BIRD IMPACT ASSESSMENT REPORT

132kV Silimela MTS to Groblersdal Substation

July 2015

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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 Groblersdal - Silimela 132kV power line.

Full Name: Chris van Rooyen
Title / Position: Director

EXECUTIVE SUMMARY

This avifaunal study assesses the potential interactions between birds and the proposed Groblersdal-Silimela 132kV power line, located between Groblersdal and Marble Hall in the Limpopo Province.

A fairly wide diversity of species (almost 300 species) could be found in the broader area within which this site falls, based on existing data sources, nine of which are Red List species. However, most of the site has in the past experienced extensive agricultural activity, human settlement, and contain existing road and power line networks. Therefore the likelihood of Red List species utilizing the site is considered to be low. This is reflected in the low reporting rates for power line sensitive Red List species.

The construction of the proposed power line will result in various threats to the birds occurring in the vicinity of the new infrastructure. The proposed power line poses a **low** electrocution, due to the proposed structure type, and can be reduced to **very low** with appropriate mitigation. Similarly, collisions have also been assessed as being of **very low** significance, and no additional mitigation is recommended. The habitat transformation and disturbance associated with the construction and decommissioning of the power line should have a **low** impact, which could be reduced to **very low** with appropriate mitigation.

Taking the above information into account, it can be concluded that, given the presence of existing habitat degradation and disturbance (associated with the agricultural activities, human settlement, and existing road and power line networks) that the power line can be constructed along the proposed route with acceptable levels of impact on the resident avifauna.

Table of Contents

1 INTRODUCTION

Mbofho Consulting (Mbofho) has been appointed by Eskom to undertake an Environmental Impact Assessment for the proposed Groblersdal-Silimela power line development. The project entails the construction of approximately 14.5 km of 132kV power line from the existing Groblersdal substation to an approved loop in loop out power line that emanates from the approved Silimela substation. This project is located between Groblersdal and Marble Hall, in the Limpopo Province.

Mbofho has appointed Chris van Rooyen Consulting to compile a specialist avifaunal assessment report (based on a desktop review and a one-day site visit, conducted on 9 June 2014) detailing the sensitive bird habitats within the study area and the potential bird related impacts associated with the proposed new sub-transmission line.

See Figures 1 and 2 below for maps showing the location of the project and of the various corridor alternatives.

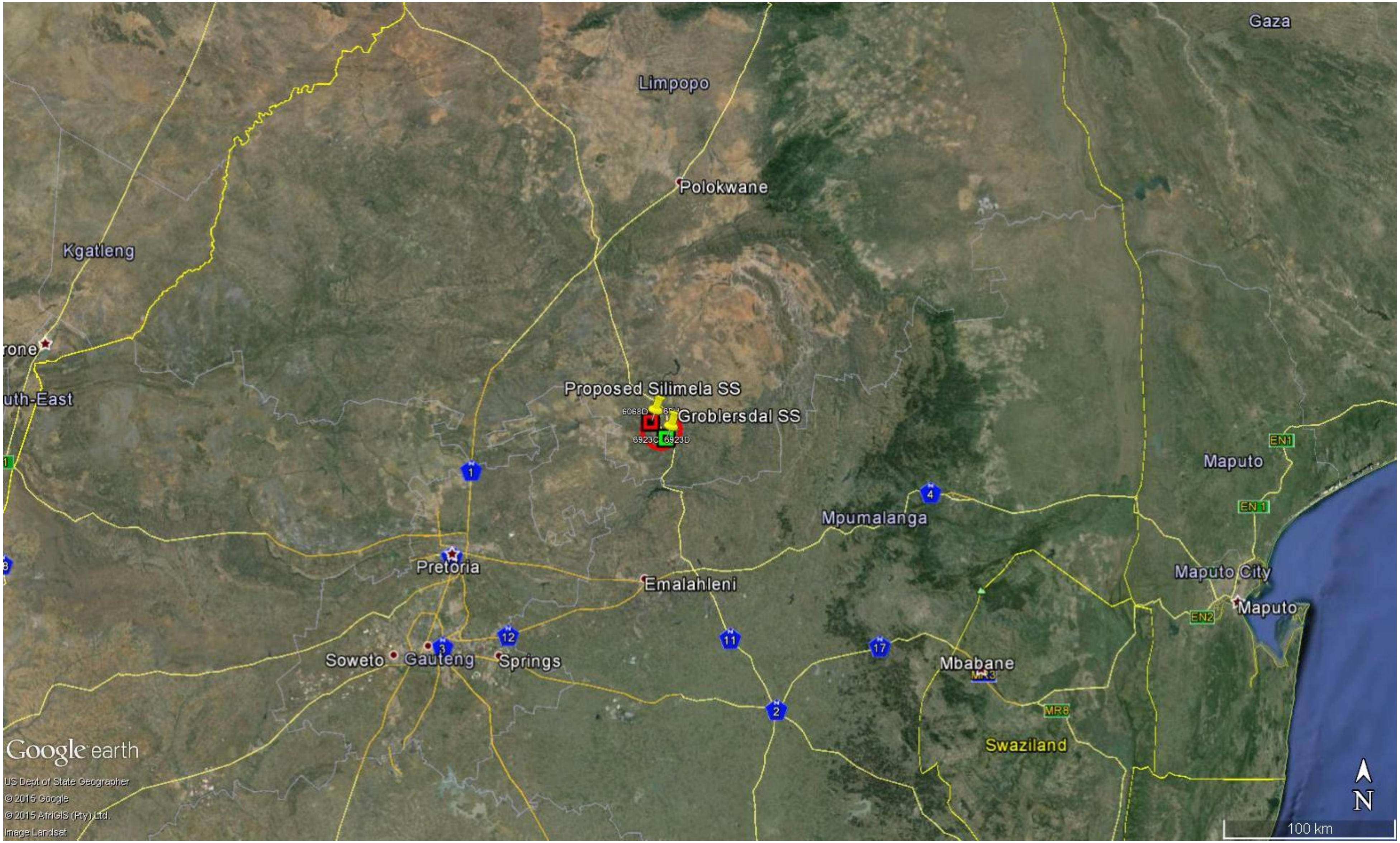

Figure 1: Regional map showing the approximate location of the study area (red circle).

