Bird Impact Assessment Report

MERINO WIND FARM

Richmond, Northern Cape

March 2022

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Chris van Rooyen

Chris has 25 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-EWT Strategic Partnership. He is the author of 15 academic papers (some with co-authors), co-author of two book chapters and several research reports. He has been involved as ornithological consultant in numerous power line and wind generation projects. Chris is also co-author of the Best Practice for Avian Monitoring and Impact Mitigation at Wind Development Sites in Southern Africa, which is currently accepted as the industry standard. Chris also works outside the electricity industry and has done a wide range of bird impact assessment studies associated with various residential and industrial developments.

Albert Froneman (Pr.Sci.Nat)

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DECLARATION OF INDEPENDENCE

I, Chris van Rooyen as duly authorised representative of Chris van Rooyen Consulting, and working under the supervision of and in association with Albert Froneman (SACNASP Zoological Science Registration number 400177/09) as stipulated by the Natural Scientific Professions Act 27 of 2003, hereby confirm my independence (as well as that of Chris van Rooyen Consulting) as a specialist and declare that neither I nor Chris van Rooyen Consulting have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which Savannah Environmental was appointed as environmental assessment practitioner in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for work performed, specifically in connection with the Environmental Impact Assessment for the Merino Wind Farm.

Full Name: Chris van Rooyen
Title / Position: Director

Executive summary

Great Karoo Renewable Energy (Pty) Ltd is proposing the development of a commercial wind farm and associated infrastructure to be known as the Merino Wind Farm on a site located approximately 35km south-west of Richmond and 80km south-east of Victoria West, within the Ubuntu Local Municipality and the Pixley Ka Seme District Municipality in the Northern Cape Province.

A preferred project site with an extent of ~29 909ha and a development area of ~6 463ha within the project site has been identified by Great Karoo Renewable Energy (Pty) Ltd as a technically suitable area for the development of the Merino Wind Farm. The project is planned as part of a larger cluster of renewable energy projects (the Great Karoo Renewable Energy Cluster), which include two (2) 140MW Wind Energy Facilities (Merino Wind Farm and Angora Wind Farm) and three (3) 100MW PV facilities (known as Moriri Solar PV, Kwana Solar PV and Nku Solar PV). The Merino Wind Farm will have a contracted capacity of up to 140MW that can accommodate up to 35 turbines.

1 AVIFAUNA IN THE STUDY AREA

The SABAP2 data indicates that a total of 165 bird species could potentially occur within the broader area – Appendix 1 provides a comprehensive list of all the species. Of these, 24 species are classified as priority species (see definition of priority species in section 1.4) and 12 of these are South African Red List species. Of the priority species, 17 are likely to occur regularly in the development area (see Table 2).

2 SUMMARY OF FINDINGS AND CONCLUDING STATEMENT

The proposed Merino Wind Farm will have several potential impacts on priority avifauna. The impacts are the following:

- Collision mortality on the wind turbines
- Displacement due to disturbance
- Displacement due to habitat transformation
- Electrocution on the 33kV MV overhead cables and in the substation yard.
- Mortality due to the collisions with the 33kV overhead lines.

2.1 Displacement of priority species due to disturbance and habitat transformation

It is inevitable that a measure of displacement will take place for all priority species during the construction phase, due to the disturbance factor associated with the construction activities. This is likely to affect ground nesting species the most, as this could temporarily disrupt their reproductive cycle. Species which fall in this category are Ludwig's Bustard, Blue Crane, Karoo Korhaan, Northern Black Korhaan and Spotted Eagle-Owl. Some raptors might also be affected, e.g, Greater Kestrel which often breeds on crow nests which have been constructed on wind pumps. Some species might be able to recolonise the area after the completion of the construction phase, but for some species this might only be partially the case, resulting in lower densities than before once the wind farm is operational, due to the disturbance factor of the operational turbines. In summary, the following species could be impacted by disturbance during the construction phase: Blue Crane, Karoo Korhaan, Ludwig's Bustard, Northern Black Korhaan, Spotted Eagle-Owl and Greater Kestrel.

The network of roads is likely to result in significant habitat fragmentation, and it could have an effect on the density of several species, particularly larger terrestrial species such as Ludwig's Bustard, Blue Crane, Northern Black Korhaan and Karoo Korhaan. Given the expected density of the proposed turbine layout and associated road infra-structure, it is not expected that any priority species will be permanently displaced from the development site. The building infrastructure and substations will all be situated in the same habitat, i.e., Karoo scrub. The habitat is not particularly sensitive, as far as avifauna is concerned; therefore, the impact of the habitat transformation will be low given the extent of available habitat and the small size of the footprint. In summary, the following species are likely to be affected by habitat transformation: Blue Crane, Karoo Korhaan, Northern Black Korhaan, Ludwig's Bustard.

2.2 Mortality of priority species due to collisions with the wind turbines

The proposed Merino Wind Farm will pose a collision risk to several priority species which could occur regularly at the site. Species exposed to this risk are large terrestrial species i.e., mostly bustards such as Karoo Korhaan, Northern Black Korhaan, Ludwig's Bustard, and Blue Crane, although bustards and cranes generally seem to be not as vulnerable to turbine collisions as was originally anticipated (Ralston-Paton & Camagu 2019). Soaring priority species, i.e., species such as Tawny Eagle, Cape Vulture, Martial Eagle, Pale Chanting Goshawk, Lanner Falcon, Booted Eagle, Verreaux's Eagle, Greater Kestrel and Black Stork are most at risk of all the priority species likely to occur at the project site. In summary, the following priority species could be at risk of collisions with the turbines: African Fish Eagle, African Harrier-Hawk, Black Harrier, Black Stork, Black-winged Kite, Blue Crane, Booted Eagle, Common Buzzard, Greater Flamingo, Greater Kestrel, Jackal Buzzard, Karoo Korhaan, Lanner Falcon, Lesser Kestrel, Ludwig's Bustard, Martial Eagle, Northern Black Korhaan, Pale Chanting Goshawk, Secretarybird, Spotted Eagle-Owl, Tawny Eagle, Verreaux's Eagle, Western Barn Owl and Cape Vulture.

2.3 Mortality of priority species due to electrocutions on the 33kV MV reticulation network and in the substation yard

While the intention is to place the medium voltage reticulation network underground where possible, there are areas where the lines might have to run above ground, for technical reasons. In these instances, the poles could potentially pose an electrocution risk to raptors. In summary, the following priority species could be vulnerable to electrocution: Spotted Eagle-Owl, Greater Kestrel, Pale Chanting Goshawk, Jackal Buzzard, Martial Eagle, Tawny Eagle, Verreaux's Eagle, African Fish Eagle, African Harrier-Hawk, Black Stork, Black-winged Kite, Booted Eagle, Common Buzzard, Lanner Falcon, Lesser Kestrel, Western Barn Owl and Cape Vulture. Electrocutions within the proposed substation yard are also possible, particularly smaller species such as Greater Kestrel and Spotted Eagle-Owl but should not affect the larger Red Data raptors such as Martial Eagle, as these species are unlikely to use the infrastructure within the substation yard for perching or roosting.

2.4 Mortality of priority species due to collisions with the 33kV overhead lines

While the intention is to place the majority of the medium voltage reticulation network underground at the wind farm, there are areas where the lines will run above ground. Priority species which are most at risk of collisions with the medium voltage powerlines are the following: Black Stork, Blue Crane, Karoo

Korhaan, Northern Black Korhaan, Ludwig's Bustard, Greater Flamingo, Secretarybird. Large dams and agricultural fields are particular high-risk areas.

2.5 Conclusions

The investigations into the potential impacts on avifauna, including the avifaunal pre-construction monitoring, by means of six surveys in the period October 2020 to November 2021, have not revealed any fatal flaws which stand in the way of the development of the proposed wind farm. However, this conclusion is subject to the implementation of the recommendations listed in this report.

2.6 Cumulative impacts

The total affected land parcel area taken up by authorised renewable energy projects within the 30 km radius is approximately 774 km². The total land parcel area affected by the Great Karoo Renewable Energy Cluster equates to approximately 299 km². The combined land parcel area affected by authorised renewable energy developments within the 30 km radius of similar habitat around the proposed Great Karoo Renewable Energy Cluster, inclusive of the Great Karoo Renewable Energy Cluster, thus equals approximately 1 073 km². Of this, the proposed Merino Wind Farm project constitutes ~6% (64.6km²). The cumulative impact of the proposed Merino Wind Farm is thus anticipated to be **low** after mitigation.

The total area within the 30km radius around the proposed projects equates to about 4 396 km² of similar habitat. The total combined size of the land parcels potentially affected by renewable energy projects will equate to ~24% of the available untransformed habitat in the 30km radius. However, the actual physical footprint of the renewable energy facilities will be much smaller than the land parcel areas themselves. Furthermore, each of these projects must still be subject to a competitive bidding process where only the most competitive projects will win a power purchase agreement required for the project to proceed to construction. The cumulative impact of all the proposed renewable energy projects is estimated to be **moderate**.

3 CONCLUDING STATEMENT

The proposed Merino Wind Farm will have a medium impact on avifauna which, in most instances, could be reduced to a low impact through appropriate mitigation. The three alternative site compound locations are all situated in Karoo scrub. This habitat is not particularly sensitive, as far as avifauna is concerned, therefore any of the alternative locations will be acceptable. The same goes for the substation site. **The currently proposed 35 turbine lay-out which was assessed in this report avoids all the recommended avifaunal turbine exclusion zones and is therefore deemed acceptable**. The development is therefore supported, provided the mitigation measures listed in this report are strictly applied.

See Appendix E for a map of the exclusion areas

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1. INTRODUCTION

Great Karoo Renewable Energy (Pty) Ltd is proposing the development of a commercial wind farm and associated infrastructure on a site located approximately 35km south-west of Richmond and 80km south-east of Victoria West, within the Ubuntu Local Municipality and the Pixley Ka Seme District Municipality in the Northern Cape Province.

A preferred project site with an extent of ~29 909ha and a development area of ~6 463ha within the project site has been identified by Great Karoo Renewable Energy (Pty) Ltd as a technically suitable area for the development of the Merino Wind Farm. The project is planned as part of a larger cluster of renewable energy projects (the Great Karoo Renewable Energy Cluster), which include two (2) 140MW Wind Energy Facilities (Merino Wind Farm and Angora Wind Farm) and three (3) 100MW PV facilities (known as Moriri Solar PV, Kwana Solar PV and Nku Solar PV). The Merino Wind Farm will have a contracted capacity of up to 140MW that can accommodate up to 35 turbines. The development area consists of four (4) affected properties, which include:

- Portion 1 of Farm Rondavel 85
- Portion 0 of Farm Rondavel 85
- Portion 9 of Farm Bult & Rietfontein 96
- Portion 0 of Farm Vogelstruisfontein 84

The Merino Wind Farm project site is proposed to accommodate the following infrastructure, which will enable the wind farm to supply a contracted capacity of up to 140MW:

- Up to 35 wind turbines with a maximum hub height of up to 170m. The tip height of the turbines will be up to 250m.
- Concrete turbine foundations to support the turbine hardstands.
- Inverters and transformers.
- Temporary laydown areas which will accommodate storage and assembly areas.
- Cabling between the turbines, to be laid underground where practical.
- A temporary concrete batching plant.
- 33/132kV onsite facility substation.
- Underground cabling from the onsite substation to the 132kV collector substation.
- Electrical and auxiliary equipment required at the collector substation that serves that wind energy facility, including switchyard/bay, control building, fences, etc.
- Battery Energy Storage System (BESS).
- Access roads and internal distribution roads.
- Site offices and maintenance buildings, including workshop areas for maintenance and storage.

The wind farm is proposed in response to the identified objectives of the national and provincial government and local and district municipalities to develop renewable energy facilities for power generation purposes. It is the developer's intention to bid the Merino Wind Farm under the Department of Mineral Resources and Energy's (DMRE's) Renewable Energy Independent Power Producer Procurement (REIPPP) Programme, with the aim of evacuating the generated power into the national grid. This will aid in the diversification and stabilisation of the country's electricity supply, in line with the objectives of the Integrated Resource Plan (IRP) with the Merino Wind Farm set to inject up to 140MW into the national grid.

See Figure 1 for a map indicating the lay-out of the proposed wind farm.

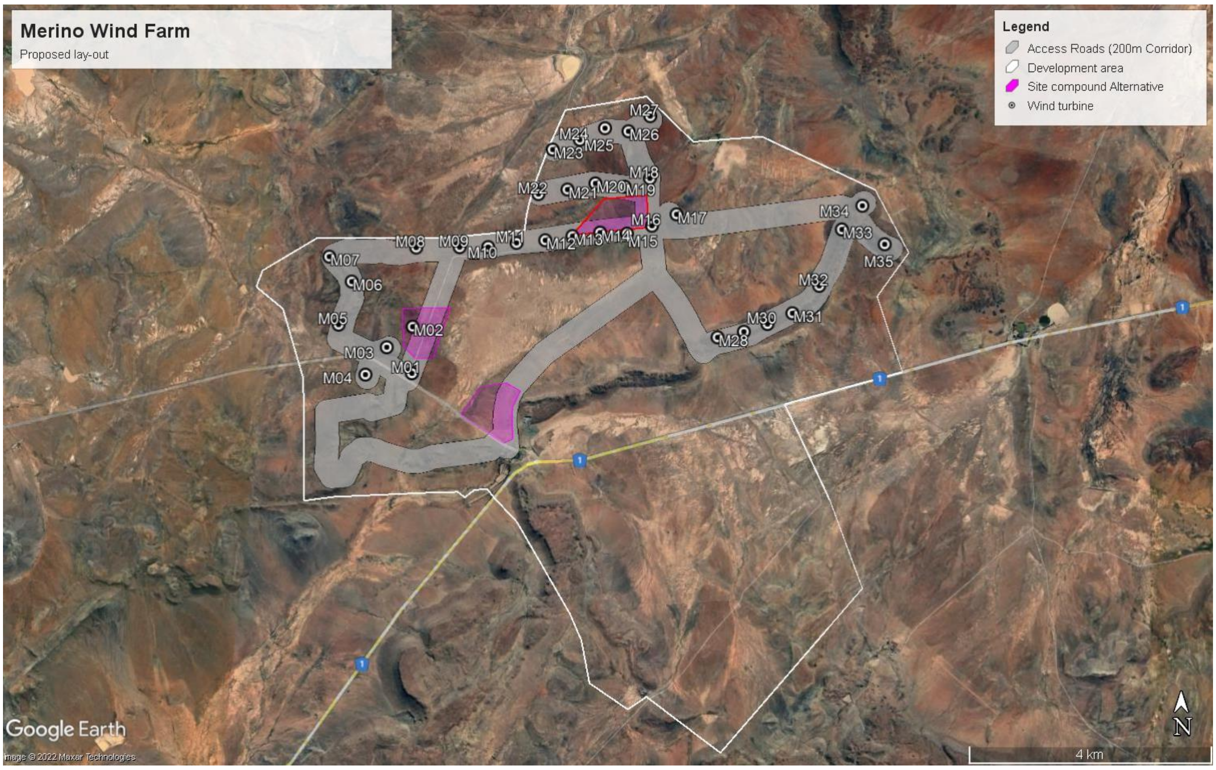


Figure 1: The lay-out of the proposed Merino Wind Farm

1.1 Terms of reference

The terms of reference for this report are the following:

- Describe the affected environment from an avifaunal perspective;
- Discuss gaps in baseline data and other limitations;
- List and describe the expected impacts;
- Assess and evaluate the potential impacts;
- Give a considered opinion whether the project is fatally flawed from an avifaunal perspective; and
- If not fatally flawed, recommend mitigation measures to reduce the expected impacts.

1.2 Sources of information

The following information sources were consulted to conduct this study:

- Bird distribution data from the Southern African Bird Atlas Project 2 (SABAP 2) was obtained (http://sabap2.adu.org.za/), in order to ascertain which species occur in the pentads where the proposed development is located. A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5' × 5'). Each pentad is approximately 8 × 7.6 km. To get a more representative impression of the birdlife, a consolidated data set was obtained for a total of 6 pentads some of which intersect and others that are near the development area, henceforth referred to as "the broader area". The decision to include multiple pentads around the development area was influenced by the fact that many of the pentads in the area have few completed full protocol surveys. The additional pentads and their data augment the bird distribution data. The 6 pentad grid cells are the following: 3125_2330, 3125_2335, 3125_2340, 3130_2330, 3130_2335, and 3130_2340 (see **Error! Reference source not found.**3). A total of 48 full protocol lists (i.e. bird listing surveys lasting a minimum of two hours each) and 66 ad hoc protocol lists (surveys lasting less than two hours but still yielding valuable data) have been completed to date for the 6 pentads where the development area is located. The SABAP2 data was therefore regarded as a reliable reflection of the avifauna which occurs in the area, but the data was also supplemented by data collected during the site surveys and general knowledge of the area.

- A classification of the vegetation types in the development 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 national threatened status of all priority species was determined with the use of the most recent edition of the Red List Book of Birds of South Africa, Lesotho and Swaziland (Taylor *et al.* 2015), and the latest authoritative summary of southern African bird biology (Hockey *et al.* 2005).
- The global threatened status of all priority species was determined by consulting the latest (2021.2) IUCN Red List of Threatened Species (http://www.iucnredlist.org/).
- The Important Bird and Biodiversity Areas of South Africa (Marnewick *et al.* 2015; http://www.birdlife.org.za/conservation/important-bird-areas) was consulted for information on potentially relevant Important Bird Areas (IBAs).
- An intensive internet search was conducted to source information on the impacts of wind energy facilities on avifauna.
- Satellite imagery (Google Earth © 2021) was used in order to view the broader area on a landscape level and to help identify bird habitat on the ground.
- The South African National Biodiversity BGIS map viewer was used to determine the locality of the development area relative to National Protected Areas.
- The DFFE National Screening Tool was used to determine the assigned avian sensitivity of the development area.
- The following sources were consulted to determine the investigation protocol that is required for the site:
  - Procedures for the Assessment and Minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of NEMA when applying for Environmental Authorisation (Gazetted October 2020)
  - Protocol for the specialist assessment and minimum report content requirements for environmental impacts om avifaunal species by onshore wind energy generation facilities where the electricity output is 20MW or more (Government Gazette No. 43110 – 20 March 2020).
  - Verreaux's Eagle Best Practice Guidelines (Ralston-Patton S. 2017. Verreaux's Eagles and Wind Farms. Guidelines for impact assessment, monitoring and mitigation. BirdLife South Africa, March 2017).
- The main source of information on the avifaunal diversity and abundance at the project site and development area is an integrated pre-construction monitoring programme which is was implemented at the project site, covering three proposed PV projects and two proposed wind energy projects (See Appendix 3).

