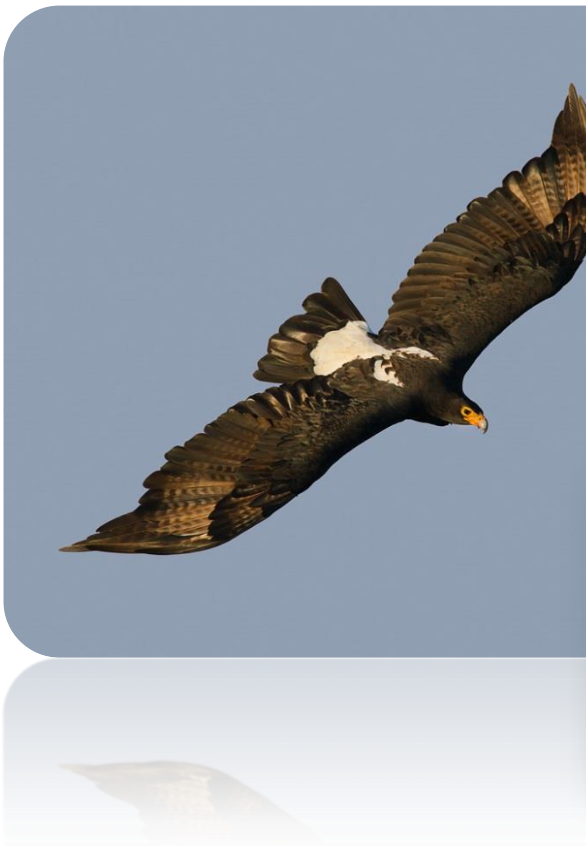
BIRD IMPACT ASSESSMENT STUDY

Longyuan Mulilo De Aar 2 North Wind Energy Facility

Basic Assessment for 132kV Grid Connection



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EXECUTIVE SUMMARY

Longyuan Mulilo De Aar 2 North (Pty) Ltd proposes to construct a 132kV overhead power line in order to connect the 140 MW Longyuan Mulilo De Aar 2 North Wind Energy Facility (DEA REF. NO. 12/12/20/2463/2) to be developed to the east of De Aar, Northern Cape, to the national transmission grid via Hydra Substation. This report forms part of a Basic Assessment process for the proposed final power line routes and associated switching station.

KEY FINDINGS

The construction of the proposed new 132kV power line will pose a limited threat to the birds occurring in the vicinity of the new infrastructure. The power line poses a **medium** collision risk, but a **negligible** electrocution risk, irrespective of which alternative is used. With the implementation of appropriate mitigation measures, the collision risk could be reduced to **low**. The habitat transformation and disturbance associated with the construction of the power line should have a **low** impact, provided appropriate mitigation is implemented. The impact of habitat transformation associated with the switching station site should be **low** and should only affect a few non-Red Data species at a local level.

SELECTING A PREFERRED ALTERNATIVE

Considering all the relevant factors, none of the two options emerges as a clear preferred alternative from a bird impact perspective. The reason for that is that the two options are both clustered in the same area, and of comparable length, meaning that the envisaged impacts are likely to be very similar. Any of the two options are therefore regarded as potentially suitable, provided appropriate mitigation is implemented.

RECOMMENDATIONS

Collisions

- All the spans, except those located adjacent to two or more high-voltage lines should be marked with Bird Flight Diverters on the earth wire of the line, ten metres apart, alternating black and white. Appendix B indicates the preferred Bird Flight Diverters to be used.

Displacement

- It is important that the construction activities, vehicle and pedestrian movement are restricted a much as possible to the actual servitude of the proposed power line. Maximum use should be made of existing roads. Vehicle traffic in and out of the area should be restricted to what is absolutely necessary for the construction process. This is especially important where the line crosses the escarpment, as this area is the most sensitive area as far as potential disturbance of breeding Verreaux's Eagles are concerned (see Figure 6).
- Immediately prior to construction commencing, an inspection should be conducted by the avifaunal specialist to record any large raptor nests on the existing transmission lines running parallel to the proposed 132kV line, that could be impacted by the construction of the proposed line.
- Should any nests be recorded, it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the avifaunal specialist, and the Environmental Control Officer. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule which will enable him/her to ascertain when and where breeding Red

Data raptors could be impacted by the construction activities. This could then be addressed through the timing of construction activities during critical periods of the breeding cycle, once it has been established that a particular nest is active.

Chris van Rooyen
Chris has seventeen 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.

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

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 Aurecon 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 Basic Assessment for the proposed Longyuan Mulilo De Aar 2 North 132kV Grid Connection.

Full Name: Chris van Rooyen
Title / Position: Director
Experience: 17 years

1. INTRODUCTION & BACKGROUND

Longyuan Mulilo De Aar 2 North (Pty) Ltd proposes to construct a 132kV overhead power line in order to connect the 140 MW Longyuan Mulilo De Aar 2 North Wind Energy Facility (DEA REF. NO. 12/12/20/2463/2) to be developed to the east of De Aar, Northern Cape, to the national transmission grid via Hydra Substation. This report forms part of a Basic Assessment process for the proposed final power line routes and associated switching station.

See Figures 1, and 2 below for maps of the study area:

