mitigate this risk through turbine micro siting, because of the narrowness of the ridge.

On site, two categories of constraints were identified (Figure 16).

High sensitivity areas

HIGH sensitivity areas should not be impacted on through the placement of any new infrastructure. These areas have been identified on the basis of the below factors:

Eagle buffer areas

Large eagles such as the Verreaux's Eagles present at the Coleskop site are often protected against wind farm impacts internationally through the use of buffers. The aim of these buffer areas is to restrict the construction of infrastructure (particularly turbines) within a certain distance of the nest site. It is believed that such restrictions should reduce the construction phase disturbance risk to the birds (since noise, light and other forms of disturbance would be further away), reduce the operational phase displacement effects on the birds (since a large proportion of the birds' territory remains unaltered), and reduce the risk of collision of birds with turbines, since most flight activity is believed to take place closest to the nest. Of these three impacts, the impact of disturbance is probably the easiest to mitigate for using a buffer approach. Without fully understanding the intricacies of the effects of disturbance on breeding eagles, it makes sense that the further the source of disturbance is from the eagles, the less the effect should be. In the case of displacement and collision it is more important to understand the eagles' behaviour within their territories, since the importance of parts of their territory may not automatically diminish with distance from the nest. For example, a prime foraging area could exist several kilometres from the nest, whilst the area immediately around the nest holds less prey. Prey populations, in particular Rock Hyrax are also well known to be subject to local population fluctuations, so these resource areas may vary in time. Establishing the territory size accurately would probably require multi-year satellite telemetry studies for each pair of eagles, which is beyond the scope of this study. At this stage, based on data collected on site, we have a reasonable level of confidence in where the three pairs of Verreaux's Eagles are flying, and equally importantly where they do not seem to be flying.

The radius of eagle nest site buffers is typically determined by the measured or estimated core foraging ranges of the affected birds (Martinéz *et al*. 2010). At Coleskop we do not yet know what the core foraging or home range is of any of the relevant pairs of eagles. In such cases, a theoretical buffer area may be imposed to provide protection for the birds. A survey of international literature available pertaining to eagle buffer sizes for various forms of development revealed a range of recommended buffers from as little as 400 metres to as much as 12.8 kilometres (DeLong, 2008;

Martinéz *et al*. 2010; Ruddock & Whitfield 2007; Marja-Liisa Kaisanlahti-Jokimäki, *et al*. 2008; Colorado Division of Wildlife 2008; Rydell *et al*, 2012; US Fish & Wildlife Service 2013, Watson, Duff & Davies, 2014). Most of these studies dealt with the Golden Eagle, an eagle quite similar to Verreaux's Eagle in some behavioural respects. One of the most recent sources, the US Fish & Wildlife Service (2013), recommended that eagle territory size estimates could be derived from an estimate of the mean inter nest distance for the species in the area. The radius of the territory would be equal to half the mean inter nest distance. This is a useful basis for determining the radius of protective buffers for Verreaux's Eagle. If full protection is necessary, buffer radius should equal half the mean inter nest distance. This assumes that the buffer would be fully encircled by development (in this case wind turbines), and that the birds do not show any displacement and shift their territory away from turbines.

The best approximation is therefore Davies' average home range size of 24km², as it was determined for a Karoo population of this species. If a circular home range is assumed (unlikely to always be the case), this implies a home range with radius of approximately 2.7km. Informal discussion with other avifaunal specialists practicing in SA reveals a range of buffers of between 800m and 2.5 kilometres for Verreaux's Eagle (pers. comm). Unfortunately since the wind energy industry is so young in South Africa we do not know of published data on buffer sizes and their ultimate effectiveness in providing protection to breeding eagles. At Coleskop it is our opinion that identified buffers should consider not only theoretical territory sizes, but also actual flight data collected on site. Section 3.6.2 described how the areas in which Verreaux's Eagle were predominantly recorded flying appears to correspond with topographic features.

We have therefore delineated buffer areas around the eagle nests on the basis of a combination of these factors. These buffers were originally a minimum of 1km radius around the nest (Smallie, 2015), but increased to larger distances in some directions. It is very important to note that all three of the eagle nest sites are on the edge of the turbine layout, and not encircled by planned turbines. These buffer areas are therefore open ended for approximately 25-50% of their perimeter.

More recently due to the project split we were required to update this report. Subsequent to the compilation of the original report (Smallie, 2015) a set of species specific guidelines have been published by BirdLife South Africa for Verreaux's Eagle. In these guidelines a circular buffer of 3km radius is recommended based on research in the Western Cape by Megan Murgatroyd. We have recommended that EDF increase the originally accepted buffers to a minimum of 2km, closer to the now recommended 3km. We have also made additional mitigation recommendations to protect Verreaux's Eagle. The resultant buffers are shown in Figure 16.

Ridge edges, cliffs and drainage lines

The valleys, cliffs and drainage lines on site should all be avoided by infrastructure. No turbines should be placed within 200m of the ridge edges on site (based on the turbine rotor diameter pus some extra leeway). Since there is so much convoluted ridge line and drainage lines on site, this has not been mapped, but no turbines should be placed closer to these features than currently the case.

Medium sensitivity areas

MEDIUM sensitivity areas can accommodate roads, but no turbines or overhead power lines. These areas are around identified dams on site. Dams are important attractants to various bird species and collision risk will be heightened close to dams. A buffer of 500 metres around known dams was delineated. However, these dams vary considerably in size, the surrounding topography varies, and no regionally Red Listed species were found to be using these dams. These buffers can therefore be considered soft buffers and exceptions may be made for certain turbines within these areas, and for roads.

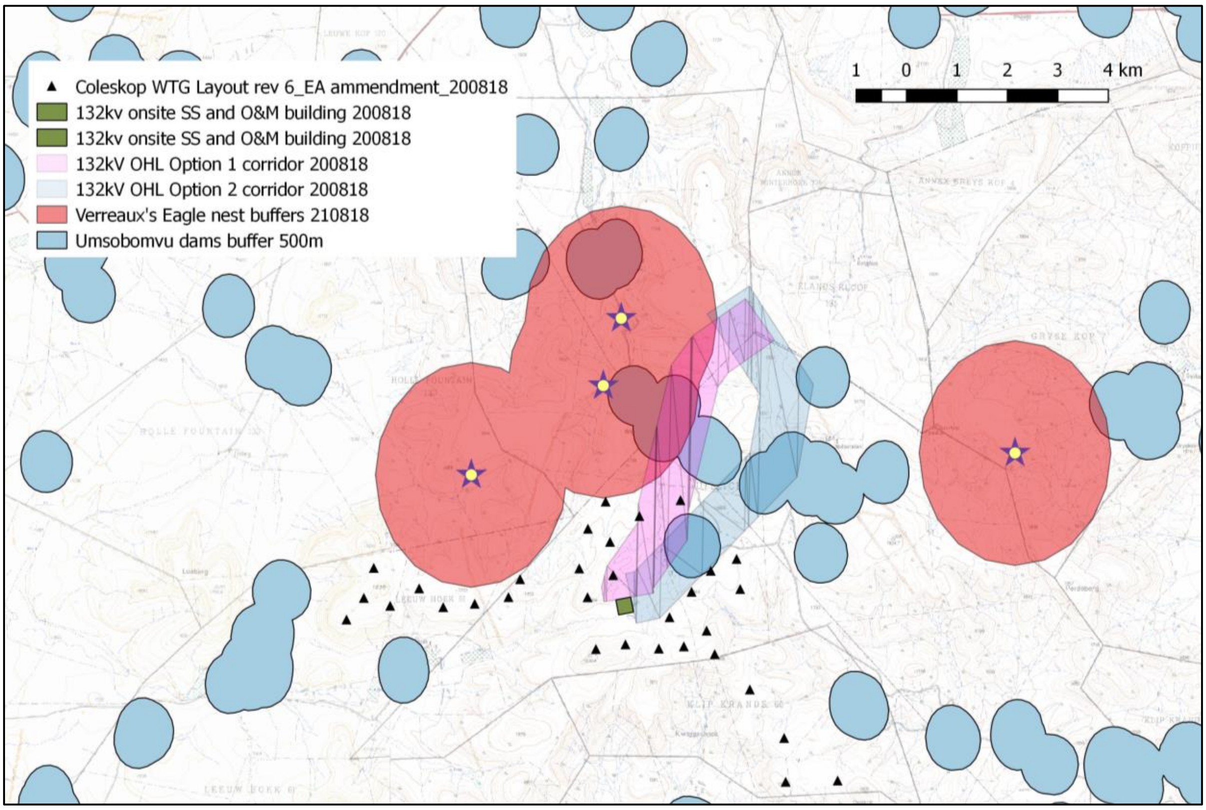


Figure 16. Avifaunal constraints map for the Umsobomvu Wind Energy Facility.