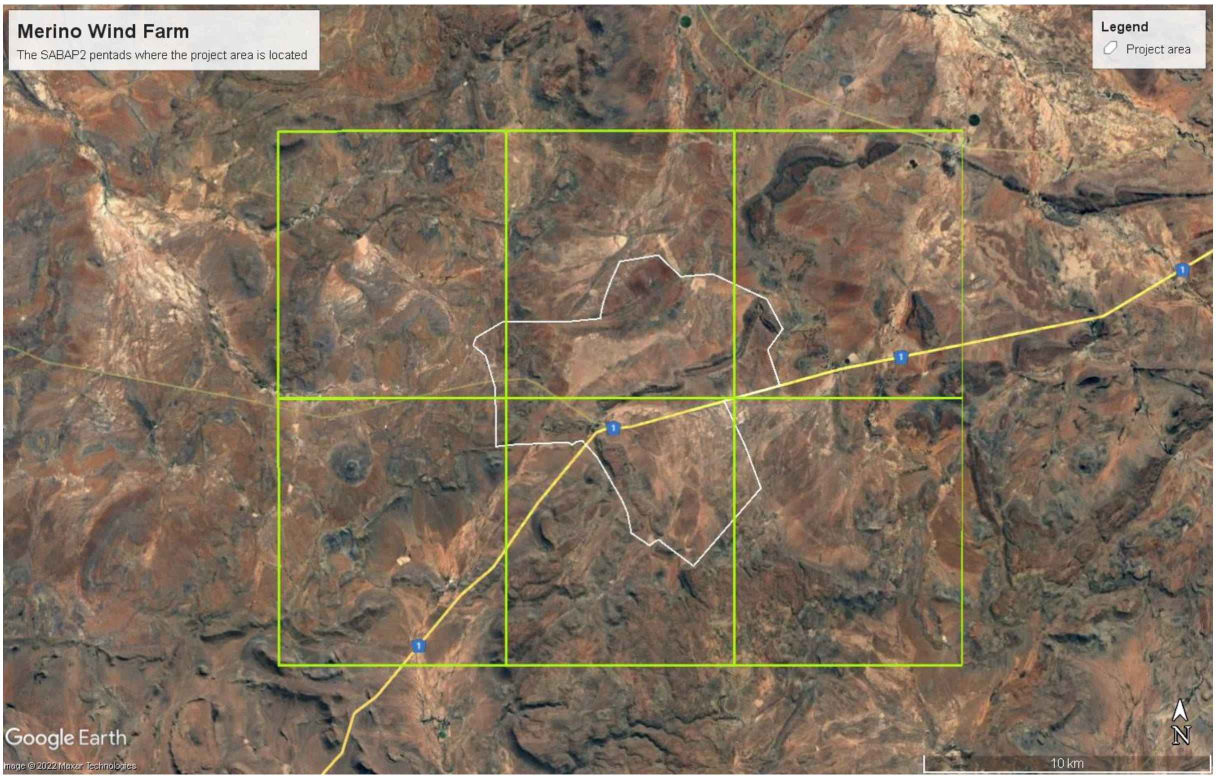


Figure 2: The broader area covered by the SABAP2 pentads.

1.3 Assumptions and limitations

This study made the basic assumption that the sources of information used are reliable and accurate. The following must be noted:

- The SABAP2 dataset is a comprehensive dataset which provides a reasonably accurate snapshot of the avifauna which could occur at the proposed site. For purposes of completeness, the list of species that could be encountered was supplemented with personal observations, general knowledge of the area, and the results of the pre-construction monitoring which is currently being conducted.
- Conclusions in this report are based on experience of these and similar species at wind farm developments in different parts of South Africa. However, bird behaviour can never be predicted with absolute certainty.
- To date, only one peer-reviewed scientific paper has been published on the impacts wind farms have on birds in South Africa (Perold *et al*. 2020). 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. 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."

- According to the specifications received from the proponent, the 33kV medium-voltage lines will be buried where practically feasible. It was therefore assumed that there could be 33kV overhead lines which could pose an electrocution risk to priority species.
- The development area is that identified area (located within the project site) where the Merino Wind Farm is planned to be located. This area has been selected as a practicable option for the facility, considering technical preference and constraints. The development area is ~6 463 ha in extent.
- The broader area refers to the area covered by the six SABAP2 pentads (see Figure 3).
- Priority species for wind development were identified from the updated list of priority species for wind farms compiled for the Avian Wind Farm Sensitivity Map (Retief *et al*. 2012).

2 LEGISLATIVE CONTEXT

2.1 Agreements and conventions

Table 2 below lists agreements and conventions which South Africa is party to, and which is directly relevant to the conservation of avifauna (BirdLife International 2021).

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

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

	conservation measures throughout a migratory range.	
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 specimens of wild animals and plants does not threaten their survival.	Global
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

2.2 National legislation

2.2.1 Constitution of the Republic of South Africa, 1996

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

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

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

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

2.2.2 The National Environmental Management Act (Act No. 107 of 1998) (NEMA)

The National Environmental Management Act (Act No. 107 of 1998) (NEMA) creates the legislative framework for environmental protection in South Africa and is aimed at giving effect to the environmental right in the Constitution. It sets out several guiding principles that apply to the actions of all organs of state that may significantly affect the environment. Sustainable development (socially, environmentally and economically) is one of the key principles, and internationally accepted principles of environmental management, such as the precautionary principle and the polluter pays principle, are also incorporated.

NEMA also provides that a wide variety of listed developmental activities, which may significantly affect the environment, may be performed only after an environmental impact assessment has been done and authorization has been obtained from the relevant authority. Many of these listed activities can potentially have negative impacts on bird populations in a variety of ways. The clearance of natural vegetation, for instance, can lead to a loss of habitat and may depress prey populations, while erecting structures needed for generating and distributing energy, communication, and so forth can cause mortalities by collision or electrocution.

NEMA makes provision for the prescription of procedures for the assessment and minimum criteria for reporting on identified environmental themes (Sections 24(5)(a) and (h) and 44) when applying for environmental authorisation. The Protocol for the Specialist Assessment and Minimum Report Content Requirements of Environmental Impacts on Avifauna by Onshore Wind and/or Solar PV Energy Generation Facilities where the Electricity Output is 20 MW or more published on 20 March 2020 (GG 43110 / GNR 320, 20 March 2020). This protocol replaces the requirements of Appendix 6 of the 2014 NEMA EIA Regulations (as amended).

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

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

2.3 Provincial legislation

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

2.4 Best Practice Guidelines

Verreaux's Eagle Best Practice Guidelines (Ralston-Patton S. 2017. Verreaux's Eagles and Wind Farms. Guidelines for impact assessment, monitoring and mitigation. BirdLife South Africa, March 2017).[1]

3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1 Natural environment

The ~29 909ha project site, within which the ~6 463ha development area is located, falls within the Nama Karoo biome (Mucina & Rutherford 2006). It consists of a flat plain with a number of inselbergs

[1] The Black Harrier Guidelines (Simmons RE, Ralston-Paton S, Colyn R and Garcia-Heras M.-S. 2020. Black Harriers and wind energy: guidelines for impact assessment, monitoring and mitigation. BirdLife South Africa, Johannesburg, South Africa) were also considered, but the site screening established that the regular occurrence of this species at the development areas is unlikely.

containing steep, boulder-strewn slopes, exposed rocky ridges and low cliffs. Two vegetation types are found in the development site, the dominant one being Eastern Upper Karoo, which is found on the plains and Upper Karoo Hardeveld occurring on the ridges (Mucina & Rutherford 2006). Eastern Upper Karoo is dominated by dwarf mycrophyllus shrubs, with white grasses of the genera Aristida and Eragrostis. On the steep slopes, mountain ridges and koppies, Upper Karoo Hardeveld is found which is characterised by dwarf Karoo scrub with drought tolerant grasses of genera such as Aristida, Eragrostis and Stipagrostis (Mucina & Rutherford 2006). The project site contains several large earth dams.

Maximum temperatures in the project site range between 31˚C in January (summer) and 5˚C in July (winter), and rainfall happens mostly between December and March and averages about 384mm per year, which makes for a fairly arid climate (worldweatheronline.com). Winters are very dry. The land is used for sheep and game farming.

The Merino Wind Farm development area itself is located on a plain that contains a number of ridges with steep, boulder-strewn slopes and exposed rock faces. There are also rocky ridges outside the development area that contain Verreaux's Eagle nests. The closest Verreaux's Eagle nests outside the development area are the following:

- FPVE2 (-31.543776° 23.597448°) situated approximately 5.3km from the closest turbine position.
- FPVE3 (-31.425449° 23.702398°) situated approximately 5.6km from the closest turbine position.
- FPVE4 (-31.540635° 23.716886°) situated approximately 8.8km from the closest turbine position.
- FPVE5 (-31.560946° 23.612253°) situated approximately 7.3km from the closest turbine position.

3.2 Modified environment

Whilst the distribution and abundance of the bird species in the development area are mostly associated with natural vegetation, as this comprises virtually all the habitat, it is also necessary to examine the few external modifications to the environment that have relevance for birds.

The following avifaunal-relevant anthropogenic habitat modifications were recorded within the development area:

- **Surface water:** The development area contains one source of permanent surface water, namely, boreholes with water troughs. There are also two large dams and a smaller dam in the development area. The dams contain water periodically. When they did contain water, flocks of Blue Cranes were observed roosting in them at night, as well as several Greater Flamingos.
- **Agricultural lands:** Cultivation in the development area is limited to a few irrigated lands near the N1 national road where lucerne is cultivated.
- **Transmission lines:** There are a number of high voltage lines that run to the north-west of the development area. Transmission lines are an important breeding substrate for raptors in the Karoo, due to the lack of large trees (Jenkins et al. 2013). The following eagle nests were recorded on transmission lines in the vicinity of the development area:
    - There is a Tawny Eagle nest (FPTE1) (-31.445988° 23.583921°) on the Droërivier – Hydra 2 400kV transmission line situated approximately 3.6km from closest turbine position. In October 2021, a large chick was recorded on the nest.

- There is another Tawny Eagle nest (FPTE4) (-31.507460° 23.550963°) on the Droërivier-Hydra 1 400kV transmission line, located approximately 3.9km away from the from the closest turbine position. When nest was inspected in July 2021, an adult Tawny Eagle was recorded on the nest, but a pair of Greater Kestrels were recorded breeding on the nest in October 2021.
- There is also a Martial Eagle nest (FPME1) (-31.524550° 23.534279°) on the Droërivier-Hydra 1 400kV transmission line located approximately 6.2km away from the closest turbine position. When the nest was inspected in October 2021, an adult eagle and a juvenile were recorded in the vicinity of the nest.

APPENDIX B provides a photographic record of the habitat at the development areas.

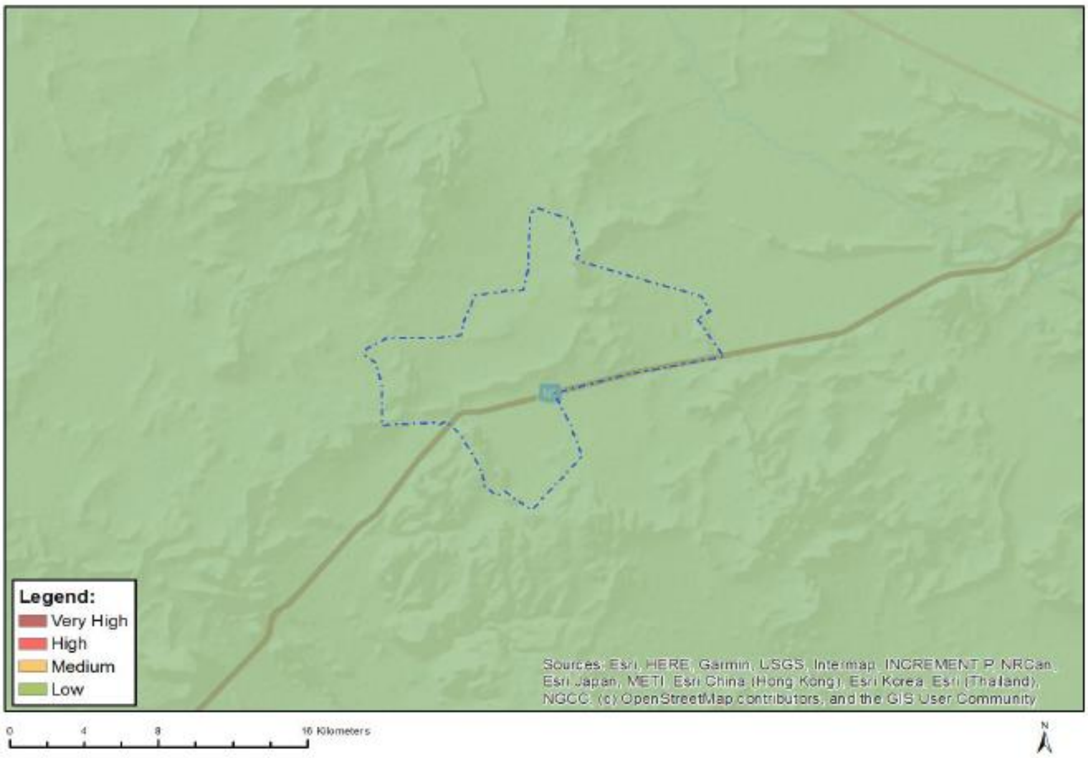
3.3 Important Bird Areas (IBAs)

There are no Important Bird Areas (IBA) within a 50km radius around the proposed Merino Wind Farm. The closest IBA to the project site is the Platberg-Karoo Conservancy IBA SA037, which is just over 50km away. It is therefore highly unlikely that the proposed development will have a negative impact on any IBA due to the distance from the project site.

3.4 The DFFE National Screening Tool

The study area and immediate environment is classified as LOW sensitivity for avifauna for wind energy developments. The development area contains confirmed habitat for species of conservation concern (SCC) as defined in the Protocol for the specialist assessment and minimum report content requirements for environmental impacts on avifaunal species by onshore wind energy generation facilities where the electricity output is 20MW or more (Government Gazette No. 43110 – 20 March 2020). SCCs are listed on the IUCN Red List of Threatened Species or South Africa's National Red List website as Critically Endangered, Endangered or Vulnerable. The occurrence of SCC at the development area was confirmed during the 12 months pre-construction monitoring programme with observations of Ludwig's Bustard (Global and Regional status Endangered), Verreaux's Eagle (Regional status Vulnerable), Martial Eagle (Global and regional status Endangered), Tawny Eagle (Regional status Endangered) and Lanner Falcon (Regional status Vulnerable). Based on the field surveys, the classification of LOW sensitivity for avifauna in the screening tool is therefore not supported, a classification of HIGH sensitivity would be more appropriate.

MAP OF RELATIVE AVIAN (WIND) THEME SENSITIVITY



Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
			X

Sensitivity Features:

Sensitivity	Feature(s)
Low	Area Outside Sensitivities

Figure 3: The National Web-Based Environmental Screening Tool map of the project site, indicating sensitivities for the Avian Wind theme. The classification should be changed to High sensitivity based on the presence of a Verreaux's Eagle nest within 3.7km from the development area.

4. AVIFAUNA IN THE STUDY AREA

The SABAP2 data indicates that a total of 165 bird species could potentially occur within the broader area – Appendix 1 provides a comprehensive list of all the species. Of these, 24 species are classified as priority species (see definition of priority species in section 1.4) and 12 of these are South African Red List species. Of the priority species, 17 are likely to occur regularly in the development area (see Table 2 below).

Table 2 below lists all the priority species that are likely to occur regularly and the possible impact on the respective species by the proposed wind farm. The following abbreviations and acronyms are used:

NT = Near threatened, VU = Vulnerable, EN = Endangered

Table 2: Priority species potentially occurring at the development area (Red List species are shaded).

Species	Taxonomic name	SABAP2 reporting rate		Conservation status		Recorded during surveys	Likelihood of regular occurrence	Habitat feature						Potential impact				
		Full protocol reporting rate	ad hoc protocol reporting rate	Global status	Regional status			Nama Karoo	Surface water	Agriculture	Ridges	Alien trees	HV lines	Collisions with turbines	Displacement: Disturbance associated with construction	Displacement: Habitat transformation	Electrocution: MV lines	Collisions: MV OHL
African Fish Eagle	*Haliaeetus vocifer*	2.08	0.00				L		x			x		x			x	
African Harrier-Hawk	*Polyboroides typus*	6.25	3.03			x	M	x	x			x		x			x	
Black Harrier	*Circus maurus*	2.08	0.00	EN	EN		L	x	x					x				
Black Stork	*Ciconia nigra*	4.17	0.00	LC	VU	x	M		x		x			x			x	x
Black-winged Kite	*Elanus caeruleus*	2.08	0.00				L	x		x		x		x			x	
Blue Crane	*Grus paradisea*	62.50	18.18	VU	NT	x	H	x	x	x				x	x	x		x
Booted Eagle	*Hieraaetus pennatus*	6.25	0.00			x	M	x	x			x		x			x	
Common Buzzard	*Buteo buteo*	2.08	7.58			x	M	x	x	x		x	x	x			x	
Greater Flamingo	*Phoenicopterus roseus*	4.17	1.52	LC	NT	x	M		x					x				x
Greater Kestrel	*Falco rupicoloides*	31.25	3.03			x	H	x				x	x	x			x	
Jackal Buzzard	*Buteo rufofuscus*	43.75	16.67			x	H	x	x		x	x	x	x			x	
Karoo Korhaan	*Eupodotis vigorsii*	52.08	7.58	LC	NT	x	H	x						x	x	x		x
Lanner Falcon	*Falco biarmicus*	2.08	3.03	LC	VU	x	M	x	x	x	x	x	x	x			x	
Lesser Kestrel	*Falco naumanni*	2.08	1.52			x	L	x		x		x	x	x			x	
Ludwig's Bustard	*Neotis ludwigii*	45.83	7.58	EN	EN	x	H	x		x				x	x	x		x
Martial Eagle	*Polemaetus bellicosus*	10.42	1.52	VU	EN	x	H	x	x			x	x	x			x	

Northern Black Korhaan	*Afrotis afraoides*	72.92	21.21			x	H	x						x	x	x		x
Pale Chanting Goshawk	*Melierax canorus*	45.83	13.64			x	H	x	x			x	x	x			x	
Secretarybird	*Sagittarius serpentarius*	12.50	6.06	VU	VU		L	x	x					x				x
Spotted Eagle-Owl	*Bubo africanus*	8.33	0.00				M	x				x		x	x		x	
Tawny Eagle	*Aquila rapax*	12.50	3.03	VU	EN	x	H	x	x			x	x	x			x	
Verreaux's Eagle	*Aquila verreauxii*	18.75	1.52	LC	VU	x	H		x		x		x	x			x	
Western Barn Owl	*Tyto alba*	2.08	0.00				L			x		x		x			x	
Cape Vulture	*Gyps coprotheres*	0.00	0.00	EN	EN	x	L	x			x		x	x			x	

4.1 Results of bird monitoring

Table 33, Figure 4**4** and Figure 55 below present the results of the pre-construction monitoring conducted at the project site and control area. The monitoring surveys were conducted by two field monitors in the following time periods:

- Survey 1: 27 October – 7 November 2020
- Survey 2: 4 – 8 January 2021
- Survey 3: 15 – 21 March 2021
- Survey 4: 5 – 9 July 2021
- Survey 5: 3 – 7 October 2021
- Survey 6: 9 – 15 November 2021

4.1.1 Transects

The results of the transect counts in the project site are tabled in Table 3 below:

Table 3: The results of the transect counts

Turbine site	Number of records
Species composition	
All Species	84
Priority Species	10
Non-Priority Species	74
Total count	
Drive transects	1829
Walk transects	3476
Total	5305
Control site	Number of records
Species composition	
All Species	53
Priority Species	8
Non-Priority Species	45
Total count	
Drive transects	1063
Walk transects	920
Total	1983

An Index of Kilometric Abundance (IKA = birds/km) was calculated for each priority species recorded during transects over all four seasons (see Figures 4 and 5 below).