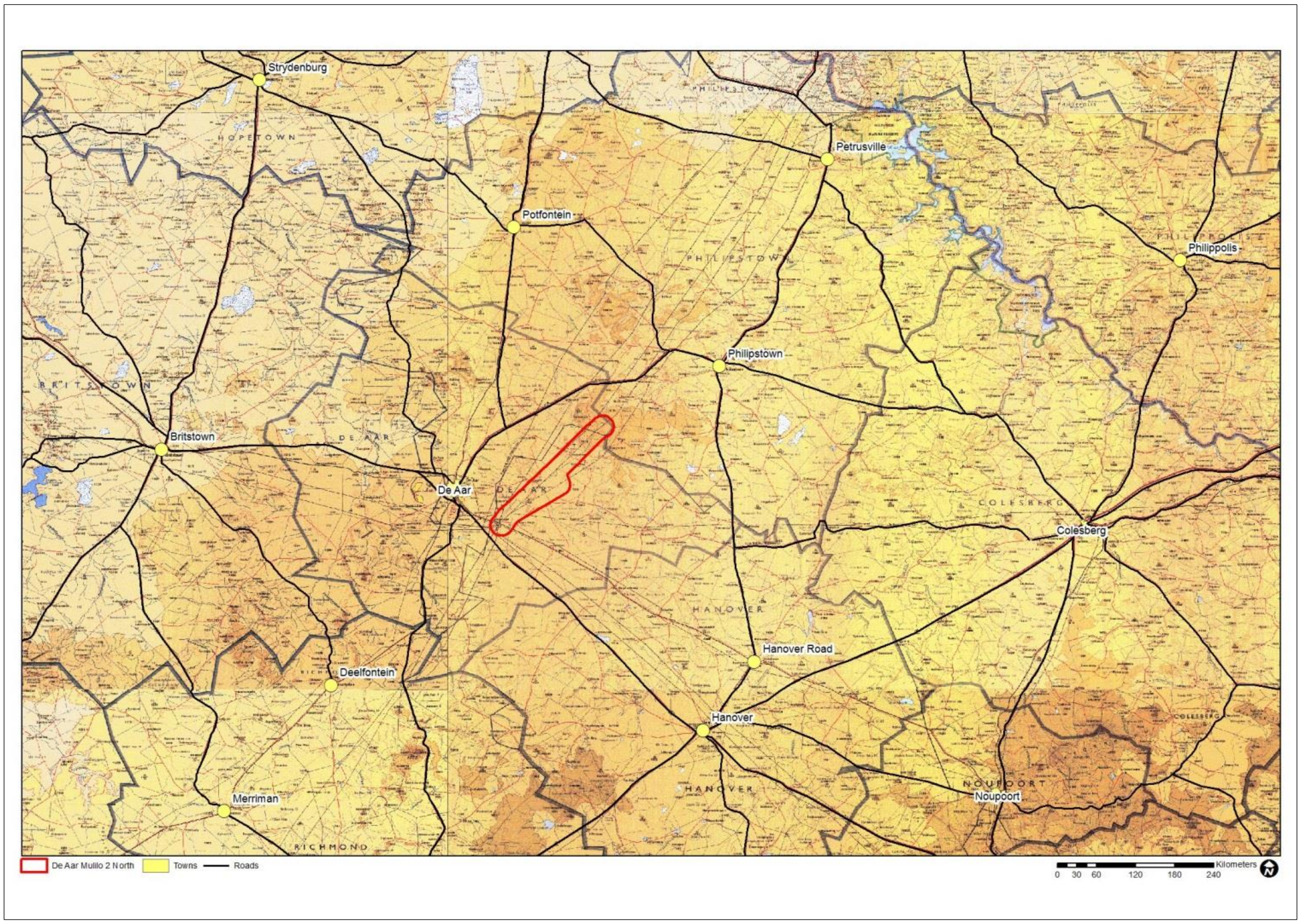

Figure 1: Map showing locality of the study area.

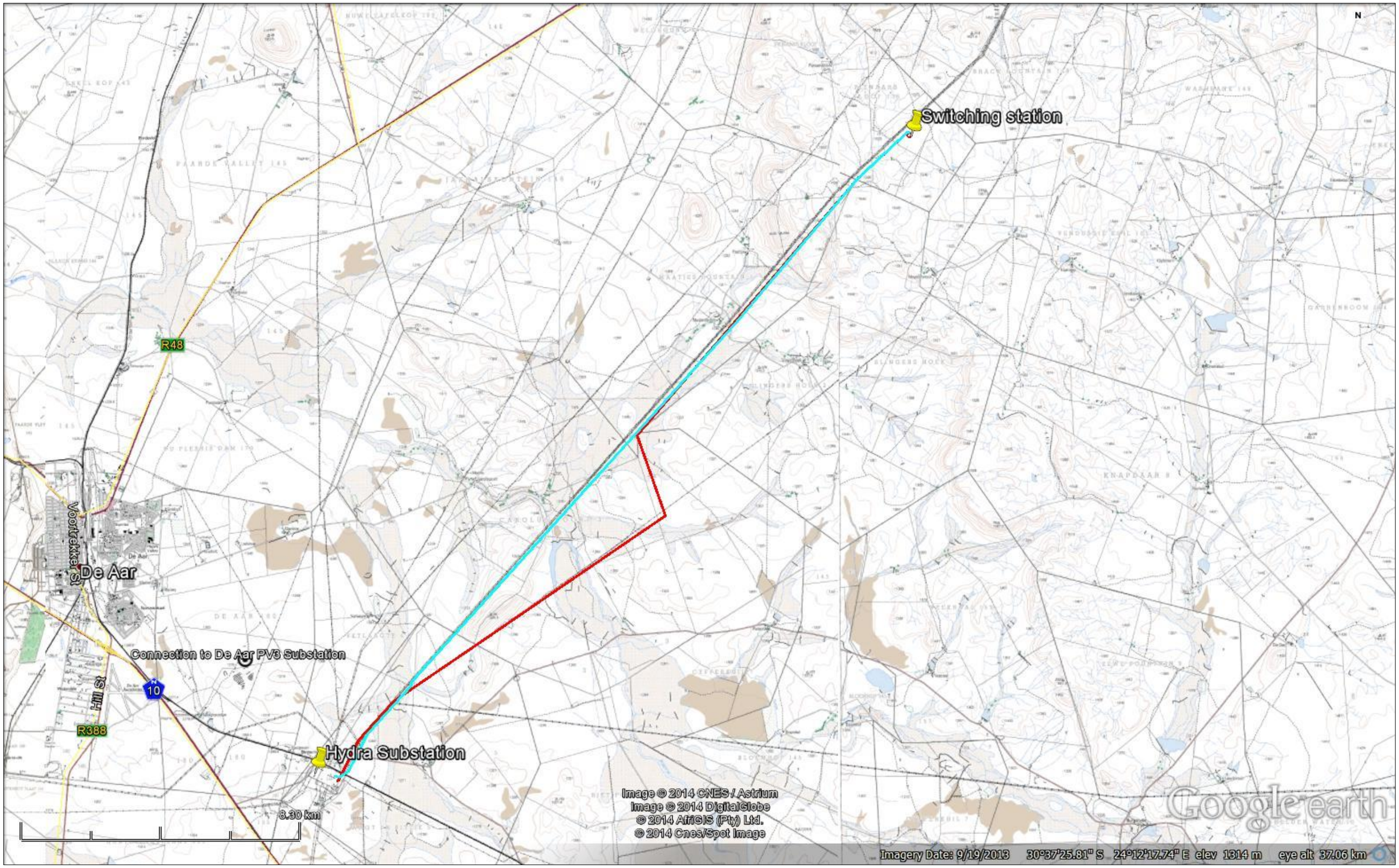

Figure 2: A close view of the proposed 132kV line (preferred alignment = red, alternative alignment = blue).

