AVIFAUNALBIRD SPECIALIST STUDY

Proposed Phezukomoya Wind Energy Facility near Noupoort in the Northern Cape

Compiled September 2017

Prepared by:

Chris van Rooyen Consulting

Prepared for

ARCUS

CONTENTS OF THE SPECIALIST REPORT – CHECKLIST

Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6	Section of Report
(a) details of the specialist who prepared the report; and the expertise of that specialist to compile a specialist report including a *curriculum vitae*;	Front pg. 3
(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Back pg. 124
(c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 2
(cA) an indication of the quality and age of base data used for the specialist report;	Sections 3 and 4
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Sections 6, 9, 10,
(d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 7 and Appendix 2
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Sections 3, 4, 7 and 9
(f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Section 13. No site plan alternative was provided
(g) an identification of any areas to be avoided, including buffers;	Section 13
(h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 13
(i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 4
(j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment, or activities;	Section 12
(k) any mitigation measures for inclusion in the EMPr;	Section 9
(l) any conditions for inclusion in the environmental authorisation;	Section 9
(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 9
(n) a reasoned opinion— i. as to whether the proposed activity, activities or portions thereof should be authorised; iA. Regarding the acceptability of the proposed activity or activities; and ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr or Environmental Authorization, and where applicable, the closure plan;	Section 9 and 12
(o) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Section 11
(p) any other information requested by the competent authority	Section 11
Where a government notice gazetted by thye Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	Not applicable

RELEVANT EXPERTISE

Chris van Rooyen

Chris has 20 years' experience in the management of wildlife interactions with electricity infrastructure. He was head of the Eskom-Endangered Wildlife Trust (EWT) Strategic Partnership from 1996 to 2007, which has received international acclaim as a model of co-operative management between industry and natural resource conservation. He is an acknowledged global expert in this field and has worked in South Africa, Namibia, Botswana, Lesotho, New Zealand, Texas, New Mexico and Florida. Chris also has extensive project management experience and has received several management awards from Eskom for his work in the Eskom-Endangered Wildlife Strategic Partnership. He is the author of 15 academic papers (some with co-authors), co-author of two book chapters and several research reports. He has been involved as ornithological consultant in more than 160 power line and 30 renewable energy projects. Chris is also co-author of the Best Practice for Avian Monitoring and Impact Mitigation at Wind Development Sites in Southern Africa, which is currently (2017) accepted as the industry standard. Chris also works outside the electricity industry and had done a wide range of bird impact assessment studies associated with various residential and industrial developments.

Albert Froneman (Pr.Sci.Nat)

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

Nico Laubscher

Nico holds a D.Sc. from the University of Potchefstroom and was head of the Statistics Division, National Research Institute for Mathematical Sciences of the CSIR from 1959 – 1975. He retired in 1989 as head of the Centre for Statistical Consultation at the University of Stellenbosch. Nico held several offices, including President of the South African Statistical Association, and editor of the South African Statistical Journal. Nico has five decades' experience in statistical analysis and data science applications, including specialisation in model building with massive data sets, designing of experiments for process improvement and analysis of data so obtained, and statistical process control. He also has published peer reviewed papers in several leading statistical journals, including Annals of Mathematical Statistics, American Statistical Journal, Technometrics and The American Statistician. He currently operates as a private statistical consultant to industry and academia.

EXECUTIVE SUMMARY

It is anticipated that the proposed Phezukomoya Wind Energy Facility will have a variety of impacts on avifauna which ranges from low to high. The impacts are:

- Collision mortality on the wind turbines;
- Displacement due to disturbance during construction (and dismantling) of the wind farm and associated infrastructure;
- Displacement due to habitat change and loss;
- Electrocution on the internal medium voltage powerline grid where the lines run above ground;
- Collision with the proposed power line grid connections and the internal medium voltage powerlines where the lines run above ground; and
- Displacement due to disturbance during the construction (and dismantling) of the power line grid connection.

An estimated 184 species could potentially occur in the study area. Of the 184 species that could occur at the site, 32 are classified as priority species for wind farm developments (Retief *et al.* 2012).

Displacement of priority species due to disturbance during the construction (and dismantling) phases of the wind energy facility and associated infrastructure is likely to be a temporary, medium negative impact, and will remain at a medium level despite the application of mitigation measures. None of the priority species are likely to be permanently displaced due to disturbance, although partial displacement of terrestrial species e.g. Blue Crane, Secretarybird, Grey-winged Francolin and African Rock Pipit in the short term during the construction phase is very likely. It is highly likely that most priority species will be temporarily displaced in the development area during the construction operations, due to the noise and activity. The implementation of buffer zones around the currently inactive Verreaux's Eagle nesting area could reduce any potential disturbance impacts on Verreaux's Eagles in future, but not for the other priority species. The significance will therefore remain at a medium level after mitigation collectively for priority species.

Displacement of priority species due to disturbance during construction (and dismantling) phases of the grid connection is likely to be a temporary, medium negative impact, and should be reduced to a low level with the application of mitigation measures. Species most likely to be affected by this impact would be terrestrial species such as Grey-winged Francolin, Blue Crane, Ludwig's Bustard, Northern Black Korhaan, Secretarybird and Blue Korhaan. The construction activities associated with the grid connection could result in the short-term displacement of priority species from the site. The implementation of the proposed mitigation measures will reduce the probability of disturbance of priority species.

Displacement of priority species due to habitat destruction during operational lifetime of the wind energy facility phase is likely to be a medium negative impact but will be reduced to a low level with the application of mitigation measures. Species most likely to be affected by the habitat destruction (particularly fragmentation) are the terrestrial species such as Blue Crane, Ludwig's Bustard, Secretarybird and Grey-winged Francolin. The rehabilitation of disturbed areas will help to mitigate the impact of the habitat transformation to some extent, but the fragmentation of the habitat due to the construction of the internal road network cannot be mitigated, and will remain an impact for the duration of the operational life-time of the facility.

Collisions of priority species with the turbines in the operational phase are likely to be a medium negative impact and it could be reduced to a low negative level through the application of mitigation measures. Species most likely to be at risk of collision with the turbines are Lesser Kestrel and Jackal Buzzard. Very little Verreaux's Eagle flight activity was recorded, but that does not exclude the potential for collisions. The impact is likely to persist for the operational life-time of the project. Implementation of the proposed mitigation measures should reduce the probability and severity of the impact on priority species to such an extent that the overall significance should be reduced to low.

Mortality of priority species with the grid connection and internal medium voltage network due to collisions in the operational phase is likely to be of medium significance, and will remain as such after the implementation of mitigation measures. Several of the priority species which occur or potentially occur in the study area are power line sensitive from a collision perspective. These include Ludwig's Bustard, Blue Crane, Northern Black Korhaan, Karoo Korhaan, Blue Korhaan, Secretarybird, White Stork and Greater Flamingo. All of these species, but particularly Ludwig's Bustard and Blue Crane, could be impacted by the proposed grid connection and the internal medium voltage MV lines (where they are above ground) through collision. The application of BFDs should reduce the probability and severity of the collision impact, but it is likely to remain at the medium level, as the application of BFD's will reduce, but not eliminate the risk.

Mortality due to electrocutions with the overhead sections of the medium voltage internal network is likely to be a medium impact, but it can be reduced to low through the use of bird-friendly pole designs, which must be approved by the avifaunal specialist. The poles could potentially be lethal for species such as Jackal Buzzard, Verreaux's Eagle, Martial Eagle, Cape Eagle-Owl, Spotted Eagle-Owl, Steppe Buzzard and African Harrier-hawk. The electrocution risk will persist as long as the lines are up, but it can be completely eliminated at the onset if bird-friendly structures are used.

From a cumulative impact perspective, the greatest potential concern in the 35km radius around Phezukomoya WEF is for the large raptor species, particularly the Red Listed Verreaux's Eagle and Martial Eagle, due to their relatively low numbers and vulnerability to turbine collisions (Ralston – Patton *et al*. 2017). Another concern is the potential impact of the powerline grid connections on large terrestrial species, particularly Blue Crane, Ludwig's Bustard and Secretarybird. The combined cumulative impact of renewable developments on priority species, and particularly wind energy developments on Verreaux's Eagle and Martial Eagle, within the 35km radius around the Phezukomoya WEF, is potentially significant at a local scale, and require the strict application of mitigation measures such as buffer zones around nests, and the establishment of mortality thresholds and subsequent curtailment of turbines, if thresholds are exceeded. The impact should be less severe at a regional and national level, due to the large distribution ranges of the species, but should nonetheless be carefully monitored. If all the mitigation measures proposed for the various renewable projects are strictly implemented, the cumulative impacts of these developments, including the proposed Phezukomoya WEF, should be reduced to low.

It is our opinion that the proposed development may be approved subject to the strict implementation of the proposed mitigation measures detailed in this report.

We are satisfied that the final mitigated layout (December 2017) incorporates the proposed avifaunal buffer zones as recommended in the avifaunal specialist study.

Contents

Appendices

1. INTRODUCTION & BACKGROUND

The proposed Phezukomoya project is a 315 MW Wind Energy Facility (WEF) located approximately 55 km south of Colesberg and approximately 4km south of the town of Noupoort in the Northern Cape, bordering the Eastern Cape.

The proposed Phezukomoya WEF would consist of the following infrastructural components:

- Up to 63 wind turbines with a generation capacity between 3 – 5 MW and a rotor diameter of up to 150 m, a hub height of up to 150 m and blade length of up to 75 m;
- Foundations and hardstands associated with the wind turbines;
- Internal access roads of between 8 m (during operation) and 14 m (during construction) wide to each turbine;
- Two 10 000 m2 on-site switching stations
- Medium voltage underground electrical cables will be laid to transmit electricity generated by the wind turbines to the on-site switching station or substation;
- Overhead medium voltage cables between turbine rows where necessary;
- An on-site substation and OMS area (180 000 m2) to facilitate stepping up the voltage from medium to high voltage (132 kV) to enable the connection of the WEF to proposed Umsobomvu WEF 132/400 kV Substation, from which the generated power will be fed into the national grid;
- Two medium voltage overhead powerlines (approximately 3 km and 5.6 km in length) connecting the on-site switching stations with the on-site medium voltage/132 kV substation;
- An approximately 16 km 132 kV voltage overhead power line from the on-site substation to the proposed 132/400 kV Umsobomvu Substation where the electricity will be transferred to the national grid;
- A 90 000 m² area for batching plant, temporary laydown area and construction compound;
- Temporary infrastructure including a site camp; and a laydown area approximately 7500 m2 in extent, per turbine.

The total size of the development site is 15 271 hectares. The footprint of the proposed development is estimated to be less than 1% of this area.

Description	**Dimensions**		
	Length (m)	**Breadth (m)**	**Area (sqm)**
Eskom 400kV Umsobomvu substation	600	600	360000
Phezukomoya medium voltage/132 kV substation and OMS area	600	300	180000
Construction compound, temporary laydown area and batching plant	300	300	90000

See Figures 1 and 2 for the location and lay-out of the proposed Phezukomoya WEF.

Figure 1: Locality of the proposed Phezukomoya WEF

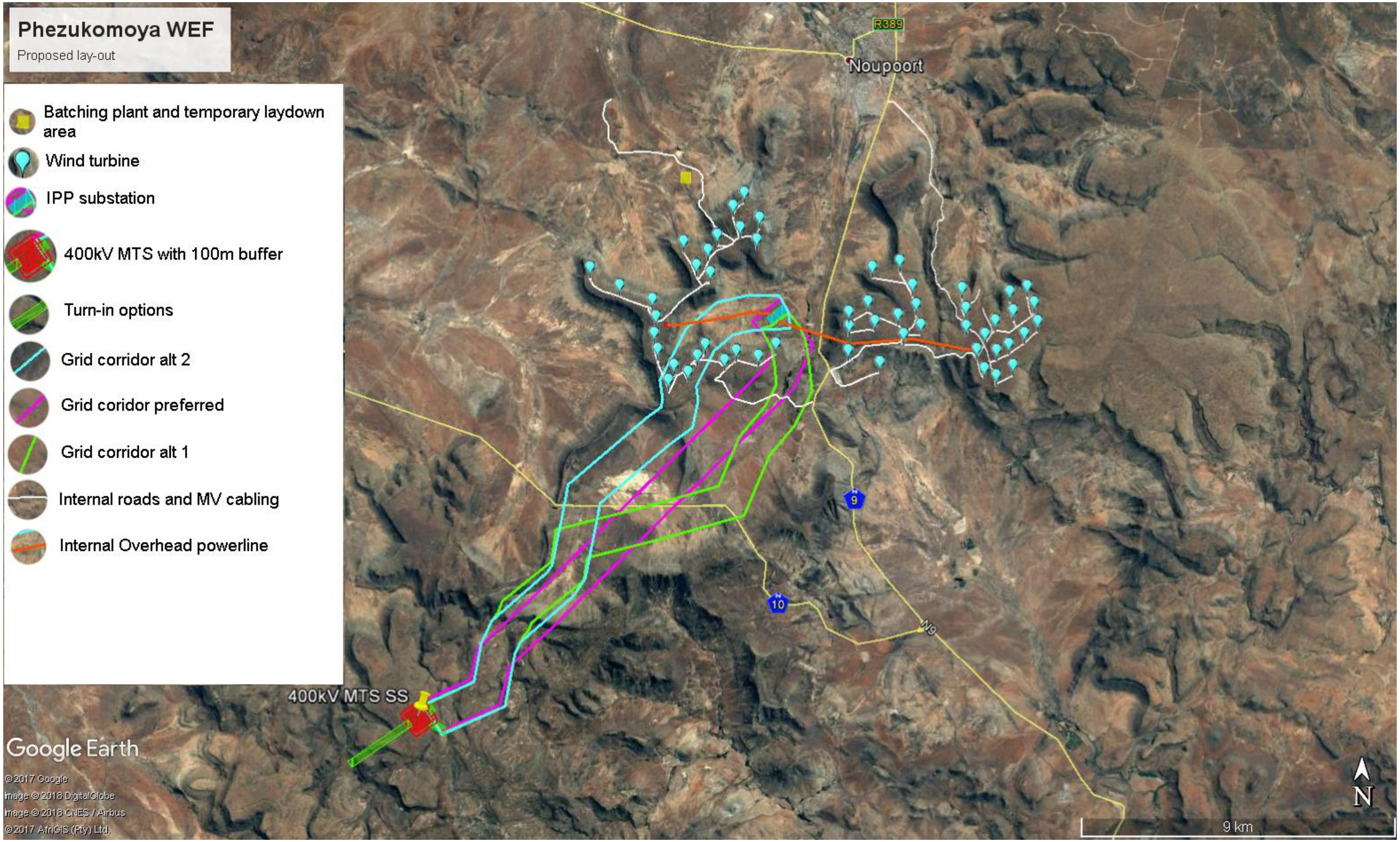

Figure 2: The lay-out of the proposed WEF

2. TERMS OF REFERENCE

The terms of reference for this avifaunal specialist study are as follows:

- Describe the affected environment from an avifaunal habitat perspective.
- Discuss any applicable legislation pertaining to impacts on avifauna.
- Identify gaps in baseline data.
- Assess the expected impacts, including cumulative.
- Provide a sensitivity map of the proposed development site from an avifaunal perspective.
- Provide recommendations for the mitigation of impacts.

3. SOURCES OF INFORMATION AND METHODOLOGY

The following methods were applied to compile this report:

- Bird distribution data of the South African Bird Atlas 2 (SABAP 2) was obtained from the Animal Demography Unit of the University of Cape Town (ADU 2017), as a means to ascertain which species occurs within the broader area i.e. within a block consisting of nine pentad grid cells within which the proposed wind facilities are situated. The nine pentad grid cells are the following: 3110_2450, 3110_2455, 3110_2500, 3115_2450, 3115_2455, 3115_2500, 3120_2450, 3120_2455 and 3120_2500. A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km. From 2011 to date, a total of 68 full protocol cards (i.e. 68 surveys lasting a minimum of two hours or more each) have been completed for this area.
- The national threatened status of all priority species was determined with the use of the most recent edition of the Red Data Book of Birds of South Africa (Taylor *et al*. 2015), and the latest authoritative summary of southern African bird biology (Hockey *et al.* 2005).
- The global threatened status of all priority species was determined by consulting the (2017.2) IUCN Red List of Threatened Species (http://www.iucnredlist.org/).
- A classification of the vegetation types in the study area was obtained from the Atlas of Southern African Birds 1 (SABAP1) and the National Vegetation Map compiled by the South African National Biodiversity Institute (Mucina & Rutherford 2006).
- The Important Bird and Biodiversity Areas of South Africa (Marnewick *et al.* 2015) was consulted for information on Important Bird Areas (IBAs).
- Satellite imagery was used in order to view the broader development area on a landscape level and to help identify sensitive bird habitat.
- Priority species were taken from the updated list (2014) of priority species for wind farms compiled for the Avian Wind Farm Sensitivity Map (Retief *et al.* 2012).
- A site visit was conducted from 7 – 9 April 2015 to record bird habitat at the site and to identify transects, vantage points and potential focal points for the 12-months pre-construction monitoring which commenced in March 2015.
- The main source of information on avifaunal abundance and species diversity was the 12-months pre-construction monitoring which was conducted from March 2015 to February 2016. See Appendix 2 for a summary of the methodology employed in the pre-construction programme.
- All the available published count data of the Coordinated Avifaunal Roadcount project (CAR) (2003 to 2014) was consulted to get an overview of the densities of large terrestrial species in the Eastern Karoo (http://car.adu.org.za/) (Appendix 3).

- The avifaunal specialist study and pre-construction monitoring report of the Mainstream Noupoort WEF (Van Rooyen 2012, Van Rooyen *et al.* 2013), and the avifaunal specialist study for the Umsobomvu WEF (Smallie 2015)), and the bird specialist study for the Noupoort CSP project (Van Niekerk 2016) were consulted for further background information on the avifaunal diversity and abundance in the greater study area.

4. ASSUMPTIONS & LIMITATIONS

The following assumptions and limitations are applicable to this study:

- A total of 68 full protocol lists have been completed to date for the 9 pentads where the study area is located (i.e. lists surveys lasting a minimum of two hours or more each). This is a comprehensive dataset which provides a reasonably accurate snapshot of the avifauna which could occur in the study area. For purposes of completeness, the list of species that could be encountered was supplemented with personal observations, general knowledge of the area, SABAP1 records (Harrison *et al.* 1997), and data from the pre-construction monitoring.
- Conclusions in this study are based on experience of these and similar species in different parts of South Africa. Bird behaviour can never be entirely reduced to formulas that will be valid under all circumstances, especially for a relatively new field such as wind energy. However, power line and substation impacts can be predicted with a fair amount of certainty, based on a robust body of research stretching back over thirty years (see References Section 10).
- To date no peer-reviewed scientific papers are available on the impacts of wind farms on birds in South Africa. The precautionary principle was therefore applied throughout. The World Charter for Nature, which was adopted by the UN General Assembly in 1982, was the first international endorsement of the precautionary principle (http://www.unep.org). The principle was implemented in an international treaty as early as the 1987 Montreal Protocol and, among other international treaties and declarations, is reflected in the 1992 Rio Declaration on Environment and Development. Principle 15 of the 1992 Rio Declaration states that: "in order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall be not used as a reason for postponing cost-effective measures to prevent environmental degradation."
- Predicted mortality rates are often inaccurate, indicating that this is still a fledgling science in many respects, even in developed countries like Spain with an established wind industry (Ferrer *et al.* 2012). Mortality data from post-construction monitoring programmes currently implemented at wind farms in South Africa was used to assist with the priority species risk assessments (Ralston – Paton *et al.* 2017).
- Priority species were taken from the updated (2014) list of priority species for wind farms compiled for the Avian Wind Farm Sensitivity Map (Retief *et al.* 2012).
- The study area was defined as the areas which comprise the wind farm development area, control area and the proposed grid connection alternatives (see Figure 2). The development area refers only to the area where turbines are planned.

5. LEGISLATIVE CONTEXT

5.1 Agreements and conventions

Table 5-1 below lists agreements and conventions which South Africa is party to and which is relevant to the conservation of avifauna (BirdLife International (2016) Country profile: South Africa. Available from: http://www.birdlife.org/datazone/country/south_africa. Checked: 2016-04-02).

Table 5-1: Agreements and conventions which South Africa is party to and which is relevant to the conservation of avifauna

Convention name	Description	Geographic scope
African-Eurasian Waterbird Agreement (AEWA)	The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) is an intergovernmental treaty dedicated to the conservation of migratory waterbirds and their habitats across Africa, Europe, the Middle East, Central Asia, Greenland and the Canadian Archipelago. Developed under the framework of the Convention on Migratory Species (CMS) and administered by the United Nations Environment Programme (UNEP), AEWA brings together countries and the wider international conservation community in an effort to establish coordinated conservation and management of migratory waterbirds throughout their entire migratory range.	Regional
Convention on Biological Diversity (CBD), Nairobi, 1992	The Convention on Biological Diversity (CBD) entered into force on 29 December 1993. It has 3 main objectives: The conservation of biological diversity The sustainable use of the components of biological diversity The fair and equitable sharing of the benefits arising out of the utilization of genetic resources.	Global
Convention on the Conservation of Migratory Species of Wild Animals, (CMS), Bonn, 1979	As an environmental treaty under the aegis of the United Nations Environment Programme, CMS provides a global platform for the conservation and sustainable use of migratory animals and their habitats. CMS brings together the States through which migratory animals pass, the Range States, and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range.	Global
Convention on the International Trade in Endangered Species of Wild Flora and Fauna, (CITES), Washington DC, 1973	CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments. Its aim is to ensure that international trade in	Global

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

5.2 Best Practice Guidelines

The South African *"Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa" (*Jenkins, A.R., Van Rooyen, C.S., Smallie, J.J., Anderson, M.D., & A.H. Smit. 2011) are followed for this study. This document was published by the Endangered Wildlife Trust (EWT) and Birdlife South Africa (BLSA) in March 2011, and subsequently revised in 2011, 2012 and 2015[1].

6. DESCRIPTION OF AFFECTED ENVIRONMENT

6.1 Important Bird Areas

At its closest point, the proposed site is situated approximately 4km south of the town of Noupoort, in the Northern Cape Province. The study area is not located in an Important Bird Area. The border of the closest Important Bird Area (IBA), the Platberg Karoo Conservancy IBA SA037, is located approximately 20km away from the centre of the proposed development wind energy site (Marnewick *et al.* 2015).

[1] [1] The BirdLife SA Verreaux's Eagle guidelines for wind farm developments (Ralston-Patton 2017) were released in May 2017, after the completion of the monitoring. However, these guidelines were considered in the delineation of buffer zones.

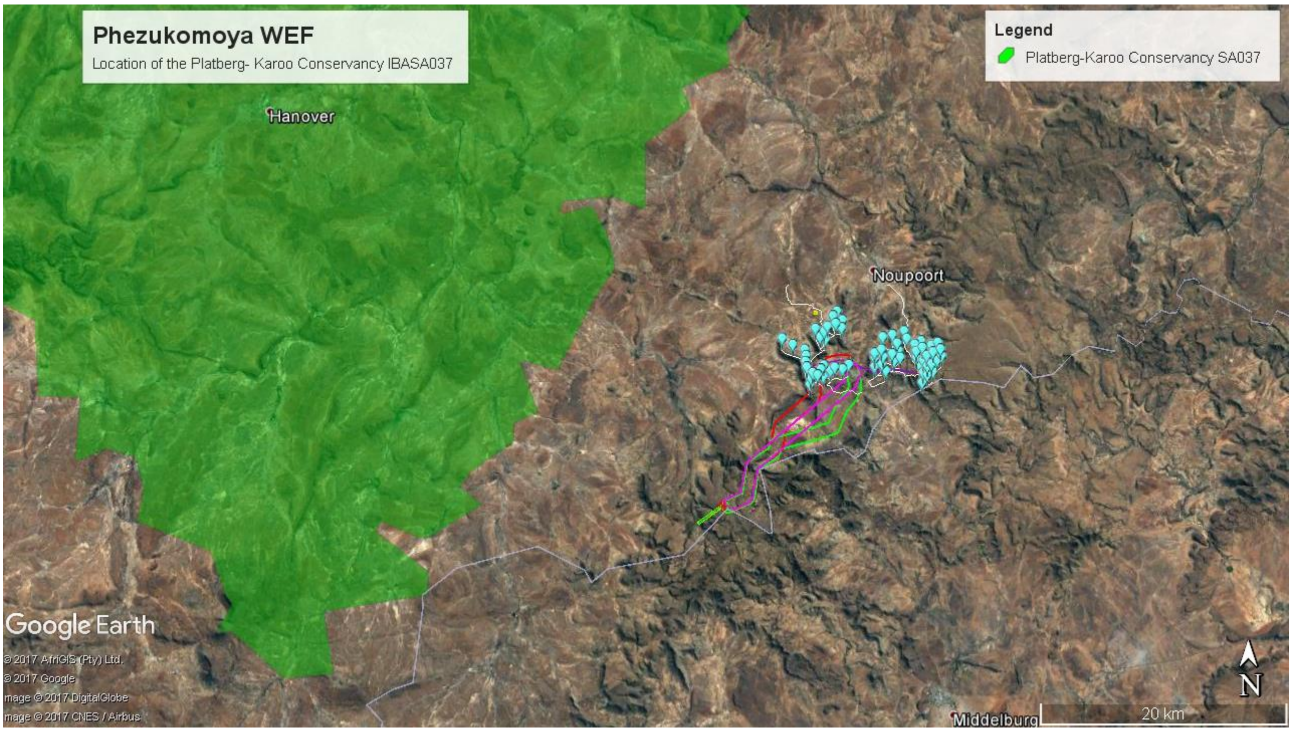

Figure 3: The study area in relation to the Platberg Karoo Conservancy IBA SA037 (green area)

6.2 Biomes and vegetation types

The proposed wind development areas are situated on a plateau, bordered by an escarpment consisting of steep, boulder-strewn slopes, exposed rocky ridges and low cliffs on all sides except to the east. Two vegetation types are found in the wind development area, namely Karoo Escarpment Grassland on the plateau, and Tarkastad Montane Shrubland on the slopes (Mucina & Rutherford 2006). Karoo Escarpment Grassland is characterised by wiry, tussock grass and low shrubs. Tarkastad Montane Grassland occurs on hills, ridges and isolated mountain slopes and is characterised by high surface rock cover, this often consisting of large, round boulders. The vegetation is low, semi-open mixed shrubland with "white" grasses and dwarf shrubs forming a prominent component of the vegetation.

The various grid connection alternatives run in a south-westerly direction from the wind development area on the plateau down the escarpment through plains country, with the last section crossing broken country consisting of steep slopes, mountain ridges and koppies. On the plains below the escarpment the vegetation type is classified as Eastern Upper Karoo which is dominated by dwarf mycrophyllus shrubs, with white grasses of the genera *Aristida* and *Eragrostis*. On the steep slopes, mountain ridges and koppies, Besemkaree Koppies Shrubland is found which is characterised by both tall and dwarf small leaved shrubs and abundant grasses, especially in precipitation-rich years (Mucina & Rutherford 2006).

Rainfall in Noupoort happens mostly between November and April and averages about 400mm per year, which makes for a fairly arid climate[2]. Winters are very dry.

[2] http://www.worldweatheronline.com/noupoort-weather-averages/northern-cape/za.aspx.

6.3 Habitat classes and avifauna in the study area

SABAP1 recognises six primary vegetation divisions within South Africa, namely (1) Fynbos (2) Succulent Karoo (3) Nama Karoo (4) Grassland (5) Savanna and (6) Forest (Harrison *et al.* 1997). The criteria used by the authors to amalgamate botanically defined vegetation units, or to keep them separate were (1) the existence of clear differences in vegetation structure, likely to be relevant to birds, and (2) the results of published community studies on bird/vegetation associations. It is important to note that no new vegetation unit boundaries were created, with use being made only of previously published data. All the natural vegetation types in the study area can be collectively classified as Grassy Karoo, which can be described is an ecological transition zone between the Grassland and Nama Karoo biomes.

Whilst much of the distribution and abundance of the bird species in the study area can be explained by the description of the biomes and vegetation types above, it is as important to examine the modifications which have changed the natural landscape, and which may have an effect on the distribution of avifauna. These are sometimes evident at a much smaller spatial scale than the biome or vegetation types, and are determined by a host of factors such as topography, land use and man-made infrastructure.

The bird habitat classes that were identified in the study area, is discussed below. See also Appendix 4 for a photographic record of the habitat in the study area.

6.3.1 Grassy Karoo

This habitat class is described above under 6.3. The Karoo vegetation types support a particularly high diversity of bird species endemic to Southern Africa, particularly in the family *Alaudidae* (Larks) (Harrison *et al.* 1997). Its avifauna typically comprises ground-dwelling species of open habitats. Many typical karroid species are nomads, able to use resources that are patchy in time and space, especially enhanced conditions associated with rainfall (Barnes 1998).

Priority species associated with Grassy Karoo which could potentially occur in the study area are the nomadic Ludwig's Bustard, which may occur in flocks following rainfall events, Karoo Korhaan, Blue Korhaan, Blue Crane, Booted Eagle, Martial Eagle, Steppe Buzzard, Southern Pale Chanting Goshawk, Northern Black Korhaan, Grey-winged Francolin, Greater Kestrel, Lesser Kestrel, Amur Falcon, Spotted Eagle-Owl, Melodious Lark, Black Harrier, Black-shouldered Kite, White Stork and Lanner Falcon. Secretarybird, Jackal Buzzard, Black Harrier and Verreaux's Eagle could occur irregularly in this habitat class (see Table 7-1 below for a complete list of priority species which could potentially occur at the site). CAR counts between 2003 and 2014 indicate particular high densities of Blue Crane, Northern Black Korhaan and White Stork in this habitat in the eastern Karoo (see Appendix 3).

6.3.2 Waterbodies

Surface water is of specific importance to avifauna in this semi-arid study area. The study area contains several man-made dams.

There are no large man-made dams or pans at the wind development site itself. There are however several large farm dams in the greater study area. These dams, when filled with water, serve as focal points for water birds and can potentially act as roosting areas for Blue Cranes and possibly Greater Flamingo.

6.3.3 Trees

The proposed wind development area is devoid of trees. In the greater study area, isolated stands of alien trees are found at farmyards, dams and inside the town of Noupoort, consisting mostly of *Eucalyptus*, *Salix* and *Salicaceae* species. Priority species that could potentially use the trees for nesting and roosting are Black Sparrowhawk, Rufous-chested Sparrowhawk, Lesser Kestrel (there is a confirmed roost in the town of Noupoort), Black-shouldered Kite, Jackal Buzzard, Steppe Buzzard, Martial Eagle, Verreaux's Eagle, Amur Falcon, Spotted Eagle-Owl and White Stork.

6.3.4 High voltage lines and telephone lines

High voltage lines are an important potential roosting and breeding substrate for large raptors in the - study area (Jenkins *et al.* 2006). There are no existing high voltage lines crossing the actual wind development area, but there are two high voltage lines running through the centre of the study area along the N9 motorway, and also in the extreme south-west of the study area. There is an abandoned Martial Eagle nest on a power line approximately 16km south of the wind development area. There are also a multitude of smaller reticulation lines and telephone lines which are used as perches by priority species such as Lesser Kestrel, Amur Falcon, Jackal Buzzard, Steppe Buzzard and Southern Pale Chanting Goshawks in the largely treeless environment.

