Bird Impact Assessment Report

Potential bird impacts of a proposed

Taunus – Diepkloof 132kV

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EXECUTIVE SUMMARY

ESKOM is proposing to construct a 40km, 132kV overhead power line from the existing Taunus substation to the existing Diepkloof substation. The proposed area of the development falls within the boundaries of the City of Johannesburg Metropolitan Municipality, in the Gauteng province. The project aims to strengthen the network capacity as well as to improve the quality of supply in the south of Soweto. This report is an amended report which was compiled as part of a new Basic Assessment application in terms of the 2014 EIA regulations, because the original environmental authorisation has expired. The project description and background information is still essentially the same.

The steel monopole structure that is used for 132kV lines is not regarded as a major electrocution threat. The only electrocutions that have been reliably recorded on this structure type are Cape Vultures (Van Rooyen 2007), which do not occur in the study area. No electrocution impact is therefore expected from the proposed 132kV power lines.

The proposed power lines could pose a limited collision threat to Red Data species. The biggest threat will be in the remaining grassland areas, where White-bellied Korhaans could still be present. There is also a possibility of collisions at dams and wetlands which could affect Maccoa Duck and Greater Flamingo and a variety of non-threatened waterbirds.

The potential for the destruction of bird habitat caused by the new power lines is limited due to the extensive impacts that are already evident in the area (urbanisation, industrialization, illegal dumping and uncontrolled burning). The most sensitive areas are the remaining grassland and wetland areas.

As is the case with habitat destruction, the potential for the disturbance of breeding birds caused by the construction of new power lines is limited due to the extensive impacts that are already evident in the area. The most sensitive area is again the remaining grassland areas (e.g. for the non-Red Data Northern Black Korhaan and the Red Data White-bellied Korhaan and Secretarybird) as well as (to a lesser degree) wetlands.

The following mitigation measures are suggested for consideration to address the potential impacts of the proposed power line:

- Electrocutions: No mitigation is required, as this impact is unlikely to occur.
- Collisions: See Appendix B (sensitivity map) for the areas to be marked with Double Loop Bird Flight Diverters. Bird Flight Diverters should be applied to the earth wire of the line, five metres apart, alternating black and white.
- Temporary displacement due to disturbance: The construction activities must be strictly limited to the construction footprint.
- Habitat destruction: This impact will inevitably occur, but it can be limited by strict adherence to Eskom's environmental guidelines for the construction of power lines, which is designed to minimise the impact on the environment.

Chris van Rooyen

Chris has 19 years' experience in the management of wildlife interactions with electricity infrastructure. He was head of the Eskom-Endangered Wildlife Trust (EWT) Strategic Partnership from 1996 to 2007, which has received international acclaim as a model of co-operative management between industry and natural resource conservation. He is an acknowledged global expert in this field and has worked in South Africa, Namibia, Botswana, Lesotho, New Zealand, Texas, New Mexico and Florida. Chris also has extensive project management experience and has received several management awards from Eskom for his work in the Eskom-EWT Strategic Partnership. He is the author of 15 academic papers (some with co-authors), co-author of two book chapters and several research reports. He has been involved as ornithological consultant in more than 100 power line and 25 wind generation projects. Chris is also co-author of the Best Practice for Avian Monitoring and Impact Mitigation at Wind Development Sites in Southern Africa, which is currently (2013) accepted as the industry standard. Chris also works outside the electricity industry and had done a wide range of bird impact assessment studies associated with various residential and industrial developments.

DECLARATION OF INDEPENDENCE

I, Chris van Rooyen as duly authorised representative of Chris van Rooyen Consulting, and working under the supervision of and in association with Albert Froneman (SACNASP Zoological Science Registration number 400177/09) as stipulated by the Natural Scientific Professions Act 27 of 2003, hereby confirm my independence (as well as that of Chris van Rooyen Consulting) as a specialist and declare that neither I nor Chris van Rooyen Consulting have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which Mbofho Consulting was appointed as environmental assessment practitioner in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for worked performed, specifically in connection with the Environmental Impact Assessment for the proposed Taunus-Diepkloof 132kV power line.

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Full Name: Chris van Rooyen
Title / Position: Director

1 Introduction

ESKOM is proposing to construct a 40km, 132kV overhead power line from the existing Taunus substation to the existing Diepkloof substation. The proposed area of the development falls within the boundaries of the City of Johannesburg Metropolitan Municipality, in the Gauteng province. The project aims to strengthen the network capacity as well as to improve the quality of supply in the south of Soweto.

Envirolution Consulting conducted the Environmental Impact Assessment study which was required in terms of the Environmental Management Act of 1998. Concern was expressed that the proposed infrastructure will impact on birdlife, and an initial desk top bird impact scoping study was therefore requested, to be followed by a site investigation and a specialist report. This was completed in November 2010, and authorisation of the project was granted in due course.

This report is an amended report which was compiled as part of a new Basic Assessment application in terms of the 2014 EIA regulations, because the original environmental authorisation has expired. The project description and background information is still the same, except that Eskom is still in negotiations with City Power regarding the servitude near the area where the powerline crosses Chris Hani/M68 (Potchefstroom Rd) towards the Diepkloof substation. This may imply a slight 20 m deviation of the line either side pending these negotiations. However, this is of no significance as far as potential impacts on birds are concerned.

Figure 1 below shows the study area with the proposed alignments.