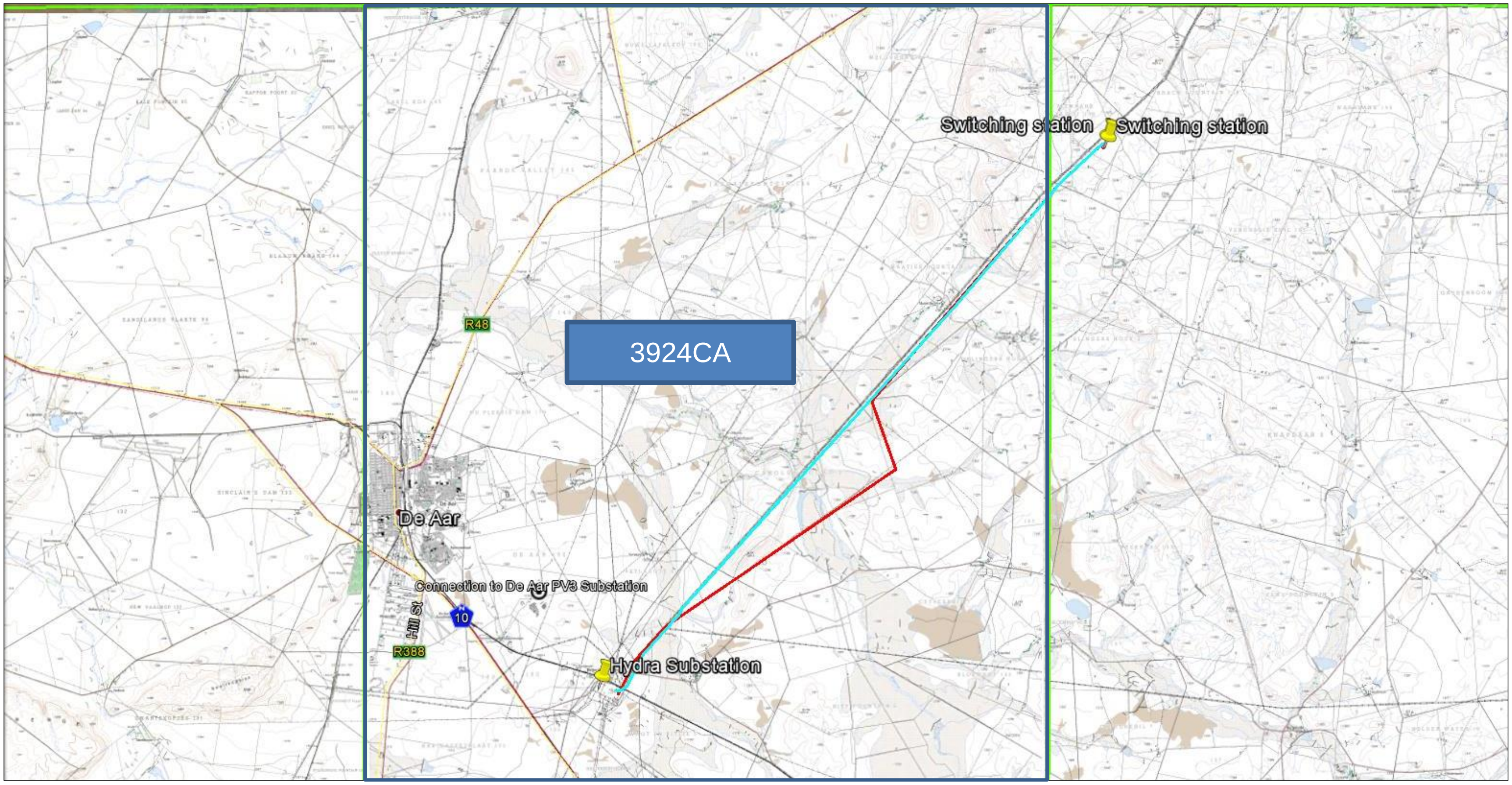

Figure 3: The location of the study area within the 3924CA quarter degree grid cell.

The terms of reference for the avifaunal impact assessment study are as follows:

- Describe the affected environment.
- Indicate how birdlife will be affected.
- Discuss gaps in baseline data.
- List and describe the expected impacts.
- Assess and evaluate the potential of impacts.
- Recommend relevant mitigation measures.

2. SOURCES OF INFORMATION

The following information sources were consulted in order to conduct this study:

- Bird distribution data of the Southern African Bird Atlas Project 2 (SABAP2) (http://sabap2.adu.org.za) was obtained for the quarter-degree grid cell (GDGC = the equivalent of a 1:50 000 map) where the study area (defined as a 2km radius around all the potential alignments and substation sites) is primarily located, namely 3024CA.
- The conservation status of all species considered likely to occur in the study area was determined as per the most recent iteration of the southern African Red Data list for birds (Taylor 2014), and the most recent and comprehensive summary of southern African bird biology (Hockey *et al.* 2005).
- The author has travelled and worked extensively on power line and wind energy projects in the Northern Cape Province since 1996. Personal observations of avifauna and bird/habitat associations have therefore also been used to supplement the data that is available from SABAP2, including sightings made during the field trip in March 2014.
- The power line bird mortality incident database of the Eskom - Endangered Wildlife Trust Strategic Partnership (1996 to 2008) was consulted to determine which of the species occurring in the study area are typically impacted upon by power lines and the extent to which they are impacted on (Jenkins *et al.* 2010).
- A classification of the vegetation types in the QDGCs was obtained from the Southern African Bird Atlas Project 1 (SABAP1, Harrison *et al.* 1997, and the Vegetation map of South Africa (Mucina & Rutherford 2006).
- Information on the micro habitat level was obtained through inspecting the study area in March 2014 and obtaining a first-hand perspective of the birdlife and habitat.
- Information on Important Bird Areas was obtained from the Birdlife SA website http://www.birdlife.org.za/conservation/important-bird-areas.

2.1 Assumptions & Limitations

The following assumptions and limitations are applicable in this study:

- In this instance the 3024CA QDGC was not particularly well covered by SABAP2, with data recorded on a total of 23 checklists to date. Different levels of survey effort for QDGCs in the SABAP2 coverage means that the reporting rates of species may not be an accurate reflection of relative densities in QDGCs that were sparsely covered to date. The reporting rates were therefore not treated as an absolute measure of the actual densities, but merely as a guideline for the potential presence of a specific species. Strong reliance was placed on professional judgment.
- Conclusions in this study are based on experience of these and similar species in different parts of South Africa. Bird behaviour can never be entirely reduced to formulas that will hold true under all circumstances. However, power line and substation impacts can be predicted with a fair amount of certainty (see References Section 9).

- It is important to note that, although the envisaged impacts are mostly concerned with Red Data species, the non-Red Data species will benefit as much from the proposed mitigation measures as they share the same habitat and face the same potential impacts as the Red Data species.

3. DESCRIPTION OF AFFECTED ENVIRONMENT

3.1 Important Bird Areas

The study area is situated within the Platberg – Karoo Conservancy which is classified as an Important Bird Area (IBA) (SA037). The conservancy covers the entire districts of De Aar, Philipstown and Hanover in the southeastern portion of the Northern Cape Province. Although the land in the IBA is primarily used for grazing and agriculture, it includes the towns of De Aar, Philipstown, Petrusville and Hanover. This huge area lies in the plains of the central Great Karoo, forming part of the South African plateau. The conservancy consists primarily of open plain-country, locally interrupted by dolerite hills and small mountain ranges which rise 200–300 m above the surrounding plateau, which varies from 1 100–1 400 m above sea level.

The IBA holds vitally important populations of two globally threatened species, several biome-restricted assemblage species and important populations of other arid-zone birds. The lowland karroid plains are particularly good for Secretarybird, Ludwig's Bustard, Kori Bustard, large numbers of Karoo Korhaan, Rufous-eared Warbler *Malcorus pectoralis*, Karoo Lark *Certhilauda albescens*, Karoo Chat *Cercomela schlegelii*, Tractrac Chat *Cercomela tractrac*, Sickle-winged Chat *Cercomela sinuata*, Lark-like Bunting *Emberiza impetuani* and the Karoo Long-billed Lark *Certhilauda (curvirostris) subcoronata*.

In the grassier areas Blue Korhaan *Eupodotis caerulescens* are common. Black Harrier *Circus maurus* are occasionally seen quartering the plains where huge numbers of Blue Cranes regularly congregate. Tawny Eagle and Martial Eagle breed on the powerlines in the area. The belts of riverine *Acacia karroo* woodland and the thicket and scrub on the slopes provide food, shelter and breeding habitat for many species including Namaqua Warbler *Phragmacia substriata*, Layard's Titbabbler *Sylvia layardi* and Grey Tit *Parus afer*. The belts of riverine *Acacia* woodland are of particular interest in the Karoo because they act as corridors along which many species are able to move in otherwise unsuitable terrain.

The Pale-winged Starling *Onychognathus nabouroup* and African Rock Pipit occur in rocky gorges and kloofs. Other arid-zone species occurring within the conservancy are Pale Chanting Goshawk *Melierax canorus*, Pririt Batis *Batis priri*t, Fairy Flycatcher *Stenostira scita* and White-throated Canary *Serinus albogularis*. The cliffs hold Black Stork, which breed during wetter periods, Booted Eagle *Hieraaetus pennatus* and Verreaux's Eagle.