7.3 Comparison of alternatives

Micro siting alternatives exist for turbine themselves and have been discussed above in Section 6.2.

Two options exist for the 132kV connection to the MTS Substation, as shown in Figure 16. Our preference is for Option 2 as it more clearly avoids the no go areas around the Verreaux's Eagle nests.

Three options for the site access road have been presented for assessment. The most preferred of these is Option 1, to the south towards Middelburg. This road passes through the least sensitive habitat in our view, and is already a large road, requiring relatively less upgrade and expansion with consequent less new impact on avifauna. Option 2 is acceptable, and has the benefit of being relatively short. Option 3 is not acceptable for avifauna. This road passes through a sensitive poort, and within a few hundred metres of a Verreaux's Eagle nest. Transport of turbine components, machinery and equipment via this road would result in significant disturbance of these birds and other sensitive species in the area.

8 POST CONSTRUCTION BIRD MONITORING FRAMEWORK

The bird monitoring work done to date on the Coleskop WEF site has established a baseline understanding of the distribution, abundance and movement of key bird species on and near the site. If the project is authorized and constructed, the baseline information will need to be compared to data collected once the facility is operational. There will also be a need to measure the impacts of the facility on avifauna, particularly through collision mortality. The following programme has therefore been developed to meet these needs. It is recommended that this programme be implemented by the developer. It is recommended that the live bird monitoring and mortality estimates be continued for at least 2 years, and that mortality estimates be repeated in years 5, 10, 15 etc. The latest available version of the best practice guidelines (Jenkins *et al*, 2015) should be adhered to in this regard.

8.1 During construction bird monitoring

Due to the presence of multiple pairs of breeding eagles on and near site, there will be a need to monitor the effect of construction itself on these birds. It is recommended that a minimum of three short site visits be conducted by an ornithologist during any breeding season during which construction takes place. These site visits should include time spent observing the relevant breeding pairs of eagles and establishing breeding success and eagles reaction to construction.

8.2 Post construction monitoring

The intention with post construction bird monitoring is to repeat as closely as possible the methods and activities used to collect data pre-construction. One very important additional component needs to be added, namely mortality estimates through carcass searches. The following programme has therefore been developed to meet these needs, and should start as soon as possible after the construction of the first phase of turbines (not later than 3 months):

The 14 walked transects of approximately one kilometre each that have been conducted during pre-construction monitoring should be continued, as should the five vehicle based road count routes. The focal sites already established as well as any new focal sites identified by the 'during construction monitoring' should be monitored. It is particularly important that the breeding success at the relevant Verreaux's Eagle nests be monitored in the long term. 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 will be carefully plotted and documented. The six Vantage Points already established should be used to continue data collection post construction.

There may be a need to move VP1 onto the site itself rather than viewing the eagle nest as the current position does. The exact positioning of these VP's may need to be refined based on the presence of new turbines and roads. A total of at least 12 hours of observation will be conducted at each vantage point on each site visit, resulting in a total of 72 hours direct observation on site per site visit. The activities at the control site should be continued, i.e. six walked transects, two Vantage Points and a single vehicle transect.

It is estimated that the above activities will require 16 - 18 days on site for four site visits in a 12 month period, including the control site.

Mortality estimates

This is a new component of the methodology. The area surrounding the base of turbines should be searched for collision victims. As an absolute minimum, the search area should be defined by a radius equal to 75% of the turbine height (ground to blade-tip). The area around each turbine should searched using transects no greater than 10 meters apart, this width should be reduced where groundcover reduces visibility. Transects should be walked at a slow pace and carefully and methodically searched for any sign of a bird collision incident (carcasses, dismembered body parts, scattered feathers, injured birds). The period between searching individual turbines, the search interval, should be informed by assessments of scavenge and decomposition rates conducted in the initial stages of the monitoring period. Ideally the search interval should be shorter than the average carcass removal time. As a rule of thumb, a search interval of one to two weeks could be expected. It may be necessary to have two different approaches to sampling, and two different search intervals: 1) intensive, regular sampling of a subset of turbines and 2) extensive, less frequent sampling for large bodied bird carcasses. While this approach is not ideal for determining average fatality rates (Smallwood 2013), it does represent a compromise where significant mortalities of large birds at a particular turbine, or group of turbines, can be identified with limited resources.

Any suspected collision casualties should be comprehensively documented (for more detail see Jenkins *et al*, 2012). The number of turbines sampled should be informed by the objectives of the monitoring, as well as the spatial variation in fatality rates. It is therefore recommended that all turbines at each wind farm are surveyed, if necessary using the two different survey methods (intervals) as described above. No less than 30% or 20 turbines (whichever is greater) should be surveyed using the more rigorous (intensive) sampling methods. It is also important that associated infrastructure such as power lines and wind masts be searched for collision victims according to similar methods. 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*, 2014).

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 as well as the rate at which they decay or are removed by scavengers should be measured. It is important that at least 20 carcasses are used, and that this is done twice in a 12 month period, in summer and in winter. Although it is important to try to use carcasses similar in size and other factors to the target species for the site, this is unlikely to be achievable in practice. It is more likely that a readily obtainable species will be used, such as ducks or geese.

Since the mortality searches need to be done more frequently than the other monitoring, this will require a separate team with different skills and hopefully based closer to the site. This should be discussed with the specialist as soon as the project is confirmed as going ahead.

At this stage the time required for this component of monitoring is difficult to determine since it will also be dependent on the exact methods. This should be discussed more with the developer as the time approaches.

This component of the monitoring should continue for at least 2 years post construction, and be repeated in year 5, 10, 15 etc.

The latest available version of the best practice guidelines should be adhered to at the relevant time.

9 CONCLUSION & RECOMMENDATIONS

The main findings of this study are as follows:

- A total of 29 target bird species were identified at the outset of this programme on the basis of their conservation status and/or likely susceptibility to impacts of the proposed facility. This group of species comprises four ecological groups: raptors; large terrestrials; water birds; and a game bird. Of these 29 species, 19 were recorded on site including: 3 Endangered species (Taylor *et al*, 2015 – Martial Eagle, Tawny Eagle, Ludwig's Bustard); and 3 Vulnerable species (Lanner Falcon, Secretarybird, and Verreaux's Eagle).
- A total of 40 small bird species were recorded on site by walked transects. This species diversity peaked in spring and summer (33 and 30 species respectively), with lower species richness in winter and autumn. None of these species were Red Listed. Approximately 21 of these species are southern African endemic or near-endemics, with some being Karoo endemics.
- Thirteen large terrestrials and raptor species were recorded by drive transects, with a slight peak in species richness in autumn (5 species), and 4 species in each of the other seasons. The most abundant species recorded by this method was Lesser Kestrel, recorded only in summer as expected as it is a migrant.
- Over the full year a total of 142 bird species were recorded on site by all data collection methods. Spring showed the highest species richness (114 species) followed by summer (104) and autumn and winter (84 species each). Approximately 55 of these species can be considered southern African endemic or near-endemic species.
- Three pairs of Verreaux's Eagle were found to breed on or near site during this study. This is certainly the most important avifaunal aspect uncovered by this study. Most of the site is mountainous, with good availability of cliffs and rock lines on the mountain slopes and in the valleys.
- Ten target bird species were recorded flying on site, including 7 raptors, 2 large terrestrials, and a water bird. The majority of recorded flight was that of raptors, particularly Verreaux's Eagle. Almost half of all recorded flights were at Vantage Point 1, of Verreaux's Eagle. At VP1 and elsewhere on site, the majority of Verreaux's Eagle flight was recorded close to (1 to 1.5km from) a nest site. Other species recorded flying relatively frequently on site included Rock Kestrel, Jackal Buzzard, Booted Eagle and Lesser Kestrel. Both these species spent most of their flight time at rotor height, placing them at risk of collision with turbines once built.