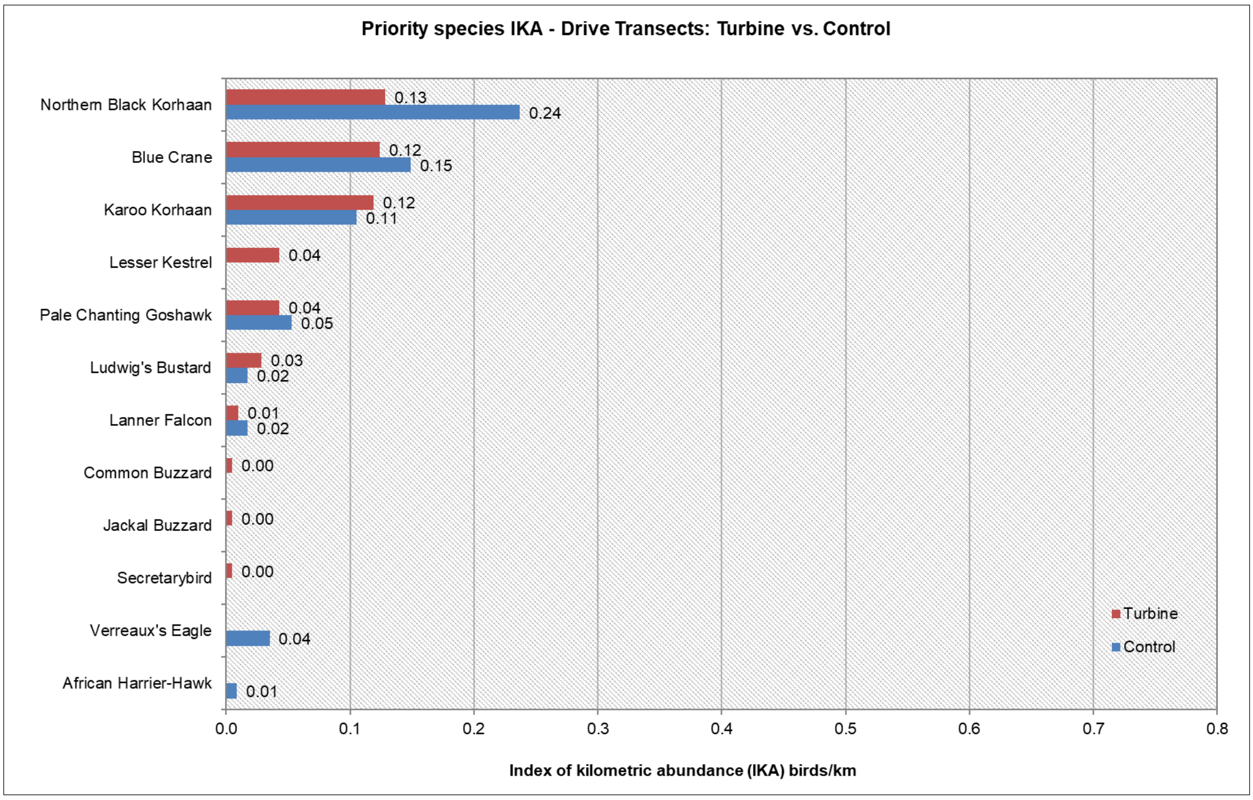


Figure 4: Index of kilometric abundance of priority species recorded at the WEFs and control site through drive transect surveys over all four seasons.

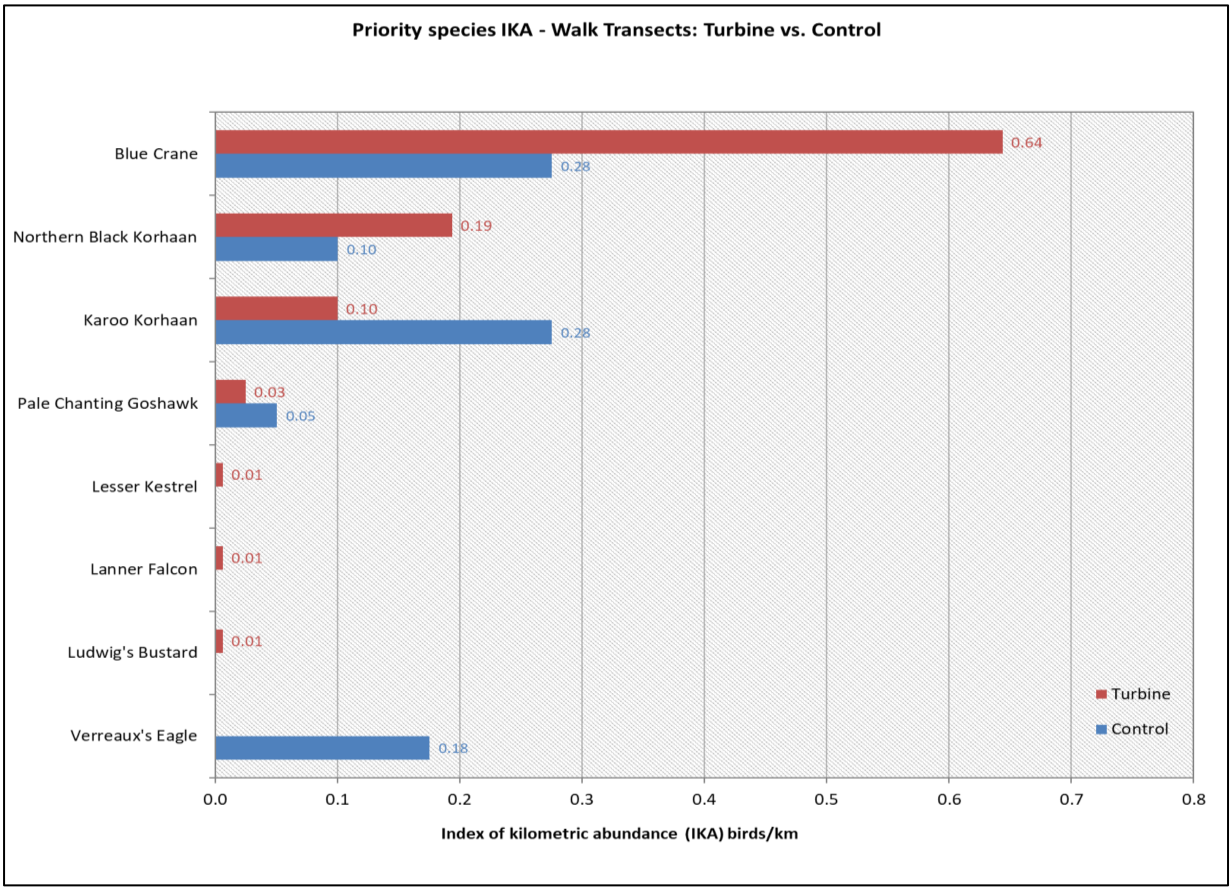


Figure 5: Index of kilometric abundance of priority species recorded at the WEFs through walk transect surveys over all four seasons.

Figure 6**6** below shows the spatial distribution of the priority species recorded during transect counts and incidental sightings over all four seasons.

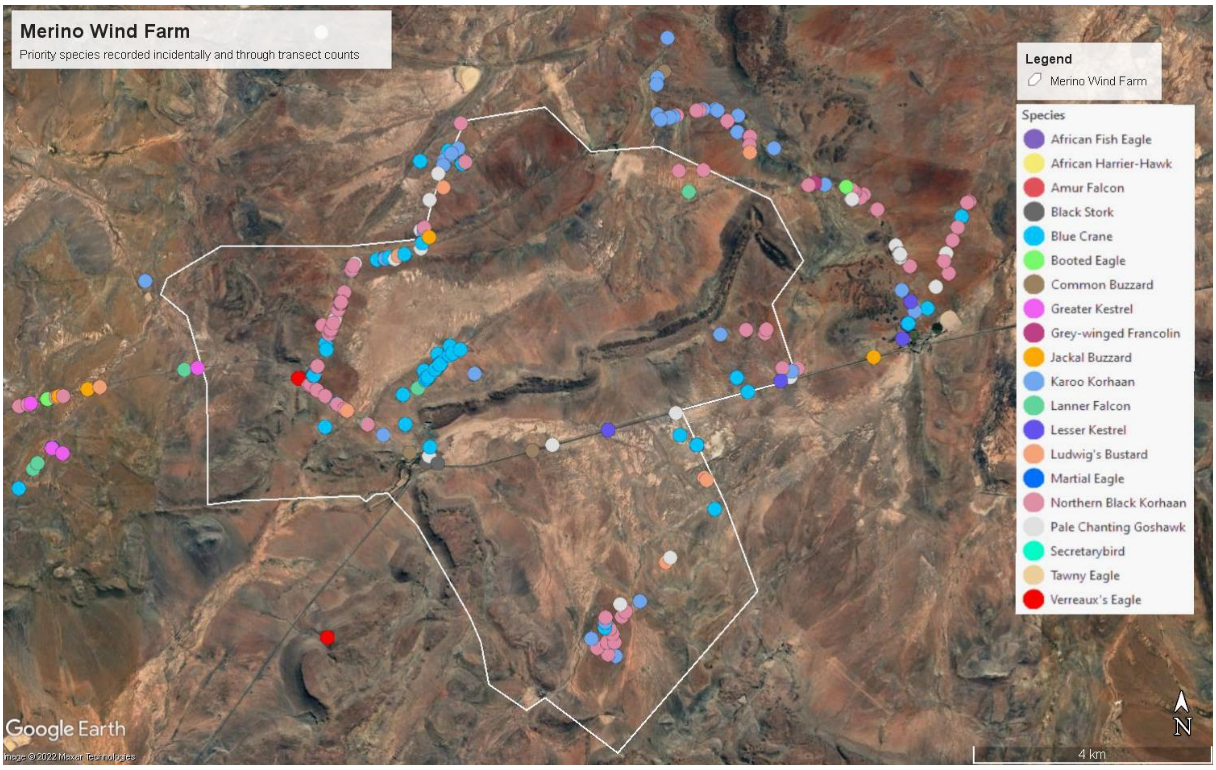


Figure 6: The location of priority species recorded at the proposed WEFs through transect counts and incidental sightings.

4.1.2 Focal points

See Appendix 2 for the location of the focal points and details of the focal point monitoring.

Table 4 provides a summary of the focal point observations made over a period of 12 months (6 surveys).

Focal point	Description	Comments
FP ME1	Martial Eagle nest on Droërivier – Hydra 1 400kV	Nest active in 2021
FPME2	Martial Eagle nest on Droërivier – Hydra 1 400kV	Nest not active in 2021
FP TE1	Tawny Eagle nest on Droërivier – Hydra 2 400kV	Nest active in 2021
FP TE2	Tawny Eagle nest on Droërivier – Hydra 1 400kV	Nest not active in 2021
FP TE3	Tawny Eagle nest on Droërivier – Hydra 2 400kV	Nest active in 2021
FP TE4	Tawny Eagle nest on Droërivier – Hydra 1 400kV	Not active in 2021. Nest taken over by Greater Kestrels.
FP VE1	Verreaux's Eagle nest on cliff	Nest active in 2021
FP VE2	Verreaux's Eagle nest on cliff	Nest possibly active in 2020

FP VE3	Verreaux's Eagle nest on cliff	Possibly active in 2021
FP VE4	Verreaux's Eagle nest on cliff	Possibly active in 2021
FP VE5	Verreaux's Eagle nest on cliff	Nest was only recorded after the monitoring was competed. Status unsure.
CFP VE	Verreaux's Eagle nest on cliff at control site	Nest active in 2021
FP 5	Earth dam	Black Stork (2), Blue Crane (62), Greater Flamingo (3) recorded in November 2020.
FP 6	Earth dam	Dam dry for duration of the monitoring
FP 7	Earth dam	Blue Crane (4) recorded in November 2021
FP 8	Earth dam	Dam dry for duration of the monitoring
FP 9	Earth dam	Dam dry for duration of the monitoring

4.1.3 Incidental counts

Table 4 provides an overview of the incidental sightings of priority species during the six surveys.

Priority Species (Incidentals)	**Sci name**	**Survey 1**	**Survey 2**	**Survey 3**	**Survey 4**	**Survey 5**	**Survey 6**	**Total**
African Fish Eagle	*Haliaeetus vocifer*	0	0	0	1	0	0	**1**
Amur Falcon	*Falco amurensis*	0	0	2	0	0	0	**2**
Black Stork	*Ciconia nigra*	4	0	0	0	0	0	**4**
Blue Crane	*Grus paradisea*	257	13	11	0	8	7	**296**
Booted Eagle	*Hieraaetus pennatus*	0	1	0	0	0	1	**2**
Common Buzzard	*Buteo buteo*	0	2	1	0	0	0	**3**
Greater Kestrel	*Falco rupicoloides*	0	1	1	2	4	2	**10**
Grey-winged Francolin	*Scleroptila afra*	1	0	0	0	1	0	**2**
Jackal Buzzard	*Buteo rufofuscus*	0	2	1	0	2	0	**5**
Karoo Korhaan	*Eupodotis vigorsii*	5	17	17	2	4	6	**51**
Lanner Falcon	*Falco biarmicus*	1	0	7	1	0	0	**9**
Lesser Kestrel	*Falco naumanni*	0	8	0	0	0	1	**9**
Ludwig's Bustard	*Neotis ludwigii*	4	0	2	0	1	0	**7**
Martial Eagle	*Polemaetus bellicosus*	0	0	1	0	2	0	**3**
Northern Black Korhaan	*Afrotis afraoides*	17	15	11	2	3	1	**49**
Pale Chanting Goshawk	*Melierax canorus*	6	9	4	1	3	1	**24**
Tawny Eagle	*Aquila rapax*	0	0	0	0	1	1	**2**
Verreaux's Eagle	*Aquila verreauxii*	2	2	0	0	1	0	**5**

See APPENDIX C for a list of all species recorded during the pre-construction monitoring at the project site.

4.1.4 Vantage point observations

A total of 576 hours of vantage point watches were completed at eight vantage points to record flight patterns of priority species. In the six sampling periods (October/November 2020, January 2021, March 2021, July 2021, October 2021 and November 2021), the duration of priority species flights amounted to 11 hours, 56 minutes and 40 seconds. A total of only 402 individual flights were recorded. The passage rate for priority species was 0.6 birds/hour, which is close to the median rate measured for 61 instances where we did a year of vantage point watches at a project site[2]. This amounts to approximately 7 - 8 birds per day.[3] See Figure 7**7** below for the duration of flights for each priority species[4].

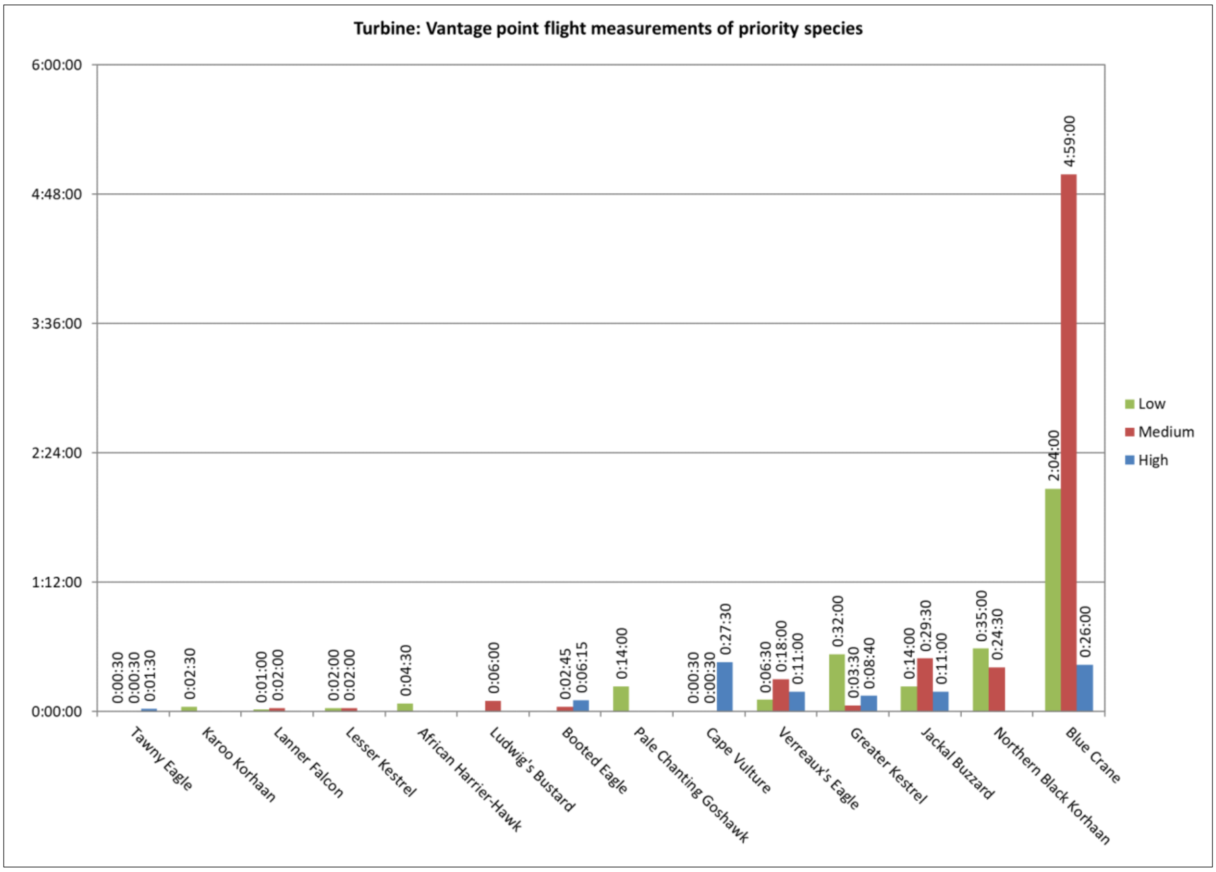


Figure 7: Flight times and altitude recorded for priority species (all 3 WEFs)

4.1.5 Site specific collision risk rating

[2] 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 it still forms part of the same passage.