Lesser Kestrels *Falco naumanni* have roosts throughout the area, including large roosts in the towns of De Aar, Hanover and Philipstown; they are frequently seen foraging in the conservancy in summer. The Nuwejaarsfontein Dam has been known to occasionally hold Greater Flamingos and important numbers of South African Shelduck *Tadorna cana*. Some of the dams are important roosts and during summer 1996/97 more than 850 Blue Cranes were counted on a dam in the area.

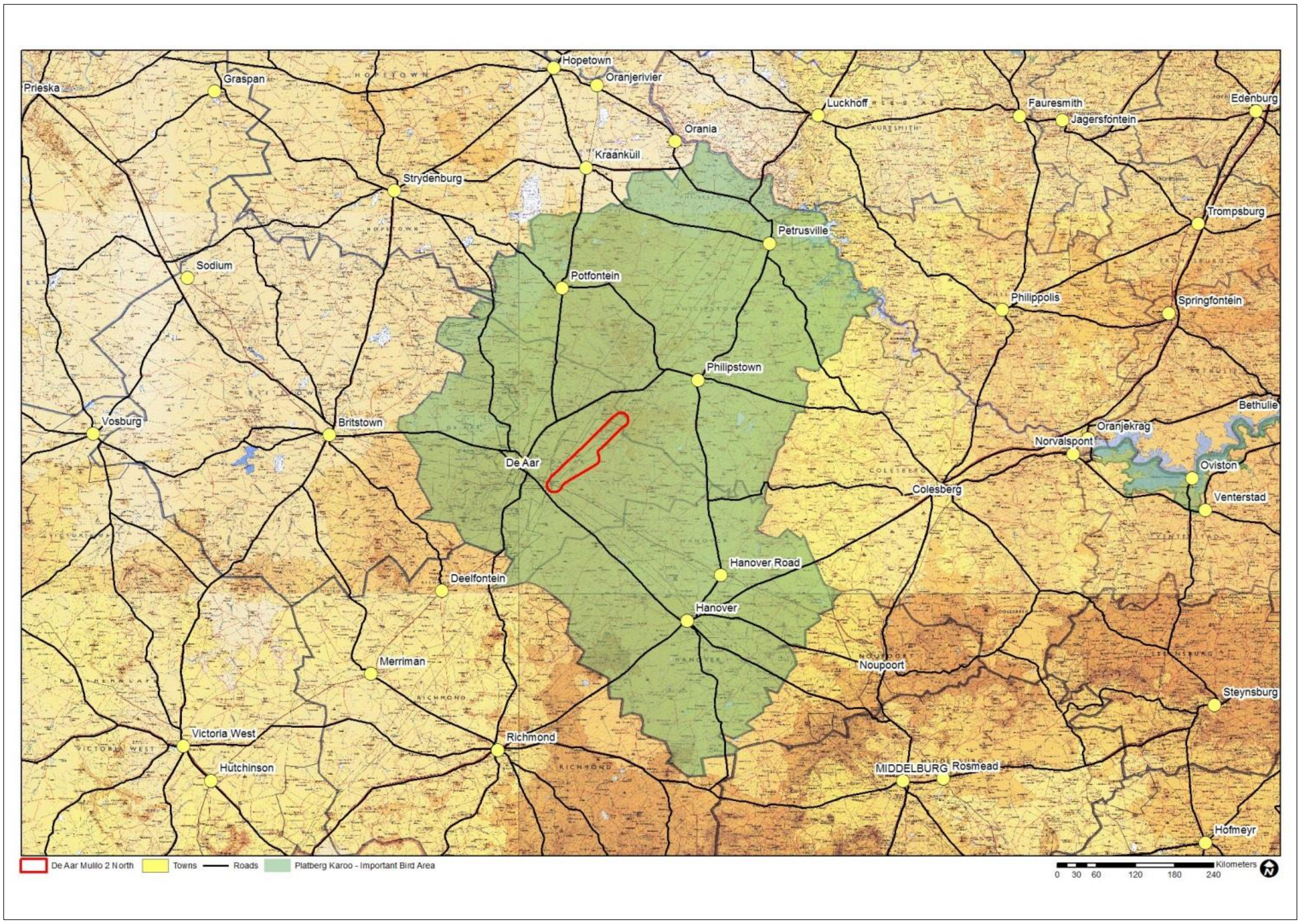

Figure 5: The location of the study area within the Platberg – Karoo Conservancy IBA.

3.2 Bird populations

A total of 160 species were recorded in 3024CA by SABAP2, with 11 classified as Red Data species. Reporting rates are an indication of the relative density of a species on the ground in that it reflects the number of times that a species was recorded relative to the total amount of cards that were completed for the square. As mentioned earlier, the QDGC was not particularly well covered by SABAP2, which means reporting rates should merely by taken as a guideline of the actual chances of encountering a species.

Table 1 provides a guideline of the Red Data species that could **potentially** be encountered in the study area, and the habitat type where they are most likely to be found. The potential of the proposed infrastructure impacting negatively on the species (displacement and collisions) are also covered.

TABLE 1: Species of conservation concern potentially occurring in the study area

NT = Near threatened
VU = Vulnerable

Name	Scientific name	Conservation status (Taylor 2014)	Karoo	Ridges and mountains	Waterbodies	Agricultural lands	Collisions	Displacement through disturbance	Displacement through habitat destruction
Blue Crane	*Anthropoides paradiseus*	NT	x	-	x	x	x	-	-
Kori Bustard	*Ardeatis kori*	NT	x	-	-	x	x	-	-
Lanner Falcon	*Falco biarmicus*	VU	x	x	x	x	x	-	-
Ludwig's Bustard	*Neotos ludwigii*	EN	x	-	-	x	x	-	-
Martial Eagle	*Polemaetus bellicosus*	EN	x	-	x	-	x	x	-
African Rock Pipit	*Anthus crenatus*	NT	-	x	-	-	-	-	-
Verreaux's Eagle	*Aquila verreauxii*	VU	-	x	-	-	x	x	-
Karoo Korhaan	*Eupodotis vigorsii*	NT	x	-	-	-	x	-	-
Black Stork	*Ciconia nigra*	VU	-	x	x	-	x	-	-
Secretarybird	*Sagittarius serpentarius*	VU	x	-	-	-	x	-	-
Greater Flamingo	*Phoenicopterus ruber*	NT	-	-	x	-	x	-	-
Tawny Eagle	*Aquila rapax*	VU	x	-	x	-	x	x	-

3.3 Biomes and bird habitats

From a botanical perspective, the natural vegetation type in the study area is predominantly Northern Upper Karoo, with a few areas of Besemkaree Koppies Shrubland which occurs on steep slopes of koppies and mountains, especially on the slopes and plateau in the east of the study area. Both vegetation types consist of a mixture of low shrubs and grasses (Mucina & Rutherford 2006). However, it is generally accepted that vegetation structure, rather than the actual plant species, most influences bird species distribution and abundance (Harrison *et al.* 1997). Therefore, the habitat descriptions used in this report does not focus on lists of plant species, but rather on factors which are relevant to bird distribution. The description of the vegetation types are largely based on the classification system used in the Atlas of Southern African Birds (SABAP1) (Harrison *et al.* 1997). From an avifaunal perspective, SABAP1 recognises six primary vegetation divisions (biomes) within South Africa, namely (1) Fynbos (2) Succulent Karoo (3) Nama Karoo (4) Grassland (5) Savanna and (6) Forest (Harrison *et al.* 1997). The criteria used by the atlas authors to amalgamate botanically defined vegetation units, or to keep them separate were (1) the existence of clear differences in vegetation structure, likely to be relevant to birds, and (2) the results of published community studies on bird/vegetation associations. According to the SABAP1 classification system, the study area is located in Nama Karoo biome, which contains two major vegetation types, namely Nama Karoo and Grassy Karoo.