- The species determined to be at most risk if the facility is constructed are: Verreaux's Eagle; Rock Kestrel; Lesser Kestrel; Jackal Buzzard; and Ludwig's Bustard (at risk from overhead power lines predominantly).
- A spatial 'collision risk index' for the site was created from the above flight data. Collision risk was highest close to (approximately 1 to 1.5km) Verreaux's Eagle nests, and over the valleys and steep valley sides. Collision risk was low on the top plateau. Flight activity of Verreaux's Eagles is not evenly distributed around nest sites, but rather follows topography.
- In a national context, this site is believed to be in a position of moderate to high sensitivity for avifauna. On site, two categories of sensitivity or constraints for development have been identified: HIGH and MEDIUM. The high sensitivity areas are identified on the basis of Verreaux's Eagle breeding sites, ridge edges, valleys and drainage lines. It is recommended that no turbines or other infrastructure be placed within the HIGH sensitivity areas. MEDIUM sensitivity areas are identified on the basis of farm dams, and can be considered soft buffer areas.
- Formal assessment of the possible impacts of the proposed facility on birds (as per criteria supplied by EOH-CES) resulted in the following findings:
    - Destruction of bird habitat is anticipated to be of HIGH significance pre-mitigation. Adherence to the recommendations of this report, in particular the sensitivity map, will reduce this to MEDIUM significance.
    - Disturbance if birds, particularly breeding Verreaux's Eagles could be of HIGH significance, but can be mitigated to LOW significance through adherence to the sensitivity map and other recommendations.
    - Displacement of birds is judged to be of MEDIUM significance, mitigated to LOW by adhering to the sensitivity map.
    - Collision of birds with turbines is judged to be of HIGH significance, mostly for Verreaux's Eagle. This can be mitigated to MEDIUM significance by avoiding placing turbines within the buffer areas identified around the eagle breeding sites.
    - Collision and electrocution of birds on overhead power lines will be of HIGH significance, but is reasonably easily mitigated to LOW significance. Note that if on site power cannot be buried for any reason, this would represent a significant change to the risk posed by this facility, and the specialist will need an opportunity to revise these findings.
    - The contribution that the Coleskop facility will make to the cumulative impacts of wind farms on birds in this area is judged to be of medium significance.
- The preferred option for the 132kv power line to the MTS Substation is Option 2 as it does not pass through the no-go area around the Verreaux's Eagle nests.

- The preferred option for the site access road is Option 1 to the south of site. Option 3 is not acceptable for avifauna as it passes too close to a Verreaux's Eagle breeding site, which could be disturbed by increased traffic on this road.
- A construction phase and post construction phase bird monitoring programme framework has been designed and presented in this report.

The following management recommendations are made for the management of risk to avifauna at this site:

- No infrastructure should be built in the areas identified as HIGH sensitivity in this report.
- All power line linking the turbines and linking turbine strings to the switching substation should be placed underground.
- There is a need to carefully manage the risk to Verreaux's Eagle at this site. The following actions will be required:
    - It may be necessary to avoid construction of certain infrastructure during Verreaux's Eagle breeding season (approximately May to October). This will depend on the final layout, construction timing and breeding status at the various nests. This must be determined by the avifaunal walk through prior to construction and once the infrastructure layout is final.
    - The effects of construction of the wind farm on the eagles must be monitored during construction. This will require a minimum of 3 site visits by a specialist during each eagle breeding season during construction. These site visits must determine breeding success at each nest and document eagle behaviour and reaction to construction as far as possible.
    - Once operational, the wind farm will have a 'duty of care' to monitor and document the effects of the operational phase of the facility on Verreaux's Eagle. This must include: thorough weekly turbine collision fatality searches; annual breeding status monitoring (3 site visits per season as above); and research into the eagles movement on and around site through the tracking of a sample of eagles (through the use of tracking devices fitted to one eagle from each pair).
    - If eagle turbine collision fatalities are recorded it will be necessary to mitigate this impact. It is recommended that the wind farm budget a suitable contingency amount for each year of operations so that identified mitigation measures can be implemented or further research can be undertaken to facilitate better understanding and mitigation.
- The post-construction bird monitoring programme outlined by this report should be implemented by a suitably qualified avifaunal specialist in accordance with the latest

available best practice guidelines at the time (see Jenkins *et al*, 2015). As mentioned above this monitoring should include the grid connection power line.

- A final avifaunal walk through should be conducted prior to construction to ensure that all the avifaunal aspects have been adequately managed and to ground truth the final layout of all infrastructure. This will most likely be done as part of the site specific Environmental Management Plan. This will also allow the development of specific management actions for the Environmental Control Officer during construction and training for relevant on site personnel if necessary.
- The findings of post-construction monitoring should be used to measure the effects of this facility on birds. If significant impacts are identified the wind farm operator will have to identify and implement suitable mitigation measures.

If these recommendations are adhered to, this project can proceed in our opinion.

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APPENDIX 1. SMALL TERRESTRIAL BIRD SPECIES RECORDED ON THE COLESKOP WIND ENERGY FACILITY SITE DURING WALKED TRANSECTS

Southern African endemic or near endemics are shown in **bold.**

	Total			Autumn			Winter			Spring			Summer		
Total # Species	**49**			**26**			**26**			**33**			**30**		
# Target Species	**7**			**3**			**1**			**3**			**4**		
Species	**# Birds**	**# Records**	**#Birds/km**	**# Birds**	**# Records**	**#Birds/km**	**# Birds**	**# Records**	**#Birds/km**	**# Birds**	**# Records**	**#Birds/km**	**# Birds**	**# Records**	**#Birds/km**
Grey-backed Cisticola	133	87	2.60	37	24	2.89	29	19	2.27	33	21	2.58	34	23	2.66
Cape Bunting	131	75	2.56	29	22	2.27	31	16	2.42	29	18	2.27	42	19	3.28
Pied Starling	94	10	1.84	42	3	3.28	21	2	1.64	31	5	2.42			
Lark-like Bunting	86	5	1.68										86	5	6.72
Karoo Scrub-Robin	78	42	1.52	19	10	1.48	12	7	0.94	29	14	2.27	18	11	1.41
Bokmakierie	54	43	1.05	16	11	1.25	8	8	0.63	14	10	1.09	16	14	1.25
Layard's Tit-Babbler	49	29	0.96	17	9	1.33	11	9	0.86	16	8	1.25	5	3	0.39
Yellow Canary	46	8	0.90	2	1	0.16	30	4	2.34	3	1	0.23	11	2	0.86
Cape Longclaw	42	20	0.82	15	6	1.17	4	2	0.31	6	3	0.47	17	9	1.33
Speckled Pigeon	38	5	0.74	25	2	1.95	8	1	0.63				5	2	0.39
Barn Swallow	36	9	0.70										36	9	2.81
Greater Striped Swallow	33	13	0.64							23	7	1.80	10	6	0.78
Rufous-eared Warbler	30	23	0.59	9	7	0.70	11	9	0.86	9	6	0.70	1	1	0.08
Karoo Prinia	30	20	0.59	4	3	0.31	5	3	0.39	18	12	1.41	3	2	0.23
Speckled Mousebird	30	3	0.59	13	1	1.02	8	1	0.63	9	1	0.70			
Helmeted Guineafowl	22	1	0.43										22	1	1.72
Pied Crow	21	9	0.41	8	3	0.63	3	2	0.23	6	3	0.47	4	1	0.31
Common Waxbill	16	1	0.31							16	1	1.25			
Spike-heeled Lark	15	6	0.29							2	1	0.16	13	5	1.02