[3] Assuming 13 hours daylight averaged over all four seasons.

[4] 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.

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

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

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

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

The results are presented in Table 55 and Figure 88 below.

Table 5: Site specific collision risk rating

Species	Duration of rotor altitude flights (hr)	Avian Wind Farm Sensitivity Map collision susceptibility rating	Site specific collision risk rating
Karoo Korhaan	0.0000	65	0.00
Pale Chanting Goshawk	0.0000	70	0.00
African Harrier-Hawk	0.0000	65	0.00
Tawny Eagle	0.0003	90	0.01
Cape Vulture	0.0003	120	0.01
Lesser Kestrel	0.0014	77	0.04
Lanner Falcon	0.0014	85	0.04
Greater Kestrel	0.0024	57	0.05
Booted Eagle	0.0019	85	0.06
Ludwig's Bustard	0.0042	85	0.12
Northern Black Korhaan	0.0170	60	0.36
Verreaux's Eagle	0.0125	115	0.50
Jackal Buzzard	0.0205	95	0.68
Blue Crane	0.2076	85	6.18
Average	*0.0193*	*82*	*0.58*

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

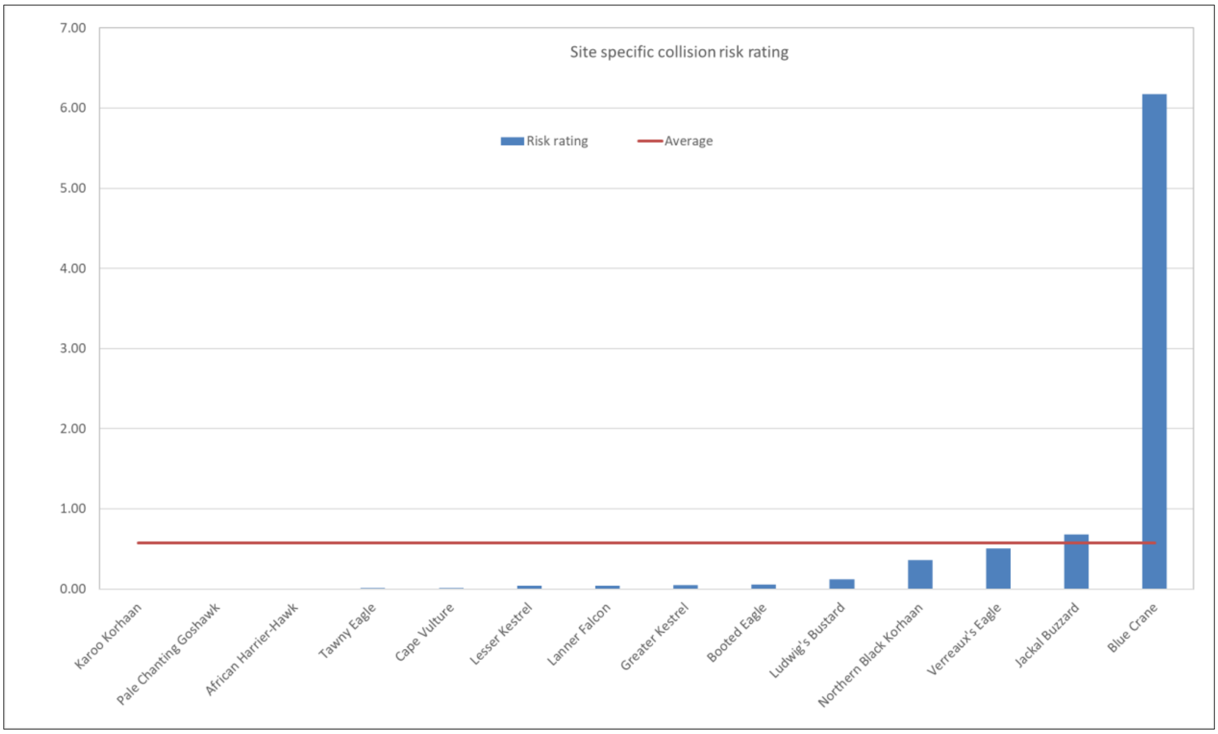


Figure 8: Site specific collision risk rating for priority species. The red line indicates the average collision risk rating for priority species at the project site, based on recorded flight behaviour in six surveys.

4.1.6 Spatial distribution of flights over the turbine area

Flight maps were prepared for the five species with highest collision risk indices, indicating the spatial distribution of flights observed from the various vantage points. This was done by overlaying a 100m x 100m grid over the survey area. Each grid cell was then given a weighting score (i.e., Very High; High; Medium; Low) taking into account the flight intensity i.e., the duration and distance of individual flight lines through a grid cell and the number of individual birds associated with each flight crossing the grid cell, in order to give an indication where the observed flight activity was most concentrated (see Figure 99 – 13).

Figure 9: Intensity of flight activity of Blue Crane recorded during six surveys

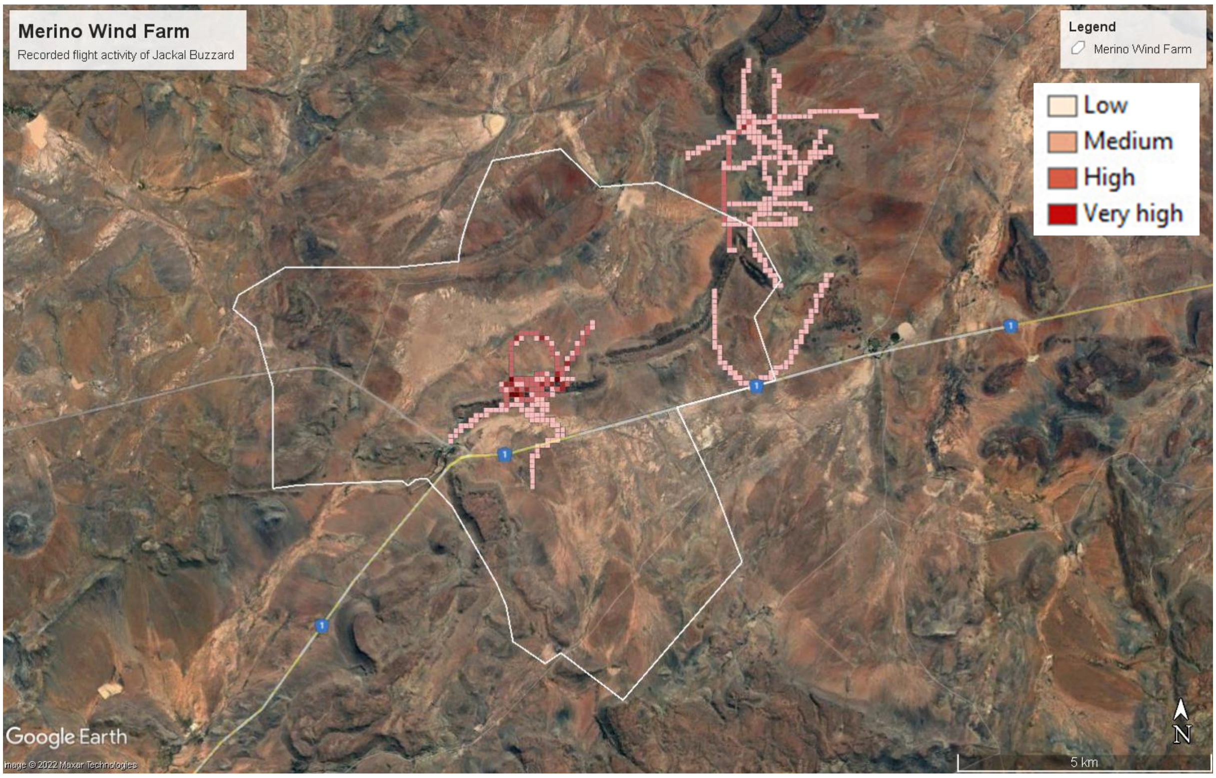


Figure 10: Intensity of flight activity of Jackal Buzzard during six surveys

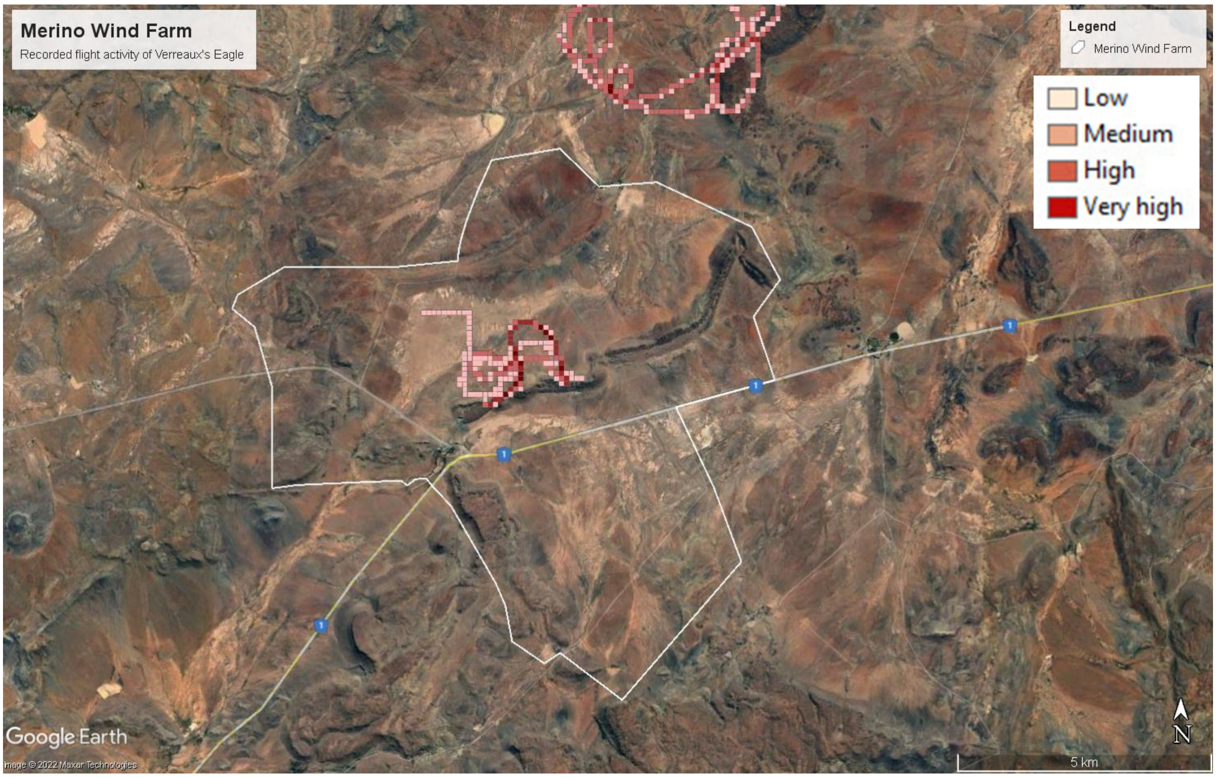


Figure 11: Intensity of flight activity of Verreaux's Eagle during six surveys

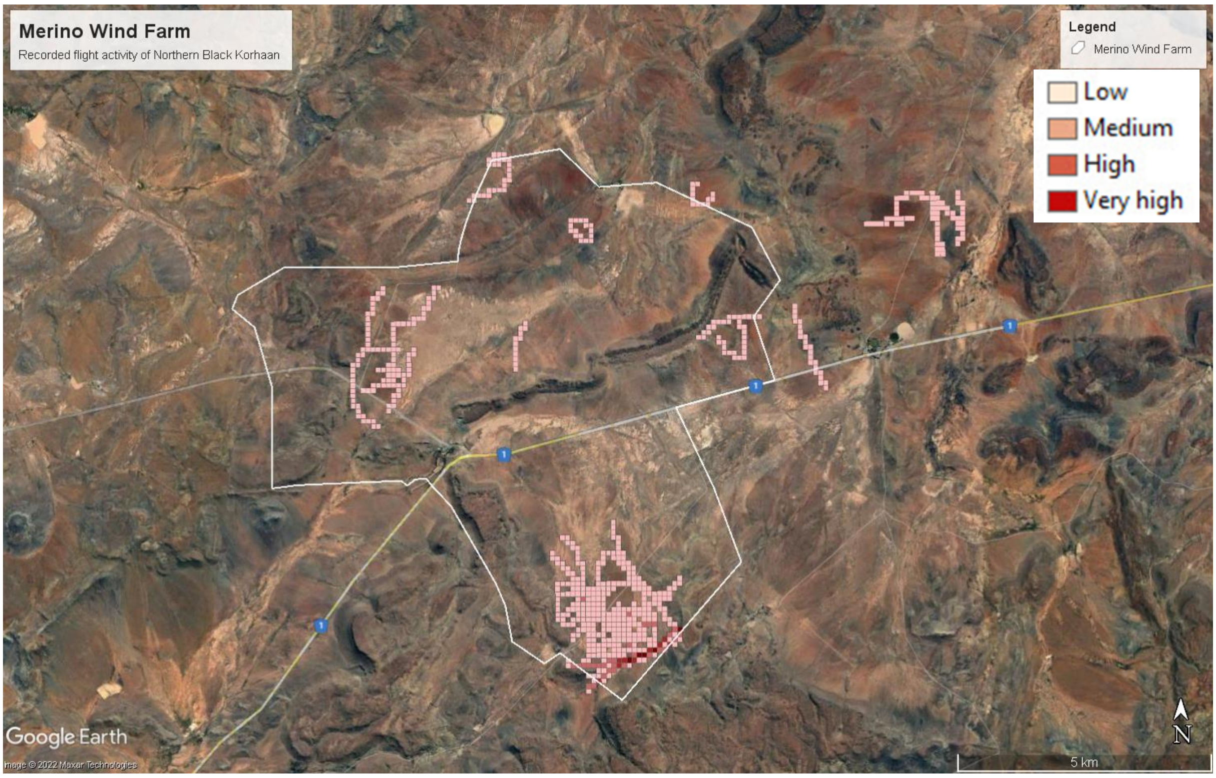


Figure 12: Intensity of flight activity of Northern Black Korhaan during six surveys

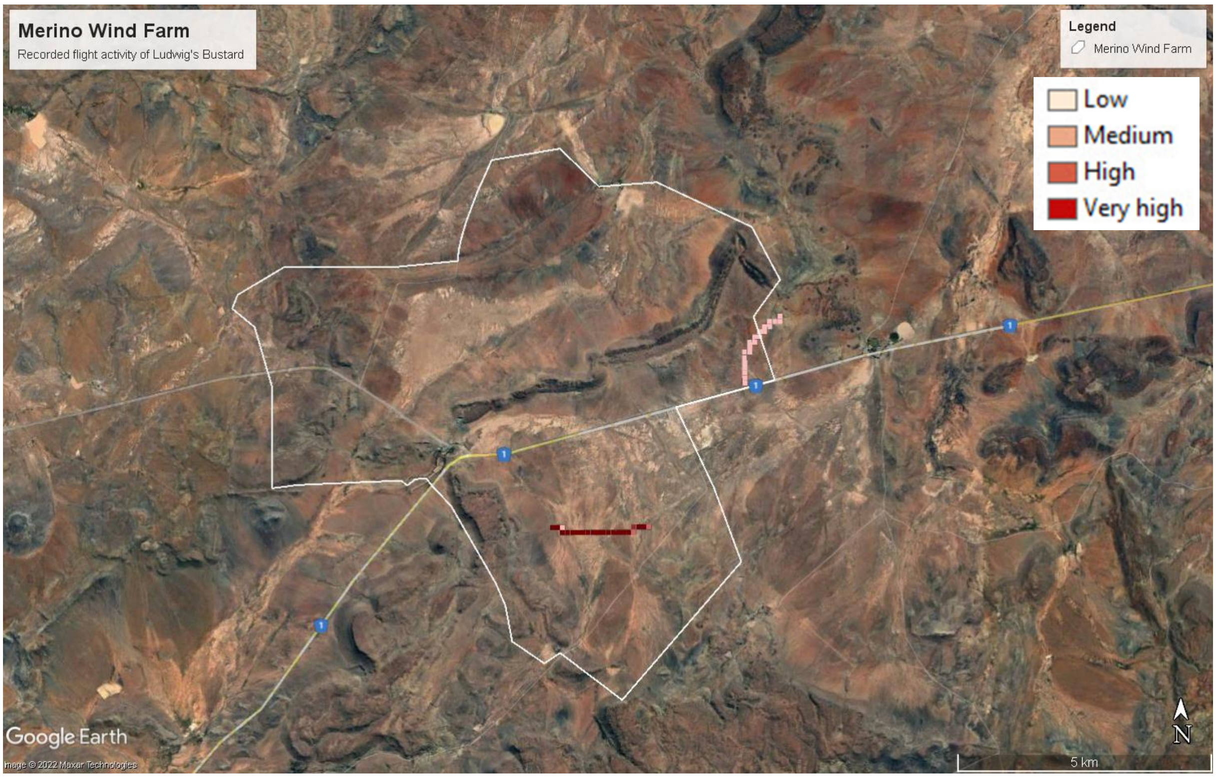


Figure 13: Intensity of flight activity of Ludwig's Bustard during six surveys

5 DESCRIPTION OF EXPECTED IMPACTS

5.1 Wind farm

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):

- Mortality due to collisions with the wind turbines
- Displacement due to disturbance during construction and operation of the wind farm
- Displacement due to habitat change and loss at the wind farm
- Mortality due to electrocution on the electrical infrastructure
- Collisions with the 33kV overhead lines

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

5.1.1 Collision mortality on wind turbines[6]

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

Collisions with wind turbines appear to kill fewer birds than collisions with other man-made infrastructures, such as 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 understanding of the factors that explain bird collision risk and how they interact with one another is therefore crucial to proposing and implementing valid mitigation measures.

Species-specific factors

- Morphological features

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

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. 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.

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

- Sensorial perception

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

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

- Phenology

Recent studies have shown that, within a 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.