The study area contains the following distinctive bird habitats:

3.3.1 Nama/Grassy Karoo

This comprises the vast majority of habitat in the study area. Nama Karoo is dominated by low shrubs and grasses; peak rainfall occurs in summer. Trees, e.g. *Acacia karroo* and alien species such as Mesquite *Proposis glandulosa* are mainly restricted to watercourses, where fairly dense stands can develop. Grassy Karoo can be viewed as an ecological transition zone between the Nama Karoo and Grassland biomes; although also primarily a dwarf-shrub habitat, it shows higher proportions of grass and in places, tree cover. The Karoo vegetation types support a remarkably high diversity of bird species endemic to Southern Africa, particularly in the family *Alaudidae* (Larks). Its avifauna typically comprises ground-dwelling species of open habitats. Many typical Karoo species are nomads, able to use resources that are patchy in time and space (Harrison *et al.* 1997). Power line sensitive Red Data species that are associated with Nama and Grassy Karoo habitat in the study area are Ludwig's Bustard, Kori Bustard, Martial Eagle, Tawny Eagle, Secretarybird, Blue Crane, Karoo Korhaan and Lanner Falcon. The major potential impact in this habitat is collisions with the earthwire of the proposed power line, particularly for Ludwig's Bustard, Blue Crane, Kori Bustard and Secretarybird.

3.3.2 Waterbodies and drainage lines

The study area contains a number of man-made water bodies and an ephemeral river, the Brakrivier, which are of specific importance to some Red Data power line sensitive species in the semi-arid study area. Ephemeral drainage lines are also corridors for woodland, which Kori Bustard often associate with, and occasionally, after good rains when pools form in the channels, it act as a draw card for waterbirds, including Black Stork. During such times, small birds are attracted to the water, which in turn may attract Lanner Falcons and other raptors. Man-made dams attract a multitude of water birds, including Greater Flamingo, and could sometimes be used as roosts by Blue Cranes. Dams with shallow sloping sides are also important for large raptors for bathing and drinking. Secretarybirds may be attracted to small *Acacia karroo* trees in the water courses for breeding purposes. The major potential impact for the aforementioned powerline sensitive Red Data species is collisions with the earthwire of the proposed lines.

3.3.3 Ridges and mountains

The eastern part of the study area contains the Pienaarskloof plateau with boulder strewn slopes and vertical cliffs. This habitat is potentially important roosting, foraging and breeding habitat for a variety of Red Data power line sensitive species, e.g. Black Stork, Lanner Falcon, Verreaux's Eagle and African Rock Pipit. It is not envisaged that the line will pose any threat to the African Rock Pipit, but a potential impact on the larger species is collisions with the proposed power line, and displacement of breeding birds due to disturbance. There are five confirmed Verreaux's Eagle nests along the escarpment, belonging to an estimated two breeding pairs (see Figure 6 below).

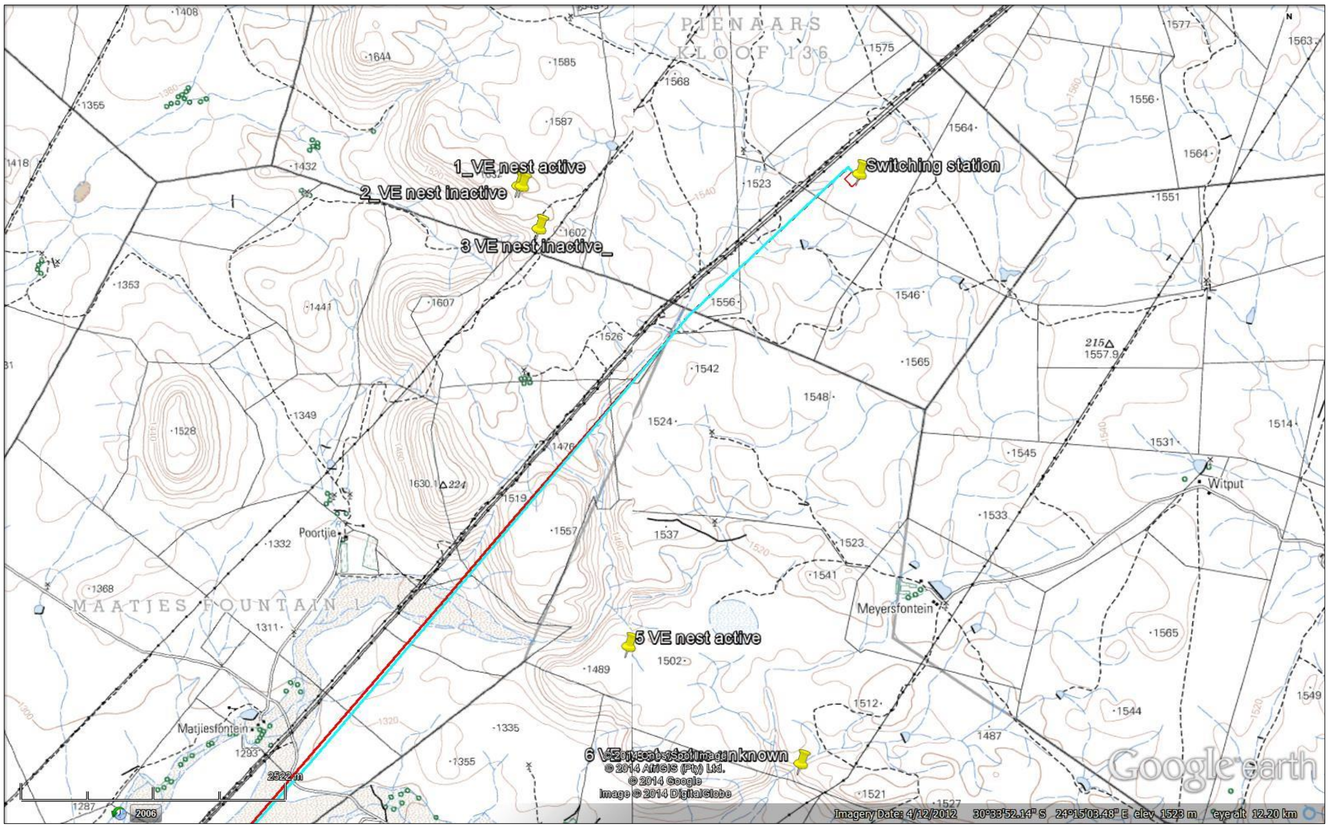

Figure 6: The location of Verreaux's Eagle nests along the escarpment, relative to existing power lines and the proposed 132kV line and switching station (blue and red lines).

3.3.4 Agriculture

The study area contains very few agricultural lands, because of low rainfall, and the land-use is mostly grazing. However there are a few agricultural lands near Hydra Substation. Agricultural lands completely destroy the structure of the original vegetation, but some birds do benefit from this transformation. Blue Crane and Ludwig's Bustard are the Red Data species most likely to utilise agricultural lands in the study area.

3.3.5 Transmission lines

Transmission lines are an important roosting and breeding substrate for large raptors in the study area. Existing transmission lines are used extensively by large raptors. Should any new lines be constructed next to existing lines, the construction activities could lead to temporary displacement of breeding eagles, resulting in breeding failure in a particular season, or even permanent abandonment of a breeding territory. No large eagle nests were recorded in the study area on the two 400kV transmission lines which are running parallel to the proposed 132kV line in the study area, but the situation requires ongoing monitoring.

