AGGENEIS PAULPUTS 400KV OVERHEAD POWER LINE

DEA REF: 14/12/16/3/3/2/1012

FINAL AVIFAUNAL IMPACT ASSESSMENT

EIA PHASE

July 2017

Submitted to:
Judith Fasheun
Mokgope Consulting
judy@mokgope.co.za

Compiled by:
Jon Smallie
WildSkies Ecological Services (Pty) Ltd
jon@wildskies.co.za

EXECUTIVE SUMMARY

This report evaluates the likely impact of a proposed 400kV overhead transmission line between the existing Aggeneis and Paulputs Substations in the Northern Cape.

This arid area is home to several large terrestrial bird and raptor species, the most important of which are Ludwig's Bustards *Neotis ludwigii*, Kori Bustards *Ardeotis kori*, Secretarybird *Sagittarius serpentarius*, Karoo Korhaan *Eupodotis vigorsii,* Verreaux's Eagle *Aquila verreauxii* and Martial Eagle *Polemaetus bellicosus*. In addition to being classified as threatened regionally and in some cases globally, most of these species are facing significant threats to their survival from the existing transmission lines in the arid parts of South Africa.

In addition, this area is home to an assemblage of arid zone adapted smaller bird species including larks, sparrow-larks, chats and others. Most important of these from a conservation perspective are Red Lark *Calendulauda burra* and Sclater's Lark *Spizocorys sclateri*, both of which are listed as regionally threatened species (Vulnerable and Near-threatened respectively), have very restricted ranges and have been recorded in the broader area within which the study area is situated. These species are Bushmanland endemics and do not occur widely elsewhere. As such it is important to ensure that this project does not impact unduly on them. While these smaller birds are unlikely to interact directly with power lines, disturbance and habitat destruction during construction could be an issue for these species. The Red Lark in particular is a habitat specialist, utilising the red sand dunes and associated plains and so impacts on this species can be managed spatially.

Likely interactions between birds and the proposed power line include destruction of bird habitat, disturbance of birds during construction, electrical faulting caused by birds, nesting of birds on the towers, and collision of birds with the overhead cables. Of these, collision and habitat destruction are of most concern for the proposed project.

Specifically, the following findings are made by this study with respect to the impacts of the proposed development on birds:

- Bird collisions with the overhead power line is rated as HIGH significance pre-mitigation, and MEDIUM significance post mitigation
- Destruction of bird habitat is rated as HIGH pre-mitigation and MEDIUM post mitigation
- Disturbance of birds is judged to be of HIGH significance pre-mitigated, but can be mitigated to LOW significance
- Nesting of birds on the new power line is rated as LOW significance both pre and post mitigation
- Electrical faulting on the new power line is rated as LOW significance both pre and post mitigation

The addition of another large transmission line has serious implications for these bird species. It is therefore of critical importance that this risk is carefully managed if this line is to be built without significant additional impact on species already under pressure from power line impacts. The following mitigation is recommended as an outcome of this report:

- It is essential that Option 1 be selected, whereby the new power line is placed immediately adjacent to (defined as not more than 150 m between outer conductors) the existing 220kV power line. This will hopefully provide partial mitigation for the impact of collision.
- In addition, the new power line must be installed with the very latest and most effective Eskom approved line marking devices available at the time of construction. These should be fitted on the earth wires, with 100% of each span marked (not the middle 60% of each span previously stipulated in Eskom Transmission guidelines). This installation must be done according to Eskom best practice at the time, but should include the following at least: markers must alternate between a light and dark colour to provide contrast against a dark and light background respectively. These markers must be no more than 20 m apart on each earth wire. It is Eskom's responsibility to ensure the integrity of these devices for the full lifespan of the power line. If these devices become damaged or their effectiveness is in any way compromised with time they must be replaced. Likewise if significantly more effective devices become available, these must be installed on the power line.
- No construction activities for the new line should take place within 1km of the Martial Eagle nest on the existing power line during breeding season if the nest is active. The exact timing of breeding season will need to be confirmed just prior to construction, but is likely to be approximately March to September.
- All existing roads and storage sites must be used where possible.
- No towers should be placed within 100m of red dunes and water sources (drinking troughs, wind mills, reservoirs). No vehicle or human traffic should be allowed through these areas either. Towers should be spaced to avoid these areas and accessed during construction from either side, not continuously along the servitude. The red dunes have been digitised as far as possible off Google Earth, but this aspect, and the surface water sources will require more confirmation during the avifaunal walk through.
- We recommend strongly that a cross rope suspension tower structure be used, since this will provide less perching and nesting substrate for large birds than a guyed-V or self-support structure.
- A construction EMP (avifaunal walk through) must be conducted to:
  - Determine whether the Martial Eagle nest is occupied and define the breeding season in that year.
  - Identify any other nests of sensitive species, that may require management measures.
  - identify any particularly sensitive habitats, including red dunes and surface water in the form of windmills/reservoirs/drainage lines
  - provide final confirmation of the high risk sections of this power line.
- An on-site ECO must be responsible for ensuring compliance with the recommendations of this report and minimising habitat destruction during construction. This person must also:
  - Identify any other breeding raptors or other Red-listed bird species. If any are found case-specific management measures must be developed by an avifaunal specialist.

SPECIALISTDETAILS

Professional registration and experience

The Natural Scientific Professions Act of 2003 aims to “Provide for the establishment of the South African Council of Natural Scientific Professions (SACNASP) and for the registration of professional, candidate and certified natural scientists; and to provide for matters connected therewith. “Only a registered person may practice in a consulting capacity” – Natural Scientific Professions Act of 2003 (20(1)-page 14)

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

Jon Smallie has been involved in bird interactions with energy infrastructure for 16 years. During this time he has completed impact assessments for at least 80 projects, many of which have been transmission power lines. Mr Smallie has spent a large part of his career working on bird interactions with overhead power lines in the arid parts of the country. A total of several months have been spent periodically driving transmission power line servitudes identifying high collision risk areas. This has resulted in an understanding of bird interactions with power lines. This has equipped him well for conducting this assessment. A full *Curriculum Vitae* can be supplied on request.

Declaration of independence

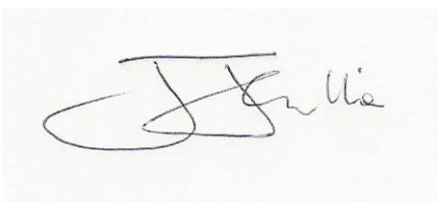
The specialist investigators declare that:

- We act as independent specialists for this project.
- We consider ourselves bound by the rules and ethics of the South African Council for Natural Scientific Professions.
- We do not have any personal or financial interest in the project except for financial compensation for specialist investigations completed in a professional capacity as specified by the Environmental Impact Assessment Regulations, 2006.
- We will not be affected by the outcome of the environmental process, of which this report forms part of.
- We do not have any influence over the decisions made by the governing authorities.
- We do not object to or endorse the proposed developments, but aim to present facts and our best scientific and professional opinion with regard to the impacts of the development.
- We undertake to disclose to the relevant authorities any information that has or may have the potential to influence its decision or the objectivity of any report, plan, or document required in terms of the Environmental Impact Assessment Regulations, 2006.

Terms and Liabilities

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

Signed in July 2017 by Jon Smallie in his capacity as specialist investigator.



Contents

Contents

1. INTRODUCTION

1.1 Background to the current study

This study forms part of an Environmental Impact Assessment for the construction and operation of a 400 kV transmission line from Aggeneis to Paulputs in the Northern Cape. The transmission line will be approximately 97 kilometres in length, depending on the route taken. Mokgope Consulting (Mokgope) was appointed to conduct the EIA and subsequently appointed WildSkies Ecological Services (WildSkies) to conduct the specialist avifaunal study, since a project of this nature has the potential to impact on birds.

Typically a project of this type could impact on birds as follows: collision of birds with overhead cables and in particular earth wires; disturbance of birds during construction and maintenance; destruction or alteration of bird habitat during construction and maintenance; electrical faulting on the line caused by birds; and the potential for birds to nest on the proposed power line. By far the most significant issue for this proposed power line is that of collision of large terrestrial birds (particularly Ludwig's Bustard *Neotis ludwigii,* Kori Bustard *Ardeotis kori,* and Secretarybird *Sagittarius serpentarius*) with the overhead cables. These species are already severely impacted nationally by existing transmission lines, and probably cannot afford to suffer significant further mortality (Shaw 2013). Several key globally threatened lark species (most importantly Red Lark *Calendulauda burra*, and Sclater's Lark *Spizocorys sclateri*) also occur in the area and will be susceptible to impact through disturbance and habitat destruction.

These issues will be elaborated on in this report.

1.2 Terms of reference

The terms of reference as supplied to WildSkies by Mokgope were as follows:

- Provide status of bird habitats and identification of all ecologically sensitive areas
- Identification of endangered species and their locations through transects and sampling within representative areas along the alternative routes
- Identify conservation worthy areas and how the proposed development can avoid them;
- Identify potential impacts of the avifauna, if any, on the proposed infrastructure per alternative route to be assessed and substations to be upgraded
- Identify potential impacts and mitigation measures of the proposed infrastructure on the avifauna per alternative route to be assessed and the substations to be upgraded
- Classification of each impact according to methods as outlined by the client (see Appendix 1)
- Recommendation of the best alternative route and technology to be used.

1.3. Description of the proposed development

The proposed project activities include the following:

- Construction of a new 400 kV transmission power line (with 3 alternative corridors and one deviation 3A) from Aggeneis to Paulputs.
- Corridors of 2 kilometres in width are provided for assessment, with a wider corridor of 4km close to Paulputs.
- The length of the new line is approximately 97kilometres.
- Aggeneis (approx. 11.6ha extension) and Paulputs (approx 3ha extension) substations will possibly require upgrades to accommodate the new line.
- Each substation has a current footprint of approximately 4 hectares, and will require expansion of the yards.
- At this stage the number and structure of towers is not yet confirmed.

Figure 1 shows the layout of the proposed activities.

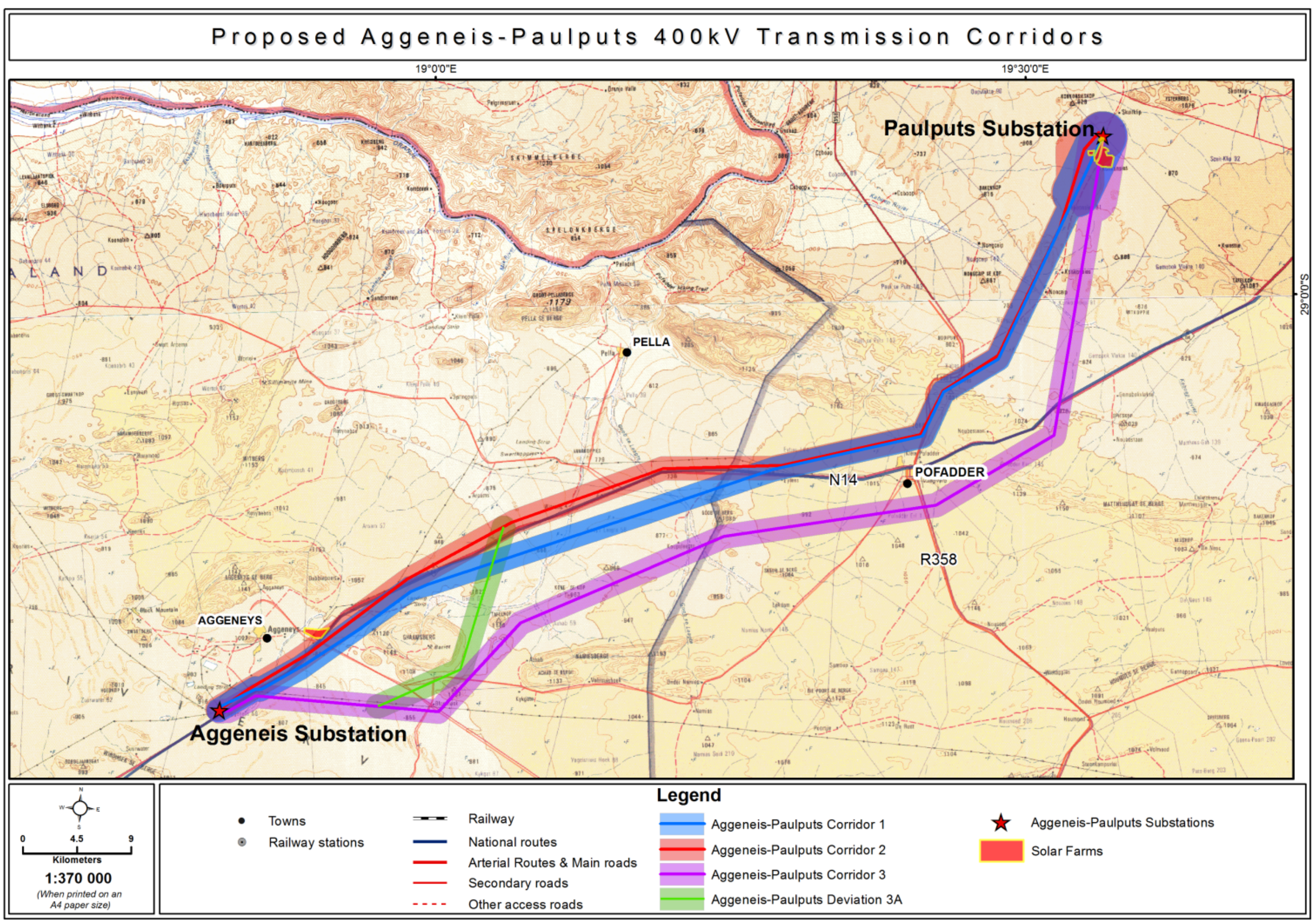


Figure 1. Layout of the Aggeneis - Paulputs400kV power line study area (map supplied by Mokgope Consulting).

1.4. Sources of information

The following information sources were consulted for this study:

- Bird distribution data from the South African Bird Atlas Projects1 and 2 were obtained to ascertain which bird species occur in the study area (Harrison *et al.* 1997, www.sabap2.adu.org.za).
- The conservation status of all bird species occurring in the study area was determined using The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland (Taylor, Peacock & Wanless, 2015).
- The power line bird mortality incident database (Central Incident Register) of the Eskom-Endangered Wildlife Trust Strategic Partnership (Eskom-EWT) was consulted to determine which of the species occurring in the study area are typically impacted upon by power lines (data from 1996 to 2012; Eskom-EWT 2012).
- A description of the vegetation types occurring in the study area was obtained from The Vegetation of South Africa, Lesotho and Swaziland (Mucina & Rutherford 2006).
- The Coordinated Avifaunal Road count project was consulted (Young *et al.* 2003), but no routes exist close to this study area.
- The Important Bird Area programme of BirdLife South Africa was consulted (Marnewick, Retief, Theron, Wright,& Anderson, 2015).
- Several people were consulted for additional information on birds in the area. These included: Rob Simmons of Birds & Bats Unlimited; Chris van Rooyen of Chris van Rooyen Consulting; Brian van der Walt of Brian's Birding; Ronelle Visagie of the Endangered Wildlife Trust; and Mossie Mostert of Port Owen.
- The author has extensive field experience in the field of power line collisions affecting large South African birds.

1.5 Methods

The field investigation followed the following methods:

1. General sampling of avifauna
    a. This was achieved through driven transects covering the study area. A total of 9 drive transects were conducted totalling 302km. These were conducted by driving slowly (<40km/hr) along the roads scanning continually for relevant bird species. Every 1-2km the vehicle was stopped and a scan was done using 10x32binoculars, and in some cases an 80mm 20-60x spotting scope. These methods follow those described by Young *et al* (2003). During these stops along each transect a listening watch was also performed for calling birds. All bird species were recorded for the general bird list (see Section 2.3.2), but particular attention was given to large terrestrial, raptor and Red Listed species. These are reported on in Section 2.3.2 using a birds/km index.
2. Sensitive species breeding survey
    a. During the above transects and additional time spent on site, all possible nesting substrate for raptors was surveyed using the same equipment as above. Due to the general lack of trees on site, nesting substrate comprised mainly rocky ridges/cliffs and existing Eskom power lines and communication towers.

