MOKOPANE INTEGRATION PROJECT

Mokopane Substation and associated 400kV loop-in and loop-out power lines Delta-Medupi, Medupi-Mokopane and Mokopane-Witkop 400kV power lines

Environmental Impact Assessment Report

May 2010

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PROFFESSIONAL DECLARATION

This study was conducted by Megan Diamond in her capacity as a field biologist of the Endangered Wildlife Trust (EWT). Ms. Diamond conducts all assessments under the supervision of Mr. Jon Smallie who is registered with The South African Council for Natural Scientific Professions (400020/06). The EWT are independent consultants to Savannah Environmental (for Eskom Holdings Limited). The EWT has no business, financial, personal or other interest in the activity, application or appeal in respect of which they were appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of these specialists performing such work.

The author has three years of experience in the field of bird interactions with electrical infrastructure and has conducted avifaunal impact assessments for four transmission line projects and approximately 30 distribution line projects. The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information.

EXECUTIVE SUMMARY

The Endangered Wildlife Trust was appointed by Savannah Environmental as specialists to investigate the potential bird related impacts associated with the construction of the proposed Mokopane Substation and its associated 400kV loop-in and loop-out power lines extending from the existing Matimba-Witkop 400kV power line, as well as that associated with the Delta-Medupi, Medupi-Mokopane and Mokopane-Witkop 400kV power lines (i.e. all components of the Mokopane Integration Project).

Various sources of information were consulted during this study, to ascertain bird distribution patterns and densities as well as the conservation status for each bird species prevalent in the study area. The Southern African Bird Atlas Project (Harrison *et al*, 1997) recorded a total of 30 Red-Data bird species across the 18 quarter degree squares within which the study area falls. In addition, the White Stork and Abdim's Stork (Protected internationally under the Bonn Convention on Migratory Species) are considered as a threatened species for the purpose of this study. Several of the Red Data species recorded here are known to be extremely vulnerable to impacts of power lines, through collision. The Blue Crane, Secretarybird, Southern Bald Ibis, Denham's Bustard, Kori Bustard, White-bellied Korhaan, Greater and Lesser Flamingos, the various vulture and stork species are all susceptible to collision and habitat destruction.

The northern part of the study area consists predominantly of degraded woodland and arable lands with the central and southern corridors consisting largely of densely vegetated mountainous areas.

Three technically feasible alternative sites for the proposed Mokopane substation were identified during the scoping phase of the project. It is anticipated that habitat destruction will be by far the most significant impacts associated with the construction of the Mokopane Substation. Areas that will be particularly vulnerable to habitat transformation, as a result of the construction of the substation, will be the riparian habitats (Options 3 and 4) particularly as a result of the construction and maintenance of the 400kV loop-in and loop-out servitudes relating to this project, as well as future distribution power line developments. Disturbance will be much greater if species are breeding on or near the area earmarked for the development of the proposed Mokopane Substation.

With regards to the proposed Delta-Medupi, Medupi-Mokopane and Mokopane-Witkop 400kV power lines, a vast quantity of vegetation will also be lost during their construction particularly in woodland areas, unlike developments in grassland areas, where the area is merely trampled during construction. Habitat destruction within sections of Corridor 2 and Corridor 8 and its deviation is not anticipated to be significant since much of the study area is considered to be already transformed and disturbed through the establishment of subsistence and commercial agricultural practices, pastoral activities and settlements. This change in land use has resulted in, some cases, a relatively small amount of natural veld left intact. However the converse is true for the vast tracts of woodland in Corridor 1 and sections of Corridor 4. Habitat destruction of the natural vegetation remaining in corridors 5, 6 and sections of corridor 8 and

its deviation is likely to be minimal since these areas are already transformed through the construction and maintenance of existing power lines.

Collision of large terrestrial Red Data bird species will be a significant impact of the proposed 400kV power lines. Species most likely to be affected by this impact are the more heavily–bodied species recorded in the area i.e. Blue Crane, Secretarybird, Southern Bald Ibis, Denham's Bustard, Kori Bustard, White-bellied Korhaan, Greater and Lesser Flamingos and the various vulture and stork species. These species are priority species due to their proven vulnerability to collision with power lines, and their reported occurrence within the study area. Non-Red Data species such as water birds will also be affected. Provided that the deviation to Corridor 8 is selected as the preferred corridor and that the relevant sections of the power line are comprehensively marked with a suitable anti-collision marking device, the EWT are confident that this impact can be reduced to acceptable levels. It must be noted that the negative impacts far outweigh the positive impacts associated with a development of this nature.

Following the **initial EIA analysis** of the proposed substation sites and corridor alignments, Option 1 (Mokopane Substation), Corridor 8 (Medupi-Mokopane) and Corridor 6 (Mokopane-Witkop) were considered to be the preferred alternatives from an avifaunal perspective. It is believed that the key impacts (i.e. collision and habitat destruction) associated with the development can be minimised and mitigated with relative ease if these alternatives are selected provided that the proposed Medupi-Mokopane and Mokopane- Witkop 400kV alignments are positioned within 200m of the existing power lines located within corridors 8 and 6 respectively. However, at a specialist integration meeting held after this initial assessment of the corridors, it emerged that Eskom had concerns regarding the technical feasibility of Corridor 8. As a result the EWT were requested to select the 'next best option' from an avifaunal perspective. As a result, corridor 2 was selected, but included a number of 'no go' areas. These areas were delineated and it was recommended that **construction, of the proposed Medupi-Mokopane 400kV power lines, within these areas should be avoided**. It was unfortunate that this information only became available subsequent to the conclusion of the initial EIA assessment. This effectively reduced the number of corridors from the legal requirement of three to just two feasible options.

In addition to the above, a deviation to Corridor 8 was proposed at a stakeholder meeting held in the Lephalale area on 11 March 2010, to address the technical constraints associated with Corridor 8. This new corridor was assessed during a site visit to the study area on 4 May 2010. Results of this latest assessment, revealed that the **Corridor 8 Deviation is the preferred Medupi-Mokopane alternative from an avifaunal perspective.** Option 1 and Corridor 6 remain the preferred Mokopane Substation and Mokopane-Witkop alternatives respectively.

A single **Delta-Medupi (Corridor 7)** corridor was assessed and the impacts are considered to be relatively low in contrast with the larger Medupi-Mokopane and Mokopane-Witkop corridors and can be mitigated where necessary.

1. INTRODUCTION

1.1 Background

In order to evacuate the power generated at the new Medupi Power Station, support the upsurge in demand for the platinum group metals in the Mokopane area and to improve the reliability of electricity supply to the Polokwane area, Eskom Transmission plans to construct and establish an additional node, the new Mokopane Substation, to support the existing Witkop Substation, the only other nodal point in the Polokwane area. The proposed substation, with a footprint of approximately 1000m x 1000m, will be located between Mokopane and Polokwane in the Limpopo Province. The proposed 400kV loop-in and loop-out power lines extending from the existing Matimba-Witkop power line will run parallel to one another and cover a distance of approximately 10 kilometres. In addition to this, the necessary transmission power line infrastructure needed to integrate the new Substation into the existing Transmission network will also be constructed i.e. Delta-Medupi, Medupi-Mokopane and Mokopane-Witkop 400kV power lines (FIGURE 1).

From the scoping study, the following preferred alternatives have been nominated for consideration in this the EIA phase of the study:

Mokopane Substation – from a technical perspective, substation site Option 2 is not considered as a preferred site due to a watercourse partly traversing the site, as well as the presence of a rock outcrop. This option was therefore excluded as an option for further investigation on the basis of technical feasilbility. As a result, Option 1 (Doornfontein, portion 721 LS), Option 3 (Zuid Holland, portion 773 LR) and Option 4 (Noord Braband, portion 774 LR) will be investigated further in this report.

Transmission Power Line Corridors – the scoping report concluded that all identified power line corridor alternatives should be investigated in detail in the EIA phase of the process. However, following the submission of the final scoping report to DEAT, it has been confirmed by Eskom that Corridor 3 is not considered to be feasible from a technical perspective. Therefore it was agreed that this alternative would not be considered in detail in the EIA report and that another corridor (Corridor 8 – the existing Matimba-Witkop alignment) would be added to the scope for assessment. In April 2010 a deviation to Corridor 8 was also included in the scope as a means of addressing the technical constraints associated with Corridor 8. Alternatives to be assessed in this report include Corridors 1, 2, 4, 5, 6, 7, 8 and a deviation to corridor 8. A 5km corridor was assessed for each of the alternatives

Typically, a development of this nature could be expected to impact on the birds of the area through: habitat destruction and disturbance as a result of the construction of the proposed Mokopane Substation and associated 400kV loop-in and loop-out power lines and the Delta-Medupi, Medupi-Mokopane and Mokopane-Witkop 400kV power lines; collision of birds with earth wires and conductors of the proposed 400kV loop-in and loop-out and 400kV power lines; possible electrocutions of nesting birds within the substation and birds causing electrical faulting on the proposed 400kV loop-in and loop-out power lines.

In line with environmental legislation, Eskom Transmission has appointed Savannah Environmental (Pty) Ltd to conduct the necessary environmental investigations for the proposed development. The Endangered Wildlife Trust (EWT) was appointed by Savannah Environmental (Pty) Ltd as specialists to investigate the potential bird related impacts associated with the construction of the proposed Mokopane substation, Delta-Medupi, Medupi-Mokopane and Mokopane-Witkop 400kV power lines.

Field investigations for this study were conducted during June 2008 (fly-over), December 2008 and May 2010 (field investigations).