Rock Martin	14	6	0.27										14	6	1.09
Grey-winged Francolin	12	7	0.23							6	5	0.47	6	2	0.47
Eastern Clapper Lark	11	9	0.21				1	1	0.08	7	5	0.55	3	3	0.23
Long-billed Pipit	11	6	0.21	2	1	0.16	7	4	0.55	2	1	0.16			
African Red-eyed Bulbul	10	6	0.20	1	1	0.08	5	3	0.39	4	2	0.31			
White-necked Raven	10	6	0.20	3	2	0.23	4	2	0.31	3	2	0.23			
Cape Wagtail	9	7	0.18	3	2	0.23	5	4	0.39	1	1	0.08			
Pale-winged Starling	9	3	0.18	1	1	0.08	4	1	0.31	4	1	0.31			
Neddicky	8	4	0.16	3	2	0.23							5	2	0.39
Cape Turtle-Dove	7	6	0.14	1	1	0.08	2	1	0.16	4	4	0.31			
African Quailfinch	6	2	0.12										6	2	0.47
Blacksmith Lapwing	6	3	0.12	2	1	0.16	2	1	0.16	2	1	0.16			
Familiar Chat	6	5	0.12	2	2	0.16	4	3	0.31						
Three Banded Plover	6	1	0.12							6	1	0.47			
Hadeda Ibis	6	3	0.12				1	1	0.08	4	1	0.31	1	1	0.08
African Stonechat	5	3	0.10	2	1	0.16	2	1	0.16	1	1	0.08			
Ground Woodpecker	5	2	0.10	3	1	0.23							2	1	0.16
Acacia Pied Barbet	4	2	0.08							2	1	0.16	2	1	0.16
Black-throated Canary	4	1	0.08							4	1	0.31			
Cape Sparrow	4	2	0.08							2	1	0.16	2	1	0.16
Plain-backed Pipit	4	3	0.08							2	2	0.16	2	1	0.16
White-throated Canary	4	1	0.08				4	1	0.31						
African Pipit	3	3	0.06										3	3	0.23
Sickle-winged Chat	3	2	0.06							1	1	0.08	2	1	0.16
Southern Red Bishop	3	1	0.06	3	1	0.23									
Ant-eating Chat	2	2	0.04										2	2	0.16
Red-winged Starling	2	1	0.04										2	1	0.16
African Rock Pipit	1	1	0.02							1	1	0.08			
Common Fiscal	1	1	0.02	1	1	0.08									

Malachite Sunbird	1	1	0.02	1	1	0.08

APPENDIX 2. LARGE TERRESTRIAL & RAPTOR SPECIES RECORDED ON THE COLESKOP WIND ENERGY FACILITY SITE DURING DRIVEN TRANSECTS

	Total for year			Autumn			Winter			Spring			Summer		
# species	**13**			**5**			**4**			**4**			**4**		
Species	**# Birds**	**# Records**	**#birds/km**	**# Birds**	**# Records**	**#birds/km**	**# Birds**	**# Records**	**#birds/km**	**# Birds**	**# Records**	**#birds/km**	**# Birds**	**# Records**	**#birds/km**
Lesser Kestrel	26	5	0.56	0	0	0.00	0	0	0.00	0	0	0.00	26	5	0.56
Yellow-billed Duck	13	1	0.28	0	0	0.00	13	1	0.28	0	0	0.00	0	0	0.00
Northern Black Korhaan	9	7	0.19	2	2	0.04	2	2	0.04	4	2	0.09	1	1	0.02
Grey-winged Francolin	9	3	0.19	7	2	0.15	0	0	0.00	0	0	0.00	2	1	0.04
Verreaux's Eagle	5	5	0.11	4	4	0.09	0	0	0.00	1	1	0.02	0	0	0.00
Blue Crane	4	2	0.09	0	0	0.00	0	0	0.00	0	0	0.00	4	2	0.09
Cape Vulture	4	1	0.09	0	0	0.00	0	0	0.00	0	0	0.00	4	1	0.09
Rock Kestrel	3	3	0.06	1	1	0.02	0	1	0.00	0	0	0.00	2	1	0.04
Booted Eagle	2	2	0.04	0	0	0.00	1	1	0.02	1	1	0.02	0	0	0.00
Southern Pale Chanting Goshawk	2	2	0.04	0	0	0.00	0	0	0.00	0	0	0.00	2	2	0.04
Jackal Buzzard	1	1	0.02	1	1	0.02	0	0	0.00	0	0	0.00	0	0	0.00
Lanner Falcon	1	1	0.02	0	0	0.00	1	1	0.02	0	0	0.00	0	0	0.00
Secretarybird	1	1	0.02	0	0	0.00	0	0	0.00	1	1	0.02	0	0	0.00

APPENDIX 3. OBSERVATIONS MADE AT FOCAL SITES ON THE COLESKOP WIND ENERGY FACILITY SITE.

Season	Number of Visits	Species	Key Observations
FOCAL SITE 1			
Autumn	4	Verreaux's Eagle	Verreaux's Eagle nest on cliffs - no activity on nest Single adult perched on rock 70m W of the nest Two adults soaring along cliff N of the nest Single adult soaring along cliff N of the nest
Winter	1	None	Verreaux's Eagle nest on cliffs No activity on nest
Spring	2	None	Verreaux's Eagle nest on cliffs No activity on nest
Summer	2	None	Verreaux's Eagle nest on cliffs No activity on nest
FOCAL SITE 2			
Autumn	2	Verreaux's Eagle	4 nests on the cliff Single adult perched (roost) to right of the nest on the extreme left Single adult flew along the cliffs to the N of nest.
Winter	2	Verreaux's Eagle	Lots of droppings at nest. Single adult perched on nest No other activity observed during second visit to the nest
Spring	3	Verreaux's Eagle	Flew from NW to NE over top of mountain above nest Adult soars above nest over top of mountain, while chick sat on nest Chick on nest and looks healthy
Summer	3	Verreaux's Eagle	No birds - but chick calling Single adult flew from NW to SE along the cliffs opposite the nest While at VP 4 observed eagles soaring above the nest outside the perimeter of the VP Single adult soared from nest site up in Visserskloof and then went back again.
FOCAL SITE 3			
Autumn	2	Martial Eagle	Two nest on separate pylons - possibly Martial Eagle nests, No birds observed in the area
Winter	2	Martial Eagle	Two nest on separate pylons - possibly Martial Eagle nests, No birds observed in the area
Spring	3	Martial Eagle	2 nest on separate pylons Adult ME sat on pylon about 800 m NW of nests. Adult flew off pylon and soar towards SE with power line
Summer	4	Martial Eagle	No birds observed in the area
FOCAL SITE 4			
Autumn	1	None	Scan cliffs with scope, no nests or raptors observed.
Winter	1	None	Scan cliffs with scope, no nests or raptors observed.
Spring	2	Verreaux's Eagle	Scan cliffs further on and found a VE nest on a bush at about 31*22'36.9S 24*52'52.8E The chick looks healthy and about the age of chick @ FS 2 No adults seen - they probably hunt down stream to E of nest.
Summer	3	Verreaux's Eagle	While on VP 6 an adult VE flew in from N and continued along the powerline to SE Suspect that it is one of eagles associated with this FS
FOCAL SITE 5			
Autumn	2	None	No raptor nests observed No eagles observed

			Hamerkop nest
Winter	2	None	No raptor nests, or eagles observed Hamerkop nest
Spring	2	None	No raptor nests, or eagles observed Hamerkop nest
Summer	2	None	No raptor nests, or eagles observed Hamerkop nest
<u>FOCAL SITE 6</u>			
Autumn	2	Verreaux's Eagle	Nest building activity observed - both adults involved Birds take turns in tending to nest while the other hunts south of VP
Winter	2	Verreaux's Eagle	Frequent movement to and from the nest by both adults Predominant movements are to the S, E, SE and SW Female brought dassie to the nest (food provisioing)
Spring	2	Verreaux's Eagle	Male and Female movement to and from nest (N, S and W) Chick remained on nest 2014-10-14 fledgling and adult left the nest (soaring N to S) Other adult soaring E to W and back. Adult & fledgling returned from SE
Summer	2	Verreaux's Eagle	On observer arrival juvenile perched on cliffs close to nest. Juvenile left perch @ 06:14 and flew to edge of mountain where it perch till 07:51 No adult VE observations
<u>FOCAL SITE 7</u>			
Autumn	1	None	Scan cliffs with scope, no nest or raptors observed.
Winter	1	None	Scan cliffs with scope, no nest or raptors observed.
Spring	1	None	Scan cliffs with scope, no nest or raptors observed.
Summer	1	None	Scan cliffs with scope, no nest or raptors observed.
<u>FOCAL SITE 8</u>			
Autumn	1	None	Verreaux's Eagle nest on cliffs No raptors observed on the nest Saw two adults above nest hunting. Single bird flew over top and other flew SE
Winter	1	None	Scan cliff and nest along cliff No signs of occupation of nest & no eagles observed
Spring	1	None	No signs of occupation of nest & no eagles observed
Summer	1	None	No signs of occupation of nest & no eagles observed

APPENDIX 4. INCIDENTAL OBSERVATIONS RECORDED ON THE COLESKOP WIND ENERGY FACILITY SITE.