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

- Bird behaviour

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

Social behaviour may also result in a greater collision risk with wind turbines due to a decreased awareness of the surroundings. Several authors have reported that flocking behaviour increases collision risk with 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). Similarly, in South Africa, only two bustard collisions with wind turbines have been reported to date, both Ludwig's Bustards (Ralston-Paton & Camagu 2019). No Denham's Bustards *Neotis denhami* turbine fatalities have been reported to date, despite the species occurring at several wind farm sites.

The priority species which could occur with some regularity at the proposed Merino Wind Farm can be classified as either terrestrial species, soaring species or occasional long-distance fliers. Terrestrial species spend most of the time foraging on the ground. They do not fly often and when they do, they generally fly for short distances at low to medium altitude. At the application site, Ludwig Bustard and Karoo Korhaan are included in this category. Occasional long-distance fliers generally behave as terrestrial species but can and do undertake long distance flights on occasion. Species in this category are Ludwig's Bustard, Blue Crane and Greater Flamingo. 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 project site, these include all the raptors, vultures and storks which could occur i.e., Cape Vulture, Lanner Falcon, Booted Eagle, Martial Eagle, Greater Kestrel, Pale Chanting Goshawk, Tawny Eagle, Verreaux's Eagle, Black Stork and Blue Crane (which soars on occasion). Based on the time spent potentially flying at rotor height, soaring species are likely to be at greater risk of collision.

- Avoidance behaviours

Two types of avoidance have been described (Furness *et al.*, 2013): 'macro-avoidance' whereby birds alter their flight path to keep clear of the entire 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 anticipated that most birds at the proposed Merino Wind Farm will avoid the wind turbines, as is generally the case at all wind farms (SNH 2010). Exceptions already mentioned are raptors that engage in hunting which might serve to distract them and place them at risk of collision, birds engaged in display behaviour or inter- and intraspecific aggressive interaction. Complete macro-avoidance of the wind farm is unlikely for any of the priority species likely to occur at the proposed Merino Wind Farm.

- Bird abundance

Some authors suggest that fatality rates are related to bird abundance, density or utilization rates (Carrete *et al.* 2012; Kitano and Shiraki, 2013; Smallwood and Karas, 2009), whereas others point out that, as birds use their territories in a non-random way, fatality rates do not depend on bird abundance alone (e.g. Ferrer *et al.* 2012; Hull *et al.* 2013). Instead, fatality rates depend on other factors such as differential use of specific areas within a 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).

The abundance of priority species at the proposed Merino Wind Farm will fluctuate depending on the season of the year, and especially in response to rainfall e.g., Ludwig's Bustard, Greater Flamingo, Lesser Kestrel and Blue Crane.

<u>*Site-specific factors*</u>

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

The project site does not contain many landscape features as it is situated on a vast, slightly undulating plain, but there are ridges which provide potential for slope soaring for raptors. The most significant landscape features from a collision risk perspective are the ground dams (when full) and drinking troughs. Surface water attracts many birds, including Red List species such as Martial Eagle, Tawny Eagle, Blue Crane, Greater Flamingo, Black Stork and Lanner Falcon.

- Flight paths

For territorial raptors like Golden Eagles (and Verreaux's Eagles – see Ralston-Patton 2017)), foraging areas are preferably located near to the nest, when compared to the rest of their home range. For example, in Scotland 98% of Golden Eagle movements were registered at ranges less than 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 close to ridges, can be used to predict the areas used by the species to forage (McLeod *et al.* 2002), and therefore provide a sensitivity map and guidance to the development of new wind farms (Bright *et al.* 2006).

There is a Tawny Eagle nest (FPTE1) (-31.445988° 23.583921°) on the Droërivier – Hydra 2 400kV transmission line situated approximately 3.6km from the closest turbine position. There is another Tawny Eagle nest (FPTE4) (-31.507460° 23.550963°) on the Droërivier-from the closest turbine position. There is also a Martial Eagle nest (FPME1) (-31.524550° 23.534279°) on the Droërivier-Hydra 1 400kV transmission line approximately 6.2km away from the turbine posistion. There are also Verreaux's Eagle nests - FPVE2 (-31.543776° 23.597448°) situated approximately 5.3km from the closest turbine position, FPVE3 (-31.425449° 23.702398°) situated approximately 5.6km from the closest turbine position, FPVE4 (-31.540635° 23.716886°) situated approximately 8.8km from the closest turbine position and FPVE5 (-31.560946° 23.612253°) situated approximately 7.3km from the closest turbine position. The nests are the hub of the flight activity for the breeding pairs of eagles. The *dams are likely to act as a focal point for flight activity as birds converge on the dam, e.g. Blue Crane to roost and Greater Flamingo to forage. There is also a ridge which may be used extensively by Verreaux's Eagles.*

- 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 availability of food (Smallie 2015).

The occurrence of Cape Vultures at the project site could be linked to the availability of food.

- Summary

The proposed Merino Wind Farm will pose a collision risk to several priority species which could occur regularly at the site. Species exposed to this risk are large terrestrial species i.e., mostly bustards such as Karoo Korhaan, Northern Black Korhaan, Ludwig's Bustard, and Blue Crane, although bustards and cranes generally seem to be not as vulnerable to turbine collisions as was originally anticipated (Ralston-Paton & Camagu 2019). Soaring priority species, i.e., species such as Tawny Eagle, Cape Vulture, Martial Eagle, Pale Chanting Goshawk, Lanner Falcon, Booted Eagle, Verreaux's Eagle, Greater Kestrel and Black Stork are most at risk of all the priority species likely to occur at the project site. In summary, the following priority species could be at risk of collisions with the turbines: African Fish Eagle, African Harrier-Hawk, Black Harrier, Black Stork, Black-winged Kite, Blue Crane, Booted Eagle, Common Buzzard, Greater Flamingo, Greater Kestrel, Jackal Buzzard, Karoo Korhaan, Lanner Falcon, Lesser Kestrel, Ludwig's Bustard, Martial Eagle, Northern Black Korhaan, Pale Chanting Goshawk, Secretarybird, Spotted Eagle-Owl, Tawny Eagle, Verreaux's Eagle, Western Barn Owl and Cape Vulture.

5.1.2 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 operation 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. 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).

The same situation seems to prevail at wind farms in the Eastern Cape where Denham's Bustard are still using wind farm sites as leks.[7] Research on small grassland species in North America indicates that permanent displacement is uncommon and very species specific (e.g. see Stevens et.al 2013, Hale et.al 2014). There also seems to be little evidence for a persistent decline in passerine populations at 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).

It is inevitable that a measure of displacement will take place for all priority species during the construction phase, due to the disturbance factor associated with the construction activities. This is likely to affect ground nesting species the most, as this could temporarily disrupt their reproductive cycle. Species which fall in this category are Ludwig's Bustard, Blue Crane, Karoo Korhaan, Northern Black Korhaan and Spotted Eagle-Owl. Some raptors might also be affected, e.g, Greater Kestrel which often breeds on crow nests which have been constructed on wind pumps. Some species might be able to recolonise the area after the completion of the construction phase, but for some species this might only be partially

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

the case, resulting in lower densities than before once the wind farm is operational, due to the disturbance factor of the operational turbines. In summary, the following species could be impacted by disturbance during the construction phase: Blue Crane, Karoo Korhaan, Ludwig's Bustard, Northern Black Korhaan, Spotted Eagle-Owl and Greater Kestrel.

5.1.3 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 site (Fox *et al.* 2006 as cited by Drewitt & Langston 2006), though effects could be more widespread where developments interfere with hydrological patterns or flows on wetland or peatland sites (unpublished data). Some changes could also be beneficial. For example, habitat changes following the development of the Altamont Pass 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 more subtle, 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 was 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. Bidwell (2004) found that Blue Cranes select nesting sites away from roads. 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).

The network of roads is likely to result in significant habitat fragmentation, and it could have an effect on the density of several species, particularly larger terrestrial species such as Ludwig's Bustard, Blue Crane, Northern Black Korhaan and Karoo Korhaan. Given the expected density of the proposed turbine layout and associated road infra-structure, it is not expected that any priority species will be permanently displaced from the development site. The building infrastructure and substations will all be situated in the same habitat, i.e., Karoo scrub. The habitat is not particularly sensitive, as far as avifauna is concerned, therefore the impact of the habitat transformation will be low given the extent of available habitat and the small size of the footprint. In summary, the following species are likely to be affected by habitat transformation: Blue Crane, Karoo Korhaan, Northern Black Korhaan, Ludwig's Bustard.

5.2. Associated infrastructure

5.2.1 Electrocution in the substation and on the 33kV medium voltage network

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

While the intention is to place the medium voltage reticulation network underground where possible, there are areas where the lines might have to run above ground, for technical reasons. In these instances, the poles could potentially pose an electrocution risk to raptors. In summary, the following priority species could be vulnerable to electrocution: Spotted Eagle-Owl, Greater Kestrel, Pale Chanting Goshawk, Jackal Buzzard, Martial Eagle, Tawny Eagle, Verreaux's Eagle, African Fish Eagle, African Harrier-Hawk, Black Stork, Black-winged Kite, Booted Eagle, Common Buzzard, Lanner Falcon, Lesser Kestrel, Western Barn Owl and Cape Vulture. Electrocutions within the proposed substation yard are also possible, particularly smaller species such as Greater Kestrel and Spotted Eagle-Owl but should not affect the larger Red Data raptors such as Martial Eagle, as these species are unlikely to use the infrastructure within the substation yard for perching or roosting.

5.2.2 Collisions with the 33kV OHL

While the intention is to place the 33kV reticulation network underground where possible, there are areas were the lines might have to run above ground, for technical reasons. This includes an option to construct a 33kV OHL of approximately 10km to link the two development areas. This could pose a collision risk to several priority species.

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

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 5 below).

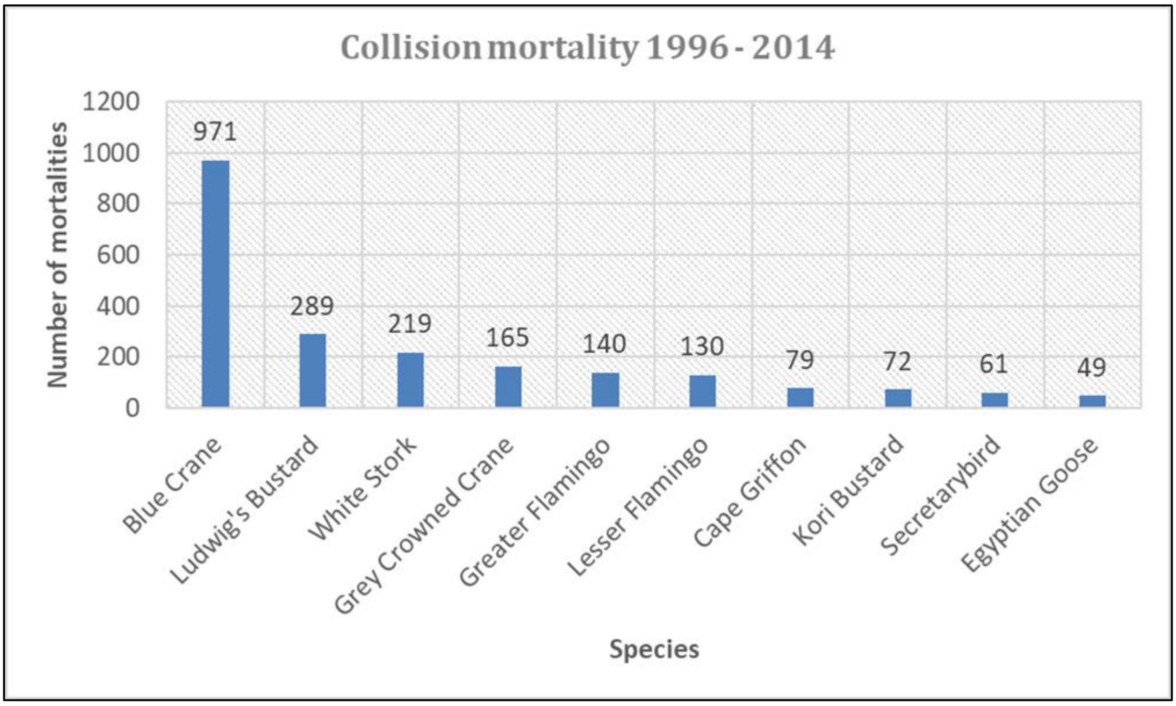


Figure 14: The top 10 collision prone bird species in South Africa, in terms of reported incidents contained in the Eskom/Endangered Wildlife Trust Strategic Partnership central incident register 1996 - 2014 (EWT unpublished data)

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 one 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 *Ardeotis kori* 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).

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

While the intention is to place the majority of the medium voltage reticulation network underground at the wind farm, there are areas where the lines will run above ground. Priority species which are most at risk of collisions with the medium voltage powerlines are the following: Black Stork, Blue Crane, Karoo Korhaan, Northern Black Korhaan, Ludwig's Bustard, Greater Flamingo, Secretarybird. Large dams and agricultural fields are particular high-risk areas.

6. ASSESSMENT OF IMPACTS ON AVIFAUNA

The assessment criteria used for the assessment of the impacts on avifauna is attached as APPENDIX D.

6.1 Impact tables

6.1.1 Construction Phase

Nature: Displacement of priority species due to disturbance during construction phase		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Very short (1)	Very short (1)
Magnitude	High (8)	Moderate (6)
Probability	Definite (5)	Definite (5)
Significance	**Medium (50)**	**Medium (40)**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	To some extent	
Mitigation: • Construction activity should be restricted to the immediate footprint of the infrastructure as far as possible, and in particular to the proposed road network. Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species. • Removal of vegetation must be restricted to a minimum and must be rehabilitated to its former state where possible after construction. • Construction of new roads should only be considered if existing roads cannot be upgraded. • Vehicle and pedestrian access to the site should be controlled and restricted as much as possible to prevent unnecessary disturbance of priority species.		
Residual Impacts: Due to the nature of the construction activities, it is inevitable that temporary displacement of priority species will happen as a result. While this can be mitigated to some extent, the significance of the residual impacts will remain at a medium level.		

6.1.2 Operation Phase

Nature: Displacement of priority species due to habitat loss in the operation phase		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long term (4)	Long term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Medium (33)**	**Low (27)**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	To some extent	

Mitigation:
• Once operational, vehicle and pedestrian access to the site should be controlled and restricted to prevent unnecessary destruction of vegetation. • Formal live-bird monitoring should be resumed once the turbines have been constructed, as per the most recent edition of the Best Practice Guidelines (Jenkins *et al*. 2015). The purpose of this would be to establish if displacement of priority species has occurred and to what extent. The exact time when operational monitoring should commence, will depend on the construction schedule, and should commence when the first turbines start operating. The Best Practice Guidelines require that, as an absolute minimum, operational monitoring should be undertaken for the first two (preferably three) years of operation, and then repeated again in year 5, and again every five years thereafter for the operational lifetime of the facility. • The mitigation measures proposed by the vegetation specialist, including rehabilitation, must be strictly implemented. • Excavated rocks should be removed, or all infilling for road construction should be compacted and all lose rock piles at the base or periphery of such infilling should be covered and packed down to eliminate all potential crevices and shelter for small mammals such as Rock Hyraxes (the primary source of food for the Verreaux's Eagles).
Residual Impacts:
Due to the nature of the infrastructure, it is highly likely that long term partial displacement of priority species will happen, particularly as a result of the habitat fragmentation caused by the associated road network. The habitat transformation can be limited to some extent through mitigation measures, to keep the significance of the residual impacts at a low level.

Nature: Mortality of priority species due to collisions with the turbines in the operation phase		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long term (4)	Long term (4)
Magnitude	Moderate (6)	Low (4)
Probability	Highly probable (4)	Probable (3)
Significance	**Medium (44)**	**Low (27)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	
Mitigation:		
• A 3.7km turbine exclusion zone should be implemented around the Verreaux's Eagle nests listed below, and the construction of turbines from 3.7km up to 5.2km from the nest should be avoided, if possible: - FPVE2 (-31.543776° 23.597448°) - FPVE4 (-31.540635° 23.716886°) - FPVE5 (-31.560946° 23.612253°) • A 3km No-Go zone should be implemented around the Tawny Eagle nest (FPTE1) (-31.445988° 23.583921°). • A 5km No-Go zone should be implemented around the Martial Eagle nest (FPME1) (-31.524550° 23.534279°). • A 750m turbine exclusion zone must be implemented around the following Jackal Buzzard nests: - JB1 -31.532193° 23.617943° - JB2 -31.453311° 23.679073°		

- An 800m turbine exclusion zone should be implemented at the large dams listed below:
  - -31.505297° 23.624400°
  - -31.463982° 23.653370°
  - -31.452242° 23.623465°
- A 500m turbine exclusion zone should be implemented at the medium-sized dam situated at -31.468068° 23.613909°
- A 200m turbine exclusion zone should be implemented around the following boreholes:
  - -31.512977° 23.608149°
  - -31.512790° 23.590034°
  - -31.524881° 23.648011°
  - -31.543646° 23.641418°
  - -31.493728° 23.682023°
  - -31.492167° 23.622478°
  - -31.485982° 23.606518°
  - -31.478371° 23.603843°
  - -31.493728° 23.682023°
- No turbines must be constructed on the ridge stretching from -31.512735° 23.617398° to -31.531996° 23.618575°.
- Carcass searches must commence to establish mortality rates, as per the most recent edition of the Best Practice Guidelines (Jenkins *et al*. 2015). The exact time when operational monitoring should commence will depend on the construction schedule, and should commence when the first turbines start operating. The Best Practice Guidelines require that, as an absolute minimum, operational monitoring should be undertaken for the first two (preferably three) years of operation, and then repeated again in year 5, and again every five years thereafter for the operational lifetime of the facility.
- If annual estimated collision rates indicate unsustainable mortality levels of priority species, i.e. if natural background mortality together with the estimated mortality caused by turbine collisions exceeds a critical mortality threshold as determined by the avifaunal specialist in consultation with other experts e.g. BLSA, additional measures will have to be implemented which could include shutdown on demand. This must be undertaken in consultation with a qualified avifauna specialist.

Residual Impacts:
It is not possible to completely eliminate the risk of turbine collisions, but through mitigation measures, it could be reduced to a low level.

Nature: Mortality of priority species due to electrocutions on the overhead MV network (where applicable) and in the substation yard.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long term (4)	Long term (4)
Magnitude	High (8)	High (8)
Probability	Highly probable (4)	Improbable (1)
Significance	**Medium (52)**	**Low (13)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	
Mitigation: • Overhead lines should be restricted to an absolute minimum and should only be allowed if underground cabling is unfeasible due to technical constraints.		