3. Assessment of micro habitats
    a. During field work all available different micro habitats available to avifauna, and any sensitive avifaunal features were photographed, mapped and described.
4. Assessment of alternative power line routes
    a. Whilst in the field any relevant factors to determining the optimal route for the proposed power line were investigated and noted.

1.6. Assumptions & limitations

This study made the assumption that the sources of information discussed above are reliable, but the following factors may potentially detract from the accuracy of the predicted results. The Atlas of Southern African Birds (Harrison *et al.* 1997) data is quite old now (covering the period 1986-1997), and bird distribution patterns fluctuate continuously according to availability of food and nesting substrate, and environmental conditions. While data is available from both SABAP 1 and SABAP 2, it is probably not comprehensive because this area of Bushmanland is amongst the least surveyed areas of the country due to its remoteness from large settlements. Various other inaccuracies could exist in this atlas data; for a full discussion of these see Harrison *et al.* (1997). In addition, no long term, verified data of species distribution at a micro-habitat level along the proposed power line route exists.

The EIA process for transmission lines of this type in South Africa relies heavily on existing information, and this avifaunal study is no different. Field work was conducted during the EIA phase in order to examine specific areas and ground truth information. However this was a once short term site investigation. By necessity much of the information used for this study is obtained from various existing sources (see Section 1.4) in order to make an educated assessment. Field work cannot incorporate landowner visits and interviews for a project of this size, and invariably the time is split unevenly throughout the study area. Invariably, the existing information on birds is obtained over a far longer period and far more representative conditions than the short term EIA study.

2. DESCRIPTION OF BASELINE CONDITIONS

2.1 Vegetation description

It is widely accepted that vegetation structure is more important in determining bird habitat than the actual plant species composition (Harrison *et al.* 1997).The description of vegetation presented in this study therefore concentrates on factors relevant to the bird species present, and is not an exhaustive list of plant species present. The following description of the vegetation types occurring in the study area makes extensive use of information presented by Mucina and Rutherford (2006). The study area lies in the Bushmanland bioregion and is classified into 6 vegetation types: "Aggenys Gravel Vygieveld"; "Bushmanland Arid Grassland"; "Bushmanland Inselberg Shrubland"; "Bushmanland Sandy Grassland"; "Eastern Gariep Plains Desert"; and "Eastern Gariep Rocky Desert". The most dominant of these (by area) is Bushmanland Arid Grassland (see Figure 2).

From an avifaunal perspective, the above vegetation types are all low grassy or shrubby vegetation, with flat landscape interspersed with occasional rocky outcrops. This low vegetation is suited to species which favour open landscapes, such as bustards, korhaans, Secretarybirds and a host of smaller species such as larks – for which Bushmanland is well known. Raptors also flourish in these areas provided that suitable perches exist.

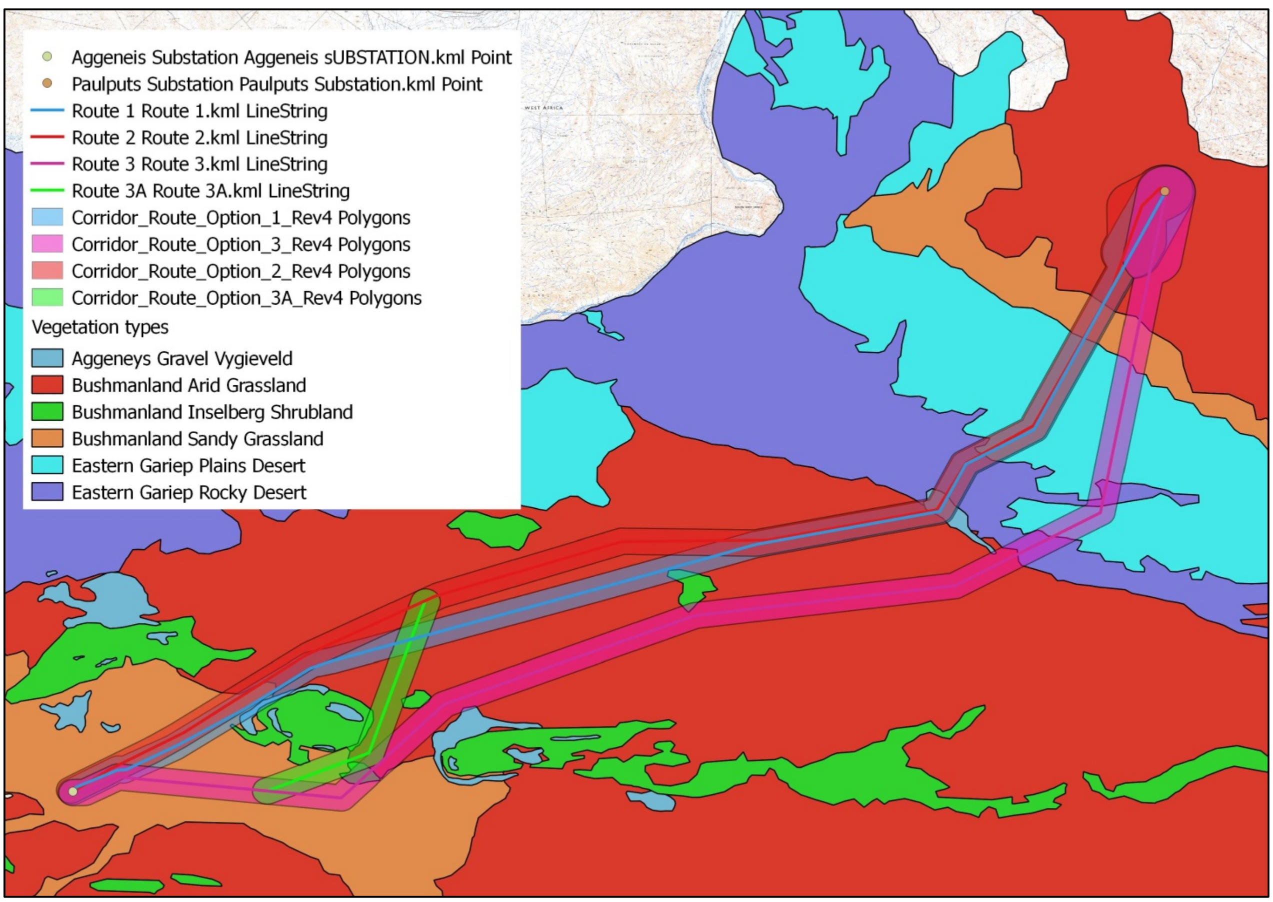


Figure 2. Vegetation classification at the site of the proposedAggeneis Paulputs 400kVpower line (Mucina & Rutherford 2006)

2.2. Bird micro-habitats

Whilst much of the distribution and density of bird species in the study area can be explained in terms of the above broad vegetation description, there are differences that correspond to variations in habitat at the micro level. These "bird micro-habitats" are evident at a much smaller spatial scale than the broader vegetation types or biomes, and can generally only be identified through a combination of field investigation and experience. Most of the study area is flat arid plains, with either quartz based gravelly plains, or red soils associated with red dunes. There are two areas of rock ridges which the power line must traverse, just north of Pofadder and in the far south towards Aggeneys.

The open plains will be of particular importance for large terrestrial bird species such as bustards and korhaans, and smaller species such as Red Lark (associated with the red dunes and associated plains); Sclater's Lark associated with gravelled plains, Burchell's Courser *Cursorius rufus*, and others.

The rock ridges will be important for African Rock Pipit *Anthus crenatus* and various other small species, in addition to Verreaux's Eagle *Aquila verreauxii*, which may breed here if suitable vertical cliffs or other nesting substrate (such as power lines) exist. For a more detailed description of the birds for which the study area is important see Section 2.3.3.

Photographs of examples of the various micro habitats can be seen in Appendix 3.

2.3. Bird species present in the study area

2.3.1 SABAP1 & SABAP2 data

The first Southern African Bird Atlas Project (SABAP1 – Harrison *et al*. 1997) and the second atlas project (SABAP2 – www.sabap2.adu.org.za) recorded a combined total of approximately 221bird species across the broad study area. This does not mean that all of these species do occur on the alignments of the proposed power line, but it does give an indication of what could occur in the area. The full species list is shown in Appendix 2.

Table 1 is an extract of the Red-listed species. For each species the preferred micro-habitat, likelihood of occurring on site and relative importance of site have been assessed. An indication of the ways in which the species could interact with the proposed power line and substation extensions has also been presented. These species are discussed in more detail below Table 1. These species cannot afford to face additional collision threats due to new power lines, making it essential that impacts on them are carefully managed for this project.

Many of the bird species in Table 1 below are species which occur widely throughout South Africa. These include the eagles, other raptors, and large terrestrials. However, the two lark species: Red Lark and Sclater's Lark are of particular interest for this study since they occur only in Bushmanland, and are also indicators for a wide assemblage of larks and similar small passerine species endemic to Bushmanland. For this reason, the actual SABAP2 report rates for these species have been consulted and presented below in Section 2.4.

Table 1. Summary of Red-listed bird species associated with the proposed Aggeneis – Paulputs 400kV power line.

Common name	Taxonomic name	SABAP1	SABAP2	Taylor *et al* 2015	TOPS list	IUCN 2013	Likelihood of occurring on site	Importance of site for species	Possible interactions with project
Harrier, Black	*Circus maurus*	✓		EN		VU	Possible	Moderate	Collision with overhead cables Habitat destruction Disturbance
Vulture, White-backed	*Gyps africanus*	✓		EN	E	EN	Possible	Low	Collision with overhead cables Habitat destruction Disturbance
Bustard, Ludwig's	*Neotis ludwigii*	✓	✓	EN	VU	EN	Probable	Moderate	Collision with overhead cables Habitat destruction Disturbance
Eagle, Martial	*Polemaetus bellicosus*	✓	✓	EN	VU	VU	Probable	High	Collision with overhead cables Habitat destruction Disturbance Nesting on power line
Eagle, Verreaux's	*Aquila verreauxii*	✓	✓	VU		LC	Probable	Moderate	Collision with overhead cables Habitat destruction Disturbance
Lark, Red	*Calendulauda burra*	✓	✓	VU		VU	Probable	High	Habitat destruction Disturbance
Stork, Black	*Ciconia nigra*	✓	✓	VU	VU	LC	Possible	Moderate	Collision with overhead cables Habitat destruction Disturbance
Courser, Burchell's	*Cursorius rufus*	✓	✓	VU		LC	Possible	Moderate	Habitat destruction Disturbance
Falcon, Lanner	*Falco biarmicus*	✓	✓	VU		LC	Probable	Moderate	Collision with overhead cables Habitat destruction Disturbance
Secretarybird	*Sagittarius serpentarius*	✓		VU		VU	Probable	Moderate	Collision with overhead cables Habitat destruction Disturbance
Pipit, African Rock	*Anthus crenatus*	✓		NT		LC	Possible	Moderate	Habitat destruction Disturbance
Bustard, Kori	*Ardeotis kori*	✓	✓	NT	VU	NT	Probable	Moderate	Collision with overhead cables Habitat destruction Disturbance

Korhaan, Karoo	*Eupodotis vigorsii*	✓	✓	NT	LC	Probable	Moderate	Collision with overhead cables Habitat destruction Disturbance
Flamingo, Greater	*Phoenicopterus ruber*	✓		NT	LC	Possible	Low	Collision with overhead cables Habitat destruction Disturbance
Lark, Sclater's	*Spizocorys sclateri*	✓	✓	NT	NT	Possible	High	Habitat destruction Disturbance

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

2.3.2 Data collected during field work on site

A full list of species recorded during field work can be seen in Appendix 4. A total of 39 species were recorded. This includes 3 Red Listed species; Martial Eagle *Polemaetus bellicosus*; Lanner Falcon *Falco biarmicus* and Karoo Korhaan *Eupodotis vigorsii*.

Table 2 below summarises the results of the drive transects conducted on site, with Figure 3 showing the location of these transects.

Table 2. Results from driven transects on the Aggeneis Paulputs site to sample large terrestrial and raptor bird species.(#individual birds in brackets)

Species	**Trans 1 birds /km**	**Trans 2 birds /km**	**Trans 3 birds /km**	**Trans 4 birds /km**	**Trans 5 birds /km**	**Trans 6 birds /km**	**Trans 7 birds /km**	**Trans 8 birds /km**	**Trans 9 birds /km**
Length of transect	24km	47km	71km	16km	49km	5km	38km	15km	37km
Karoo Korhaan	0.13 (3)			0.13 (2)			0.08 (3)		
Pale Chanting Goshawk		0.02 (1)			0.02 (1)		0.03 (1)		0.05 (2)
Pygmy Falcon				0.13(2)					0.05 (2)
Rock Kestrel					0.02 (1)				
Lanner Falcon		0.04 (2)							
Martial Eagle									0.05 (2) Nest
Total	0.13	0.06	0.00	0.25	0.04	0.00	0.11	0.00	0.16

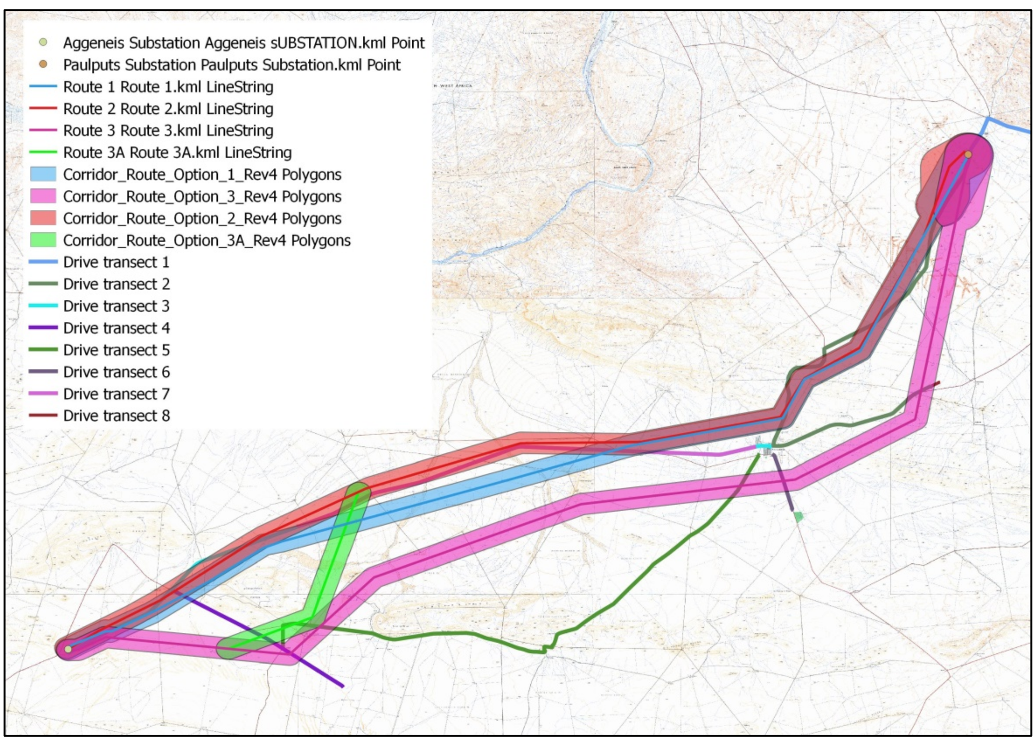


Figure 3. The position and layout of the driven transects on the Aggeneis Paulputs site (some transects are hidden under others).

These are very low abundances of these species shown in Table 2. This is to be expected in this area where many of the large terrestrial species one would expect here are nomadic, in response to rainfall and food availability. The important factor for this assessment is that these species could occur in much higher abundances on site from time to time in response to rainfall and hence be at temporarily high risk of impact from the proposed power line.