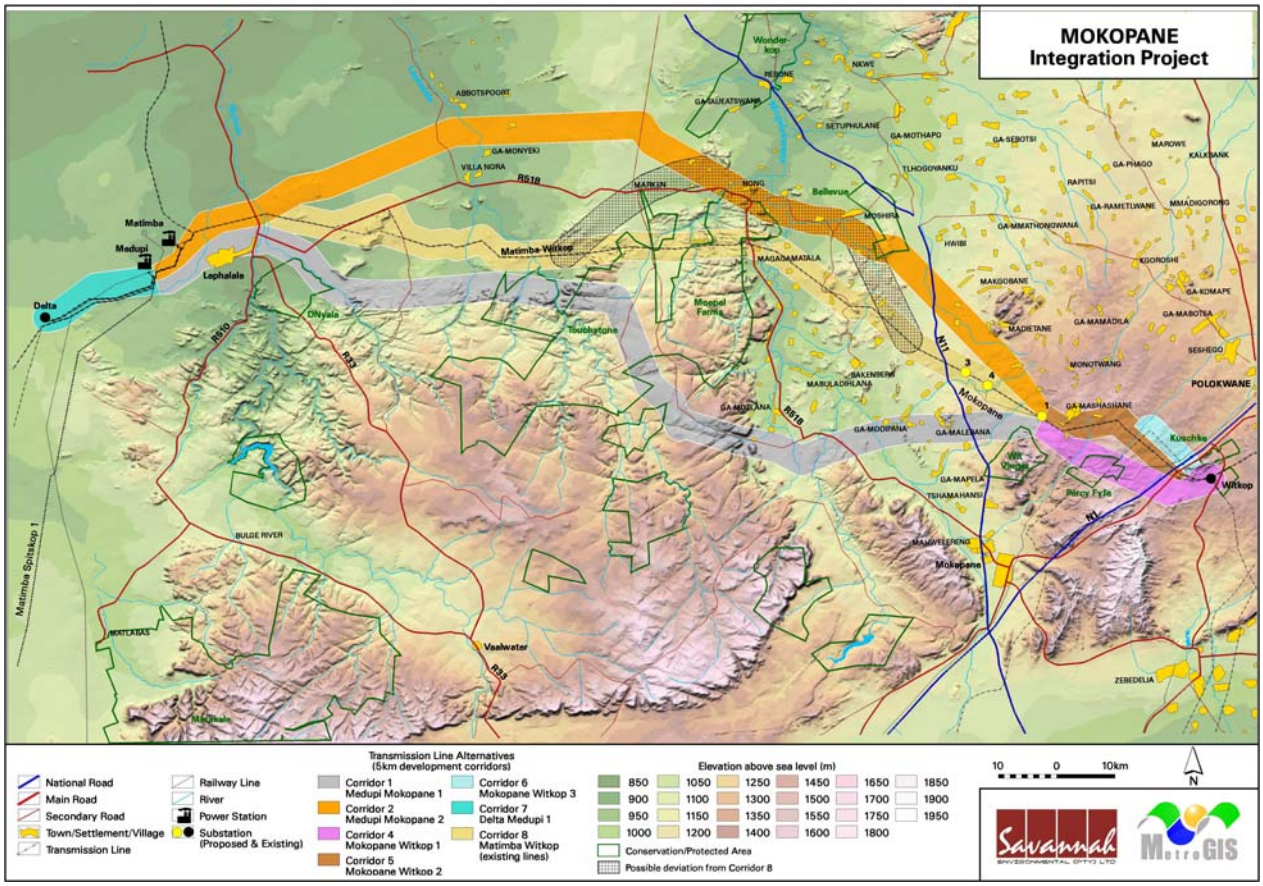

FIGURE 1: Map indicating the Mokopane substation site and corridor alternatives for the Delta-Medupi, Medupi-Mokopane and Mokopane-Witkop 400kV power lines (map supplied by Savannah Environmental).

1.2 Terms of Reference

The following terms of reference for the avifaunal EIA study were supplied by Savannah Environmental:

- Description of the affected environment
- Description of the issues identified during the scoping phase
- Methodology of determining the significance of the impacts (and assumptions)
- Impact statement
- Assessment of the impacts, including a summary in tabular format

- Comparative assessment of alternatives for all components of the project and the do nothing alternative
- Conclusions
- Recommendations in terms of a preferred alternative and site specific mitigation

1.3 Study approach

1.3.1 Sources of information

The study made use of the following data sources:

- Bird distribution data of the Southern African Bird Atlas Project (SABAP – Harrison, Allan, Underhill, Herremans, Tree, Parker and Brown, 1997) obtained from the Avian Demography Unit of the University of Cape Town, in order to ascertain which species occur in the study area. A separate data set is obtained for each of the 18 quarter degree squares i.e. 2327DA, 2327DB, 2327DC, 2327DD, 2328CA, 2328CB, 2328CC, 2328CD 2328DA, 2328DB, 2328DC, 2328DD, 2428AB, 2428BA, 2329CC, 2329CD, 2429AA and 2429AB.
- Data from the Co-ordinated Avifaunal Road count project (CAR – Young, Harrison, Navarro, Anderson & Colahan, 2003) was consulted to determine whether any CAR routes exist in the study area.
- Data from the Co-ordinated Waterbird Count (CWAC) project was also used to determine whether any important water bird sites are located in study area (Taylor, Navarro, Wren-Sargent, Harrison and Kieswetter, 1999).
- Environmental Potential Atlas (ENPAT) data for the Limpopo province was consulted to determine environmental sensitivity. (ENPAT 2000 version. DEAT, University of Pretoria and GISBS).
- The Important Bird Areas (IBA) project data was consulted to establish if any bird areas are located in the study area (Barnes 1998).
- Comments and responses received via a questionnaire directed at Interested and Affected Parties (I&AP). A telephonic survey was conducted with those landowners that would be affected by the development associated with the deviation to Corridor 8, in May 2010.
- The conservation status of all bird species occurring in the aforementioned quarter degree squares was determined with the use of The Eskom Red Data book of birds of South Africa, Lesotho and Swaziland (Barnes 2000).
- The power line bird mortality incident database of the Eskom/Endangered Wildlife Trust Strategic Partnership (1996 to present) was consulted to determine which of the species occurring in the study area are typically impacted upon by power lines.
- A classification of the vegetation types in each quarter degree square was obtained from the Southern African Bird Atlas Project (Harrison, Allan, Underhill, Herremans, Tree, Parker and Brown (1997).
- Information on the micro-habitat level was obtained during a flyover and field investigation of the study area in June and December 2008 respectively. An additional site visit was conducted in May 2010 to assess the potential avian impacts associated with the deviation to Corridor 8
- The CSIR Land Cover Database and associated Geographical Information System (GIS) layers.

- High resolution imagery from Google Earth was used to further informally examine the study area.

1.3.2 Limitations & assumptions

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

- The SABAP data covers the period 1986-1997, which means that some of the data is now more than a decade old. Bird distribution patterns fluctuate continuously according to availability of food and nesting substrate (for a full discussion of potential inaccuracies in ASAB data, see Harrison, Allan, Underhill, Herremans, Tree, Parker and Brown, 1997).
- Predictions in this study are based on experience of these and similar species in different parts of South Africa. Bird interactions with power lines cannot be reduced to formulas that will hold true under all circumstances; at most impacts can be predicted with a fair amount of confidence based on field experience.
- Corridors for the proposed loop-in and loop-out 400kV power lines associated with the Mokopane substation were not indicated on the maps provided and could therefore not be assessed in detail.
- Various sections of the proposed Medupi-Mokopane corridors were inaccessible during the December 2008 and May 2010 field visits to the area. Both the existing Matimba-Witkop corridor and these areas were assessed using high resolution Google Earth imagery.

2. DESCRIPTION OF THE RECEIVING ENVIRONMENT

The greater study area contains elements of both grassland and woodland, but the proposed substation sites, associated turn-ins, Delta-Medupi, Medupi-Mokopane and Mokopane-Witkop 400kV power lines are situated largely within woodland. The land use is largely mining, commercial farming with a mixture of game, cattle and crop cultivation – both dryland and irrigation. Other sections of the study area contain subsistence farming, with a mixture of cattle and crop cultivation and numerous settlements.

2.1 Vegetation types and bird habitats

TABLE 1 below shows the average historical vegetation composition of the 18 quarter degree squares within the study area (Harrison *et al,* 1997). It is widely accepted within the ornithological community that vegetation structure, rather than the actual plant species, influences bird species distribution and abundance (in Harrison *et al,* 1997). The description of vegetation presented in this study therefore concentrates on factors relevant to the bird species present, and is not an exhaustive list of plant species present. The description of the vegetation types occurring in the study area makes extensive use of information presented in the Atlas of southern African birds (Harrison *et al,* 1997).

TABLE 1. Vegetation composition of the study area (Harrison *et al,* 1997).

Vegetation Type	Moist Woodland	Arid Woodland	Sour Grassland
Average Percentage	81%	17%	2%

It is evident from the table above that the dominant vegetation type found within the study area is woodland of one type or another, i.e. Arid or Moist woodland. It must however be noted that the majority of the northern and eastern parts of this study area are in a state of transformation, with a number of settlements (FIGURE 2) scattered throughout the immediate surrounds intermingled with mining areas and both commercial and subsistence forms of cultivation. As a result, a large portion of the vegetation within the most northern corridor (Corridor 2) of the study area has and is being transformed. The habitat in the area has been subjected to severe pressure from the neighbouring communities and the various land use types.

FIGURE 2: Settlements can be found scattered throughout the greater study area.

2.1.1 Woodland biome

The woodland biome covers most of the northern and eastern sections of southern Africa. Canopy cover ranges from sparse – such as Kalahari woodland, to an almost closed canopy such as Miombo woodland. Woodland is defined as having a grassy under-storey and a distinct woody upper-storey of trees and tall shrubs.

- Arid woodland comprises predominantly fine-leaved, semi-deciduous *Acacia*- dominated woodlands on rich soils. This vegetation type occurs where there is intermediate, though variable, rainfall with hot, wet summers and cool, dry winters.
- Moist woodland comprises predominantly broadleaved, winter deciduous woodland. Soil types are varied but are generally nutrient poor.

Woodland habitat, in its undisturbed state, is suitable for a wide range of birds – in fact the woodland species are the most species rich community.

2.1.2 Grassland biome

This biome encompasses the open grassland regions of the eastern interior plateau of South Africa. Grasslands are maintained largely by a combination of relatively high summer rainfall, frequent fires, frost and grazing, which preclude the presence of shrubs and trees.

- Sour grasslands occur in the higher rainfall regions on acidic soils. They are characterised by being shorter and denser in structure when compared to Sweet grasslands.

Relevant to this study area, much of the grassland biome has been transformed predominantly by crop farming, afforestation and human settlement. The only true indication of grassland vegetation lies within close proximity to Corridor 4. The other grassland patches that are found in isolated patches within the study area are more than likely old fallow fields that have long since been abandoned.