6.3.5 Agriculture

There are a few agricultural lands in the study area where lucerne is cultivated as fodder for livestock. Priority species which could be attracted to these fields are White Stork, Ludwig's Bustard, Blue Crane, Amur Falcon, Steppe Buzzard and Lesser Kestrel.

6.3.6 Slopes and cliffs

The wind development area is situated on a plateau, bordered by an escarpment consisting of steep boulder-strewn slopes with exposed rocky ridges and low cliffs on all sides except to the east. In the extreme south-west of the study area some of the proposed powerline alternatives cross broken country consisting of similar steep slopes, mountain ridges, low cliffs and koppies.

Priority species that could be attracted to slopes and cliffs habitat are Verreaux's Eagle, Booted Eagle, Jackal Buzzard, Cape Eagle-Owl, Lanner Falcon and African Rock-Pipit.

7. AVIFAUNA

An estimated 184 species could potentially occur in the study area. Of the 184 species that could occur at the site, 32 are classified as priority species for wind farm developments (Retief *et al.* 2012).

Tables 7-1 lists <u>priority</u> species[3] that could potentially occur in the study area. The list is based on a combination of the pre-construction monitoring that was conducted (see Appendix 3), supplemented with other data sources

[3] Priority species were identified from the updated list (2014) of priority species for wind farms compiled for the Avian Wind Farm Sensitivity Map (Retief et al. 2012).

e.g. SABAP1, SABAP2 and environmental impact assessment and 12-months monitoring conducted for the neighbouring Mainstream Noupoort Wind Farm.

Table 7-2 lists all species that were recorded through pre-construction monitoring in the development area, while Table 7-3 lists the way in which a specific priority species was recorded. Data was collected by means of drive transect and walk transects, vantage point (VP) watches, focal point counts and incidental sightings.

See Appendix 2 for a summary of the methodology employed in the pre-construction programme.

Table 7-1: Priority species potentially occurring in the study area.

Family name	Taxonomic name	Priority species	Global status	Regional status	Endemic status South Africa	Endemic status Southern Africa	SABAP2 reporting rate	Recorded during pre-construction monitoring	Potential impacts			
									Collisions with associated power line	**Collisions with turbines**	**Displacement through disturbance**	**Displacement through habitat transformation**
Bustard, Ludwig's	*Neotis ludwigii*	*x*	EN	EN		Near-endemic	4.41	x	x	x	x*	x
Buzzard, Jackal	*Buteo rufofuscus*	*x*			Near endemic	Endemic	34.62	x		x		
Crane, Blue	*Anthropoides paradiseus*	*x*	VU	NT		Endemic	42.65	x	x	x	x*	
Eagle, Booted	*Hieraaetus pennatus*	*x*					20.59	x		x		
Eagle, Martial	*Polemaetus bellicosus*	*x*	VU	EN			2.94	x		x		
Eagle, Verreaux's	*Aquila verreauxii*	*x*	LC	VU			16.18	x		x		
Francolin, Grey-winged	*Scleroptila afra*	*x*			Endemic (SA, Lesotho, Swaziland)	Endemic	30.88	x		x	x*	
Goshawk, Southern Pale Chanting	*Melierax canorus*	*x*				Near-endemic	23.53			x		
Kestrel, Greater	*Falco rupicoloides*	*x*					2.94			x		
Kestrel, Lesser	*Falco naumanni*	*x*					35.29	x		x		
Kestrel, Rock	*Falco rupicolus*	*x*					38.24	x		x		
Lark, Melodious	*Mirafra cheniana*	*x*	NT	LC	Near endemic	Endemic	2.94			x	x*	
Pipit, African Rock	*Anthus crenatus*	*x*	LC	NT	Endemic (SA,	Endemic	39.71	x		x	x*	x

Family name	Taxonomic name	Priority species	Global status	Regional status	Endemic status South Africa	Endemic status Southern Africa	SABAP2 reporting rate	Recorded during pre-construction monitoring	Potential impacts			
									Collisions with associated power line	Collisions with turbines	Displacement through disturbance	Displacement through habitat transformation
					Lesotho, Swaziland)							
Sparrowhawk, Rufous-chested	*Accipiter rufiventris*	*x*					1.47					
Buzzard, Steppe	*Buteo buteo*	*x*					14.71			x		
Eagle, Tawny	*Aquila rapax*	*x*	LC	EN			1.47			x		
Eagle, African Fish	*Haliaeetus vocifer*	*x*					0	x	x	x		
Eagle-owl, Cape	*Bubo capensis*	*x*					1.47	x		x		
Eagle-owl, Spotted	*Bubo africanus*	*x*					5.88			x		
Falcon, Amur	*Falco amurensis*	*x*					7.35			x		
Falcon, Lanner	*Falco biarmicus*	*x*	LC	VU			2.94			x		
Flamingo, Greater	*Phoenicopterus roseus*	*x*	LC	NT			1.47		x			
Harrier, Black	*Circus maurus*	*x*	VU	EN	Near endemic	Endemic	0			x		
Hawk, African Harrier-	*Polyboroides typus*	*x*					1.47	x		x		
Kite, Black-shouldered	*Elanus caeruleus*	*x*					13.24			x		
Korhaan, Blue	*Eupodotis caerulescens*	*x*	NT	LC	Endemic (SA, Lesotho, Swaziland)	Endemic	10.29	x	x	x	x*	x

Family name	Taxonomic name	Priority species	Global status	Regional status	Endemic status South Africa	Endemic status Southern Africa	SABAP2 reporting rate	Recorded during pre-construction monitoring	Potential impacts			
									Collisions with associated power line	Collisions with turbines	Displacement through disturbance	Displacement through habitat transformation
Korhaan, Karoo	*Eupodotis vigorsii*	*x*	LC	NT		Endemic	1.47		x	x	x*	x
Korhaan, Northern Black	*Afrotis afraoides*	*x*				Endemic	33.82	x	x	x	x*	x
Secretarybird	*Sagittarius serpentarius*	*x*	VU	VU			0		x	x	x*	
Sparrowhawk, Black	*Accipiter melanoleucus*	*x*					1.47					
Stork, Black	*Ciconia nigra*	*x*	LC	VU			2.94		x	x		
Stork, White	*Ciconia ciconia*	*x*					5.88		x	x	x*	

* This is likely to be a temporary impact during the construction phase.

7.1 Transect counts in the development area

See Appendix 2 for a detailed breakdown of the data capture methodology employed in the pre-construction programme, including the number of transects, vantage points and focal points.

The drive transect was surveyed three times per seasonal survey. A total of 597 individual birds were recorded during drive transect counts at the proposed development area, of which 22 were priority species and 586 were non-priority species, belonging to 50 species (3 priority species and 47 non-priority species). At the control area, a total of 921 birds were recorded during drive transect counts, of which 108 were priority species and 867 non-priority species, belonging to 53 species (5 priority species and 48 non-priority species).

The walk transects were counted 48 times, i.e. 12 times per season. A total of 4 661 individual birds were recorded at the proposed development area, of which 138 were priority species and 4 592 non-priority species, belonging to 66 species (5 priority species and 61 non-priority species). At the control area, a total of 1 001 birds were recorded, of which 8 were priority species and 997 non-priority species, belonging to 46 species (3 priority species and 43 non-priority species).

An Index of Kilometric Abundance (IKA = birds/km) was calculated for each priority species, and also for all priority species combined recorded during transect counts. Figures 4 and 5 show the relative abundance of priority species recorded during the pre-construction monitoring through drive and walk transect counts. The IKA for all birds recorded in the development area during drive transect counts was 6.91 birds/km, and 16.18 for walk transect counts. At the control site, the IKA for all birds recorded during drive transect counts was 4.36 birds/km and 1.69 birds/km for walk transects.

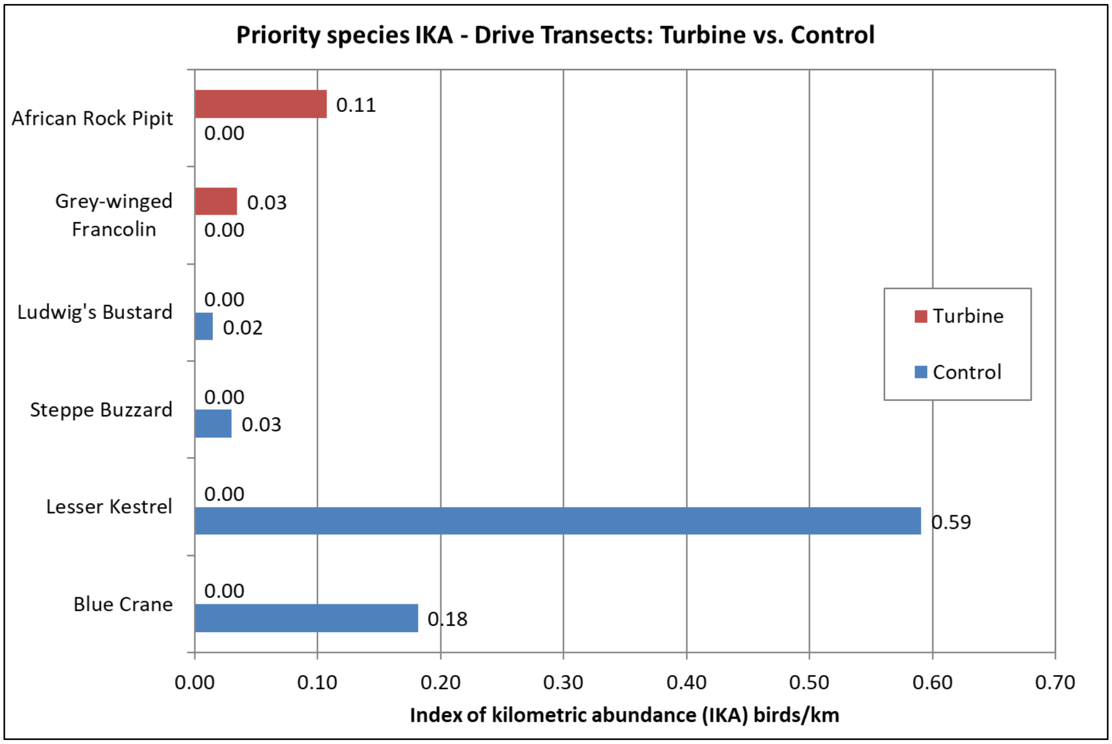

Figure 4: Priority species recorded in the study area and control area through drive transect counts

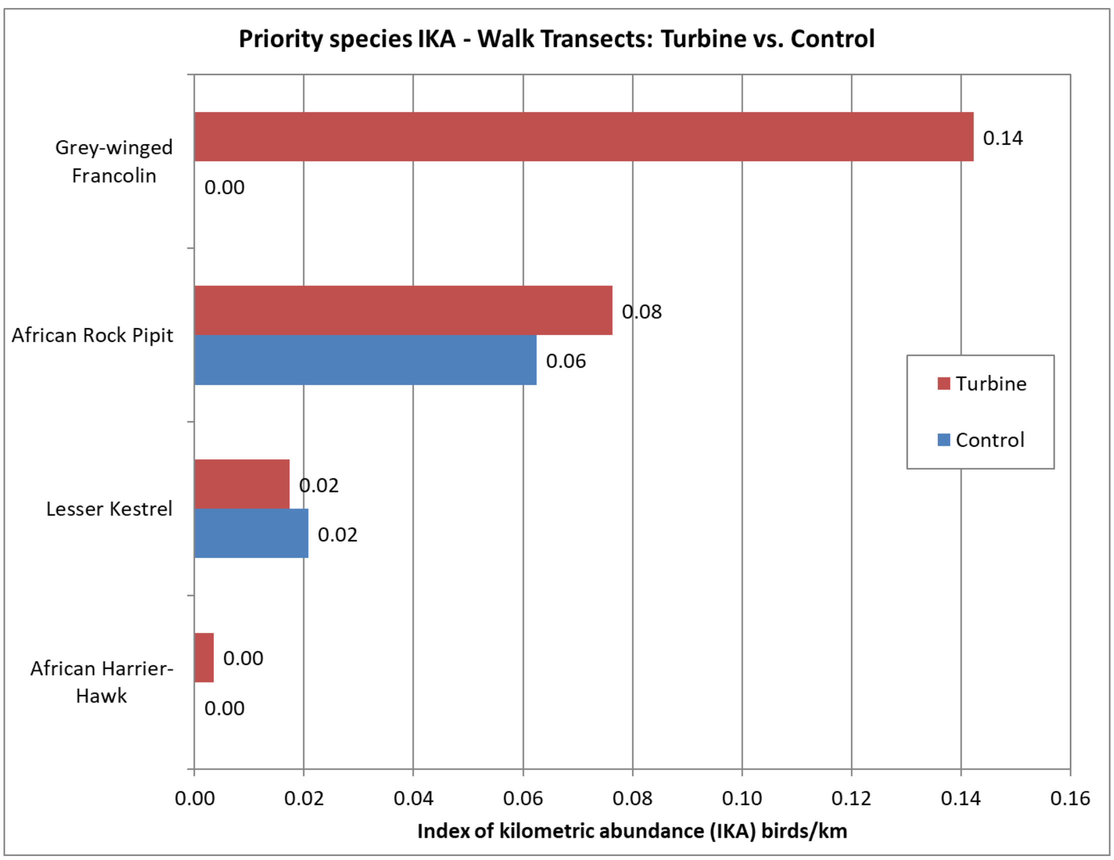

Figure 5: Priority species recorded in the study area and control area through walk transect counts

7.2 Overall species composition

The results of the transect counts indicate a moderate diversity of avifauna at both the development area and the control site, which is to be expected of an arid area such as this.

7.3 Abundance

The overall abundance of priority species at the development area is low, with 0.13 birds/km recorded during drive transect counts, and 0.24 birds/km during walk transect counts. Grey-winged Francolin and African Rock Pipit were the two priority species most often recorded at the development area, which reflects the mountainous character of the site. The difference in overall numbers between the development area and the control site is likely to be a function of effort rather than inherent differences in habitat, as less time was spent in the control area than in the development area.

7.4 Spatial distribution of transect records and incidental sightings in the development area

Figure 6 below indicates the spatial distribution of priority species recorded during transect counts and incidental sightings.

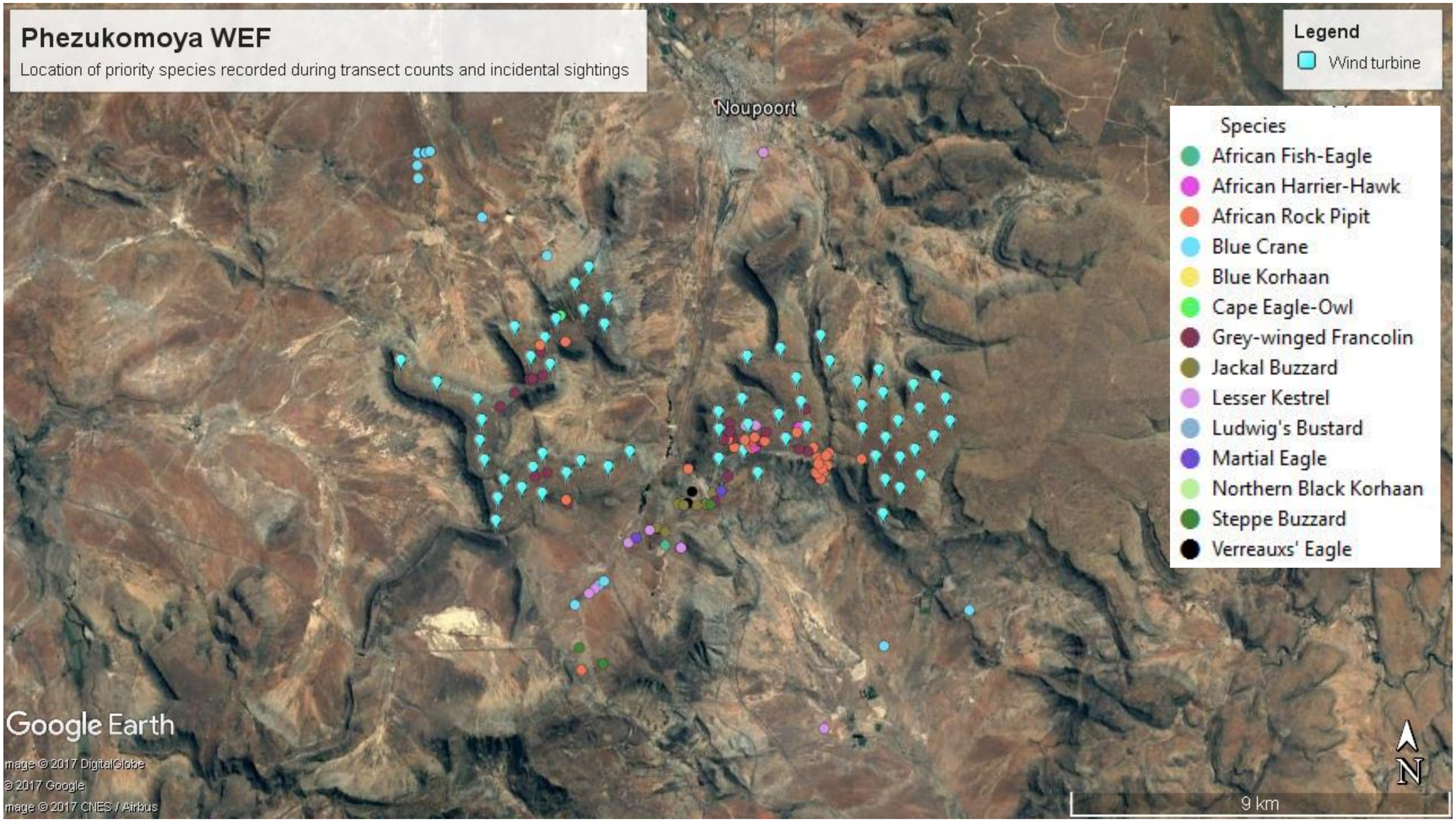

Figure 6: Spatial distribution of sightings of priority species recorded during transect counts and point counts (includes incidental sightings).

Table 7-2 lists all the species recorded during the pre-construction surveys and incidental counts. Table 4-3 lists the manner in which the priority species were recorded.

Table 7-2: List of all species recorded during pre-construction surveys and incidental counts in the development area.

Priority Species	
African Fish-Eagle	*Haliaeetus vocifer*
African Harrier-Hawk	*Polyboroides typus*
African Rock Pipit	*Anthus crenatus*
Blue Crane	*Anthropoides paradiseus*
Blue Korhaan	*Eupodotis caerulescens*
Booted Eagle	*Aquila pennatus*
Cape Eagle-Owl	*Bubo capensis*
Grey-winged Francolin	*Scleroptila africanus*
Ground Woodpecker	*Geocolaptes olivaceus*
Jackal Buzzard	*Buteo rufofuscus*
Lesser Kestrel	*Falco naumanni*
Ludwig's Bustard	*Neotis ludwigii*
Martial Eagle	*Polemaetus bellicosus*
Northern Black Korhaan	*Afrotis afraoides*
Rock Kestrel	*Falco rupicolus*
Steppe Buzzard	*Buteo vulpinus*
Verreaux's Eagle	*Aquila verreauxii*
Total: 17	
Non-Priority Species	
African Pipit	*Anthus cinnamomeus*
African Quailfinch	*Ortygospiza atricollis*
African Red-eyed Bulbul	*Pycnonotus nigricans*
African Stonechat	*Saxicola torquatus*
Alpine Swift	*Tachymarptis melba*
Anteating Chat	*Myrmecocichla formicivora*
Barn Swallow	*Hirundo rustica*
Black-headed Canary	*Serinus alario*
Blacksmith Lapwing	*Vanellus armatus*
Black-throated Canary	*Crithagra atrogularis*
Bokmakierie	*Telophorus zeylonus*
Buffy Pipit	*Anthus vaalensis*
Cape Bunting	*Emberiza capensis*
Cape Canary	*Serinus canicollis*
Cape Crow	*Corvus capensis*
Cape Longclaw	*Macronyx capensis*
Cape Penduline-Tit	*Anthoscopus minutus*
Cape Robin-chat	*Cossypha caffra*
Cape Rock-Thrush	*Monticola rupestris*
Cape Sparrow	*Passer melanurus*
Cape Turtle-dove	*Streptopelia capicola*

Cape Wagtail	*Motacilla capensis*
Chat Flycatcher	*Bradornis infuscatus*
Common Fiscal	*Lanius collaris*
Common Swift	*Apus apus*
Desert Cisticola	*Cisticola aridulus*
Eastern Clapper Lark	*Mirafra [apiata] fasciolata*
Eastern Long-billed Lark	*Certhilauda semitorquata*
Egyptian Goose	*Alopochen aegyptiaca*
Familiar Chat	*Cercomela familiaris*
Greater Striped Swallow	*Hirundo cucullata*
Grey-backed Cisticola	*Cisticola subruficapilla*
Ground Woodpecker	*Geocolaptes olivaceus*
Hadeda Ibis	*Bostrychia hagedash*
Helmeted Guineafowl	*Numida meleagris*
Karoo Prinia	*Prinia maculosa*
Karoo Scrub-robin	*Cercotrichas coryphoeus*
Large-billed Lark	*Galerida magnirostris*
Lark-like Bunting	*Emberiza impetuani*
Layard's Tit-babbler	*Parisoma layardi*
Little Swift	*Apus affinis*
Long-billed Crombec	*Sylvietta rufescens*
Long-billed Pipit	*Anthus similis*
Malachite Sunbird	*Nectarinia famosa*
Mountain Wheatear	*Oenanthe monticola*
Namaqua Sandgrouse	*Pterocles namaqua*
Neddicky	*Cisticola fulvicapilla*
Pale-winged Starling	*Onychognathus nabouroup*
Pied Crow	*Corvus albus*
Pied Starling	*Spreo bicolor*
Plain-backed Pipit	*Anthus leucophrys*
Pririt Batis	*Batis pririt*
Red-faced Mousebird	*Urocolius indicus*
Red-winged Starling	*Onychognathus morio*
Rock Kestrel	*Falco rupicolus*
Rock Martin	*Hirundo fuligula*
Rufous-eared Warbler	*Malcorus pectoralis*
Short-toed Rock-Thrush	*Monticola brevipes*
Sickle-winged Chat	*Cercomela sinuata*
South African Shelduck	*Tadorna cana*
Southern Masked-weaver	*Ploceus velatus*
Southern Red Bishop	*Euplectes orix*
Speckled Pigeon	*Columba guinea*
Spike-heeled Lark	*Chersomanes albofasciata*
Spur-winged Goose	*Plectropterus gambensis*
Steppe Buzzard	*Buteo vulpinus*

White-necked Raven	*Corvus albicollis*
White-rumped Swift	*Apus caffer*
White-throated Canary	*Crithagra albogularis*
Wing-snapping Cisticola	*Cisticola ayresii*
Yellow canary	*Crithagra flaviventris*
Yellow-bellied Eremomela	*Eremomela icteropygialis*
Yellow-billed Duck	*Anas undulata*
Zitting Cisticola	*Cisticola juncidis*
Total: 74	

Table 7-3: The manner in which priority species were recorded.

Priority Species	Scientific Name	Turbine transect	Control transect	VP	Ctrl VP	Incidental
African Fish-Eagle	*Haliaeetus vocifer*					*
African Harrier-Hawk	*Polyboroides typus*	*				*
African Rock Pipit	*Anthus crenatus*	*	*		*	*
Blue Crane	*Anthropoides paradiseus*		*	*		*
Blue Korhaan	*Eupodotis caerulescens*					*
Booted Eagle	*Aquila pennatus*				*	
Cape Eagle-Owl	*Bubo capensis*					*
Grey-winged Francolin	*Scleroptila africanus*	*		*	*	*
Ground Woodpecker	*Geocolaptes olivaceus*					*
Jackal Buzzard	*Buteo rufofuscus*			*	*	*
Lesser Kestrel	*Falco naumanni*	*	*	*		*
Ludwig's Bustard	*Neotis ludwigii*		*			*
Martial Eagle	*Polemaetus bellicosus*					*
Northern Black Korhaan	*Afrotis afraoides*					*
Rock Kestrel	*Falco rupicolus*					*
Steppe Buzzard	*Buteo vulpinus*			*		*
Verreaux's Eagle	*Aquila verreauxii*			*	*	*
17		4	4	6	5	16

7.5 Vantage point watches

Six priority species were recorded during vantage point (VP) watches in the proposed development area. A total of 288 hours of vantage point watches (12 hours per sampling period per vantage point) was completed at 6 VPs in order to record flight patterns of priority species. In the four sampling periods, priority species were recorded flying over development areas for a total of 3 hours, 3 minutes and 15 seconds. A total of 85 individual flights were recorded. Of these, 23 (27%) flights were at high altitude (>220m), 30 (35.2%) were at medium altitude (between 30m and 220m) and 32 (37.6%) were at a low altitude (<30m). The passage rate for priority species (all flight heights) was 0.26 birds/hour[4]. See Figure 7 below for the duration of flights for each priority species, at each height class[5].

For purposes of flight analyses, priority species recorded during VP watches at the site were classified in two classes (see also statistical analysis Appendix 5):

[4] For calculating the passage rate, a distinction was drawn between passages and flights. A passage may consist of several flights e.g. every time an individual bird changes height or mode of flight; this was recorded as an individual flight, although all the flights still form part of the same passage.
[5] Flight duration was calculated by multiplying the flight time with the number of individuals in the flight e.g. if the flight time was 30 seconds and it contained two individuals, the flight duration was 30 seconds x 2 = 60 seconds.

- Terrestrial species: Birds that spend most of the time foraging on the ground. They do not fly often and then generally short distances at low to medium altitude, usually powered flight. Some larger species undertake longer distance flights at higher altitudes, when commuting between foraging and roosting areas. Korhaans, bustards, some Blue Crane flights and francolins were included in this category.
- Soaring species: Species that spend a significant time on the wing in a variety of flight modes including soaring, kiting, hovering and gliding at medium to high altitudes. All the diurnal raptor species were included in this class well as some Blue Crane flights.

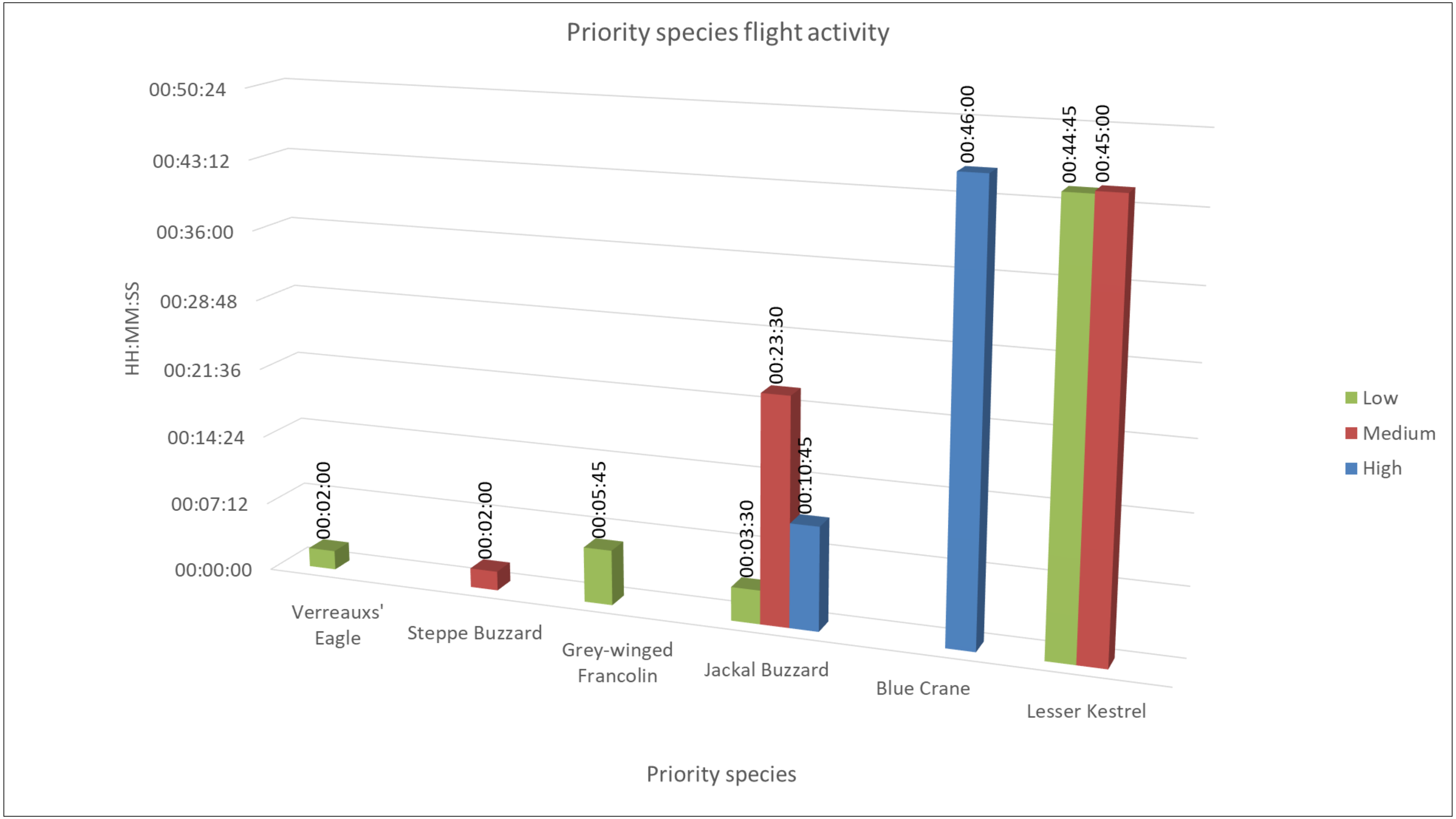

Figure 7: Flight duration and heights recorded for priority species within the development area. Duration (hours: minutes: seconds) are indicated on the bars.

7.6 Collision risk rating

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

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

This was done in order to gain some understanding of which species are likely to be most at risk of collision. The formula used is as follows[6]:

Collision risk rating = duration of medium altitude flights (decimal hours) x collision susceptibility score calculated as the sum of morphology and behaviour ratings in the Avian Wind Farm Sensitivity Map of South Africa x number of planned turbines ÷ 100.

The results are displayed in Table 7-4 and Figure 8 below.

Table 4-4: Site specific collision risk rating for all priority species recorded during VP watches in the development area.

Species	Duration of medium height flights (in decimal hour)	Collision susceptibility score	Planned number of turbines	Collision risk rating
Grey-winged Francolin	0.000	50	55	0.00
Blue Crane	0.000	80	55	0.00
Verreaux's' Eagle	0.000	110	55	0.00
Steppe Buzzard	0.001	70	55	0.05
Jackal Buzzard	0.016	95	55	0.85
Lesser Kestrel	0.031	72	55	1.24
Average	*0.008*	*79.5*	*55*	*0.36*

[6] It is important to note that the formula does not incorporate avoidance behaviour. This may differ between species and may have a significant impact on the size of the risk associated with a specific species. It is generally assumed that 95-98% of birds will successfully avoid the turbines (SNH 2010). It is also important to note that there is not necessarily a direct correlation between time spent at rotor height, and the likelihood of collision.