The most important finding from field work is the presence of an active Martial Eagle nest on the existing 220kV Aggeneis Paulputs power line, in the far north of the site near Paulputs Substation (see Figures 4& 9). This nest had an immature and an adult eagle on it at the time. This will be a sensitive feature and will need to be carefully managed during the construction of the proposed power line to ensure that breeding of these birds is not disturbed. This is discussed more in Section 3.

Figure 4. The Martial Eagle *Polemaetus bellicosus* nest in the Aggeneis Paulputs study area.

Of importance (but less important than the Martial Eagle nest) was the presence of a Greater Kestrel *Falco rupicoloides* nest just below the eagle nest, on the same tower (see Figure 5).

Figure 5. The Greater Kestrel *Falco rupicoloides* nest in the Aggeneis Paulputs study area.

2.3.3 Important Bird & Biodiversity Areas (IBBAs)

Important Bird & Biodiversity Areas are classified on the basis of the following criteria:

- The site regularly holds significant numbers of a globally threatened species;
- The site is thought to hold a significant component of a group of species whose breeding distributions define an Endemic Bird Area (EBA) or Secondary Area; and
- The site is known or thought to hold a significant component of a group of species whose distributions are largely or wholly confined to one biome.

Two such IBA's are relevant to this study: the Haramoep and Black Mountain Mine IBA, which encompasses the Aggeneis Substation in the west; and the Mattheus-Gat Conservation Area IBA which encompasses the Paulputs Substation area. In both cases, these IBA's are unavoidable by the proposed power line, since it must connect the two existing substations, which lie in the IBA's.

Both these IBA's are important for globally threatened species such as Red Lark, Sclater's Lark, Kori and Ludwig's Bustards, and Black Harrier *Circus maurus* (Marnewick *et al,* 2015). **Karoo Korhaan** is regionally threatened and occurs here. Additional species present in this IBA include: Martial Eagle *Polemaetus bellicosus*; Secretarybird *Saggittarius serpentarius*; Verreaux's Eagle *Aquila verreauxii*; Booted Eagle *Hieraaetus pennatus*; Black-chested Snake Eagle *Circaetus pectoralis*; Cape Eagle Owl *Bubo capensis*; and Spotted Eagle-Owl *Bubo africanus*. Nama Karoo biome specialist species which occur here include: Stark's Lark*Spizocorys starki*; **Karoo Long-billed Lark*Certhilauda subcoronata***; Black-eared Sparrow-lark

Eremopterix australis; **Tractrac Chat *Cercomela tractrac***; **Sickle-winged Chat *Cercomela sinuate***; **Karoo Chat *Cercomela schlegelii***; Layard's Tit-Babbler *Sylvia layardi*; Karoo Eremomela *Eremomela gregalis*; Cinnamon-breastedWarbler *Euryptila subcinnamomea*; Namaqua Warbler *Phragmacia substriata*; **Sociable Weaver *Philetairus socius***; **Pale-winged Starling *Onychognathus nabouroup*** and Black-headed Canary *Serinus alario*. Species in bold above were recorded on site during this current assessment (see section 2.3.2).

Renewable energy developments (some of which are already operational) are the newest threat to the habitat in these IBA's. New power lines are also listed a threat to the birds in this IBA (Marnewick *et al,* 2015).

Figure 6 shows the layout of these IBA's relative to the proposed power line.

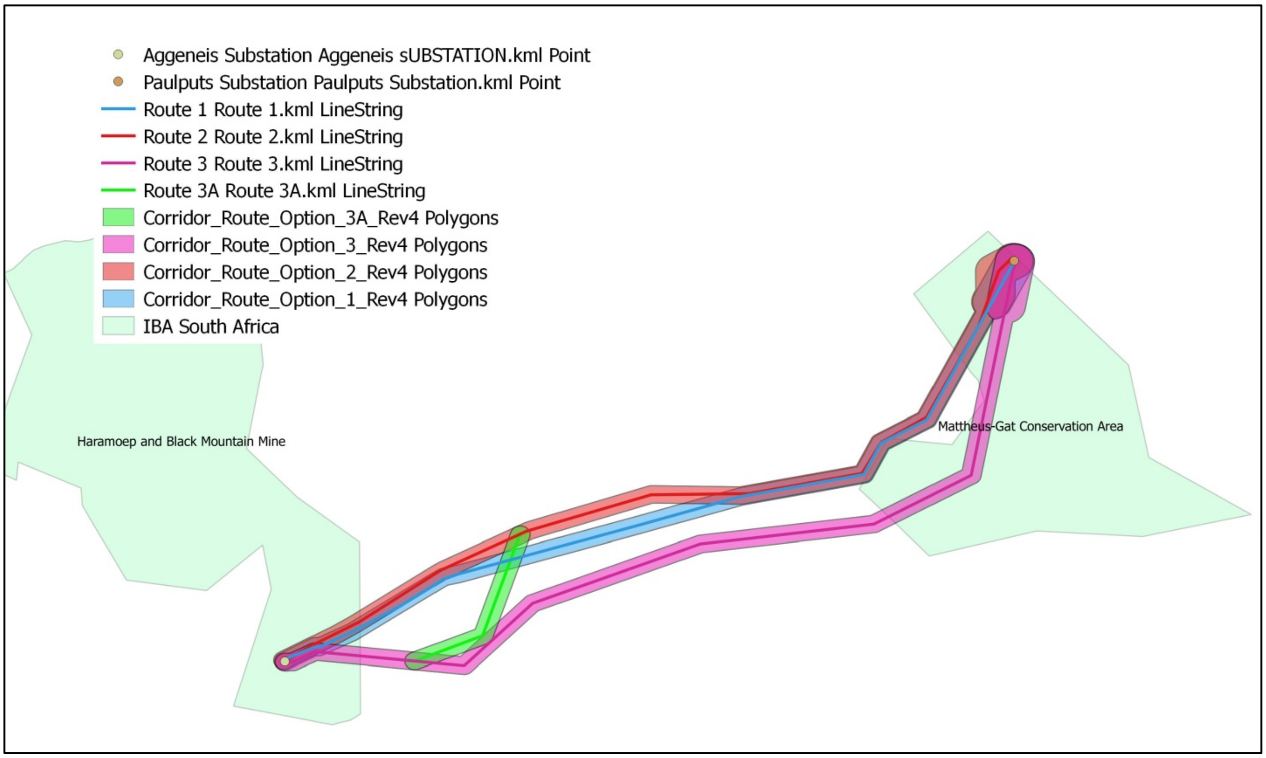


Figure 6. Important Bird & Biodiversity Areas position relative to the proposed Aggeneis Paulputs 400kV power line.

2.4. Summary description of most important bird species for this study

2.4.1. Large terrestrials

Ludwig's & Kori Bustards

These physically large species are very vulnerable to collision with overhead power lines, and are also likely to be affected by disturbance and habitat destruction. Ludwig's Bustard is a wide-ranging bird endemic to the south-western region of Africa (Hockey *et al.* 2005). This species was listed as globally Endangered in 2010 because of potentially unsustainable power line collision mortality, exacerbated by the current lack of proven mitigation and the rapidly expanding power grid

(Jenkins *et al.* 2011, BirdLife International 2013). Ludwig's Bustards are both partially nomadic and migratory (Allan 1994, Shaw 2013), with a large proportion of the population moving west in the winter months to the Succulent Karoo. In the arid and semi-arid Karoo environment, bustards are also thought to move in response to rainfall, so the presence and abundance of bustards in any one area are not predictable. Therefore, collisions are also largely unpredictable, and vary greatly between seasons and years (Shaw 2013). While there is no evidence yet of population-level declines resulting from collision mortality, detailed range-wide power line surveys estimate that tens of thousands of bustards (from a total South African population of approximately 114,000 birds) die annually on the existing power grid in this country, which is of grave concern given that they are likely to be long-lived and slow to reproduce. It seems likely that there will be a threshold power line load at which population declines will become apparent, but it is not possible to accurately predict what this will be, and such effects will probably only be noticed when it is too late to do anything about it (Shaw 2013). Therefore, extreme caution is necessary in the planning of any new power lines in the range of this species.

Kori Bustards are classified as regionally Near-threatened (Taylor *et al* 2015), with an estimated population of 2,000 – 5,000 birds in South Africa (Hockey *et al.* 2005). There are also worries for the population consequences of power line mortality for this species, given that some 14% of the population are estimated to die annually on Karoo transmission lines alone (Shaw 2013). Kori Bustards in the arid areas are thought to be locally nomadic (Hockey *et al.* 2005) and thus likely suffer greater collision rates than more sedentary populations in other areas (e.g. the Kalahari; Senyatso 2011).

Karoo Korhaan

Karoo Korhaan has recently been upgraded to Near-threatened (Taylor *et al* 2015). As a sedentary species, they seem to be less susceptible to collision than the larger, more mobile bustards, but they are still frequently recorded as collision victims in the Karoo, which is their stronghold (Shaw 2013). There is some evidence that Karoo Korhaans are not as abundant as previously thought (Shaw 2013), so additional mortality caused by this proposed power line is of concern.

Secretarybird

This species is classified as regionally Vulnerable (Taylor *et al* 2015), and has recently been up-listed to globally Vulnerable on the basis of population declines (BirdLife International 2013). While there is no current population estimate in South Africa, there has been a reduction of sightings in the areas it previously occupied (SABAP2 c.f. SABAP1 data). This is probably mainly due to habitat loss, but power line collisions may also be a significant factor. The physical attributes of Secretarybirds mean that they are highly vulnerable to collision, and data from Karoo transmission lines (Shaw 2013) and the Central Incident Register (Eskom-EWT 2012) indicate that these birds do indeed collide across their range. However, as the population is sparsely distributed it is probably underrepresented in available collision data, and further research would be necessary to better understand potential population impacts of this source of unnatural mortality. Unfortunately, the species' movement is not well understood so BirdLife South Africa have recently placed satellite transmitters on Secretarybirds in order to track their movements in the Free State, but this data is not useful for the current study.

Greater Flamingo

Greater Flamingo is classified as regionally Near-threatened by Taylor *et al*(2015). These birds move extensively in response to rainfall, often suddenly arriving at pans which hold water after a rainfall event. This unpredictable movement and habit of flying at night and in flocks makes them a challenging species to manage in relation to power lines. They are highly vulnerable to collision, with Greater and Lesser Flamingos listed as the 5th and 6th most commonly reported species killed by power lines in South Africa (Eskom-EWT 2012). Their vulnerability to collision is believed to be at least partially due to their tendency to fly at night, when visibility of overhead cables would be low. This factor makes it difficult to mitigate for collisions, since line marking devices designed for diurnal fliers are not effective at night. Fortunately surface water is almost non-existent in the current study area so the likelihood of this species occurring here is low.

Black Stork

Black Stork is classified as Vulnerable and has experienced a population decline (Taylor *et al,* 2015). This species will be mostly confined to larger river valleys and gorges, and we do not expect it to be a regular visitor to the current study area.

2.4.2. Raptors

Martial & Verreaux's Eagle

The Martial Eagle is classified as globally Near-threatened, and regionally Endangered (Taylor *et al* 2015, BirdLife International 2013), whilst Verreaux's Eagle is regionally Vulnerable. Both species are well known to have adapted to using Eskom transmission line towers for perching, roosting and nesting. One Martial Eagle nest was found in this study area, on the existing Aggeneis Paulputs 220kV power line, and another historic (unconfirmed if it is still active) nest approximately 3.3km north of Aggeneis Substation (Mostert pers comm). Although nesting on power lines appears at face value to be a positive impact (allowing the birds to expand their range into areas previously unsuitable for breeding due to a lack of trees) residing on a power line also increases the risk of collision that the birds face, particularly for young birds recently fledged (who can also become entangled and die in the tower lattice when fledging; J. Shaw pers. obs.). Although we recommend the proposed power line be constructed on a cross rope suspension tower which is unsuitable for nesting, the proposed routes of the power line pass close to the existing 220 kV power line, which houses at least one existing eagle nest. This new power line may pose a new collision risk within existing territories and a possible disturbance of breeding if construction of the new line takes place during breeding season.

White-backed Vulture

This species is classified as regionally Endangered, with some 15,000 pairs estimated in southern Africa and 300 in the Northern Cape (Taylor *et al* 2015, Hockey *et al.* 2005). Despite being locally common in parts of South Africa, the population is thought to be in decline because of anthropogenic threats such as habitat loss, poisoning, and collision with or electrocution on power infrastructure. White-backed Vultures nest in large trees (often *Acacia erioloba*), but can also use electricity pylons, making them vulnerable to collision and electrocution (Taylor *et al* 2015). An estimated 2% of the population around Kimberley is killed annually in power line collisions (Hockey *et al.* 2005). The proposed study area is probably a marginal area for this species, meaning that it will be rare here.

Black Harrier

The conservation status of the endemic Black Harrier *Circus maurus* has recently been upgraded to Endangered in both South Africa (Taylor *et al* 2015) and Namibia (Simmons *et al* 2015). Fynbos destruction and fragmentation are known to be the main causes of decline (Curtis *et al* 2004), but limited genetic variation (Fuchs *et al* 2014) now add to the concern over this species. Additional mortality factors due to operational wind farms (Smallie 2015) in its tiny breeding range in South Africa mean that this species is now more threatened than ever. The current study area is probably relatively marginal in this species range, but the risk that the proposed power line poses in terms of collision, and habitat destruction still needs careful assessment.

Lanner Falcon

The Lanner Falcon is classed as Vulnerable and the species does seem to be in decline (Taylor *et al,* 2015). This species was recorded in the study area (a pair of birds). This species is susceptible to collision with overhead cables such as power lines, and also has a tendency to nest on power line structures, which could bring it into close proximity of the proposed power line.

2.4.3. Small terrestrials

Bushmanland is renowned for its high diversity and abundance of larks, many of which are endemic to southern Africa (Hockey *et al.* 2005). Up to 14 lark species can be seen in this area.

Red & Sclater's Lark

Of particular relevance to this study are the Red Lark and Sclater's Lark, both of which are listed as regionally threatened species (Vulnerable and Near-threatened respectively; Taylor *et al* 2015), have very restricted ranges and have been recorded in the broader area within which the study area is situated (Harrison *et al.* 1997, SABAP 2 2013). While these birds are unlikely to interact directly with power lines, disturbance and habitat destruction during construction could be an issue. The Red Lark in particular is a habitat specialist, utilising the red sand dunes and adjacent plains and so impacts on this species can be managed spatially.

Figure 7 shows the context of where these two species have been recorded by the Southern African Bird Atlas 2. The current study area is an important area for both of these species as they are not widespread in distribution. All impacts on these species within their range should therefore be kept to an absolute minimum.

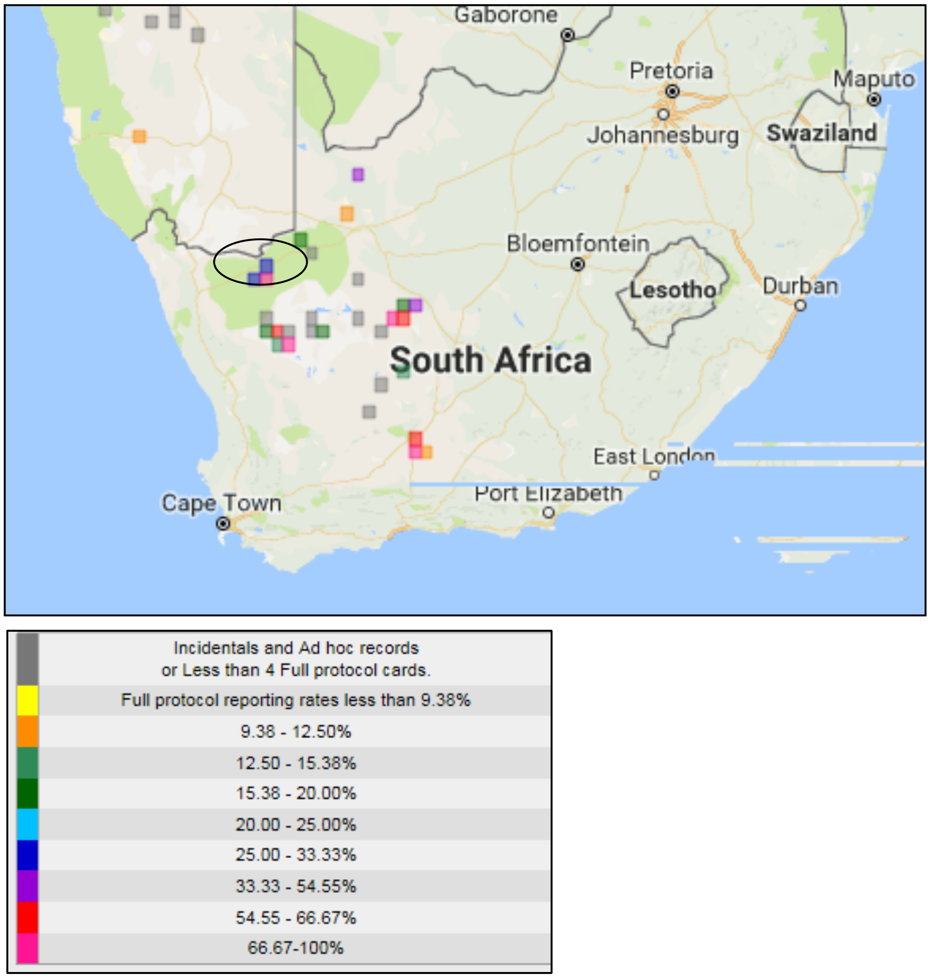


Figure 7. Red Lark *Calendulauda burra* (top) and Sclater's Lark *Spizocorys sclateri* (bottom) SABAP2 report rates. The current study area is shown with a red circle.