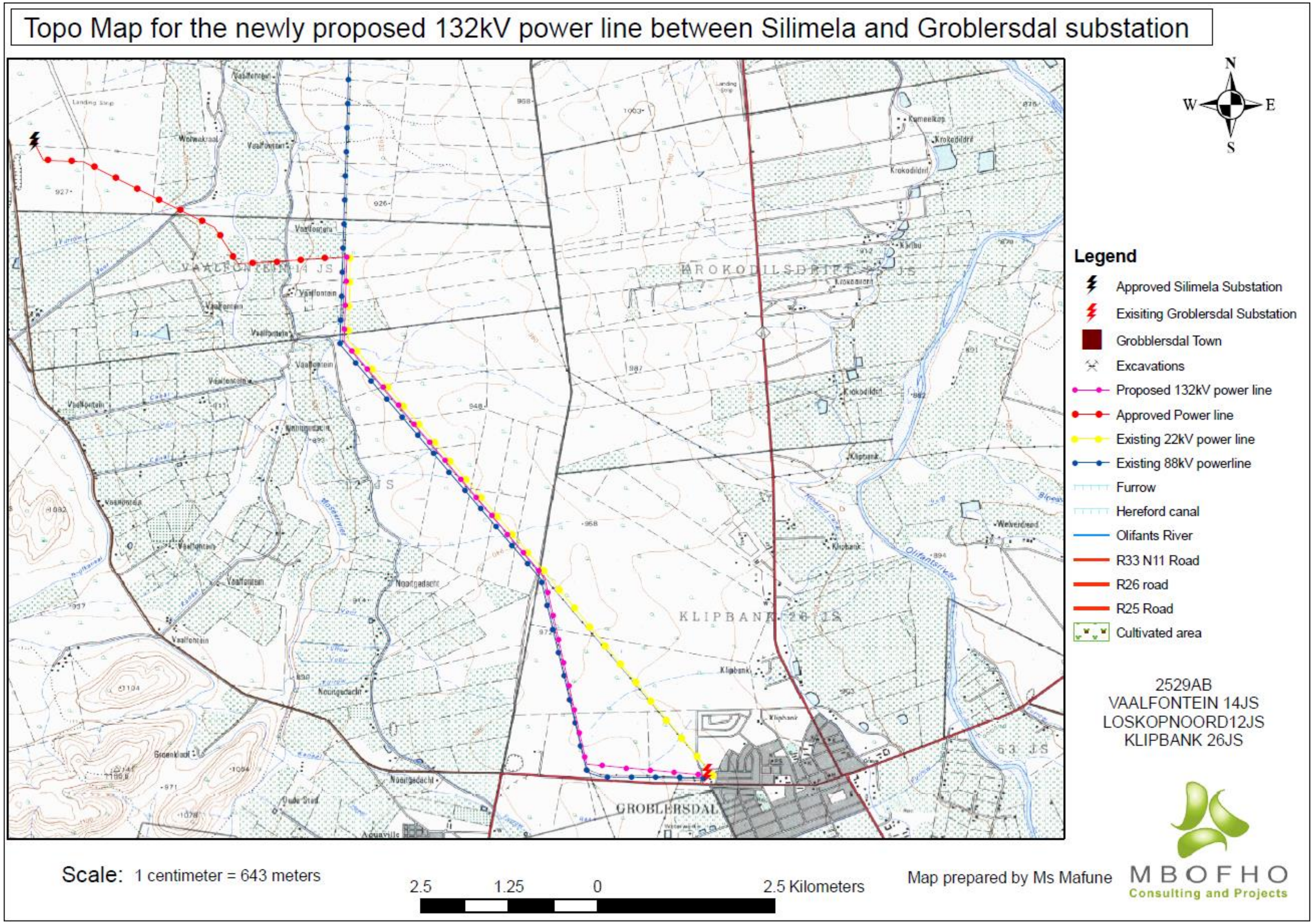

Figure 2: Close-up view of the study area and proposed alignment.

2 BACKGROUND AND BRIEF

The terms of reference for this bird impact assessment study are as follows:

- Describe the affected environment;
- Indicate how birdlife will be affected;
- Discuss gaps in baseline data;
- List and assess the expected impacts; and
- Provide recommendations for mitigating measures.

3 STUDY APPROACH

3.1 Sources of information

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, as a means to ascertain which species occur within the broader area i.e. within a block consisting of three pentad grid cells within which the study area is situated. 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 15 full protocol cards (i.e. 18 bird surveys lasting a minimum of two hours each) have been completed for this area. The pentads are the following: 2505_2920; 2505_2915 and 2510_2920 (see Figure 3 below).