	Total		Autumn		Winter		Spring		Summer	
Species	# Birds	# Records	# Birds	# Records	# Birds	# Records	# Birds	# Records	# Birds	# Records
Grey-winged Francolin	27	5	8	2	0	0	8	2	11	1
Verreaux's Eagle	23	15	12	8	4	4	3	1	4	2
Lesser Kestrel	23	7	0	0	0	0	0	0	23	7
Jackal Buzzard	11	10	3	3	0	0	4	3	4	4
Booted Eagle	9	7	0	0	5	3	2	2	2	2
Rock Kestrel	7	7	2	2	0	0	3	3	2	2
Greater Kestrel	7	6	2	1	3	3	1	1	1	1
Southern Pale Chanting Goshawk	6	6	2	2	0	0	3	3	1	1
Secretarybird	4	3	0	0	3	2	0	0	1	1
Cape Vulture	4	1	0	0	0	0	0	0	4	1
Northern Black Korhaan	3	3	0	0	1	1	0	0	2	2
African Harrier-Hawk	2	2	1	1	0	0	1	1	0	0
Ludwig's Bustard	2	2	0	0	0	0	2	2	0	0
African Black Duck	2	1	0	0	2	1	0	0	0	0
Blue Crane	2	1	2	1	0	0	0	0	0	0
Amur Falcon	1	1	0	0	0	0	0	0	1	1
Black-shouldered Kite	1	1	0	0	0	0	1	1	0	0
Martial Eagle	1	1	1	1	0	0	0	0	0	0
Tawny Eagle	1	1	0	0	0	0	0	0	1	1

APPENDIX 5. SEASONAL BIRD SPECIES LIST FOR THE COLESKOP WIND ENERGY FACILITY SITE – FROM PRE-CONSTRUCTION BIRD MONITORING

1 denotes presence, not abundance

Common Name	***Scientific Name***	**Cons status (Taylor *et al*, 2015)**	**Sthn Afr end/near end**	**Karoo endemic**	**Aut**	**Win**	**Spr**	**Sum**
White-breasted Cormorant	*Phalacrocorax lucidus*						1	
Reed Cormorant	*Phalacrocorax africanus*				1		1	
Grey Heron	*Ardea cinerea*						1	
Black-headed Heron	*Ardea melanocephala*							1
Hamerkop	*Scopus umbretta*						1	1
African Sacred Ibis	*Threskiornis aethiopicus*				1	1	1	
Hadeda Ibis	*Bostrychia hagedash*				1	1	1	1
Egyptian Goose	*Alopochen aegyptiaca*				1	1	1	1
South African Shelduck	*Tadorna cana*		1		1	1	1	1
Yellowbilled Duck	*Anas undulata*				1	1	1	1
African Black Duck	*Anas sparsa*					1		1
Secretarybird	*Sagittarius serpentarius*	VU				1	1	1
Cape Vulture	*Gyps coprotheres*	EN	1					1
Black-shouldered Kite	*Elanus caeruleus*						1	
Verreaux's Eagle	*Aquila verreauxii*	VU			1	1	1	1
Tawny Eagle	*Aquila rapax*	EN						1
Booted Eagle	*Aquila pennatus*					1	1	1
Martial Eagle	*Polemaetus bellicosus*	EN			1		1	
Steppe Buzzard	*Buteo vulpinus*							1
Jackal Buzzard	*Buteo rufofuscus*		1		1	1	1	1
Southern Pale Chanting Goshawk	*Melierax canorus*		1		1	1	1	1
African Harrier-Hawk	*Polyboroides typus*				1	1	1	
Lanner Falcon	*Falco biarmicus*	VU						1
Amur Falcon	*Falco amurensis*							1
Rock Kestrel	*Falco rupicolus*				1	1	1	1
Greater Kestrel	*Falco rupicoloides*				1	1	1	1
Lesser Kestrel	*Falco naumanni*							1
Grey-winged Francolin	*Scleroptila africanus*		1		1		1	1
Helmeted Guineafowl	*Numida meleagris*				1	1	1	1
Blue Crane	*Anthropoides paradiseus*	NT	1		1	1	1	1
Ludwig's Bustard	*Neotis ludwigii*	EN	1	1			1	1
Karoo Korhaan	*Eupodotis vigorsii*	NT	1	1	1			
Three-banded Plover	*Charadrius tricollaris*					1	1	1
Crowned Lapwing	*Vanellus coronatus*				1		1	

Blacksmith Lapwing	*Vanellus armatus*			1	1	1	1
Common Greenshank	*Tringa nebularia*					1	1
Black-winged Stilt	*Himantopus himantopus*				1		
Spotted Thick-knee	*Burhinus capensis*			1	1	1	
Namaqua Sandgrouse	*Pterocles namaqua*	1			1	1	
Speckled Pigeon	*Columba guinea*			1	1	1	1
Red-eyed Dove	*Streptopelia semitorquata*				1	1	1
Cape Turtle-Dove	*Streptopelia capicola*			1	1	1	1
Laughing Dove	*Streptopelia senegalensis*			1	1	1	1
Namaqua Dove	*Oena capensis*					1	1
Diderick Cuckoo	*Chrysococcyx caprius*					1	
Spotted Eagle Owl	*Bubo africanus*					1	
White-rumped Swift	*Apus caffer*						1
Little Swift	*Apus affinis*					1	1
Alpine Swift	*Tachymarptis melba*				1	1	1
Speckled Mousebird	*Colius striatus*			1	1	1	1
White-backed Mousebird	*Colius colius*	1		1	1	1	1
Red-faced Mousebird	*Urocolius indicus*			1	1	1	1
Malachite Kingfisher	*Alcedo cristata*					1	
European Bee-eater	*Merops apiaster*					1	
African Hoopoe	*Upupa africana*				1	1	1
Acacia Pied Barbet	*Tricholaema leucomelas*	1		1	1	1	1
Crested Barbet	*Trachyphonus vaillantii*					1	1
Greater Honeyguide	*Indicator indicator*					1	
Ground Woodpecker	*Geocolaptes olivaceus*	1		1	1	1	1
Sabota Lark	*Calendulauda sabota*	1			1	1	
Spike-heeled Lark	*Chersomanes albofasciata*	1	1			1	1
Red-capped Lark	*Calandrella cinerea*						1
Large-billed Lark	*Galerida magnirostris*	1		1	1		1
Grey-backed Sparrowlark	*Eremopterix verticalis*	1					
Barn Swallow	*Hirundo rustica*					1	1
White-throated Swallow	*Hirundo albigularis*					1	1
Greater Striped Swallow	*Hirundo cucullata*	1				1	1
Rock Martin	*Hirundo fuligula*			1	1	1	1
Cape Crow	*Corvus capensis*			1	1		1
Pied Crow	*Corvus albus*			1	1	1	1
House Crow	*Corvus spendens*						
White-necked Raven	*Corvus albicollis*			1	1	1	1
Southern Grey Tit	*Parus afer*						1
Cape Penduline-Tit	*Anthoscopus minutus*	1		1			1
African Red-eyed Bulbul	*Pycnonotus nigricans*	1		1	1	1	1
Karoo Thrush	*Turdus smithi*	1	1	1	1	1	1
Cape Rock-Thrush	*Monticola rupestris*	1				1	