Burchell's Courser

Burchell's Courser is classified as Vulnerable by Taylor *et al*(2015). It is a nomadic species with an estimated regional population of <10 000 birds. It has undergone a significant reduction in population size in recent decades. This species will most likely be found on the open plains in the study area, often in the most sparse vegetation. Habitat loss is a key threat for this species, although its nomadic nature means that it would most likely move to better habitat elsewhere if disturbed or displaced from this site.

African Rock Pipit

African Rock Pipit is classified as Near-threatened by Taylor *et al* (2015). It is endemic to South Africa and Lesotho and has also undergone a significant reduction in recent times. This bird selects rocky areas such as the rocky ridges in the current study area. It will be most susceptible to habitat destruction.

3. EVALUATION OF IMPACTS

3.1. General description of bird interactions with power lines

Because of its size and prominence, electrical infrastructure constitutes an important interface between wildlife and man. Wildlife interactions with power lines are almost all negative, with the two main problems caused by electrocution of birds (and other animals) and birds colliding with power lines (Ledger & Annegarn 1981, APLIC 1994, Bevanger 1998, Kruger 1999, van Rooyen & Ledger 1999, Lehman *et al.* 2007, Jenkins *et al.* 2010, Shaw *et al*. 2010, Prinsen *et al.* 2011, APLIC 2012, Shaw 2013). Other issues are electrical faults caused by bird excreta when roosting or breeding on electricity infrastructure (van Rooyen & Ledger 1999), and disturbance and habitat destruction during construction and maintenance activities (e.g. Silva *et al.* 2010, Raab *et al.* 2011a).

Electrocutions

Electrocution of birds on overhead lines is an important cause of unnatural mortality of raptors and storks, and has been a focus of much attention in Europe, USA and South Africa (APLIC 1994, Alonso & Alonso 1999, van Rooyen & Ledger 1999, Lehman 2001, Lehman *et al.* 2007). Electrocution can occur when a bird is perched or attempts to perch on an electrical structure and causes a short circuit by physically bridging the air gap between live components and/or live and earthed components. However, for overhead lines above 132 kV, electrocutions are not a major issue because the large clearances separating dangerous components cannot be bridged by even the largest birds (Lehman *et al.* 2007). Therefore, electrocution will not be discussed further in this report.

Collisions

Collision with power lines is a well-known conservation problem for many birds, and for some species can be a significant source of mortality (Bevanger 1998, Erickson *et al.* 2005, Drewitt & Langston 2008, Shaw *et al.* 2010, Jenkins *et al.* 2011). The reasons for collisions are complex, with each case involving a variety of biological, topographical, meteorological and technical factors (Bevanger 1994). Although all birds have the potential to be affected by collisions, those most heavily impacted are generally large, flocking species which fly often, with waterfowl, gamebirds, cranes, bustards and storks usually among the most frequently reported casualties (Bevanger 1998, Janss 2000, Jenkins *et al.* 2010). The large body size of such species mean that they have limited manoeuvrability in the air and are less able to take necessary evasive action to avoid colliding with power lines (Bevanger 1998).

In South Africa, incidentally discovered mortality incidents reported by Eskom staff, conservationists and the general public are collated in the Central Incident Register, which is maintained by the Eskom-Endangered Wildlife Trust Strategic Partnership (Eskom-EWT 2012). These data, together with those from more systematic power line surveys near De Aar (Anderson 2002), in the Overberg (Shaw *et al.* 2010) and across the Karoo (Jenkins *et al.* 2011, Shaw 2013) highlight the high levels of large terrestrial bird mortality caused by existing power lines in this country. Particularly affected are Red-listed birds including cranes, bustards, storks, Secretarybirds, flamingos and vultures, which are generally long-lived and slow to reproduce (Shaw 2013). These species have not evolved to cope with high adult mortality, with the result that consistent mortality in this age group over an extended period could seriously affect a population's ability to sustain itself in the long or even medium term. The cumulative effects of collisions together with other anthropogenic threats to these species (e.g. habitat destruction, disturbance) are unknown over the long term.

Mitigating bird collisions with power lines typically involves the installation of line marking devices on the cables in order to make them more visible to approaching birds. Worldwide, a variety of marking devices are used, but very few have been adequately field-tested (Jenkins *et al.* 2010). Great uncertainty remains about which are best, as they vary enormously in effectiveness between species and in different conditions (van Rooyen & Ledger 1999, Anderson 2002). Generally though, marking seems to be fairly effective, with a recent meta-analysis showing a 78% decrease in mortality rates on marked lines (Barrientos *et al.* 2011). However, bustards are particularly difficult to mitigate for. Janss & Ferrer (1998) found no evidence of a decrease in Great Bustard *Otis tarda* mortality following line marking in Spain, although markers did seem to be effective for Little Bustards *Tetrax tetrax*. Raab *et al.* (2011b) suggested that Great Bustards benefitted from line marking in Austria and Hungary, but the effect was minimal compared to the reduction in mortality resulting from burying power lines. Most recently, Barrientos *et al.*(2012) demonstrated a slight reduction in collision rates for Great and Little Bustards following marking in Spain, but rates remained high even after marking.

The reason for this apparently low efficacy is likely to be a result of the visual capacity of bustards. A recent South African study on Kori Bustards demonstrated that these birds have a narrow field of frontal vision, so when in flight, head movements in the vertical plane (pitching the head to look downwards, perhaps to look for other birds or foraging patches) will render the bird blind in the direction of travel and they will not see the power line at all (Martin & Shaw 2010). This study also examined the visual capacity of Blue Cranes and White Storks, and in contrast to Kori Bustards, these species have much broader fields of view. However, the visual constraint for bustards has significant implications for collision mitigation and suggests that marking devices installed on cables themselves are unlikely to be 100% effective. Similar visual constraints were subsequently found in *Gyps* vultures, including White-backed Vultures (Martin *et al.* 2012). Development of additional mitigation to draw the bird's attention to the marked line (which must still be marked, because the bird will see the markers if it is looking at the line) is a priority for future research for these groups of birds.

To formally test marking devices in the Karoo environment, the Eskom-EWT Strategic Partnership commissioned a large-scale experimental test of line marking devices on transmission lines close to the Hydra substation in the eastern Karoo, which has been underway since May 2011. Currently, there are still insufficient data to be able to draw statistically significant results, but initial indications are that marking has a positive effect in lowering collision rates for Blue Cranes (Shaw 2013). Updated results of this research will be obtained during the EIA Phase. Current practice is to mark the central two-thirds of the span only, as previous studies demonstrated that the number of collisions decrease towards the pylons (Anderson 2002, Shaw *et al.* 2010, Shaw 2013). However, indications from the recent marking experiment are that this practice may displace Ludwig's Bustard collisions to the unmarked sections close to the pylons, and therefore 100% of the span should be marked. It is likely that by the time the proposed power line is built this test will have conclusive results.

While collisions generally occur in hot-spots (i.e. many collisions, sometimes of multiple species in small areas) and are not spread evenly across the landscape, the factors describing these locations are still very difficult to understand. Landscape level GIS studies on Blue Cranes and Ludwig's Bustard in South Africa have failed to find useful contributory factors (Shaw *et al.* 2010, Shaw 2013). While some locations are clearly high risk for resident birds with predictable movement patterns (e.g. lines in close proximity to roosting dams for cranes), in arid areas such as the current study area resources are patchy in time and space. As mentioned before, this means that birds must move to capitalise on resources e.g. insect outbreaks brought about by localised rain, and many of the species frequently killed by power lines in South Africa are therefore nomadic or migratory (Dean 1997, Shaw 2013). Because such birds are unlikely to follow specific routes, it is difficult to say which sections of a Karoo power line might be high risk and contribute to collision hot-spots. There is some evidence that Ludwig's Bustards avoid roads and congregate on transformed land (Shaw 2013), but this is not enough information on which to decide which sections of line to mark. Given our currently poor understanding of collision hot-spots, 100% of all spans of the entire length of this new power line must be marked. However, even if this is done, the slight reduction in collisions of local bustards which is expected given the results of marking studies of bustards in other parts of the world (e.g. Raab *et al.* 2011b, Barrientos *et al.* 2012) will still mean high levels of mortality. It is for this reason that additional mitigation measures in the form of building the proposed line adjacent to the existing 220 kV line is seen as essential if we are to provide an acceptable level of mitigation.

Habitat destruction & disturbance

During the construction phase and maintenance of power lines, and extension of substations, some habitat destruction and alteration inevitably takes place. This happens with the construction of access roads, and the clearing of servitudes. Servitudes have to be cleared of excess vegetation at regular intervals in order to allow access to the line for maintenance, to prevent vegetation from intruding into the legally prescribed clearance gap between the ground and the conductors, and to minimise the risk of fire under the line which can result in electrical flashovers. These activities have an impact on birds breeding, foraging and roosting in or in close proximity of the servitude, both through modification of habitat and disturbance caused by human activity.

Nesting

Raptors, large eagles, crows, Hadeda Ibises *Bostrychia hagedash* and Egyptian Geese *Alopochen aegyptiaca* have learnt to nest on transmission towers, and this has allowed them to breed in areas of the country where breeding would not previously have been possible due to limited nesting substrates(van Rooyen & Ledger 1999, de Goede & Jenkins 2001). This has probably resulted in a range expansion for some of these species, and large eagles such as Tawny, Martial and Verreaux's are now quite common inhabitants of transmission towers in the Karoo (e.g. de Goede &Jenkins 2001). Cape Vultures *Gyps africanus* and White-backed Vultures have also taken to roosting on power lines in certain areas in large numbers, while Lappet-faced Vultures are also known to use power lines as roosts, especially in areas where large trees are scarce (J. Smallie pers.obs.). At face value this appears a positive contribution that power lines can make to these species. However the situation is more complex in that nesting on the tower places the adults and young at much greater risk of collision with the overhead cables than would otherwise be the case. Due to the electrical faulting that these birds can cause on transmission towers, Eskom also sometimes wishes to remove nests in order to manage the risk of faulting, with negative effects for the birds if not correctly handled.

This report makes a strong argument for building the proposed power line as close as possible to existing transmission lines. However, a consequence of this is that if eagles are nesting on the existing line (such as the Martial Eagle nest described elsewhere in this report), disturbance of these birds will be a very real risk during construction of the new line. This EIA study cannot possibly check every existing tower for nests (and new nests could be built between the EIA and construction), so it is recommended that an avifaunal walk-through be conducted to do this, as detailed elsewhere in this report.

If additional nests are found, case specific recommendations will be developed. Likely recommendations will be to avoid construction of the new line within a buffer area around nests during breeding season, but in spite of such efforts there is a real chance that breeding birds may be disturbed and breeding success negatively affected (see de Goede 2011). However, we are of the opinion that the benefits of placing the new line adjacent to the existing one for a lifespan of 50 – 60 years outweigh the risks to one season's breeding during construction. The actual nesting of birds on the proposed new power line only becomes an issue if Eskom need to intervene with nesting and breeding activities. It is essential that all activities related to raptor nests be subject to Eskom Transmissions nest management guidelines, and to the relevant provincial and national legislation.

A very different species known to nest on Eskom transmission towers is the Sociable Weaver, which builds massive communal nests of grass, normally in the waists of transmission towers (Figure 8). This can have implications for fire risk, and perhaps also be a concern in terms of the weight of the nest on the structure. Once again, management of such nests must be according to legislation and best practice as these nests are often complex ecosystems in their own right, with other raptors such as falcons and kestrels nesting on top of them, and various predators such as snakes frequenting them.

Figure 8. A Sociable Weaver *Philetairus socius* nest on the existing Aries-Kronos 400 kV power line.

Nesting is very dependent on the exact tower structure used. The tower structure to be used for the proposed power line has not yet been confirmed by Eskom. We recommend strongly that a cross rope suspension tower be used, as this presents less suitable perching or nesting substrate for large birds than a guyed-V or self-support tower.

Electrical faulting caused by birds

Birds are able to cause electrical faults on transmission lines in the following ways: nest material can intrude into the air gap and cause a short circuit (this is particularly so for eagles with large stick nest material and crows with conductive wire nest material), bird faeces can drop through onto insulator strings until the build-up renders the insulator ineffective and a fault occurs, or birds can produce a long continuous streamer of faeces which bridges the air gap as it falls. None of these mechanisms necessarily result in the death of the bird, but they can cause an electrical fault which affects line performance. This is typically managed for by installing perch deterrents (Bird Guards) on the steel work to manipulate where birds can perch, reducing perching directly above the live conductors. This is very dependent on the tower structure used. Self-support and guyed-V type towers provide ample suitable perching substrate for large birds directly above the live conductors. This increases the probability of faulting occurring. It is believed that large birds will be less comfortable perching on the cross rope suspension towers and this will reduce the probability of faulting (although to this authors' knowledge this has not yet been confirmed with data).

Electrical faulting is very dependent on the exact tower structure used. The tower structure to be used for the proposed power line has not yet been confirmed by Eskom. We recommend strongly that a cross rope suspension tower be used, as this presents less suitable perching or nesting substrate for large birds than a guyed-V or self-support tower.

3.2. Evaluation of expected impacts of the proposed power line on birds in study area

Generally speaking, it is inevitable that some birds will be killed through interaction with power infrastructure, despite the best possible mitigation measures. It is therefore important to direct risk or impact assessments and mitigation efforts towards species that have a high biological significance, in order to achieve maximum results with the available resources at hand. While society places other values on certain species, e.g. aesthetic or commercial, this impact assessment is primarily aimed at assessing the potential threat to important or Red-listed species that occur or potentially occur along the proposed power line routes. It is believed that the Red Listed species will also serve as surrogates for other non Red List species in the same ecological groups (as described in Section 2.4).

The identified impacts have been assessed according to the criteria provided by Mokgope Consulting (Appendix 1). The most significant impacts are believed to be collision of large terrestrial birds with the overhead cables, and destruction of habitat for habitat specialist bird species like Red Lark.