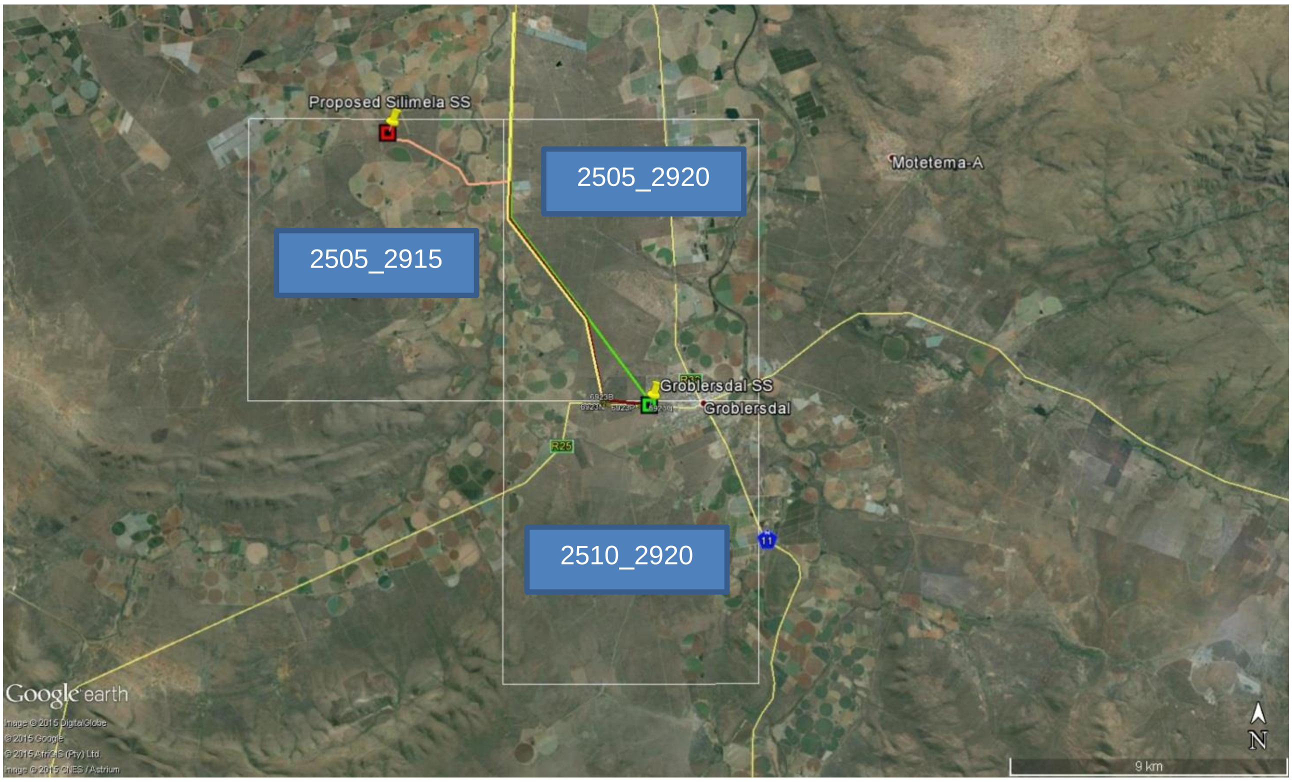

Figure 3: The three SABAP2 pentads within which the study area is located.

- The Important Bird Areas project data was consulted to get an overview of important bird areas (IBAs) and species diversity in the study area (BLSA 2014).

- 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 power lines (Jenkins *et al.* 2010).
- Data on vegetation types 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 Limpopo 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.
- A field visit to the study area was conducted on 9 June 2015 to form a first-hand impression of the micro-habitat on site.
- Location of White-backed Vulture nests in the Limpopo Province, was obtained from Josef Heymans from the Limpopo Department of Economic Development, Environment and Tourism (LEDET 2013).

3.2 Limitations & assumptions

This study made the following assumptions:

- The coverage by SABAP2 has not been as extensive, with a total of 15 checklists which give an updated, but incomplete snapshot of the birds currently occurring there. In view of this, the reporting rates for the species in the study area are regarded as only a guideline, and not necessarily reflecting true densities on the ground. Historical bird distribution data of the Southern African Bird Atlas Project 1 (Harrison *et al.* 1997) was also obtained for the quarter-degree grid cell (QDGC = the equivalent of a 1:50 000 topo-cadastral map) traversed by the proposed line, namely 2529AB, to give a more complete picture of the avifauna that could potentially occur in the study area.
- The author has travelled and worked extensively on avifaunal impact assessments in the Limpopo Province since 1996. 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.
- The study area was defined as a 2km buffer around the proposed alignments.
- The field visit was conducted mostly from public roads as access to private property was largely restricted.

4. STUDY AREA

4.1 Important Bird Areas

There are no IBA's within the immediate study area. The closest IBA to the proposed project (SA015 – Loskop Dam Nature Reserve) is located approximately 20km to the south. The proximity of the IBA and the unlikely occurrence of the associated trigger species (White-backed Night Heron, African Finfoot and African Grass Owl *Tyto capensis)* within the study area, means that the IBA will not have a significant impact on the routing of the final alignment and was therefore not used as a criterion to assess the anticipated impacts in the study area.

4.2 Primary vegetation divisions (biomes)

The study area extends over a single primary vegetation division, namely savanna (woodland) (Mucina & Rutherford 2006). It is generally accepted that vegetation structure, rather than the actual plant species, influences bird species distribution and abundance (Harrison *et al.* 1997). From an avifaunal perspective, the Atlas of southern African Birds (SABAP1) recognises six primary vegetation divisions or biomes within South Africa, namely (1) Fynbos (2) Succulent Karoo (3) Nama Karoo (4) Grassland (5) Savanna and (6) Forest (Harrison *et al.* 1997). These vegetation descriptions do not focus on lists of plant species, but rather on factors which are relevant to bird distribution. The criteria used by the SABAP1 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.