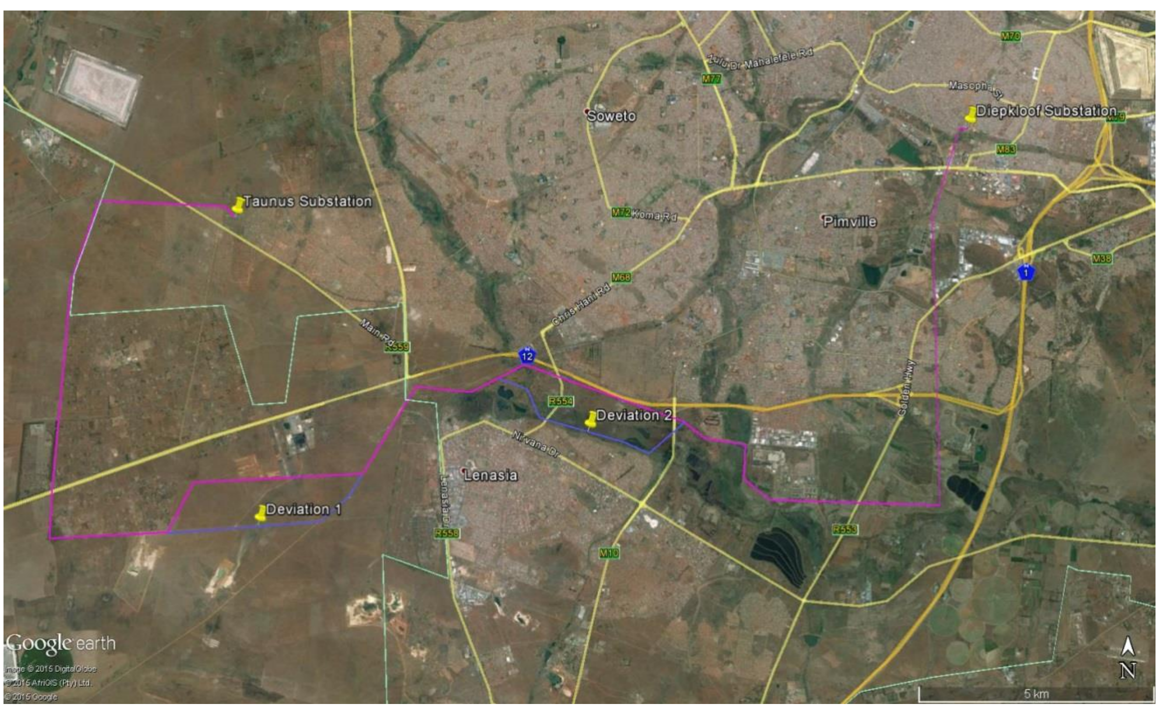

Figure 1: Proposed alignments for Taunus – Diepkloof 132kV. The purple line represents the proposed alignment and the blue sections the alternative alignments.

2 Terms of reference

The terms of reference for this report remain the same namely:

- Describe the affected environment.
- Indicate how birdlife will be affected.
- Discuss gaps in baseline data.
- List and describe the expected impacts.
- Assess the expected impacts.
- Evaluate the proposed alignments and indicate a preferred alignment from a bird impact perspective.
- Provide proposals for mitigation of identified impacts.

3 Sources of information

The following information sources were consulted in order to compile this amended report:

The study made use of the following data sources:

- Bird distribution data of the South African Bird Atlas 2 (SABAP 2) was obtained from the Animal Demography Unit of the University of Cape Town (ADU 2015), as a means to ascertain which species occurs within the four pentads where the study area is situated, namely 2615_2740, 2615_2745, 2615_2750, 2615_2755. A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km. Between 2007 and 2015, a total of 106 full protocol cards (i.e. 35 bird surveys lasting a minimum of two hours or more each) have been completed for this area (see Figure 2 below).