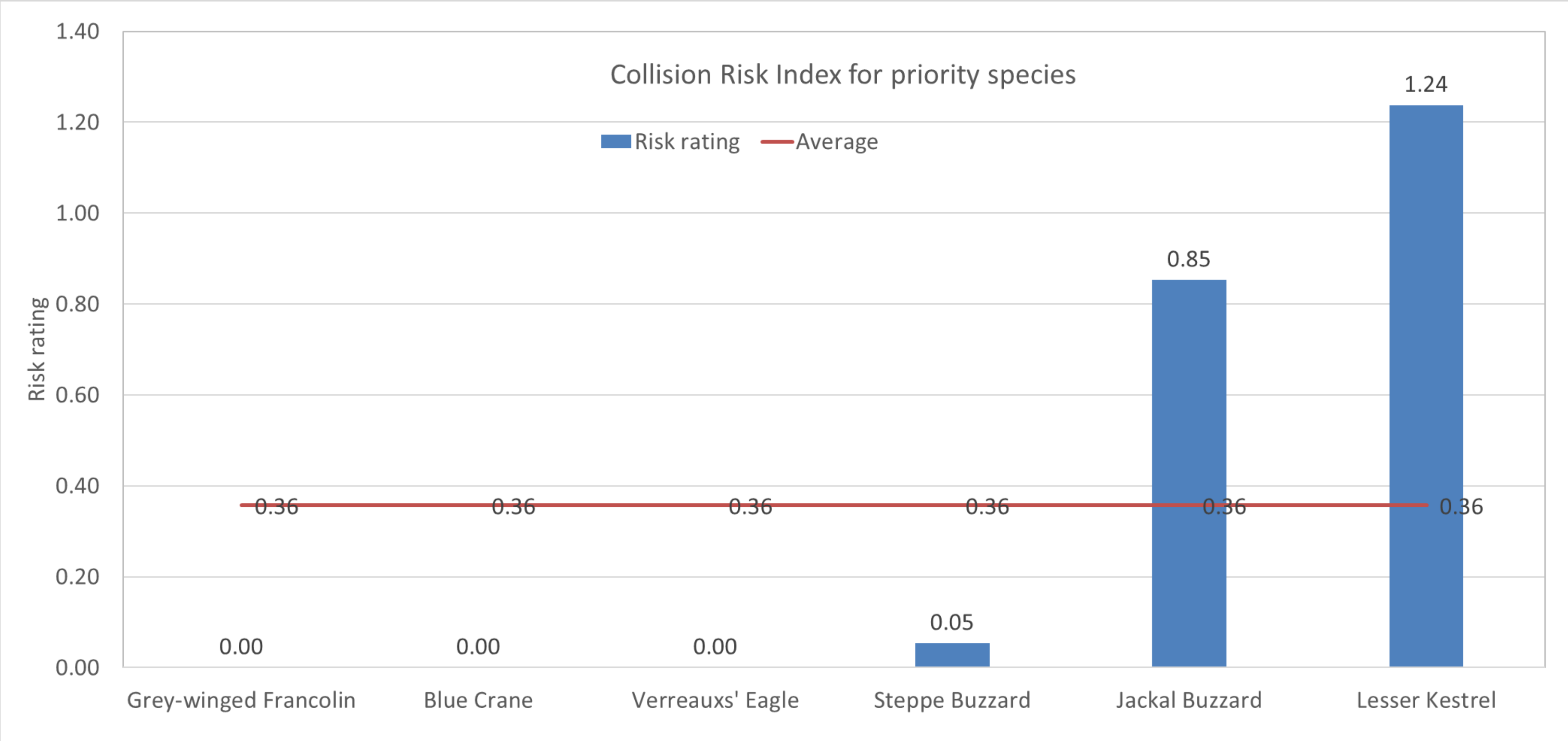

Figure 8: Site specific collision risk rating for priority species recorded in the development area.

7.7 Sample size and representativeness of flight data

The computations and the outcome of the data exhibited in the tables and graphs in the statistical analysis (Appendix 5) show that the surveys may be taken to be statistically representative of the flight activity of priority species of birds that occur in the area during the sampling periods. It has also been demonstrated that more samples would not yield a meaningful improvement in the accuracy and precision.

See Appendix 5 for a detailed explanation of the statistical methods.

7.8 Spatial distribution of flight activity

Flight maps were prepared for the two priority species with above average collision ratings, indicating the spatial distribution of flights observed from the various vantage points during the 12-month pre-construction monitoring programme (see Figures 9-11 below). This was done by overlaying a 100m x 100m grid over the survey area. Each grid cell was then given a weighting score taking into account the duration and distance of individual flight lines through a grid cell and the number of individual birds associated with each flight crossing the grid cell. It is important to interpret these maps bearing in mind the amount of time that each species spent flying over the site e.g. the “High” (flight concentration) category on the map for Lesser Kestrel is not equivalent to the “High” (flight concentration) category on the map for Jackal Buzzard, as the flight duration of flights for Lesser Kestrel is much higher than the flight duration for Jackal Buzzard (see Table 7-4).

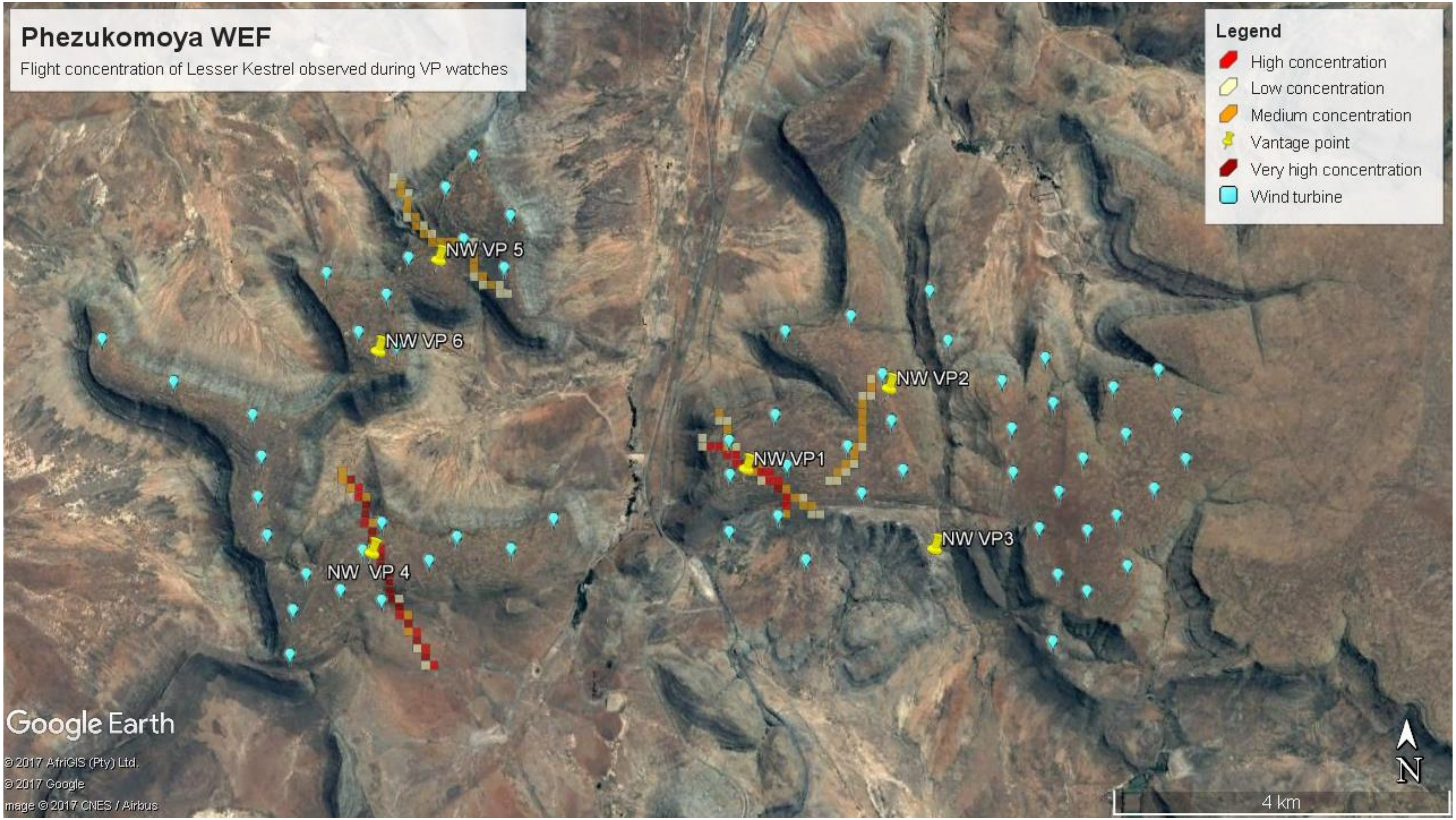

Figure 9: Spatial distribution and concentration of rotor height flights of Lesser Kestrel.

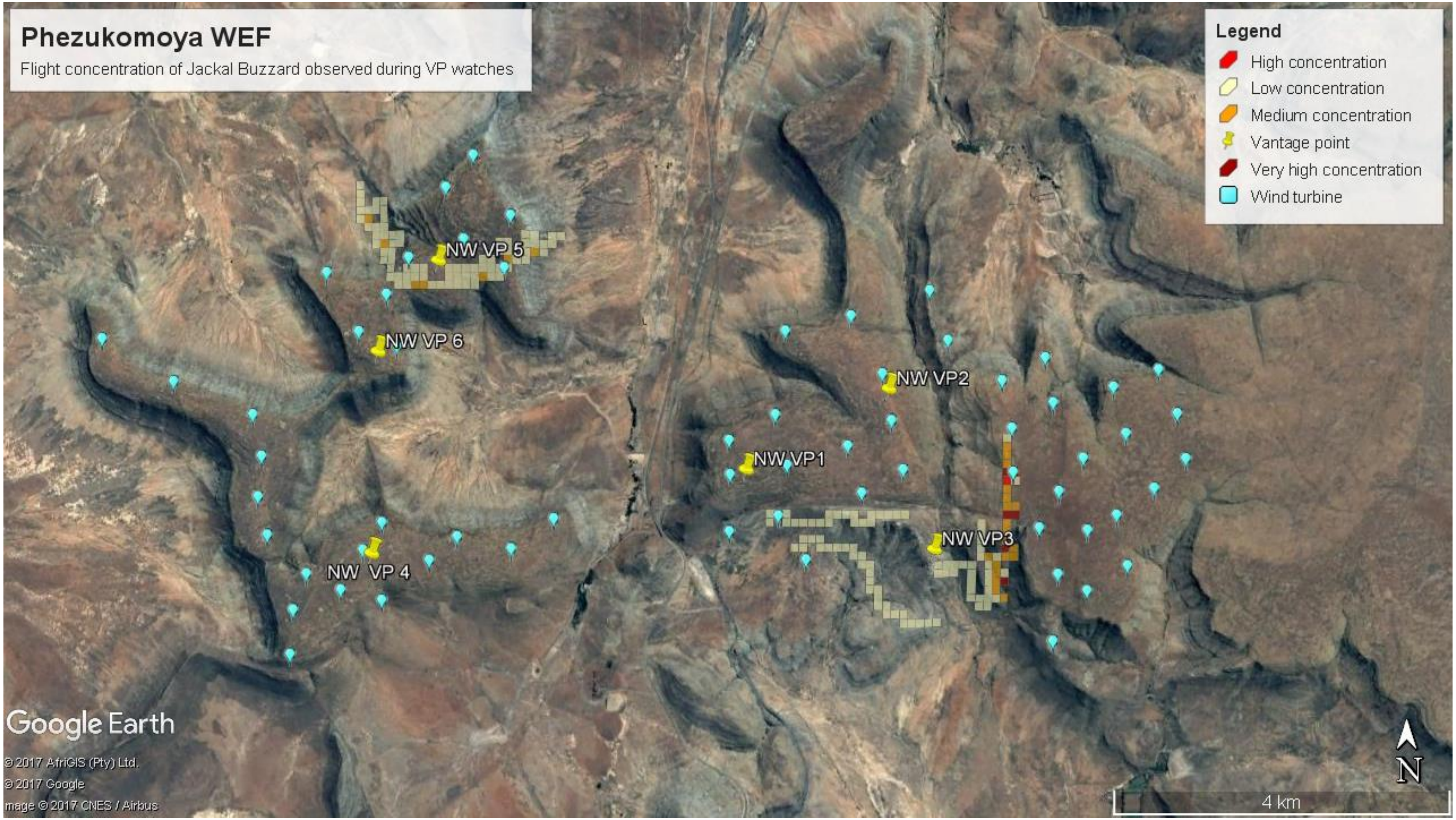

Figure 10: Spatial distribution and concentration of rotor height flights of Jackal Buzzard.

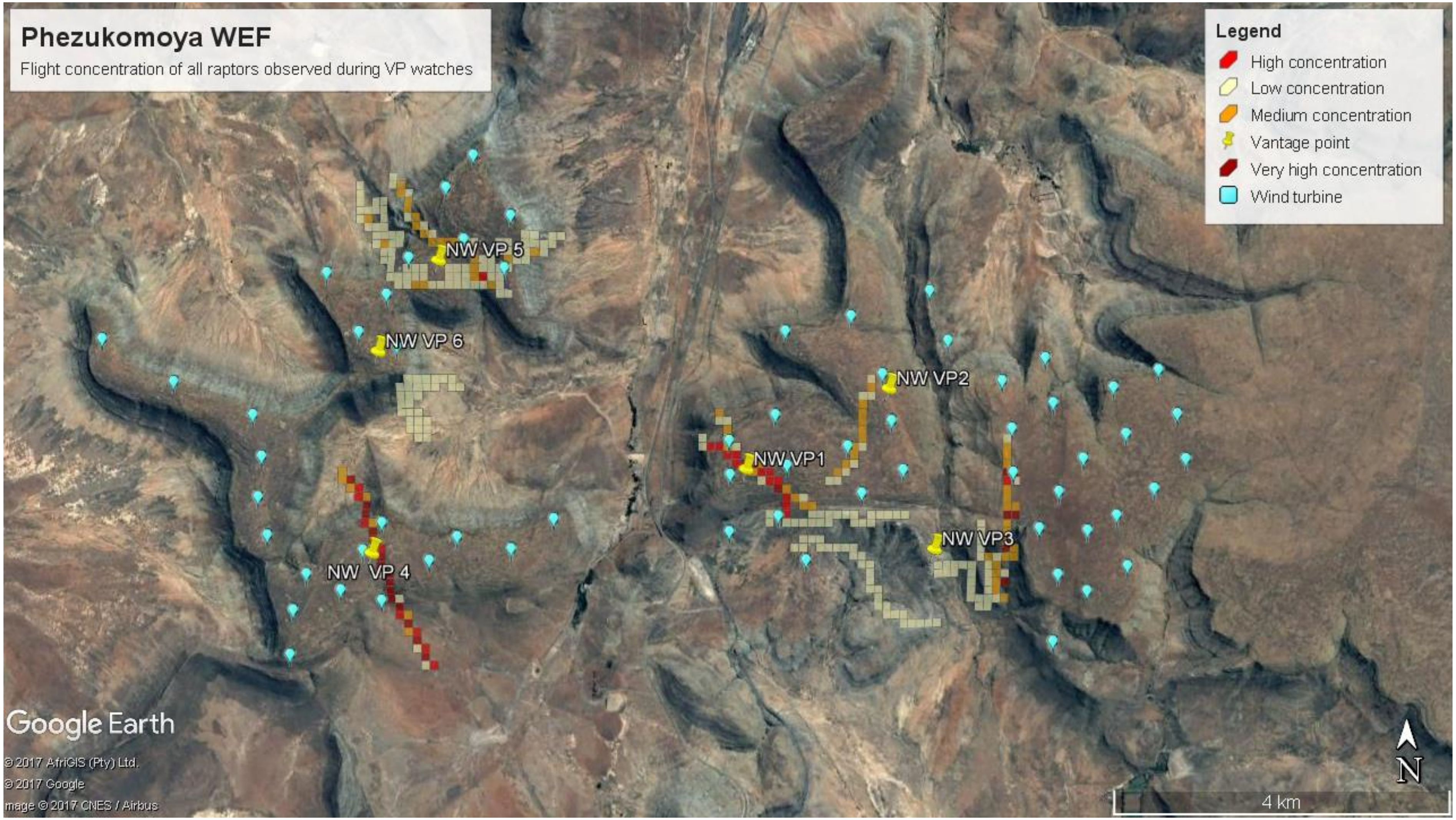

Figure 11: Spatial distribution and flight concentration of rotor height flights of all raptors.

7.9 Focal points

Three dams, FP2a, FP2b and FP5 were monitored as potential avifaunal focal points. Counts in April (autumn), August (winter) and November (spring) 2015 did not produce any priority species, only common species i.e. Yellow-billed Duck, Southern Pochard, Grey Heron, Black-winged Stilt, Red-knobbed Coot, South African Shelduck, Little Grebe and Egyptian Goose. During the summer counts in January and February 2016, all the dams were dry. However, the attractiveness of the dams is largely determined by the water levels, and it must be assumed that highly mobile species such as flamingos and cranes could potentially turn up at any large dam in the study area. The drought conditions that prevailed in 2015/16 may be partially responsible for the lack of priority species.

Figure 12 below indicates the locality of waterbodies which were monitored as focal points as part of the pre-construction monitoring.

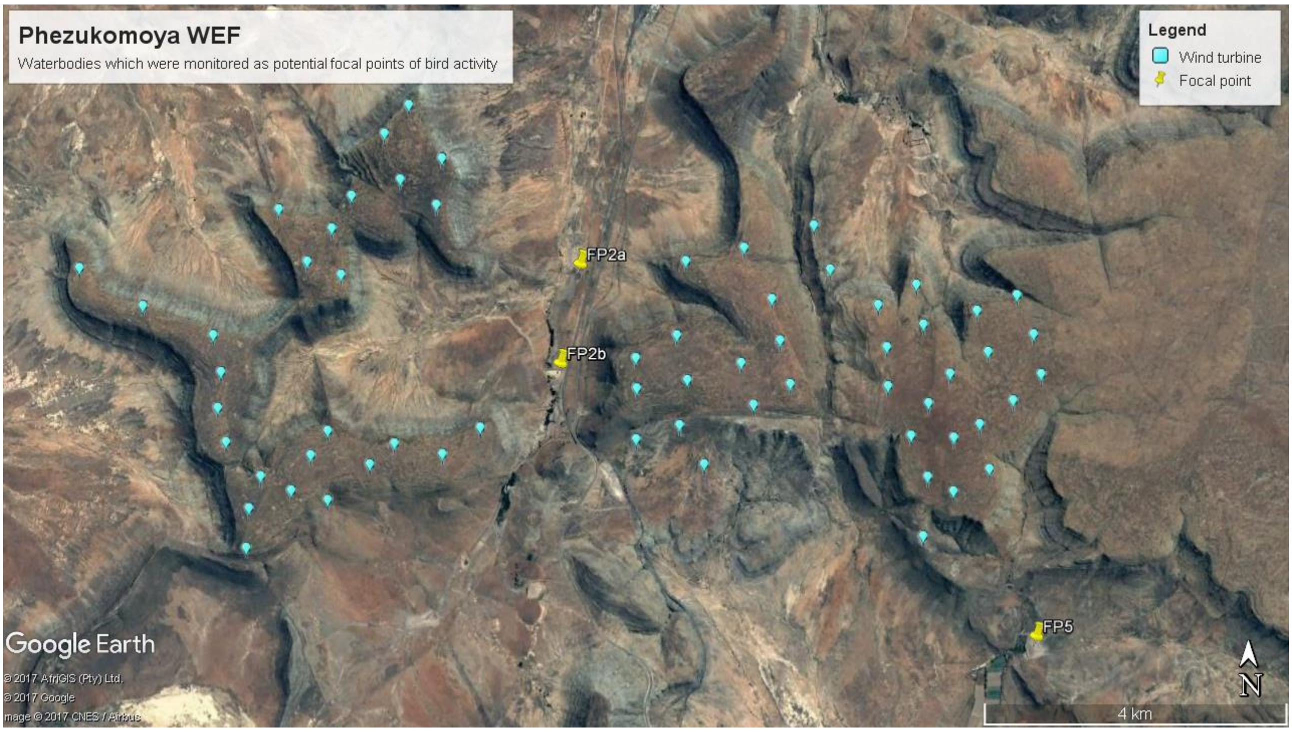

Figure 12: Waterbodies which were monitored as focal points as part of the pre-construction monitoring. FP2a, FP2b and FP5 are man-made dams.

The escarpment at the wind development site was systematically inspected with binoculars and a telescope during each site visit for signs of Lanner Falcon, Jackal Buzzard, Booted Eagle and Verreaux's Eagle breeding activity, but none were found. The reason for that is most likely that the cliffs are too low and not vertical enough to provide suitable nesting habitat.

The one exception is a Verreaux's Eagle nest located at the northern-most border of the wind development area. The nest was monitored as a focal point as part of the pre-construction monitoring. The nest was occupied with a pair of eagles recorded at the nest during the initial site visit in April 2015. The nest was subsequently monitored for four seasons. Breeding activity was recorded in June 2015, but somehow inexplicably, the pair did not breed successfully, and was not recorded at the nest again that year. An adult bird was recorded soaring near the nest in October 2015, and the nest showed signs of still being occupied (fresh droppings). The nest was subsequently inspected several times after the 12-months monitoring had come to an end, the latest inspection having been performed on 10 and 11 August 2017, but the nest was not active. The nest has now been inactive since June 2015, with the last breeding activity was observed more than two years ago. While it cannot be assumed yet that the territory has been abandoned, it seems increasingly likely to be the case. The reason for that might be human disturbance, as the nest is accessible and human activity has been observed at the nest previously by the field monitors.

There are several Verreaux's Eagle nests south of the study area, but they all fall outside the immediate vicinity of the proposed WEF development area (see Figure 13)[7].

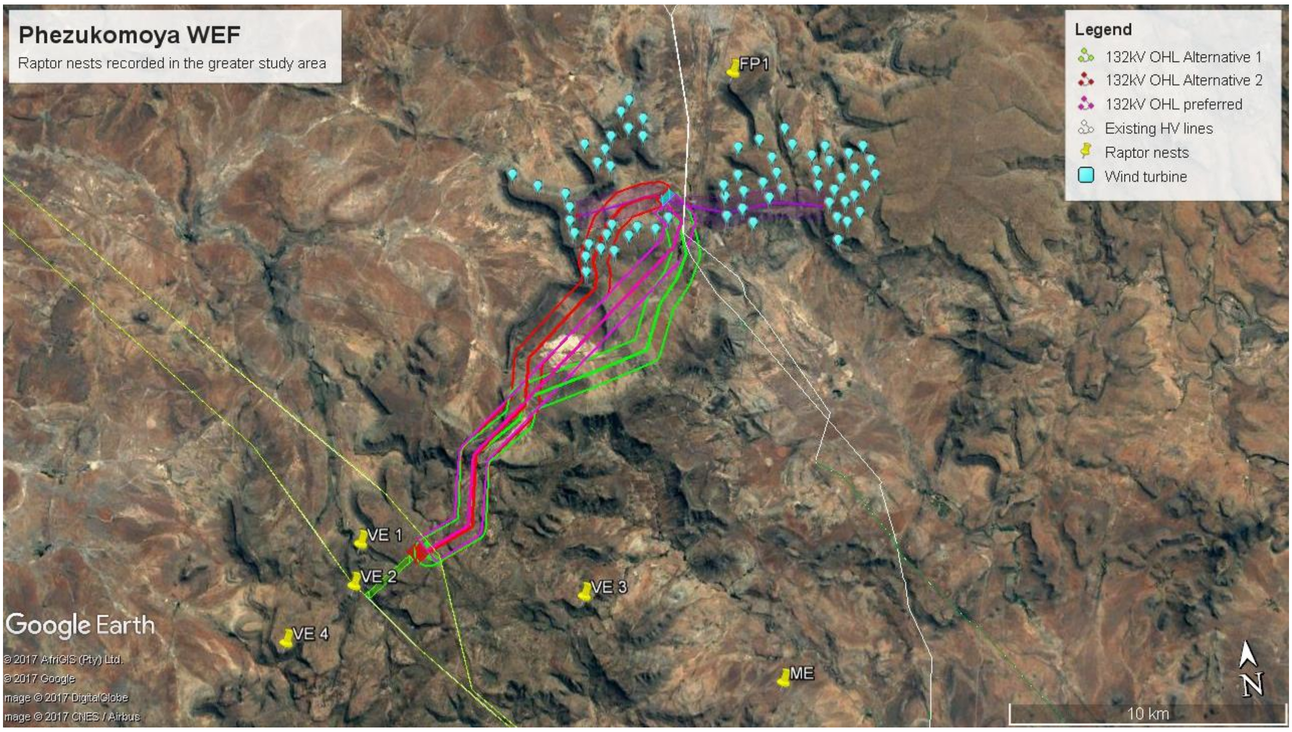

Figure 13: Verreaux's Eagle nests in the study area and immediate surrounds. FP1 was monitored as a focal point. ME is an abandoned Martial Eagle nest.

8. DESCRIPTION OF EXPECTED IMPACTS

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

- Collision mortality on the wind turbines;
- Displacement due to disturbance during construction (and dismantling) of the wind farm and associated infrastructure;
- Displacement due to habitat change and loss;
- Electrocution on the internal medium voltage powerline grid where the lines run above ground;
- Collision with the proposed power line grid connections and the internal medium voltage powerlines where the lines run above ground; and

[7] The proposed turn-ins to the 400kV MTS were not assessed as they did not form part of this EIA

- Displacement due to disturbance during the construction (and dismantling) of the power line grid connection.

It is important to note that the assessment is made on the status quo as it is currently in the study area. A possible change in land use in the broader development area is not taken into account because the extent and nature of future developments are unknown at this stage. It is however highly unlikely that the land use will change in the foreseeable future.

8.1 Collision mortality on wind turbines[8]

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

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

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

8.1.1 Species-specific factors

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

- Morphological features

Certain morphological traits of birds, especially those related to size, are known to influence collision risk with structures such as power lines and wind turbines. The most likely reason for this is that large birds often need to use thermal and orographic updrafts to gain altitude, particularly for long distance flights. Thermal updrafts (thermals) are masses of hot, rising wind that form over heated surfaces, such as plains. Being dependent on solar radiation, they occur at certain times of the year or the day. Conversely, orographic lift (slope updraft), is formed when wind is deflected by an obstacle, such as mountains, slopes or tall buildings. Soaring birds use these two types of lift to gain altitude (Duerr *et al.* 2012). Janss (2000) identified weight, wing length, tail length and total bird length as being collision risk determinant. Wing loading (ratio of body weight to wing area) and aspect ratio (ratio of wing span squared to wing area) are particularly relevant, as they influence flight type and thus collision risk (Bevanger, 1994; De Lucas *et al.* 2008; Herrera-Alsina *et al.* 2013; Janss, 2000). Birds with high wing loading, such as the Griffon Vulture (*Gyps fulvus*), seem to collide more frequently with wind turbines at the same sites than birds with lower wing loadings, such as Common Buzzards (*Buteo buteo*) and Short-toed Eagles (*Circaetus gallicus*), and this pattern is not related with their local abundance (Barrios and Rodríguez, 2004; De Lucas *et al.* 2008). High wing-loading is associated with low flight manoeuvrability (De Lucas *et al.* 2008), which determines whether a bird can escape an encountered object fast enough to avoid collision.

<u>Phezukomoya wind farm</u>
Priority species that could potentially be vulnerable to wind turbine collisions due to morphological features (high wing loading) are Northern Black Korhaan, Blue Korhaan, Karoo Korhaan, Grey-winged Francolin and Ludwig's Bustard. It is noted though that no Ludwig's Bustard mortalities have as yet been reported at wind farms in South Africa, despite initial concerns that the species might be vulnerable in this respect (Ralston - Patton *et al.* 2017). It is also noted that very little flight activity of terrestrial species was recorded during the 12-months pre-construction monitoring.

- Sensorial perception

Birds are assumed to have excellent visual acuity, but this assumption is contradicted by the large numbers of birds killed by collisions with man-made structures (Drewitt and Langston, 2008; Erickson *et al.* 2005). A common explanation is that birds collide more often with these structures in conditions of low visibility, but recent studies have shown that this is not always the case (Krijgsveld *et al.* 2009). The visual acuity of birds seems to be slightly superior to that of other vertebrates (Martin, 2011; McIsaac, 2001). Unlike humans, who have a broad horizontal binocular field of 120°, some birds have two high acuity areas that overlap in a very narrow horizontal binocular field (Martin, 2011). Relatively small frontal binocular fields have been described for several species that are particularly vulnerable to power line collisions, such as vultures (Gyps *sp.*) cranes and bustards (Martin and Katzir, 1999; Martin and Shaw, 2010; Martin, 2012, 2011; O'Rourke *et al.* 2010). Furthermore, for some species, their high resolution vision areas are often found in the lateral fields of view, rather than frontally (e.g. Martin and Shaw, 2010; Martin, 2012, 2011; O'Rourke *et al.* 2010). Finally, some birds tend to look downwards when in flight, searching for conspecifics or food, which puts the direction of flight completely inside the blind zone of some species (Martin and Shaw, 2010; Martin, 2011). For example, the visual fields of vultures (*Gyps sp.*) include extensive blind areas above, below and behind the head and enlarged supra-orbital ridges (Martin *et al.* 2012). This, combined with their tendency to angle their head toward the ground in flight, might make it difficult for them to see wind turbines ahead, which might at least partially explain their high collision rates with wind turbines (Martin, 2012).

Currently, there is little information on whether noise from wind turbines can play a role in bird collisions with wind turbines. Nevertheless, wind turbines with whistling blades are expected to experience fewer avian collisions than silent ones, with birds hearing the blades in noisy (windy) conditions. However, the hypothesis that louder blade noises (to birds) result in fewer fatalities has not been tested so far (Dooling, 2002).

Phezukomoya wind farm

Many of the priority species at the proposed wind farm probably have high resolution vision areas found in the lateral fields of view, rather than frontally, e.g., the bustards, cranes, korhaans and passerines. The possible exceptions to this are the raptors which all have wider binocular fields, although as pointed out by Martin (2011, 2012), this does not necessarily result in these species being able to avoid obstacles better. It is therefore unlikely that differences in sensorial perception will play a significant role in the collision risk associated with priority species at the proposed wind farm, as behaviour is more important from a risk perspective.

- Phenology

It has been suggested that resident birds would be less prone to collision, due to their familiarity with the presence of the structures (Drewitt and Langston, 2008). However, recent studies have shown that, within a wind farm, raptor collision risk and fatalities are higher for resident than for migrating birds of the same species. An explanation for this may be that resident birds generally use the wind farm area several times while a migrant bird crosses it just once (Krijgsveld *et al.* 2009). However, other factors like bird behaviour are certainly relevant. Katzner *et al.* (2012) showed that Golden Eagles performing local movements fly at lower altitudes, putting them at a greater risk of collision than migratory eagles. Resident eagles flew more frequently over cliffs and steep slopes, using low altitude slope updrafts, while migratory eagles flew more frequently over flat areas and gentle slopes, where thermals are generated, enabling the birds to use them to gain lift and fly at higher altitudes. Also, Johnston *et al.* (2014) found that during migration when visibility is good Golden Eagles can adjust their flight altitudes and avoid the wind turbines.