4.3 Description of bird habitat classes

The following bird habitat classes were recorded in the study area (vegetation descriptions based largely on Harrison *et al.* 1997 and Mucina & Rutherford 2006):

4.3.1 Savanna

The study area is situated in the savanna biome and any natural woodland occurring within the study area consists entirely of Central Sandy Bushveld (Mucina & Rutherford 2006). This particular woodland type occurs in low undulating areas, sometimes between mountains and sandy plains supporting tall, deciduous *Terminalia sercia* and *Bureka Africana* woodland on deep sandy soils and low broad leafed *Combretum* woodland on shallow rocky or gravelly soils. The natural woodland in the study area has been disturbed by both past and present agricultural practices. Evidence of bush clearing and removal of trees is clearly visible to the west of the proposed alignment, where commercial agriculture, alongside the Moses River, dominates the landscape. This has resulted in very little undisturbed woodland remaining. Structurally the woodland to the east of the proposed alignment ranges from open shrub with scattered trees, to dense shrubs with many medium to large trees, depending on the level of bush clearing which happened in the past. Game and cattle farming practices are prevalent to the east of the proposed alignment.

SABAP2 reporting rates for power line sensitive Red List avifauna potentially occurring in woodland habitat in the study area are very low (see Table 4-1), indicating that previous agricultural activity has impacted on the avifauna and that levels of disturbance might be higher than what is immediately evident. Red List species that could potentially be found foraging in this habitat are Secretarybird *Sagittarius serpentarius* and Lanner Falcon *Falco biarmicus*. There is a cluster of White-backed Vulture nests located approximately 30km north-west of the study area. The possibility of these vultures occasionally foraging over the study area cannot be excluded.

4.3.2 Rivers

Two prominent rivers occur within the boarder study area, the Olifants River to the east of the proposed alignment and Moses River to the west. It is noted that the banks of the rivers show signs of infestation with alien vegetation, but perhaps more importantly, in several places the riparian vegetation has been removed for agricultural purposes right up to the edge of the river. Rivers are extremely important sources of water for most bird species and will be regularly utilised not only as a source of drinking water and food, but also for bathing. It is clear that both the Olifants and Moses Rivers have been impacted by human activity to some extent, especially through commercial agriculture, thus making it less desirable to birds that would, under more favourable conditions, utilise the river systems more extensively. Notwithstanding, it remains important for birds. Red List species that could potentially be found in this habitat are Yellow-billed Stork *Mycteria ibis*, Black Stork *Ciconia nigra,* and Half-collared Kingfisher *Alcedo semitorquata.*

4.3.3 Dams

Many thousands of earthen and other dams exist in the southern African landscape. Whilst dams have altered flow patterns of streams and rivers, and affected many bird species detrimentally, a number of species have benefited from their construction. The construction of these dams has probably resulted in a range expansion for many water bird species that were formerly restricted to areas of higher rainfall. Man-made impoundments, although artificial in nature, can be very important for variety of birds, particularly water birds. Apart from the water quality, the structure of the dam, and specifically the margins and the associated shoreline and vegetation, plays a big role in determining the species that will be attracted to the dam. Common species in the study area that could use dams and dam edges include Red-knobbed Coot *Fulica cristata*, Black-headed Heron *Ardea melanocephala*, African Darter *Anhinga rufa*, White-faced Duck *Dendrocygna viduata*, Yellow-billed Duck *Anas undulata*, Blacksmith Lapwing *Vanellus armatus,* African Sacred Ibis *Threskiornis aethiopicus* and Egyptian Goose *Alopochen aegyptiaca.* Red List species recorded in the study area by SABAP1 that are likely to specifically be attracted to dams include Black Stork, Yellow-billed Stork and Abdim's Stork *Ciconia abdimii.* A couple of small to medium sized dams were observed along the proposed route alignment with several more occurring in the broader study area.

4.3.4 Agricultural clearings

The tilling of soil is one of the most drastic and irrevocable transformations brought on the environment. It completely destroys the structure and species composition of the natural vegetation, either temporarily or permanently. However, arable or cultivated land may represent a significant feeding area for many bird species in any landscape for the following reasons: through opening up the soil surface, land preparation makes many insects, seeds, bulbs and other food sources suddenly accessible to birds and other predators; the crop or pasture plants cultivated are often eaten themselves by birds, or attract insects which are in turn eaten by birds; during the dry season arable lands often represent the only green or attractive food sources in an otherwise dry landscape. The study area to the west of the proposed power line alignment contains extensive agricultural clearings mostly in the form of irrigated pivots along the Moses River.

Generally speaking, agricultural areas are of lesser importance for the majority of Red List species recorded in the study area, as the agriculture is mostly intensive irrigation of monocultures, which is less suitable for them when compared to the natural habitats (i.e. woodland, rivers and wetlands) occurring in the broader study area. The only Red List species that is most likely to utilise agricultural lands and clearings in the study area is the Abdim's Stork. This species can occur in flocks of several hundred on irrigated fields. Other large, non-threatened power line sensitive species such as and Spur-winged Goose *Plectropteris gabensis* may also use freshly ploughed and irrigated lands in the study area to feed in.

See Appendix 1 for a photographic record of the bird habitats in the study area.

4.4 Power line sensitive species occurring in the study area

Eight Red List species (Table 4-1) have been recorded in the broader study during the SABAP 1 atlassing period. Only Abdim's Stork and an additional Red List species (Verreaux's Eagle) have been recorded during the SAPAB 2 project to date. For each species, the potential for occurring in a specific habitat class is indicated, as well as the type of impact that could potentially affect the species in the study area.

Table 4-1: Red List species that could potentially occur in the study area.