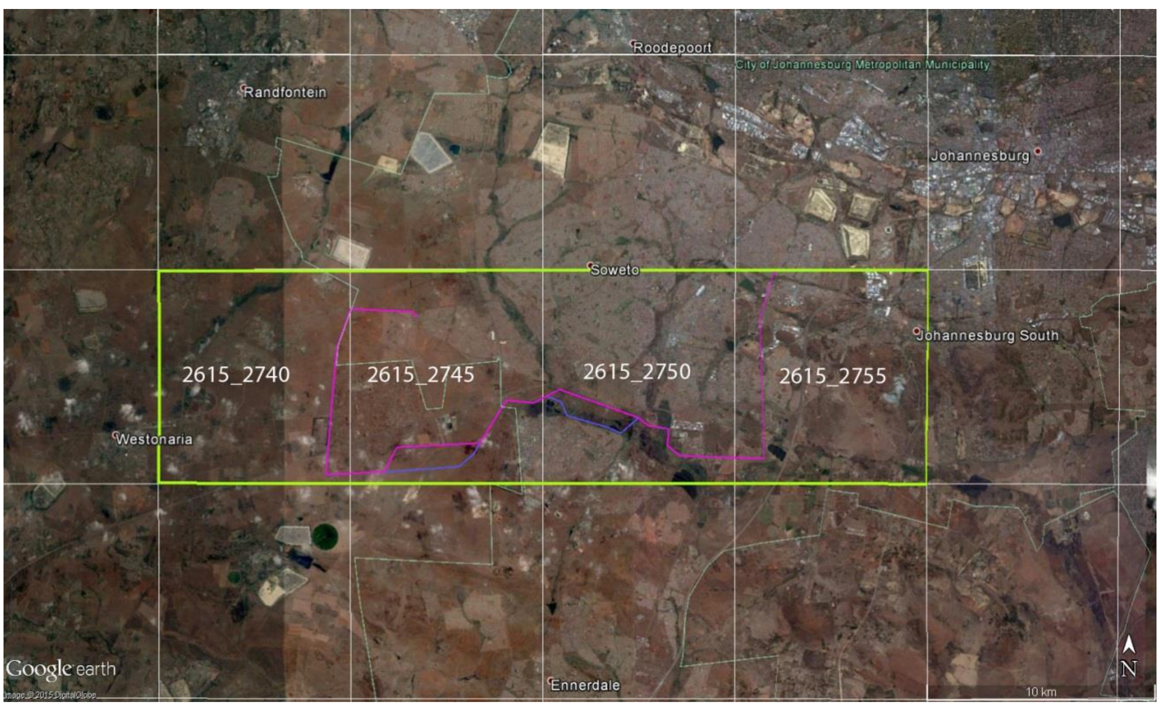

Figure 2: The block of 4 SABAP2 pentads within which the study area is located.

- The power line bird mortality incident database of the Endangered Wildlife Trust (1996 to 2007) was consulted to determine which of the species occurring in the study area are typically impacted upon by electricity infrastructure (Jenkins *et al.* 2010).
- Data on vegetation types and biomes in the study area was obtained from the Vegetation Map of South Africa, (Mucina & Rutherford 2006).
- The conservation status of all species considered likely to occur in the area was determined as per the most recent iteration of the South African Red Data list for birds (Taylor 2014), and the most recent and comprehensive summary of southern African bird biology (Hockey *et al.* 2005).
- Personal observations, especially experience from other projects which the author worked on in the Gauteng Province since 1996, have also been used to supplement the data that is available from SABAP2, and has been used extensively in forming a professional opinion of likely bird/habitat associations.
- Coordinated Avifaunal Roadcount (CAR) data from 2006 to 2014 was obtained for a route which falls partially within the study area and runs through grassland in the western part of the study area.
- A field visit to the study area was originally conducted in June 2010 to form a first-hand impression of the micro-habitat on site. Satellite imagery of the study area in July 2010 was carefully compared with satellite imagery of the study area in November 2015 and all changes potentially relevant to avifauna were noted. No significant changes in avifaunal habitat were detected, with the exception of some additional urbanisation. The latter did not have a significant impact on the rating of the various alternatives.

4 Assumptions & Limitations

This study made the assumption that the above sources of information are adequately reliable. However, the following factors may potentially detract from the accuracy of the predicted results:

- The SABAP2 data is regarded as a reliable record of the avifauna due to the reasonable number of full protocol data cards (n = 106) which have been completed to date for the area.
- The author has lived and birded in the Gauteng Province since 1970. Personal observations and past experience have therefore also been used to supplement the data that is available from SABAP2, and has been used extensively in identifying likely bird/habitat associations.
- Predictions in this study are based on experience of these and similar species in different parts of South Africa. Bird behaviour can never be entirely reduced to formulas that will hold true under all circumstances; therefore professional judgment played an important role in this assessment. It should also be noted that the impact of power lines on birds has been well researched with a robust body of published research stretching over thirty years.

5 Description of the receiving environment

The study area has been heavily impact by urban development with few natural grassland areas remaining. The remaining natural grassland in the study area is predominantly Carltonville Dolomite Grassland (sour grassland), which occurs on slightly undulating plains dissected by chert ridges. Species-rich grassland forms a complex mosaic pattern dominated by many grass species. Rainfall is in summer with an overall mean annual precipitation of 593mm, with temperatures ranging from very cold with frost in winter to very hot in summer (Mucina & Rutherford 2006).

It is widely accepted that vegetation structure is more critical in determining bird habitat, than the actual plant species composition (Harrison *et al.* 1997). The description of the vegetation types occurring in the study area makes use of classification system presented in the Atlas of southern African birds (Harrison *et al.,* 1997). The criteria used to amalgamate botanically defined vegetation units, or to keep them separate were (1) the existence of clear differences in vegetation structure, likely to be relevant to birds, and (2) the results of published community studies on bird/vegetation associations. It is important to note that no new vegetation unit boundaries were created, with use being made only of previously published data. 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 dominant plants in the grassland biome are grass species, with geophytes and herbs also well represented. Grasslands are maintained mainly by a combination of the following factors: relatively high summer rainfall; frequent fires; frost and grazing. These factors preclude the growth of trees and shrubs (Harrison *et al.,* 1997). This biome has been largely transformed in South Africa through various land uses such as afforestation, crop cultivation and, in Gauteng in particular, urbanisation and industrialisation. Sour grassland generally occurs in the higher rainfall areas, on leached soils. The structure is short and dense, and nutrients are withdrawn from the leaves during the winter months.