Table 3. Collision of birds with proposed power line

Nature: **Collision of birds with earth wires and conductors – key species being Ludwig's Bustard, Kori Bustard, Secretarybird, Karoo Korhaan, Martial Eagle (particularly fledglings at nest)**		
	Without mitigation	With mitigation
Extent	4 - national	4
Duration	4 - long term	4
Magnitude	3 – moderate	3 – moderate
Reversibility	5 – irreversible	5
Probability	4 – almost certain	2 – unusual but possible
Significance	**64 (high)**	**32 (medium)**
Status	Negative. Adding another 100 km of line to the network has negative implications, and it is essential that every effort is made to minimise the impacts of the new line as far as possible.	
Irreplaceable loss of resources	Yes - birds are killed	
Can impacts be mitigated	Yes, but not fully effective	
Mitigation: It is essential that Option 1 be selected, whereby the new power line is placed immediately adjacent to (defined as not more than 150 m between outer conductors) the existing 220kV power line. This will hopefully provide partial mitigation for the impact of collision. In addition, the new power line must be installed with the very latest and		

most effective Eskom approved line marking devices available at the time of construction. These should be fitted on the earth wires, with 100% of each span marked (not the middle 60% of each span previously stipulated in Eskom Transmission guidelines). This installation must be done according to Eskom best practice at the time, but should include the following at least: markers must alternate between a light and dark colour to provide contrast against a dark and light background respectively. These markers must be no more than 20 m apart on each earth wire and must be placed along the full length of the earth wire (not only the middle two-thirds as done previously). It is Eskom's responsibility to ensure the integrity of these devices for the full lifespan of the power line. If these devices become damaged or their effectiveness is in any way compromised with time they must be replaced. Likewise if significantly more effective devices become available, these must be installed on the power line. In addition, a site specific EMP (avifaunal walk through) must be conducted to identify and provide final confirmation of the high risk sections of this power line. It is also Eskom's responsibility to monitor the impacts of this power line and the effectiveness of the mitigation measures installed.

Table 4. Impact of habitat destruction on avifauna

Nature: **Destruction of bird habitat during construction of the power line and substation extensions, and to a lesser extent maintenance. Key species are Red & Sclater's Lark, Burchell's Courser and other arid zone small passerines**		
	Without mitigation	With mitigation
Extent	1 – site bound	1
Duration	4 - long term	4
Magnitude	3 – moderate	2
Reversibility	3 – with human intervention	3
Probability	4 – almost certain	3 – can occur
Significance	**44 (high)**	**30 (moderate)**
Status	Negative. Increasing density of power lines and other renewable energy projects through this area could be significant. Also the increased perch availability for 'sit and wait' raptors probably means that large areas of ground below these lines is unsuited to smaller birds that would be vulnerable to these predators.	
Irreplaceable loss of resources	Yes - habitat lost	
Can impacts be mitigated	Partially, a certain amount of habitat has to be altered.	
Mitigation: A construction EMP (avifaunal walk through) must be conducted to identify any particularly sensitive habitats and environmental best practice must be followed during construction and maintenance activities. An on-site ECO must be responsible for ensuring compliance and minimising habitat destruction during construction. All existing roads and storage sites must be used where possible. No towers should be placed within 100m of red dunes and water sources (drinking troughs, wind mills, reservoirs). No vehicle or human traffic should be allowed through these areas either. Towers should be spaced to avoid these areas and accessed during construction from either side, not continuously along the servitude. The red dunes have been digitised as far as possible off Google Earth (See Figure 9), but this aspect, and the surface water sources will require more confirmation during the avifaunal walk through.		

Table 5. Impact of disturbance on avifauna

Nature: **Disturbance of birds, during construction of the power line & substation extensions and to a lesser extent maintenance. Key species are Martial Eagle (at the identified nest site), Red & Sclater's Lark, Burchell's Courser and other arid zone small passerines**		
	Without mitigation	With mitigation
Extent	2 – local	1
Duration	2 – short term	2
Magnitude	3 – moderate	3
Reversibility	2 – partially reversible	2
Probability	4 – can occur	2
Significance	**36 (high)**	**16 (moderate)**

Status	Negative	
Irreplaceable loss of resources	Possible loss of breeding success	
Can impacts be mitigated	Yes, partially	
Mitigation: A site specific avifaunal walk through for the construction EMP must be conducted and environmental best practice must be followed during construction and maintenance activities. The avifaunal walk through must include an assessment of any nests in the area, particularly on the other power lines existing in the area. An on-site ECO must be responsible for ensuring compliance and minimising disturbance during construction. No construction activities for the new line should take place within 1km of the Martial Eagle nest (see Figure 9)on the existing power line during breeding season. The exact timing of breeding season will need to be confirmed just prior to construction, but is likely to be approximately March to September. If any other breeding raptors or other Red-listed bird species are identified during the site-specific EMP/avifaunal walk through, case-specific management measures must be developed by an avifaunal specialist. No towers should be placed within 100m of red dunes and water sources (drinking troughs, wind mills, reservoirs). No vehicle or human traffic should be allowed through these areas either. Towers should be spaced to avoid these areas and accessed during construction from either side, not continuously along the servitude. The red dunes have been digitised as far as possible off Google Earth (see Figure 9), but this aspect, and the surface water sources will require more confirmation during the avifaunal walk through.		

Table 6. Nesting of birds on the towers

Nature: **Nesting on towers. Key species are Martial & Verreaux's Eagle, Lanner Falcon, Greater Kestrel**		
	Without mitigation	With mitigation
Extent	1 – site bound	1
Duration	4 – long term	4
Magnitude	3 – moderate	3
Reversibility	0	0
Probability	3 – Nesting is very dependent on the exact tower structure used. The tower structure to be used for the proposed power line has not yet been confirmed by Eskom. We recommend strongly that a cross rope suspension tower be used, as this presents less suitable perching or nesting substrate for large birds than a guyed-V or self-support tower.	3
Significance	**24 (low)**	**24 (low)**
Status	Neutral	
Irreplaceable loss of resources	No	
Can impacts be mitigated	Not necessary – but note that any intervention with nesting once line is operational must be subject to national and provincial legislation and Eskom nest management guidelines. We suggest using a cross rope suspension configuration to minimise the chances of nests being built.	

Table 7. Impact of birds on faulting of the lines

Nature: **Electrical faulting on lines, caused by birds. Key species are Martial & Verreaux's Eagle**		
	Without mitigation	With mitigation
Extent	1 – site bound	1
Duration	4 – long term	4
Magnitude	3 - moderate	2 – low
Reversibility	1	1

Probability	3 - Electrical faulting is very dependent on the exact tower structure used. The tower structure to be used for the proposed power line has not yet been confirmed by Eskom. We recommend strongly that a cross rope suspension tower be used, as this presents less suitable perching or nesting substrate for large birds than a guyed-V or self-support tower.	2
Significance	**27 (low)**	**16 (low)**
Status	Negative for business	
Irreplaceable loss of resources	No - business risk	
Can impacts be mitigated	Yes	
Mitigation: Dependent on tower structure used. Finalise during site specific avifaunal walk down.		

3.3. Evaluation of cumulative impacts

In areas such as this, where multiple facilities impacting on birds in similar ways may be built, it is important to consider the overall or cumulative impact of these facilities on birds. Consideration of each project in isolation may not adequately judge the effect that projects will have on avifauna when combined.

We are aware of the following developments within a 30km radius of the proposed power line:

- We are aware of two operational renewable energy facilities in the Paulputs area: the large Kaxu Solar One parabolic trough concentrating solar power facility (approximately 780ha); and the much smaller Konkoensies 1 PV facility (approximately 15ha) (Figure 7). In addition to those two, we are aware of another proposed solar PV facility just south of Paulputs Substation.
- Other existing relevant infrastructure includes the existing Paulputs Substation, and two overhead power lines: a 33kV line and the existing Aggeneis Paulputs 220kV line.
- At the Aggeneis Substation end of the project we are aware of one 40 MW Solar PV project SW of Aggeneis Substation; multiple existing mines; and multiple existing power lines.

The International Finance Corporation (IFC) recognises Cumulative Impact Assessment (CIA) and management as essential in risk management. However CIA is also “One of the biggest risk management challenges currently facing project developers in emerging markets…”. Challenges include: a lack of basic baseline data, uncertainty associated with anticipated developments, limited government capacity, and absence of strategic regional, sectoral, or integrated resource planning schemes. Considerable debate exists as to whether CIA should be incorporated into good practice of Environmental and Social Impact Assessment, or whether it requires a separate stand-alone process. As a minimum, according to the IFC, developers should assess whether their projects could contribute to cumulative impacts or be impacted upon by other projects. The IFC recommend that developers conduct a Rapid Cumulative Impact Assessment (RCIA) either as part of the EIA or separately. This RCIA should follow 6 steps: 1 & 2 – scoping; 3 - baseline determination; 4 - assessment of the contribution of the development under evaluation to the predicted cumulative impacts; 5 - evaluation off the significance of predicted cumulative impacts to the viability or sustainability of the affected environmental components; 6 - design and implementation of mitigation measures to manage the development’s contribution to the cumulative impacts and risks (see the “Good Practice Handbook - Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets”. International Finance Corporation).

Additional challenges specific to the Aggeneis Paulputs area and avifauna include:

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

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

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

Step 3: This has been conducted on a ‘per species’ basis in Section 4.

Step 4: requires a judgment of the contribution that the Aggeneis Paulputs power line makes to the predicted cumulative impacts. In our opinion, with respect to the key species listed as most important for this area, the Aggeneis Paulputs project makes a MODERATE contribution to impacts in the area, on account of its small size (area and number of turbines).

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

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

Table 8. Cumulative impact of multiple projects on birds in the area.

Nature: **Cumulative impacts on birds**		
	Without mitigation	With mitigation
Extent	3 – landscape (up to 30km radius)	3 – landscape (up to 30km radius)
Duration	4 – long term	4
Magnitude	3 - moderate	2 – low
Reversibility	1	1
Probability	3	2
Significance	**27 (low)**	**16 (low)**

Status	Negative	
Irreplaceable loss of resources	Yes	
Can impacts be mitigated	Yes – provided each project provides sufficient mitigation	
Mitigation: Detailed in Tables 3 to 7.		

3.4. Avifaunal management plan

Activity	**Mitigation**	**Responsibility**	**Schedule/Frequency**
Avifaunal monitoring & management plan	Identification of high collision risk sections of line through avifaunal walk through	Eskom/Avifaunal specialist	During site specific EMP
	Installation of suitable anti bird collision line marking devices	Eskom/ECO	During construction, asap after earth wire stringing
	Identification of high sensitivity habitat along line through avifaunal walk through	Eskom/Avifaunal specialist	During site specific EMP
	Monitoring of adherence to above	ECO	During construction
	Identification of exact Martial Eagle breeding status and season prior to construction	Eskom/ Avifaunal specialist	During site specific EMP
	Monitoring of no construction within 1km of Martial Eagle nest during breeding season	ECO	During construction
	Annual patrol of full line for monitoring of effectiveness and durability of line marking mitigation for bird collision	Eskom	Operational phase of power line

4. IDENTIFICATION OF PREFERRED ALTERNATIVE

Each alternative route has been assessed according to a number of criteria explained below. Appendix 3 presents photographs taken at representative locations along each of the routes.

Length of line adjacent to existing power lines

From a bird impact perspective, it is important to place the new line adjacent to an existing high voltage overhead line for the following reasons:

- The more overhead power lines there are together, the more visible they will be to birds in the area (APLIC 1994, APLIC 2012). While this is very difficult to test, there are initial indications that transmission lines running on a common servitude in the vicinity of De Aar kill less Blue Cranes and Ludwig's Bustards than those built apart (Shaw 2013).
- Resident birds in an area become accustomed to a power line that crosses their flight paths, and learn to avoid it during their everyday activities. Hence adding a new power line adjacent to an existing line would probably have less impact than putting it in a totally new area, where the resident birds are not yet accustomed to overhead power lines.
- Spatially, it makes sense to have all the threats to birds (in particular through collision) in one relatively confined area, rather than spread out across the landscape.
- Building the new line adjacent to an existing line should theoretically eliminate the need for new access roads and gates, and therefore reduce levels of disturbance and habitat destruction during construction.
- Building lines together facilitates monitoring of these lines to establish impact levels and evaluate effectiveness of mitigation measures.

Overall length of line

Generally speaking, the longer the power line, the more risk it is likely to pose to birds. This is particularly true of this project where the risk to birds is not confined to known hot-spots, but could be spread out along the length of the line and extremely difficult to predict in the largely uniform arid landscape. The collision rates and issues with line marking explained for bustards earlier in this report make it clear that the length of transmission line in the range of these species must be restricted if we are to limit the mortality of these species.

Number of open water sources (pans, dams, wetlands) close to the alignment

None are evident in the study area.

Length of line adjacent to either large road or railway

This makes good sense for similar reasons to those listed above, and there is some evidence that Ludwig's Bustard collisions are lower on distribution power lines that run alongside district roads (Shaw 2013).

Key avifaunal features

Generally, the landscape in the study area is uniform and there are few features which stand out as particularly sensitive. The exception is the areas of Red Dunes, which are particularly important for the Red Lark as described elsewhere in this report. Routes 1 and 2 avoid the most significant concentration of red dunes in the west near Aggeneis Substation, whilst Route 3 passes a significant distance through them. The other two patches of dunes are traversed by all 3 alternatives. The Martial Eagle nest is also a sensitive feature, which Route 1 passes close to, and Routes 2 and 3 less so.

Protected or conservation areas

The length of each alternative route that passes through protected areas and Important Bird Areas was measured and summarised in the table below.

Table 9. Assessment of avifaunal factors for each alternative route.

Factor	Route 1	Route 2	Route 3	Route 3A
Length of line adjacent to existing high voltage lines	103km (100%)	46km (44%)	20km (18%)	61km (56%)
Length of line	103km	105km	111km	108km
Length of line within 1 km of a railway or district road (or larger)	36km (35%)	37km (35%)	6km (0.05%)	41km (38%)
Patches of Red Dunes traversed	2	2	3	3
Length of line within IBAs	23km	24km	45km	22km
Final ranking	**1**	**3**	**4**	**2**

We conclude that Route 1 is the preferred route from an avifaunal perspective. This is primarily because the line can be placed adjacent to an existing line for its entire route, an option not possible with the other alternatives. It also passes through Important Bird Areas for the least possible distance. Route 3A is second most preferred, Route 2 is third preferred and Route 3 is least preferred.

5. SENSITIVITY MAPPING

This is an arid, relatively uniform study area, in which it is challenging to identify areas of higher and lower sensitivity. However, two features do stand out: the red dune areas; and the Martial Eagle nests. These have been mapped in Figure 9. These areas correspond to management recommendations elsewhere in this report.

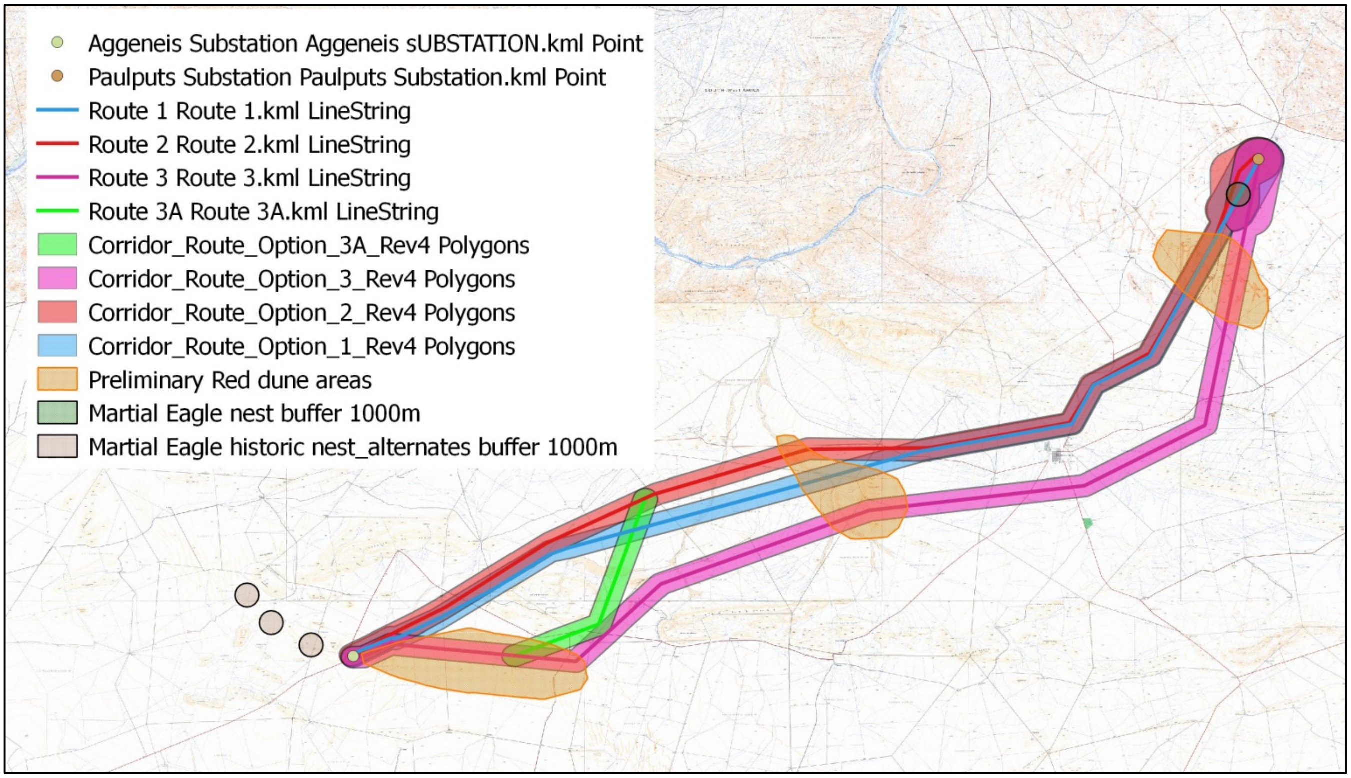


Figure 9. Sensitive avifaunal features in the Aggeneis Paulputs 400kV power line study area.