EN = Endangered VU = Vulnerable NT = Near-threatened

Name	Scientific name	Conservation status (Taylor, 2014)	Consolidated SABAP2 reporting rate in the 3 pentads %	Rivers & Drainage Lines	Dams	Savanna	Agricultural clearings	Collisions	Electrocutions	Displacement through disturbance	Displacement through habitat destruction
Yellow-billed Stork	*Mycteria ibis*	EN	0	x	x	-	-	-	-	-	-
Lanner Falcon	*Falco biarmicus*	VU	0	-	-	x	x	x	-	-	-
Verreaux's Eagle[1]	*Aquila verreauxii*	VU	1.33	-	-	-	-	-	-	-	-
Black Stork	*Ciconia nigra*	VU	0	x	x	-	-	-	-	-	-
Secretarybird	*Sagittarius serpentarius*	VU	0	-	-	x	x	x	-	-	-
African Grass-Owl	*Tyto capensis*	VU	0	x	-	-	-	-	-	-	-
European Roller	*Coracias garrulus*	NT	0	-	-	x	x	-	-	-	-
Half-collared Kingfisher	*Alcedo semitorquata*	NT	0	x	-	-	-	-	-	-	-
Abdim's Stork	*Ciconia abdimii*	NT	2.22	x	x	-	x	x	-	-	-
White-backed Vulture	*Gyps africanus*	EN	0	-	-	x	-	-	x	-	-

[1] This is an unusual record for the area and should be regarded as a vagrant.

5 DESCRIPTION OF EXPECTED 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 electrocution of birds (and other animals) and birds colliding with power lines. (Ledger and Annegarn 1981; Ledger 1983; Ledger 1984; Hobbs and Ledger 1986a; Hobbs and Ledger 1986b; Ledger, Hobbs and Smith, 1992; Verdoorn 1996; Kruger and Van Rooyen 1998; Van Rooyen 1998; Kruger 1999; Van Rooyen 1999; Van Rooyen 2000; Anderson 2001; Shaw 2013).

5.1 Electrocutions

Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2004). The electrocution risk is largely determined by the pole/tower design. The tower design that has been proposed for this project is the steel monopole (see Appendix 2).

5.1.1 Steel monopole

Clearance between phases on the same side of the 132kV pole structure is approximately 2.2m for this type of design, and the clearance on strain structures is 1.8m. This clearance should be sufficient to reduce the risk of phase – phase electrocutions of birds on the towers to negligible. The length of the stand-off insulators is approximately 1.6m. If very large species attempts to perch on the stand-off insulators, they are potentially able to touch both the conductor and the earthed pole simultaneously potentially resulting in a phase – earth electrocution. This is particularly likely when more than one bird attempts to sit on the same pole, which is an unlikely occurrence, except occasionally with vultures. Vultures have not been recorded and are unlikely to occur regularly within the study area, but sporadic occurrence cannot be ruled out. The only envisaged high risk scenario would be when a carcass becomes available within a few hundred metres of the line, attracting White-backed Vultures which may cluster on a few poles. This is likely to be an irregular event in the study area.

In summary it is concluded that the risk of electrocution posed to avifauna by the steel monopole design is likely to be of **LOW** significance and restricted to vultures. It should be mentioned that the pole design holds no inherent electrocution risk for other large solitary raptors such as eagles, as they almost never perch together in large numbers on the same structure.

5.2 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 although due to the location of the proposed alignments away from sensitive habitat this should not be a particularly high risk. 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.

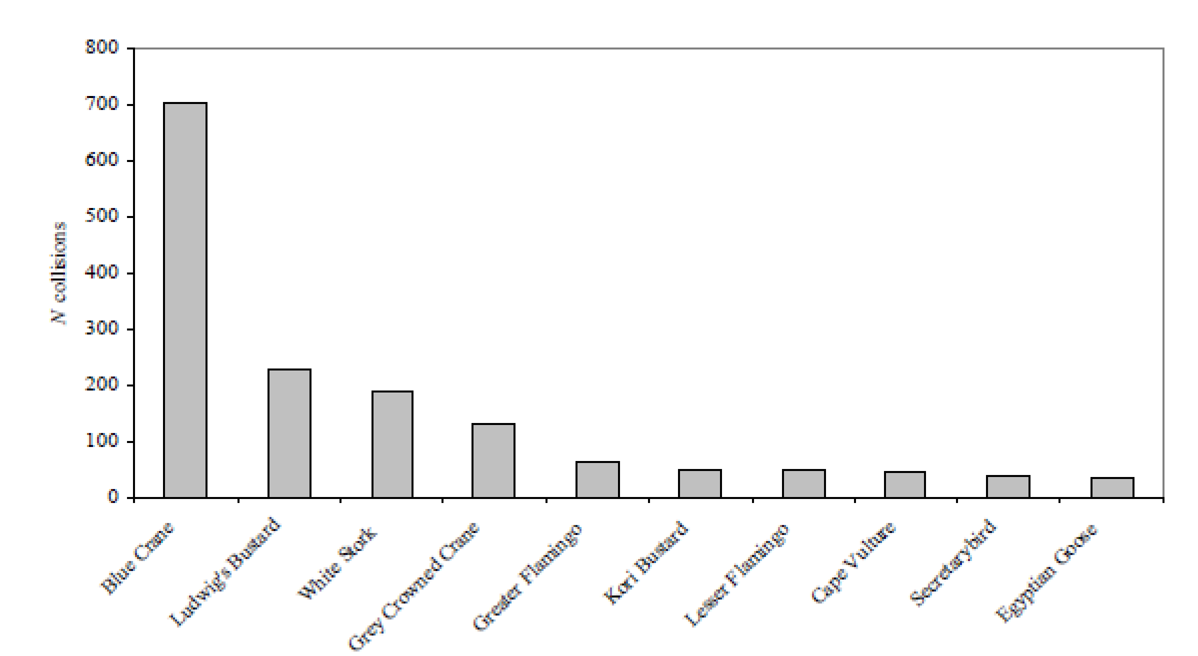

Figure 5: The top ten collision prone bird species in South Africa, in terms of reported incidents contained in the Eskom/EWT Strategic Partnership central incident register 1996 - 2008 (Jenkins *et al.* 2010)