• The final pole designs must be signed off by the bird specialist to ensure that a bird-friendly design is used, where relevant. • Bi-monthly inspections of the overhead sections of the MV network must be conducted to look for carcasses under the poles, where relevant. • With regards to the infrastructure within the substation yard, the hardware is too complex to warrant any mitigation for electrocution at this stage. It is rather recommended that if any impacts are recorded once operational, site specific mitigation be applied reactively and in consultation with a qualified avifauna specialist.
Residual Impacts: It is possible to almost completely eliminate the risk of electrocutions through the use of bird-friendly designs, although all structures carry some risk of electrocution.

Nature: Mortality of priority species due to collisions with the 33kV OHL		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long term (4)	Long term (4)
Magnitude	High (8)	Moderate (6)
)Probability	Highly probable (4)	Probable (3)
Significance	**Medium (52)**	**Medium (33)**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	To a limited extent	To a limited extent
Mitigation: • Overhead lines should be restricted to an absolute minimum and should only be allowed if underground cabling is unfeasible due to technical constraints. • Bird flight diverters should be installed on all 33kV overhead lines on the full span length on the earthwire (according to Eskom guidelines - five metres apart). Light and dark colour devices must be alternated to provide contrast against both dark and light backgrounds respectively. These devices must be installed as soon as the conductors are strung.		
Residual Risks: There will be an ongoing residual risk of collisions with the OHL, but mitigation should reduce the risk by some extent.		

6.1.3 De-commissioning Phase

Nature: Displacement of priority species due to disturbance during the decommissioning phase		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Very short (1)	Very short (1)
Magnitude	High (8)	Moderate (6)
Probability	Definite (5)	Definite (5)
Significance	**Medium (50)**	**Medium (40)**
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	To some extent	
Mitigation:		

• Decommissioning activity should be restricted to the immediate footprint of the infrastructure as far as possible, and in particular to the proposed road network. Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species. • Construction of new roads should only be considered if existing roads cannot be utilised / upgraded. • Vehicle and pedestrian access to the site should be controlled and restricted as much as possible to prevent unnecessary disturbance of priority species.
Residual Impacts: Due to the nature of the decommissioning activities, it is inevitable that temporary displacement of priority species will happen as a result. While this can be mitigated to some extent, the significance of the residual impacts will remain at a medium level.

6.2 Inputs into the Environmental Management Plan (EMPr)

Please see APPENDIX G for suggested inputs into the EMPr.

7 CUMULATIVE IMPACTS

Cumulative effects are commonly understood to be impacts from different projects that combine to result in significant change, which could be larger than the sum of all the individual impacts. The assessment of cumulative effects therefore needs to consider all renewable energy projects within a 30 km radius that have received an EA at the time of starting the environmental impact process, as well as the proposed Great Karoo cluster projects. There are currently ten (10) renewable energy projects authorised within a 30 km radius around the proposed five Great Karoo cluster projects. These projects were identified using the DFFE's Renewable Energy EIA Application Database for SA in conjunction with information provided by Independent Power Producers (IPPs) operating in the broader region. It should be noted that this list is based on information available at the time of writing this report and as such there may be other renewable energy projects proposed within the study area. The locality of renewable projects (affected properties) which are authorised are displayed in Figure 15.

7.1 The cumulative impact of the proposed Merino Wind Farm 2

The total affected land parcel area taken up by authorised renewable energy projects within the 30 km radius is approximately 774 km². The total land parcel area affected by the Great Karoo Renewable Energy Cluster equates to approximately 299 km². The combined land parcel area affected by authorised renewable energy developments within the 30 km radius of similar habitat around the proposed Great Karoo Renewable Energy Cluster, inclusive of the Great Karoo Renewable Energy Cluster, thus equals approximately 1 073 km². Of this, the proposed Merino Wind Farm project constitute ~6% (64.6km²). The cumulative impact of the proposed Merino Wind Farm is thus anticipated to be **low** after mitigation.

The total area within the 30km radius around the proposed projects equates to about 4 396 km² of similar habitat. The total combined size of the land parcels potentially affected by renewable energy projects will equate to ~24% of the available untransformed habitat in the 30km radius. However, the actual physical footprint of the renewable energy facilities will be much smaller than the land parcel areas themselves. Furthermore, each of these projects must still be subject to a competitive bidding process where only the most competitive projects will win a power purchase agreement required for the project to proceed to construction. The cumulative impact of all the proposed renewable energy projects is estimated to be **moderate**.

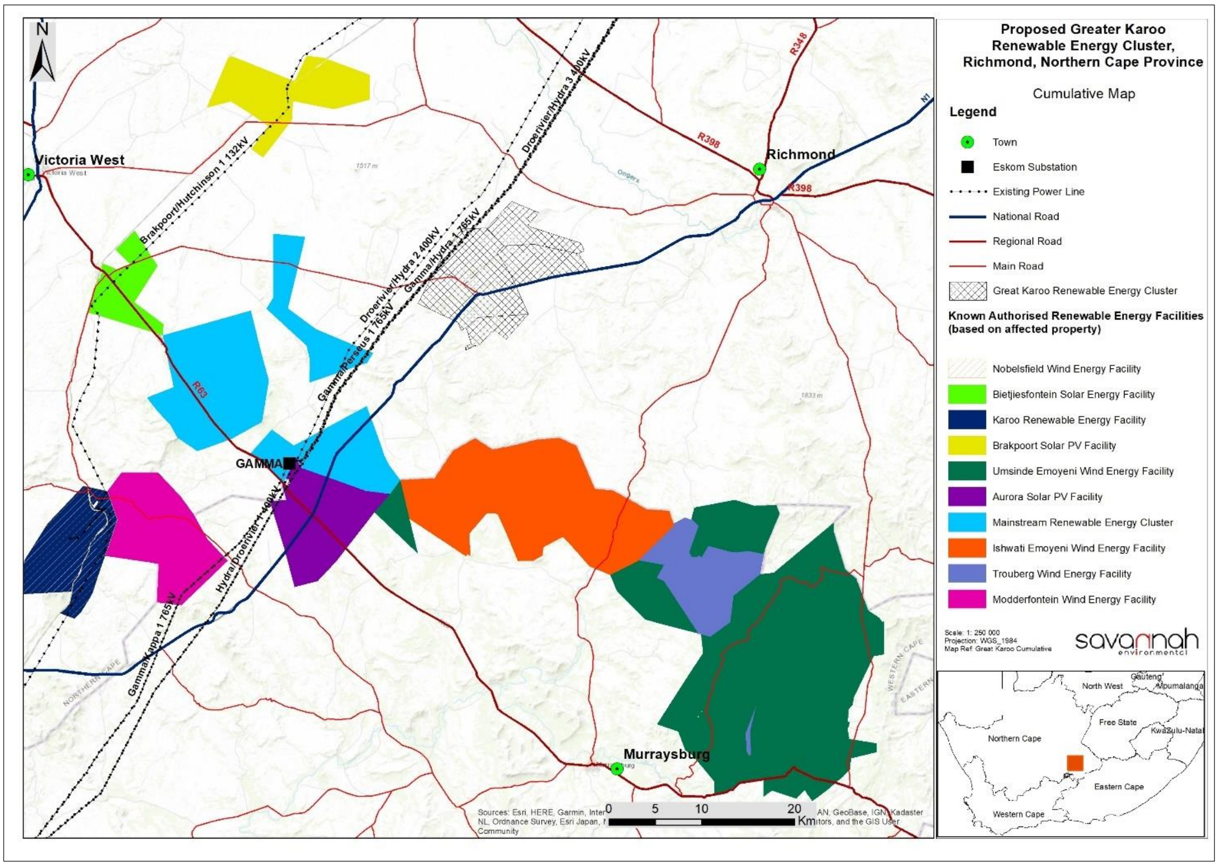


Figure 15: Regional EA applications for renewable energy projects located within a 30 km radius from the proposed Great Karoo Renewable Energy Cluster (Source: DEFF – Q3, 2021).

***Nature:* Cumulative impacts in terms of:** • **Displacement of priority species due to disturbance during construction phase** • **Displacement of priority species due to habitat loss in the operation phase** • **Mortality of priority species due to collisions with the turbines in the operation phase** • **Mortality of priority species due to electrocutions on the overhead MV network and in the substation yard.** • **Mortality of priority species due to collisions with the 33kV medium voltage overhead lines in the operation phase**		
	Overall impact of the proposed project considered in isolation (post mitigation)	***Cumulative impact of the project and other projects in the area (post mitigation)***
Extent	Low (1)	High (3)
Duration	Long term (4)	Long term (4)
Magnitude	Low (4)	Moderate (6)
Probability	Probable (3)	Probable (3)
Significance	**Low (27)**	**Medium (39)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	Yes
Mitigation: All the mitigation measures which have been listed in the bird impact assessment reports for all the relevant wind energy projects must be applied to the relevant projects. These include the following: • Construction activity should be restricted to the immediate footprint of the infrastructure as far as possible. • Burying of internal MV cables. • Rehabilitation of disturbed vegetation. • Using bird-friendly structures for the MV poles. • Curtailment of turbines if mortality thresholds are exceeded. • Maximum use of existing roads. • Implementation of operational monitoring to assess mortality levels. • Avoidance of no-go buffers around sensitive areas, including raptor nests. • Marking of overhead lines with Bird Flight Diverters.		
Residual Impacts: The implementation of the proposed mitigation measures will result in a reduction of the cumulative impacts, but it will still have a medium residual impact at a regional level.		

8 NO-GO ALTERNATIVE

The no-go alternative will result in the current *status quo* being maintained as far as the avifauna is concerned. The low human population in the area is definitely advantageous to avifauna. The no-go option would therefore eliminate any additional impact on the ecological integrity of the proposed development site as far as avifauna is concerned.

9 SUMMARY OF FINDINGS AND CONCLUDING STATEMENT

The proposed Merino Wind Farm will have several potential impacts on priority avifauna. The impacts are the following:

- Collision mortality on the wind turbines
- Displacement due to disturbance
- Displacement due to habitat transformation
- Electrocution on the 33kV MV overhead cables and in the substation yard.
- Mortality due to the collisions with the 33kV overhead lines.

9.1 Displacement of priority species due to disturbance and habitat transformation

It is inevitable that a measure of displacement will take place for all priority species during the construction phase, due to the disturbance factor associated with the construction activities. This is likely to affect ground nesting species the most, as this could temporarily disrupt their reproductive cycle. Species which fall in this category are Ludwig's Bustard, Blue Crane, Karoo Korhaan, Northern Black Korhaan and Spotted Eagle-Owl. Some raptors might also be affected, e.g, Greater Kestrel which often breeds on crow nests which have been constructed on wind pumps. Some species might be able to recolonise the area after the completion of the construction phase, but for some species this might only be partially the case, resulting in lower densities than before once the wind farm is operational, due to the disturbance factor of the operational turbines. In summary, the following species could be impacted by disturbance during the construction phase: Blue Crane, Karoo Korhaan, Ludwig's Bustard, Northern Black Korhaan, Spotted Eagle-Owl and Greater Kestrel.

The network of roads is likely to result in significant habitat fragmentation, and it could have an effect on the density of several species, particularly larger terrestrial species such as Ludwig's Bustard, Blue Crane, Northern Black Korhaan and Karoo Korhaan. Given the expected density of the proposed turbine layout and associated road infra-structure, it is not expected that any priority species will be permanently displaced from the development site. The building infrastructure and substations will all be situated in the same habitat, i.e., Karoo scrub. The habitat is not particularly sensitive, as far as avifauna is concerned, therefore the impact of the habitat transformation will be low given the extent of available habitat and the small size of the footprint. In summary, the following species are likely to be affected by habitat transformation: Blue Crane, Karoo Korhaan, Northern Black Korhaan, Ludwig's Bustard.

9.2 Mortality of priority species due to collisions with the wind turbines

The proposed Merino Wind Farm will pose a collision risk to several priority species which could occur regularly at the site. Species exposed to this risk are large terrestrial species i.e., mostly bustards such as Karoo Korhaan, Northern Black Korhaan, Ludwig's Bustard, and Blue Crane, although bustards and cranes generally seem to be not as vulnerable to turbine collisions as was originally anticipated (Ralston-Paton & Camagu 2019). Soaring priority species, i.e., species such as Tawny Eagle, Cape Vulture, Martial Eagle, Pale Chanting Goshawk, Lanner Falcon, Booted Eagle, Verreaux's Eagle, Greater Kestrel and Black Stork are most at risk of all the priority species likely to occur at the project site. In summary, the following priority species could be at risk of collisions with the turbines: African Fish Eagle, African Harrier-Hawk, Black Harrier, Black Stork, Black-winged Kite, Blue Crane, Booted Eagle, Common Buzzard, Greater Flamingo, Greater Kestrel, Jackal Buzzard, Karoo Korhaan, Lanner Falcon, Lesser Kestrel, Ludwig's Bustard, Martial Eagle, Northern Black Korhaan, Pale Chanting Goshawk, Secretarybird, Spotted Eagle-Owl, Tawny Eagle, Verreaux's Eagle, Western Barn Owl and Cape Vulture.

9.3 Mortality of priority species due to electrocutions on the 33kV MV reticulation network and in the substation yard

While the intention is to place the medium voltage reticulation network underground where possible, there are areas where the lines might have to run above ground, for technical reasons. In these instances, the poles could potentially pose an electrocution risk to raptors. In summary, the following priority species could be vulnerable to electrocution: Spotted Eagle-Owl, Greater Kestrel, Pale Chanting Goshawk, Jackal Buzzard, Martial Eagle, Tawny Eagle, Verreaux's Eagle, African Fish Eagle, African Harrier-Hawk, Black Stork, Black-winged Kite, Booted Eagle, Common Buzzard, Lanner Falcon, Lesser Kestrel, Western Barn Owl and Cape Vulture. Electrocutions within the proposed substation yard are also possible, particularly smaller species such as Greater Kestrel and Spotted Eagle-Owl but should not affect the larger Red Data raptors such as Martial Eagle, as these species are unlikely to use the infrastructure within the substation yard for perching or roosting.

9.4 Mortality of priority species due to collisions with the 33kV overhead lines

While the intention is to place the majority of the medium voltage reticulation network underground at the wind farm, there are areas where the lines will run above ground. Priority species which are most at risk of collisions with the medium voltage powerlines are the following: Black Stork, Blue Crane, Karoo Korhaan, Northern Black Korhaan, Ludwig's Bustard, Greater Flamingo, Secretarybird. Large dams and agricultural fields are particular high-risk areas.

9.5 Conclusions

The investigations into the potential impacts on avifauna, including the avifaunal pre-construction monitoring, by means of six surveys in the period October 2020 to November 2021, have not revealed any fatal flaws which stand in the way of the development of the proposed wind farm. However, this conclusion is subject to the implementation of the recommendations listed in this report.

9.6 Cumulative impacts

The total affected land parcel area taken up by authorised renewable energy projects within the 30 km radius is approximately 774 km². The total land parcel area affected by the Great Karoo Renewable Energy Cluster equates to approximately 299 km². The combined land parcel area affected by authorised renewable energy developments within the 30 km radius of similar habitat around the proposed Great Karoo Renewable Energy Cluster, inclusive of the Great Karoo Renewable Energy Cluster, thus equals approximately 1 073 km². Of this, the proposed Merino Wind Farm project constitute ~6% (64.6km²). The cumulative impact of the proposed Merino Wind Farm is thus anticipated to be **low** after mitigation.

The total area within the 30km radius around the proposed projects equates to about 4 396 km² of similar habitat. The total combined size of the land parcels potentially affected by renewable energy projects will equate to ~24% of the available untransformed habitat in the 30km radius. However, the actual physical footprint of the renewable energy facilities will be much smaller than the land parcel areas themselves. Furthermore, each of these projects must still be subject to a competitive bidding process where only the most competitive projects will win a power purchase agreement required for the project to proceed to construction. The cumulative impact of all the proposed renewable energy projects is estimated to be **moderate**.

10 CONCLUDING STATEMENT

The proposed Merino Wind Farm will have a medium impact on avifauna which, in most instances, could be reduced to a low impact through appropriate mitigation. The three alternative site compound locations are all situated in Karoo scrub. This habitat is not particularly sensitive, as far as avifauna is concerned, therefore any of the alternative locations will be acceptable. The same goes for the substation. **The currently proposed 35 turbine lay-out which was assessed in this report avoids all the recommended avifaunal turbine exclusion zones and is therefore deemed acceptable**. The development is therefore supported, provided the mitigation measures listed in this report are strictly applied.

See Appendix E for a map of the exclusion areas

11 POST CONSTRUCTION PROGRAMME

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

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APPENDIX A: PRE-CONSTRUCTION MONITORING

1. Objectives

The objective of the pre-construction monitoring at the proposed Great Karoo Wind Energy Cluster was to gather baseline data over an initial period of 12 months on the following aspects pertaining to avifauna:

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

2. Methods

Three sets of guidelines were used to guide the monitoring. These are the following:

- Jenkins, A.R., Ralston-Patton, Smit- Robinson, A.H. 2017. *Guidelines for assessing and monitoring the impact of solar power generating facilities on birds in southern Africa. BirdLife South Africa*. Hereafter referred to as the solar guidelines.
- Ralston-Patton S. & Murgatroyd, M. 2021. *Verreaux's Eagles and Wind Farms. Guidelines for impact assessment, monitoring and mitigation* (Second Edition). BirdLife South Africa, November 2021. Henceforth referred to as the VE guidelines.
- Jenkins, A.R., Van Rooyen, C.S., Smallie, J.J., Anderson, M.D., & A.H. Smit. 2015. *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa.* Produced by the Wildlife & Energy Programme of the Endangered Wildlife Trust & BirdLife South Africa. Henceforth referred to as the wind guidelines.

After it was established that the proposed wind farm sites overlap with a number of Verreaux's Eagles territories, a decision was taken in August 2021 for the Verreaux's Eagle guidelines to be applied, which are more stringent than the conventional guidelines, especially in terms of the amount of time that need to be spent at vantage points (VPs). This resulted in the scheduling of two extra surveys to meet the requirement of 72 hours of VP watches per VP per year.