6. RELEVANT LEGISLATION

Various sets of legislation and policy frameworks are relevant to this specialist study and development, including the following:

- The Convention on Biological Diversity is dedicated to promoting sustainable development. The Convention recognises that biological diversity is about more than plants, animals and micro-organisms and their ecosystems. It is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live. It is an international convention signed by 150 leaders at the Rio 1992 Earth Summit, and South Africa is a signatory.
- An important principle encompassed by the CBD is the precautionary principle, which essentially states that where serious threats to the environment exist, lack of full scientific certainty should not be used a reason for delaying management of these risks. The burden of proof that the impact will not occur lies with the proponent of the activity posing the threat.
- The Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or the Bonn Convention) aims to conserve terrestrial, aquatic and avian migratory species throughout their range. It is an intergovernmental treaty, concluded under the aegis of the United Nations Environment Programme, concerned with the conservation of wildlife and habitats on a global scale. Since the Convention's entry into force, its membership has grown steadily to include 117 (as of 1 June 2012) Parties from Africa, Central and South America, Asia, Europe and Oceania. South Africa is a signatory.
- The African-Eurasian Waterbird Agreement: the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) is the largest of its kind developed so far under the CMS. The AEWA covers 255 species of birds ecologically dependent on wetlands for at least part of their annual cycle, including many species of divers, grebes, pelicans, cormorants, herons, storks, rails, ibises, spoonbills, flamingos, ducks, swans, geese, cranes, waders, gulls, terns, tropic birds, auks, frigate birds and even the South African penguins.The agreement covers 119 countries from Europe, parts of Asia and Canada, the Middle East and Africa.
- National Environmental Management – Biodiversity Act - Threatened or Protected Species list (TOPS):the following target species for this study are on the list: Endangered – White-backed Vulture; Vulnerable – Kori Bustard, Ludwig’s Bustard, Black Stork, Martial Eagle.
- The Northern Cape Nature Conservation Act 9 of 2009.

7. CONCLUSION&RECOMMENDATIONS

The proposed power line passes through an area of the country where large terrestrial bird species such as bustards, raptors and several important lark species are present. Very careful management of the collision and habitat destruction risk will be needed if this is to be reduced to acceptable levels. The primary means of mitigating risks to avifauna is the correct routing of the power line.

Specifically, the following findings are made by this study with respect to the impacts of the proposed development on birds:

- Bird collisions with the overhead power line is rated as HIGH significance pre-mitigation, and MEDIUM significance post mitigation
- Destruction of bird habitat is rated as HIGH pre-mitigation and MEDIUM post mitigation
- Disturbance of birds is judged to be of HIGH significance pre-mitigated, but can be mitigated to LOW significance
- Nesting of birds on the new power line is rated as LOW significance both pre and post mitigation
- Electrical faulting on the new power line is rated as LOW significance both pre and post mitigation

The following mitigation is recommended as an outcome of this report:

- It is essential that Option 1 be selected, whereby the new power line is placed immediately adjacent to (defined as not more than 150 m between outer conductors) the existing 220kV power line. This will hopefully provide partial mitigation for the impact of collision.
- In addition, the new power line must be installed with the very latest and most effective Eskom approved line marking devices available at the time of construction. These should be fitted on the earth wires, with 100% of each span marked (not the middle 60% of each span previously stipulated in Eskom Transmission guidelines). This installation must be done according to Eskom best practice at the time, but should include the following at least: markers must alternate between a light and dark colour to provide contrast against a dark and light background respectively. These markers must be no more than 20 m apart on each earth wire. It is Eskom's responsibility to ensure the integrity of these devices for the full lifespan of the power line. If these devices become damaged or their effectiveness is in any way compromised with time they must be replaced. Likewise if significantly more effective devices become available, these must be installed on the power line.
- No construction activities for the new line should take place within 1km of the Martial Eagle nest (see Figure 9) on the existing power line during breeding season if it is active. The exact timing of breeding season will need to be confirmed just prior to construction, but is likely to be approximately March to September.
- All existing roads and storage sites must be used where possible.
- No towers should be placed within 100m of red dunes and water sources (drinking troughs, wind mills, reservoirs). No vehicle or human traffic should be allowed through these areas either. Towers should be spaced to avoid these areas and accessed during construction from either side, not continuously along the servitude. The red dunes have

been digitised as far as possible off Google Earth (See Figure 9), but this aspect, and the surface water sources will require more confirmation during the avifaunal walk through.

- We recommend strongly that a cross rope suspension tower structure be used, since this will provide less perching and nesting substrate for large birds than a guyed-V or self-support structure.
- A construction EMP (avifaunal walk through) must be conducted to:
    - Determine whether the Martial Eagle nest is occupied and define the breeding season in that year.
    - Identify any other nests of sensitive species, that may require management measures.
    - identify any particularly sensitive habitats, including red dunes and surface water in the form of windmills/reservoirs/drainage lines
    - provide final confirmation of the high risk sections of this power line.
- An on-site ECO must be responsible for ensuring compliance with the recommendations of this report and minimising habitat destruction during construction. This person must also:
    - Identify any other breeding raptors or other Red-listed bird species. If any are found case-specific management measures must be developed by an avifaunal specialist.

8. REFERENCES

Allan, D.G. 1994. The abundance and movements of Ludwig's Bustard *Neotis ludwigii*. Ostrich 65: 95-105.

Alonso, J.A. and Alonso, J.C. 1999. Collision of birds with overhead transmission lines in Spain. In: Ferrer, M. and Janss, G.F.E. (Eds.) Birds and Power Lines. Collision, Electrocution and Breeding: pages 57-82. ServiciosInformativos Ambientales/Quercus, Madrid.

Anderson, M.D. 2002. Karoo large terrestrial bird powerline project: Report No 1. Eskom, Johannesburg.

Avian Power Line Interaction Committee (APLIC). 1994. Mitigating bird collisions with power lines: the state of the art in 1994. Edison Electrical Institute, Washington D.C.

Avian Power Line Interaction Committee (APLIC). 2012. Reducing avian collisions with power lines: the state of the art in 2012. Edison Electric Institute and APLIC. Washington, D.C.

Barnes, K.N. (Ed.) 1998. The Important Bird Areas of southern Africa. BirdLife South Africa, Johannesburg.

Barrientos, R., Alonso, J.C., Ponce, C., and Palacín, C. 2011. Meta-analysis of the effectiveness of marked wire in reducing avian collisions with power lines. Conservation Biology 25: 893-903.

Barrientos, R., Ponce, C., Palacín, C., Martín, C.A., Martín, B. and Alonso, J.C. 2012. Wire marking results in a small but significant reduction in avian mortality at power lines: a BACI designed study. PLoS ONE 7: 1-10.

Bevanger, K. 1994. Bird interactions with utility structures: collision and electrocution, causes and mitigating measures. Ibis 136: 412-425. 184

Bevanger, K. 1998. Biological and conservation aspects of bird mortality caused by electricity power lines: a review. Biological Conservation 86: 67-76.

Bevanger, K. 1999. Estimating bird mortality caused by collision and electrocution with power lines; a review of methodology. In: Ferrer, M. and Janss, G.F.E. (Eds.) Birds and Power Lines. Collision, Electrocution and Breeding: pages 29-56. ServiciosInformativosAmbientales/Quercus, Madrid.

BirdLife International. 2013. IUCN Red List for Birds. Downloaded from http://www.birdlife.org in April 2013.

BirdLife South Africa. 2013. Important Bird Areas Programme. Downloaded from http://www.birdlife.org.za/conservation/iba in April 2013.

De Goede, K. 2011. Monitoring large eagle nest sites on Eskom power lines in the south-western Karoo – Progress report 2011.Unpublished report, Endangered Wildlife Trust, Johannesburg.

De Goede, K. and Jenkins, A. 2001.Electric eagles of the Karoo. Africa - Birds & Birding 6: 62-67.

Dean, W.R.J. 1997. The distribution and biology of nomadic birds in the Karoo, South Africa. Journal of Biogeography 24: 769-779.

Dean, W.R.J. and Siegfried, W.R. 1997. The protection of endemic and nomadic avian diversity in the Karoo, South Africa. South African Journal of Wildlife Research 27: 11-21.

Drewitt, A.L. and Langston, R.H.W. 2008. Collision effects of wind-power generators and other obstacles on birds. Annals of the New York Academy of Sciences 1134: 233-266.

Erickson, W.P., Johnson, G.D. and Young Jr., D.P. 2005. A summary and comparison of bird mortality from anthropogenic causes with an emphasis on collisions.General Technical Report PSW-GTR-191.United States Department of Agriculture Forest Service, Washington D.C.

Eskom-Endangered Wildlife Trust Strategic Partnership (Eskom-EWT). 2012. Central Incident Register. Wildlife & Energy Programme, Endangered Wildlife Trust, Johannesburg.

Harrison, J.A., Allan, D.G., Underhill, L.G., Herremans, M., Tree, A.J., Parker, V. and Brown, C.J. (Eds.) 1997.The Atlas of Southern African Birds.BirdLife South Africa, Johannesburg.

Hockey, P.A.R., Dean, W.R.J. and Ryan, P.G. (Eds.) 2005. Roberts Birds of Southern Africa, 7th edn. The Trustees of the John Voelcker Bird Book Fund, Cape Town.

Janss, G.F.E. 2000. Avian mortality from power lines: a morphological approach of a species-specific mortality. Biological Conservation 95: 353–359.

Janss, G.F.E. and Ferrer, M. 1998. Rate of bird collision with power lines: effects of conductor-marking and static wire-marking. Journal of Field Ornithology 69: 8-17.

Jenkins, A.R., Smallie, J.J. and Diamond, M. 2010. Avian collisions with power lines: a global review of causes and mitigation with a South African perspective. Bird Conservation International 20: 263-278.

Jenkins, A.R., Shaw, J.M., Smallie, J.J., Gibbons, B., Visagie, R. and Ryan, P.G. 2011. Estimating the impacts of power line collisions on Ludwig's Bustards *Neotis ludwigii*. Bird Conservation International 21: 303 – 310.

Kruger, R. 1999. Towards solving raptor electrocutions on Eskom Distribution Structures in South Africa.M.Phil. mini-thesis.University of the Orange Free State. Bloemfontein.

Ledger, J.A. and Annegarn, H.J. 1981. Electrocution Hazards to the Cape Vulture *(Gyps coprotheres)* in South Africa. Biological Conservation 20:15-24.

Lehman, R.N. 2001. Raptor electrocution on power lines: current issues and outlook. Wildlife Society Bulletin 29: 804-813.

Lehman, R.N., Kennedy, P.L. and Savidge, J.A. 2007. The state of the art in raptor electrocution research: a global review. Biological Conservation 136: 159-174.

Marnewick MD, Retief EF, Theron NT, Wright DR, Anderson TA.2015. Important Bird and Biodiversity Areas of South Africa. Johannesburg: BirdLife South Africa.

Martin, G.R. and Shaw, J.M. 2010. Bird collisions with power lines: failing to see the way ahead? Biological Conservation 143: 2695-2702.

Martin, G.R., Portugal, S.J. and Murn, C.P. 2012. Visual fields, foraging and collision vulnerability and *Gyps* vultures. Ibis 154: 626-631.

Mucina, L. and Rutherford, M.C. (Eds.) 2006.The Vegetation of South Africa, Lesotho and Swaziland, Strelitzia 19. South African National Biodiversity Institute, Pretoria.

Prinsen, H.A.M., Boere, G.C., Píres, N. and Smallie, J.J. (Eds.) 2011. Review of the conflict between migratory birds and electricity power grids in the African-Eurasian region. CMS Technical Series/AEWA Technical Series, Bonn.

Raab, R., Spakovszky, P., Julius, E., Schütz, C. and Schulze, C.H. 2011a. Effects of power lines on flight behaviour of the West-Pannonian Great Bustard *Otis tarda*population. Bird Conservation International 21:142-155.

Raab, R., Schütz, C., Spakovszky, P., Julius, E. and Schulze, C.H. 2011b. Underground cabling and marking of power lines: conservation measures rapidly reduced mortality of West-Pannonian Great Bustards *Otis tarda*. Bird Conservation International 22: 299-306.

Schutgens, M., Shaw, J.M. and Ryan, P.G.In review.Estimating scavenger and search bias for collision mortality surveys of large birds on power lines in the Karoo, South Africa.Journal of Field Ornithology.

Senyatso, K.J. 2011. Conserving widely distributed wildlife species in an African savannah: parks, cattle-grazing and community-managed areas. PhD thesis, University of East Anglia, Norwich.

Senyatso, K.J., Collar, N.J. and Dolman, P.M. 2012. Assessing range-wide conservation status change in an unmonitored widespread African bird species. Diversity and Distributions 19: 106-119.

Shaw, J.M. 2013. Power line collisions in the Karoo: Conserving Ludwig's Bustard. PhD Thesis, University of Cape Town, Cape Town.

Shaw, J.M., Jenkins, A.R., Smallie, J.J. and Ryan, P.G. 2010. Modelling power-line collision risk for the Blue Crane *Anthropoidesparadiseus*in South Africa. Ibis 152: 590-599.

Shaw, J.M., van der Merwe, R., van der Merwe, E. and Ryan, P.G. In prep. Camera traps reveal high winter scavenging rates under power lines in the Karoo.

Silva, J.P., Santos, M., Queirós, L., Leitão, D., Moreira, F., Pinto, M., Leqoc, M., and Cabral, J.A. 2010.Estimating the influence of overhead transmission power lines and landscape context on the density of Little Bustard *Tetraxtetrax*breeding populations. Ecological Modelling 221: 1954-1963.

Simmons, R.E., Brown, C.J., & Kemper, J. 2015. Birds to watch in Namibia: red, rare and endemic species. Ministry of Environment and Tourism and Namibia Nature Foundation, Windhoek

South African Bird Atlas Project 2 (SABAP 2). 2013. Downloaded from http://sabap2.adu.org.za/ in August 2016.
South African National Biodiversity Institute (SANBI). 2011. National Freshwater Ecosystem Priority Areas Map. CSIR, Stellenbosch.

Taylor, M. R, Peacock, F., & Wanless, R. 2015. The 2015 Eskom Red Data Book of Birds of South Africa, Lesotho & Swaziland.