In the present instance, the most likely potential candidates for collision mortality on the proposed power line are Secretarybird, Lanner Falcon and Abdim's Stork. None of the Red List waterbird species are likely to be at risk of collisions because the alignment does not cross any major waterbodies or rivers. A large proportion of the proposed power line occurs in savanna habitat where the risk of collisions are likely to be few and far between, as there are no specific areas where one would expect a concentration of birds. Vultures would be most at risk if they descend to a carcass near the line, which is not likely to be a regular event, given the fact that the occurrence of vultures are likely to be the exception rather than the rule. Abdim's Stork will be most at risk in agricultural clearings, where they can occur in large flocks, especially on freshly ploughed fields and irrigated crops. In summary, the risk of collision posed to avifauna by proposed power line is likely to be of **LOW** significance

5.3 Displacement due to habitat destruction 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 List species due to **habitat destruction** is likely to be fairly limited given the low reporting rate for Red List species in the study area, the small footprint of the proposed project and the presence of existing power line infrastructure routed on either side of the proposed 132kV power line.

Apart from direct habitat destruction, the above mentioned construction and maintenance activities also impact on birds through **disturbance**; this could lead to breeding failure if the disturbance happens during a critical part of the breeding cycle. Construction activities in close proximity could be a source of disturbance and could lead to temporary breeding failure or even permanent abandonment of nests. The very low reporting rates for Red List species in the study area are an indication that they are not regularly utilising the area for breeding. The impact of disturbance is therefore likely to be **LOW** and temporary as far as Red List species are concerned. However, if the alignment is authorised, a detailed inspection would be required to establish if there are any breeding Red List species that could be disturbed. In such an event, appropriate mitigation measures would need to be implemented (such as postponing the construction of the line to avoid peak breeding season).

6 ASSESSMENT OF EXPECTED IMPACTS

6.1 Assessment criteria

Impacts are described and then evaluated in terms of the criteria given below.

Criteria	Rating Scales	Notes
Nature	**Positive**	This is an evaluation of the type of effect the construction, operation and management of the proposed development would have on the affected environment. Would it be positive, negative or neutral?
	Negative	
	Neutral	
Extent	**Footprint**	Site-specific, affects only the development footprint
	Site	The impact could affect the whole or a significant portion of the site.
	Regional	The impact could affect the area including the neighbouring farms, the transport routes and adjoining towns or cities.
Duration	**Short**	The impact will be relevant through to the end of the construction phase.
	Medium	The impact will last up to the end of the development phases, where after it will be entirely negated.
	Long term	The impact will continue or last for the entire operational lifetime of the development
Severity	**Low**	Where the impact affects the environment in such a way that natural, cultural and social functions and processes are minimally affected
	Medium	Where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way; and valued, important, sensitive or vulnerable systems or communities are negatively affected
	High	Where natural, cultural or social functions and processes are altered to the extent that the impact will temporarily or permanently cease; and valued, important, sensitive or vulnerable systems or communities are substantially affected.
Potential for impact on irreplaceable resources	**No**	No irreplaceable resources will be impacted.
	Yes	Irreplaceable resources will be impacted.
Consequence	**Extremely detrimental**	A combination of extent, duration, intensity and the potential for impact on irreplaceable resources.
	Highly	

Criteria	Rating Scales	Notes
	detrimental	
	Moderately detrimental	
	Slightly detrimental	
	Negligible	
	Slightly beneficial	
	Moderately beneficial	
Probability	**Improbable**	Improbable. It is highly unlikely or less than 50 % likely that an impact will occur.
	Probable	Distinct possibility. It is between 50 and 70 % certain that the impact will occur.
	Definite	Most likely. It is more than 75 % certain that the impact will occur or it is definite that the impact will occur.
Significance	**Very high - negative**	A function of Consequence and Probability
	High - negative	
	Moderate - negative	
	Low - negative	
	Very low	
	Low - positive	
	Moderate - positive	
	High - positive	
	Very high - positive	

- ***Nature:*** This is an evaluation of the type of effect the construction, operation and management of the proposed development would have on the affected environment. Will the impact change in the environment be positive, negative or neutral?

- ***Extent or scale:*** This refers to the spatial scale at which the impact will occur. Extent of the impact is described as: footprint (affecting only the footprint of the development), site (limited to the site) and regional (limited to the immediate surroundings and closest towns to the site).

- ***Duration:*** The lifespan of the impact is indicated as short, medium and long term.

- ***Severity:*** This is a relative evaluation within the context of all the activities and the other impacts within the framework of the project. Does the activity destroy the impacted environment, alter its functioning, or render it slightly altered?

- ***Impact on irreplaceable resources:*** This refers to the potential for an environmental resource to be replaced, should it be impacted. A resource could possibly be replaced by natural processes (e.g. by natural colonisation from surrounding areas), through artificial means (e.g. by reseeding disturbed areas or replanting rescued species) or by providing a substitute resource, in certain cases. In natural systems, providing substitute resources is usually not possible, but in social systems substitutes are often possible (e.g. by constructing new social facilities for those that are lost). Should it not be possible to replace a resource, the resource is essentially irreplaceable e.g. Red List species that are restricted to a particular site or habitat of very limited extent.

- ***Consequence:*** The consequence of the potential impacts is a summation of above criteria, namely the extent, duration, intensity and impact on irreplaceable resources.