Short-toed Rock-Thrush	*Monticola brevipes*	1		1	1		
Mountain Wheatear	*Oenanthe monticola*	1		1	1	1	1
Capped Wheatear	*Oenanthe pileata*						1
Familiar Chat	*Cercomela familiaris*			1	1	1	1
Sickle-winged Chat	*Cercomela sinuata*	1	1		1	1	1
Karoo Chat	*Cercomela schlegelii*	1	1	1	1	1	
Anteating Chat	*Myrmecocichla formicivora*	1		1	1	1	1
African Stonechat	*Saxicola torquatus*			1	1	1	1
Cape Robin-Chat	*Cossypha caffra*			1	1	1	1
Karoo Scrub-Robin	*Cercotrichas coryphoeus*	1	1	1	1	1	1
Chestnut-vented Tit-Babbler	*Parisoma subcaeruleum*	1				1	1
Layard's Tit-Babbler	*Parisoma layardi*	1	1	1	1	1	1
Bar-throated Apalis	*Apalis thoracica*					1	
Long-billed Crombec	*Sylvietta rufescens*			1	1	1	1
Yellow-bellied Eremomela	*Eremomela icteropygialis*			1	1		1
Zitting Cisticola	*Cisticola juncidis*			1			
Desert Cisticola	*Cisticola aridulus*			1			1
Grey-backed Cisticola	*Cisticola cinnamomeus*	1		1	1	1	1
Levaillant's Cisticola	*Cisticola tinniens*					1	
Neddicky	*Cisticola fulvicapilla*			1		1	1
Karoo Prinia	*Prinia maculosa*	1		1	1	1	1
Rufous-eared Warbler	*Malcorus pectoralis*	1		1	1	1	1
Chat Flycatcher	*Bradornis infuscatus*	1		1		1	
Fiscal Flycatcher	*Sigelus silens*	1		1	1		1
Pririt Batis	*Batis pririt*	1		1		1	
Fairy Flycatcher	*Stenostira scita*	1		1	1	1	1
African Paradise-Flycatcher	*.Terpsiphone viridis*					1	1
Cape Wagtail	*Motacilla capensis*			1	1	1	1
African Pipit	*Anthus cinnamomeus*			1	1	1	1
Long-billed Pipit	*Anthus similis*			1	1	1	1
Plain-backed Pipit	*Anthus leucophrys*			1		1	1
Buffy Pipit	*Anthus vaalensis*					1	
African Rock Pipit	*Anthus crenatus*	1	1	1	1	1	
Cape Longclaw	*Macronyx capensis*	1		1	1	1	1
Common Fiscal	*Lanius collaris*			1	1	1	1
Southern Boubou	*Laniarius ferrugineus*	1				1	
Southern Tchagra	*Tchagra tchagra*	1		1			
Bokmakierie	*Telophorus zeylonus*	1		1	1	1	1
Common Starling	*Sturnus vulgaris*					1	1
Pied Starling	*Spreo bicolor*	1		1	1	1	1
Wattled Starling	*Creatophora cinerea*			1			
Red-winged Starling	*Onychognathus morio*			1	1	1	1
Pale-winged Starling	*Onychognathus nabouroup*	1		1	1	1	

Malachite Sunbird	*Nectarinia famosa*					1	1	1
Southern Double-collared Sunbird	*Cinnyris chalybeus*		1		1	1	1	
Cape White-Eye	*Zosterops virens*		1		1	1	1	1
House Sparrow	*Passer domesticus*				1	1	1	1
Cape Sparrow	*Passer melanurus*		1		1	1	1	1
Southern Grey-headed Sparrow	*Passer diffusus*					1	1	1
Cape Weaver	*Ploceus capensis*		1			1		
Southern Masked Weaver	*Ploceus velatus*				1	1	1	1
Southern Red Bishop	*Euplectes orix*				1	1	1	1
Common Waxbill	*Estrilda astrild*				1	1	1	1
African Quailfinch	*Ortygospiza atricollis*							1
Pin-tailed Whydah	*Vidua macroura*						1	1
Black-throated Canary	*Crithagra atrogularis*		1			1	1	1
Cape Canary	*Serinus canicollis*		1		1	1	1	1
Black-headed Canary	*Serinus alario*						1	1
Yellow Canary	*Crithagra flaviventris*		1		1	1	1	1
White-throated Canary	*Crithagra albogularis*		1		1	1	1	1
Cape Bunting	*Emberiza capensis*		1		1	1	1	1
Lark-like Bunting	*Emberiza impetuani*		1		1		1	1
Northern Black Korhaan	*Afrotis afraoides*		1	1	1	1	1	1
Eastern Clapper Lark	*Mirafra fasciolata*				1	1	1	1
Karoo Long-billed Lark	*Certhilauda subcoronata*		1	1			1	1
		Total	**55**	**11**	**84**	**84**	**114**	**106**

APPENDIX 6. BIRD SPECIES LIST FOR THE COLESKOP WIND ENERGY FACILITY SITE – SOUTHERN AFRICAN BIRD ATLAS PROJECT 1 & 2

Common Name	Scientific Name	SABAP 1	SABAP 2
Apalis, Bar-throated	*Apalis thoracica*		x
Avocet, Pied	*Recurvirostra avosetta*	x	x
Barbet, Acacia Pied	*Tricholaema leucomelas*	x	x
Barbet, Crested	*Trachyphonus vaillantii*		x
Batis, Pririt	*Batis pririt*	x	x
Bee-eater, European	*Merops apiaster*	x	x
Bishop, Southern Red	*Euplectes orix*	x	x
Bittern, Little	*Ixobrychus minutus*		x
Bokmakierie, Bokmakierie	*Telophorus zeylonus*	x	x
Boubou, Southern	*Laniarius ferrugineus*		x
Bulbul, African Red-eyed	*Pycnonotus nigricans*	x	x
Bunting, Cape	*Emberiza capensis*	x	x
Bunting, Cinnamon-breasted	*Emberiza tahapisi*	x	x
Bunting, Golden-breasted	*Emberiza flaviventris*	x	x
Bunting, Lark-like	*Emberiza impetuani*	x	x
Bustard, Kori	*Ardeotis kori*	x	
Bustard, Ludwig's	*Neotis ludwigii*	x	x
Buzzard, Jackal	*Buteo rufofuscus*	x	x
Buzzard, Steppe	*Buteo vulpinus*	x	x
Canary, Black-headed	*Serinus alario*	x	x
Canary, Black-throated	*Crithagra atrogularis*	x	x
Canary, Brimstone	*Crithagra sulphuratus*	x	
Canary, Cape	*Serinus canicollis*	x	x
Canary, White-throated	*Crithagra albogularis*	x	x
Canary, Yellow	*Crithagra flaviventris*	x	x
Chat, Anteating	*Myrmecocichla formicivora*	x	x
Chat, Familiar	*Cercomela familiaris*	x	x
Chat, Karoo	*Cercomela schlegelii*	x	x
Chat, Sickle-winged	*Cercomela sinuata*	x	x
Chat, Tractrac	*Cercomela tractrac*	x	
Cisticola, Cloud	*Cisticola textrix*	x	x
Cisticola, Desert	*Cisticola aridulus*	x	x
Cisticola, Grey-backed	*Cisticola subruficapilla*	x	x
Cisticola, Levaillant's	*Cisticola tinniens*	x	x
Cisticola, Zitting	*Cisticola juncidis*	x	x
Cliff-Swallow, South African	*Hirundo spilodera*	x	x