At two wind farms in the Strait of Gibraltar, the majority of Griffon Vulture deaths occurred in the winter. This probably happened because thermals are scarcer in the winter, and resident vultures in that season probably relied more on slope updrafts to gain lift (Barrios and Rodríguez, 2004). The strength of these updrafts may not have been sufficient to lift the vultures above the turbine blades, thereby exposing them to a higher collision risk. Additionally, migrating vultures did not seem to follow routes that crossed these two wind farms, so the number of collisions did not increase during migratory periods. Finally, at Smøla, collision risk modelling showed that White-tailed Eagles are most prone to collide during the breeding season, when there is increased flight activity in rotor swept zones (Dahl *et al.* 2013).

The case seems to be different for passerines, with several studies documenting high collision rates for migrating passerines at certain wind farms, particularly at coastal or offshore sites. However, comparable data on collision rates for resident birds is lacking. This lack of information may result from fewer studies, lower detection rates and rapid scavenger removal (Johnson *et al.* 2002; Lekuona and Ursua, 2007). One of the few studies reporting passerine collision rates (from Navarra, northern Spain) documents higher collision rates in the autumn migration period, but it is unclear if this is due to migratory behaviour or due to an increase in the number of individuals because of recently fledged juveniles (Lekuona and Ursua, 2007).

Phezukomoya wind farm

Migratory priority species that could be encountered at the wind development site are White Stork, Steppe Buzzard, Booted Eagle, Lesser Kestrel and Amur Falcon. Lesser Kestrels emerged as the species with the highest potential collision risk, and are expected to occur regularly in considerable numbers during the summer, especially in precipitation-rich years. The closely related Amur Falcon is currently the species with the highest confirmed mortality due to collisions with wind turbines at South African wind farms (Ralston-Patton *et al*. 2017), it is therefore expected that the closely related Lesser Kestrel would display a similar high vulnerability to collisions.

- Bird behaviour

Flight type seems to play an important role in collision risk, especially when associated with hunting and foraging strategies. Kiting flight, which is used in strong winds and occurs in rotor swept zones, has been highlighted as a factor explaining the high collision rate of Red-tailed Hawks (*Buteo jamaicensis*) at APWRA (Hoover and Morrison, 2005). The hovering behaviour exhibited by Common Kestrels (*Falco tinnunculus*) when hunting may also explain the fatality levels of this species at wind farms in the Strait of Gibraltar (Barrios and Rodríguez, 2004). Kiting and hovering are associated with strong winds, which often produce unpredictable gusts that may suddenly change a bird's position (Hoover and Morrison, 2005). Additionally, while birds are hunting and focused on prey, they might lose track of wind turbine positions (Krijgsveld *et al.* 2009; Smallwood *et al.* 2009).

Collision risk may also be influenced by behaviour associated with a specific sex or age. In Belgium, only adult Common Terns (*Sterna hirundo*) were impacted by a wind farm (Everaert and Stienen, 2007) and the high fatality rate was sex-biased (Stienen *et al.* 2008). In this case, the wind farm is located in the foraging flight path of an important breeding colony, and the differences between fatality of males and females can be explained by the different foraging activity during egg-laying and incubation (Stienen *et al.* 2008). Another example comes from Portugal, where recent findings showed that the mortality of the Skylark (*Alauda arvensis*) is sex and age biased, and affecting mainly adult males. This was related with the characteristic breeding male song-flights that make them more vulnerable to collision with wind turbines (Morinha *et al.* 2014). It seems this may also be responsible for mortalities of Red-capped Lark (*Calandrella cinerea*) at a wind farm in South Africa (Ralston, M. in litt. 2016).

Social behaviour may also result in a greater collision risk with wind turbines due to a decreased awareness of the surroundings. Several authors have reported that flocking behaviour increases collision risk with power lines as opposed to solitary flights (e.g. Janss, 2000). However, caution must be exercised when comparing the particularities of wind farms with power lines, as some species appear to be vulnerable to collisions with power lines but not with wind turbines, e.g. indications are that bustards, which are highly vulnerable to power line collisions, are not prone to wind turbine collisions – a Spanish database of over 7000 recorded turbine collisions contains no Great Bustards *Otis tarda* (A. Camiña 2012a). The same may be true for Blue Crane, as preliminary indications are that the species are not particularly vulnerable to turbine collisions (Ralston, M. in litt. 2016), despite being highly vulnerable to powerlines collisions.

Several collision risk models incorporate other variables related to bird behaviour. Flight altitude is widely considered important in determining the risk of bird collisions with offshore and onshore wind turbines, as birds that tend to fly at the height of rotor swept zones are more likely to collide (e.g. Band *et al.* 2007; Furness *et al.* 2013; Garthe and Hüppop, 2004).

Phezukomoya wind farm

The priority species at the wind farm can be classified as either terrestrial species or soaring species, with some, e.g. Secretarybird, Blue Crane and White Stork exhibiting both types of flight behaviour.

Terrestrial species spend most of the time foraging on the ground. They do not fly often and then generally short distances at low to medium altitude, usually powered flight. At the wind farm site, korhaans, bustards, cranes and larks are included in this category. Some larger species undertake longer distance flights at higher altitudes (specifically Ludwig's Bustard and Blue Crane). Soaring species spend a significant time on the wing in a variety of flight modes including soaring, kiting, hovering and gliding at medium to high altitudes. At the wind farm site, the raptor species are included in this class.

Based on the potential time spent potentially flying at rotor height, soaring species are likely to be at greater risk of collision, especially Jackal Buzzard, which is clearly highly vulnerable to turbine collisions ((Ralston-Patton *et al*. 2017). Lesser Kestrels emerged as the species with the highest potential collision risk, based on the numbers foraging on the plateau, and time spent at rotor height, followed by Jackal Buzzard. Verreaux's Eagle was recorded only once, below turbine height, which indicates that while the risk of collisions for the species may not be as high as a site with an active breeding pair, it cannot entirely be excluded. The risk rating for Jackal Buzzard is very low, compared to wind farm sites elsewhere (Van Rooyen *et al.*unpublished data)[9]. Specific behaviour of some terrestrial species might put them at risk of collision, e.g. display flights of Northern Black Korhaan might place them within the rotor swept zone, but the species was not recorded during pre-construction monitoring.

- Avoidance behaviours

Collision fatalities are also related to displacement and avoidance behaviours, as birds that do not exhibit either of these behaviours are more likely to collide with wind turbines. The lack of avoidance behaviour has been highlighted as a factor explaining the high fatality of White-tailed Eagles at Smøla wind farm, as no significant differences were found in the total amount of flight activity within and outside the wind farm area (Dahl *et al.* 2013). However, the birds using the Smøla wind farm are mainly sub-adults, indicating that adult eagles are being displaced by the wind farm (Dahl *et al.* 2013).

Two types of avoidance have been described (Furness *et al.*, 2013): 'macro-avoidance' whereby birds alter their flight path to keep clear of the entire wind farm (e.g. Desholm and Kahlert, 2005; Plonczkier and Simms, 2012; Villegas-Patraca *et al.* 2014), and 'micro-avoidance' whereby birds enter the wind farm but take evasive actions to avoid individual wind turbines (Band *et al.* 2007). This may differ between species and may have a significant impact on the size of the risk associated with a specific species. It is generally assumed that 95-98% of birds will successfully avoid the turbines (SNH 2010). It is also important to note that there is not necessarily a direct correlation between time spent at rotor height, and the likelihood of collision.

Displacement due to wind farms, which can be defined as reduced bird breeding density within a short distance of a wind turbines, has been described for some species (Pearce-Higgins *et al.* 2009). Birds exhibiting this type of displacement behaviour when defining breeding territories are less vulnerable to collisions, not because of morphological or site-specific factors, but because of altered behaviour (see also section 6.2 below).

[9] A dataset comprising 12 potential wind farm sites where the species was recorded during monitoring, recorded collision risk ratings for Jackal Buzzard ranging from 1.38 to 283.

Phezukomoya wind farm

It is anticipated that most birds at the proposed wind farm will successfully avoid the wind turbines. Possible exceptions might be raptors (especially Lesser Kestrel, Jackal Buzzard and possibly Verreaux's Eagle) engaged in hunting which might serve to distract them and place them at risk of collision, or birds engaged in display behaviour, e.g. Northern Black Korhaan (see earlier point). Despite being potential collision candidates based on morphology and flight behaviour, bustards do not seem to be particularly vulnerable to wind turbine collisions, indicating a high avoidance rate (A. Camiña 2012a). Complete macro-avoidance of the wind farm is unlikely for any of the priority species. To date, three Blue Crane collision mortalities have been recorded at eight operational wind farms in South Africa (Ralston-Patton *et al*. 2017). At the wind farm where it happened, it was the first mortalities in 21 months of monitoring, despite having high densities of Blue Cranes at the site, including breeding pairs. It is likely that these three birds represent the actual mortality figures for the species at operational wind farms where monitoring is taking place, as Blue Crane carcasses are large and easily visible, and tend to persist for months (Smallie J. 2016 pers. comm). Obviously, it is too early to make conclusive statements about the vulnerability of the species to wind turbine collisions, but these early indications are promising.

- Bird abundance

Some authors suggest that fatality rates are related to bird abundance, density or utilization rates (Carrete *et al.* 2012; Kitano and Shiraki, 2013; Smallwood and Karas, 2009), whereas others point out that, as birds use their territories in a non-random way, fatality rates do not depend on bird abundance alone (e.g. Ferrer *et al.* 2012; Hull *et al.* 2013; Smallie 2015). Instead, fatality rates depend on other factors such as differential use of specific areas within a wind farm (De Lucas *et al.* 2008). For example, at Smøla, White-tailed Eagle flight activity is correlated with collision fatalities (Dahl *et al.* 2013). In the APWRA, Golden Eagles, Red-tailed Hawks and American Kestrels (*Falco spaverius*) have higher collision fatality rates than Turkey Vultures (*Cathartes aura*) and Common Raven (*Corvus corax*), even though the latter are more abundant in the area (Smallwood *et al.* 2009), indicating that fatalities are more influenced by each species' flight behaviour and turbine perception. Also, in southern Spain, bird fatality was higher in the winter, even though bird abundance was higher during the pre-breeding season (De Lucas *et al.* 2008).

Phezukomoya wind farm

The abundance of priority species at the proposed wind farm site will fluctuate depending on season of the year, and particularly in response to rainfall. This is a common phenomenon in arid ecosystems, where stochastic rainfall events can trigger irruptions of insect populations which in turn attract large numbers of birds. This is particularly likely to be the case with Lesser Kestrels. In general, higher populations of priority species are likely to be present when the veld conditions are good, especially in the rainy season. In the case of Verreaux's Eagles, mortality has been correlated with high flight activity (Ralston-Patton *et al*. 2017), but at least one Verreaux's Eagle mortality has been confirmed at a wind farm where no pre-construction flight activity was recorded for the species (Van Rooyen unpubl. data), indicating that for this species, low abundance does not entirely exclude the potential for collision mortality.

8.1.2 Site-specific factors

- Landscape features

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

<u>Phezukomoya wind farm</u>
Landscape features are likely to play an important role at the wind development area. As mentioned before, the wind development area is virtually surrounded by the steep slopes. These slopes are likely to be important landscape features for soaring species, particularly raptors such as Jackal Buzzard, Booted Eagle, Verreaux's Eagle and Martial Eagle, due to the presence of declivity currents. The flight activity map for Jackal Buzzard points towards a concentration of flight activity along the plateau edge. It is therefore necessary to buffer the edges of the escarpment, as it likely to be the area where most of the Jackal Buzzard (and other large raptor) flight activity will take place at turbine height. In the case of the Lesser Kestrels, the high lying plateau seems to be the area of choice, as this is an important foraging area for them.

- Flight paths

Although the abundance of a species per se may not contribute to a higher collision rate with wind turbines, as previous discussed, areas with a high concentration of birds seem to be particularly at risk of collisions (Drewitt and Langston, 2006), and therefore several guidelines on wind farm construction advise special attention to areas located in migratory paths (e.g. Atienza *et al.* 2012; CEC, 2007; USFWS, 2012). As an example, Johnson *et al.* (2002) noted that over two-thirds of the carcasses found at a wind farm in Minnesota were of migrating birds. At certain times of the year, nocturnally migrating passerines are the most abundant species at wind farm, particularly during spring and fall migrations, and are also the most common fatalities (Strickland *et al.* 2011).

For territorial raptors like Golden Eagles, foraging areas are preferably located near to the nest, when compared to the rest of their home range. For example, in Scotland 98% of movements were registered at ranges less than 6 km from the nest, and the core areas were located within a 2–3 km radius (McGrady *et al.* 2002). These results, combined with the terrain features selected by Golden Eagles to forage such as areas closed to ridges, can be used to predict the areas used by the species to forage (McLeod *et al.* 2002), and therefore provide a sensitivity map and guidance to the development of new wind farms (Bright *et al.* 2006). In Spain, on the other hand, a study spanning 7 provinces with an estimated Golden Eagle population of 384 individuals, with a combined total of 46 years of post-construction monitoring, involving 5 858 turbines, collisions did not occur at the nearest wind farm to the nest site but occurred in hunting areas with high prey availability far from the breeding territories, or randomly. A subset of data was used to investigate, inter alia, the relationship between collision mortality and proximity to wind turbines. Data was gathered for over a 12-year period. Analysis revealed that collisions are not related with the distance from the nest to the nearest turbine (Camiña 2014).

Wind farms located within flight paths can increase collision rates, as seen for the wind farm located close to a seabird breeding colony in Belgium (Everaert and Stienen, 2008). In this case, wind turbines were placed along feeding routes, and several species of gulls and terns were found to fly between wind turbines on their way to marine feeding grounds. Additionally, breeding adults flew closer to the structures when making frequent flights to feed chicks, which potentially increased the collision risk.

Phezukomoya Wind Farm

The proposed windfarm site is not located on any known migration route. The pair of Verreaux's Eagles which was breeding near the northern border of the site may have foraged over the site, but very little Verreaux's Eagle flights were recorded over the site during pre-construction surveys, perhaps because the nest has not been active since May 2015. Monitoring at other wind farm sites in the Karoo have indicated that the majority of Verreaux's Eagle flight activity is within a 2-3km radius around the nest (pers. obs, Ralston 2017). The areas where Verreaux's Eagles, Lanner Falcons, Booted Eagles and Jackal Buzzards are most likely to be found foraging, is along the escarpment. Buffer zones will be necessary to ensure that the areas where most flight activity is likely to take place are appropriately buffered. In this respect, a 150m set-back from the escarpment edge was recommended, as well as a 2.5km no turbine zone around the VE nest at FP1, in case the nest becomes active again in future (see Figure 15 below).

- Food availability

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

Phezukomoya Wind Farm

In semi-arid zones such as where this proposed wind farm is located, food availability is often linked to rainfall. It is a well-known fact that insect outbreaks may occur after rainfall events, which could draw in various priority species such as Ludwig's Bustard, and particularly Lesser Kestrel. This in turn could heighten the risk of collisions. Rock piles which are created as a result of construction activities at the proposed site could create habitat for Rock Hyrax, which in turn could result in Verreaux's Eagles being attracted to the area and exposing themselves to collision risk.

- Weather

Certain weather conditions, such as strong winds that affect the ability to control flight manoeuvrability or reduce visibility, seem to increase the occurrence of bird collisions with artificial structures (Longcore *et al.* 2013). Some high bird fatality events at wind farms have been reported during instances of poor weather. For example, at an offshore research platform in Helgoland, Germany, over half of the bird strikes occurred on just two nights that were characterized by very poor visibility (Hüppop *et al.* 2006). Elsewhere, 14 bird carcasses were found at two adjacent wind turbines after a severe thunderstorm at a North American wind farm (Erickson *et al.* 2001). However, in these cases, there may be a cumulative effect of bad weather and increased attraction to artificial light. Besides impairing visibility, low altitude clouds can in turn lower bird flight height, and therefore increasing their collision risk with tall obstacles (Langston and Pullan, 2003). For wind farms located along migratory routes, the collision risk may not be the same throughout a 24-h period, as the flight altitudes of birds seem to vary. The migration altitudes of soaring birds have been shown to follow a typically diurnal pattern, increasing during the morning hours, peaking toward noon, and decreasing again in the afternoon, in accordance with general patterns of daily temperature and thermal convection (Kerlinger, 2010; Shamoun-Baranes *et al.* 2003).

Collision risk of raptors is particularly affected by wind. For example, Golden Eagles migrating over a wind farm in Rocky Mountain showed variable collision risk according to wind conditions, which decreased when the wind speed raised and increased under head- and tailwinds when compared to western crosswinds (Johnston *et al.* 2014).

<u>Phezukomoya Wind Farm</u>
Weather conditions at the proposed wind farm are likely to influence flight behaviour in much the same manner as has been recorded elsewhere at wind farms. Analysis of the flight data collected during the pre-construction monitoring indicates that the majority of soaring flights happened during gentle to moderate breezes, in winds with a predominantly northerly and easterly orientation (see Appendix 5 tables F and G).

8.1.3 Wind farm-specific factors

- Turbine features

Turbine features may play a role in collision risk. Older lattice-type towers have been associated with high collision risk, as some species exhibiting high fatality rates used the turbine poles as roosts or perches when hunting (Osborn *et al.* 1998; Thelander and Rugge, 2000). However, in more recent studies, tower structure did not influence the number of bird collisions, as it was not higher than expected according to their availability when compared to collisions with tubular turbines (Barrios and Rodríguez, 2004).

Turbine size has also been highlighted as an important feature, as higher towers have a larger rotor swept zone and, consequently, a larger collision risk area. While this makes intuitive sense, the majority of published scientific studies indicate that an increase in rotor swept area do not automatically translate into a larger collision risk. Turbine dimensions seem to play an insignificant role in the magnitude of the collision risk in general, relative to other factors such as topography, turbine location, morphology and a species' inherent ability to avoid the turbines, and may only be relevant in combination with other factors, particularly wind strength and topography (see Howell 1997, Barrios & Rodriguez 2004; Barclay *et al.* 2007, Krijgsveld *et al.* 2009, Smallwood 2013; Everaert 2014). Only two studies so far found a correlation between turbine hub height and mortality (De Lucas *et al.* 2008; Loss *et al.* 2013).

Rotor speed (revolutions per minute) also seems to be relevant, as faster rotors are responsible for higher fatality rates (Thelander *et al.* 2003). However, caution is needed when analysing rotor speed alone, as it is usually correlated with other features that may influence collision risk as turbine size, tower height and rotor diameter (Thelander *et al.* 2003), and because rotor speed is not proportional to the blade speed. In fact, fast spinning rotors have fast moving blades, but rotors with lower resolutions per minute may drive higher blade tip speeds.

<u>Phezukomoya Wind Farm</u>
Due to the fact that the turbine dimensions are constantly changing as newer models are introduced, it is best to take a pre-cautionary approach in order to anticipate any future potential changes in the turbine dimensions. The pre-construction monitoring programme worked on a potential rotor swept area of 30m – 220m to incorporate a wide range of models, which accommodates the current proposed turbines.

The assumption that a larger rotor-swept area will automatically increase the risk of collision is questionable. While the assumption seems to make intuitive sense, it should be noted that the majority of published scientific studies indicate that an increase in rotor swept area do not automatically translate into a larger collision risk. Turbine dimensions seem to play an insignificant role in the magnitude of the collision risk in general, relative to other factors such as topography, turbine location, morphology and a species' inherent ability to avoid the turbines, and may only be relevant in combination with other factors, particularly wind strength and topography (see Howell 1997, Barrios & Rodriguez 2004; Barclay *et al.* 2007, Krijgsveld *et al.* 2009, Smallwood 2013; Everaert 2014). Only two studies found a correlation between turbine hub height and mortality (De Lucas *et al*. 2008; Loss *et al*. 2013). It is therefore deemed unnecessary to provide a specific recommendation as far as hub height and rotor diameter is concerned, from avifaunal perspective.

- Blade visibility

When turbine blades spin at high speeds, a motion smear (or motion blur) effect occurs, making wind turbines less conspicuous. This effect occurs both in the old small turbines that have high rotor speed and in the newer high turbines that despite having slower rotor speeds, achieve high blade tip speeds. Motion smear effect happens when an object is moving too fast for the brain to process the images and, as a consequence, the moving object appears blurred or even transparent to the observer. The effect is dependent on the velocity of the moving object and the distance between the object and the observer. The retinal-image velocity of spinning blades increases as birds get closer to them, until it eventually surpasses the physiological limit of the avian retina to process temporally changing stimuli. As a consequence, the blades may appear transparent and perhaps the rotor swept zone appears to be a safe place to fly (Hodos, 2003). For example, McIsaac (2001) showed that American Kestrels were not always able to distinguish moving turbine blades within a range of light conditions.

<u>Phezukomoya Wind Farm</u>
Motion smear is inherent to all wind turbines and will therefore also be a potential risk factor at the proposed wind farm.

- Wind farm configuration

Wind farm lay-out can also have a critical influence on bird collision risk. For example, it has been demonstrated that wind farms arranged perpendicularly to the main flight path may be responsible for a higher collision risk (Everaert *et al.* 2002 & Isselbacher and Isselbacher, 2001 in Hötker *et al.* 2006). At APWRA, wind farms located at the ends of rows, next to gaps in rows, and at the edge of local clusters were found to kill disproportionately more birds (Smallwood and Thellander, 2004). In this wind farm, serially arranged wind turbines that form wind walls are safer for birds (suggesting that birds recognize wind turbines and towers as obstacles and attempt to avoid them while flying), and fatalities mostly occur at single wind turbines or wind turbines situated at the edges of clusters (Smallwood and Thellander, 2004). However, this may be a specificity of APWRA. For instance, De Lucas *et al.* (2012a) found that the positions of the wind turbines within a row did not influence the turbine fatality rate of Griffon Vultures at Tarifa. Additionally, engineering features of the newest wind turbines require a larger minimum distance between adjacent wind turbines and in new wind farms it is less likely that birds perceive rows of turbines as impenetrable walls. In fact, in Greece it was found that the longer the distance between wind turbines, the higher is the probability that raptors will attempt to cross the space between them (Cárcamo *et al.* 2011).

<u>Phezukomoya Wind Farm</u>
See in this respect Figure 16 indicating proposed turbine-free buffer zones from an avifaunal perspective.

8.2 Displacement due to disturbance

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

Unfortunately, few studies of displacement due to disturbance are conclusive, often because of the lack of before-and-after and control-impact (BACI) assessments. Onshore, disturbance distances (in other words the distance from wind farms up to which birds are absent or less abundant than expected) up to 800 m (including zero) have been recorded for wintering waterfowl (Pedersen & Poulsen 1991 as cited by Drewitt & Langston 2006), though 600m is widely accepted as the maximum reliably recorded distance (Drewitt & Langston 2006). The variability of displacement distances is illustrated by one study which found lower post-construction densities of feeding European White-fronted Geese *Anser albifrons* within 600 m of the turbines at a wind farm in Rheiderland, Germany (Kruckenberg & Jaene 1999 as cited by Drewitt & Langston 2006), while another showed displacement of Pink-footed Geese *Anser brachyrhynchus* up to only 100–200 m from turbines at a wind farm in Denmark (Larsen & Madsen 2000 as cited by Drewitt & Langston 2006). Indications are that Great Bustard *Otis tarda* could be displaced by wind farms up to one kilometre from the facility (Langgemach 2008). An Austrian study found displacement for Great Bustards up to 600m (Wurm & Kollar as quoted by Raab *et al.* 2009). However, there is also evidence to the contrary; information on Great Bustard received from Spain points to the possibility of continued use of leks at operational wind farms (Camiña 2012b). Research on small grassland species in North America indicates that permanent displacement is uncommon and very species specific (e.g. see Stevens *et al.* 2013, Hale *et al.* 2014). There also seem to be little evidence for a persistent decline in passerine populations at wind farm sites in the UK (despite some evidence of turbine avoidance), with some species, including Skylark, showing increased populations after wind farm construction (see Pierce-Higgins *et al.* 2012). Populations of Thekla Lark *Galerida theklae* were found to be unaffected by wind farm developments in Southern Spain (see Farfan *et al.* 2009).

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

The effect of birds altering their migration flyways or local flight paths to avoid a wind farm is also a form of displacement. This effect is of concern because of the possibility of increased energy expenditure when birds have to fly further, as a result of avoiding a large array of turbines, and the potential disruption of linkages between distant feeding, roosting, moulting and breeding areas otherwise unaffected by the wind farm. The effect depends on species, type of bird movement, flight height, distance to turbines, the layout and operational status of turbines, time of day and wind force and direction, and can be highly variable, ranging from a slight 'check' in flight direction, height or speed, through to significant diversions which may reduce the numbers of birds using areas beyond the wind farm (Drewitt & Langston 2006). A review of the literature suggests that none of the barrier effects identified so far have significant impacts on populations (Drewitt & Langston 2006). However, there are circumstances where the barrier effect might lead indirectly to population level impacts; for example where a wind farm effectively blocks a regularly used flight line between nesting and foraging areas, or where several wind farms interact cumulatively to create an extensive barrier which could lead to diversions of many tens of kilometres, thereby incurring increased energy costs.

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None of the priority species are likely to be permanently displaced due to disturbance, although displacement in the short term during the construction phase is very likely. The risk of permanent displacement is larger for large species such as Blue Crane and Ludwig’s Bustard, although displacement of the closely related Denham’s Bustard (*Neotis denhami*) is evidently not happening at existing wind farms in the Eastern Cape (M. Langlands 2016 pers. comm, Rossouw 2016 pers.comm). Blue Cranes are likewise not being displaced at wind farms in the Western Cape (Ralston - Patton *et al.* 2017). If the wind farm follows the modern trend of fewer, larger turbines, the risk of displacement is also lower. However, this will only be established through a post-construction monitoring programme.

The Verreaux’s Eagle guidelines adopted by BLSA in March 2017 states as follows:

“A buffer of 3 km is recommended around all nests (including alternate nests). This is intended to reduce the risk of collisions and displacement. This is a precautionary buffer and may be reduced (or increased) based on the results of rigorous avifaunal surveys, but nest buffers should never be less than 1.5 km” (Ralston 2017).

It is recommended that a 2.5km pre-cautionary no-go buffer is implemented around the Verreaux’s Eagle nest at FP1 (31°12'59.66"S 24°57'26.08"). The lack of recent breeding activity and absence of flight activity of Verreaux’s Eagles at the site may point to possible abandonment of the territory, but that cannot be assumed and therefore a substantial pre-cautionary buffer should still be implemented.

8.3 Displacement due to habitat loss

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

Thomomys bottae around turbine bases), though this may also have increased collision risk (Thelander *et al.* 2003 as cited by Drewitt & Langston 2006).

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

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The direct habitat transformation at the proposed wind farm is likely to be fairly minimal. The indirect habitat transformation is likely to have a bigger impact on priority species. It is expected that the densities of most priority species will decrease due to this impact, but complete displacement is unlikely. Indications are that bustards and cranes continue to use the wind farm areas (M. Langlands 2016 pers. comm, Rossouw 2016 pers.comm,). Raptors are unlikely to be affected at all. Species most likely to be affected by the habitat fragmentation are the terrestrial species such as Blue Crane, Ludwig's Bustard, Secretarybird and Grey-winged Francolin.

8.4 Mortality on the associated medium voltage MV distribution and 132kV HV transmission lines

Negative impacts on birds by electricity infrastructure generally take two forms namely electrocution and collisions (Ledger & Annegarn 1981; Ledger 1983; Ledger 1984; Hobbs and Ledger 1986a; Hobbs & Ledger 1986b; Ledger, Hobbs & Smith, 1992; Verdoorn 1996; Kruger & Van Rooyen 1998; Van Rooyen 1998; Kruger 1999; Van Rooyen 1999; Van Rooyen 2000; Van Rooyen 2004; Jenkins *et al* 2010). Birds also impact on the infrastructure through nesting and streamers, which can cause interruptions in the electricity supply (Van Rooyen *et al.* 2002).

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 electrocution risk is largely determined by the pole/tower design. In the case of the proposed Phezukomoya WEF, no electrocution risk is envisaged as far as the 132kV grid connection is concerned, because the design of the steel mono-pole 132kV lines will not pose an electrocution threat to any of the priority species which are likely to occur at the site. However, the situation with the medium voltage MV poles are very different, and they could be potentially lethal to a variety of raptors.

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

> *"The collision risk posed by power lines is complex and problems are often localised. While any bird flying near a power line is at risk of collision, this risk varies greatly between different groups of birds, and depends on the interplay of a wide range of factors (APLIC 1994). Bevanger (1994) described these factors in four main groups – biological, topographical, meteorological and technical. Birds at highest risk are those that are both susceptible to collisions and frequently exposed to power lines, with waterbirds, gamebirds, rails, cranes and bustards usually the most numerous reported victims (Bevanger 1998, Rubolini et al. 2005, Jenkins et al. 2010).*
>
> *The proliferation of man-made structures in the landscape is relatively recent, and birds are not evolved to avoid them. Body size and morphology are key predictive factors of collision risk, with large-bodied birds with high wing loadings (the ratio of body weight to wing area) most at risk (Bevanger 1998, Janss 2000). These birds must fly fast to remain airborne, and do not have sufficient manoeuvrability to avoid unexpected obstacles. Vision is another key biological factor, with many collision-prone birds principally using lateral vision to navigate in flight, when it is the lower-resolution, and often restricted, forward vision that is useful to detect obstacles (Martin & Shaw 2010, Martin 2011, Martin et al. 2012). Behaviour is important, with birds flying in flocks, at low levels and in crepuscular or nocturnal conditions at higher risk of collision (Bevanger 1994). Experience affects risk, with migratory and nomadic species that spend much of their time in unfamiliar locations also expected to collide more often (Anderson 1978, Anderson 2002). Juvenile birds have often been reported as being more collision-prone than adults (e.g. Brown et al. 1987, Henderson et al. 1996).*
>
> *Topography and weather conditions affect how birds use the landscape. Power lines in sensitive bird areas (e.g. those that separate feeding and roosting areas, or cross flyways) can be very dangerous (APLIC 1994, Bevanger 1994). Lines crossing the prevailing wind conditions can pose a problem for large birds that use the wind to aid take-off and landing (Bevanger 1994). Inclement weather can disorient birds and reduce their flight altitude, and strong winds can result in birds colliding with power lines that they can see but do not have enough flight control to avoid (Brown et al. 1987, APLIC 2012).*
>
> *The technical aspects of power line design and siting also play a big part in collision risk. Grouping similar power lines on a common servitude, or locating them along other features such as tree lines, are both approaches thought to reduce risk (Bevanger 1994). In general, low lines with short span lengths (i.e. the distance between two adjacent pylons) and flat conductor configurations are thought to be the least dangerous (Bevanger 1994, Jenkins et al. 2010). On many higher voltage lines, there is a thin earth (or ground) wire above the conductors, protecting the system from lightning strikes. Earth wires are widely accepted to cause the majority of collisions on power lines with this configuration because they are difficult to see, and birds flaring to avoid hitting the conductors often put themselves directly in the path of these wires (Brown et al. 1987, Faanes 1987, Alonso et al. 1994a, Bevanger 1994)."*

From incidental record keeping by the Endangered Wildlife Trust, it is possible to give a measure of what species are generally susceptible to power line collisions in South Africa (see Figure 14 below - Jenkins *et al.* 2010).