2.2. Bird Micro Habitats

Whilst much of the bird species distribution in the study area can be explained in terms of the above broad vegetation description (based on the quarter degree squares), there are many differences in bird species distribution and density that correspond to differences in habitat at the micro level. These "bird micro-habitats" are evident at a much smaller spatial scale than the broader vegetation types or biomes, and can largely only be identified through a combination of field investigation and experience. The habitat that is relevant to the birds may also be broader than merely the vegetation type and structure and may include abiotic elements such as man-made infrastructure. It was therefore important to visit the study area and examine these characteristics first hand.

The following bird micro-habitats were identified within the immediate surrounds of the three proposed substation sites and the seven proposed corridors:

2.2.1 Dams

There are several small man-made impoundments within the study area (FIGURE 3). 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. These include the pelicans, darters and cormorants. Many species from these families occur in this study area including Yellow-billed, Black, Woolly-necked and White Storks, flamingos and a variety of non-Red Data species such as ducks, geese and herons.

2.2.2 Arable land

Arable or cultivated land represents 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 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. In this study area, there are significant arable lands, both commercial and subsistence varieties. Much of the commercial agriculture in the area is irrigation based (FIGURE 4), mostly along the Lephalale, Mokolo and Mogalakwena rivers and some of the associated tributaries and drainage lines.

White Storks might visit some of the irrigated crops in summer, mostly patches of lucerne which comprises most of the irrigated crops. Cattle Egrets, Abdim's Stork and Black-headed Heron might follow tractors in the planting season to scoop up insects that have been exposed. Relevant to this study, a great deal of agriculture can be found within close proximity to Option 1 of the proposed substation sites and along Corridor 2.

FIGURE 3: An example of a dam located in the study area

FIGURE 4: An example of an irrigated land occurring along Corridor 2 within the study area

2.2.3 Rivers, pans and wetlands

There are at least three major rivers that occur within the study area – the Lephalale, Mokolo and Mogalakwena Rivers as well as a number of smaller rivers or associated tributaries. Riparian vegetation is characterised by tall, fringing riverine forest and well developed woodland quite distinct from the surrounding dryland vegetation. These well vegetated areas usually support a diverse and distinct forest and woodland avifauna (Taylor *et al.* 1999). These

are areas of particular importance for birds, with riparian vegetation being extremely important to threatened riverine bird species and waterbird communities. Option 3 of the proposed substation sites, is located a short distance (0.3km) from the Groot-Sandsloot River and Witrivier respectively with Option 4 located approximately 1km from the Witrivier. Corridor 1, Corridor 2 and Corridor 8 cross the Lephalale, Mokolo and Mogalakwena Rivers at least once.

Some other small perennial wetlands and seasonal pan examples (see FIGURE 5 and 6) are also scattered throughout the study area. Ordinarily, of the bird species highlighted in TABLE 3, the most likely of those to be associated with these rivers, pans and wetlands are the flamingos, the various stork species and a variety of non Red Data species such as ducks and geese. In this area, wetlands 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.

FIGURE 5: An example of a pan occurring within the study area.

FIGURE 6: An example of a wetland system

2.2.4 Escarpment areas

The mountainous areas along Corridor 1 and the existing Matimba-Witkop corridor (Corridor 8) represent a very distinct habitat type (FIGURE 7). This is most likely to be used by species such as the Cape Griffon Vulture, various raptors, Black Stork and Southern Bald Ibis.

FIGURE 7: An example of mountainous areas located within Corridor 1 and the existing Matimba-Witkop corridor

2.2.5 Woodland

Patches of the study area are communal land, especially along the northern alignment (Corridor 2), and are heavily grazed by livestock. In these areas, the tree cover has been drastically reduced, and the vegetation is generally in a severe state of degradation. In the commercial game farming areas, particularly along the Corridors 1 and 8, the original woodland vegetation still persists (FIGURE 8) and human population densities are reasonably limited, compared to some of the other areas. In these areas, the presence of cattle and game carcasses could attract vultures, Marabou Storks and the occasional Tawny Eagle. The open woodland country will also be attractive to snake eagles, particularly Black-breasted Snake Eagles. In these areas, it could be expected that most of the medium to large raptors will still occur, for example Martial Eagle, Bateleur, Wahlberg's Eagle, Steppe Buzzard, Jackal Buzzard and Brown Snake Eagle.

FIGURE 8: Pristine woodland habitat within Corridor 1

2.3 Bird Sensitive Areas

2.3.1 *CAR Data*

Cranes, bustards, storks and other large birds that spend most of their time on the ground, need wide, open spaces and are certainly not restricted to protected areas. Agricultural habitats are used extensively for feeding, roosting and breeding, often because no natural, pristine habitats are available, and sometimes because the agricultural habitats are especially attractive to birds. The Co-ordinated Avifaunal Roadcounts (CAR) project monitors the populations of 21 species of large 'terrestrial' birds in agricultural habitats (Young *et.al.* 2003). Although CAR road counts do not give an absolute count of the all the individuals in a population, they do provide a measure of relative abundance in a particular area.

There are no CAR routes within the confines of the study area. This data will therefore not be assessed further.

2.3.2 CWAC Data

A CWAC site is any body of water, other than the oceans, which supports a significant number (set at approximately 500 individual waterbirds, irrespective of the number of species) of birds which use the site for feeding, and/or breeding and roosting (Harrison and Harebottle, 2002). This definition includes natural pans, vleis, marshes, lakes, rivers, as well as a range of manmade impoundments (i.e. sewage works). The presence of a CWAC site within the study area is an indication of a large number of bird species occurring there and the overall sensitivity of the area.

A number of CWAC sites (Doorndraai Dam, Moorddrift Dam, Rondepan Farm Dams, Kalkfontein Irrigation Dams, Doornbult Farm Dam, Polokwane Bird Sanctaury, Polokwane Nature Reserve, Turfloop Dam and Deloskop Farm Dam) exist within the immediate surrounds of the proposed

corridors. However it is worth noting that none of proposed substation sites and corridors traverse across any of the abovementioned CWAC sites (FIGURE 9).

2.3.3 IBA Data

Some sites are exceptionally important for maintaining the taxa dependent upon the habitats and ecosystems in which they occur. Vigorous protection of the most critical sites is one important approach to conservation. Many species may be effectively conserved by this means. Patterns of bird distribution are such that, in most cases, it is possible to select sites that support many species. These sites, carefully identified on the basis of the bird numbers and species complements they hold, are termed Important Bird Areas (IBAs). IBAs are selected such that, taken together, they form a network throughout the species' biogeographic distributions. IBAs are key sites for conservation – small enough to be conserved in their entirety and often already part of a protected-area network. They are responsible for one (or more) of three things:

- Hold significant numbers of one or more globally threatened species
- Are one of a set of sites that together hold a suite of restricted-range species or biome-restricted species
- Have exceptionally large numbers of migratory or congregatory species

None of the proposed corridors or substation sites are located within an Important Bird Area. The closest IBAs to the proposed corridors are the Waterberg and Nyl River Floodplain systems, Blouberg Vulture Colony, Wolkberg Forest Belt and Pietersburg Nature Reserve (FIGURE 9).

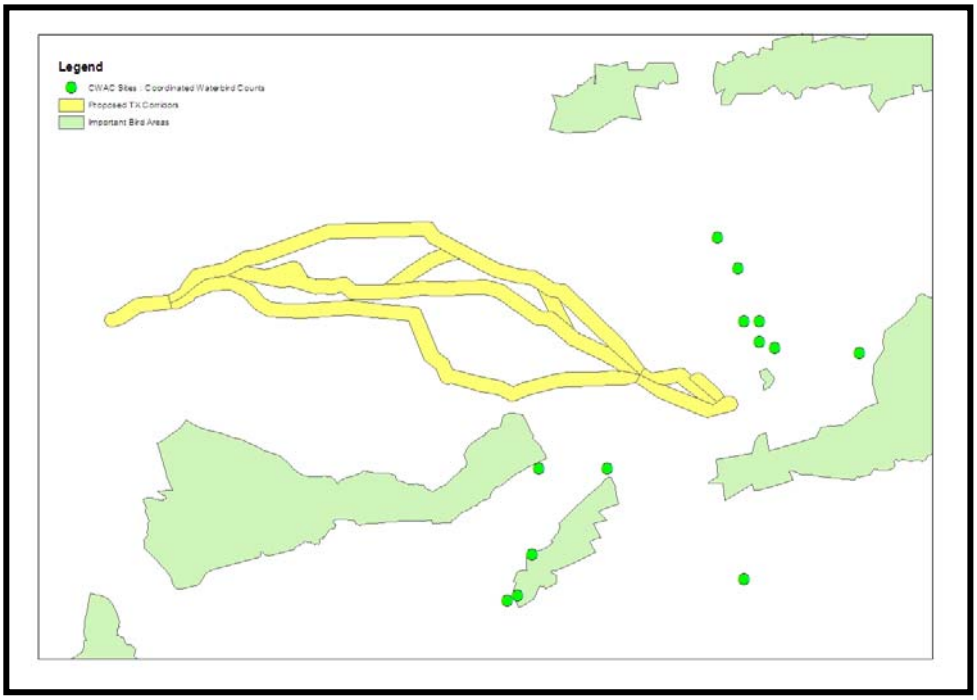

FIGURE 9: Map of the study area with CWAC (green point data) and IBA locations (green polygon data) relative to the proposed substation sites and route alignments

ENPAT Data

Relevant to this study ENPAT data reveals that all areas of faunal and conservation significance occur outside of the study area and pertain specifically to mammals. This data will therefore not be assessed further.