Coot, Red-knobbed	*Fulica cristata*	x	x
Cormorant, Reed	*Phalacrocorax africanus*	x	x
Cormorant, White-breasted	*Phalacrocorax carbo*	x	x
Courser, Double-banded	*Rhinoptilus africanus*	x	x
Crane, Blue	*Anthropoides paradiseus*	x	x
Crombec, Long-billed	*Sylvietta rufescens*	x	x
Crow, Cape	*Corvus capensis*	x	x
Crow, Pied	*Corvus albus*	x	x
Cuckoo, Diderick	*Chrysococcyx caprius*	x	x
Cuckoo, Great Spotted	*Clamator glandarius*	x	
Cuckoo, Jacobin	*Clamator jacobinus*	x	
Cuckoo, Red-chested	*Cuculus solitarius*	x	x
Darter, African	*Anhinga rufa*	x	x
Dove, Laughing	*Streptopelia senegalensis*	x	x
Dove, Namaqua	*Oena capensis*	x	x
Dove, Red-eyed	*Streptopelia semitorquata*	x	x
Dove, Rock	*Columba livia*	x	x
Drongo, Fork-tailed	*Dicrurus adsimilis*	x	x
Duck, African Black	*Anas sparsa*	x	x
Duck, White-faced	*Dendrocygna viduata*		x
Duck, Yellow-billed	*Anas undulata*	x	x
Eagle, Booted	*Aquila pennatus*	x	x
Eagle, Martial	*Polemaetus bellicosus*	x	x
Eagle, Tawny	*Aquila rapax*	x	
Eagle, Verreaux's	*Aquila verreauxii*	x	x
Eagle-Owl, Cape	*Bubo capensis*	x	
Eagle-Owl, Spotted	*Bubo africanus*	x	x
Egret, Cattle	*Bubulcus ibis*	x	x
Egret, Great	*Egretta alba*	x	
Egret, Little	*Egretta garzetta*	x	x
Eremomela, Karoo	*Eremomela gregalis*	x	
Eremomela, Yellow-bellied	*Eremomela icteropygialis*	x	x
Falcon, Amur	*Falco amurensis*		x
Falcon, Lanner	*Falco biarmicus*	x	x
Falcon, Peregrine	*Falco peregrinus*		x
Finch, Red-headed	*Amadina erythrocephala*	x	x
Fiscal, Common	*Lanius collaris*	x	x
Fish-Eagle, African	*Haliaeetus vocifer*		x
Flamingo, Greater	*Phoenicopterus ruber*	x	x
Flamingo, Lesser	*Phoenicopterus minor*	x	
Flycatcher, Chat	*Bradornis infuscatus*	x	x

Flycatcher, Fairy	*Stenostira scita*	x	x
Flycatcher, Fiscal	*Sigelus silens*	x	x
Flycatcher, Spotted	*Muscicapa striata*	x	x
Francolin, Grey-winged	*Scleroptila africanus*	x	x
Francolin, Orange River	*Scleroptila levaillantoides*	x	
Goose, Egyptian	*Alopochen aegyptiacus*	x	x
Goose, Spur-winged	*Plectropterus gambensis*	x	x
Goshawk, Gabar	*Melierax gabar*	x	x
Goshawk, Southern Pale Chanting	*Melierax canorus*	x	x
Grassbird, Cape	*Sphenoeacus afer*	x	
Grebe, Black-necked	*Podiceps nigricollis*		x
Grebe, Great Crested	*Podiceps cristatus*	x	
Grebe, Little	*Tachybaptus ruficollis*	x	x
Greenbul, Sombre	*Andropadus importunus*	x	
Greenshank, Common	*Tringa nebularia*	x	x
Guineafowl, Helmeted	*Numida meleagris*	x	x
Hamerkop, Hamerkop	*Scopus umbretta*	x	x
Harrier, Black	*Circus maurus*	x	
Harrier-Hawk, African	*Polyboroides typus*		x
Heron, Black-headed	*Ardea melanocephala*	x	x
Heron, Grey	*Ardea cinerea*	x	x
Honeyguide, Greater	*Indicator indicator*	x	x
Hoopoe, African	*Upupa africana*	x	x
House-Martin, Common	*Delichon urbicum*	x	
Ibis, African Sacred	*Threskiornis aethiopicus*	x	x
Ibis, Glossy	*Plegadis falcinellus*	x	x
Ibis, Hadeda	*Bostrychia hagedash*	x	x
Jacana, African	*Actophilornis africanus*	x	
Kestrel, Greater	*Falco rupicoloides*	x	x
Kestrel, Lesser	*Falco naumanni*	x	x
Kestrel, Rock	*Falco rupicolus*	x	x
Kingfisher, Brown-hooded	*Halcyon albiventris*	x	x
Kingfisher, Giant	*Megaceryle maximus*	x	x
Kingfisher, Malachite	*Alcedo cristata*	x	x
Kingfisher, Pied	*Ceryle rudis*	x	
Kite, Black-shouldered	*Elanus caeruleus*	x	x
Korhaan, Black	*Eupodotis afra*	x	
Korhaan, Blue	*Eupodotis caerulescens*	x	x
Korhaan, Karoo	*Eupodotis vigorsii*	x	x
Korhaan, Northern Black	*Afrotis afraoides*		x
Lapwing, Blacksmith	*Vanellus armatus*	x	x

Lapwing, Crowned	*Vanellus coronatus*	x	x
Lark, Agulhas Clapper	*Mirafra marjoriae*	x	
Lark, Agulhas Long-billed	*Certhilauda brevirostris*	x	
Lark, Barlow's	*Calendulauda barlowi*	x	
Lark, Benguela Long-billed	*Certhilauda benguelensis*	x	
Lark, Cape Clapper	*Mirafra apiata*	x	x
Lark, Cape Long-billed	*Certhilauda curvirostris*	x	
Lark, Clapper	*Mirafra apiata*	x	
Lark, Eastern Clapper	*Mirafra fasciolata*	x	x
Lark, Eastern Long-billed	*Certhilauda semitorquata*	x	x
Lark, Karoo	*Calendulauda albescens*	x	
Lark, Karoo Long-billed	*Certhilauda subcoronata*	x	x
Lark, Large-billed	*Galerida magnirostris*	x	x
Lark, Longbilled	*Mirafra curvirostris*	x	
Lark, Melodious	*Mirafra cheniana*	x	x
Lark, Red-capped	*Calandrella cinerea*	x	x
Lark, Sabota	*Calendulauda sabota*	x	x
Lark, Spike-heeled	*Chersomanes albofasciata*	x	x
Longclaw, Cape	*Macronyx capensis*	x	x
Marsh-Harrier, African	*Circus ranivorus*	x	
Martin, Brown-throated	*Riparia paludicola*	x	x
Martin, Rock	*Hirundo fuligula*	x	x
Masked-Weaver, Southern	*Ploceus velatus*	x	x
Moorhen, Common	*Gallinula chloropus*	x	x
Mousebird, Red-faced	*Urocolius indicus*	x	x
Mousebird, Speckled	*Colius striatus*	x	x
Mousebird, White-backed	*Colius colius*	x	x
Neddicky, Neddicky	*Cisticola fulvicapilla*	x	x
Night-Heron, Black-crowned	*Nycticorax nycticorax*	x	x
Nightjar, Fiery-necked	*Caprimulgus pectoralis*	x	
Nightjar, Rufous-cheeked	*Caprimulgus rufigena*	x	x
Ostrich, Common	*Struthio camelus*	x	x
Owl, Barn	*Tyto alba*	x	x
Palm-Swift, African	*Cypsiurus parvus*		x
Paradise-Flycatcher, African	*Terpsiphone viridis*	x	x
Penduline-Tit, Cape	*Anthoscopus minutus*		x
Petronia, Yellow-throated	*Petronia superciliaris*	x	
Pigeon, Speckled	*Columba guinea*	x	x
Pipit, African	*Anthus cinnamomeus*	x	x
Pipit, African Rock	*Anthus crenatus*	x	x
Pipit, Buffy	*Anthus vaalensis*	x	x

Pipit, Long-billed	*Anthus similis*	x	x
Pipit, Plain-backed	*Anthus leucophrys*	x	x
Plover, Kittlitz's	*Charadrius pecuarius*	x	x
Plover, Three-banded	*Charadrius tricollaris*	x	x
Pochard, Southern	*Netta erythrophthalma*	x	
Prinia, Black-chested	*Prinia flavicans*	x	
Prinia, Drakensberg	*Prinia hypoxantha*	x	
Prinia, Karoo	*Prinia maculosa*	x	x
Prinia, Spotted	*Prinia hypoxantha*	x	
Quail, Common	*Coturnix coturnix*	x	x
Quailfinch, African	*Ortygospiza atricollis*	x	x
Quelea, Red-billed	*Quelea quelea*	x	x
Raven, White-necked	*Corvus albicollis*	x	x
Reed-Warbler, African	*Acrocephalus baeticatus*	x	x
Robin-Chat, Cape	*Cossypha caffra*	x	x
Rock-Thrush, Cape	*Monticola rupestris*	x	x
Rock-Thrush, Short-toed	*Monticola brevipes*		x
Roller, European	*Coracias garrulus*	x	x
Ruff, Ruff	*Philomachus pugnax*	x	
Sandgrouse, Namaqua	*Pterocles namaqua*	x	x
Sandpiper, Common	*Actitis hypoleucos*	x	x
Sandpiper, Green	*Tringa ochropus*		x
Sandpiper, Marsh	*Tringa stagnatilis*	x	
Sandpiper, Wood	*Tringa glareola*	x	x
Scrub-Robin, Karoo	*Cercotrichas coryphoeus*	x	x
Secretarybird	*Sagittarius serpentarius*	x	x
Seedeater, Streaky-headed	*Crithagra gularis*		x
Shelduck, South African	*Tadorna cana*	x	x
Shoveler, Cape	*Anas smithii*	x	x
Shrike, Red-backed	*Lanius collurio*		x
Snake-Eagle, Black-chested	*Circaetus pectoralis*		x
Snipe, African	*Gallinago nigripennis*	x	x
Sparrow, Cape	*Passer melanurus*	x	x
Sparrow, Greyheaded	*Passer diffusus*	x	
Sparrow, House	*Passer domesticus*	x	x
Sparrow, Northern Grey-headed	*Passer griseus*	x	
Sparrow, Southern Grey-headed	*Passer diffusus*	x	x
Sparrow-Weaver, White-browed	*Plocepasser mahali*	x	x
Sparrowhawk, Black	*Accipiter melanoleucus*		x
Sparrowhawk, Rufous-chested	*Accipiter rufiventris*	x	x
Sparrowlark, Grey-backed	*Eremopterix verticalis*	x	x