Examples of the habitat in the study area are presented in APPENDIX A.

4. ASSESSMENT OF IMPACTS

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 (a) electrocution of birds and other animals and (b) 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; Shaw 2013). Other problems include electrical faults caused by bird excreta when roosting or breeding on electricity infrastructure (Van Rooyen *et al*. 2002), disturbance and habitat destruction during construction and maintenance activities.

4.1 Displacement through habitat transformation and disturbance

During the construction phase and maintenance of power lines and substations, some habitat destruction and transformation inevitably takes place. This happens with the construction of access roads, the clearing of servitudes and the levelling of substation yards. 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 have an impact on birds breeding, foraging and roosting in or in close proximity of the servitude through transformation of habitat, which could result in temporary or permanent displacement. In the present instance, the risk of displacement of Red Data species due to **habitat destruction** is likely to be fairly limited, given the nature of the habitat.

Apart from direct habitat destruction, the above mentioned construction and maintenance activities also impact on birds through **disturbance**, particularly during breeding activities. This could lead to breeding failure if the disturbance happens during a critical part of the breeding cycle. As far as disturbance is concerned, a potential situation may arise if the line is constructed near an existing transmission line. As mentioned earlier in this report, transmission lines are highly sought after by large raptors, particularly Martial Eagles, Verreaux's Eagles and Tawny Eagles, for roosting and breeding purposes. Construction activities in close proximity could be a source of disturbance and could lead to temporary breeding failure or even permanent abandonment of nests. However, no active eagle nests were recorded on the existing transmission lines in the study area during the field inspection in March 2014, therefore displacement of breeding birds due to disturbance should not be a major problem. However, the situation could change over time, and therefore the two 400kV lines running parallel with the proposed 132kV line will have to be inspected again prior to construction commencing on the 132kV line. Provided construction activity is restricted as much as possible to the actual servitude, and vehicle and pedestrian traffic in and out of the area is strictly controlled, the possibility of Verreaux's Eagles breeding along the escarpment being disturbed when the new 132kV line is constructed is considered to be unlikely. The closest nest is 1.6km away from the proposed line, and out of sight.

As far as the proposed new switching station (100m x 100m) for the wind facility is concerned, the habitat at the proposed site (Grassy Karoo) does not contain particularly unique features that will make these areas of vegetation critically important for Red Data power line sensitive species. The species that will be most directly affected by the loss of habitat are the smaller, non-threatened passerines that are currently potentially resident in the development area. It is not envisaged that any Red Data species will be permanently displaced from the study area by the habitat transformation that will take place at the site of the proposed substation and switching station.

4.2 Collisions with the proposed power line

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 have 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 they 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 (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).

Quantifying the impact of collisions 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 7 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.

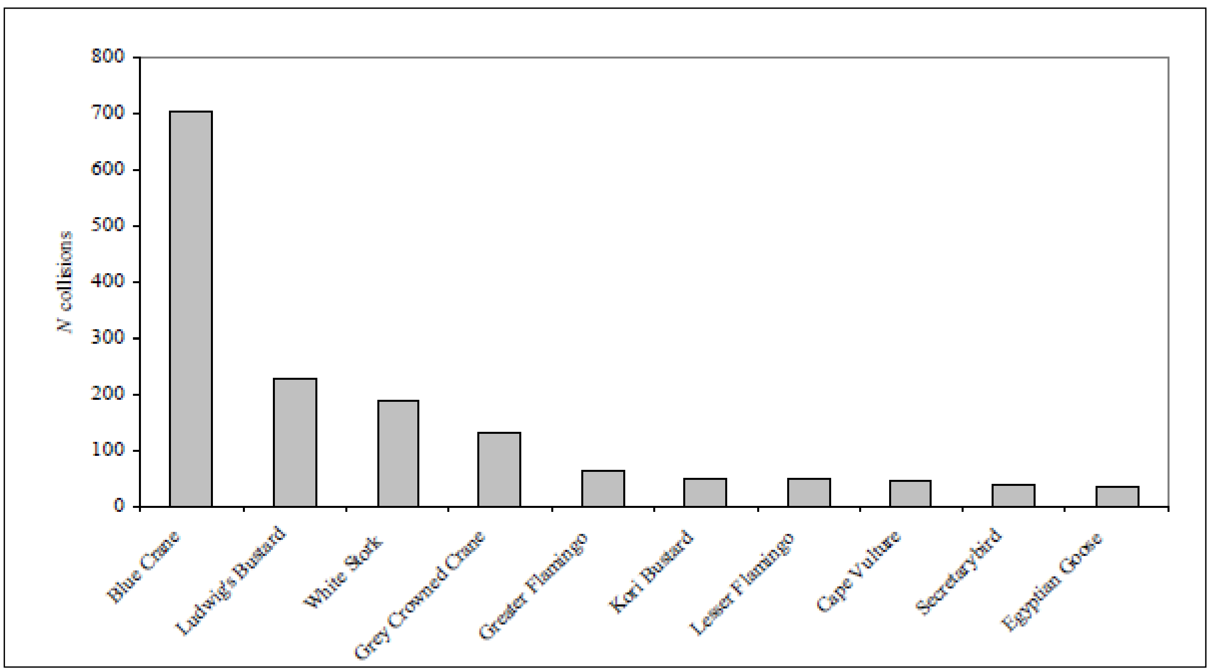

Figure 7: The top 10 collision prone bird species in South Africa, in terms of reported incidents contained in the Eskom/EWT Strategic Partnership central incident register 1996 - 2008 (Jenkins *et al.* 2010)

The most likely potential candidates for collision mortality on the proposed 132kV power line are Black Stork, Ludwig's Bustard, Kori Bustard, Karoo Korhaan, Blue Crane, Greater Flamingo and Secretarybird. Ludwig's Bustard is highly vulnerable to power line collisions (Jenkins & Smallie 2009; Jenkins *et al.* 2010; Shaw 2013). Ludwig's Bustard will be at risk, based on the species flight characteristics and tendency to fly long distances between foraging and roosting areas and when migrating. Movements by this species are triggered by rainfall (Allan 1994), and so are inherently erratic and unpredictable in this arid environment, where the quantity and timing of rains are highly variable between years. Hence, it is difficult to anticipate the extent to which Ludwig's Bustard may be exposed to collision risk, but with a SABAP2 reporting rate of 26% in 3024CA, the risk may be significant. Greater Flamingos might be at risk near larger dams, e.g.

the large dam in the Brakrivier at Caroluspoort. The biggest risk for Blue Cranes will be near dams that could potentially be used as roost sites e.g. evidence of Blue Crane collision mortalities was recorded at the Caroluspoort Dam during the site inspection. Black Storks might be at risk at dams and ephemeral drainage lines when temporary pools are present. Kori Bustards might be at risk anywhere along the alignment, particularly when flying to roost sites in the late afternoon and early evening. It is not possible to link the risk to Secretarybirds to any specific habitat or behaviour, they could be at risk anywhere along the alignment, but particularly in the predominantly Grassy Karoo areas. Karoo Korhaan could be at risk anywhere in Karoo habitat, but the risk is for these medium-sized bustards are less than for their larger relatives as they are not as mobile as the larger species. Birds of mountainous habitat such as Verreaux's Eagle, Lanner Falcon and Black Stork are also potential candidates for collisions, with the highest risk where the proposed line runs across potential flight paths along the escarpment.