2.3.4 I&AP Data

The following data presented in TABLE 2 was received from I&APs with regards to resident avifauna and breeding sites:

TABLE 2. Responses to a written questionnaire and telephonic survey directed to I&APs

WRITTEN QUESTIONNAIRE			
Farm / Property Name	**Resident Species**	**Breeding**	**Corridor**
Thabankulu	Secretarybird, korhaans, Kori Bustard, Denham's Bustard, Martial Eagle, Crowned Eagle	Number of breeding species in the Palala and Goud Rivers	3 (no longer applicable)
Izintaba	Secretarybird, Denham's Bustard, various water dependent species	Breeding pair of Denham's Bustard	3 (no longer applicable)
Eastland 441 LR	Secretarybird, korhaans, Kori Bustard	Raptor and owl nests	2
Donkerhoek 615 LQ Leopard Leap	Southern Ground Hornbill, bustards and African Fish Eagle	None reported	3 (no longer applicable)
Swebeswebe 870 LR	Korhaans, Black Stork, bustards and African Fish Eagle	None reported	1
Turflaagte 214 LR Gaspare Spanio	Secretarybird and korhaans **VULTURE RESTAURANT**	None reported	2
Zoetfontein 612 LQ Waterberg Sanctuary	Kori Bustard, korhaans, Secretarybird	Breeding pair of Verreaux's Eagle, Black Stork and African Fish Eagle	3
Grobelaarshoek 462 LR	Kori Bustard, korhaans, Secretarybird	None reported	2
Smitswinkel 446	Kori Bustard, korhaans, Secretarybird, vultures, owls, and various raptors	Breeding sites – species not specified	2
Roodepunt 689 LQ Bergsig 598 LQ Tswana Game Reserve	Bustards and African Fish Eagles	None reported	3 (no longer applicable)
Daggakraal 591 LR	Kori Bustard, korhaans, Secretarybird	Breeding pair of African Fish Eagles	1
Pieterman 445 LR	Kori Bustard, korhaans, Secretarybird	Breeding raptors and vultures	2
Dew Drop 161 LR Pretorius Myn 157 LR	Kori Bustard, korhaans, Secretarybird	Breeding Kori Bustard, korhaans, Secretarybird and raptors	2

Rooibokpan 216 LR Marken Safaris	Kori Bustard, korhaans, Secretarybird	Breeding Kori Bustard, korhaans, Secretarybird	2
Deugdzaamheid 197 LR	Kori Bustard and korhaans	None reported	2
Shelanti Game Ranch	Kori Bustard, korhaans, Secretarybird and vultures **VULTURE RESTAURANT**	None reported	2
Moon River	Kori Bustard, korhaans, African Fish Eagles	None reported	3 (no longer applicable)
Tholo 704 LQ Tholo Bush Estate	African Fish Eagles	None reported	3 (no longer applicable)
Iganu Game Ranch	Secretarybird, Kori Bustard, Southern Ground Hornbill	Breeding pair of Secretarybirds	2
Gouda 453 LR	Southern Bald Ibis, Secretarybird, Southern Ground Hornbill and korhaans	None reported	2
Lindani Game Lodge	Secretarybird and bustards	Breeding pair of Verreaux's Eagles	3 (no longer applicable)
Klipplaat 34 KR Grootfontein 31 KR Madikela Game Lodge	Secretarybird, korhaans, Southern Ground Hornbill	None reported	1, 2 and 8
Klipfontein 30 KR Palala 35 KR Jobedi Game Lodge	Korhaans, bustards	Breeding pair of African Fish Eagles	1
Varkensfontein 641	Korhaans, Secretarybird, Southern Ground Hornbill, bustards and Southern Bald Ibis	None reported	1 and 3
Mujabe Game Farm	Korhaans, Secretarybird, Southern Ground Hornbill and bustards	Breeding eagles – species not specified	1
TELEPHONIC/EMAIL SURVEY – APRIL 2010			
Farm/Property Name	**Resident Species**	**Breeding**	**Corridor**
Marken 457 portion 00015	Herons (species not specified)	None reported	8 Deviation
Marken 457 portion 00013	None reported	None reported	8 Deviation
Marken 457 portions 00005, 00016 and 00018	Secretarybird, African Fish Eagle, Herons (species not specified) Vultures (Species not specified and Korhaans (species not specified)	Yes, species not specified	8 Deviation
Marken 457 portions 00003 and 00019	Herons (species not specified) and has observed Bald Ibis on the property	None reported	8 Deviation
Marken 457 portions 00020 and 00021	None reported	None reported	8 Deviation
Marken 457 portion 00023	None reported	None reported	8 Deviation
Marken 457 portion 00026	None reported	None reported	8 Deviation
Klipput 458 portion 0000	None reported	None reported	8 Deviation

KETA Republiek 456 portions 00002 and 00003 Goedbevonden 454 portions 00000, 00001 and 00002	None reported	None reported	8 Deviation
BLUE CLOUD INV 7 PTY LTD Marken 457 portions 00000 and 00010	None reported	None reported	8 Deviation
Marken 457 portion 00001	None reported	None reported	8 Deviation
NEDERDUITSE GEREFORMEERDE KERK VAN TRANSVAAL-MARKEN Marken 457 portion 00008	Kori Bustard, Secretarybird, Vultures (species not specified) Martial Eagle and African Fish Eagle **UNICO Safaris has a vulture restaurant**	None reported	8 Deviation
Marken 457 portions 00009 and 00017	None reported	None reported	8 Deviation
N T K LIMPOPO AGRIC LTD Marken 457 portion 00012	Martial Eagle, Secretraybird, Kori Bustard, Herons (species not specified) and Egyptian Geese Observed Southern Ground Hornbill on farm recently	None reported	8 Deviation
Liliefontein506 portion 00000	None reported	None reported	8 Deviation
Welgevonden 449 portion 00000	Secretarybird, Kori Bustard, Martial Eagle, Owls (species not specified) and Korhaans (species not specified) **Small vulture restaurant**	None reported	8 Deviation
NATIONAL GOVERNMENT OF THE REPUBLIC OF SOUTH AFRICA Grootpan452 portion 00000	None reported	None reported	8 Deviation
Gouda 453 portion 00000	Vultures, Herons and Korhaans (species not specified) Secretraybird and Kori Bustard	None reported	8 Deviation (corridor 2)
Gouda 453 portion 00001	Herons and Korhaans (species not specified) and Secretraybird	None reported	8 Deviation (corridor 2)
Sterkforntein 459 portion 00002	Large raptors, vultures and herons (species not specified)	Raptors nest on property	8 Deviation
Murchison 460 portion 00006	Martial Eagle, Kori Bustard, Vultures and large raptors (species not specified)	Raptors nest on property	8 Deviation

Murchison 460 portion 00007	Secretarybird, Kori bustard, herons and large raptors (species not specified)	Raptor nests on property	8 Deviation
Murchison 460 portion 00009	Secretarybird, Kori bustard, Owls, large raptors and vultures (species not specified)	Several raptor nests on property including Brown-headed Parrot and Owl (species unknown)	8 Deviation
CORNIC MAKELAARS CC Grobbelaarshoek 462 portion 00000	Kori bustard, African Fish Eagle, korhaans and large raptors (species not specified)	Raptor and African Fish Eagle nests on property	8 Deviation (corridor 2)
Diepspruit 463 portion 00000	Secretarybird, African Fish Eagle and korhaans (species not specified)	Fish Eagles	8 Deviation
Diepspruit 463 portion 00001 – Farm Sold	None reported	None reported	8 Deviation
Diepspruit 463 portion 00002 Groenefontein 494 portion 00000	Secretarybird, korhaans (species not specified)	African Fish Eagles	8 Deviation
Kleindenteren 495 portion 00000	None reported	None reported	8 Deviation
Burgersvlei 496 portion 00000	None reported	None reported	8 Deviation

Of the 25 respondents to the written questionnaire, 12 of the properties (48%) are located within Corridor 2. The presence of large terrestrial bird species (Kori Bustard, Secretarybird, Southern Ground Hornbill and various bustard species) and breeding sites reported on each these properties highlights the sensitivity of this corridor particularly with regards to collisions, habitat destruction and disturbance associated with the construction of the 400kV Medupi-Mokopane power lines. Although the collision mechanism can be mitigated, large portions of the power line (if constructed within Corridor 2) will have to be marked at a considerable cost. Habitat destruction and disturbance are not easily mitigated; therefore it is recommended that construction of the power line within this corridor be avoided. It must also be noted that both of the vulture restaurants located on the Shelanti Game Reserve and Turflaagte properties respectively, are also situated within Corridor 2. It is highly probable that the vultures, feeding at these sites, will roost on the 400kV structures further increasing the likelihood of collisions (as the vultures jostle for space on the towers) if the proposed Medupi-Mokopane power line is constructed within close proximity to these restaurants. In addition to this, a significant threat to the quality of the electrical supply will also be posed as a result of streamer induced faulting and faecal pollution associated with vultures. Again, this impact can be mitigated through the use of bird guards (an anti-perching device) however the efficacy of the devices, particularly if installed incorrectly, is questionable.

A smaller proportion of the respondents (i.e. six properties – 24%) are located within Corridor 1. Similarly, the presence of large terrestrial bird species in this corridor also highlights the potential collision risk associated with the proposed Medupi-Mokopane power line. It is likely that significant sections of line will have to be mitigated if the power line is to be constructed

within this corridor. The vegetation within Corridor 1 is also considerably less transformed compared to that of corridors 2 and 8 where a change in land use i.e. subsistence and commercial agriculture, the establishment of settlements and development of an existing transmission power line has resulted in significant tracts of natural veld having been transformed; therefore the habitat destruction and disturbance impacts associated with the construction and maintenance of the proposed power line within Corridor 1 will be significant. As mentioned previously, these impacts are not easily mitigated and construction in this corridor should rather be avoided.

A dedicated telephonic/email survey was conducted (in May 2010) with landowners affected by the proposed **corridor 8 deviation**. The EWT was able to contact and receive bird related information from 29 landowners during this process. The presence of large terrestrial bird and water dependent bird species (Kori Bustard, Secretarybird, Southern Ground Hornbill, various bustard and heron species) and breeding sites reported on each these properties also highlights the sensitivity of this particular corridor particularly with regards to collisions, habitat destruction and disturbance associated with the construction of the 400kV Medupi-Mokopane power lines. An additional two vulture restaurants were reported to occur in this corridor. It is highly probable that the vultures, feeding at these sites, will roost on the 400kV structures further increasing the likelihood of collisions (as the vultures jostle for space on the towers) if the proposed Medupi-Mokopane power line is constructed within close proximity to these restaurants. In addition to this, a significant threat to the quality of the electrical supply will also be posed as a result of streamer induced faulting and faecal pollution associated with vultures. Again, this impact can be mitigated through the use of bird guards (an anti-perching device) however the efficacy of the devices, particularly if installed incorrectly, is questionable.