Spoonbill, African	*Platalea alba*	x	x
Starling, Cape Glossy	*Lamprotornis nitens*	x	x
Starling, Common	*Sturnus vulgaris*	x	x
Starling, Pale-winged	*Onychognathus nabouroup*	x	x
Starling, Pied	*Spreo bicolor*	x	x
Starling, Red-winged	*Onychognathus morio*	x	x
Starling, Wattled	*Creatophora cinerea*	x	x
Stilt, Black-winged	*Himantopus himantopus*	x	x
Stint, Little	*Calidris minuta*	x	x
Stonechat, African	*Saxicola torquatus*	x	x
Stork, Black	*Ciconia nigra*	x	x
Stork, White	*Ciconia ciconia*	x	x
Sunbird, Amethyst	*Chalcomitra amethystina*	x	x
Sunbird, Dusky	*Cinnyris fuscus*	x	x
Sunbird, Malachite	*Nectarinia famosa*	x	x
Sunbird, Southern Double-collared	*Cinnyris chalybeus*	x	x
Swallow, Barn	*Hirundo rustica*	x	x
Swallow, Greater Striped	*Hirundo cucullata*	x	x
Swallow, Pearl-breasted	*Hirundo dimidiata*		x
Swallow, White-throated	*Hirundo albigularis*	x	x
Swamp-Warbler, Lesser	*Acrocephalus gracilirostris*	x	x
Swift, African Black	*Apus barbatus*	x	x
Swift, Alpine	*Tachymarptis melba*	x	x
Swift, Common	*Apus apus*		x
Swift, Horus	*Apus horus*	x	
Swift, Little	*Apus affinis*	x	x
Swift, White-rumped	*Apus caffer*	x	x
Teal, Cape	*Anas capensis*	x	x
Teal, Red-billed	*Anas erythrorhyncha*	x	x
Tern, White-winged	*Chlidonias leucopterus*	x	
Thick-knee, Spotted	*Burhinus capensis*	x	x
Thrush, Karoo	*Turdus smithi*	x	x
Thrush, Olive	*Turdus olivaceus*	x	
Tit, Ashy	*Parus cinerascens*	x	
Tit, Grey	*Parus afer*	x	x
Tit-Babbler, Chestnut-vented	*Parisoma subcaeruleum*	x	x
Tit-Babbler, Layard's	*Parisoma layardi*	x	x
Turtle-Dove, Cape	*Streptopelia capicola*	x	x
Wagtail, Cape	*Motacilla capensis*	x	x
Warbler, Namaqua	*Phragmacia substriata*	x	x
Warbler, Rufous-eared	*Malcorus pectoralis*	x	x

Warbler, Willow	*Phylloscopus trochilus*	x	x
Waxbill, Common	*Estrilda astrild*	x	x
Weaver, Cape	*Ploceus capensis*	x	x
Wheatear, Capped	*Oenanthe pileata*	x	x
Wheatear, Mountain	*Oenanthe monticola*	x	x
White-eye, Cape	*Zosterops pallidus*	x	
White-eye, Cape	*Zosterops virens*	x	x
White-eye, Orange River	*Zosterops pallidus*	x	
Whydah, Pin-tailed	*Vidua macroura*	x	x
Woodpecker, Cardinal	*Dendropicos fuscescens*	x	x
Woodpecker, Ground	*Geocolaptes olivaceus*	x	x

APPENDIX 7. METHOD OF ASSESSING THE SIGNIFICANCE OF POTENTIAL ENVIRONMENTAL IMPACTS

This section outlines the proposed method for assessing the significance of the potential environmental impacts outlined above. As indicated, these include both operational and construction phase impacts.

For each impact, the EXTENT (spatial scale), MAGNITUDE and DURATION (time scale) would be described. These criteria would be used to ascertain the SIGNIFICANCE of the impact, firstly in the case of no mitigation and then with the most effective mitigation measure(s) in place. The mitigation described in the EIAR would represent the full range of plausible and pragmatic measures but does not necessarily imply that they would be implemented.[1]

The tables on the following pages show the scale used to assess these variables, and defines each of the rating categories.

CRITERIA	CATEGORY	DESCRIPTION
Extent or spatial influence of impact	**Regional**	Beyond a 10 kilometre radius of the candidate site.
	Local	Within a 10 kilometre radius of the candidate site.
	Site specific	On site or within 100 m of the candidate site.
Magnitude of impact (at the indicated spatial scale)	**High**	Natural and/ or social functions and/ or processes are *severely* altered
	Medium	Natural and/ or social functions and/ or processes are *notably* altered
	Low	Natural and/ or social functions and/ or processes are *slightly* altered
	Very Low	Natural and/ or social functions and/ or processes are *negligibly* altered
	Zero	Natural and/ or social functions and/ or processes remain *unaltered*
Duration of impact	**Construction period**	Up to 3 years
	Short Term	Up to 5 years after construction
	Medium Term	5-15 years after construction
	Long Term	More than 15 years after construction

The SIGNIFICANCE of an impact is derived by taking into account the temporal and spatial scales and magnitude. The means of arriving at the different significance ratings is explained below.

SIGNIFICANCE RATINGS	LEVEL OF CRITERIA REQUIRED
High	• High magnitude with a regional extent and long term duration • High magnitude with either a regional extent and medium term duration or a local extent and long term duration • Medium magnitude with a regional extent and long term duration
Medium	• High magnitude with a local extent and medium term duration • High magnitude with a regional extent and construction period or a site specific extent and long term duration • High magnitude with either a local extent and construction period duration or a site specific extent and medium term duration • Medium magnitude with any combination of extent and duration except site specific and construction period or regional and long term • Low magnitude with a regional extent and long term duration
Low	• High magnitude with a site specific extent and construction period duration • Medium magnitude with a site specific extent and construction period duration • Low magnitude with any combination of extent and duration except site specific and construction period or regional and long term • Very low magnitude with a regional extent and long term duration
Very low	• Low magnitude with a site specific extent and construction period duration • Very low magnitude with any combination of extent and duration except regional and long term
Neutral	• Zero magnitude with any combination of extent and duration

Once the significance of an impact has been determined, the PROBABILITY of this impact occurring as well as the CONFIDENCE in the assessment of the impact, would be determined using the rating systems outlined below. It is important to note that the significance of an impact should always be considered in concert with the probability of that impact occurring. Lastly, the REVERSIBILITY of the impact is estimated using the rating system outlined below.

PROBABILITY RATINGS	CRITERIA
Definite	Estimated greater than 95 % chance of the impact occurring.
Probable	Estimated 5 to 95 % chance of the impact occurring.
Unlikely	Estimated less than 5 % chance of the impact occurring.

CONFIDENCE RATINGS	CRITERIA
Certain	Wealth of information on and sound understanding of the environmental factors potentially influencing the impact.
Sure	Reasonable amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact.

Unsure	Limited useful information on and understanding of the environmental factors potentially influencing this impact.