Whilst some of the bird species recorded in the study area can be explained in terms of the above broad vegetation description, there are many differences in bird species distribution and density that correspond to differences 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 largely only be identified through a combination of field investigation and experience. The habitat that is relevant to the birds may also be broader than merely the vegetation type and structure and may include elements such as man-made infrastructure. The following bird micro-habitats were identified via satellite imagery and the site visit which was conducted in June 2010:

- **Woodland:** The study area contains some a few clumps of "woodland" consisting mainly of alien species. From a Red Data bird perspective, this habitat type is not of particular importance. No Red Data species which generally favour woodland were recorded in the four pentads, except European Roller, which was recorded in very low numbers and occurs only irregularly.
- **Grassland:** There are a few areas of grassland in the west of the study area that have remained relatively intact, and most of it is found on old agricultural lands. From a bird impact perspective, these areas are the most important as it might still act as occasional refuges for a few Red Data power line sensitive species such as White-bellied Korhaan and Secretarybird.
- **Dams:** The study area contains dams, mostly associated with the Klip River (water quality unknown). Common species that could use dams and dam edges include Red-knobbed Coot *Fulica cristata*, Black-headed Heron *Ardea melanocephala*, African Darter *Anhinga rufa*, Blacksmith Lapwing *Vanellus*

armatus and Egyptian Goose *Alopochen aegyptiaca.* Red Data species recorded by SABAP2 in the relevant pentads that may use the dams are Greater Flamingo and Maccoa Duck, both of which were recorded in low numbers.

- **Wetlands:** The study area contains several wetlands associated with the Klip River. Several common species could be using tall reeds in these wetlands e.g. Southern Red Bishop *Euplectes orix*, White-winged Widowbird *Euplectes albonotatus*, Red-collared Widowbird *Euplectes ardens* and African Stonechat *Saxicola torquatus*. The Red Data wetland species recorded by SABAP2 in the relevant pentads, namely African Marsh-harrier, could still use these areas on occasion.

Appendix A provides a photographic record of the habitat in the study area.

6 Birds in the study area

TABLE 1 below shows the reporting rates for the Red Data species that have been recorded in the four pentads by the SABAB2 project in which the proposed development is situated.

TABLE 1. SABAP2 Red Data species reporting rates for the four pentads covering the study area.

Species	Conservation status	2615_2740 Reporting rate	2615_2745 Reporting rate	2615_2750 Reporting rate	2615_2755 Reporting rate	Habitat requirements (Barnes 2000; Hockey *et al.*, 2005; Harrison *et al.*, 1997; Young 2003; personal observations)
African Marsh-Harrier *Circus ranivorus*	Vulnerable	0	6.25	0	1.69	Large permanent wetlands with dense reed beds. Sometimes forages over smaller wetlands and grassland
White-bellied Korhaan *Eupodotis senegalensis*	Vulnerable	0	0	0	15.25	Relatively tall grassland, often in the interface between grassland and savanna. Avoids severely grazed and recently burnt sites.
Greater Flamingo *Phoenicopterus ruber*	Near threatened	0	0	0	5.08	Open shallow, saline wetlands.
European Roller *Coracias garrulus*	Near threatened	0	0	0	1.69	Woodland
Maccoa Duck *Oxyura maccoa*	Near threatened	0	0	0	3.39	Prefers permanent wetlands in open grassland
Verreaux's Eagle *Aquila verreauxii*	Vulnerable	0	0	0	1.69	Mountainous and rocky areas with cliffs. One resident pair breeds on private land adjacent to the Klipriviersberg Nature Reserve on an artificial nest platform (K.Lavery pers.comm 2015)
Secretarybird *Sagittarius serpentarius*	Vulnerable	0	0	0	0	Two individuals were recorded during CAR counts in natural grassland in the western part of the study area. Favours open grassland with scattered trees or shrubs.

The very low reporting rates for Red Data species is unquestionably the result of the extensive urbanisation in the study area. The remaining natural grasslands are extremely fragmented and it is not known how many of these patches are also earmarked for development. Apart from formal development, the encroachment of informal settlements is notable when the satellite imagery from 2010 is compared to that of 2015. It is therefore quite possible that the marked absence of Red Data grassland species in the SABAP2 checklists such as Blue Crane, Secretarybird, African Grass-Owl and Lesser Kestrel is linked to rapid urbanisation of the area, which has resulted in large scale transformation of grassland to residential and industrial areas and a huge influx of people and traffic.

Two Red Data species associated with man-made water bodies namely Greater Flamingo and Maccoa Duck were recorded in the SABAP2 checklists. Whether they are regularly visiting dams in the study area is unknown, but Maccoa Duck could be a regular resident on dams in the study area. .

The woodland in the area consists primarily of exotic species (Eucalyptus sp. and Australian Black Wattle) of which dense stands have developed. The dense stands of exotics are not regarded as critical habitat for any of the Red Data species previously recorded in the area, but it is important habitat for two non-threatened species of raptors namely Ovambo Sparrowhawk *Accipiter ovampensis* and Black Sparrowhawk *Accipiter melanoleucus*. The Red Data European Roller was recorded marginally in the relevant pentads and may occasionally roost in stands of exotic trees.

The wetlands and rivers in the area have not escaped the impact of urbanisation and industrialisation. The most important wetlands in the area are associated with the the Klip River, which runs through the densely populated city of Soweto. There are also smaller wetlands in the study area. It is difficult to envisage the Red Data African Marsh-harrier using the wetlands in the study area as regular foraging areas due to general degradation, but many common species are definitely still present. The wetlands in the study area are subjected to regular uncontrolled burning, which may partially account for the absence of African Grass-Owl *Tyto capensis*.