The respondents whose properties are located within Corridor 3 were not assessed further, as the corridor is not considered to be feasible from a technical perspective.

2.4 Power line sensitive bird species occurring in the study area

TABLE 3 below lists the Red Data (Barnes 2000) bird species recorded in the 2327DA, 2327DB, 2327DC, 2327DD, 2328CA, 2328CB, 2328CC, 2328CD 2328DA, 2328DB, 2328DC, 2328DD, 2428AB, 2428BA, 2329CC, 2329CD, 2429AA and 2429AB quarter degree squares. A total of 30 Red-Data bird species were recorded across the 18 squares during the atlas period (Harrison *et al*, 1997). One of these is classified as 'endangered', 14 of these species are classified as 'vulnerable' and 15 as 'near threatened' (Barnes, 2000). In addition to the Red Data species, the White Stork and Abdim's Stork are included in TABLE 3 as both are protected internationally under 'The Bonn Convention on Migratory Species'. As mentioned elsewhere in this report, the atlas data is now relatively old, having been collected during the period leading up to 1997. The spatial scale of the atlas data is also relatively large i.e. the quarter degree square. This means that certain species could have been recorded in a square but not necessarily in this study area. This emphasises the importance of the approach taken by this study, in which the micro habitats available along the proposed corridors are evaluated for their potential to be used by Red Data and other species. This "potential for occurrence" of a species, in conjunction with the Atlas data on distribution and abundance provides a strong basis for the assessment on

the impact of the proposed developments. Furthermore, despite its shortcomings, the atlas data remains our best formal, scientifically presented data source for the study area.

TABLE 3: Red Data species recorded across 18 quarter degree squares (Harrison *et.al.* 1997).

Species	Cons. status	Preferred habitat
Saddle-billed Stork	E	Rivers
Southern Bald Ibis	V	Heavily grazed pastures, cultivated lands
African White-backed Vulture	V	Woodland
Cape Griffon	V	Woodland, cliffs
Tawny Eagle	V	Woodland
Martial Eagle	V	Anywhere within the study area
Bateleur	V	Woodland
White-backed Night-Heron	V	Rivers with dams with overhanging vegetation
African Finfoot	V	Rivers with thick riparian vegetation
Blue Crane	V	Grassland, old lands
Kori Bustard	V	Grasslands, open woodland
Denham's Bustard	V	Grasslands, occasionally in cultivated fields
White-bellied Korhaan	V	Grassland, old lands
Lesser Kestrel	V	Fallow fields
African Grass Owl	V	Tall, dense grassland
Black Stork	NT	Rivers, dams and cliffs
Marabou Stork	NT	Anywhere in the study area
Woolly-necked Stork	NT	Rivers, pans and dams
Yellow-billed Stork	NT	Rivers and dams
Greater Flamingo	NT	Rivers and dams
Lesser Flamingo	NT	Rivers and dams
Secretarybird	NT	Old lands, open grassland patches, open woodland
Pallid Harrier	NT	Grasslands, occasionally in cultivated fields
Lanner Falcon	NT	Grassland and cultivated fields
Half-collared Kingfisher	NT	Rivers
Greater Painted Snipe	NT	Dams and pans
Black-winged Pratincole	NT	Fallow fields devoid of vegetation
Short-clawed Lark	NT	Sparsely vegetated woodland
Melodious Lark	NT	Grasslands, occasionally in planted pastures
Red-billed Oxpecker	NT	Open woodland
White Stork	Bonn	Cultivated land, fallow fields and dams
Abdim's Stork	Bonn	Grassland patches, cultivated and fallow fields

The majority of the Red Data species listed above are physically large species, meaning that they are capable of interacting directly with electrical infrastructure through collision, nesting, and electrical faulting. All bird species, including even the smaller ones are vulnerable to indirect impact by the proposed development through factors such as disturbance and habitat destruction.

Although this assessment focuses on the impacts on Red Data species as these are the species of highest conservation concern, the impact on the more common species has also been taken into account, although not on an individual species basis. Certain key species known to interact with power lines were assessed, rather than an exhaustive list of all species. It should

also be noted that since the impacts are usually the same across various species, the Red Data species can often be used as surrogate species for the others in terms of impacts and the necessary mitigation.

3. DESCRIPTION OF THE PROPOSED ACTIVITIES

3.1. Description of the potential substation sites

This component of the Mokopane Integration Project considers three alternative sites for the placement of the proposed Mokopane Substation:

Option 1:

This option is located on the farm Doornfontein, portion 721 LS, with co-ordinates
S 23°56.819 and E 029°04.219

Option 3:

This option is located on the farm Zuid Holland, portion 773 LR, with co-ordinates
S 23°52.659 and E 028°56.520

Option 4:

This option is located on the farm Noord Braband, portion 774 LR, with co-ordinates
S 23°53.905 and E 028°58.752

3.2 Description of the potential corridors

This component of the Mokopane Integration Project considers three alternative corridors for the Medupi-Mokopane 400kV power lines, an additional three alternative corridors for the Mokopane-Witkop 400kV power line and a single corridor for the Delta-Medupi 400kV power line.

Corridor 1 (Medupi-Mokopane):

The corridor south of the existing Matimba-Witkop 400kV power line. This corridor has been routed in such a manner that it now largely avoids the Waterberg Biosphere Reserve.

Corridor 2 (Medupi-Mokopane):

The most northerly of the three corridors

Corridor 4 (Mokopane-Witkop):

The southern alternative

Corridor 5 (Mokopane-Witkop):

The northern corridor that follows the existing Matimba-Witkop 400kV power line.

Corridor 6 (Mokopane-Witkop):

An adaptation of the northern corridor that follows the existing Matimba-Witkop 400kV power line and then also the Warmbad-Wikop power line.

Corridor 7 (Delta–Medupi):

A single corridor connecting the new Delta substation to the Medupi substation.

Corridor 8 - Existing Matimba-Witkop Corridor (Medupi-Mokopane): The corridor that runs parallel to the existing Matimba-Witkop 400kV power line

Corridor 8 Deviation - (Medupi-Mokopane): This corridor runs parallel to the existing Matimba-Witkop 400kV power line emanating from the Medupi substation, deviates in a north-easterly direction to follow Corridor 2 and then deviates in a south easterly direction to again

follow the existing Matimba-Witkop 400kV power line. This deviation accommodates the technically constrained areas associated with Corridor 8.

4. ASSESSMENT OF IMPACTS

4.1 Description of generic avifaunal 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). Other problems are electrical faults caused by bird excreta when roosting or breeding on electricity infrastructure, (Van Rooyen and Taylor 1999) and disturbance and habitat destruction during construction and maintenance activities.

Below follows a short background discussion of the above impacts which should be read in conjunction with the impact assessment table in APPENDIX 4. The nature of each impact was assessed using criteria supplied by Savannah Environmental (Pty) Ltd (APPENDIX 1).

4.1.1 Electrocutions

Electrocution of birds on overhead lines is an important cause of unnatural mortality of raptors and storks. It has attracted plenty of attention in Europe, USA and South Africa (APLIC 1994; van Rooyen and Ledger 1999). However, in the context of overhead lines above 132kV, electrocutions are not a major issue. 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). Due to the large size of the clearances on most overhead lines of above 132kV, electrocutions are generally ruled out as even the largest birds cannot physically bridge the gap between dangerous components. In fact, transmission lines have proven to be beneficial to many birds, including species such as Southern Bald Ibis, Martial Eagles, Tawny Eagles, African White-backed Vultures, and even occasionally Verreauxs' Eagles by providing safe nesting and roosting sites in areas where suitable natural alternatives are scarce (van Rooyen 2004). Cape Vultures have also taken to roosting on power lines in certain areas in large numbers, while Lappet-faced Vultures are known to use power lines as roosts, especially in areas where large trees are scarce (pers.obs.).

Electrocutions are not envisaged as an impact on the proposed 400kV transmission loop-in and loop-out line emanating from the new Mokopane substation as well as the proposed Delta-Medupi, Medupi-Mokopane and Mokopane-Witkop 400kV power lines as the relevant clearances between live parts and live and earthed components exceed the wingspan of any bird.

Electrocutions of certain bird species within the substation, during its operation, could potentially have a negative impact on a variety of bird species, particularly those species that

regularly utilise the electrical infrastructure within the substation yard on which to breed and nest e.g. crows, herons, sparrows, owls and geese. However, the more sensitive eagle species recorded in the area do not utilise substation yards extensively and therefore the significance of the impact is considered to be negligible. This impact will therefore not be assessed further.

4.1.2 Collisions

Collisions are the biggest single threat posed by transmission lines to birds in southern Africa (van Rooyen 2004). 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). Unfortunately, many of the collision sensitive species are considered threatened in southern Africa. Many of the heavily affected species are Red Data species (EWT unpublished data).

The Red Data species vulnerable to power line collisions are generally long-lived, slow reproducing species under natural conditions. Some require very specific conditions for breeding, resulting in very few successful breeding attempts, or breeding might be restricted to very small areas. These species have not evolved to cope with high adult mortality, with the result that consistent high adult mortality over an extended period could have a serious effect on a population's ability to sustain itself in the long- or even medium-term. Many of the anthropogenic threats to these species are non-discriminatory as far as age is concerned (e.g. habitat destruction, disturbance and existing power lines) and therefore contribute to adult mortality, and it is not known what the cumulative effect of these impacts could be over the long term.

Relevant to this study, the earth wire of the 400kV power lines will be the biggest risk from a bird collision perspective. Birds in flight tend to see the bundled conductors, and then gain height to avoid them. In the process, the much thinner earth wire is not noticed and the birds may then collide with it (APLIC 1994). The species most likely to be impacted upon include the Blue Crane, Secretarybird, Southern Bald Ibis, Denham's Bustard, Kori Bustard, White-bellied Korhaan, Greater and Lesser Flamingos, the various vulture and stork species. The dams, rivers, pans, wetlands and arable lands identified, during the field investigations, will undoubtedly attract most of these species and since these habitats feature along each of the proposed corridors, it is likely that significant mitigation will have to be employed regardless of the corridor chosen, however this is particularly true for Corridors 1, 2 and sections of the corridor 8 deviation (TABLE 2).