Taylor, P.B., Navarro, R.A., Wren-Sargent, M., Harrison, J.A. and Kieswetter, S.L. 1999. TOTAL CWAC Report: Coordinated Waterbird Counts in South Africa, 1992 – 1997. Avian Demography Unit, Cape Town.

van Rooyen, C.S. and Ledger, J.A. 1999. Birds and utility structures: developments in southern Africa. In: Ferrer, M. and

Janss, G.F.E. (Eds.) Birds and Power Lines. Collision, Electrocution and Breeding: pages 205-230. ServiciosInformativosAmbientales/Quercus, Madrid.

Young, D.J., Harrison, J.A., Navarro, R.A., Anderson, M.D. and Colahan, B.D. (Eds.) 2003. Big Birds on Farms: Mazda CAR Report 1993-2001. Avian Demography Unit, University of Cape Town, Cape Town.

APPENDIX 1.CRITERIA AGAINST WHICH IMPACTS ARE ASSESSED (SUPPLIED BY MOKGOPE)

To determine the significance ranking, the following ranking (or similar) should be applied to each impact identified:

1. Nature of impact

The environmental impacts of a project are those resultant changes in environmental parameters, in space and time, compared with what would have happened had the project not been undertaken. It is an appraisal of the type of effect the proposed activity would have on the affected environmental parameter. Its description should include what is being affected, and how.

2. Spatial extent

This addresses the physical and spatial scale of the impact. A series of standard terms relating to the spatial extent of an impact / effect are outlined in Table 1.

Table 1 Rating scale for the assessment of the spatial extent of predicted effect / impact

Rating	Spatial descriptor
7	International - The impacted area extends beyond national boundaries
6	National - The impacted area extends beyond provincial boundaries
5	Ecosystem - The impact could affect areas essentially linked to the property in terms of significantly impacting ecosystem functioning
4	Regional - The impact could affect the area including the neighbouring farms, the transport routes and the adjoining towns
3	Landscape - The impact could affect all areas generally visible to the naked eye, as well as those areas essentially linked to the property in terms of ecosystem functioning
2	Site related - The impacted area extends further than the actual physical disturbance footprint; the impact could affect the whole, or a measurable portion of a number of properties
1	Local - The impacted area extends only as far as the activity e.g. a footprint; the loss is considered inconsequential in terms of the spatial context of the relevant environmental aspect

3. Severity / Intensity / Magnitude

A qualitative assessment of the severity of a predicted impact / effect was undertaken. Quantitative measures were undertaken wherever possible. A series of standard terms relating to the magnitude of an impact / effect are outlined in Table 2.

Table 2 Rating scale for the assessment of the severity of a predicted effect / impact[1]

Rating	Magnitude descriptor
7	Total / consuming / eliminating - Function or process of the affected environment is altered to the extent that it is permanently changed
6	Profound / considerable / substantial - Function or process of the affected environment is altered to the extent where it is permanently modified to a sub-optimal state. In the case of positive impacts it is permanently modified to an improved state

5	Material / important - Function or process of the affected environment is altered to the extent where it is temporarily altered, be it in a positive or negative manner.
4	Discernible / noticeable - The affected environment is altered, but function and process continue, albeit in a modified way.
3	Marginal / slight / minor - The affected environment is altered, but natural function and process continue.
2	Unimportant / inconsequential / indiscernible - The impact alters the affected environment in such a way that the natural processes or functions are negligibly affected.
1	No effect / not applicable

4. Duration

This describes the predicted lifetime of the impact.

Table 3 Rating scale for the assessment of the temporal scale of a predicted effect / impact

Rating	Temporal descriptor
7	Long-term – Permanent. Beyond decommissioning and cannot be negated on decommissioning. More than 15 years.
3	Medium term – Lifespan of the project. Reversible over time. 5 to 15 years.
1	Short-term – Quickly reversible. Less than the project lifespan. The impact will either disappear with mitigation or will be mitigated through natural process in a span shorter than any of the phases. 0 to 5 years.

5. Irreplaceable loss of resources

Environmental resources cannot always be replaced; once destroyed, some may be lost forever. It may be possible to replace, compensate for or reconstruct a lost resource in some cases, but substitutions are rarely ideal. The loss of a resource may become more serious later, and assessment must take this into account.

Table 4 Rating scale for the assessment of the loss of resources due to a predicted effect / impact

Rating	Resource loss descriptor
7	Long-term – The loss of a non-renewable / threatened resource which cannot be renewed / recovered with or through natural process, in a time span of over 15 years, or by artificial means.
5	Long-term – The loss of a non-renewable / threatened resource which cannot be renewed / recovered with or through natural process, in a time span of over 15 years, but can be mitigated by other means.
4	Loss of an 'at risk' resource - one that is not deemed critical for biodiversity targets, planning goals, community welfare, agricultural production, or other criteria, but cumulative effects may render such loss as significant.
3	Medium term – The resource can be recovered within the lifespan of the project. The resource can be renewed / recovered with mitigation or will be mitigated through natural process in a span between 5 and 15 years.
2	Loss of an 'expendable' resource - one that is not deemed critical for biodiversity targets, planning goals, community welfare, agricultural production, or other criteria.
1	Short-term – Quickly recoverable. Less than the project lifespan. The resource can be renewed / recovered with mitigation or will be mitigated through natural process in a span shorter than any of the phases, or in a time span of 0 to 5 years.

6. Reversibility / potential for rehabilitation

The distinction between reversible and irreversible impacts is a very important one, and the irreversible impacts, not susceptible to mitigation, can constitute significant impacts in an EIA (Glasson *et al*, 1999). The potential for rehabilitation is the major determinant factor when considering the temporal scale of most predicted impacts.

Table 5 Rating scale for the assessment of reversibility of a predicted effect / impact

Rating	Reversibility descriptor
7	Long-term – The impact / effect will never be returned to its benchmark state.
3	Medium term – The impact / effect will be returned to its benchmark state through mitigation or natural processes in a span shorter than the lifetime of the project, or in a time span between 5 and 15 years.
1	Short-term – The impact / effect will be returned to its benchmark state through mitigation or natural processes in a span shorter than any of the phases of the project, or in a time span of 0 to 5 years.

7. Probability

An assessment of the probability of an impact / effect was undertaken in accordance with Table 6.

Table 6 Rating scale for the assessment of the probability of a predicted effect / impact [2]

Rating	Probability descriptor
1.0	Absolute certainty
0.9	Near certainty / very high probability
0.7 – 0.8	High probability – to be expected
0.4 - 0.6	Likelihood / normal anticipation – to be anticipated
0.3	Seriously anticipated possibility
0.2	Possibility
0.0 - 0.1	Remote possibility

8. Mitigation

The potential to mitigate the negative impacts and enhance the positive impacts should be determined for each identified impact, mitigation objectives that would result in a measurable reduction in impact should be provided. For each impact, practical mitigation measures that can affect the significance rating should be recommended. Management actions that could enhance the condition of the environment (i.e. potential positive impacts of the proposed project) should be identified. Where no mitigation is considered feasible, this must be stated and the reasons provided (DEAT, 2002).

The significance of environmental impacts will be assessed taking into account any proposed mitigations. The significance of the impact "without mitigation" is the prime determinant of the nature and degree of mitigation required.

Table 7 Significance scoring of a (a) Negative impact / effect

Scoring value	Significance
35	Total / consuming / eliminating - In the case of adverse impacts, there is no possible mitigation that could offset the impact, or mitigation is difficult, expensive, time-consuming or some combination of these. Social, cultural and economic activities of communities are disrupted to such an extent that these come to a halt. Mitigation may not be possible / practical. Consider fatal flaw.
26 - 34	Profound - In the case of adverse impacts, there are few opportunities for mitigation that could offset the impact, or mitigation has a limited effect on the impact. Social, cultural and economic activities of communities are disrupted to such an extent that their operation is severely impeded. Mitigation may not be possible / practical. Consider fatal flaw.
21 – 25	Considerable / substantial - The impact is of great importance. Failure to mitigate with the objective of reducing the impact to acceptable levels could render the entire project option or entire project proposal unacceptable. Mitigation is therefore essential.
8 – 20	Material / important to investigate - The impact is of importance and is therefore considered to have a substantial impact. Mitigation is required to reduce the negative impacts and such impacts need to be evaluated carefully.
5 – 7	Marginal / slight / minor - The impact is of little importance, but may require limited mitigation; or it may be rendered acceptable in light of proposed mitigation.
0 – 4	Unimportant / inconsequential / indiscernible; or it may be rendered acceptable in light of proposed mitigation.

(b) Positive impact / effect

Scoring value	Significance
16 - 21	Very highly beneficial
12 – 15	Highly beneficial
5 - 11	Moderately beneficial
3 – 4	Slightly beneficial
0 – 2	Beneficial

To determine the significance ranking, the following ranking (or similar) should be applied to each impact identified:

SIGNIFICANCE RANKING MATRIX

RANKING	MAGNITUDE	REVERSIBILITY	EXTENT	DURATION	PROBABILITY
5	Very high/ don't know	Irreversible	International	Permanent	Certain/inevitable
4	High		National	Long term (impact ceases after operational life of asset	Almost certain
3	Moderate	Reversibility with human intervention	Provincial	Medium term	Can occur
2	Low		Local	Short term	Unusual but possible
1	Minor	Completely reversible	Site bound	Immediate	Extremely remote
0	None		None		None

Significance= Consequence (Magnitude+ Duration+ Extent + Reversibility) X Probability wherein the following meaning applies:

- **The Magnitude** of the impact: This will be quantified as either:
  - Low: Will cause a low impact on the environment;
  - Moderate: Will result in the process continuing but in a controllable manner;
  - High: Will alter processes to the extent that they temporarily cease; and
  - Very High: Will result in complete destruction and permanent cessation of processes.

- **The Probability:** which shall describe the likelihood of impact occurring and will be rated as follows:
  - Extremely remote: Which indicates that the impact will probably not happen;
  - Unusual but Possible: Distinct possibility of occurrence;
  - Can Occur: there is a possibility of occurrence;
  - Almost Certain: Most likely to occur; and
  - Certain/ Inevitable: Impact will occur despite any preventative measures put in place.

- **The duration (Exposure):** wherein it will be indicated whether:

  - The impact will be of a immediate;
  - The impact will be of a short tem (Between 0-5 years);
  - The impact will be of medium term (between 5-15 years);
  - The impact will be long term (15 and more years); and
  - The impact will be permanent.

- **Reversibility/ Replaceability:** The degree at which the impact can be **reversible or the lost resource can be replaced.**

RANKING	100-65	64-36	35-16	15-5	4-1
SIGNIFICANCE	Very High	High	Moderate	Low	Minor

APPENDIX 2.BIRD SPECIES RECORDED IN THE BROADER STUDY AREA BY THE SABAP 1 AND SABAP2 PROJECTS (AMENDED SLIGHTLY WITH AUTHORS' KNOWLEDGE OF THE AREA)

Common name	Taxonomic name	SAB AP1	SAB AP2	Taylor *et al* 2015	TOPS list
Harrier, Black	*Circus maurus*	1		EN	
Vulture, White-backed	*Gyps africanus*	1		EN	E
Bustard, Ludwig's	*Neotisludwigii*	1	1	EN	VU
Eagle, Martial	*Polemaetusbellicosus*	1	1	EN	VU
Eagle, Verreaux's	*Aquila verreauxii*	1	1	VU	
Lark, Red	*Calendulaudaburra*	1	1	VU	
Stork, Black	*Ciconianigra*	1	1	VU	VU
Courser, Burchell's	*Cursoriusrufus*	1	1	VU	
Falcon, Lanner	*Falco biarmicus*	1	1	VU	
Secretarybird	*Sagittarius serpentarius*	1		VU	
Pipit, African Rock	*Anthuscrenatus*	1		NT	
Bustard, Kori	*Ardeotiskori*	1	1	NT	VU
Korhaan, Karoo	*Eupodotisvigorsii*	1	1	NT	
Flamingo, Greater	*Phoenicopterusruber*	1		NT	
Lark, Sclater's	*Spizocoryssclateri*	1	1	NT	
Reed-warbler, African	*Acrocephalusbaeticatus*	1	1		
Swamp-warbler, Lesser	*Acrocephalusgracilirostris*	1	1		
Sandpiper, Common	*Actitishypoleucos*	1	1		
Korhaan, Northern Black	*Afrotisafraoides*		1		
Lovebird, Rosy-faced	*Agapornisroseicollis*	1			
Kingfisher, Malachite	*Alcedocristata*	1	1		
Goose, Egyptian	*Alopochenaegyptiacus*	1	1		
Finch, Red-headed	*Amadinaerythrocephala*	1	1		
Teal, Cape	*Anascapensis*	1	1		
Teal, Red-billed	*Anaserythrorhyncha*	1			
Shoveler, Cape	*Anassmithii*	1	1		
Duck, African Black	*Anassparsa*	1	1		
Duck, Yellow-billed	*Anasundulata*	1	1		
Darter, African	*Anhinga rufa*	1	1		
Penduline-tit, Cape	*Anthoscopusminutus*	1	1		
Pipit, African	*Anthuscinnamomeus*	1	1		
Pipit, Long-billed	*Anthussimilis*	1	1		
Swift, Little	*Apus affinis*	1	1		
Swift, Common	*Apus apus*	1			
Swift, Bradfield's	*Apus bradfieldi*	1	1		
Swift, White-rumped	*Apus caffer*	1	1		
Eagle, Booted	*Aquila pennatus*	1	1		
Heron, Grey	*Ardeacinerea*	1	1		
Heron, Goliath	*Ardea goliath*	1	1		
Heron, Black-headed	*Ardeamelanocephala*	1	1		
Heron, Purple	*Ardeapurpurea*	1			
Turnstone, Ruddy	*Arenariainterpres*	1			
Batis, Pririt	*Batispririt*	1	1		
Ibis, Hadeda	*Bostrychiahagedash*		1		
Flycatcher, Chat	*Bradornisinfuscatus*	1	1		
Eagle-owl, Spotted	*Bubo africanus*	1	1		
Eagle-owl, Cape	*Bubo capensis*	1	1		
Egret, Cattle	*Bubulcus ibis*	1			
Thick-knee, Spotted	*Burhinuscapensis*	1	1		
Buzzard, Jackal	*Buteorufofuscus*	1	1		
Buzzard, Steppe	*Buteovulpinus*	1			
Lark, Red-capped	*Calandrellacinerea*	1	1		
Lark, Fawn-coloured	*Calendulaudaafricanoides*	1	1		
Lark, Sabota	*Calendulaudasabota*	1	1		
Sandpiper, Curlew	*Calidrisferruginea*	1			

Stint, Little	*Calidrisminuta*	1	1	
Woodpecker, Golden-tailed	*Campetheraabingoni*	1	1	
Nightjar, Rufous-cheeked	*Caprimulgusrufigena*	1	1	
Nightjar, Freckled	*Caprimulgustristigma*	1		
Chat, Familiar	*Cercomelafamiliaris*	1	1	
Chat, Karoo	*Cercomelaschlegelii*	1	1	
Chat, Sickle-winged	*Cercomelasinuata*	1	1	
Chat, Tractrac	*Cercomelatractrac*	1	1	
Scrub-robin, Karoo	*Cercotrichascoryphoeus*	1	1	
Scrub-robin, Kalahari	*Cercotrichaspaena*		1	
Lark, Karoo Long-billed	*Certhilaudasubcoronata*	1	1	
Kingfisher, Pied	*Cerylerudis*	1	1	
Plover, Common Ringed	*Charadriushiaticula*	1		
Plover, Chestnut-banded	*Charadrius pallidus*	1		
Plover, Kittlitz's	*Charadriuspecuarius*	1		
Plover, Three-banded	*Charadriustricollaris*	1	1	
Lark, Spike-heeled	*Chersomanesalbofasciata*	1	1	
Tern, White-winged	*Chlidoniasleucopterus*	1		
Cuckoo, Diderick	*Chrysococcyxcaprius*	1	1	
Sunbird, Southern Double-collared	*Cinnyrischalybeus*	1	1	
Sunbird, Dusky	*Cinnyrisfuscus*	1	1	
Snake-eagle, Black-chested	*Circaetus pectoralis*	1	1	
Cisticola, Desert	*Cisticolaaridulus*		1	
Cisticola, Zitting	*Cisticolajuncidis*	1		
Cisticola, Grey-backed	*Cisticolasubruficapilla*	1	1	
Mousebird, White-backed	*Coliuscolius*	1	1	
Pigeon, Speckled	*Columba guinea*	1	1	
Dove, Rock	*Columba livia*	1	1	
Crow, Pied	*Corvusalbus*	1	1	
Crow, Cape	*Corvuscapensis*	1	1	