- ***Probability of occurrence:*** The probability of the impact actually occurring based on professional experience of the specialist with environments of a similar nature to the site and/or with similar projects. It is important to distinguish between probability of the impact occurring and probability that the activity causing a potential impact will occur. Probability is defined as the probability of the impact occurring, not as the probability of the activities that may result in the impact. The fact that an activity will occur does not necessarily imply that an impact will occur. For instance, the fact that a road will be built does not necessarily imply that it will impact on a wetland. If the road is properly routed to avoid the wetland, the impact may not occur at all, or the probability of the impact will be low, even though it is certain that the activity will occur.

- ***Significance:*** Impact significance is defined to be a combination of the consequence (as described below) and probability of the impact occurring. The relationship between consequence and probability highlights that the risk (or impact significance) must be evaluated in terms of the seriousness (consequence) of the impact, weighted by the probability of the impact actually occurring. The following analogy provides an illustration of the relationship between consequence and probability. The use of a vehicle may result in an accident (an impact) with multiple fatalities, not only for the driver of the vehicle, but also for passengers and other road users. There are certain mitigation measures (e.g. the use of seatbelts, adhering to speed limits, airbags, anti-lock braking, etc.) that may reduce the consequence or probability or both. The probability of the impact is low enough that millions of vehicle users are prepared to accept the risk of driving a vehicle on a daily basis. Similarly, the consequence of an aircraft crashing is very high, but the risk is low enough that thousands of passengers happily accept this risk to travel by air on a daily basis.In simple terms, if the consequence and probability of an impact is high, then the impact will have a high significance. The significance defines the level to which the impact will influence the proposed development and/or environment. It determines whether mitigation measures need to be identified and implemented and whether the impact is important for decision-making.

- ***Degree of confidence in predictions:*** The specialist must provide an indication of the degree of confidence (low, medium or high) that there is in the predictions made for each impact, based on the available information and their level of knowledge and expertise. Degree of confidence is not taken into account in the determination of consequence or probability.

- ***Mitigation measures:*** Mitigation measures are designed to reduce the consequence or probability of an impact, or to reduce both consequence and probability. The significance of impacts has been assessed both with mitigation and without mitigation.

6.2 Assessment tables

The assessment of each impact is discussed and presented in tabular format as shown below for both "pre" and "post" mitigation. The different phases (Construction, Operation, and Decommissioning) are treated separately:

6.2.1 Construction phase

Impact	*Nature*	*Extent*	*Duration*	*Severity*	*Impact on Irreplaceable Resources*	*Consequence*	*Probability*	*Significance*	*Confidence*
Impact : Displacement of Red List species due to habitat destruction and disturbance associated with the construction of the power line and substation									
Impact Description: Displacement of Red List species may occur during the construction phase of the power line and substation, and may be caused by the noise and movement associated with the construction activities.									
Without Mitigation	Negative	Site	Short	Low	No	Slightly detrimental	Probable	Low - negative	Medium
Mitigation Description: • Construction activity should be restricted to the immediate footprint of the infrastructure. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of Red List species. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint and rehabilitation of disturbed areas is concerned. • The final alignment must be inspected on foot by the avifaunal specialist prior to construction to ascertain if any Red List species nests are present. All relevant detail must be recorded i.e. species, coordinates and nest status. 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 such breeding Red List species 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.									
With Mitigation	Negative	Site	Short	Low	No	Slightly detrimental	Improbable	Very Low - Negative	High
Cumulative Impact: Very low									

6.2.2 Operational phase

Impact	*Nature*	*Extent*	*Duration*	*Severity*	*Impact on Irreplaceable Resources*	*Consequence*	*Probability*	*Significance*	*Confidence*
Impact : Electrocution of Red List species on the 132kV line									
Impact Description: Electrocution of Red List species on the steel monopole structure.									
Without Mitigation	Negative	Regional	Long term	Low	No	Slightly detrimental	Improbable	Low - negative	High
Mitigation Description: Fit bird perching bracket to the top of the pole (see Appendix 2).									
With Mitigation	Negative	Regional	Long term	Low	No	Negligible	Improbable	Very Low-Negative	High
Cumulative Impact: Very low									

Impact	*Nature*	*Extent*	*Duration*	*Severity*	*Impact on Irreplaceable Resources*	*Consequence*	*Probability*	*Significance*	*Confidence*
Impact : Collision of Red List species with the earthwire of the 132kV line									
Impact Description: Red List species mortality due to collisions with the earthwire of the power line.									
Without Mitigation	Negative	Regional	Long term	Low	No	Slightly detrimental	Improbable	Very Low - negative	High
Mitigation: None required.									
With Mitigation	Negative	Regional	Long term	Low	No	Slightly detrimental	Improbable	Very Low-Negative	High
Cumulative Impact: The low reporting rates for Red List species in the study area indicate that the collision impact is likely to be very low to start with, due to low numbers of collision sensitive species. Cumulative impact is therefore very low.									

6.2.3 De-commissioning phase

Impact	*Nature*	*Extent*	*Duration*	*Severity*	*Impact on Irreplaceable Resources*	*Consequence*	*Probability*	*Significance*	*Confidence*
Impact : Displacement of Red List species due to habitat destruction and disturbance associated with the decommissioning of the power line and substation									
Impact Description: Displacement of Red List species may occur during the decommissioning phase of the power line and substation, and may be caused by the noise and movement associated with the dismantling activities.									
Without Mitigation	Negative	Site	Short	Low	No	Moderately detrimental	Improbable	Low - negative	Medium
• Decommissioning activity should be restricted to the immediate footprint of the infrastructure. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of Red List species. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as rehabilitation of disturbed areas is concerned.									
With Mitigation	Negative	Site	Short	Low	No	Slightly detrimental	Improbable	Very Low-Negative	Medium
Cumulative Impact: Very low									

7 CONCLUSIONS

In conclusion, given the presence of existing habitat degradation and disturbance, it is anticipated that the Groblersdal-Silimela 132kV power line can be constructed along the proposed route alignment with acceptable levels of impact on the resident avifauna.