4.1.3 Habitat destruction

During the construction and maintenance of power lines and substations, 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 minimise the risk of fire under the line, which can result in electrical

flashovers. These activities have an impact on birds breeding, foraging and roosting in or in close proximity of the servitude through modification of habitat.

In general, much of the proposed study area surrounding all three of the substation site options is disturbed and degraded to some extent already. In this context, habitat destruction associated with construction of the proposed 400kV lines turn-ins and substation at any of the sites is not anticipated to be significant. However the proximity of the Groot-Sandsloot and Witrivier river systems relative to Options 3 and 4 must be considered, particularly with regards to future electrical development (i.e. distribution power lines) which will inevitably extend from the new Mokopane Substation. Future construction of power lines in the areas surrounding Options 3 and 4 could potentially impact negatively on the riparian vegetation and resident bird species occurring there through habitat destruction.

Similarly, the vast tracts of woodland in Corridor 1 (Medupi-Mokopane) and sections of Corridor 4 (Mokopane-Witkop) would be particularly vulnerable to habitat destruction. It is likely that the majority of the raptor species recorded in the study area are resident within these woodlands. The clearing of servitudes along these corridors would pose a significant threat to these species as they require large trees in which to breed and nest successfully. Since habitat destruction is not easily mitigated, construction at Options 3 and 4 of the proposed substation sites and Corridors 1 and 4 should be avoided.

4.1.4 Disturbance

Similarly, the above-mentioned construction and maintenance activities 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 season.

Disturbance is anticipated to be a significant impact on avifauna occurring within Corridors 1, 2 and the deviation to Corridor 8 as a number of breeding sites are reported to be located in each of these corridors (TABLE 2). The relatively untransformed woodland vegetation within Corridor 4 suggests that a number of raptor species could potentially be breeding in this area too.

Although existing disturbance levels are moderate to low along Corridors 5, 6, 7, 8, the corridor 8 deviation and at the proposed substation sites (emanating from the existing settlements, agricultural practices and maintenance of existing power lines) it is likely that the cumulative impact of these sources of disturbance could impact negatively on the breeding activities of most bird species occurring in these corridors.

4.1.5 Impact of birds on quality of supply

A number of mechanisms exist through which birds are able to cause electrical faults on transmission lines. Frequent faulting affects the quality of electrical supply to the end customers. Power utilities aim to maximise the quality of supply to customers at all times.

In the case of a bird streamer induced fault, the fault is caused by the bird releasing a "streamer" of faeces which can constitute an air gap intrusion between the conductor and the earthed structure. The fault appears to flash across the air gap (i.e. between the live conductor and the tower steelwork which is earthed) and *does not* follow an insulator creepage path as observed on pollution faults (See Taylor *et al* 1999 for an exhaustive analysis of the propagation characteristics of the bird streamer mechanism). Bird species capable of producing large or long streamers are more likely to cause streamer faults. Bird stomach volume is important in this respect. Larger birds such as vultures and eagles are capable of holding larger quantities of food and therefore defecating larger volumes.

Bird pollution is a form of pre-deposit pollution. A flashover occurs when an insulator string gets coated with pollutant, which compromises the insulation properties of the string. When the pollutant is wetted, the coating becomes conductive, insulation breakdown occurs and a flashover results. Since this involves a build up of bird faeces or bird pollution and not a once off event such as a streamer, the size of the bird is less important, although still a factor. Obviously the more an insulator string becomes coated with faeces, the more likely a fault. Larger birds and congregations of many birds are likely to result in heavy pollution of insulator strings.

Bird nests may also cause faults through nest material protruding and constituting an air gap intrusion. Crows in particular often incorporate wire and other conductive material into their nests. When nests cause flashovers, the nesting material may catch fire. This in turn can lead to equipment damage or a general veld fire. Apart from the cost of replacing damaged equipment, the resultant veld fire can lead to claims for damages from landowners. Certain species such as crows and large eagles are likely to nest on power line towers such as the proposed power line.

Relevant to this study, faulting associated with streamers and faecal pollution is possible on the **self support towers** of the proposed 400kV power lines, particularly those towers that are located close to water sources (rivers, dams and pans). Towers constructed within Corridor 2 will also be highly susceptible to this impact because of the proximity of the two vulture restaurants (i.e. high cumulative impact). An assessment table for this impact has not been compiled as the impact is specific to self support towers in areas close to water sources regardless of the Corridor chosen. The negative impact caused to the quality of the electrical supply can be mitigated through the installation of Bird Guards on towers identified during the site specific EMP (walk down).

5. COMPARISON OF SUBSTATION SITES

All three sites are bordered by secondary roads making them readily accessible for construction and maintenance purposes, preventing further vegetation and possible habitat loss as a result of the construction of an additional road. However, the proximity of the Groot-Sandsloot and Witrivier river systems relative to two of the proposed substation sites i.e. Options 3 (Zuid Holland) and 4 (Noord Braband) must be considered, particularly with regards to future

electrical development (i.e. distribution power lines) which will inevitably extend from the new Mokopane Substation. Future construction of power lines in the areas surrounding Options 3 and 4 could potentially impact negatively on the riparian vegetation and resident bird species occurring there through habitat destruction. It must be borne in mind that through the establishment of the Mokopane Substation, future electrical infrastructure in the form of distribution power lines will undoubtedly be added to the network in and around the substation site. Although the proposed loop-in and loop-out lines may not necessarily cross any of the afore-mentioned river systems at present, there is the potential that additional power lines might just do so, increasing the likelihood of collisions occurring in these sensitive areas. It is therefore recommended that development be restricted to a minimum around these water sources.

Although Option 1 is bordered by cultivated fields, a draw card for various species, the area is already in a state of transformation through a change in land use and is also comprised almost entirely of degraded woodland, limiting the number and diversity of bird species. In addition to this, the absence of water sources and riparian vegetation within the immediate area surrounding this option further highlights its suitability.

In order to demonstrate the relative preference of the three alternatives from an avifaunal perspective, a score of 1 to 10 was assigned to each alternative, based on EWT's experience of bird interactions with electrical infrastructure (TABLE 4). A score of 10 would mean that the substation site is highly preferred, whilst a score of 1 would suggest that the proposed substation site is regarded a 'no go' area.

TABLE 4: Preference scores relating to the proposed Mokopane Substation

Alternative	Preference Score
Option 1	7
Option 3	5
Option 4	5

From the information provided above, coupled with the knowledge and experience of bird interactions with electrical infrastructure it can be concluded that **Option 1 (Doornfontein)** presents itself as the **preferred substation site.**

6. COMPARISON OF THE MEDUPI-MOKOPANE & MOKOPANE-WITKOP CORRIDORS

6.1 Relevant factors in selecting a preferred corridor

The following factors were incorporated in the formula using field observations, the CSIR Land Cover Database and high resolution Google satellite imagery as the main source of data:

- Wetlands and dams: Wetlands and dams are of particular importance for birds in the study area, as the area is relatively arid. Currently the study area contains many large wetlands and dams which is an indicator of a higher collision risk.

- Rivers: The study area contains the Lephalale, Mokolo and Mogalakwena and their tributaries. Rivers are obviously important for birds and many waterbird species occur only along the rivers. The rivers are particularly important for stork species such as Black Stork and Yellow-billed Stork and are an indication of a higher collision risk. *Please note that the number of rivers crossed by each of the alignments has changed significantly from the initial EIA report, due to the use of an updated GIS shape file utilised in this assessment*.
- Woodland: Sections of Corridors 2, 4 and 8 lie within pristine woodland habitat. Woodland is an indication of a higher habitat destruction and disturbance risk.
- Other transmission lines: It is a proven fact that placing a new line next to an existing line reduces the risk of collisions to birds. The reasons for that are two-fold, namely it creates a more visible obstacle to birds and the resident birds, particularly breeding adults, are used to an obstacle in that geographic location and have learnt to avoid it (APLIC 1994). Other transmission lines running parallel to the proposed alignments were therefore treated as a risk reducing factor.
- Roads: These were taken as an indication of human activity and particularly vehicle and pedestrian traffic. It was assumed that the birds will avoid the immediate vicinity of roads due to the presence of traffic and pedestrians, and therefore it will reduce the risk of collision with lines running next to roads.
- Settlements: Towns are obvious centres of human activity and are generally avoided by large power line sensitive species. The presence of towns and settlements is therefore a risk reducing factor. *Please note that the number of settlements has changed significantly from the initial EIA report, due to the use of an updated GIS shape file utilised in this assessment*.
- Irrigation: Irrigation crops, especially lucerne, are important draw cards for species such as cranes and storks, especially in an arid landscape thereby increasing the risk of collisions.
- Fallow lands: Fallow lands create artificial open areas in woodland, which are much favoured by species such as Kori Bustards and Secretarybirds.

6.2 Designing an index to calculate the collision risk in each corridor

The factors mentioned in 6.1 were incorporated into a formula to arrive at a risk rating for each corridor (TABLE 5). The formula was designed as follows:

- The number of a dams or wetlands within 500m of the proposed alignment was calculated.
- The number of rivers crossed by each alignment was counted. *Please note that the number of rivers crossed by each of the alignments has changed significantly from the initial EIA report, due to the use of an updated GIS shape file utilised in this assessment*.
- The distance that the proposed corridors lie directly within pristine natural woodland was measured in kilometres.
- The number of times a primary and/or secondary road was crossed by each of the corridors was calculated.

- The number of settlements located within 1km of each alignment was counted. *Please note that the number of settlements has changed significantly from the initial EIA report, due to the use of an updated GIS shape file utilised in this assessment*.
- The distance that the proposed alignments are directly parallel to other lines was measured.
- The length of alignment running parallel with or across irrigated crops and fallow lands was measured in kilometres.