Robin-chat, Cape	*Cossyphacaffra*	1	1	
Quail, Common	*Coturnixcoturnix*	1	1	
Starling, Wattled	*Creatophoracinerea*	1		
Canary, White-throated	*Crithagraalbogularis*	1	1	
Canary, Black-throated	*Crithagraatrogularis*	1	1	
Canary, Yellow	*Crithagraflaviventris*	1	1	
Palm-swift, African	*Cypsiurusparvus*		1	
House-martin, Common	*Delichonurbicum*	1		
Drongo, Fork-tailed	*Dicrurusadsimilis*	1		
Egret, Little	*Egrettagarzetta*		1	
Egret, Yellow-billed	*Egretta intermedia*	1		
Kite, Black-shouldered	*Elanuscaeruleus*	1	1	
Bunting, Cape	*Emberizacapensis*	1	1	
Bunting, Lark-like	*Emberizaimpetuani*	1	1	
Eremomela, Karoo	*Eremomelagregalis*	1	1	
Eremomela, Yellow-bellied	*Eremomelaicteropygialis*	1	1	
Sparrowlark, Black-eared	*Eremopterixaustralis*	1	1	
Sparrowlark, Grey-backed	*Eremopterixverticalis*	1	1	
Waxbill, Common	*Estrildaastrild*	1	1	
Bishop, Southern Red	*Euplectesorix*	1	1	
Warbler, Cinnamon-breasted	*Euryptilasubcinnamomea*	1	1	
Falcon, Red-necked	*Falco chicquera*	1		
Falcon, Peregrine	*Falco peregrinus*	1		VU
Kestrel, Greater	*Falco rupicoloides*	1	1	
Kestrel, Rock	*Falco rupicolus*	1	1	
Coot, Red-knobbed	*Fulicacristata*	1	1	
Lark, Large-billed	*Galeridamagnirostris*	1	1	
Moorhen, Common	*Gallinulachloropus*		1	
Fish-eagle, African	*Haliaeetusvocifer*	1	1	
Stilt, Black-winged	*Himantopushimantopus*	1	1	
Swallow, White-throated	*Hirundoalbigularis*	1	1	

Swallow, Greater Striped	*Hirundocucullata*	1	1
Martin, Rock	*Hirundofuligula*	1	1
Swallow, Barn	*Hirundorustica*	1	1
Bittern, Little	*Ixobrychusminutus*	1	
Firefinch, Red-billed	*Lagonostictasenegala*	1	1
Starling, Cape Glossy	*Lamprotornisnitens*	1	1
Fiscal, Common (Southern)	*Laniuscollaris*	1	1
Shrike, Red-backed	*Laniuscollurio*	1	
Shrike, Lesser Grey	*Lanius minor*	1	
Warbler, Rufous-eared	*Malcorus pectoralis*	1	1
Goshawk, Southern Pale Chanting	*Melieraxcanorus*	1	1
Goshawk, Gabar	*Melieraxgabar*	1	
Bee-eater, European	*Meropsapiaster*	1	1
Bee-eater, Swallow-tailed	*Meropshirundineus*	1	1
Kite, Yellow-billed	*Milvus aegyptius*	1	
Lark, Cape Clapper	*Mirafraapiata*	1	1
Lark, Clapper	*Mirafraapiata*	1	
Lark, Longbilled	*Mirafracurvirostris*	1	
Lark, Eastern Clapper	*Mirafrafasciolata*	1	1
Rock-thrush, Short-toed	*Monticolabrevipes*	1	1
Wagtail, African Pied	*Motacillaaguimp*	1	1
Wagtail, Cape	*Motacillacapensis*	1	1
Flycatcher, Spotted	*Muscicapastriata*	1	1
Chat, Anteating	*Myrmecocichlaformicivora*	1	1
Sunbird, Malachite	*Nectariniafamosa*	1	
Pochard, Southern	*Nettaerythrophthalma*	1	1
Brubru	*Nilausafer*	1	
Guineafowl, Helmeted	*Numidameleagris*	1	1
Dove, Namaqua	*Oenacapensis*	1	1
Wheatear, Mountain	*Oenanthemonticola*	1	1

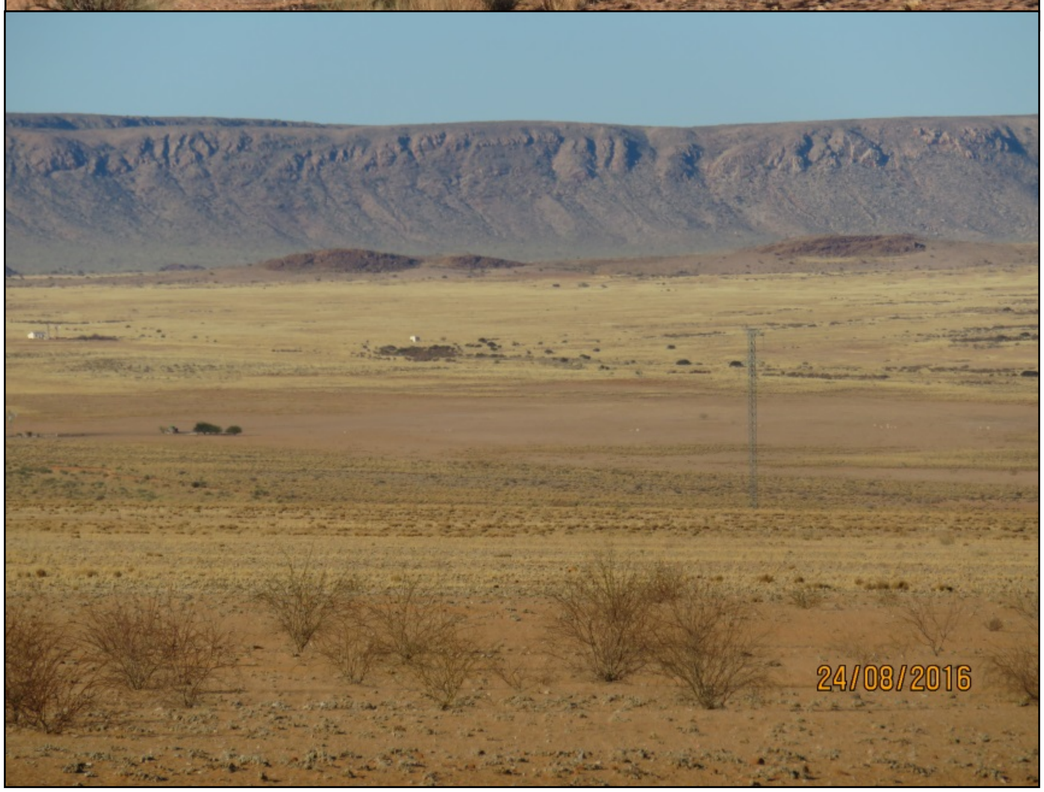
Wheatear, Capped	*Oenanthepileata*	1	1
Starling, Pale-winged	*Onychognathusnabouroup*	1	1
Duck, Maccoa	*Oxyuramaccoa*	1	1
Tit-babbler, Layard's	*Parisomalayardi*	1	1
Tit-babbler, Chestnut-vented	*Parisomasubcaeruleum*	1	1
Tit, Grey	*Parusafer*		1
Tit, Ashy	*Paruscinerascens*		1
Sparrow, Grey-headed	*Passer diffusus*	1	
Sparrow, Southern Grey-headed	*Passer diffusus*	1	1
Sparrow, House	*Passer domesticus*	1	1
Sparrow, Northern Grey-headed	*Passer griseus*	1	
Sparrow, Cape	*Passer melanurus*	1	1
Cormorant, Reed	*Phalacrocoraxafricanus*	1	1
Cormorant, White-breasted	*Phalacrocorax carbo*	1	
Weaver, Sociable	*Philetairussocius*	1	1
Ruff, Ruff	*Philomachuspugnax*	1	1
Warbler, Namaqua	*Phragmaciasubstriata*	1	1
Warbler, Willow	*Phylloscopustrochilus*	1	1
Goose, Spur-winged	*Plectropterusgambensis*	1	
Sparrow-weaver, White-browed	*Plocepassermahali*	1	1
Weaver, Cape	*Ploceuscapensis*	1	1
Masked-weaver, Southern	*Ploceusvelatus*	1	1
Falcon, Pygmy	*Polihieraxsemitorquatus*	1	1
Harrier-Hawk, African	*Polyboroidestypus*	1	
Swamphen, African Purple	*Porphyriomadagascariensis*	1	
Prinia, Black-chested	*Priniaflavicans*	1	1
Prinia, Drakensberg	*Priniahypoxantha*	1	
Prinia, Spotted	*Priniahypoxantha*	1	
Prinia, Karoo	*Priniamaculosa*	1	1

Spurfowl, Red-necked	*Pternistisafer*	1	
Spurfowl, Cape	*Pternistiscapensis*	1	
Sandgrouse, Double-banded	*Pteroclesbicinctus*	1	1
Sandgrouse, Namaqua	*Pteroclesnamaqua*	1	1
Bulbul, African Red-eyed	*Pycnonotusnigricans*	1	1
Quelea, Red-billed	*Queleaquelea*	1	1
Rail, African	*Ralluscaerulescens*	1	
Avocet, Pied	*Recurvirostraavosetta*	1	
Scimitarbill, Common	*Rhinopomastuscyanomelas*	1	
Courser, Double-banded	*Rhinoptilusafricanus*	1	1
Martin, Brown-throated	*Ripariapaludicola*	1	1
Hamerkop	*Scopus umbretta*	1	1
Canary, Black-headed	*Serinusalario*	1	1
Flycatcher, Fiscal	*Sigelussilens*		1
Lark, Pink-billed	*Spizocorysconirostris*	1	
Lark, Stark's	*Spizocorysstarki*	1	1
Finch, Scaly-feathered	*Sporopipessquamifrons*	1	1
Flycatcher, Fairy	*Stenostirascita*	1	1
Turtle-dove, Cape	*Streptopeliacapicola*	1	1
Dove, Red-eyed	*Streptopeliasemitorquata*	1	1
Dove, Laughing	*Streptopeliasenegalensis*	1	1
Ostrich, Common	*Struthiocamelus*	1	1
Starling, Common	*Sturnus vulgaris*	1	
Crombec, Long-billed	*Sylviettarufescens*	1	1
Grebe, Little	*Tachybaptusruficollis*	1	1

Swift, Alpine	*Tachymarptis melba*	1	1
Shelduck, South African	*Tadornacana*	1	1
Bokmakierie	*Telophoruszeylonus*	1	1
Ibis, African Sacred	*Threskiornisaethiopicus*	1	1
Hornbill, African Grey	*Tockusnasutus*	1	
Barbet, Acacia Pied	*Tricholaemaleucomelas*	1	1
Sandpiper, Wood	*Tringaglareola*	1	1
Greenshank, Common	*Tringanebularia*	1	
Sandpiper, Marsh	*Tringastagnatilis*	1	
Thrush, Olive	*Turdusolivaceus*	1	
Thrush, Olive	*Turdusolivaceus*	1	
Thrush, Karoo	*Turdussmithi*	1	1
Owl, Barn	*Tyto alba*	1	1
Hoopoe, African	*Upupaafricana*	1	1
Mousebird, Red-faced	*Urocoliusindicus*	1	1
Lapwing, Blacksmith	*Vanellusarmatus*	1	1
Lapwing, Crowned	*Vanelluscoronatus*	1	1
Whydah, Pin-tailed	*Viduamacroura*	1	1
White-eye, Cape	*Zosterops pallidus*	1	
White-eye, Orange River	*Zosterops pallidus*	1	1
White-eye, Cape	*Zosteropsvirens*	1	1

APPENDIX 3. PHOTOGRAPHS OF MICRO HABITATS ON SITE

Examples of the dominant micro habitat on site – arid plains



Drainage lines on site

Red dunes on the site

Rocky ridges on site

APPENDIX 4. LIST OF SPECIES RECORDED DURING FIELD WORK ON SITE

Species primary name	*Species tertiary name*	Latitude	Longitude
Karoo Korhaan	*Eupodotis vigorsii*	-28.9074	19.77457
Sociable Weaver	*Philetairus socius*	-28.9073	19.77416
Sabota Lark	*Calendulauda sabota*	-28.8982	19.74513
Pied Crow	*Corvusalbus*	-28.8961	19.73853
Rufous-eared Warbler	*Malcorus pectoralis*	-28.8895	19.71731
Ant-eating Chat	*Myrmecocichlaformicivora*	-28.8537	19.59352
Mountain Wheatear	*Myrmecocichlamonticola*	-28.8537	19.59352
Rock Martin	*Ptyonoprognefuligula*	-28.8381	19.58584
Chat Flycatcher	*Bradornisinfuscatus*	-28.9547	19.5324
Cape Turtle Dove	*Streptopeliacapicola*	-28.9985	19.51182
Lanner Falcon	*Falco biarmicus*	-29.0206	19.48708
Greater Kestrel	*Falco rupicoloides*	-29.0225	19.48498
Spike-heeled Lark	*Chersomanesalbofasciata*	-29.0225	19.48496
Southern Fiscal	*Laniuscollaris*	-29.1184	19.42525
Pale Chanting Goshawk	*Melieraxcanorus*	-29.1075	19.4516
Pygmy Falcon	*Polihieraxsemitorquatus*	-29.075	19.53309
Cape Robin-Chat	*Cossyphacaffra*	-29.129	19.39607
Laughing Dove	*Spilopeliasenegalensis*	-29.1278	19.39583
Bokmakierie	*Telophoruszeylonus*	-29.1321	19.33302
Southern Masked Weaver	*Ploceusvelatus*	-29.1301	19.28843
White-browed Sparrow-Weaver	*Plocepassermahali*	-29.1301	19.28856
Karoo Long-billed Lark	*Certhilauda subcoronata*	-29.1301	19.28864
Pale-winged Starling	*Onychognathus nabouroup*	-29.1901	19.0071
Rock Martin	*Ptyonoprognefuligula*	-29.1901	19.0071
Familiar Chat	*Oenanthefamiliaris*	-29.1271	19.21552
Rock Kestrel	*Falco rupicolus*	-29.2965	18.81177
Karoo Prinia	*Priniamaculosa*	-29.2558	18.91016
Mountain Wheatear	*Myrmecocichlamonticola*	-29.1901	19.0071
Pygmy Falcon	*Polihieraxsemitorquatus*	-29.1901	19.0071
Karoo Korhaan	*Eupodotis vigorsii*	-29.3147	19.01607
Pale Chanting Goshawk	*Melieraxcanorus*	-29.2948	18.9865
African Red-eyed Bulbul	*Pycnonotusnigricans*	-29.1279	19.39586
Dusky Sunbird	*Cinnyrisfuscus*	-29.129	19.39623
Orange River White-eye	*Zosterops pallidus*	-29.129	19.39623
Cape Sparrow	*Passer melanurus*	-29.1254	19.39797
House Sparrow	*Passer domesticus*	-29.1255	19.39799
White-throated Swallow	*Hirundoalbigularis*	-29.1552	19.10527
Red-eyed Dove	*Streptopeliasemitorquata*	-28.8381	19.58584
Cape Bunting	*Emberiza capensis*	-28.8381	19.58584

White-backed Mousebird	*Coliuscolius*	-29.059	19.42618
White-throated Canary	*Crithagraalbogularis*	-29.0591	19.42616
Namaqua Dove	*Oena capensis*	-28.9184	19.7661
Scaly-feathered Finch	*Sporopipessquamifrons*	-28.8381	19.58584
Martial Eagle	*Polemaetus bellicosus*	-28.9097	19.55209
Sabota Lark	*Calendulauda sabota*	-28.9097	19.55222