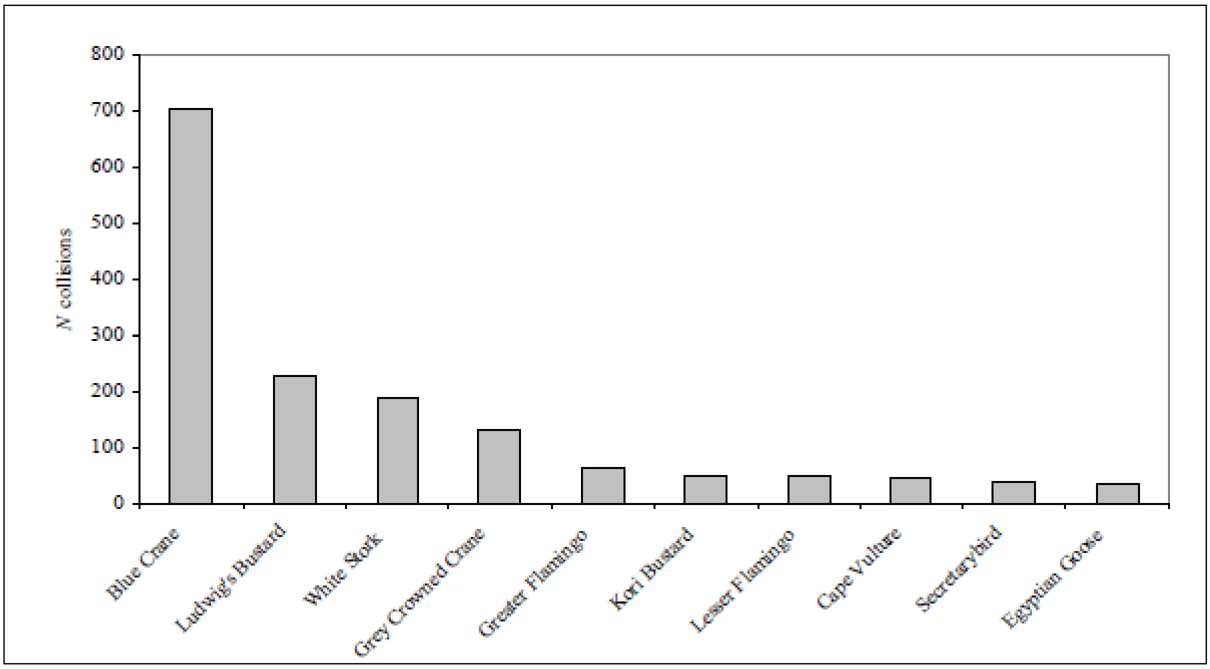

Figure 14: The top ten collision prone bird species in South Africa, in terms of reported incidents contained in the Eskom/EWT Strategic Partnership central incident register 1996 - 2008 (Jenkins *et al.* 2010)

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

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

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

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Several of the priority species which occur or potentially occur in the study area are power line sensitive from a collision perspective. These include Ludwig's Bustard, Blue Crane, Northern Black Korhaan, Karoo Korhaan, Blue Korhaan, Secretarybird, White Stork and Greater Flamingo. All of these species, but particularly Ludwig's Bustard and Blue Crane, could be impacted by the proposed grid connection and the internal medium voltage lines (where they are above ground) through collision. Pro-active marking of powerlines will have to happen, based on a walk-through exercise to identify potential collision high risk areas.

It is not clear at this stage which design type will be employed for the sections of the medium voltage lines which will be above ground, but it is of critical importance that the design is raptor-friendly to eliminate any risk of electrocution. The poles could potentially be lethal for species such as Jackal Buzzard, Verreaux's Eagle, Martial Eagle, Cape Eagle-Owl, Spotted Eagle-Owl, Steppe Buzzard and African Harrier-hawk.

8.5 Displacement due to disturbance and habitat loss associated with the construction of the 132kV grid connection and Eskom 400kV Umsobomvu substation.

In the present instance, the risk of displacement of priority species due to habitat destruction is likely to be fairly limited given the nature of the vegetation. Very little vegetation clearing will have to be done in the 132kV powerline servitude itself. The Grassy Karoo habitat at the proposed Umsobovu substation is common in the greater study area and the transformation of approximately 3.6 hectares of habitat should not impact any of the priority species significantly.

Apart from direct habitat destruction, the above-mentioned construction and maintenance activities could also potentially displace priority species through disturbance; this could lead to breeding failure if the displacement happens during a critical part of the breeding cycle. Construction activities could be a source of disturbance and could lead to temporary or even permanent abandonment of nests. None of the priority species are likely to be permanently displaced due to disturbance associated to the construction of the proposed grid connection, although displacement in the short term during the construction phase is very likely. Species most likely to be affected by this impact would be large terrestrial species such as Blue Crane, Secretarybird, Ludwig's Bustard, Northern Black Korhaan and Blue Korhaan. No known eagle nests are at risk of disturbance by any of the three alignment alternatives. It would be necessary, though, to conduct a walk-through on the final alignment to inspect the area for any priority species breeding activity, once the pole positions have been determined.

There are several Verreaux's Eagle nests south of the study area, but they all fall outside the immediate vicinity of the proposed WEF development area (see Figure 12).

9. IMPACT ASSESSMENT

Where significant environmental aspects are present, significant environmental impacts ***may*** result. The significance of the impacts associated with the significant aspects can be determined by considering the risk:

Significance of Environmental Impact (Risk) = Probability x Consequence

The consequence of impacts can be described by considering the severity, spatial extent and duration of the impact.

9.1 Severity of Impacts

Table 9-1 presents the ranking criteria that were used to determine the severity of impacts on priority species.

Table 9-1: Criteria for ranking the *Severity* of negative impacts on priority species

Environment	Ranking Criteria		
	Low (L-)	**Medium (M-)**	**High (H-)**
Ecology (Plant and animal life)	Disturbance of areas that are degraded, have little conservation value. Minor change in species variety or prevalence.	Disturbance of areas that have some conservation value. Complete change in species variety or prevalence.	Disturbance of areas that are pristine, have conservation value. Destruction of rare or endangered species.

9.2 Spatial Extent and Duration of Impacts

The duration and spatial scale of impacts were ranked using the following criteria:

Table 9-2: Ranking the *Duration* and *Spatial Scale* of impacts

	Ranking Criteria		
	L	**M**	**H**
Duration	Quickly reversible Less than the project life Short-term	Reversible over time/life of the project Medium-term	Permanent Beyond closure Long-term
Spatial Scale	Localised Within site boundary Site	Fairly widespread Beyond site boundary Local	Widespread Far beyond site boundary Regional/national

9.3 Consequence of Impacts

Having ranked the severity, duration and spatial extent, the overall consequence of impacts was determined using the following qualitative guidelines:

Table 9-3: Ranking the *Consequence* of an impact

				SEVERITY = L	
DURATION	Long-term	**H**			
	Medium-term	**M**			**MEDIUM**
	Short-term	**L**	**LOW**		
				SEVERITY = M	
DURATION	Long-term	**H**			**HIGH**
	Medium-term	**M**		**MEDIUM**	
	Short-term	**L**	**LOW**		
				SEVERITY = H	
DURATION	Long-term	**H**			
	Medium-term	**M**			**HIGH**
	Short-term	**L**	**MEDIUM**		
			L	**M**	**H**
			Localised Within site boundary Site	Fairly widespread Beyond site boundary Local	Widespread Far beyond site boundary Regional/national
				SPATIAL SCALE	

To use Table 5, one of the three “layers” based on the severity ranking was obtained from Table 3. Thereafter the consequence ranking was obtained by locating the intersection of the appropriate duration and spatial scale rankings.

9.4 Overall Significance of Impacts

Combining the consequence of the impact and the probability of occurrence, as shown by Table 9-4, provided the overall significance (risk) of impacts.

Table 9-4: Ranking the *Overall Significance* of impacts

PROBABILITY	Definite Continuous	**H**	**MEDIUM**		**HIGH**
	Possible Frequent	**M**		**MEDIUM**	
	Unlikely Seldom	**L**	**LOW**		**MEDIUM**
			L	**M**	**H**
			CONSEQUENCE (from Table 9-3)		

The overall significance ranking of the negative environmental impacts provides the following guidelines for decision making:

Table 9-5: **Guidelines for decision-making**

Overall Significance Ranking	**Nature of Impact**	**Decision Guideline**
High	Unacceptable impacts.	Likely to be a fatal flaw.
Medium	Noticeable impact.	These are unavoidable consequence, which will need to be accepted if the project is allowed to proceed.
Low	Minor impacts.	These impacts are not likely to affect the project decision.

9.5 Impact ratings tables

Table 9-6: Displacement of priority species due to construction activities at the wind development area

Impact Phase (Construction)							
Potential Impact: Displacement of priority species due to construction activities at the wind development area							
ANTICIPATED IMPACTS							
	Extent	**Duration**	**Severity**	**Status**	**Significance**	**Probability**	**Confidence**
Without Mitigation	**Low**	**Low**	**Medium**	**Negative**	**Medium**	**High**	**Medium**
With Mitigation	**Low**	**Low**	**Low**	**Negative**	**Medium**	**Medium**	**Medium**

Can the impact be reversed?	YES. The impacts should be temporary and restricted to the construction phase.	
Will impact cause irreplaceable loss or resources?		NO. The impacts should be temporary and restricted to the construction phase.
Can impact be avoided, managed of mitigated?	YES: To some extent, however the impact will be negated naturally after the construction phase.	

Mitigation measures to reduce residual risk or enhance opportunities:

- Restrict the construction activities to the construction footprint area.
- Do not allow any access to the remainder of the property during the construction period.

- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum.
- It is recommended that a 2.5km pre-cautionary no-go buffer is implemented around the Verreaux's Eagle nest at FP1 (31°12'59.66"S 24°57'26.08"). This buffer should apply to all infrastructure, except the proposed electricity cable which will be located along an existing dirt road, which is partially located within this buffer zone.
- The appointed Environmental Control Officer (ECO) should be trained by an avifaunal specialist to identify the signs that indicate possible breeding by priority species. The ECO must then, during audits/site visits, make a concerted effort to look out for such breeding activities of such species, and such efforts may include the training of construction staff to identify such species, followed by regular questioning of staff as to the regular whereabouts on site of the species. If any priority species are confirmed to be breeding (e.g. if a nest site is found), construction activities within 500m of the breeding site must cease, and the avifaunal specialist will be contacted immediately for further assessment of the situation and instruction on how to proceed.

Rationale: It is highly likely that most priority species will be temporarily displaced in the development area during the construction operations, due to the noise and activity, The implementation of a 2.5km no-go buffer zone around the Verreaux's Eagle nesting area could reduce any potential disturbance impacts on Verreaux's Eagles[10], but not for the other priority species[11]. There is an existing dirt road which is located within the 2.5km proposed no-go buffer zone, and 2km away from the nest at its closest point. One of the proposed underground electricity cables are to be located along this dirt road. This cable can be exempted from the no-go buffer zone as the road is already an existing source of disturbance, therefore the temporary construction activity is unlikely to be a major disturbance factor. It should be noted that the nest is situated approximately 400m from the busy N9 provincial tarred road, and 860m from a railway station, none of which have in the past deterred the eagles from using the nest, indicating a measure of habituation to vehicle and pedestrian traffic.

The significance will remain at a medium level collectively for priority species after mitigation.

[10] Although the nest has not been occupied since June 2015, it may become active again in future.

[11] The BLSA Best Practice guidelines for Verreaux's Eagles and Wind Farms (Ralston-Patton 2017) require a minimum buffer zone of between 1.5 (non-negotiable) and 3km, based on the level of flight activity recorded during pre-construction monitoring

Table 9-7: Displacement of priority species due to construction activities associated with the grid connection powerline

Impact Phase (Construction)							
Potential Impact: Displacement of priority species due to construction activities associated with the grid connection powerline.							
ANTICIPATED IMPACTS							
	Extent	**Duration**	**Severity**	**Status**	**Significance**	**Probability**	**Confidence**
Without Mitigation	**Low**	**Low**	**Medium**	**Negative**	**Medium**	**Medium**	**High**
With Mitigation	**Low**	**Low**	**Low**	**Negative**	**Low**	**Low**	**Medium**
Can the impact be reversed?	YES. The impacts should be temporary and restricted to the construction phase.						
Will impact cause irreplaceable loss of resources?		NO. The impacts should be temporary and restricted to the construction phase.					
Can impact be avoided, managed or mitigated?	YES: To some extent, however the impact will be negated naturally after the construction phase.						
Mitigation measures to reduce residual risk or enhance opportunities: • Restrict the construction activities to the construction footprint area. • Do not allow any access to the remainder of the property during the construction period. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • The final powerline route should be assessed by the avifaunal specialist way of a walk-down to identify any priority species nests which could be impacted by the construction activities. Should a nest be discovered, the avifaunal specialist must have input into the construction schedule to assess how and which of the construction activities can be timed to minimize the disturbance potential to the occupants of the nest.							

The construction activities associated with the grid connection could result in the short-term displacement of priority species from the site. The implementation of the proposed mitigation measures will reduce the probability of disturbance of priority species.

Table 9-8: Mortality of priority species due to electrocution associated with the internal medium voltage MV powerlines

Impact Phase (Operational)							
Potential Impact: Direct mortality of priority species due to electrocution associated with the internal medium voltage MV powerline at the wind development area.							
ANTICIPATED IMPACTS							
	Extent	**Duration**	**Severity**	**Status**	**Significance**	**Probability**	**Confidence**
Without Mitigation	**Low**	**Medium**	**Medium**	**Negative**	**Medium**	**High**	**High**
With Mitigation	**Low**	**Medium**	**Medium**	**Negative**	**Low**	**Low**	**High**
Can the impact be reversed?	YES: Completely reversible. Mitigation measures could eliminate the risk of electrocution.						
Will impact cause irreplaceable loss or resources?		NO: It is not expected that the mortality will lead to the					

		complete eradication of a priority species from the study area.
Can impact be avoided, managed or mitigated?	YES: Through the use of raptor friendly poles.	
Mitigation measures to reduce residual risk or enhance opportunities: • The final powerline design and associated electrocution mitigation measures (if necessary) must be approved and signed off by the avifaunal specialist.		

Rationale: The electrocution risk will persist as long as the lines are up, but it can be completely eliminated at the onset, if bird-friendly structures are used.

Table 9-9: Displacement of priority species due to habitat destruction at the wind development site

Impact Phase (Operational)							
Potential Impact: Displacement of priority species due to habitat destruction at the wind development site							
ANTICIPATED IMPACTS							
	Extent	**Duration**	**Severity**	**Status**	**Significance**	**Probability**	**Confidence**
Without Mitigation	**Low**	**High**	**Low**	**Negative**	**Medium**	**Medium**	**Medium**
With Mitigation	**Low**	**High**	**Low**	**Negative**	**Low**	**Low**	**Medium**

Can the impact be reversed?		NO: While it is expected that most species will continue to use the wind farm area, some species might do so in reduced densities, primarily due to the fragmentation of the habitat.
Will impact cause irreplaceable loss or resources?	YES: While it is expected that most species will continue to use the wind farm area, some species might do so in reduced densities, primarily due to the fragmentation of the habitat.	
Can impact be avoided, managed or mitigated?	YES: To some extent by ensuring that no impacts occur outside the immediate footprint.	

Mitigation measures to reduce residual risk or enhance opportunities:

- The recommendations of the specialist ecological study must be strictly adhered to.
- Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum.
- Following construction, rehabilitation of all areas disturbed (e.g. temporary access tracks and laydown areas) must be undertaken and to this end a habitat restoration plan is to be developed by a rehabilitation specialist.

Rationale: The rehabilitation of disturbed areas will help to mitigate the impact of the habitat transformation to some extent, but the fragmentation of the habitat due to the construction of the internal road network cannot be mitigated, and will remain an impact for the duration of the operational life-time of the facility.

Table 9-10: Direct mortality of priority species due to collisions with the turbines at the wind development area

<table>
<tr><td colspan="8">Impact Phase (Operational)</td></tr>
<tr><td colspan="8">Potential Impact: Direct mortality of priority species due to collisions with the turbines at the wind development area</td></tr>
<tr><td colspan="8">ANTICIPATED IMPACTS</td></tr>
<tr><td></td><td>Extent</td><td>Duration</td><td>Severity</td><td>Status</td><td>Significance</td><td>Probability</td><td>Confidence</td></tr>
<tr><td>Without Mitigation</td><td>Low</td><td>Medium</td><td>Medium</td><td>Negative</td><td>Medium</td><td>High</td><td>Medium</td></tr>
<tr><td>With Mitigation</td><td>Low</td><td>Medium</td><td>Low</td><td>Negative</td><td>Low</td><td>Low</td><td>Low</td></tr>
<tr><td colspan="3">Can the impact be reversed?</td><td colspan="3">YES: Partly reversible. Mitigation measures could reduce the risk of collisions.</td><td colspan="2"></td></tr>
<tr><td colspan="3">Will impact cause irreplaceable loss or resources?</td><td colspan="3"></td><td colspan="2">NO: It is not expected that the mortality will led to the complete eradication of a priority species at the wind development area.</td></tr>
<tr><td colspan="3">Can impact be avoided, managed or mitigated?</td><td colspan="3">YES: To some extent through the application of buffer zones and selective curtailment.</td><td colspan="2"></td></tr>
<tr><td colspan="8">Mitigation measures to reduce residual risk or enhance opportunities:

• Once the turbines have been constructed, post-construction monitoring should be implemented to compare actual collision rates with predicted collision rates.
• The avifaunal specialist, in consultation with external experts and relevant NGO’s such as BLSA, should determine annual mortality thresholds for priority anticipated to be at risk of collision mortality, prior to the wind farm going operational.
• If actual collision rates exceed the pre-determined threshold levels, curtailment of turbines should be implemented for high risk situations.
• A 150m no-turbine set-back buffer zone (other infrastructure is allowed) is required around the escarpment to minimise the risk of collisions for slope soaring species.
• It is recommended that a 2.5km pre-cautionary no-go buffer is implemented around the Verreaux’s Eagle nest at FP1 (31°12'59.66"S 24°57'26.08").
• Care should be taken not to create habitat for prey species that could draw priority raptors into the area and expose them to collision risk. Rock piles must be removed from site or covered with topsoil to prevent them from becoming habitat for Rock Hyrax (Dassie).</td></tr>
</table>

Rationale: The impact is likely to persist for the operational life-time of the project. Implementation of the proposed mitigation measures should reduce the probability and severity of the impact on priority species to such an extent that the overall significance should be reduced to low.

Table 9-11: Direct mortality of priority species due to collisions with the internal medium voltage MV lines and the 132kV grid connection powerline

Impact Phase (Operational)							
Potential Impact: Direct mortality of priority species due to collisions with the grid connection powerline at the wind development area – Preferred Alternative, Alternative 1 and Alternative 2							
ANTICIPATED IMPACTS							
	Extent	**Duration**	**Severity**	**Status**	**Significance**	**Probability**	**Confidence**
Without Mitigation	**Medium**	**Medium**	**Medium**	**Negative**	**Medium**	**High**	**Medium**
With Mitigation	**Medium**	**Medium**	**Low**	**Negative**	**Medium**	**Medium**	**Medium**

Can the impact be reversed?	YES: Partly reversible. Mitigation measures could reduce the risk of collisions.	
Will impact cause irreplaceable loss of resources?		NO: It is not expected that the mortality will lead to the complete eradication of a priority species from the study area.
Can impact be avoided, managed or mitigated?	YES: Partially through the application of anti-collision devices.	
Mitigation measures to reduce residual risk or enhance opportunities: • The final power line route should be assessed by way of a walk-through and those sections requiring Bird Flight Diverters (BFDs) must be identified.		

Rationale: The application of BFDs should reduce the probability and severity of the collision impact to a lower level, but it is likely to remain at the medium level, as the application of BFD's will reduce, but not eliminate the risk. No preferred alternative has been identified from a bird impact perspective as the proposed grid connections are very similar in length and traverse similar habitat.

Table 9-12: Displacement of priority species due to dismantling activities at the wind development area

Impact Phase (Closure)							
Potential Impact: Displacement of priority species due to dismantling activities at the wind development area							
ANTICIPATED IMPACTS							
	Extent	**Duration**	**Severity**	**Status**	**Significance**	**Probability**	**Confidence**
Without Mitigation	**Low**	**Low**	**Medium**	**Negative**	**Medium**	**High**	**Medium**
With Mitigation	**Low**	**Low**	**Low**	**Negative**	**Medium**	**Medium**	**Medium**
Can the impact be reversed?	YES. The impacts should be temporary and restricted to the closure phase.						
Will impact cause irreplaceable loss or resources?		NO. The impacts should be temporary and restricted to the closure phase.					
Can impact be avoided, managed or mitigated?	YES: To some extent, however the impact will be negated naturally after the closure phase.						
Mitigation measures to reduce residual risk or enhance opportunities: • Restrict the dismantling activities to the footprint area. • Do not allow any access to the remainder of the property during the dismantling period. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum.							

Rationale: It is highly likely that most priority species will be temporarily displaced in the development area during the dismantling operations, due to the noise and activity. The significance will therefore remain at a medium level in the dismantling phase after mitigation. However, once the dismantling has been completed, the impact will be negated naturally.

Table 9-13: Displacement of priority species due to dismantling of the powerline

Impact Phase (Closure)							
Potential Impact: Displacement of priority species due to dismantling of the powerline							
ANTICIPATED IMPACTS							
	Extent	**Duration**	**Severity**	**Status**	**Significance**	**Probability**	**Confidence**
Without Mitigation	**Low**	**Low**	**Low**	**Negative**	**Medium**	**Medium**	**High**
With Mitigation	**Low**	**Low**	**Low**	**Negative**	**Low**	**Low**	**Medium**

Can the impact be reversed?	YES. The impacts should be temporary and restricted to the closure phase.	
Will impact cause irreplaceable loss or resources?		NO. The impacts should be temporary and restricted to the closure phase.
Can impact be avoided, managed or mitigated?	YES: To some extent, however the impact will be negated naturally after the closure phase.	
Mitigation measures to reduce residual risk or enhance opportunities: • Restrict the dismantling activities to the footprint area. • Do not allow any access to the remainder of the property during the dismantling period. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • An avifaunal specialist should perform a walk-through of the powerline prior to the commencement of the dismantling activities to identify any raptor nests on the line. Should a nest be discovered, the avifaunal specialist must have input into the dismantling schedule to assess how and which of the dismantling activities can be timed to minimize the disturbance potential to the occupants of the nest.		

The dismantling activities associated with the grid connection could result in the short-term displacement of priority species from the site. The implementation of the proposed mitigation measures will greatly reduce the probability of disturbance of specifically raptors breeding on the powerline.

10. CUMULATIVE IMPACTS

A cumulative impact, in relation to an activity, is the impact of an activity that may not be significant on its own but may become significant when added to the existing and potential impacts arising from similar or other activities in the area.

Currently there is no agreed method for determining significant adverse cumulative impacts on ornithological receptors. The Scottish Natural Heritage (2005) recommends a five-stage process to aid in the ornithological assessment:

- Define the species/habitat to be considered;
- Consider the limits or 'search area' of the study;
- Decide the methods to be employed;
- Review the findings of existing studies; and
- Draw conclusions of cumulative effects within the study area.

10.1 Species to be considered

The potential cumulative impacts on the priority species listed in Table 7-1 were considered.

10.2 Area considered in the cumulative assessment

This assessment includes all operational and planned renewable energy applications, within a 35km radius of the Phezukomoya WEF, for which public information could be sourced. While all projects were considered, emphasis was placed on relevant developments, i.e. developments which are likely to have similar impacts as the proposed Phezukomoya WEF, including unrelated activities.

Table 10-1 below lists the renewable energy projects which are currently planned or are operational within a 35km radius around Phezukomoya WEF.

Table 10-1: List of proposed and existing renewable projects within a 35km radius around Phezukomoya WEF. Those projects with particular relevance to the Phezukomoya WEF are shaded.

TYPE		PROJECT TITLE	DETAILS
1	WIND	Umsobomvu Wind Energy Facility	**EAP** - Coastal and Environmental Services **Client: Umsobomvu Wind Power**(Pty) Ltd **DEA**: 14/12/16/3/3/2/730 Approved NPB
2	WIND	The Construction of A 188.6 Mw Wind Energy Facility And Its Associated Infrastructure At Noupoort Within The Umsobomvu Local Municipality, Northern Cape Province	**EAP** - SiVest SA (Pty) Ltd **Client**: South African Mainstream Renewable Power Noupoort Pty Ltd **DEA**: 12/12/20/2319 Operational PB_R3
3	**WIND**	Proposed San Kraal 390 Mw Wind Energy Facility, Northern And Eastern Cape Provinces	**EAP: Arcus** **Client San Kraal Wind Power (Pty) Ltd** DEA: 14/12/16/3/3/2/1029 Proposed
4	SOLAR	Construction of the 75MW Naauw Poort Solar Energy Facility near Naupoort	**EAP**-Savannah Environmental Consultants (Pty) Ltd **DE**A: 14/12/16/3/3/2/355 Approved NPB
5	SOLAR	The Construction of The Collet 75mw Photovoltaic Power Plant On Farm Harmsfontein 335, Buffelspoort 336 And Remainder Of Brakke Kuilen 180 Near Middelburg In The Eastern Cape Province	**EAP** - Coastal and Environmental Services **DEA**: 14/12/16/3/3/2/385/AM1 Approved NPB
6	SOLAR	Proposed Establishment of A 150mw Photovoltaic (Pv) Solar Power Plant On A Site Near Middleburg, Eastern Cape Province	**EAP**- Savannah Environmental Consultants (Pty) Ltd **DEA**: 12/12/20/2465/2 Approved NPB
7	SOLAR	For The Proposed Klip Gat Solar Energy Facility (75mw) Near Noupoort, Emthangeni Local Municipality In The Northern Cape Province	**EAP** - Savannah Environmental Consultants (Pty) Ltd **DEA**: 14/12/16/3/3/2/354 Approved NPB
8	SOLAR	Construction of Allemans Fontein Solar Energy Facility near Noupoort, Northern Cape (20MW)	**EAP**- Savannah Environmental Consultants (Pty) Ltd **DEA**: 14/12/16/3/3/1/730 Approved NPB

9	SOLAR	The Proposed Establishment Of Photovoltaic (Solar Power) Farms In The Northern Cape Province- Linde	**EAP**: Sustainable Development Projects cc **Client:** Scatec Solar SA Pty Ltd **DEA**: 12/12/20/2258/2 Approved PB_R2
11	SOLAR	Proposed Dida Solar Energy installation on a site near Noupoort, Northern cape (20 MW)	**EAP**: Savannah Environmental Consultants (Pty) Ltd **DEA**: 14/12/16/3/3/1/529 Approved NPB
12	SOLAR	Noupoort Concentrated Solar Power (CSP) Project, Northern Cape Province (150MW)	**EAP**: Savannah Environmental Consultants (Pty) Ltd **DEA**: 14/12/16/3/3/2/944 Approved NPB

10.3 Current impacts

Below is a summary of the typical threats currently facing avifauna in the Karoo environment (Marnewick *et al*. 2015):

10.3.1 Overgrazing

This results in a depletion of palatable plant species, erosion, and encroachment by Karoo shrubs. The result is loss of suitable habitat and a decrease in the availability of food for large terrestrial birds.

10.3.2 Poisoning

Strychnine poison was used extensively in the past to control damage-causing predators, such as Black-backed Jackal *Canis mesomelas* and Caracal *Caracal caracal*, and reduced scavenging raptor populations. The use of poison may be continuing, and the potential impacts on threatened raptor species has not been confirmed or quantified.

10.3.3 Road-kills

Many birds are commonly killed on roads, especially nocturnal species such as Spotted Eagle-Owl.

10.3.4 Renewable energy developments

Three wind and several solar developments have been approved or are proposed for development within a 35km radius around the proposed Phezukomoya WEF (see Table 10-1). This has implications for several priority species, both in terms of collision mortality for some species, especially raptors, and displacement due to permanent habitat transformation, which affects most of the priority species to some degree.

10.3.5 Powerlines

Numerous existing and new power lines are significant threats to large terrestrial priority species in the Karoo. Power lines kill substantial numbers of all large terrestrial bird species in the Karoo, including threatened species such as Karoo Korhaan, Kori Bustard and Ludwig's Bustard (Jenkins *et al*. 2010; Shaw, J. 2013) There is currently no completely effective mitigation method to prevent collisions.

10.3.6 Climate change

Climate change scenarios for the region predict slightly higher summer rainfall by 2050, and increased rainfall variability. Droughts are expected to become more severe. The climate change is predicted to have both positive and negative consequences for priority species. Increased summer rainfall could improve survival, and conversely drought years can lower long-term average survival. Large, mainly resident species dependent on rainfall are also more vulnerable to climate change. This would include the slow-breeding Martial Eagle, which also exhibit extended parental care. Severe hailstorms kill many priority species, e.g. Lesser Kestrel, and could become more frequent.

10.3.7 Shale gas fracking

There is a potential threat of shale gas fracking throughout the Karoo. Populations of bird species may be locally reduced through disturbance caused by lights, vibration, vehicles and dust, and may be affected by pollutants in ponds containing contaminated water produced by returned fracking fluids.

10.3.8 Persecution

Although it is difficult to prove, the direct persecution of raptors such as Verreaux's Eagle and Martial Eagle for stock predation is still taking place (R. Visagie pers. comm).

10.4 Mitigation measures from other relevant renewable energy projects considered relevant for the cumulative assessment

The following mitigation measures were proposed for the two other wind energy developments in the Noupoort area for which avifaunal information was available

10.4.1 Umsobomvu Wind Energy Facility (Smallie et al. 2015)

- No infrastructure should be built in the areas identified as HIGH sensitivity.
- There may be a requirement to avoid construction of certain infrastructure during Verreaux's Eagle breeding season (approximately May to September-October). This will be determined by the avifaunal walk through prior to construction and once the infrastructure layout is final.
- All power line linking the turbines and linking turbine strings to the on-site substation should be placed underground.
- The power line linking the site to the Eskom grid will be above ground but must conform to all Eskom standards in terms of bird friendly pole monopole structures with Bird Perches on every pole top (to mitigate for bird electrocution), and anti-bird collision line marking devices (to mitigate for bird collision). It is particularly important that the collision mitigation devices used are durable and remain in place on the line for the full lifespan of the power line. It will be InnoWind/Eskom's responsibility to maintain these devices in effective condition for this period. Systematic patrols of

this power line should be conducted during post construction bird monitoring for the wind energy facility, in order to monitor the impacts, the effectiveness of mitigation, and the durability of the mitigation measures. An avifaunal walk down will need to be conducted to assess the route of this power line once available.

- 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 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.* 2014). As mentioned above this monitoring should include the grid connection power line.
- 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.

10.4.1 Mainstream Noupoort Wind Energy Facility (Van Rooyen 2012, Van Rooyen et al. 2013)

DISPLACEMENT

- Formal monitoring should be resumed once the turbines have been constructed, as per best practice guidelines (Jenkins *et al*. 2011). The purpose of this would be to establish if displacement of priority species has occurred and to what extent. The exact time when post-construction monitoring should commence, will depend on the construction schedule, and will be agreed upon with Mainstream once these timelines have been finalised.
- The duration of the post-construction monitoring would need to be for at least an equivalent period to the pre-construction monitoring (four seasons), thereafter the need for additional monitoring will be determined and agreed to with Mainstream, based on the results of the first year of post-construction monitoring.
- A 500m buffer has already been implemented in the lay-out to accommodate the Blue Cranes that are breeding on the site. This should be strictly enforced as a no turbine zone for the duration of the project. In addition, no access roads should be constructed within that zone.
- Habitat destruction should be limited to what is absolutely necessary for the construction of the infrastructure, including the construction of new roads. In this respect, the recommendations from the Ecological Specialist Study should be applied strictly. Personnel should be adequately briefed on the need to restrict habitat destruction, and must be restricted to the actual construction area.