7 Potential impacts of the proposed power line and proposed mitigation measures

Because of their size and prominence, electrical infrastructures constitute an important interface between wildlife and man. Negative interactions between wildlife and electricity structures take many forms, but two common problems in southern Africa are electrocution of birds and other animals and birds colliding with power lines. (Ledger & Annegarn 1981; Ledger 1983; Ledger 1984; Hobbs & Ledger 1986a; Hobbs & Ledger 1986b; Ledger *et al*, 1992; Verdoorn 1996; Kruger & Van Rooyen 1998; Van Rooyen 1998; Kruger 1999; Van Rooyen 1999; Van Rooyen 2000, Anderson 2001). Other problems are electrical faults caused by bird excreta when roosting or breeding on electricity infrastructure (Van Rooyen *et al,* 2002), and disturbance and habitat destruction during construction and maintenance activities.

7.1 Electrocutions

Large birds of prey are the most commonly electrocuted on power lines, but the larger power lines from 220kV to the massive 765kV structures are usually not a threat to large raptors, because the pylons are designed in such a manner that the birds do not perch in close proximity the potentially lethal conductors. In fact, these power lines have proved to be beneficial to birds such as Martial Eagles, Tawny Eagles, White-backed Vultures *Gyps africanus*, and even occasionally Verreauxs' Eagles by providing safe nesting and roosting sites in areas where suitable natural alternatives are scarce (pers.obs). Cape Vultures have also taken to roosting on power lines in certain areas in large numbers, while Lappet-faced Vultures *Torgos tracheliotis* are increasingly using power lines as roosts, especially in the Northern Cape (pers.obs.).

The steel monopole structure that is used for 132kV lines is not regarded as a major electrocution threat. The only electrocutions that have been reliably recorded on this structure type are Cape Vultures (Van Rooyen 2007), which do not occur in the study area. No electrocution impact is therefore expected from the proposed 132kV power lines.

7.2 Collisions

Collisions are probably the biggest single threat posed by transmission lines to birds in southern Africa (van Rooyen 2004; Shaw 2013). Most heavily impacted upon are bustards, storks, cranes and various species of waterbirds. These species are mostly heavy-bodied birds with limited manoeuvrability, which makes it difficult for them to take the necessary evasive action to avoid colliding with power lines (van Rooyen 2004; Anderson 2001; Shaw 2013).

In a recent PhD study, Shaw (2013) provides a concise summary of the phenomenon of avian collisions with power lines:

"The collision risk posed by power lines is complex and problems are often localised. While any bird flying near a power line is at risk of collision, this risk varies greatly between different groups of birds, and depends on the interplay of a wide range of factors (APLIC 1994). Bevanger (1994) described these factors in four main groups – biological, topographical, meteorological and technical. Birds at highest risk are those that are both susceptible to collisions and frequently exposed to power lines, with waterbirds, gamebirds, rails, cranes and bustards usually the most numerous reported victims (Bevanger 1998, Rubolini *et al.* 2005, Jenkins *et al.* 2010).

The proliferation of man-made structures in the landscape is relatively recent, and birds are not evolved to avoid them. Body size and morphology are key predictive factors of collision risk, with large-bodied birds with high wing loadings (the ratio of body weight to wing area) most at risk (Bevanger 1998, Janss 2000). These birds must fly fast to remain airborne, and do not have sufficient manoeuvrability to avoid unexpected obstacles. Vision is another key biological factor, with many collision-prone birds principally using lateral vision to navigate in flight, when it is the lower-resolution, and often restricted, forward vision that is useful to detect obstacles (Martin & Shaw 2010, Martin 2011, Martin *et al.* 2012). Behaviour is important, with birds flying in flocks, at low levels and in crepuscular or nocturnal conditions at higher risk of collision (Bevanger 1994). Experience affects risk, with migratory and nomadic species that spend much of their time in unfamiliar locations also expected to collide more often (Anderson 1978, Anderson 2002). Juvenile birds have often been reported as being more collision-prone than adults (e.g. Brown *et al.* 1987, Henderson *et al.* 1996).

Topography and weather conditions affect how birds use the landscape. Power lines in sensitive bird areas (e.g. those that separate feeding and roosting areas, or cross flyways) can be very dangerous (APLIC 1994, Bevanger 1994). Lines crossing the prevailing wind conditions can pose a problem for large birds that use the wind to aid take-off and landing (Bevanger 1994). Inclement weather can disorient birds and reduce their flight altitude, and strong winds can result in birds colliding with power lines that they can see but do not have enough flight control to avoid (Brown et al. 1987, APLIC 1994).

The technical aspects of power line design and siting also play a big part in collision risk. Grouping similar power lines on a common servitude, or locating them along other features such as tree lines, are both approaches thought to reduce risk (Bevanger 1994). In general, low lines with short span lengths (i.e. the distance between two adjacent pylons) and flat conductor configurations are thought to be the least dangerous (Bevanger 1994, Jenkins *et al.* 2010). On many higher voltage lines, there is a thin earth (or ground) wire above the conductors, protecting the system from lightning strikes. Earth wires are widely accepted to cause the majority of collisions on power lines with this configuration because they are difficult to see, and birds flaring to avoid hitting the conductors often put themselves directly in the path of these wires (Brown et al. 1987, Faanes 1987, Alonso *et al.* 1994a, Bevanger 1994)."