TABLE 5: Results of measurements and counts for the seven alternatives

Risk Factor	Corridor 1	Corridor 2	Corridor 4	Corridor 5	Corridor 6	Corridor 8	Corridor 8 Deviation
Dams/wetlands	5	4	16	6	5	19	15
River crossings	11	9	2	3	3	10	9
Pristine woodland	71.04	0.00	0.00	0.00	0.00	43.07	0.00
Existing TX lines	3.10	0.00	0.00	33.64	35.64	199.3	113.60
Roads	5	6	2	2	2	7	8
Settlements	9	16	1	3	3	9	13
Irrigation/fallow lands	30.94	59.49	10.26	16.17	18.78	32.96	38.60
Total	**55.04**	**78.49**	**36.26**	**65.81**	**68.42**	**316.33**	**197.20**

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

The following weights were assigned (TABLE 6). Risk reducing factors were assigned a negative weight:

TABLE 6: Risk factors and associated weightings

Risk weighting	
Dams/wetlands	5
River crossings	4
Pristine woodland	2
Irrigation/fallow lands	2
Existing TX lines	-1
Roads	-2
Settlements	-5

The final risk score for a **factor** was calculated as follows: measurements or counts multiplied by the risk weighting. The final risk rating for a **corridor** was calculated as the sum of the risk scores of the individual factors. The preferred option is indicated as the corridor with the lowest risk rating (TABLE 7).

TABLE 7: Preference scores for the seven proposed corridors

Alternatives	Score
Corridor 1 (Medupi-Mokopane)	214.86
Corridor 2 (Medupi-Mokopane)	82.98
Corridor 4 (Mokopane-Witkop)	99.52
Corridor 5 (Mokopane-Witkop)	21.70
Corridor 6 (Mokopane-Witkop)	**19.92**
Corridor 8 (Medupi-Mokopane)	28.76
Corridor 8 Deviation (Medupi-Mokopane)	**-6.40**

Medupi-Mokopane Corridors:

Results of the initial EIA analysis conducted in August 2009 revealed that **Corridor 8** held the least risk from a bird interaction perspective. The presence of the existing Matimba-Witkop 400kV power line within this corridor played a major role in the outcome of the scores, despite the relatively large amount of pristine woodland, agriculture and fallow lands. The area surrounding the existing servitudes is subjected to periodic disturbance as a result of annual maintenance being carried out on the Matimba-Witkop 400kV power line and the mere presence of the existing transmission line could potentially reduce the risk of collisions along the proposed Delta-Witkop and Delta-Mokopane power lines provided that the outer line is constructed within 200m of the existing Matima-Witkop 400kV power lines.

In September 2009, at a specialist integration meeting held after the assessment of the corridors, it emerged that Eskom had concerns regarding the feasibility of Corridor 8. The two concerns raised included the construction of the Medupi-Mokopane 400kV power lines in two narrow gorges along the existing Matimba-Witkop alignment within Corridor 8 and possible resistance from landowners as a result of the appeals made against the ROD relating to the existing Matimba-Witkop power lines. It was therefore concluded that it would not be technically feasible to place the proposed Medupi-Mokopane power lines directly adjacent to the existing lines for its full length and should Corridor 8 be selected as the preferred option, the new lines would have to deviate from the existing lines in a number of places (FIGURE 10). It is unfortunate that this information only became available subsequent to the conclusion of the assessment. This effectively reduced the number of corridors from the legal requirement of three to just two feasible options.

With this new information in mind, Corridor 8 was still considered to hold the least risk from a bird-interaction perspective despite the need for deviations to this corridor, provided that the deviations indicated in FIGURE 10 were:

- the only areas where the proposed lines will deviate from the existing lines;
- the deviation distances are kept short and
- that the deviations denoted in FIGURE 10 are still located within the 5km corridor (that was originally assessed during the EIA phase of the project).

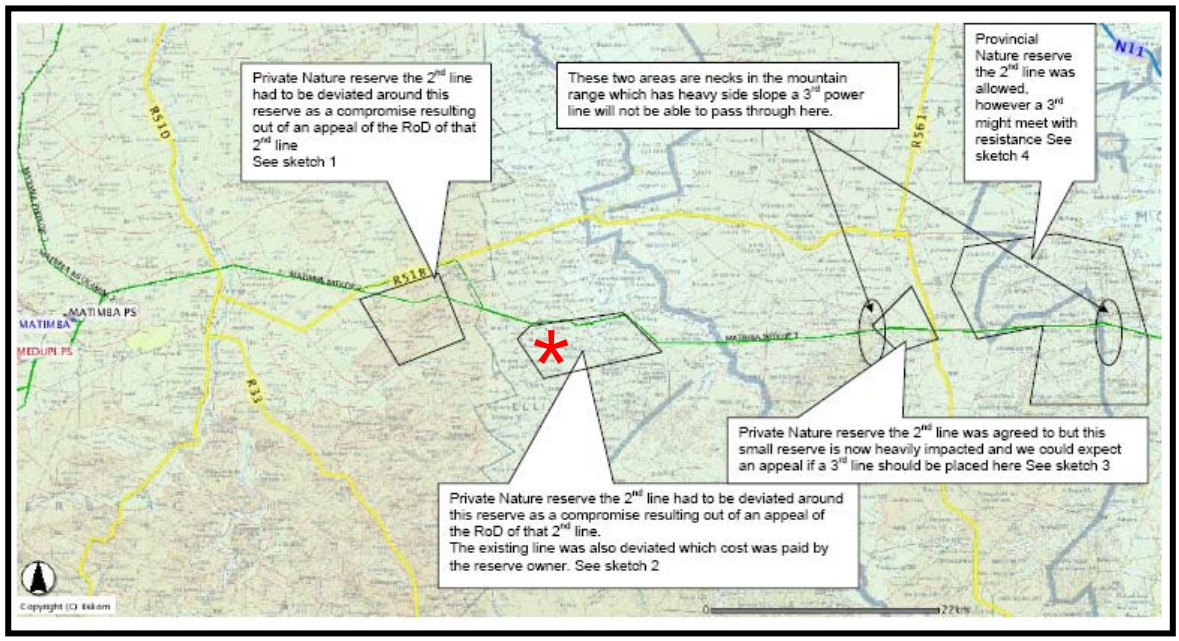

FIGURE 10: Map indicating the two narrow gorges and sections of line that had to be moved as a result of appeals against the Matimba-Witkop ROD

The deviation indicated with a red asterisk (FIGURE 10) would require special attention. The proposed Medupi-Mokopane power lines alongside this nature reserve cannot be placed anywhere within the 5km corridor. It was highly recommended that the proposed line be placed to the north of the existing lines, on the outer side of reserve's northern boundary as indicated in FIGURE 11 below (yellow hatched line).

In light of these comments and the likelihood that Corridor 8 would not be selected, it was suggested at the integration meeting that the EWT nominate a 'next best alternative' from an avifaunal perspective. Based on the risk assessment ratings (TABLE 7), Corridor 2 presented itself as this alternative option, however a series of maps were compiled detailing the no go areas (FIGURES 12 to 17 – highlighted in yellow) within Corridor 2. These areas (pans, dams, irrigated lands and agricultural fields) are classed as no go areas based on their ability to support water dependent and large terrestrial bird species, highly susceptible to collisions with the earth wires of transmission lines, therefore **construction within these areas would have to be avoided**. It must be noted that avoiding these areas would not preclude the marking of the proposed power lines in other areas within Corridor 2. It is likely that extensive marking would be required within this corridor owing to the open nature of the vegetation and its ability to support the large terrestrial bird species recorded in the area. These areas will be identified during the site specific walk down during the EMP phase of the project.