COLLISIONS

- Formal monitoring should be resumed once the turbines have been constructed, as per best practice guidelines (Jenkins et al 2011) (see previous section Displacement). The purpose of this would be (a) to establish if displacement of priority species has occurred and to what extent through the altering of flight patterns post-construction, and (b) to search for carcasses at turbines.
- Ensuring that key areas of conservation importance and sensitivity are avoided, in this instance slopes and potential funnels of bird flight activity.

- The proposed power line should be routed as far as possible from high risk areas (e.g. Blue Crane nest, agricultural lands, and dams). In addition, the proposed alignment must be assessed for potential collision risks and those sections must be marked with Bird Flight Diverters.
- The proposed pole design must be assessed by the author of this report to ensure that the power line design poses no potential electrocution risk of large raptors, particularly Martial Eagle, which may use the poles as hunting perches.
- Once the turbines have been constructed, post-construction monitoring should be implemented as part of the continuation of the current monitoring programme, to assess displacement and actual collision rates. If actual collision and displacement levels are deemed too high, the following mitigation measures would need to be considered:
    - Negotiating appropriate off-set compensation for turbine related displacement and collision mortality;
    - As a last resort, halting operation of specific turbines during peak flight periods, or reducing rotor speed, to reduce the risk of collision mortality.

10.4.2 San Kraal Wind Energy Facility (Van Rooyen et al. 2017)

Potential Impact: Displacement of priority species due to construction activities at the wind development area

- Restrict the construction activities to the construction footprint area.
- Do not allow any access to the remainder of the property during the construction period.
- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum.
- Implement a 500m no development buffer zone around each of the two pans at FP3 at 31°14'15.02"S 25° 2'44.17"E and FP4 at 31°13'55.42"S 25° 2'50.37"E to protect the pair of Blue Cranes from disturbance.
- The appointed Environmental Control Officer (ECO) should be trained by an avifaunal specialist to identify the signs that indicate possible breeding by priority species. The ECO must then, during audits/site visits, make a concerted effort to look out for such breeding activities of such species, and such efforts may include the training of construction staff to identify such species, followed by regular questioning of staff as to the regular whereabouts on site of the species. If any priority species are confirmed to be breeding (e.g. if a nest site is found), construction activities within 500m of the breeding site must cease, and the avifaunal specialist will be contacted immediately for further assessment of the situation and instruction on how to proceed.

Potential Impact: Displacement of priority species due to construction activities associated with the grid connection powerline.

- The final powerline design and associated electrocution mitigation measures (if necessary) must be approved and signed off by the avifaunal specialist.

Potential Impact: Displacement of priority species due to habitat destruction at the wind development site

- Once the turbines have been constructed, post-construction monitoring should be implemented to compare actual collision rates with predicted collision rates.
- The avifaunal specialist, in consultation with external experts and relevant NGO's such as BLSA, should determine annual mortality thresholds for priority species anticipated to be at risk of collision mortality, prior to the wind farm going operational.
- If actual collision rates exceed the pre-determined threshold levels, curtailment of turbines should be implemented for high risk situations.
- A 150m no-turbine set-back buffer zone (infrastructure is allowed) is required around the escarpment to minimise the risk of collisions for slope soaring species.
- Care should be taken not to create habitat for prey species that could draw priority raptors into the area and expose them to collision risk. Rock piles must be removed from site or covered with topsoil to prevent them from becoming habitat for Rock Hyrax (Dassie).

Potential Impact: Direct mortality of priority species due to collisions with the grid connection powerline at the wind development area – Preferred Alternative, Alternative 1 and Alternative 2

- The final power line route should be assessed by way of a walk-through and those sections requiring Bird Flight Diverters (BFDs) must be identified.
- Use the Preferred Alternative or Alternative 1 for the grid connection in order to avoid the No-Go zone around the Verreaux's Eagle nest at FP1.

Potential Impact: Displacement of priority species due to dismantling activities at the wind development area

- Restrict the dismantling activities to the footprint area.
- Do not allow any access to the remainder of the property during the dismantling period.
- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum.

Potential Impact: Displacement of priority species due to dismantling of the powerline

- Restrict the dismantling activities to the footprint area.
- Do not allow any access to the remainder of the property during the dismantling period.
- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum.
- An avifaunal specialist should perform a walk-through of the powerline prior to the commencement of the dismantling activities to identify any raptor nests on the line. Should a nest be discovered, the avifaunal specialist must have input into the dismantling schedule to assess how and which of the dismantling activities can be timed to minimize the disturbance potential to the occupants of the nest.

10.4.3 Proposed Solar Facilities within a 35km radius around the proposed Phezukomoya WEF

No stand-alone bird impact assessment studies could be located for any of the solar facilities proposed within a 35km radius around the proposed Phezukomoya WEF development, except for the Noupoort CSP Facility. The recommendations in the avifaunal impact assessment report for the CSP project entail that the preferred powerline alternative is marked with Bird Flight Diverters in high risk areas, and that a monitor programme is implemented to assess the impact on bird communities of collisions with the parabolic troughs (Van Niekerk 2016).

10.5 Assessment of cumulative impacts

The greatest potential concern in the 35km radius around Phezukomoya WEF is for the large raptor species, particularly the Red Listed Verreaux's Eagle, due to their relatively low numbers and vulnerability to turbine collisions (Ralston – Patton *et al*. 2017). Another concern is the potential impact of the powerline grid connections on large terrestrial species, particularly Blue Crane, Ludwig's Bustard and Secretarybird. The combined cumulative impact of renewable developments on priority species, and particularly wind energy developments on Verreaux's Eagle, within the 35km radius around the Phezukomoya WEF, is potentially significant at a local, and require the strict application of mitigation measures such as buffer zones around nests, and the establishment of mortality thresholds and subsequent curtailment of turbines, if thresholds are exceeded. In addition, the marking of powerlines associated with these projects, with anti-collision devices, will be of paramount importance. The impact should be less severe at a regional or national level, due to the large distribution ranges of the species, but should nonetheless be carefully monitored.

Table 10-2 below summarises the anticipated cumulative impacts of the proposed Phezukomoya WEF.

Table 10-2: Assessment of cumulative impacts

Impact Phase: Cumulative impacts							
Potential impact description: • Displacement of priority species due to construction activities at the wind development area • Mortality of priority species due to electrocution associated with the internal medium voltage MV powerlines • Direct mortality of priority species due to collisions with the turbines at the wind development area • Displacement of priority species due to dismantling activities at the wind development area • Direct mortality of priority species due to collisions with the internal medium voltage MV lines and the 132kV grid connection powerline							
	Extent	**Duration**	**Severity**	**Status**	**Significance**	**Probability**	**Confidence**
Without Mitigation	Medium	Medium	Medium	Negative	Medium	High	High
With Mitigation	Medium	Medium	Low	Negative	Low	Low	Medium
Can the impact be reversed?			YES, with the application of mitigation measures as detailed in the previous impact tables				
Will impact cause irreplaceable loss or resources?			NO, not with the application of mitigation measures as detailed in the previous impact tables				
Can impact be avoided, managed or mitigated?			YES, with the application of mitigation measures as detailed in the previous impact tables				
Mitigation measures to reduce residual risk or enhance opportunities: • See tables 9-6 to 9-13 for proposed mitigation measures • All the proposed mitigation measures proposed for the other renewable energy facilities within a 35km radius should be implemented.							

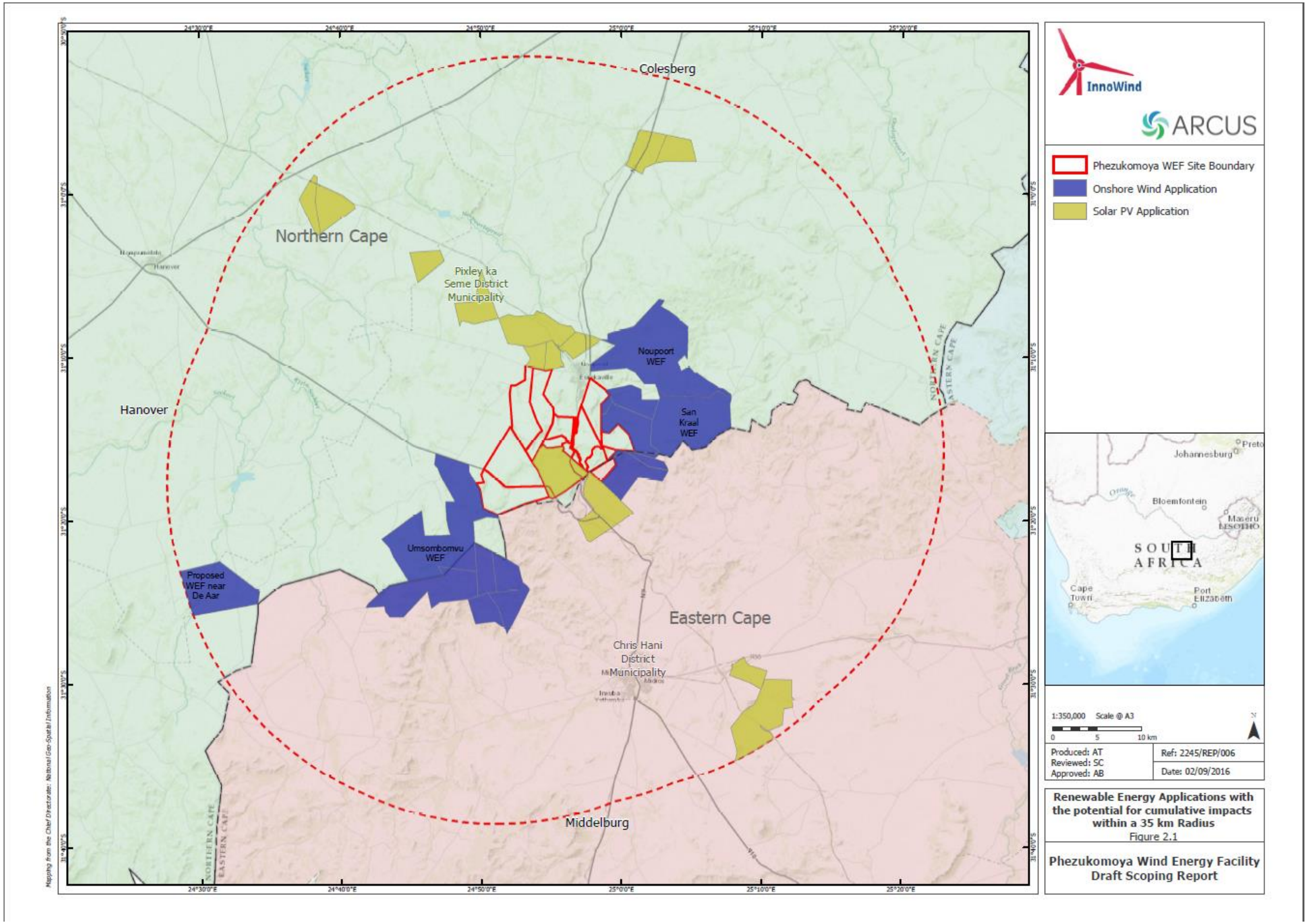

Figure 15: Renewable energy developments planned in a 35km radius around the Phezukomoya WEF.

11. NO-GO OPTION

If the proposed wind farm does not go-ahead, the status quo will be maintained. It is anticipated that the current land use will continue for an indefinite period, which will result in no significant changes to the ecological integrity of the study as it currently exists. This would be beneficial to avifauna in the long term.

12. RESPONSES TO COMMENTS FROM PUBLIC PARTICIPATION

The comments pertaining to avifauna received through the public participation process, and the responses thereto, is listed in Table 11-1 below:

Table 11-1: Responses to comments received from stakeholders

COMMENT	STAKEHOLDER	RESPONSE
Please confirm that Van Rooyen will undertake a cumulative impacts assessment for all priority Avian species considering all impacts as per NEMA requirements	Karoo News Group	This is covered by Section 10 of the report
Please also be advised that the site lies on a very important Interval on the Southern Great Escarpment and that the Scoping needs to consider this context.	Karoo News Group	A 12-months pre-construction monitoring programme was implemented to assess the importance of the site for priority avifauna
The bird specialist will need to do a cumulative impacts assessment that takes in all likely and existing impacts. Please provide detail We would like the avaina (sic) consultant also to use the Southern Great Escarpments in its context for migrating boirds (sic) as well as semigrating (sic) bird species	Karoo News Group	A 12-months pre-construction monitoring programme was implemented assess the importance of the site for priority avifauna. The presence of migrating birds at the site was recorded and factored into the assessments and mitigation measures.
Please ask the Avian specialist how he intends to comply with International Bird Conservation Agreements which require a SEA for industrial wind farms (sic) which is consider and assess cumulative impacts	Karoo News Group	The issue of cumulative impacts is covered in Section 10. An SEA for wind and solar developments has been completed under the auspices of the CSIR and falls outside the scope of this specialist study.

for priority specis (sic) for which current RE SEA does not comply		
We are sure you are aware of what is required, however….. 1)Convention on the Conservation of Migratory Species of Wild Animals (CMS) and 2) the Agreement on the Conservation of African Eurasian Migratory Waterbirds (AEWA),	Karoo News Group	The legislative context is covered in section 5. The issue of cumulative impacts is covered in Section 10. A SEA for wind and solar developments has been completed under the auspices of the CSIR and falls outside the scope of this specialist study.
What is required and is quite clear in the agreements is that a spatial cumulative impact assessment for priority species is a requirement. This would mean that all renewable energy developments in the Noupoort area need to be considered cumulative impacts assessments are required that assess all renewable energy impacts on the Great Escarpment	Karoo News Group	The issue of cumulative impacts is covered in Section 10.
Specialist studies to be conducted must provide a detailed description of their methodology, as well as indicate the locations and descriptions of turbine positions, and all other associated infrastructures that they have assessed and are recommending for authorisation.	DEA	These aspects are covered in Section 1: Introduction and Background, Section 3: Sources of Information and Methodology, Section 4: Assumptions and Limitations
The specialist studies must also provide a detailed description of all limitations to their studies. All specialist studies must be conducted in the right season and providing that as a limitation, will not be accepted.	DEA	The study was conducted over four seasons. See also Section 4: Assumptions and Limitations
Please note that the Department considers a 'no-go' area as an area where no development of any	DEA	This was noted in the report.

infrastructure is allowed; therefore no development of associated infrastructure including access roads and internal cables is allowed in the 'no-go' areas.		
Should the specialist definition of 'no-go' area differ from the Departments definition; this must be clearly indicated. The specialist must also indicate the 'no-go' area's buffer.	DEA	This was noted in the report
The bat and avifaunal assessments must assess and make recommendations for definite measurements for the preferred hub heights and rotor diameter.	DEA	The assumption that a larger rotor-swept area will automatically increase the risk of collision is questionable. While the assumption seems to make intuitive sense, it should be noted that the majority of published scientific studies indicate that an increase in rotor swept area do not automatically translate into a larger collision risk. Turbine dimensions seem to play an insignificant role in the magnitude of the collision risk in general, relative to other factors such as topography, turbine location, morphology and a species' inherent ability to avoid the turbines, and may only be relevant in combination with other factors, particularly wind strength and topography (see Howell 1997, Barrios & Rodriguez 2004; Barclay et al. 2007, Krijgsveld et al. 2009, Smallwood 2013; Everaert 2014). Only two studies found a correlation between turbine hub height and mortality (De Lucas et al. 2008; Loss et al. 2013). It is therefore deemed unnecessary to provide a specific recommendation as far as hub height and rotor diameter is concerned, from avifaunal perspective.

It is noted that the 12 months avifaunal and bat monitoring was conducted in 2015. The EAP is advised to ensure that the proposed mitigation measures are in line with the latest guidelines from BirdLife South Africa and SABAAP.	DEA	The last update of the Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa" (Jenkins, A.R., Van Rooyen, C.S., Smallie, J.J., Anderson, M.D., & A.H. Smit. 2011), was in 2015. The Verreaux's Eagle and Wind Farms. Guidelines for Impact Assessment, Monitoring and Mitigation. BirdLife South Africa (2017) was released after the completion of the monitoring, but it was considered in the determination of buffer zones for Verreaux's Eagles.
Should there be any other similar projects within a 30km radius of the proposed development site, the cumulative assessment for all identified and assessed impacts must be refined to indicate the following: Identified cumulative impacts must be clearly defined, and where possible the size of the identified impact must be quantified and indicated, i.e. hectares of cumulatively transformed land. Detailed process and flow and proof must be provided, to indicate how the specialist's recommendations, mitigation measured and conclusions from the various similar developments in the area were taken into consideration in the assessment of cumulative impacts and when the conclusion and mitigation measures were drafted for this project. A **cumulative impact environmental statement** on whether the proposed development must proceed.	DEA	The issue of cumulative impacts is covered in Section 10.

The avifaunal specialist must provide an overview of bird movements along the Southern Great Escarpment and especially discuss the possibility of migration routes in the study area.	DEA	No evidence could be found of a well-defined, recognised avifaunal, migratory fly-way along the Southern Great Escarpment, such as for example in the Great Rift valley in East Africa. A 12-months pre-construction monitoring programme was implemented assess the importance of the site for priority avifauna. The presence of migrating birds at the site was recorded and factored into the assessments and mitigation measures. The presence of migratory species at he proposed site is linked to the presence of food, and not topography.
An avifauna monitoring and management plan to be implemented during the construction and operation of the facility. This plan must be drafted by a suitably qualified avifauna specialist.	DEA	Plse see Appendix 7 for an Avifaunal Management Plan

13. CONCLUSIONS

It is anticipated that the proposed Phezukomoya Wind Energy Facility will have a variety of impacts on avifauna which ranges from low to high. The impacts are:

- Collision mortality on the wind turbines;
- Displacement due to disturbance during construction (and dismantling) of the wind farm and associated infrastructure;
- Displacement due to habitat change and loss;
- Electrocution on the internal medium voltage powerline grid where the lines run above ground;
- Collision with the proposed power line grid connections and the internal medium voltage powerlines where the lines run above ground; and
- Displacement due to disturbance during the construction (and dismantling) of the power line grid connection.

Of the 184 species that could occur at the site, 32 are classified as priority species for wind farm developments (Retief *et al*. 2012).

Displacement of priority species due to disturbance during the construction (and dismantling) phases of the wind energy facility and associated infrastructure is likely to be a temporary, medium negative impact, and will remain at a medium level despite the application of mitigation measures. None of the priority species are likely to be permanently displaced due to disturbance, although partial displacement of terrestrial species e.g. Blue Crane, Secretarybird, Grey-winged Francolin and African Rock Pipit in the short term during the construction phase is very likely. It is highly likely that most priority species will be temporarily displaced in the development area during the construction operations, due to the noise and activity, The implementation of a 2.5km buffer zone around the Verreaux's Eagle nesting area could reduce any potential disturbance impacts on Verreaux's Eagles, but not for the other priority species. The significance will therefore remain at a medium level collectively for priority species, after mitigation.

Displacement of priority species due to disturbance during construction (and dismantling) phases of the grid connection is likely to be a temporary, medium negative impact, and should be reduced to a low level with the application of mitigation measures. Species most likely to be affected by this impact would be terrestrial species such as Grey-winged Francolin, Blue Crane, Ludwig's Bustard, Northern Black Korhaan, Secretarybird and Blue Korhaan. The construction activities associated with the grid connection could result in the short-term displacement of priority species from the site. The implementation of the proposed mitigation measures should reduce the probability of disturbance of priority species.

Displacement of priority species due to habitat destruction during operational lifetime of the wind energy facility phase is likely to be a medium negative impact but will be reduced to a low level with the application of mitigation measures. Species most likely to be affected by the habitat destruction (particularly fragmentation) are the terrestrial species such as Blue Crane, Ludwig's Bustard, Secretarybird and Grey-winged Francolin. The rehabilitation of disturbed areas will help to mitigate the impact of the habitat transformation to some extent, but the fragmentation of the habitat due to the construction of the internal road network cannot be mitigated, and will remain an impact for the duration of the operational life-time of the facility.

Collisions of priority species with the turbines in the operational phase are likely to be a medium negative impact and it could be reduced to a low negative level through the application of mitigation measures. Species most likely to be at risk of collision with the turbines are Lesser Kestrel and Jackal Buzzard. Very little Verreaux's Eagle flight activity was recorded, but that does not exclude the potential for collisions. The impact is likely to persist for the operational life-time of the project. Implementation of the proposed mitigation measures should reduce the probability and severity of the impact on priority species to such an extent that the overall significance should be reduced to low.

Mortality of priority species with the grid connection and internal medium voltage network due to collisions in the operational phase is likely to be of medium significance, and will remain as such after the implementation of mitigation measures. Several of the priority species which occur or potentially occur in the study area are power line sensitive from a collision perspective. These include Ludwig's Bustard, Blue Crane, Northern Black Korhaan, Karoo Korhaan, Blue Korhaan, Secretarybird, White Stork and Greater Flamingo. All of these species, but particularly Ludwig's Bustard and Blue Crane, could be impacted by the proposed grid connection and the internal medium voltage MV lines (where they are above ground) through collision. The application of BFDs should reduce the probability and severity of the collision impact, but it is likely to remain at the medium level, as the application of BFD's will reduce, but not eliminate the risk.

Mortality due to electrocutions with the overhead sections of the medium voltage internal network is likely to be a medium impact, but it can be reduced to low through the use of bird-friendly pole designs, which must be approved by the avifaunal specialist. The poles could potentially be lethal for species such as Jackal Buzzard, Verreaux's

Eagle, Martial Eagle, Cape Eagle-Owl, Spotted Eagle-Owl, Steppe Buzzard and African Harrier-hawk. The electrocution risk will persist as long as the lines are up, but it can be completely eliminated at the onset if bird-friendly structures are used.

From a cumulative impact perspective, the greatest potential concern in the 35km radius around Phezukomoya WEF is for the large raptor species, particularly the Red Listed Verreaux's Eagle and Martial Eagle, due to their relatively low numbers and vulnerability to turbine collisions (Ralston – Patton *et al*. 2017). Another concern is the potential impact of the powerline grid connections on large terrestrial species, particularly Blue Crane, Ludwig's Bustard and Secretarybird. The combined cumulative impact of renewable developments on priority species, and particularly wind energy developments on Verreaux's Eagle and Martial Eagle, within the 35km radius around the Phezukomoya WEF, is potentially significant at a local scale, and require the strict application of mitigation measures such as buffer zones around nests, and the establishment of mortality thresholds and subsequent curtailment of turbines, if thresholds are exceeded. The impact should be less severe at a regional and national level, due to the large distribution ranges of the species, but should nonetheless be carefully monitored. If all the mitigation measures proposed for the various renewable projects are strictly implemented, the cumulative impacts of these developments, including the proposed Phezukomoya WEF, should be reduced to low.

It is our opinion that the proposed development be approved, subject to the strict implementation of the proposed mitigation measures detailed in this report.

We are satisfied that the final mitigated layout (December 2017) incorporates the proposed avifaunal buffer zones as recommended in the avifaunal specialist study.

14. SENSITIVITY MAP

See Figure 16 below for a sensitivity map indicating proposed buffer zones. Two categories of buffer zones are suggested namely:

- Infrastructure free buffer zone, which is a total no-go area[12]; and
- No turbine buffer zone, which still allows for associated infrastructure e.g. roads and internal powerlines.

[12] This buffer should apply to all infrastructure, except a proposed electricity cable which will be located along the existing dirt road which is partially located within this buffer zone (see Table 9-6).

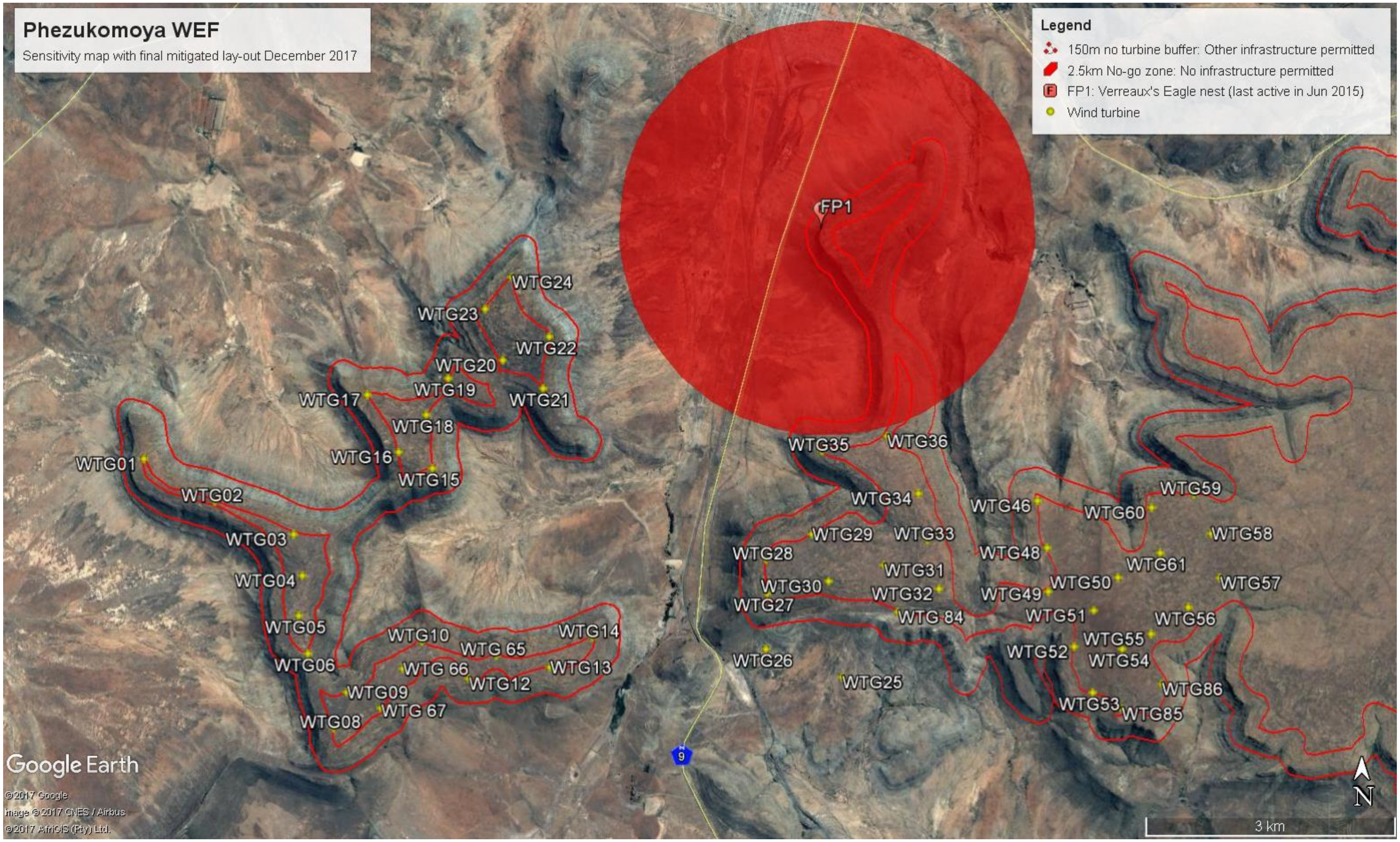

Figure 16: Sensitivity map of the study area, indicating proposed buffer zones and turbines to be re-located. FP1 indicates the locality of a Verreaux's Eagle nest.