A factor which could be reducing the risk of collisions along the entire alignment is the fact that the preferred alignment, and most of the alternative alignment, is situated directly next to existing transmission lines. It has been persuasively argued (although not proved unequivocally) 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).

4.3 Electrocutions on the proposed 132kV power lines.

A mono-pole steel pole will be used for the new 132kV lines (see Figure 8). Clearance between phases on the same side of the pole structure is normally around 2.2m for this type of design, and the clearance on strain structures is 1.8m. This clearance should be sufficient to prevent phase – phase electrocutions of birds on the towers. The length of the stand-off insulators is likely to be a maximum of 1.5 metres. This is relevant as large birds (eagles, vulture and storks) are able to touch both the conductor and the earthed pole simultaneously potentially resulting in a phase – earth electrocution. In general though, the steel monopole is safe for birds except vultures (and only in very specific circumstances i.e. when multiple vultures attempt to perch on the same pole and end up on the insulators). A factor that further reduces the already minimal risk of electrocution is the fact that the proposed alignments are situated next to existing 400kV transmission lines which are higher with large lattice towers, and therefore are more likely to be used for perching and roosting than the smaller, lower 132kV steel poles. Taking all the relevant factors into account, it can be concluded that the new 132kV line will pose a negligible risk of electrocution and it can therefore be discounted as a potential impact.

Figure 8: Steel monopole

5 RATING SYSTEM USED TO CLASSIFY IMPACTS

The rating system is applied to the potential impact on the receiving environment and includes an evaluation of the mitigation of the impact. Impacts have been consolidated into one rating. In assessing the significance of each issue the following criteria (including an allocated point system) is used:

NATURE		
Include a brief description of the impact of environmental parameter being assessed in the context of the project. This criterion includes a brief written statement of the environmental aspect being impacted upon by a particular action or activity.		
GEOGRAPHICAL EXTENT		
This is defined as the area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales and as such bracketing ranges are often required. This is often useful during the detailed assessment of a project in terms of further defining the determined.		
4	International and National	Will affect the entire country
3	Province/region	Will affect the entire province or region
2	Local/district	Will affect the local area or district
1	Site	The impact will only affect the site
PROBABILITY		
This describes the chance of occurrence of an impact		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
REVERSIBILITY		
This describes the degree to which an impact on an environmental parameter can be successfully reversed upon completion of the proposed activity.		
4	Irreversible	The impact is irreversible and no mitigation measures exist.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures
IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource.	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.

DURATION		
This describes the duration of the impacts on the environmental parameter. Duration indicates the lifetime of the impact as a result of the proposed activity		
1	Short term	The impact and its effects will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (0 – 1 years), or the impact and its effects will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
	Medium term	The impact and its effects will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 50 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered transient (Indefinite).
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts on the environmental parameter. A cumulative effect/impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.		
1	Negligible Cumulative Impact	The impact would result in negligible to no cumulative effects
2	Low Cumulative Impact	The impact would result in insignificant cumulative effects
3	Medium Cumulative impact	The impact would result in minor cumulative effects
4	High Cumulative Impact	The impact would result in significant cumulative effects
INTENSITY / MAGNITUDE		
Describes the severity of an impact		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component but system/ component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity).

3	High	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.
4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired (system collapse). Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.

SIGNIFICANCE

Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. This describes the significance of the impact on the environmental parameter. The calculation of the significance of an impact uses the following formula:

(Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity.

The summation of the different criteria will produce a non-weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.

Points	**Impact Significance Rating**	**Description**
6 to 28	Negative Low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive Low impact	The anticipated impact will have minor positive effects.
29 to 50	Negative Medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive Medium impact	The anticipated impact will have moderate positive effects.
51 to 73	Negative High impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.
51 to 73	Positive High impact	The anticipated impact will have significant positive effects.
74 to 96	Negative Very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
74 to 96	Positive Very high impact	The anticipated impact will have highly significant positive effects.

5.1 Displacement due to habitat destruction and disturbance caused by the construction of the 132kV power line: Preferred and alternative routes

IMPACT TABLE 1		
Environmental Parameter	*Avifauna*	
Issue/Impact/Environmental Effect/Nature	*Displacement due to habitat destruction and disturbance*	
Extent	*The impact will only affect the site.*	
Probability	*Possible.*	
Reversibility	*Completely reversible. The construction activities associated with the power line will inevitably cause temporary displacement of some species. Once the source of the disturbance has been removed, i.e. the noise and movement associated with the construction activities, most species should re-colonise the areas once the vegetation recovers sufficiently.*	
Irreplaceable loss of resources	*Marginal loss of resources in the case of the power line.*	
Duration	*Short term for the power line. Once the source of the disturbance has been removed, i.e. the noise and movement associated with the construction activities, most species should re-colonise the areas which have not been transformed by the footprint of the power line.*	
Cumulative effect	*Medium cumulative impact*	
Intensity/magnitude	*Medium*	
Significance Rating	*Low significance. Once the source of the disturbance has been removed, i.e. the noise and movement associated with the construction activities, most species should re-colonise the areas which have not been transformed by the footprint.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	2	2
Reversibility	1	1
Irreplaceable loss	2	2
Duration	1	1
Cumulative effect	3	2
Intensity/magnitude	2	1
Significance rating	-20 (low negative)	-9 (low negative)
Mitigation measures	*It is important that the construction activities, vehicle and pedestrian movement are restricted a much as possible to the actual servitude of the proposed power line. Maximum use should be made of existing roads. Vehicle traffic in and out of the area should be restricted to what is absolutely necessary for the construction process. This is especially important where the line crosses the escarpment, as this area is the most sensitive area as far as potential disturbance of breeding Verreaux's Eagles are concerned (see Figure 6).*	

5.2 Displacement due to habitat destruction and disturbance: switching station

IMPACT TABLE 2		
Environmental Parameter	*Avifauna*	
Issue/Impact/Environmental Effect/Nature	*Displacement due to habitat destruction and disturbance*	
Extent	*The impact will only affect the site.*	
Probability	*Probable, but should only affect non Red Data species.*	
Reversibility	*Barely reversible. The displacement due to habitat transformation associated with the construction of the substation/switching station could be reversed only if the substation is dismantled and the area rehabilitated.*	
Irreplaceable loss of resources	*Complete loss of resources in the case of the substation/switching station..*	
Duration	*Permanent for the substation/switching station due to extensive habitat transformation.*	
Cumulative effect	*Low cumulative impact due to the low likelihood of impacts on Red Data species.*	
Intensity/magnitude	*Medium*	
Significance Rating	*Low significance. No Red Data species expected to be impacted by the substation/switching station site.*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	3	3
Reversibility	3	3
Irreplaceable loss	4	4
Duration	4	4
Cumulative effect	2	2
Intensity/magnitude	1	1
Significance rating	-17 (low negative)	-17 (low negative)
Mitigation measures	*Maximum use should be made of existing roads. Vehicle traffic in and out of the area should be restricted to what is absolutely necessary for the construction process.*	

5.3 Collisions with the earthwire of the proposed 132kV line: Preferred and alternative routes

IMPACT TABLE 3		
Environmental Parameter	*Avifauna*	
Issue/Impact/Environmental Effect/Nature	*Collisions with the earthwire of the proposed 132kV line*	
Extent	*Regional*	
Probability	*Possible*	
Reversibility	*Barely reversible. It will require the dismantling of the line if it is de-commissioned.*	
Irreplaceable loss of resources	*Marginal loss of resources*	
Duration	*Long term*	
Cumulative effect	*Medium*	
Intensity/magnitude	*High*	
Significance Rating	*Medium*	
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	3	3
Probability	2	2
Reversibility	3	3
Irreplaceable loss	2	2
Duration	4	4
Cumulative effect	2	1
Intensity/magnitude	2	1
Significance rating	-32 (medium negative)	-15 (low negative)
Mitigation measures	*All the spans, except those located adjacent to two or more existing high voltage lines, should be marked with Bird Flight Diverters on the earth wire of the line, ten metres apart, alternating black and white. APPENDIX B indicates the preferred Bird Flight Diverters to be used.*	

6 CONCLUSIONS

The construction of the proposed new 132kV power line will pose a limited threat to the birds occurring in the vicinity of the new infrastructure. The power line poses a **medium** collision risk, but a **negligible** electrocution risk, irrespective of which alternative is used. With the implementation of appropriate mitigation measures, the collision risk could be reduced to **low**. The habitat transformation and disturbance associated with the construction of the power line should have a **low** impact, provided appropriate mitigation is implemented. The impact of habitat transformation associated with the switching station site should be **low** and should only affect a few non-Red Data species at a local level.