The project can proceed subject to the recommendations made below.

- An avifaunal walk through of the final power line route should be conducted prior to construction, to identify any species that may be breeding on the site or within the immediate surrounds and to ensure that any impacts likely to affect breeding species (if any) are adequately managed.
- The correct pole structure must be utilized to avoid electrocution (APPENDIX 2).
- In addition to this, the normal suite of environmental best practices should be applied, such as ensuring strict control of staff, vehicles and machinery on site and limiting the creation of new roads as far as possible.

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APPENDIX 1: BIRD HABITATS

Figure 1: Dense woodland in the study area

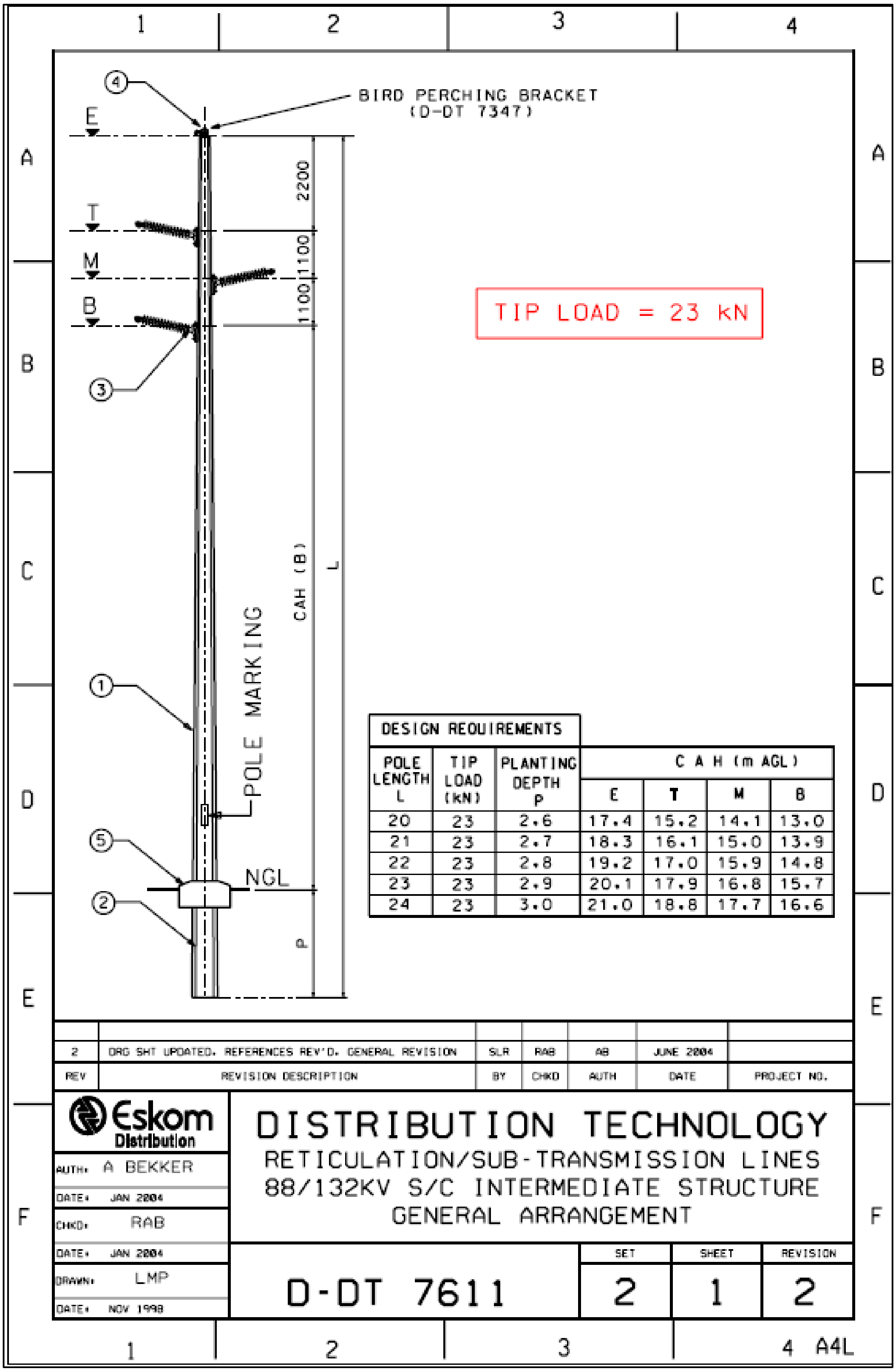
Figure 2: Open woodland in the study area

Figure 3: Agricultural clearing with stands of alien trees in the background.

Figure 4: Irrigated pivots in the west of the study area

Figure 5: The Moses River

APPENDIX 2: STRUCTURE TYPES



DESIGN REQUIREMENTS

POLE LENGTH L	TIP LOAD (kN)	PLANTING DEPTH P	C A H (m AGL) E	T	M	B
20	23	2.6	17.4	15.2	14.1	13.0
21	23	2.7	18.3	16.1	15.0	13.9
22	23	2.8	19.2	17.0	15.9	14.8
23	23	2.9	20.1	17.9	16.8	15.7
24	23	3.0	21.0	18.8	17.7	16.6