As mentioned by Shaw (2013) in the extract above, several factors are thought to influence avian collisions, including the manoeuvrability of the bird, topography, weather conditions and power line configuration. An important additional factor that previously has received little attention is the visual capacity of birds; i.e. whether they are able to see obstacles such as power lines, and whether they are looking ahead to see obstacles with enough time to avoid a collision. In addition to helping explain the susceptibility of some species to collision, this factor is key to planning effective mitigation measures. Recent research provides the first evidence that birds can render themselves blind in the direction of travel during flight through voluntary head movements (Martin & Shaw 2010). Visual fields were determined in three bird species representative of families known to be subject to high levels of mortality associated with power lines i.e. Kori Bustards, Blue Cranes and White Storks *Ciconia ciconia*. In all species the frontal visual fields showed narrow and vertically long binocular fields typical of birds that take food items directly in the bill under visual guidance. However, these species differed markedly in the vertical extent of their binocular fields and in the extent of the blind areas which project above and below the binocular fields in the forward facing hemisphere. The importance of these blind areas is that when in flight, head movements in the vertical plane (pitching the head to look downwards) will render the bird blind in the direction of travel. Such movements may frequently occur when birds are scanning below them (for foraging or roost sites, or for conspecifics). In bustards and cranes pitch movements of only 25° and 35° respectively are sufficient to render the birds blind in the direction of travel; in storks head movements of 55° are necessary. That flying birds can render themselves blind in the direction of travel has not been previously recognised and has important implications for the effective mitigation of collisions with human artefacts including wind turbines and power lines. These findings have applicability to species outside of these families especially raptors (Accipitridae) which are known to have small binocular fields and large blind areas similar to those of bustards and cranes, and are also known to be vulnerable to power line collisions.

Thus visual field topographies which have evolved primarily to meet visual challenges associated with foraging may render certain bird species particularly vulnerable to collisions with human artefacts, such as power lines and wind turbines that extend into the otherwise open airspace above their preferred habitats. For these species placing devices upon power lines to render them more visible may have limited success since no matter what the device the birds may not see them. It may be that in certain situations it may be necessary to distract birds away from the obstacles, or encourage them to land nearby (for example by the use of decoy models of conspecifics, or the provision of sites attractive for roosting) since increased marking of the obstacle cannot be guaranteed to render it visible if the visual field configuration prevents it being detected. Perhaps most importantly, the results indicate that collision mitigation may need to vary substantially for different collision prone species, taking account of species specific behaviours, habitat and foraging preferences, since an effective all-purpose marking device is probably not realistic if some birds do not see the obstacle at all (Martin & Shaw 2010).

Despite speculation that line marking might be ineffective for some species due to differences in visual fields and behaviour, or have only a small reduction in mortality in certain situations for certain species, particularly bustards (Martin & Shaw 2010; Barrientos et al. 2012; Shaw 2013), it is generally accepted that marking a line with PVC spiral type Bird Flight Diverters (BFDs) can reduce the collision mortality rates (Sporer *et al.* 2013; Barrientos *et al.* 2012, Alonso & Alonso 1999; Koops & De Jong 1982). Regardless of statistical significance, a slight mortality reduction may be very biologically relevant in areas, species or populations of high conservation concern (e.g. Ludwig's Bustard) (Barrientos *et al.* 2012). Beaulaurier (1981) summarised the results of 17 studies that involved the marking of earth wires and found an average reduction in mortality of 45%. A recent study reviewed the results of 15 wire marking experiments in which transmission or distribution wires were marked to examine the effectiveness of flight diverters in reducing bird mortality. The presence of flight diverters was associated with a decrease in bird collisions. At unmarked lines, there were 0.21 deaths/1000 birds (n = 339,830) that flew among lines or over lines. At marked lines, the mortality rate was 78% lower (n = 1,060,746) (Barrientos et al. 2011). Koops and De Jong (1982) found that the spacing of the BFDs were critical in reducing the mortality rates - mortality rates are reduced up to 86% with a spacing of 5 metres, whereas using the same devices at 10 metre intervals only reduces the mortality by 57%. Line markers should be as large as possible, and highly contrasting with the background. Colour is probably less important, as during the day the background will be brighter than the obstacle with the reverse true at lower light levels (e.g. at twilight, or during overcast conditions). Black and white interspersed patterns are likely to maximise the probability of detection (Martin *et al.* 2010).

A potential impact of the proposed 132kV sub-transmission line is collisions with the earth wire of the proposed line. Quantifying this impact in terms of the likely number of birds that will be impacted, is very difficult because such a huge number of variables play a role in determining the risk, for example weather, rainfall, wind, age, flocking behaviour, power line height, light conditions, topography, population density and so forth. However, from incidental record keeping by the Endangered Wildlife Trust, it is possible to give a measure of what species are likely to be impacted upon (see Figure 5 below - Jenkins *et al.* 2010). This only gives a measure of the general susceptibility of the species to power line collisions, and not an absolute measurement for any specific line.