7 SELECTING A PREFERRED ALTERNATIVE

Considering all the relevant factors, none of the two options emerges as a clear preferred alternative from a bird impact perspective. The reason for that is that the two options are both clustered in the same area, and of comparable length, meaning that the envisaged impacts are likely to be very similar. Any of the two options are therefore regarded as potentially suitable, provided appropriate mitigation is implemented.

8 RECOMMENDATIONS

8.1 Collisions

- All the spans, except those located directly adjacent to existing high voltage lines,should be marked with Bird Flight Diverters on the earth wire of the line, ten metres apart, alternating black and white. Appendix B indicates the preferred Bird Flight Diverters to be used.

8.2 Displacement

- It is important that the construction activities, vehicle and pedestrian movement are restricted a much as possible to the actual servitude of the proposed power line. Maximum use should be made of existing roads. Vehicle traffic in and out of the area should be restricted to what is absolutely necessary for the construction process. This is especially important where the line crosses the escarpment, as this area is the most sensitive area as far as potential disturbance of breeding Verreaux's Eagles are concerned (see Figure 6).
- Immediately prior to construction commencing, an inspection should be conducted by the avifaunal specialist to record any large raptor nests on the existing transmission lines running parallel to the proposed 132kV line, that could be impacted by the construction of the proposed line.
- Should any nests be recorded, it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the avifaunal specialist, and the Environmental Control Officer. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule which will enable him/her to ascertain when and where breeding Red Data raptors could be impacted by the construction activities. This could then be addressed through the timing of construction activities during critical periods of the breeding cycle, once it has been established that a particular nest is active.

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APPENDIX A: BIRD HABITAT

Figure 1: Typical Nama Karoo in the study area.

Figure 2: Typical Grassy Karoo in the study area.

Figure 3: A water body in the study area.

Figure 4: The habitat on top of the plateau where the proposed substation and switching station will be located.

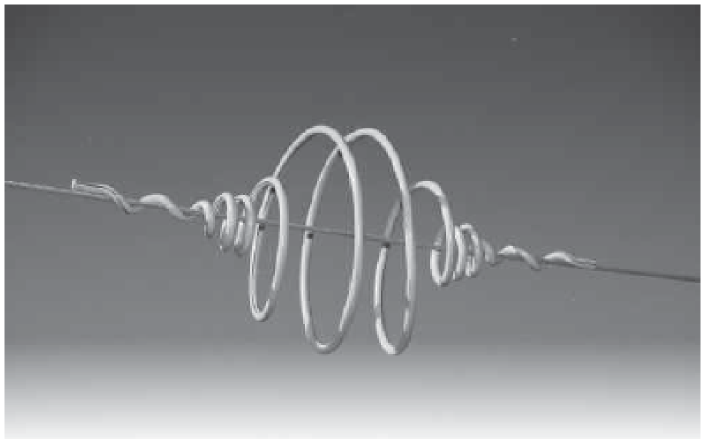
Figure 6: The escarpment in the eastern part of the study area

Figure 7: One of the Verreaux's Eagle nests (nest No 3) along the escarpment in typical habitat.

APPENDIX B: PREFERRED BIRD FLIGHT DIVERTER

PLP – The connection you can count on

Double Loop Bird Flight Diverter



General Recommendation

The Bird Flight Diverter is designed to make overhead lines visible to birds and provides and economic means of reducing the hazard to both lines and birds. For low and medium voltage construction (up to 40kV) it is applied to the phase conductors (bare or jacketed). For high voltage it is used on the earth wire.

The fitting is light in weight, offers little wind resistance and is easily and quickly applied. The positive grip of the fitting on the conductor ensures that it remains in the applied position and cannot move along the span under vibration.

Visibility: The diverter section increases the visibility profile of the cable or conductor to a degree necessary to ensure safety, but avoids undesirably bulky outline.

Spacing: Spacing distances are not critical and will depend upon local conditions. Since wind resistance is very limited, sufficient fittings can be used to ensure adequate visibility without creating stresses on the line. When marking adjacent spans, overall visibility is improved by staggering the application.

We recommend generally a spacing of 10 or 15 metres.

INDEX

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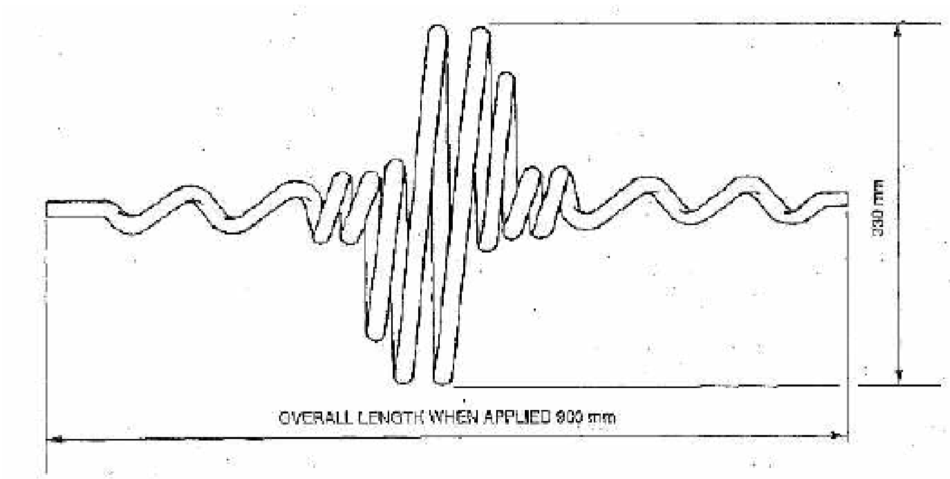
PLP – The connection you can count on

Double Loop Bird Flight Diverter



Material Used: Manufactured from rigid solid high impact polyvinyl chloride, possessing excellent chemical and strength properties and which will retain good physical characteristics within the range of extreme temperatures. Outdoor aging tests indicate that the material does not deteriorate in function or appearance from the effects of severe weather conditions. Industrial fumes and salt water cannot seriously degrade the properties of rigid PVC.

Colour: White or Black

Lay Direction: Bird Flight Diverters are supplied right hand lay for both right hand and left hand lay bare conductors and insulated cables.

CATALOGUE NO.	CONDUCTOR/ E/WIRE DIA. RANGE
BFD 0914/LD2*	9 mm – 14 mm

*Add B or W to denote colour

INDEX

E - 4

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