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

Surveys were conducted at the proposed development sites and a control site in the following periods:

- Survey 1: 27 October - 7 November 2020
- Survey 2: 4 - 8 January 2021
- Survey 3: 15 – 21 March 2021
- Survey 4: 5 – 9 July 2021
- Survey 5: 3 – 7 October 2021
- Survey 6: 9 – 15 November 2021

Monitoring was conducted in the following manner:

- Two drive transects were identified totalling 14km on the development site and one drive transect in the control site with a total length of 7.59km.
- Two monitors travelling slowly (± 10km/h) in a vehicle recorded all birds on both sides of the transect. The observers stopped at regular intervals (every 500m) to scan the environment with binoculars. Drive transects were counted three times per sampling session, four times per year.
- In addition, eight (8) walk transects of 1km each were identified at the wind development areas and two (2) at the control site. The transects were counted four (4) times per each seasonal sampling season, four (4) times per year. The PV transects were counted four (4) times in spring and then again four (4) times in autumn i.e. twice (2) a year. All birds were recorded during walk transects.
- The following variables were recorded:
  - Species
  - Number of birds
  - Date
  - Start time and end time
  - Estimated distance from transect
  - Wind direction
  - Wind strength (estimated Beaufort scale)
  - Weather (sunny; cloudy; partly cloudy; rain; mist)
  - Temperature (cold; mild; warm; hot)
  - Behaviour (flushed; flying-display; perched; perched-calling; perched-hunting; flying-foraging; flying-commute; foraging on the ground) and
  - Co-ordinates (priority species only)

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

- Eight (8) vantage points (VPs) were identified from which the majority of the wind buildable area can be observed, to record the flight altitude and patterns of priority species. One (1) VP was also identified on the control site. VP watches were conducted for 12 hours per VP, six times per year. The following variables were recorded for each flight:
  - Species
  - Number of birds
  - Date
  - Start time and end time
  - Wind direction
  - Wind strength (estimated Beaufort scale 1-7)
  - Weather (sunny; cloudy; partly cloudy; rain; mist)
  - Temperature (cold; mild; warm; hot)
  - Flight altitude (high i.e. above rotor altitude; medium i.e. rotor altitude; low i.e. below rotor altitude)
  - Flight mode (soar; flap; glide; kite; hover) and
  - Flight time (in 15 second intervals).

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

A total of seventeen (17) potential focal points (FPs) of bird activity were identified in the course of the monitoring and were inspected during each survey i.e. six times per year. The focal points were as follows:

- FP ME1: Martial Eagle nest on Droërivier - Hydra 1 400kV
- FP ME2: Martial Eagle nest on Droërivier - Hydra 1 400kV
- FP TE1: Tawny Eagle nest on Droërivier - Hydra 2 400kV
- FP TE2: Tawny Eagle nest on Droërivier - Hydra 2 400kV
- FP TE3: Tawny Eagle nest on Droërivier - Hydra 2 400kV
- FP TE4: Tawny Eagle nest on Droërivier - Hydra 1 400kV
- FP VE1: Verreaux's Eagle nest on cliff
- FP VE2: Verreaux's Eagle nest on cliff
- FP VE3: Verreaux's Eagle nest on cliff
- FP VE4: Verreaux's Eagle nest on cliff
- FP VE5: Verreaux's Eagle nest on a cliff[8]
- CFP VE: Verreaux's Eagle nest on cliff at control site
- FP5 – FP9: Earth dams

Figure 1 below indicates the project site where the monitoring as implemented.

[8] This is a new nest that was recorded very late in the monitoring programme.

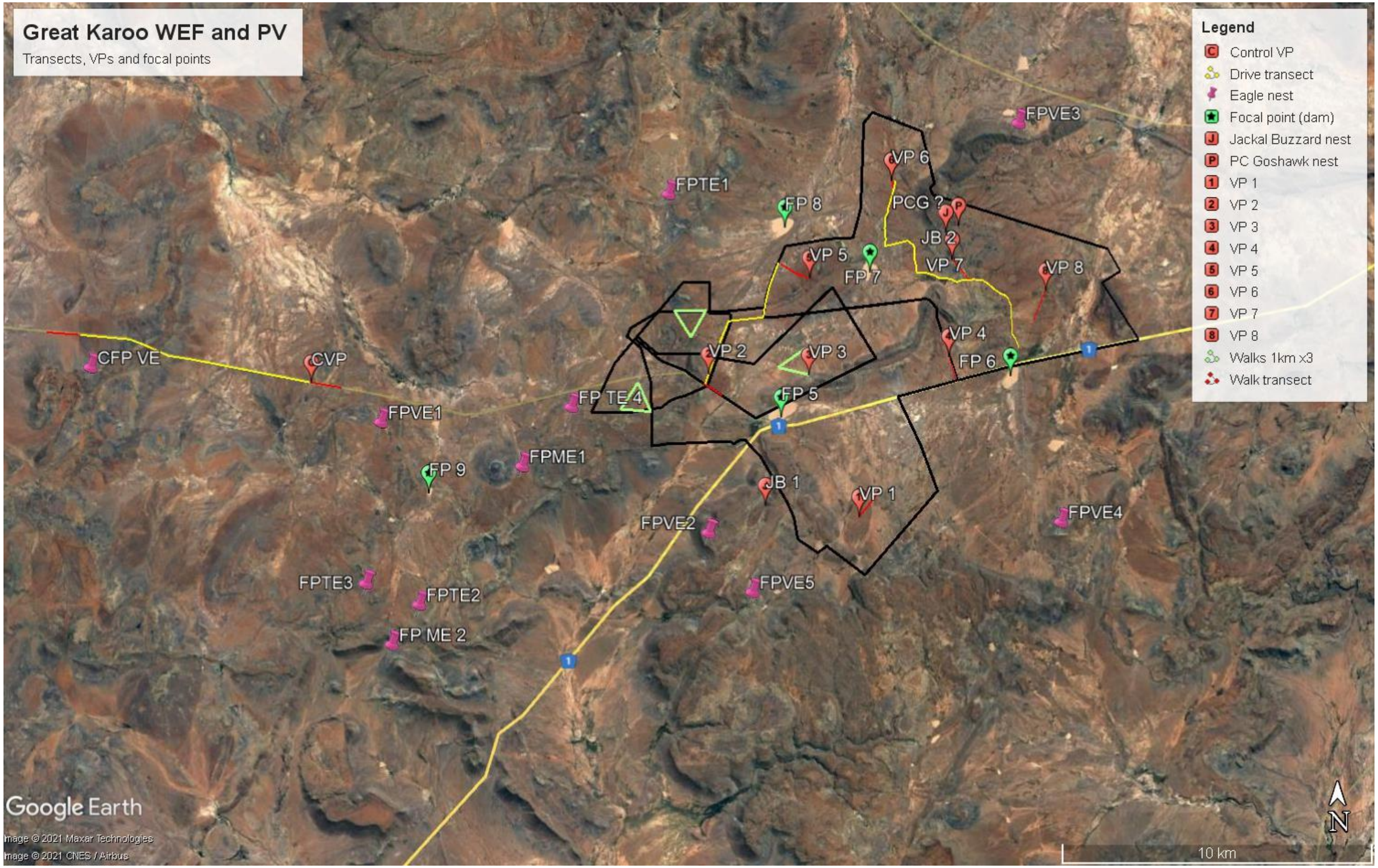


Figure 1: Area where monitoring was performed, with position of VPs, focal points, drive transects, walk transects and development sites. The area to the west of the development sites is the control area.

APPENDIX B: BIRD HABITAT

Figure 1: Typical Nama Karoo habitat in the development area, which comprises the vast majority of the project site.

Figure 2: A Tawny Eagle nest (FPTE1) on the Droërivier Hydra 400kV transmission line.

Figure 3: An example of a large dam at the project site.

Figure 4: An example of alien trees at the development area.

Figure 5: Rocky ridges and inselbergs at the project site

Figure 6: A borehole with a water reservoir at the project site

APPENDIX C: SPECIES LIST FOR BROADER AREA

Species	Taxonomic name	Full protocol reporting rate	ad hoc protocol reporting rate	Global status	Regional status	Priority species wind
Acacia Pied Barbet	*Tricholaema leucomelas*	50.00	9.09			
African Fish Eagle	*Haliaeetus vocifer*	2.08	0.00			x
African Harrier-Hawk	*Polyboroides typus*	6.25	3.03			x
African Hoopoe	*Upupa africana*	16.67	3.03			
African Palm Swift	*Cypsiurus parvus*	8.33	3.03			
African Pipit	*Anthus cinnamomeus*	20.83	3.03			
African Red-eyed Bulbul	*Pycnonotus nigricans*	60.42	13.64			
African Reed Warbler	*Acrocephalus baeticatus*	10.42	0.00			
African Rock Pipit	*Anthus crenatus*	8.33	0.00	NT	NT	
African Sacred Ibis	*Threskiornis aethiopicus*	12.50	0.00			
African Spoonbill	*Platalea alba*	6.25	4.55			
African Stonechat	*Saxicola torquatus*	2.08	0.00			
Alpine Swift	*Tachymarptis melba*	4.17	0.00			
Ant-eating Chat	*Myrmecocichla formicivora*	62.50	25.76			
Barn Swallow	*Hirundo rustica*	29.17	12.12			
Black Harrier	*Circus maurus*	2.08	0.00	EN	EN	x
Black Stork	*Ciconia nigra*	4.17	0.00	LC	VU	x
Black-eared Sparrow-Lark	*Eremopterix australis*	18.75	3.03			
Black-headed Canary	*Serinus alario*	25.00	0.00			
Black-headed Heron	*Ardea melanocephala*	12.50	0.00			
Blacksmith Lapwing	*Vanellus armatus*	37.50	4.55			
Black-throated Canary	*Crithagra atrogularis*	25.00	1.52			
Black-winged Kite	*Elanus caeruleus*	2.08	0.00			x
Black-winged Stilt	*Himantopus himantopus*	12.50	1.52			
Blue Crane	*Grus paradisea*	62.50	18.18	VU	NT	x
Bokmakierie	*Telophorus zeylonus*	56.25	13.64			
Booted Eagle	*Hieraaetus pennatus*	6.25	0.00			x
Brown-hooded Kingfisher	*Halcyon albiventris*	4.17	0.00			
Brown-throated Martin	*Riparia paludicola*	14.58	0.00			
Buffy Pipit	*Anthus vaalensis*	6.25	0.00			
Cape Bunting	*Emberiza capensis*	37.50	4.55			
Cape Canary	*Serinus canicollis*	12.50	3.03			
Cape Crow	*Corvus capensis*	8.33	4.55			
Cape Penduline Tit	*Anthoscopus minutus*	29.17	4.55			
Cape Robin-Chat	*Cossypha caffra*	31.25	3.03			
Cape Shoveler	*Spatula smithii*	2.08	1.52			

Species	Taxonomic name	Full protocol reporting rate	ad hoc protocol reporting rate	Global status	Regional status	Priority species wind
Cape Sparrow	*Passer melanurus*	83.33	16.67			
Cape Teal	*Anas capensis*	4.17	3.03			
Cape Turtle Dove	*Streptopelia capicola*	62.50	6.06			
Cape Wagtail	*Motacilla capensis*	64.58	4.55			
Cape Weaver	*Ploceus capensis*	4.17	1.52			
Cape White-eye	*Zosterops virens*	10.42	1.52			
Capped Wheatear	*Oenanthe pileata*	20.83	4.55			
Chat Flycatcher	*Melaenornis infuscatus*	54.17	7.58			
Chestnut-vented Warbler	*Curruca subcoerulea*	16.67	1.52			
Common Buzzard	*Buteo buteo*	2.08	7.58			x
Common Greenshank	*Tringa nebularia*	10.42	1.52			
Common Moorhen	*Gallinula chloropus*	2.08	0.00			
Common Sandpiper	*Actitis hypoleucos*	2.08	0.00			
Common Swift	*Apus apus*	2.08	1.52			
Common Waxbill	*Estrilda astrild*	14.58	1.52			
Desert Cisticola	*Cisticola aridulus*	22.92	3.03			
Diederik Cuckoo	*Chrysococcyx caprius*	10.42	1.52			
Double-banded Courser	*Rhinoptilus africanus*	4.17	0.00			
Dusky Sunbird	*Cinnyris fuscus*	25.00	0.00			
Eastern Clapper Lark	*Mirafra fasciolata*	70.83	21.21			
Egyptian Goose	*Alopochen aegyptiaca*	37.50	6.06			
European Bee-eater	*Merops apiaster*	16.67	0.00			
Fairy Flycatcher	*Stenostira scita*	12.50	1.52			
Familiar Chat	*Oenanthe familiaris*	27.08	6.06			
Fiscal Flycatcher	*Melaenornis silens*	33.33	3.03			
Fork-tailed Drongo	*Dicrurus adsimilis*	6.25	1.52			
Greater Flamingo	*Phoenicopterus roseus*	4.17	1.52	LC	NT	x
Greater Kestrel	*Falco rupicoloides*	31.25	3.03			x
Greater Striped Swallow	*Cecropis cucullata*	33.33	10.61			
Grey Heron	*Ardea cinerea*	8.33	1.52			
Grey Tit	*Melaniparus afer*	18.75	4.55			
Grey-backed Cisticola	*Cisticola subruficapilla*	29.17	6.06			
Grey-backed Sparrow-Lark	*Eremopterix verticalis*	39.58	15.15			
Grey-winged Francolin	*Scleroptila afra*	8.33	1.52			
Hadada Ibis	*Bostrychia hagedash*	33.33	1.52			
Hamerkop	*Scopus umbretta*	8.33	1.52			
Helmeted Guineafowl	*Numida meleagris*	12.50	1.52			
House Sparrow	*Passer domesticus*	22.92	3.03			
Jackal Buzzard	*Buteo rufofuscus*	43.75	16.67			x
Karoo Chat	*Emarginata schlegelii*	25.00	6.06			

Species	Taxonomic name	Full protocol reporting rate	ad hoc protocol reporting rate	Global status	Regional status	Priority species wind
Karoo Eremomela	*Eremomela gregalis*	2.08	6.06			
Karoo Korhaan	*Eupodotis vigorsii*	52.08	7.58	LC	NT	x
Karoo Lark	*Calendulauda albescens*	2.08	0.00			
Karoo Long-billed Lark	*Certhilauda subcoronata*	54.17	9.09			
Karoo Prinia	*Prinia maculosa*	43.75	7.58			
Karoo Scrub Robin	*Cercotrichas coryphoeus*	83.33	19.70			
Karoo Thrush	*Turdus smithi*	39.58	3.03			
Kittlitz's Plover	*Charadrius pecuarius*	6.25	1.52			
Lanner Falcon	*Falco biarmicus*	2.08	3.03	LC	VU	x
Large-billed Lark	*Galerida magnirostris*	50.00	13.64			
Lark-like Bunting	*Emberiza impetuani*	72.92	19.70			
Laughing Dove	*Spilopelia senegalensis*	35.42	7.58			
Layard's Warbler	*Curruca layardi*	25.00	1.52			
Lesser Kestrel	*Falco naumanni*	2.08	1.52			x
Lesser Swamp Warbler	*Acrocephalus gracilirostris*	12.50	0.00			
Levaillant's Cisticola	*Cisticola tinniens*	6.25	0.00			
Little Bittern	*Ixobrychus minutus*	2.08	0.00			
Little Grebe	*Tachybaptus ruficollis*	4.17	0.00			
Little Stint	*Calidris minuta*	4.17	0.00			
Little Swift	*Apus affinis*	22.92	3.03			
Long-billed Crombec	*Sylvietta rufescens*	14.58	0.00			
Ludwig's Bustard	*Neotis ludwigii*	45.83	7.58	EN	EN	x
Malachite Sunbird	*Nectarinia famosa*	8.33	0.00			
Marsh Sandpiper	*Tringa stagnatilis*	2.08	0.00			
Martial Eagle	*Polemaetus bellicosus*	10.42	1.52	VU	EN	x
Mountain Wheatear	*Myrmecocichla monticola*	43.75	6.06			
Namaqua Dove	*Oena capensis*	14.58	10.61			
Namaqua Sandgrouse	*Pterocles namaqua*	29.17	3.03			
Neddicky	*Cisticola fulvicapilla*	0.00	1.52			
Nicholson's Pipit	*Anthus nicholsoni*	14.58	1.52			
Northern Black Korhaan	*Afrotis afraoides*	72.92	21.21			x
Orange River White-eye	*Zosterops pallidus*	4.17	0.00			
Pale Chanting Goshawk	*Melierax canorus*	45.83	13.64			x
Pale-winged Starling	*Onychognathus nabouroup*	62.50	3.03			
Pearl-breasted Swallow	*Hirundo dimidiata*	4.17	0.00			
Pied Avocet	*Recurvirostra avosetta*	16.67	6.06			
Pied Crow	*Corvus albus*	81.25	48.48			
Pied Starling	*Lamprotornis bicolor*	35.42	9.09			
Pink-billed Lark	*Spizocorys conirostris*	2.08	0.00			
Pin-tailed Whydah	*Vidua macroura*	16.67	1.52			

Species	Taxonomic name	Full protocol reporting rate	ad hoc protocol reporting rate	Global status	Regional status	Priority species wind
Plain-backed Pipit	*Anthus leucophrys*	18.75	1.52			
Pririt Batis	*Batis pririt*	2.08	1.52			
Red-billed Quelea	*Quelea quelea*	29.17	3.03			
Red-billed Teal	*Anas erythrorhyncha*	14.58	3.03			
Red-capped Lark	*Calandrella cinerea*	20.83	0.00			
Red-eyed Dove	*Streptopelia semitorquata*	35.42	4.55			
Red-faced Mousebird	*Urocolius indicus*	14.58	3.03			
Red-headed Finch	*Amadina erythrocephala*	4.17	9.09			
Red-knobbed Coot	*Fulica cristata*	6.25	0.00			
Red-winged Starling	*Onychognathus morio*	20.83	4.55			
Reed Cormorant	*Microcarbo africanus*	2.08	0.00			
Rock Kestrel	*Falco rupicolus*	41.67	3.03			
Rock Martin	*Ptyonoprogne fuligula*	58.33	7.58			
Rufous-cheeked Nightjar	*Caprimulgus rufigena*	4.17	0.00			
Rufous-eared Warbler	*Malcorus pectoralis*	75.00	28.79			
Sabota Lark	*Calendulauda sabota*	52.08	9.09			
Scaly-feathered Weaver	*Sporopipes squamifrons*	0.00	3.03			
Secretarybird	*Sagittarius serpentarius*	12.50	6.06	VU	VU	x
Short-toed Rock Thrush	*Monticola brevipes*	2.08	1.52			
Sickle-winged Chat	*Emarginata sinuata*	56.25	7.58			
South African Cliff Swallow	*Petrochelidon spilodera*	12.50	6.06			
South African Shelduck	*Tadorna cana*	47.92	4.55			
Southern Fiscal	*Lanius collaris*	62.50	7.58			
Southern Double-collared Sunbird	*Cinnyris chalybeus*	2.08	0.00			
Southern Grey-headed Sparrow	*Passer diffusus*	35.42	4.55			
Southern Masked Weaver	*Ploceus velatus*	66.67	10.61			
Southern Red Bishop	*Euplectes orix*	31.25	7.58			
Speckled Pigeon	*Columba guinea*	54.17	10.61			
Spike-heeled Lark	*Chersomanes albofasciata*	77.08	18.18			
Spotted Eagle-Owl	*Bubo africanus*	8.33	0.00			x
Spotted Thick-knee	*Burhinus capensis*	2.08	1.52			
Spur-winged Goose	*Plectropterus gambensis*	8.33	4.55			
Tawny Eagle	*Aquila rapax*	12.50	3.03	VU	EN	x
Three-banded Plover	*Charadrius tricollaris*	33.33	0.00			
Tractrac Chat	*Emarginata tractrac*	2.08	4.55			
Verreaux's Eagle	*Aquila verreauxii*	18.75	1.52	LC	VU	x
Wattled Starling	*Creatophora cinerea*	4.17	0.00			
Western Barn Owl	*Tyto alba*	2.08	0.00			x

Species	Taxonomic name	Full protocol reporting rate	ad hoc protocol reporting rate	Global status	Regional status	Priority species wind
Western Cattle Egret	*Bubulcus ibis*	2.08	0.00			
White-backed Mousebird	*Colius colius*	45.83	7.58			
White-breasted Cormorant	*Phalacrocorax lucidus*	4.17	0.00			
White-necked Raven	*Corvus albicollis*	35.42	10.61			
White-rumped Swift	*Apus caffer*	14.58	9.09			
White-throated Canary	*Crithagra albogularis*	62.50	10.61			
White-throated Swallow	*Hirundo albigularis*	14.58	1.52			
Yellow Canary	*Crithagra flaviventris*	16.67	4.55			
Yellow-bellied Eremomela	*Eremomela icteropygialis*	39.58	9.09			
Yellow-billed Duck	*Anas undulata*	20.83	3.03			

APPENDIX D: ASSESSMENT CRITERIA

Assessment of Impacts

Direct, indirect and cumulative impacts associated with the projects must be assessed in terms of the following criteria:

- » The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- » The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
- » The **duration**, wherein it will be indicated whether:
  - ∗ the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  - ∗ the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  - ∗ medium-term (5–15 years) – assigned a score of 3;
  - ∗ long term (> 15 years) - assigned a score of 4; or
  - ∗ permanent - assigned a score of 5;
- » The **magnitude**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- » The **probability** *of occurrence*, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- » the **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
- » the **status**, which will be described as either positive, negative or neutral.
- » the degree to which the impact can be reversed.
- » the degree to which the impact may cause irreplaceable loss of resources.
- » the *degree* to which the impact can be *mitigated.*

The **significance** is calculated by combining the criteria in the following formula:

S=(E+D+M)P

S = Significance weighting

E = Extent
D = Duration
M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

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

Assessment of impacts must be summarised in the following table format. The rating values as per the above criteria must also be included.