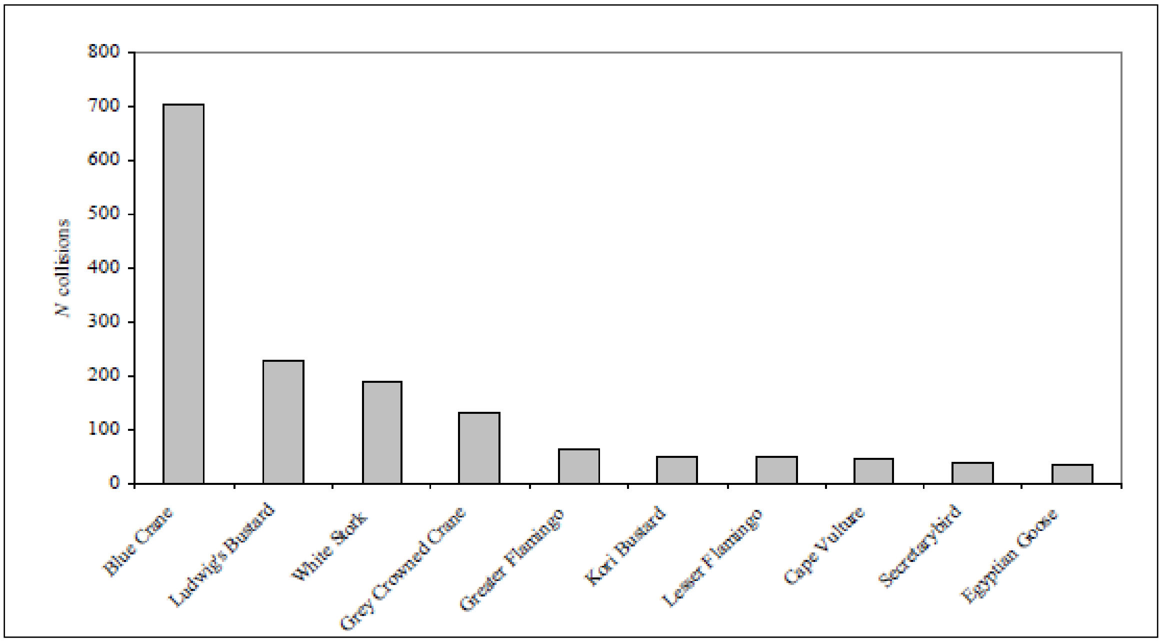

Figure 3: The top ten collision prone bird species in South Africa, in terms of reported incidents contained in the Eskom/EWT Strategic Partnership central incident register 1996 - 2008 (Jenkins *et al.* 2010)

The proposed power lines could pose a limited collision threat to Red Data species. The biggest threat will be in the remaining grassland areas, where White-bellied Korhaans and Secretarybirds could still be present. There is also a possibility of collisions at dams and wetlands which could affect Maccoa Duck and Greater Flamingo and a variety of non-threatened waterbirds.

7.3 Habitat destruction

During the construction phase and maintenance of power lines, 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 minimize the risk of fire under the line which can result in electrical flashovers. These activities could have an impact on birds breeding, foraging and roosting in or in close proximity of the servitude, through destruction of habitat.

The potential for the destruction of bird habitat caused by the new power lines is limited due to the extensive impacts that are already evident in the area (urbanisation, industrialization, illegal dumping and uncontrolled burning). The most sensitive areas are the remaining grassland and wetland areas.

7.4 Disturbance

The construction of a power line can be highly disturbing to birds breeding in the vicinity of the construction activities. Many birds are highly susceptible to disturbance, and should this disturbance take place during a critical time in the breeding cycle, for example when the eggs have not hatched or just prior to the chick fledging, it could lead to temporary or permanent abandonment of the nest or premature fledging. In both instances, the consequences are almost invariably fatal for the eggs or the fledgling. Such a sequence of events can have far reaching implications for certain large, rare species that only breed once a year or once every two years.

As is the case with habitat destruction, the potential for the disturbance of breeding birds caused by the construction of new power lines is limited due to the extensive impacts that are already evident in the area. The most sensitive area is again the remaining grassland areas (e.g. for the non-Red Data Northern Black Korhaan and the Red Data White-bellied Korhaan) as well as (to a lesser degree) wetlands.

8 Evaluation of impacts

Below follows an assessment of impacts that have been identified.

The assessment of impact significance is based on the following convention:

- **Nature of impact** – this reviews the type of effect that a proposed activity will have on the environment and includes "what will be affected and how?"
- **Extent** – this indicates whether the impact will be local and limited to the immediate area of development (the site); limited to within 5km of the development; or whether the impact may be realized regionally, nationally or even internationally.
- **Duration** – this reviews the lifetime of the impact, as being short term (0 – 5 years), medium (5 – 15 years), long term (>15 years but where the impacts will cease after the operation of the site), or permanent.
- **Intensity** – here it is established whether the impact is destructive or innocuous and it is described as either low (where no environmental functions and processes are affected), medium (where the environment continues to function but in a modified manner) or high (where environmental functions and processes are altered such that they temporarily or permanently cease).
- **Probability** – this considers the likelihood of the impact occurring and is described as improbable (low likelihood), probable (distinct possibility), highly probable (most likely) or definite (impact will occur regardless of prevention measures).

The status of the impacts and degree of confidence with respect to the assessment of the significance is stated as follows:

- **Status of the impact**: A description as to whether the impact will be positive (a benefit), negative (a cost), or neutral.
- **Degree of confidence in predictions**: The degree of confidence in the predictions, based on the availability of information and specialist knowledge. This is assessed as high, medium or low.