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APPENDIX 1: SPECIES POTENTIALLY OCCURRING IN THE STUDY AREA

EN = Endangered VU = Vulnerable NT = Near threatened LC = Least concern

Species	Taxonomic name	SABAP2 reporting rate	Global status	Regional status	Priority species
Apalis, Bar-throated	*Apalis thoracica*	2.94			
Avocet, Pied	*Recurvirostra avosetta*	8.82			
Barbet, Acacia Pied	*Tricholaema leucomelas*	63.24			
Barbet, Crested	*Trachyphonus vaillantii*	5.88			
Batis, Pririt	*Batis pririt*	1.47			
Bee-eater, European	*Merops apiaster*	22.06			
Bishop, Southern Red	*Euplectes orix*	60.29			
Bittern, Little	*Ixobrychus minutus*	1.47			
Bokmakierie, Bokmakierie	*Telophorus zeylonus*	92.65			
Bulbul, African Red-eyed	*Pycnonotus nigricans*	75			
Bunting, Cape	*Emberiza capensis*	82.35			
Bunting, Cinnamon-breasted	*Emberiza tahapisi*	7.35			
Bunting, Lark-like	*Emberiza impetuani*	25			
Bustard, Ludwig's	*Neotis ludwigii*	4.41	EN	EN	x
Buzzard, Jackal	*Buteo rufofuscus*	34.62			x
Buzzard, Steppe	*Buteo vulpinus*	14.71			x
Canary, Black-headed	*Serinus alario*	41.18			
Canary, Black-throated	*Crithagra atrogularis*	27.94			
Canary, Cape	*Serinus canicollis*	35.29			
Canary, White-throated	*Crithagra albogularis*	30.88			
Canary, Yellow	*Crithagra flaviventris*	20.59			
Chat, Anteating	*Myrmecocichla formicivora*	67.65			
Chat, Familiar	*Cercomela familiaris*	83.82			
Chat, Karoo	*Cercomela schlegelii*	1.47			
Chat, Sickle-winged	*Cercomela sinuata*	22.06			
Cisticola, Cloud	*Cisticola textrix*	13.24			
Cisticola, Desert	*Cisticola aridulus*	14.71			
Cisticola, Grey-backed	*Cisticola subruficapilla*	67.65			
Cisticola, Levaillant's	*Cisticola tinniens*	25			
Cisticola, Zitting	*Cisticola juncidis*	7.35			
Coot, Red-knobbed	*Fulica cristata*	23.53			
Cormorant, Reed	*Phalacrocorax africanus*	2.94			
Cormorant, White-breasted	*Phalacrocorax carbo*	2.94			
Crane, Blue	*Anthropoides paradiseus*	42.65	VU	NT	x
Crombec, Long-billed	*Sylvietta rufescens*	19.12			
Crow, Cape	*Corvus capensis*	2.94			
Crow, Pied	*Corvus albus*	86.76			
Cuckoo, Diderick	*Chrysococcyx caprius*	17.65			
Cuckoo, Jacobin	*Clamator jacobinus*	1.47			
Dove, Laughing	*Streptopelia senegalensis*	54.41			
Dove, Namaqua	*Oena capensis*	8.82			
Dove, Red-eyed	*Streptopelia semitorquata*	42.65			
Dove, Rock	*Columba livia*	1.47			
Drongo, Fork-tailed	*Dicrurus adsimilis*	16.18			
Duck, African Black	*Anas sparsa*	7.35			
Duck, Yellow-billed	*Anas undulata*	38.24			

Species	Taxonomic name	SABAP2 reporting rate	Global status	Regional status	Priority species
Eagle, Booted	*Aquila pennatus*	20.59			x
Eagle, Martial	*Polemaetus bellicosus*	2.94	VU	EN	x
Eagle, Tawny	*Aquila rapax*	1.47	LC	EN	x
Eagle, Verreaux's	*Aquila verreauxii*	16.18	LC	VU	x
Eagle-owl, Cape	*Bubo capensis*	1.47			x
Eagle-owl, Spotted	*Bubo africanus*	5.88			x
Egret, Cattle	*Bubulcus ibis*	7.35			
Eremomela, Yellow-bellied	*Eremomela icteropygialis*	11.76			
Falcon, Amur	*Falco amurensis*	7.35			x
Falcon, Lanner	*Falco biarmicus*	2.94	LC	VU	x
Fiscal, Common (Southern)	*Lanius collaris*	94.12			
Fish-eagle, African	*Haliaeetus vocifer*	0			x
Flamingo, Greater	*Phoenicopterus ruber*	1.47	LC	NT	x
Flycatcher, Chat	*Bradornis infuscatus*	1.47			
Flycatcher, Fairy	*Stenostira scita*	25			
Flycatcher, Fiscal	*Sigelus silens*	55.88			
Francolin, Grey-winged	*Scleroptila africanus*	30.88			x
Goose, Egyptian	*Alopochen aegyptiacus*	61.76			
Goose, Spur-winged	*Plectropterus gambensis*	22.06			
Goshawk, Gabar	*Melierax gabar*	5.88			
Goshawk, Southern Pale Chanting	*Melierax canorus*	23.53			x
Grebe, Great Crested	*Podiceps cristatus*	1.47			
Grebe, Little	*Tachybaptus ruficollis*	5.88			
Greenshank, Common	*Tringa nebularia*	7.35			
Guineafowl, Helmeted	*Numida meleagris*	54.41			
Hamerkop, Hamerkop	*Scopus umbretta*	11.76			
Harrier, Black	*Circus maurus*	0	VU	EN	x
Harrier-Hawk, African	*Polyboroides typus*	1.47			x
Heron, Black-headed	*Ardea melanocephala*	13.24			
Heron, Grey	*Ardea cinerea*	27.94			
Honeyguide, Greater	*Indicator indicator*	5.88			
Honeyguide, Lesser	*Indicator minor*	2.94			
Hoopoe, African	*Upupa africana*	38.24			
Ibis, African Sacred	*Threskiornis aethiopicus*	11.76			
Ibis, Glossy	*Plegadis falcinellus*	1.47			
Ibis, Hadeda	*Bostrychia hagedash*	69.12			
Kestrel, Greater	*Falco rupicoloides*	2.94			x
Kestrel, Lesser	*Falco naumanni*	35.29			x
Kestrel, Rock	*Falco rupicolus*	38.24			x
Kingfisher, Brown-hooded	*Halcyon albiventris*	2.94			
Kingfisher, Malachite	*Alcedo cristata*	1.47			
Kite, Black-shouldered	*Elanus caeruleus*	13.24			x
Korhaan, Blue	*Eupodotis caerulescens*	10.29	NT	LC	x
Korhaan, Karoo	*Eupodotis vigorsii*	1.47	LC	NT	x
Korhaan, Northern Black	*Afrotis afraoides*	33.82			x
Lapwing, Blacksmith	*Vanellus armatus*	48.53			
Lapwing, Crowned	*Vanellus coronatus*	35.29			
Lark, Cape Clapper	*Mirafra apiata*	1.47			
Lark, Eastern Clapper	*Mirafra fasciolata*	66.18			
Lark, Eastern Long-billed	*Certhilauda semitorquata*	16.18			

Species	Taxonomic name	SABAP2 reporting rate	Global status	Regional status	Priority species
Lark, Karoo Long-billed	*Certhilauda subcoronata*	1.47			
Lark, Large-billed	*Galerida magnirostris*	32.35			
Lark, Melodious	*Mirafra cheniana*	2.94	NT	LC	x
Lark, Red-capped	*Calandrella cinerea*	8.82			
Lark, Spike-heeled	*Chersomanes albofasciata*	33.82			
Longclaw, Cape	*Macronyx capensis*	35.29			
Martin, Brown-throated	*Riparia paludicola*	20.59			
Martin, Rock	*Hirundo fuligula*	51.47			
Masked-weaver, Southern	*Ploceus velatus*	88.24			
Moorhen, Common	*Gallinula chloropus*	16.18			
Mousebird, Red-faced	*Urocolius indicus*	27.94			
Mousebird, Speckled	*Colius striatus*	38.24			
Mousebird, White-backed	*Colius colius*	42.65			
Neddicky, Neddicky	*Cisticola fulvicapilla*	67.65			
Nightjar, Fiery-necked	*Caprimulgus pectoralis*	1.47			
Nightjar, Rufous-cheeked	*Caprimulgus rufigena*	1.47			
Owl, Barn	*Tyto alba*	2.94			
Paradise-flycatcher, African	*Terpsiphone viridis*	2.94			
Pigeon, Speckled	*Columba guinea*	75			
Pipit, African	*Anthus cinnamomeus*	52.94			
Pipit, African Rock	*Anthus crenatus*	39.71	LC	NT	x
Pipit, Buffy	*Anthus vaalensis*	4.41			
Pipit, Long-billed	*Anthus similis*	35.29			
Pipit, Plain-backed	*Anthus leucophrys*	4.41			
Plover, Kittlitz's	*Charadrius pecuarius*	2.94			
Plover, Three-banded	*Charadrius tricollaris*	33.82			
Prinia, Karoo	*Prinia maculosa*	82.35			
Quailfinch, African	*Ortygospiza atricollis*	8.82			
Quelea, Red-billed	*Quelea quelea*	8.82			
Raven, White-necked	*Corvus albicollis*	38.24			
Reed-warbler, African	*Acrocephalus baeticatus*	13.24			
Robin-chat, Cape	*Cossypha caffra*	63.24			
Rock-thrush, Short-toed	*Monticola brevipes*	7.35			
Roller, European	*Coracias garrulus*	1.47	LC	NT	
Sandgrouse, Namaqua	*Pterocles namaqua*	5.88			
Sandpiper, Common	*Actitis hypoleucos*	1.47			
Scrub-robin, Karoo	*Cercotrichas coryphoeus*	95.59			
Shelduck, South African	*Tadorna cana*	39.71			
Shoveler, Cape	*Anas smithii*	2.94			
Shrike, Red-backed	*Lanius collurio*	1.47			
Snipe, African	*Gallinago nigripennis*	1.47			
Sparrow, Cape	*Passer melanurus*	80.88			
Sparrow, House	*Passer domesticus*	35.29			
Sparrow, Southern Grey-headed	*Passer diffusus*	29.41			
Sparrowhawk, Black	*Accipiter melanoleucus*	1.47			x
Sparrowhawk, Rufous-chested	*Accipiter rufiventris*	1.47			x
Sparrowlark, Grey-backed	*Eremopterix verticalis*	1.47			
Spoonbill, African	*Platalea alba*	8.82			
Starling, Cape Glossy	*Lamprotornis nitens*	11.76			
Starling, Common	*Sturnus vulgaris*	13.24			

Species	Taxonomic name	SABAP2 reporting rate	Global status	Regional status	Priority species
Starling, Pale-winged	*Onychognathus nabouroup*	20.59			
Starling, Pied	*Spreo bicolor*	92.65			
Starling, Red-winged	*Onychognathus morio*	38.24			
Starling, Wattled	*Creatophora cinerea*	8.82			
Stilt, Black-winged	*Himantopus himantopus*	8.82			
Stonechat, African	*Saxicola torquatus*	26.47			
Stork, Black	*Ciconia nigra*	2.94	LC	VU	x
Stork, White	*Ciconia ciconia*	5.88			x
Sunbird, Amethyst	*Chalcomitra amethystina*	1.47			
Sunbird, Malachite	*Nectarinia famosa*	27.94			
Sunbird, Southern Double-collared	*Cinnyris chalybeus*	17.65			
Swallow, Barn	*Hirundo rustica*	52.94			
Swallow, Greater Striped	*Hirundo cucullata*	80.88			
Swallow, Pearl-breasted	*Hirundo dimidiata*	1.47			
Swallow, White-throated	*Hirundo albigularis*	16.18			
Swamp-warbler, Lesser	*Acrocephalus gracilirostris*	20.59			
Swift, Alpine	*Tachymarptis melba*	11.76			
Swift, Little	*Apus affinis*	38.24			
Swift, White-rumped	*Apus caffer*	42.65			
Teal, Cape	*Anas capensis*	2.94			
Teal, Red-billed	*Anas erythrorhyncha*	13.24			
Thick-knee, Spotted	*Burhinus capensis*	14.71			
Thrush, Karoo	*Turdus smithi*	44.12			
Tit, Grey	*Parus afer*	4.41			
Tit-babbler, Chestnut-vented	*Parisoma subcaeruleum*	30.88			
Tit-babbler, Layard's	*Parisoma layardi*	44.12			
Turtle-dove, Cape	*Streptopelia capicola*	86.76			
Wagtail, Cape	*Motacilla capensis*	83.82			
Warbler, Namaqua	*Phragmacia substriata*	8.82			
Warbler, Rufous-eared	*Malcorus pectoralis*	67.65			
Warbler, Willow	*Phylloscopus trochilus*	1.47			
Waxbill, Common	*Estrilda astrild*	29.41			
Weaver, Cape	*Ploceus capensis*	1.47			
Wheatear, Capped	*Oenanthe pileata*	1.47			
Wheatear, Mountain	*Oenanthe monticola*	60.29			
White-eye, Cape	*Zosterops virens*	42.65			
White-eye, Orange River	*Zosterops pallidus*	1.47			
Whydah, Pin-tailed	*Vidua macroura*	14.71			
Woodpecker, Cardinal	*Dendropicos fuscescens*	1.47			
Woodpecker, Ground	*Geocolaptes olivaceus*	17.65			

APPENDIX 2: PRE-CONSTRUCTION MONITORING AT PHEZUKOMOYA WEF

1. Objectives

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

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

2. Methods

The monitoring protocol for the site was designed according to the latest version (2015) of the *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa. Endangered Wildlife Trust and Birdlife South Africa (Jenkins A R; Van Rooyen C S; Smallie J J; Anderson M D & Smit H A. 2011)* which was applicable at the time of the commencement of the pre-construction monitoring[13].

The monitoring was conducted at the proposed turbine site and a control site by four field monitors.

Monitoring was conducted during the following time periods:

- 30 March – 7 April 2015
- 18 June - 25 June 2015
- 27 October - 3 November 2015
- 11 January – 13 January 2016
- 7 - 17 February 2016

Monitoring was conducted in the following manner:

- One drive transect was identified totalling 7.2km on the turbine site and one drive transect in the control site with a total length of 5.52km (see Figure 1).
- Two observers travelling slowly (± 10km/h) in a vehicle recorded all species on both sides of the transect. The observers stopped at regular intervals (every 500 m) to scan the environment with binoculars. Drive transects were counted 3 x per sampling session (see Figure 1).
- In addition, six walk transects of 1km each were identified at the turbine site, and one at the control site (see Figure 1). All birds were recorded during walk transects, not only priority species. Walk transects were counted 12 x per sampling session.
- The following variables were recorded:
    - Species;
    - Number of birds;

[13] The BirdLife SA Verreaux's Eagle guidelines for wind farm developments only was only released in May 2017, after the completion of the monitoring

  - Date;
  - Start time and end time;
  - Distance from transect (0-50 m, 50-100 m, >100 m);
  - Wind direction;
  - Wind strength (calm; moderate; strong);
  - Weather (sunny; cloudy; partly cloudy; rain; mist);
  - Temperature (cold; mild; warm; hot);
  - Behaviour (flushed; flying-display; perched; perched-calling; perched-hunting; flying-foraging; flying-commute; foraging on the ground); and
  - Co-ordinates (priority species only).

- Six vantage points (VPs) were selected from which the majority of the proposed turbine area can be observed (the "VP area")[14], to record the flight altitude and patterns of priority species. A single observer was employed per VP to cover a 360˚ viewshed[15].One VP was also identified on the control site. The following variables were recorded for each flight:
  - Species;
  - Number of birds;
  - Date;
  - Start time and end time;
  - Wind direction;
  - Wind strength (estimated Beaufort scale 1-7);
  - Weather (sunny; cloudy; partly cloudy; rain; mist);
  - Temperature (cold; mild; warm; hot);
  - Flight altitude (high i.e. >200 m; medium i.e. 30 -220 m; low i.e. <30 m);
  - Flight mode (soar; flap; glide; kite; hover); and
  - Flight time (in 15 second-intervals).

The aim with drive transects was primarily to record large priority species (i.e. raptors and large terrestrial species), while walk transects were primarily aimed at recording small passerines. The objective of the transect monitoring was to gather baseline data on the use of the site by birds in order to measure potential displacement by the wind farm activities. The objective of vantage point counts was to measure the potential collision risk with the turbines. Priority species were identified using the January 2014 BLSA list of priority species for wind farms.

- Three dams, FP2a, FP2b, FP5 and Verreaux's Eagle nest were monitored as potential avifaunal focal points.
- The escarpment at the wind development site was systematically inspected with binoculars and a telescope during each site visit for signs of Lanner Falcon, Jackal Buzzard, Booted Eagle, Black Stork and Verreaux's Eagle breeding activity, but none were found. The reason for that is most likely that the cliffs are too low and not vertical enough to provide suitable nesting habitat.

[14] 80% of the proposed turbines positions were located within 2km of a VP

[15] The best practice guidelines provide for the use of a single observer when the activity of target species is low and visibility is good, as was the case here.

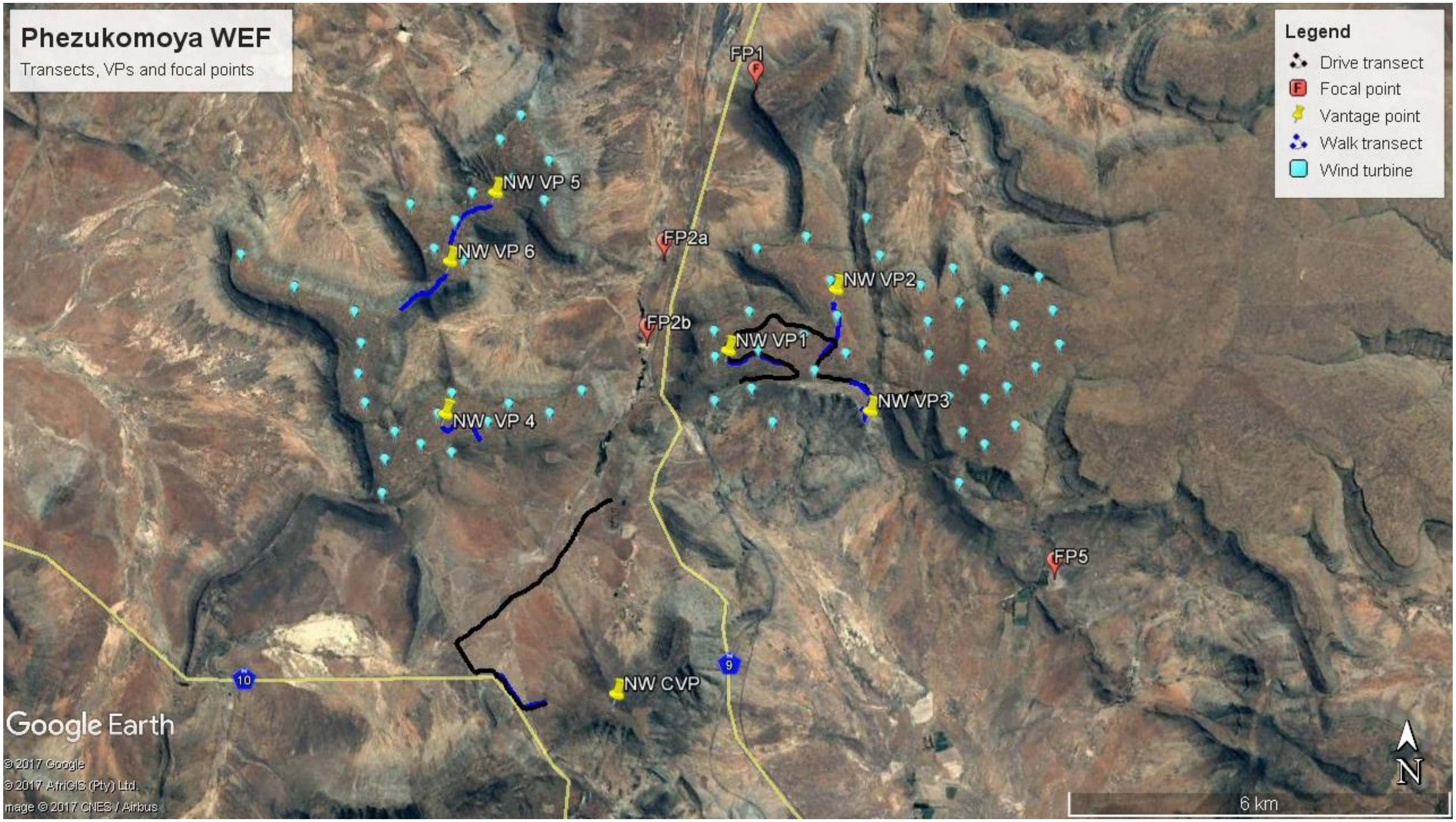


Figure 1: Vantage points, walk transects, focal points and drive transects at Phezukomoya WEF.

APPENDIX 3: COORDINATED AVIFAUNAL ROADCOUNT DATA 2003 – 2014 FOR EASTERN KAROO

Summer - birds/km							
	Blue Crane	Karoo Korhaan	Ludwig's Bustard	Secretarybird	Blue Korhaan	Northern Black Korhaan	White Stork
2003	59.80	3.50	14.70	1.30	3.20	12.40	14.80
2004	22.90	3.20	6.50	2.20	2.30	20.40	39.50
2005	36.00	4.00	5.30	2.00	1.70	18.30	30.90
2006	18.50	2.20	6.20	2.30	2.20	41.70	0.40
2007	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2008	16.70	35.80	30.30	0.90	3.60	17.00	60.00
2009	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2010	47.50	5.80	7.50	2.80	3.00	32.80	38.30
2011	26.60	4.00	5.20	1.80	0.20	43.10	14.10
2012	59.60	5.40	11.00	1.70	0.00	15.00	2.10
2013	43.10	3.40	3.40	2.60	0.00	18.70	1.50
2014	64.50	0.00	1.80	1.60	1.80	15.80	10.40
Average	**39.52**	**6.73**	**9.19**	**1.92**	**1.80**	**23.52**	**21.20**

Winter - birds/km							
	Blue Crane	Karoo Korhaan	Ludwig's Bustard	Secretarybird	Blue Korhaan	Northern Black Korhaan	White Stork
2003	52.50	4.10	14.70	0.90	3.00	8.20	0.00
2004	77.40	4.00	8.40	0.40	1.00	12.30	0.00
2005	30.00	4.00	1.20	0.40	1.30	5.70	0.00
2006	85.40	3.70	5.30	1.10	2.80	23.10	0.00
2007	29.30	2.80	16.80	1.20	1.20	14.50	0.00
2008	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2009	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2010	36.70	3.90	32.60	1.00	0.50	15.90	0.00
2011	100.00	9.10	15.70	1.70	0.00	14.80	0.00
2012	77.32	6.40	3.40	0.90	0.20	9.46	0.00
2013	77.32	6.40	3.40	0.90	0.20	9.46	0.00
2014	267.50	2.10	3.30	0.80	5.40	12.10	2.50
Average	**83.34**	**4.65**	**10.48**	**0.93**	**1.56**	**12.55**	**0.25**

APPENDIX 4: EXAMPLES OF HABITAT


Figure 1: View of the Grassy Karoo habitat on the plateau near VP 3.


Figure 2: A view from the escarpment near VP3.

Figure 3: A view of the Grassy Karoo on the plateau near VP4.

Figure 4: A view of the Grassy Karoo below the escarpment along the control drive transect.

Figure 5: The dam at FP2b, surrounded by many alien trees.

Figure 6: A view of the escarpment west of the N9 provincial road.

APPENDIX 5: STATISTICAL ANALYSIS

Phezukomoya Wind Energy Facility

STATISTICAL ANALYSIS: DEVELOPMENT AREA

1 Introduction

This report is based on data captured in the MS Excel file "Noupoort West VP Au_Wi_Sp_Su_af 20160721.*xls*". This file contains records for each individual flight of priority species birds that were recorded at a vantage point set up at the *Noupoort East* turbine site. Observations were recorded in "watch periods" of two hours duration. The word *"flight"* indicates a group of birds flying or associating together. Individual birds in a flight were counted and recorded and these are referred to as "*individual*" counts. When no bird was sighted during a watch period, the "species" was identified by the label "*None*". Every species is categorised into a *"Flight Class".* In this survey two flight classes were recorded viz. "Soaring" and "Terrestrial".

There were *144* watch periods of two hours each, spread over six vantage points, allocated to each of the four seasons as set out in Table *1*. Environmental and other relevant information were also recorded (e.g. Temperature, Wind Direction, Wind Speed, categories of height at which the birds were observed, etc.).

Table *1*. The survey dates and times

Start Date	End Date	Season	# Watch Periods
2015-03-30	2015-04-07	Autumn 2015	36
2015-06-18	2015-06-25	Winter 2015	36
2015-10-25	2015-11-03	Spring 2015	36
2016-01-11	2016-02-17	Summer 2015/16	36

The total observation time allocated to each season was *72* hours.

Some basic statistics concerning the data set are presented in this report. It is also investigated if the sample size was sufficiently large for estimating the average number of birds per watch period with good precision. This is done together with the question if the sampling process yielded results that are representative of the true occurrence of the priority species birds.

2 Descriptive statistics

Several tables of descriptive statistics are computed and captured as described in what follows. The watch periods were all of the same length, viz. two hours and thus average counts and variability are expressed per *2* hours. The following basic statistics were computed:

- A count of the total number of individual birds (by species and flight class) observed during the survey against the *Height* at which they flew. These data are displayed in Table A in the *Appendix*.
- Table B shows the times that the soaring and terrestrial birds flew at medium height and at all heights. The times spent at medium height are expressed as a percentage of the total observed flying times. These percentages have to be interpreted with care and should always be seen together with the total time in flight.
- Tables C – G (in the Appendix) provide summary statistics intended to give insight into the behaviour of the species observed w.r.t. their presence according to season and their occurrence profiles during various weather conditions such as temperature, wind direction and wind strength.
- The survey recorded only three flights and a total of eight individual *terrestrial* birds (only one species, Grey-winged Francolin: *Scleroptila africanus*). It was thus decided to focus analyses primarily on the soaring birds (5 species with 77 individuals recorded). With such a small count of the terrestrials (and in particular 141 of the 144 watch periods with a zero count) implies a small standard deviation. A small standard deviation implies good precision (and small number of counts required).

  Thus the counts observed during consecutive watch periods for soaring individuals, identified by season and vantage point, are listed in Table H in the *Appendix.* Updated average counts for consecutive watch periods are also presented in that table.

The computations were done using STATISTICA statistical software (see Dell Inc., 2015) and with routines developed for this purpose in "Statistica Visual Basic", the programming language of STATISTICA.

3 Distribution of the data

The four notes that follow also explain some of the terminology to be used.

Note 1: The *average value* (also referred to as the *mean value*) is a measure of the location of the centre of gravity of a data distribution. The *variance* is a measure of the variability of the observed data around the mean value of the data. Its square root, the *standard deviation*, does the same but is scaled to the same units (counts per *2*h, as in the observed data.

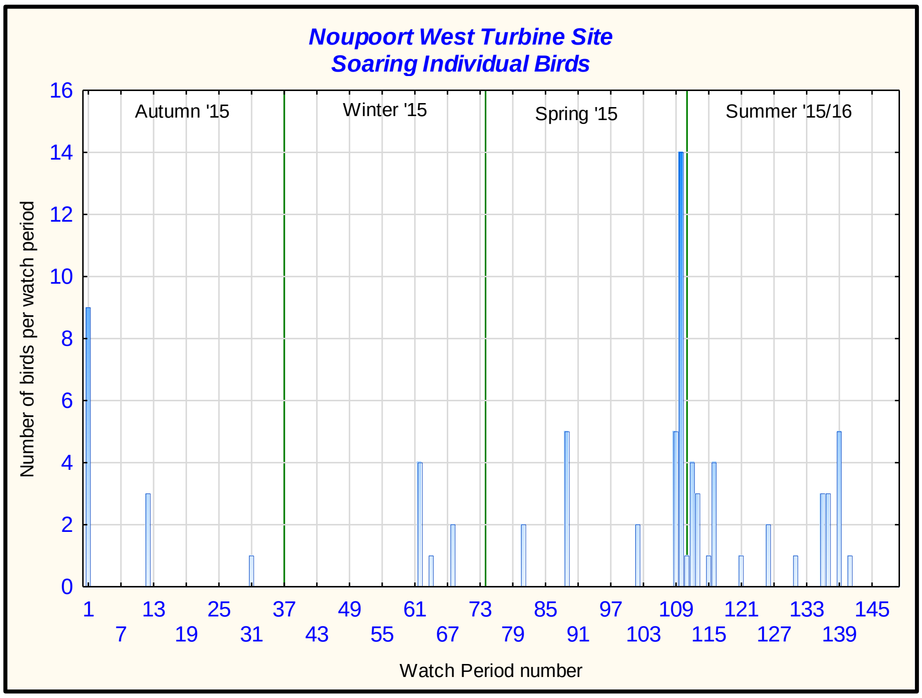
Note 2: A *confidence interval* for the mean at a selected confidence level implies that if it were possible to take the infinite number of all possible samples of size *N = 36* (in the present case of sampling per season) and a *95%* confidence interval for the mean is computed in each case, then *95%* of those intervals are expected to contain the true mean value. The larger the standard deviation of a distribution, the wider the confidence interval for the mean will be. More details about confidence intervals in the Appendix.

Note 3: A sample estimate of a parameter that describes a population (e.g. its true mean) shall be close to the true value of the parameter. The closeness of such an estimate to the true value is known as its *precision*. Half the width of a confidence interval will be taken as the precision of the estimate of the relevant parameter.

Note 4: It is recognised that counts of events that took place in a fixed time period (e.g. the counts of birds in a watch period of fixed length) may have a *Poisson distribution*. The Poisson distribution has the property that its mean value and its variance (the squared standard deviation) are identical. More about the Poisson distribution in the Appendix.

The raw data counts for soaring birds are presented in Figure *1* for each of the watch periods *1* to *136*.

Figure *1*: Sequential time plot (by consecutive watch period number) of *individual* soaring bird counts.



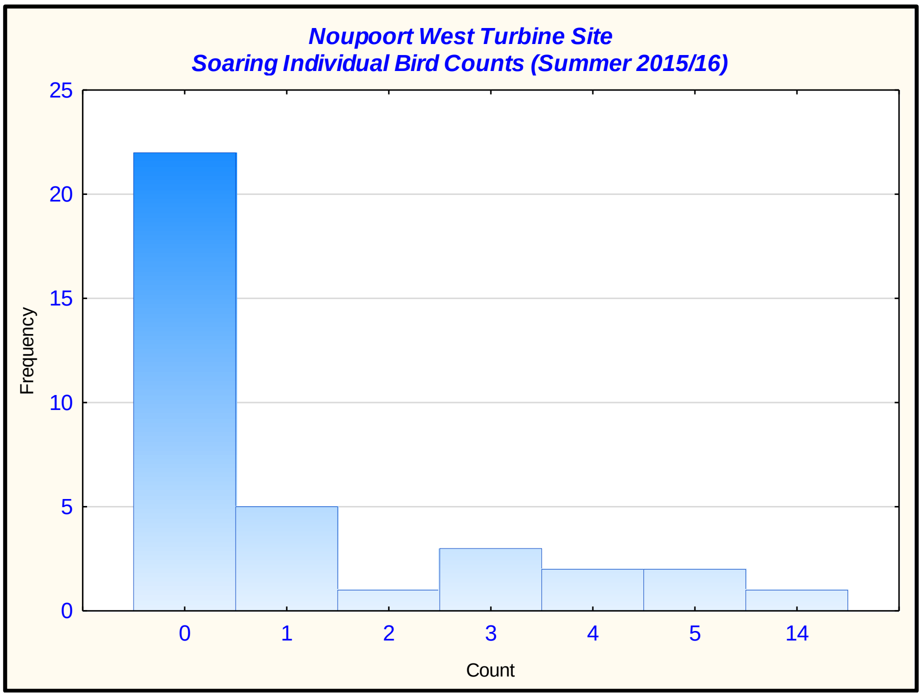
4 Estimating the population mean

The descriptive statistics of average counts, variance of the counts and *95%* lower and upper confidence intervals (LCL and UCL) for the mean count per watch period in each of the four seasons are computed from the data presented in Table H (section 3 in the Appendix, which lists the number of flights and individual birds recorded in each watch period). The mentioned statistics are listed in Table *2* for individual soaring birds.

The computation of confidence intervals assumes that certain assumptions are to be met by the underlying distribution. One possibility is to assume the normal distribution which is the benchmark standard for such computations.

Figure 2 shows the distribution for the counts of individual soaring birds over all seasons.

Figure *2*. Histogram of the count distributions.



The distributions for the individual seasons follow much the same form. From this it is clear that these count distributions is all but a normal distribution.

The average and variance of the Poisson distribution are identical (see Kalbfleisch, *1985*, p. *172*). Other distributions may also possess this property but in the case of counts per fixed sampling unit (SU, in this case a watch period) the Poisson is particularly relevant (see Kalbfleisch, 1985, pp. *128 – 133*).

Table *2* shows that these distributions do not have that property. However, the Poisson distribution would be a much more appropriate approximation than the normal. The estimates in Table 2 for the data at hand are thus based on the assumption of an underlying Poisson distribution for the counts (for details of the methodology, see the notes on the Poisson Distribution in section *1* of the Appendix). This may not be correct for the present data but it is assumed that confidence intervals computed under that assumption is likely to be better than assuming the distribution to be a normal distribution.

Table *2*. Soaring birds, Individuals: average, variance , 95% lower and upper confidence limits and precision for the number of flights per 2h watch period.

Season	Watch periods	Soaring birds: Individuals					
		Count	Avge	Variance	95% LCL	95% UCL	Precision
Autumn '15	36	13	0.36	2.47	0.19	0.62	0.21
Winter '15	36	7	0.19	0.56	0.08	0.40	0.16
Spring '15	36	9	0.25	0.88	0.11	0.47	0.18
Summer '15/16	36	48	1.33	7.14	0.98	1.77	0.39
Overall	144	77	0.53	2.92	0.42	0.67	0.12

The interpretation of the data in Table *2* is as follows: each season had *36* watch periods allocated to it. The Spring *2015* row, column *3*, shows that *9* soaring birds were counted during the *36* watch periods, leading to an estimated average of *0.25* individuals per *2*h watch period, a variance of *0.88* (implying a standard deviation of *0.94*) and a *95%* confidence interval for the true mean of *0.11 – 0.47*. The *95%* precision is *0.18* which means that the true mean value (for Spring) lies in the interval *0.29* ± *0.18* with *95%* certainty.

5 Precision and sample size

Table *2* shows for soaring individual birds for all four individual seasons that the precision achieved by sample of size $N = 36$ is $d < 0.40$. This means that a precision of better than ½ a bird is achieved with 95% certainty, which is considered adequate precision.

6 Stability and Representativeness

Insight into the representativeness and stability of the counting process may be obtained by noting that as the data are gathered in consecutive watch periods an improved estimate of the average number of birds occurring in the area will be achieved for each added count. As more data are gathered the more precise the estimate will become. The issue is to determine if the updated average count begins to stabilise towards the end of the survey (and thus the conclusion that a representative sample has been achieved).