Example of Impact table summarising the significance of impacts (with and without mitigation)

Nature: **[Outline and describe fully the impact anticipated as per the assessment undertaken]**		
	Without mitigation	**With mitigation**
Extent	High (3)	Low (1)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Medium (36)**	**Low (24)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	
Mitigation: "Mitigation", means to anticipate and prevent negative impacts and risks, then to minimise them, rehabilitate or repair impacts to the extent feasible. Provide a description of how these mitigation measures will be undertaken keeping the above definition in mind		
Residual Impacts: "Residual Risk", means the risk that will remain after all the recommended measures have been undertaken to mitigate the impact associated with the activity (Green Leaves III, 2014).		

Assessment of Cumulative Impacts

As per DEA's requirements, specialists are required to assess the cumulative impacts. In this regard, please refer to the methodology below that will need to be used for the assessment of Cumulative Impacts.

"Cumulative Impact", in relation to an activity, means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant, but may become significant when added to existing and reasonably foreseeable impacts eventuating from similar or diverse activities[9].

The role of the cumulative assessment is to test if such impacts are relevant to the proposed project in the proposed location (i.e. whether the addition of the proposed project in the area will increase the impact). This section should address whether the construction of the proposed development will result in:

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

The specialist is required to conclude if the proposed development will result in any unacceptable loss or impact considering all the projects proposed in the area.

Example of a cumulative impact table:

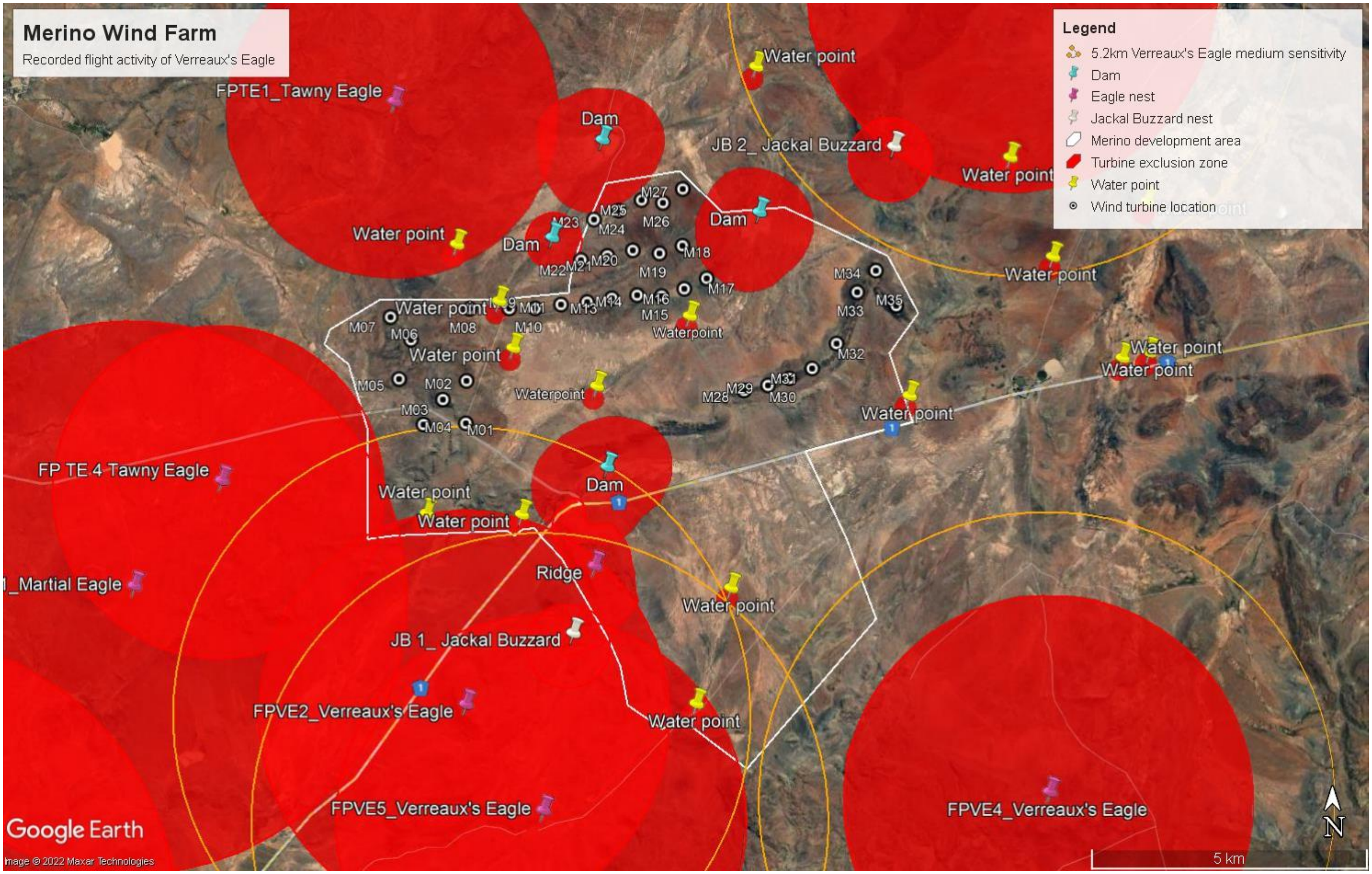
Nature: Complete or whole-scale changes to the environment or sense of place (example)

Nature: **[Outline and describe fully the impact anticipated as per the assessment undertaken]**		
	Overall impact of the proposed project considered in isolation	***Cumulative impact of the project and other projects in the area***
Extent	Low (1)	High (3)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Low (4)	Moderate (6)
Probability	Probable (3)	Probable (3)
Significance	**Low (24)**	**Medium (36)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	No	Yes
Can impacts be mitigated?	Yes	Yes
Mitigation:		

[9] Unless otherwise stated, all definitions are from the 2014 EIA Regulations, GNR 326.

"Mitigation", means to anticipate and prevent negative impacts and risks, then to minimise them, rehabilitate or repair impacts to the extent feasible. Provide a description of how these mitigation measures will be undertaken keeping the above definition in mind
Residual Impacts: "Residual Risk", means the risk that will remain after all the recommended measures have been undertaken to mitigate the impact associated with the activity (Green Leaves III, 2014).

APPENDIX E: SENSITIVITY MAP



APPENDIX F: POST-CONSTRUCTION MONITORING

1 INTRODUCTION

The avifaunal post-construction monitoring at the proposed Merino Wind Farm must be conducted 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* (Jenkins *et al*. 2011)[10].

2 AIM OF POST-CONSTRUCTION MONITORING

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

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

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

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

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

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

3 TIMING

Post-construction monitoring should commence as soon as possible after the first turbines become operational to ensure that the immediate effects of the facility on resident and passing birds are recorded, before they have time to adjust or habituate to the development. However, it should be borne in mind that it is also important to obtain an understanding of the impacts of

[10] Jenkins, A.R., Van Rooyen, C.S., Smallie, J.J., Anderson, M.D., & A.H. Smit. 2011. Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa. Produced by the Wildlife & Energy Programme of the Endangered Wildlife Trust & BirdLife South Africa.

the facility as they would be over the lifespan of the facility. Over time the habitat within the wind farm may change, birds may become habituated to, or learn to avoid the facility. It is therefore necessary to monitor over a longer period than just an initial one year.

4 DURATION

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

5 HABITAT CLASSIFICATION

Any observed changes in bird numbers and movements at a wind farm may be linked to changes in the available habitat. The avian habitats available must be mapped at least once a year (at the same time every year), using the same methods which were used during pre-construction.

6 BIRD NUMBERS AND MOVEMENTS

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

7 COLLISIONS

The collision monitoring must have three components:

- Experimental assessment of search efficiency and scavenging rates of bird carcasses on the site;
- Regular searches in the immediate vicinity of the wind farm turbines for collision casualties;
- Estimation of collision rates.

8 SEARCHER EFFICIENCY AND SCAVENGER REMOVAL

The value of surveying the area for collision victims is only valid if some measure of the accuracy of the survey method is developed. The probability of a carcass being detected and the rate of removal/decay of the carcass must be accounted for when estimating collision rates and when designing the monitoring protocol. This must be done in the form of searcher and scavenger trails twice a year.

9 COLLISION VICTIM SURVEYS

9.1 Aligning search protocols

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

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

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

When a carcass is found, it must be bagged, labeled and kept refrigerated for species confirmation when the specialist visits the site.

9.2 Estimation of collision rates

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

10 DELIVERABLES

10.1 Annual report

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

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

10.2 Quarterly reports

Concise quarterly reports must be provided with basic statistics and any issues that need to be red-flagged.

APPENDIX G: ENVIRONMENTAL MANAGEMENT PROGRAMME

OBJECTIVE: Minimizing the displacement of priority species due to disturbance during the construction phase

Project component/s	All infrastructure
Potential Impact	Displacement of priority species
Activity/risk source	Construction activities resulting in the displacement of priority species due to disturbance
Mitigation: Target/Objective	Reducing sources of disturbance to the absolute minimum to minimise the potential displacement of priority species

Mitigation: Action/control	Responsibility	Timeframe
A site-specific Environmental Management Plan (EMPr) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted. All contractors are to adhere to the EMPr and should apply good environmental practice during construction. The EMPr should include the following directives: • Construction activity should be restricted to the immediate footprint of the infrastructure as far as possible, and in particular to the proposed road network. Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species. • Removal of vegetation must be restricted to a minimum and must be	Contractor	Construction Phase

rehabilitated to its former state where possible after construction. • Construction of new roads should only be considered if existing roads cannot be upgraded. • Vehicle and pedestrian access to the site should be controlled and restricted as much as possible to prevent unnecessary disturbance of priority species.		

Performance Indicator	Audit reports by the Environmental Control Officer (ECO)
Monitoring	Weekly inspections by the ECO to assess if the requirements of the EMPr are adhered to by the Contractor

OBJECTIVE: Preventing the displacement of priority species due to habitat transformation during the operation phase

Project component/s	Infrastructure footprint, including the turbines, roads and buildings
Potential Impact	Displacement of priority species
Activity/risk source	Operational activities resulting in the displacement of priority species due to habitat transformation
Mitigation: Target/Objective	Reducing sources of habitat transformation to the absolute minimum to minimise the potential displacement of priority species

Mitigation: Action/control	**Responsibility**	**Timeframe**

A site-specific Environmental Management Plan (EMPr) must be implemented, which gives appropriate and detailed description of how operational activities must be conducted. All operational staff and contractors are to adhere to the EMPr and should apply good environmental practice during operations. The EMPr should include the following directives: • Once operational, vehicle and pedestrian access to the site should be controlled and restricted to prevent unnecessary destruction of vegetation. • Formal live-bird monitoring should be resumed once the turbines have been constructed, as per the most recent edition of the Best Practice Guidelines (Jenkins et al. 2015). The purpose of this would be to establish if displacement of priority species has occurred and to what extent. The exact time when operational monitoring should commence, will depend on the construction schedule, and should commence when the first turbines starts operating. The Best Practice Guidelines require that, as an absolute minimum, operational monitoring should be undertaken for the first two (preferably three) years of operation, and then repeated again in year 5, and again every five years thereafter	Wind farm operator	Operation Phase

for the operational lifetime of the facility. • The mitigation measures proposed by the vegetation specialist, including rehabilitation, must be strictly implemented. • Excavated rocks should be removed, or all infilling for road construction should be compacted and all lose rock piles at the base or periphery of such infilling should be covered and packed down to eliminate all potential crevices and shelter for small mammals such as Rock Hyraxes (the primary source of food for the Verreaux's Eagles).		

Performance Indicator	Quarterly and annual reports by vegetation and avifaunal specialists
Monitoring	Weekly carcass searches under turbines and quarterly live bird surveys

OBJECTIVE: Preventing the mortality of priority species due to turbine collisions during the operation phase

Project component/s	Wind turbines
Potential Impact	Mortality of priority species
Activity/risk source	Operational activities resulting in the mortality of priority species due to collisions with the turbines

Mitigation: Target/Objective	Keeping the annual estimated mortality of local populations of priority species due to turbine collisions to below the threshold determined by the avifaunal specialist in consultation with other avifaunal experts e.g., BLSA.

Mitigation: Action/control	Responsibility	Timeframe
A site-specific Environmental Management Plan (EMPr) must be implemented, which gives appropriate and detailed description of how operational activities must be conducted. All operational staff and contractors are to adhere to the EMPr and should apply good environmental practice during operations. The EMPr should include the following directives: • A 3.7km turbine exclusion zone should be implemented around the Verreaux's Eagle nests listed below, and the construction of turbines from 3.7km up to 5.2km from the nest should be avoided if possible: - FPVE2 (-31.543776° 23.597448°) - FPVE4 (-31.540635° 23.716886°) - FPVE5 (-31.560946° 23.612253°) • A 3km No-Go zone should be implemented around the Tawny Eagle nest (FPTE1) (-31.445988° 23.583921°) • A 5km No-Go zone should be implemented around the Martial Eagle nest (FPME1) (-31.524550° 23.534279°) • A 750m turbine exclusion zone must be implemented around the following Jackal Buzzard nests:	Contractor Wind farm operator	Operational phase The Best Practice Guidelines require that, as an absolute minimum, operational monitoring should be undertaken for the first two (preferably three) years of operation, and then repeated in year 5, and again every five years thereafter for the operational lifetime of the facility.

- JB1 -31.532193° 23.617943° - JB2 -31.453311° 23.679073° • An 800m turbine exclusion zone should be implemented at the large dams listed below: - -31.505297° 23.624400° - -31.463982° 23.653370° - -31.452242° 23.623465° • A 500m turbine exclusion zone should be implemented at the medium-sized dam situated at -31.468068° 23.613909° • A 200m turbine exclusion zone should be implemented around the following boreholes: - -31.512977° 23.608149° - -31.512790° 23.590034° - -31.524881° 23.648011° - -31.543646° 23.641418° - -31.493728° 23.682023° - -31.492167° 23.622478° - -31.485982° 23.606518° - -31.478371° 23.603843° - -31.493728° 23.682023° • No turbines must be constructed on the ridge stretching from -31.512735° 23.617398° to -31.531996° 23.618575°. • Carcass searches must commence to establish mortality rates, as per the most recent edition of the Best Practice Guidelines (Jenkins et al. 2015). The exact time when		

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

Performance Indicator	Quarterly and annual reports by avifaunal specialist

Monitoring	Weekly carcass searches under turbines

OBJECTIVE: Preventing the mortality of priority species on the 33kV overhead lines and substations

Project component/s	MV network and substation
Potential Impact	Mortality of priority species
Activity/risk source	Operational activities resulting in the mortality of priority species due to electrocution and collisions
Mitigation: Target/Objective	Keeping the annual estimated mortality of local populations of priority species due to powerline mortality to below the threshold determined by the avifaunal specialist in consultation with other avifaunal experts e.g. BLSA.

Mitigation: Action/control	**Responsibility**	**Timeframe**
• Overhead lines should be restricted to an absolute minimum and should only be allowed if underground cabling is unfeasible due technical (not financial) constraints. • The final pole designs must be signed off by the bird specialist to ensure that a bird-friendly design is used, where relevant. • Bi-monthly inspections of the overhead sections of the MV network must be conducted to look for carcasses under the poles. • With regards to the infrastructure within the substation yard, the hardware is too complex to warrant any mitigation for electrocution at this	Wind farm developer Wind farm operator	Design phase and Operational Phase The Best Practice Guidelines require that, as an absolute minimum, operational monitoring should be undertaken for the first two (preferably three) years of operation, and then repeated in year 5, and again every five years thereafter for the operational lifetime of the facility. This should include the monthly inspections of the overhead sections of the MV network, where relevant.

stage. It is rather recommended that if any impacts are recorded once operational, site specific mitigation be applied reactively. This must be undertaken in consultation with the avifauna specialist. • Bird flight diverters should be installed on all 33kV overhead lines on the full span length on the earthwire (according to Eskom guidelines - five metres apart). Light and dark colour devices must be alternated to provide contrast against both dark and light backgrounds respectively. These devices must be installed as soon as the conductors are strung.		

Performance Indicator	Quarterly and annual reports by avifaunal specialist
Monitoring	Bi-monthly powerline inspections