Based on the above considerations, an overall evaluation of the significance of the potential impact is provided, which is described as follows:

- **Low***:* Where the impact will not have an influence on the decision or require to be significantly accommodated in the project design
- **Medium:** Where it could have an influence on the environment which will require modification of the project design or alternative mitigation;
- **High:** Where it could have a 'no-go' implication for the project unless mitigation or re-design is practically achievable.

Table 2 below summarizes the envisaged impacts.

TABLE 2: Summary of expected impacts

Impact description	Status	Extent	Duration	Intensity	Probability	Significance (without mitigation)	Confidence level
Bird electrocutions particularly of Red Data species	Negative	Local (within 5km of the development)	Long term >15 years	Low	Improbable	Low	High
Bird collisions, particularly Red Data species, with the proposed power line	Negative	Local (within 5km of the development)	Long term >15 years	Medium	Probable	Medium	High
Temporary displacement of Red Data species due to disturbance	Negative	Local (within 5km of the development)	Short (0-5 years)	Low	Probable	Low	High
Habitat change and loss impacting on Red Data species due to the footprint of the infrastructure	Negative	Local (within 5km of the development)	Short (0-5 years)	Low	Highly probable	Low	High

9 Mitigation measures

The following mitigation measures are suggested for consideration to address the potential impacts of the proposed power line:

- Electrocutions: No mitigation is required, as this impact is unlikely to occur.
- Collisions: See Appendix B (Sensitivity Map) for the areas to be marked with Double Loop Bird Flight Diverters. Bird Flight Diverters should be applied to the earth wire of the line, five metres apart, alternating black and white.
- Temporary displacement due to disturbance: The construction activities must be strictly limited to the construction footprint.
- Habitat destruction: This impact will inevitably occur, but it can be limited by strict adherence to Eskom's environmental guidelines for the construction of power lines, which is designed to minimise the impact on the environment.

10 Identifying a preferred alignment

One of the objectives of this study is to arrive at a preferred corridor for the proposed power line in terms of impacts on avifauna. The following factors were incorporated in the formula to arrive at a preferred corridor, using high resolution Google Earth imagery and observations on the ground as the main sources of data:

- Wetlands and dams: Wetlands and dams are always of particular importance for birds. The presence of wetlands and dams are an indicator of a higher collision risk, and in the case of wetlands, also a higher habitat destruction risk.
- Transmission lines: It is a proven fact that placing a new line next to an existing line reduces the risk of collisions to birds. The reasons for that are two-fold namely it creates a more visible obstacle to birds and the resident birds, particularly breeding adults, are used to an obstacle in that geographic location and have learnt to avoid it (APLIC 1994; Sundar & Choudhury 2005). Other transmission lines running parallel to the proposed alignments were therefore treated as a risk reducing factor.
- Roads: These were taken as an indication of human activity and particularly vehicle and pedestrian traffic. It is assumed that the birds will avoid the immediate vicinity of roads due to the presence of traffic and pedestrians, and therefore it will reduce the risk of collision with lines running next to roads.
- Towns: Towns are obvious centres of human activity and are generally avoided by large power line sensitive species. The presence of towns, settlements and industrial activity is therefore a risk reducing factor, both from a collision and a habitat destruction perspective.
- Grassland/old lands: This habitat may attract species such as Secretarybird and Lanner Falcon, as old lands are essentially artificial grassland patches. Old lands represent a higher collision risk.

The factors mentioned above were incorporated into a formula to arrive at a risk rating for each corridor. The formula was designed as follows:

- Wetlands and dams: The length of alignment running within 250m of a dam or wetland was measured.
- The distance that the proposed alignments are running directly next to existing transmission lines was measured.
- The distance that the proposed alignments are running parallel to existing roads within a 250m zone was measured.
- The length of line running through or within 1km of settlements/urban/industrial activity was measured.
- The length of alignment skirting or running across grassland/old lands was measured.

TABLE 3: The results of the measurements for each option in km.

Factor	Deviation 1	Deviation 2
Dams and wetlands	11.66	16.43
TX lines	19.59	22.02
Roads	2.47	2.47
Suburban	13.58	14.58
Grassland/old lands	9.43	11.76

Obviously all these factors do not have an equal impact on the size of the risk, therefore a weighting was assigned to each factor, based on this author's judgment on how important the factor is within the total equation.

The following weights were assigned. Risk reducing factors were assigned a negative weight:

TABLE 4: Weights assigned to risk factors

Factor	Weighting
Dams/wetlands	4
TX lines	-1
Roads	-2
Suburban/industrial	-5
Grassland/old lands	2

The final risk score for a **factor** was calculated as follows: measurements/counts x weighting. The final risk rating for an **alignment** was calculated as the sum of the risk scores of the individual factors:

TABLE 5: The final scores for the respective options

Factor	Deviation 1	Deviation 2
Dams/wetlands	46.64	65.72
TX lines	-19.59	-22.02
Roads	-4.94	-4.94
Suburban/industrial	-67.9	-72.9
Grassland/old lands	18.86	23.52
Total	**-26.93**	**-10.62**

From the analysis above it is clear that **deviation 1 is the preferred alternative from a bird impact perspective**.

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APPENDIX A: HABITAT

Figure 1: Taunus Substation

Figure 2: Old lands

Figure 3: Artificial woodland

Figure 4: Mining

Figure 5: Existing power lines

Figure 6: Urban areas

Figure 7: Urban areas

Figure 8: Natural grassland


Figure 8: Wetland


Figure 9: Wetland

APPENDIX B: SENSITIVITY MAP