The actual watch periods have been ordered in time over all vantage points. To investigate the behaviour of the change in estimated average number of *individual*s the averages are computed from all preceding data as the data become available in the ordered watch periods. These updated averages are expected to vary to some extent in the initial stages of sampling. However, for a stable process it should stabilise as more data become available. Since the counts may vary (in principle) substantially over the seasons (especially for individual counts as is the case in the current data set) the updated averages are determined separately for each season and are listed in Table H in the Appendix. These data are plotted (by season) in Figure 3 for soaring birds only as explained earlier.

Figure 3. Soaring birds: updated average for *Flight* and *Individual* counts, separately by season.

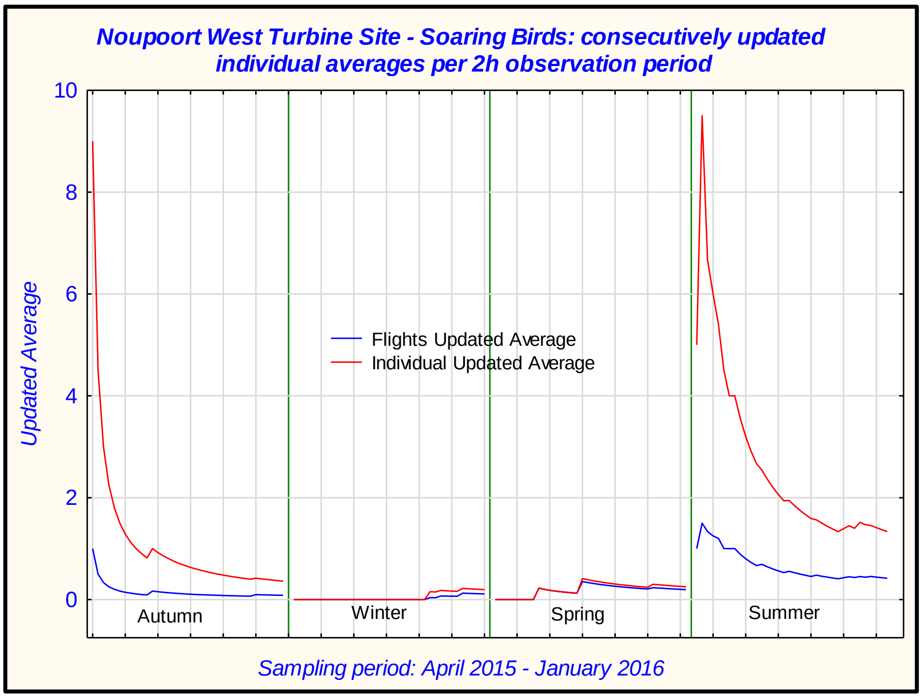


Figure 3 shows that the updated averages for flights and individual birds are practically identical for Winter and Spring 2015. The data stabilise well over all four seasons and accordingly it is not expected that further sampling will succeed in changing the estimated average number of flight or individual counts in any substantial way.

7 Conclusion

The precisions listed in Table *2* show that the estimates of average counts are precise up to at least half a bird per watch period with much better results for the Autumn, Winter and Spring counts*.* This is considered to be sufficiently precise and therefore it is concluded that *36* sample units of *2*h each provide adequate precision for the purpose of this study.

The graphs in Figure 3 show that the counts and computation of averages have stabilized well towards the end of the sampling periods in each season and therefore the data may be accepted as representative of the true situation.

8 References

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APPENDIX

1 Poisson distribution – confidence interval

If the count of birds per sampling unit (SU) [i.e. a watch period] is assumed to have a Poisson distribution with an (unknown) average value of λ and if N SUs were sampled (for example 2h watch periods are sampled $N = 30$ times) the sum of the N counts also has a Poisson distribution (with true average λN), see Brownlee, *1960*, p. *141*.

The Poisson probability (which is characterised uniquely by its average parameter (in this case λN) for finding a count of X = x birds from the N SUs is given by: $P(X = x) = e^{-\lambda N}(\lambda N)^x / x!$, for values of $x = 0, 1, 2, ...$.

A $(1-\beta)$ confidence interval for the mean value, λN, of this Poisson is determined by a lower limit $L_1 = \frac{1}{2}\chi^2_{\beta/2}(2X)$ and an upper limit $L_2 = \frac{1}{2}\chi^2_{1-\beta/2}(2X+2)$, see Zar (2010), pp. 587 – 589. Here $\chi^2_\alpha(\nu)$ is the α-point of the chi-squared distribution with ν degrees of freedom, i.e. the χ^2-value with cumulative probability of α up to that value. X denotes the count of the number of birds over N SUs.

This means that the coverage probability for λN , based on a count of X birds per N SUs is $P(L_1 \le \lambda N \le L_2) = 1 - \beta$. Thus a $1-\beta$ confidence interval for λ (the expected average value per SU) is given by the interval $(L_1 / N; \quad L_2 / N)$.

These formulas were used to determine the confidence intervals in Table *2.*

2 Poisson distribution – Sample Size

Consider the question of how many watch periods (i.e. sampling units, N) must be sampled in order to obtain an estimate of the true count per SU with *precision* of "*d*" units with prescribed probability, e.g. 95%. Thus, what must N be so that the true mean count per SU lies in an interval of half-width d with certainty of $1-\beta$?

As was indicated in the previous section, this interval is $(L_1 / N; \quad L_2 / N)$ and thus the precision is $d = \frac{1}{2}(L_2 - L_1) / N$. The true average is estimated from the observed total count, X, and is given by $\hat{\lambda} = X / N$. This estimate is NOT in the centre of the confidence interval, but even so, we shall take half of the width of the confidence interval and call it the $1-\beta$ *precision*. A sample size that will be sufficiently large to provide an estimate of the true mean count per SU with an acceptable value for its precision (say $d = d_0$) must thus satisfy the inequality: $\frac{1}{2}(L_2 - L_1) / N \le d_0$ or, solving for N:

(1) $$N \ge \tfrac{1}{2}(L_2 - L_1) / d_0 = \left(\chi^2_{1-\beta/2}(2X+2) - \chi^2_{\beta/2}(2X)\right) / 4d_0.$$

If a count *of* $X = x$ is observed and a specified value for d_0 is desired, the sample size must be at least N as in (*1*). This allows the user to verify, for a given count, if the actual number of SU's is sufficiently large to achieve the desired precision.

3 Additional Statistics

Table A. Number of individual priority species birds recorded during the survey by Species, Flight Class and Flying Height distribution.

Species	Flight Class	Flying Height			Row Totals
		Low	Medium	High	
Lesser Kestrel	Soaring	21	22	0	43
Blue Crane	Soaring	0	0	19	19
Verreauxs' Eagle	Soaring	2	0	0	2
Jackal Buzzard	Soaring	1	7	4	12
Steppe Buzzard	Soaring	0	1	0	1
Count (Soaring)		24	30	23	77
Grey-winged Francolin	Terrestrial	8	0	0	8
Count (Terrestrial)		8	0	0	8
Total count (Overall)		32	30	23	85

Table B. Number of individual priority species birds recorded during the survey by Species, Flight Class, Flight Duration (seconds) at Medium Height and the latter as a percentage of total Flight Duration at all heights.

Species	Flight Class	Valid N and Flight Duration (minutes)				
		At Medium Height		At All Heights		Time at Medium Ht
		N	Time (min)	N	Time (min)	
Lesser Kestrel	Soaring	22	45.0	43	89.75	50%
Blue Crane	Soaring	0	0	19	46.00	0%
Jackal Buzzard	Soaring	7	23.5	12	37.75	62%
Verreauxs' Eagle	Soaring	0	0	2	2.00	0%
Steppe Buzzard	Soaring	1	2.0	1	2.00	100%
Count (Soaring)		30	70.5	77	177.50	40%
Grey-winged Francolin	Terrestrial	0	0	8	5.75	0%
Count (Terrestrial)		0	0	8	5.75	0%
Total count (Overall)		30	70.5	85	183.25	38%

Table C: Number of individual priority species birds recorded by Species, Flight Class and Season.						
Species	**Flight Class**	**Season**				**Row Totals**
		Autumn '15	**Winter '15**	**Spring '15**	**Summer '15/16**	
Lesser Kestrel	Soaring	10	0	0	33	43
Blue Crane	Soaring	3	4	2	10	19
Verreauxs' Eagle	Soaring	0	2	0	0	2
Jackal Buzzard	Soaring	0	1	7	4	12
Steppe Buzzard	Soaring	0	0	0	1	1
Count (Soaring)		13	7	9	48	77
Grey-winged Francolin	Terrestrial	8	0	0	0	8
Count (Terrestrial)		8	0	0	0	8
Total count (Overall)		21	7	9	48	85

Table D: Number of individual priority species birds recorded by Species, Flight Class and Temperature.						
Species	**Flight Class**	**Temperature**				
		Cold	**Mild**	**Warm**	**Hot**	**Totals**
Lesser Kestrel	Soaring	0	18	22	3	43
Blue Crane	Soaring	4	5	10	0	19
Verreauxs' Eagle	Soaring	2	0	0	0	2
Jackal Buzzard	Soaring	1	5	3	3	12
Steppe Buzzard	Soaring	0	0	0	1	1
Count (Soaring)		7	28	35	7	77
Grey-winged Francolin	Terrestrial	0	8	0	0	8
Count (Terrestrial)		0	8	0	0	8
Total count (Overall)		7	36	35	7	85

Table E: Number of individual priority species birds, by Species, Flight Class and Weather Condition.					
Species	**Flight Class**	**Cloudy**	**Partly Cloudy**	**Sunny**	**Row Totals**
Lesser Kestrel	Soaring	5	35	3	43
Blue Crane	Soaring	0	10	9	19
Verreauxs' Eagle	Soaring	0	0	2	2
Jackal Buzzard	Soaring	0	8	4	12
Steppe Buzzard	Soaring	0	1	0	1
Count (Soaring)		5	54	18	77
Grey-winged Francolin	Terrestrial	4	4	0	8
Count (Terrestrial)		4	4	0	8
Total count (Overall)		9	58	18	85

Table F: Number of individual priority species birds recorded by Species and Wind Direction.										
Species	**Flight Class**	**Wind Direction**								**Row Totals**
		N	**NE**	**E**	**SE**	**S**	**SW**	**W**	**NW**	
Lesser Kestrel	Soaring	0	12	19	0	0	0	1	11	43
Blue Crane	Soaring	0	0	0	2	0	0	2	15	19
Verreauxs' Eagle	Soaring	0	0	0	0	0	0	0	2	2
Jackal Buzzard	Soaring	2	1	0	6	0	0	0	3	12
Steppe Buzzard	Soaring	0	0	0	0	0	0	0	1	1
Count (Soaring)		2	13	19	8	0	0	3	32	77
Grey-winged Francolin	Terrestrial	0	0	0	4	0	0	0	4	8
Count (Terrestrial)		0	0	0	4	0	0	0	4	8
Total count (Overall)		2	13	19	12	0	0	3	36	85

Table G: Number of individual priority species birds recorded by Species, Flight Class and Wind Strength (Beaufort scale).

Species	Flight Class	Wind Strength					Row Totals
		Light Air	Light Breeze	Gentle Breeze	Moderate Breeze	Fresh Breeze	
Lesser Kestrel	Soaring	9	0	8	26	0	43
Blue Crane	Soaring	0	5	9	5	0	19
Verreauxs' Eagle	Soaring	0	0	0	0	2	2
Jackal Buzzard	Soaring	0	7	2	1	2	12
Steppe Buzzard	Soaring	0	0	0	1	0	1
Count (Soaring)		9	12	19	33	4	77
Grey-winged Francolin	Terrestrial	4	4	0	0	0	8
Count (Terrestrial)		4	4	0	0	0	8
Total count (Overall)		13	16	19	33	4	85

Table H: ***Soaring Birds*****: Flights and Individuals for priority species per watch period and by vantage point over time with updated averages per consecutive watch period.**

Watch Number	Date	Season	VP	Flights count	Flights Updated Average *	Individuals count	Individuals Updated Average*
1	2015-03-30	Autumn	VP3	1.0	1.00	9.0	9.00
2	2015-03-30	Autumn	VP1	0.0	0.50	0.0	4.50
3	2015-03-30	Autumn	VP2	0.0	0.33	0.0	3.00
4	2015-03-30	Autumn	VP4	0.0	0.25	0.0	2.25
5	2015-03-30	Autumn	VP5	0.0	0.20	0.0	1.80
6	2015-03-30	Autumn	VP6	0.0	0.17	0.0	1.50
7	2015-03-31	Autumn	VP1	0.0	0.14	0.0	1.29
8	2015-03-31	Autumn	VP5	0.0	0.13	0.0	1.13
9	2015-03-31	Autumn	VP6	0.0	0.11	0.0	1.00
10	2015-03-31	Autumn	VP2	0.0	0.10	0.0	0.90
11	2015-03-31	Autumn	VP3	0.0	0.09	0.0	0.82
12	2015-03-31	Autumn	VP4	1.0	0.17	3.0	1.00
13	2015-04-01	Autumn	VP5	0.0	0.15	0.0	0.92
14	2015-04-01	Autumn	VP6	0.0	0.14	0.0	0.86
15	2015-04-01	Autumn	VP4	0.0	0.13	0.0	0.80
16	2015-04-01	Autumn	VP1	0.0	0.13	0.0	0.75
17	2015-04-01	Autumn	VP2	0.0	0.12	0.0	0.71
18	2015-04-01	Autumn	VP3	0.0	0.11	0.0	0.67
19	2015-04-02	Autumn	VP4	0.0	0.11	0.0	0.63

20	2015-04-02	Autumn	VP5	0.0	0.10	0.0	0.60
21	2015-04-02	Autumn	VP6	0.0	0.10	0.0	0.57
22	2015-04-03	Autumn	VP1	0.0	0.09	0.0	0.55
23	2015-04-03	Autumn	VP5	0.0	0.09	0.0	0.52
24	2015-04-03	Autumn	VP3	0.0	0.08	0.0	0.50
25	2015-04-03	Autumn	VP6	0.0	0.08	0.0	0.48
26	2015-04-03	Autumn	VP4	0.0	0.08	0.0	0.46
27	2015-04-03	Autumn	VP2	0.0	0.07	0.0	0.44
28	2015-04-04	Autumn	VP2	0.0	0.07	0.0	0.43
29	2015-04-04	Autumn	VP3	0.0	0.07	0.0	0.41
30	2015-04-04	Autumn	VP5	0.0	0.07	0.0	0.40
31	2015-04-04	Autumn	VP6	1.0	0.10	1.0	0.42
32	2015-04-04	Autumn	VP1	0.0	0.09	0.0	0.41
33	2015-04-05	Autumn	VP2	0.0	0.09	0.0	0.39
34	2015-04-05	Autumn	VP3	0.0	0.09	0.0	0.38
35	2015-04-05	Autumn	VP4	0.0	0.09	0.0	0.37
36	2015-04-07	Autumn	VP1	0.0	0.08	0.0	0.36
37	2015-06-18	Winter	VP1	0.0	0.00	0.0	0.00
38	2015-06-18	Winter	VP5	0.0	0.00	0.0	0.00
39	2015-06-18	Winter	VP2	0.0	0.00	0.0	0.00
40	2015-06-18	Winter	VP6	0.0	0.00	0.0	0.00
41	2015-06-18	Winter	VP4	0.0	0.00	0.0	0.00
42	2015-06-19	Winter	VP2	0.0	0.00	0.0	0.00
43	2015-06-19	Winter	VP3	0.0	0.00	0.0	0.00
44	2015-06-19	Winter	VP4	0.0	0.00	0.0	0.00
45	2015-06-19	Winter	VP5	0.0	0.00	0.0	0.00
46	2015-06-19	Winter	VP6	0.0	0.00	0.0	0.00
47	2015-06-20	Winter	VP5	0.0	0.00	0.0	0.00
48	2015-06-20	Winter	VP1	0.0	0.00	0.0	0.00
49	2015-06-20	Winter	VP3	0.0	0.00	0.0	0.00
50	2015-06-20	Winter	VP6	0.0	0.00	0.0	0.00
51	2015-06-20	Winter	VP2	0.0	0.00	0.0	0.00
52	2015-06-21	Winter	VP2	0.0	0.00	0.0	0.00
53	2015-06-21	Winter	VP3	0.0	0.00	0.0	0.00
54	2015-06-21	Winter	VP5	0.0	0.00	0.0	0.00
55	2015-06-21	Winter	VP6	0.0	0.00	0.0	0.00
56	2015-06-21	Winter	VP4	0.0	0.00	0.0	0.00
57	2015-06-22	Winter	VP5	0.0	0.00	0.0	0.00
58	2015-06-22	Winter	VP6	0.0	0.00	0.0	0.00
59	2015-06-22	Winter	VP1	0.0	0.00	0.0	0.00
60	2015-06-22	Winter	VP2	0.0	0.00	0.0	0.00
61	2015-06-22	Winter	VP3	0.0	0.00	0.0	0.00
62	2015-06-23	Winter	VP1	1.0	0.04	4.0	0.15

63	2015-06-23	Winter	VP3	0.0	0.04	0.0	0.15
64	2015-06-23	Winter	VP4	1.0	0.07	1.0	0.18
65	2015-06-23	Winter	VP2	0.0	0.07	0.0	0.17
66	2015-06-23	Winter	VP5	0.0	0.07	0.0	0.17
67	2015-06-23	Winter	VP6	0.0	0.06	0.0	0.16
68	2015-06-24	Winter	VP4	2.0	0.13	2.0	0.22
69	2015-06-24	Winter	VP1	0.0	0.12	0.0	0.21
70	2015-06-25	Winter	VP1	0.0	0.12	0.0	0.21
71	2015-06-25	Winter	VP4	0.0	0.11	0.0	0.20
72	2015-06-25	Winter	VP3	0.0	0.11	0.0	0.19
73	2015-10-27	Spring	VP1	0.0	0.00	0.0	0.00
74	2015-10-27	Spring	VP2	0.0	0.00	0.0	0.00
75	2015-10-27	Spring	VP4	0.0	0.00	0.0	0.00
76	2015-10-27	Spring	VP5	0.0	0.00	0.0	0.00
77	2015-10-27	Spring	VP6	0.0	0.00	0.0	0.00
78	2015-10-28	Spring	VP2	0.0	0.00	0.0	0.00
79	2015-10-28	Spring	VP1	0.0	0.00	0.0	0.00
80	2015-10-28	Spring	VP4	0.0	0.00	0.0	0.00
81	2015-10-28	Spring	VP3	2.0	0.22	2.0	0.22
82	2015-10-29	Spring	VP4	0.0	0.20	0.0	0.20
83	2015-10-29	Spring	VP2	0.0	0.18	0.0	0.18
84	2015-10-29	Spring	VP3	0.0	0.17	0.0	0.17
85	2015-10-29	Spring	VP5	0.0	0.15	0.0	0.15
86	2015-10-29	Spring	VP6	0.0	0.14	0.0	0.14
87	2015-10-30	Spring	VP1	0.0	0.13	0.0	0.13
88	2015-10-30	Spring	VP2	0.0	0.13	0.0	0.13
89	2015-10-30	Spring	VP3	4.0	0.35	5.0	0.41
90	2015-10-30	Spring	VP4	0.0	0.33	0.0	0.39
91	2015-10-31	Spring	VP3	0.0	0.32	0.0	0.37
92	2015-10-31	Spring	VP5	0.0	0.30	0.0	0.35
93	2015-10-31	Spring	VP6	0.0	0.29	0.0	0.33
94	2015-10-31	Spring	VP4	0.0	0.27	0.0	0.32
95	2015-10-31	Spring	VP1	0.0	0.26	0.0	0.30
96	2015-11-01	Spring	VP4	0.0	0.25	0.0	0.29
97	2015-11-01	Spring	VP5	0.0	0.24	0.0	0.28
98	2015-11-01	Spring	VP6	0.0	0.23	0.0	0.27
99	2015-11-01	Spring	VP1	0.0	0.22	0.0	0.26
100	2015-11-01	Spring	VP3	0.0	0.21	0.0	0.25
101	2015-11-02	Spring	VP5	0.0	0.21	0.0	0.24
102	2015-11-02	Spring	VP6	1.0	0.23	2.0	0.30
103	2015-11-02	Spring	VP1	0.0	0.23	0.0	0.29
104	2015-11-02	Spring	VP2	0.0	0.22	0.0	0.28
105	2015-11-03	Spring	VP6	0.0	0.21	0.0	0.27

106	2015-11-03	Spring	VP5	0.0	0.21	0.0	0.26
107	2015-11-03	Spring	VP2	0.0	0.20	0.0	0.26
108	2015-11-03	Spring	VP3	0.0	0.19	0.0	0.25
109	2016-01-11	Summer	VP1	1.0	1.00	5.0	5.00
110	2016-01-11	Summer	VP2	2.0	1.50	14.0	9.50
111	2016-01-11	Summer	VP3	1.0	1.33	1.0	6.67
112	2016-01-11	Summer	VP4	1.0	1.25	4.0	6.00
113	2016-01-12	Summer	VP5	1.0	1.20	3.0	5.40
114	2016-01-12	Summer	VP6	0.0	1.00	0.0	4.50
115	2016-01-12	Summer	VP4	1.0	1.00	1.0	4.00
116	2016-01-13	Summer	VP2	1.0	1.00	4.0	4.00
117	2016-01-13	Summer	VP3	0.0	0.89	0.0	3.56
118	2016-01-13	Summer	VP1	0.0	0.80	0.0	3.20
119	2016-02-07	Summer	VP4	0.0	0.73	0.0	2.91
120	2016-02-07	Summer	VP1	0.0	0.67	0.0	2.67
121	2016-02-07	Summer	VP2	1.0	0.69	1.0	2.54
122	2016-02-08	Summer	VP5	0.0	0.64	0.0	2.36
123	2016-02-08	Summer	VP6	0.0	0.60	0.0	2.20
124	2016-02-09	Summer	VP1	0.0	0.56	0.0	2.06
125	2016-02-09	Summer	VP2	0.0	0.53	0.0	1.94
126	2016-02-10	Summer	VP4	1.0	0.56	2.0	1.94
127	2016-02-11	Summer	VP5	0.0	0.53	0.0	1.84
128	2016-02-11	Summer	VP6	0.0	0.50	0.0	1.75
129	2016-02-11	Summer	VP2	0.0	0.48	0.0	1.67
130	2016-02-11	Summer	VP3	0.0	0.45	0.0	1.59
131	2016-02-12	Summer	VP5	1.0	0.48	1.0	1.57
132	2016-02-12	Summer	VP6	0.0	0.46	0.0	1.50
133	2016-02-13	Summer	VP2	0.0	0.44	0.0	1.44
134	2016-02-13	Summer	VP3	0.0	0.42	0.0	1.38
135	2016-02-13	Summer	VP5	0.0	0.41	0.0	1.33
136	2016-02-13	Summer	VP6	1.0	0.43	3.0	1.39
137	2016-02-15	Summer	VP1	1.0	0.45	3.0	1.45
138	2016-02-15	Summer	VP3	0.0	0.43	0.0	1.40
139	2016-02-15	Summer	VP4	1.0	0.45	5.0	1.52
140	2016-02-15	Summer	VP5	0.0	0.44	0.0	1.47
141	2016-02-15	Summer	VP6	1.0	0.45	1.0	1.45
142	2016-02-16	Summer	VP1	0.0	0.44	0.0	1.41
143	2016-02-16	Summer	VP4	0.0	0.43	0.0	1.37
144	2016-02-17	Summer	VP3	0.0	0.42	0.0	1.33

* The updated averages at a given stage are computed over the number of watch periods up to that stage.

APPENDIX 6: SPECIALIST DECLARATION

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	12/12/20/ or 12/9/11/L
NEAS Reference Number:	DEA/EIA
Date Received:	

Application for integrated environmental authorisation and waste management licence in terms of the-

(1) National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2014; and

(2) National Environmental Management Act: Waste Act, 2008 (Act No. 59 of 2008) and Government Notice 921, 2013

PROJECT TITLE

Proposed Phezukomoya Wind Energy Facility near Noupoort in the Northern Cape

Specialist:	Chris van Rooyen Consulting		
Contact person:	Chris van Rooyen		
Postal address:	30 Roosevelt Street, Robindale, Randburg		
Postal code:	2194	Cell:	082 454 9570
Telephone:	-	Fax:	-
E-mail:	Vanrooyen.chris@gmail.com		
Professional affiliation(s) (if any)	-		

Project Consultant:	Arcus Consultancy Services South Africa (PTY) Ltd		
Contact person:	Ashlin Bodasing		
Postal address:	Office 220 Cube Workspace, Cnr Long Street and Hans Strijdom Road, Cape Town Cnr Long Street and Hans Strijdom Road		
Postal code:	8001	Cell:	076 340 8914
Telephone:	021 412 1533	Fax:	
E-mail:	anjat@arcusconsulting.co.za		

4.2 The specialist appointed in terms of the Regulations_

I, Chris van Rooyen, declare that

-- General declaration:

I act as the independent specialist in this application;

I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;

I declare that there are no circumstances that may compromise my objectivity in performing such work;

I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;

I will comply with the Act, Regulations and all other applicable legislation;

I have no, and will not engage in, conflicting interests in the undertaking of the activity;

I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;

all the particulars furnished by me in this form are true and correct; and

I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of

Signature of the specialist:

Chris van Rooyen Consulting

Name of company (if applicable):

Date: 01 October 2017

APPENDIX 7: AVIFAUNAL MANAGEMENT PLAN

Activity	Mitigation and Management Measure	Responsible Person	Applicable Development Phase	Include as Condition of Authorisation	Monitoring requirements
Displacement of priority species due to disturbance during construction operations	1) A site-specific Environmental Management Plan (EMP) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted. All contractors are to adhere to the EMP and should apply good environmental practice during construction. 2) Environmental Control Officer (ECO) to oversee activities and ensure that the site-specific EMP is implemented and enforced via regular inspections. 3) The ECO must be trained by the avifaunal specialist to identify the potential priority species as well as the signs that indicate possible breeding by these species. The ECO must then, during audits/site visits, make a concerted effort to look out for such breeding activities of Red Data species, and such efforts may include the training of construction staff to identify Red Data species, followed by regular questioning of staff as to the regular whereabouts on site of these species. If any of the Red Data species are confirmed to be breeding (e.g. if a nest site is found), construction activities within 500 m of the breeding site must cease, and an avifaunal specialist is to be contacted immediately for further assessment of the situation and instruction on how to proceed.	ECO and Avifaunal specialist	Construction	Yes	If a priority species nest is discovered during the construction phase, the ECO must conduct weekly inspections of the nest to monitor the breeding effort, in consultation with the avifaunal specialist.

Activity	Mitigation and Management Measure	Responsible Person	Applicable Development Phase	Include as Condition of Authorisation	Monitoring requirements
	4) Prior to construction, an avifaunal specialist should conduct a site walkthrough, covering the final road and power line routes as well as the final turbine positions, to identify any nests/breeding/roosting activity of priority species. The results of which may inform the final construction schedule in close proximity to that specific area, including abbreviating construction time, scheduling activities around avian breeding and/or movement schedules, and lowering levels of associated noise. 5) During the construction phase, the avifaunal specialist must conduct surveys/exploration of the WEF site (particularly focussing on potential Verreaux's Eagle roost sites as well as suitable nesting habitat). This should be done during and after, the breeding season (i.e. approximately in July and again in September). The aim will be to locate any new nest sites, so that these may be monitored during the construction and operational phase.				
Displacement of priority species due to <u>habitat transformation</u> during construction phase	1) A site-specific Environmental Management Plan (EMP) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted to reduce unnecessary destruction of habitat. All contractors are to adhere to the EMP and should apply good environmental practice during construction. EMP should include the following:	ECO Avifaunal specialist Rehabilitation specialist	Construction	Yes	ECO to oversee activities and ensure that the site-specific EMP is implemented and enforced via regular inspections;

Activity	Mitigation and Management Measure	Responsible Person	Applicable Development Phase	Include as Condition of Authorisation	Monitoring requirements
	• Existing roads and farm tracks should be used where possible; • The minimum footprint areas of infrastructure should be used wherever possible, including road widths and lengths; • No off-road driving; • ECO to hold regular inspections ensure that the EMP is implemented and enforced; • Any clearing of stands of alien trees on site should be approved first by the avifaunal specialist. • Following construction, rehabilitation of all areas disturbed (e.g. temporary access tracks and laydown areas) must be undertaken and to this end a habitat restoration plan is to be developed by a rehabilitation specialist and included within the EMP.				
Priority species mortality due to <u>collisions with the turbines</u>	1) Mortality thresholds should be determined by the avifaunal specialist in consultation with BirdLife SA, for priority species recorded during the pre-construction monitoring, prior to the wind farm becoming operational. 1) Once the turbines have been constructed, operational monitoring should be implemented under the	Wind farm management, ECO, and avifaunal specialist (in consultation with BirdLife SA)	Operational	Yes	Once the turbines have been constructed, operational monitoring should be implemented under the guidance of an avifaunal specialist to assess collision rates, in accordance with the latest version of the Best practice guidelines for avian monitoring and impact mitigation at proposed wind

Activity	Mitigation and Management Measure	Responsible Person	Applicable Development Phase	Include as Condition of Authorisation	Monitoring requirements
	guidance of an avifaunal specialist to assess collision rates, in accordance with the latest version of the Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa. 3) If collision rates indicate mortality exceeding threshold levels of priority species, curtailment must be implemented during high risk periods. These periods, and the number of turbines to be curtailed, will be determined by the avifaunal specialist in consultation with the wind farm management. 4) Regular inspections must be conducted by the ECO to ensure that rock piles are removed from site or covered with topsoil to prevent them from becoming habitat for Rock Hyrax (Dassie)*Procavia capensis.*				energy development sites in southern Africa.
Priority species mortality due to collision with the on-site powerlines	1)An avifaunal specialist must conduct a site walk through of final pylon positions prior to construction to determine if, and where, bird flight diverters (BFDs) are required. 2) Bird flight diverters must be installed as per the instructions of the specialist following the site walkthrough, which may include the need for modified BFDs fitted with solar powered LED lights on certain spans. 3) The operational monitoring programme must include quarterly monitoring of all overhead power lines for collision	Avifaunal specialist	Operational	Yes	The operational monitoring programme must also include quarterly monitoring of the overhead power lines for collision mortalities.

Activity	Mitigation and Management Measure	Responsible Person	Applicable Development Phase	Include as Condition of Authorisation	Monitoring requirements
	mortalities, with a view to mark additional spans with BFDs if necessary.				
Priority species mortality due to electrocution on the on-site powerlines	1)An avifaunal specialist must certify that the pole structures to be used on the internal MV network is bird-friendly.	Avifaunal specialist	Design	Yes	The operational monitoring programme must also include quarterly monitoring of the overhead power lines for electrocution mortalities.
Displacement of priority species due to disturbance during decommissioning operations	1) A site-specific Environmental Management Plan (EMP) must be implemented, which gives appropriate and detailed description of how decommissioning activities must be conducted to reduce unnecessary destruction of habitat. All contractors are to adhere to the EMP and should apply good environmental practice during decommissioning. 2) Following decommissioning, rehabilitation of all areas disturbed must be undertaken and to this end a habitat restoration plan is to be developed by a rehabilitation specialist and included within the Environmental Management Plan (EMP).	Site management Rehabilitation specialist	Decommissioning	Yes	None