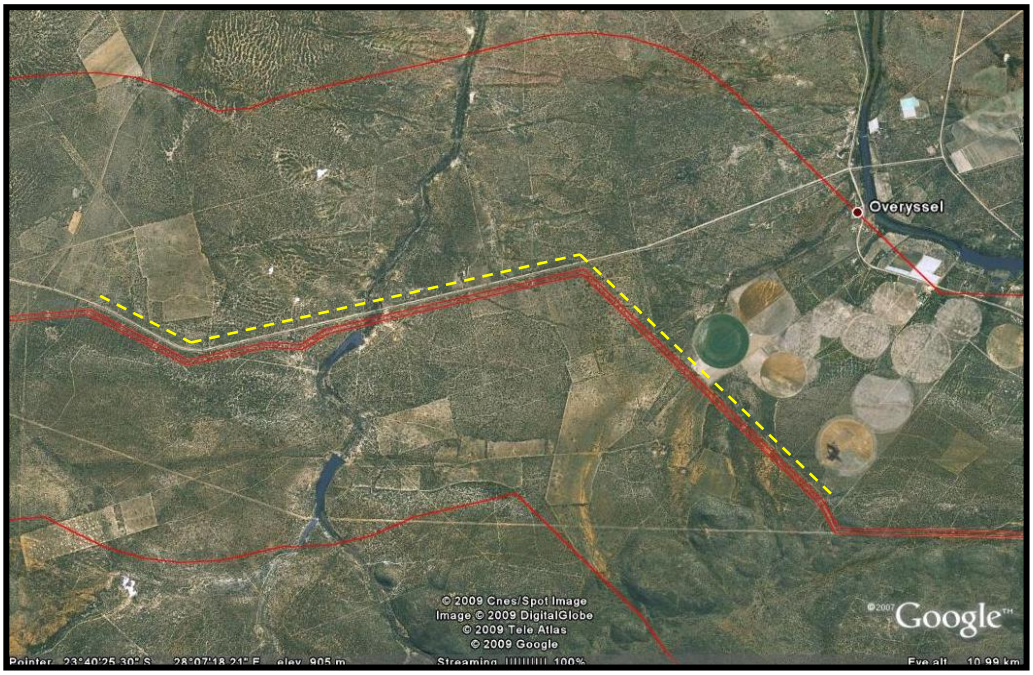

FIGURE 11: The recommended deviation route

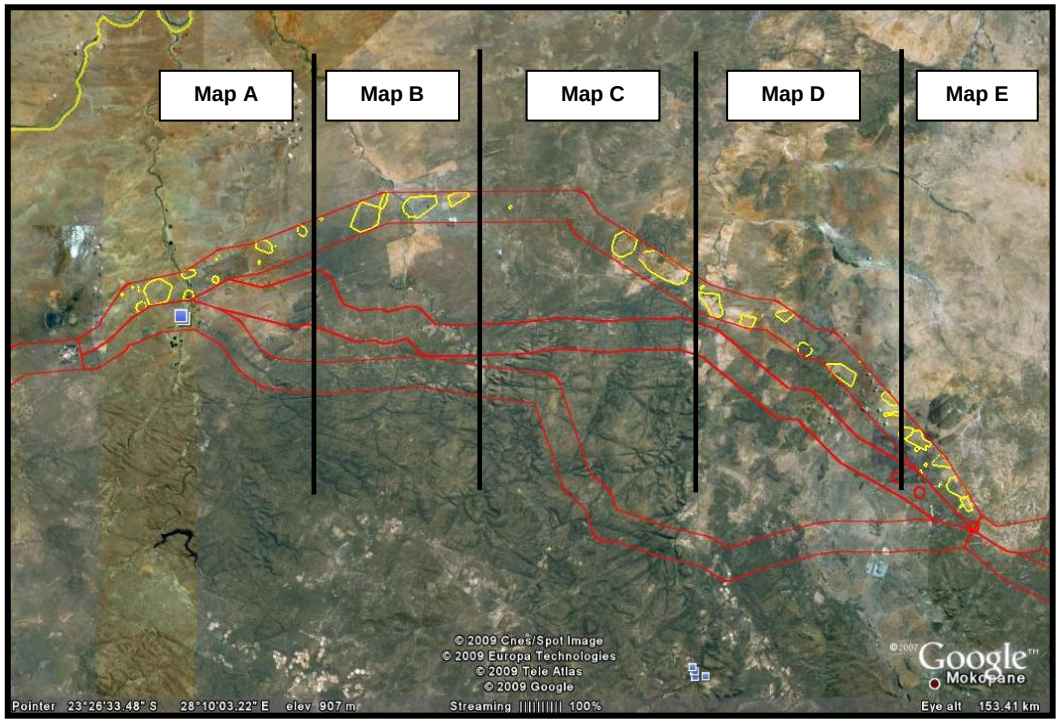

FIGURE 12: No go areas (delineated in yellow) within Corridor 2

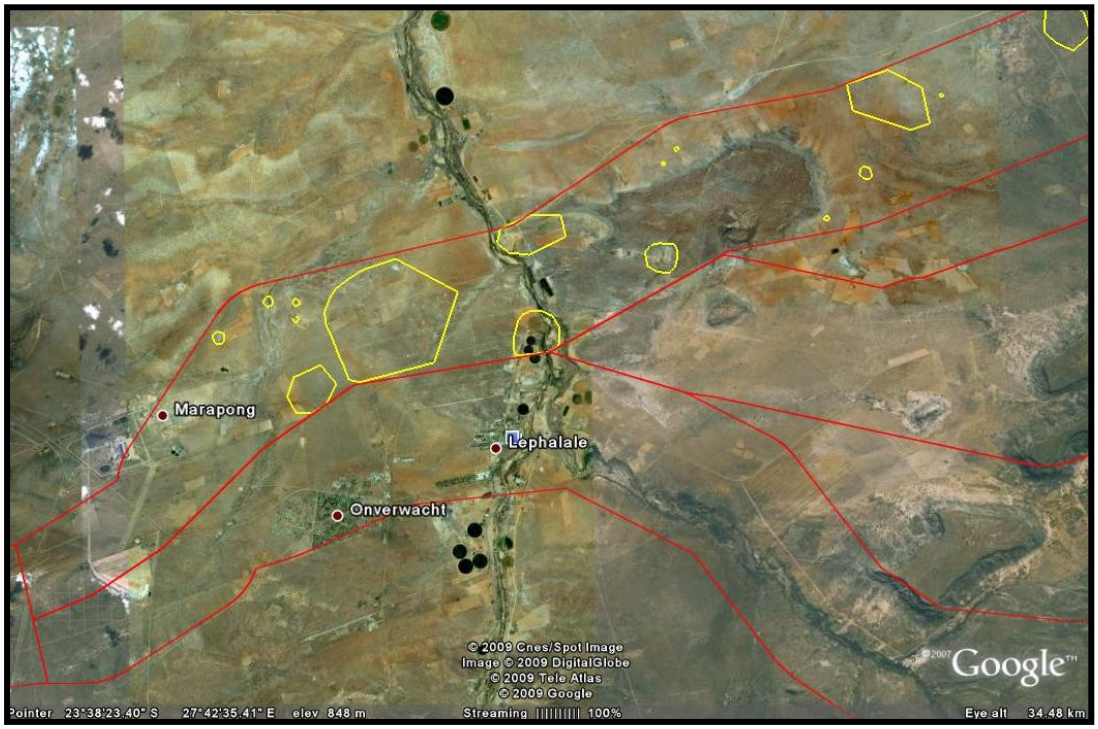

FIGURE 13: No go areas within Corridor 2 (Map A)

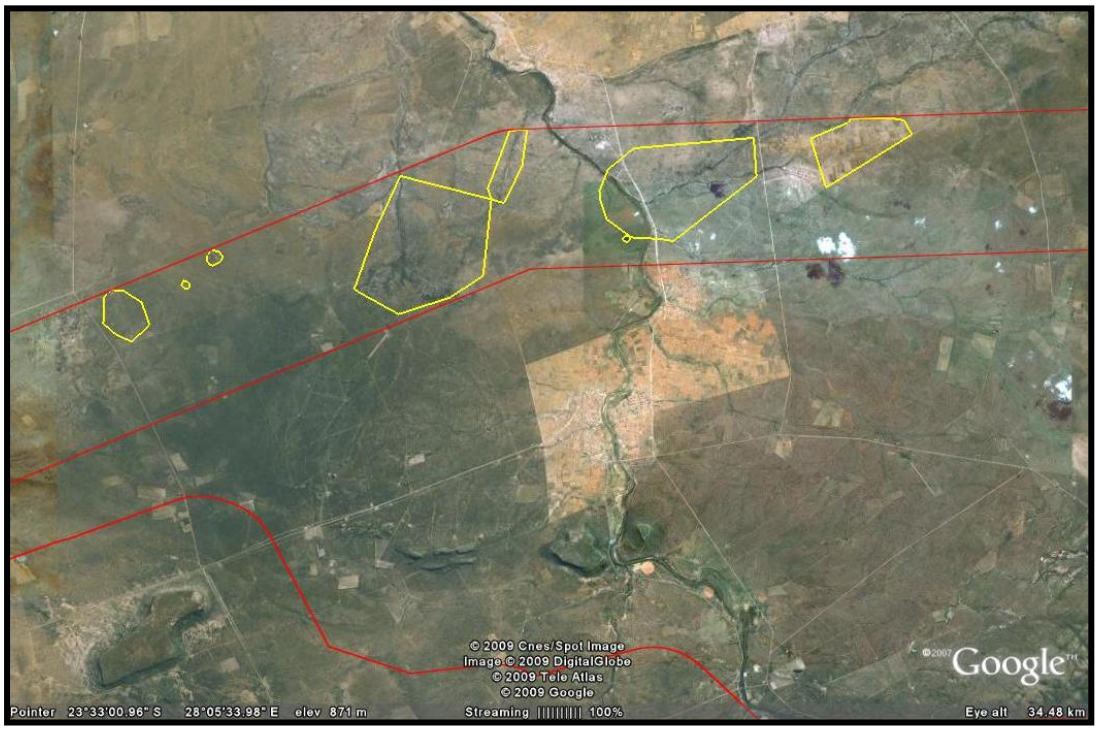

FIGURE 14: No go areas within Corridor 2 (Map B)

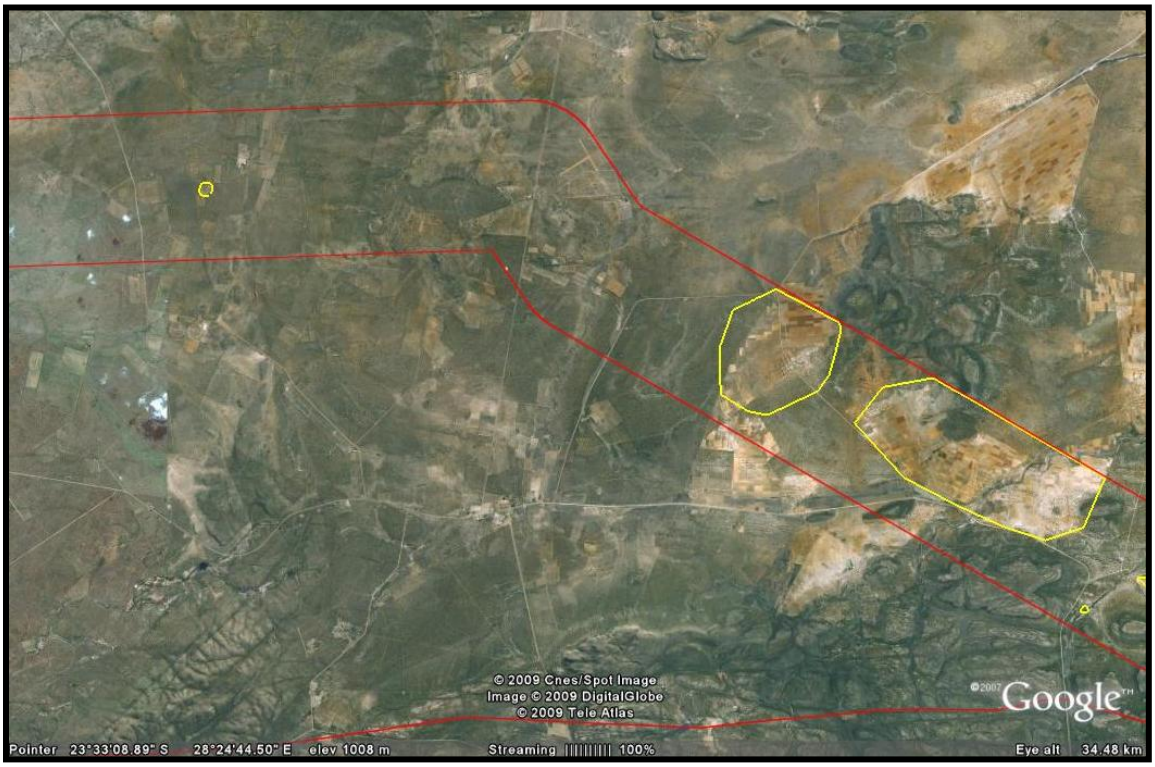

FIGURE 15: No go areas within Corridor 2 (Map C)

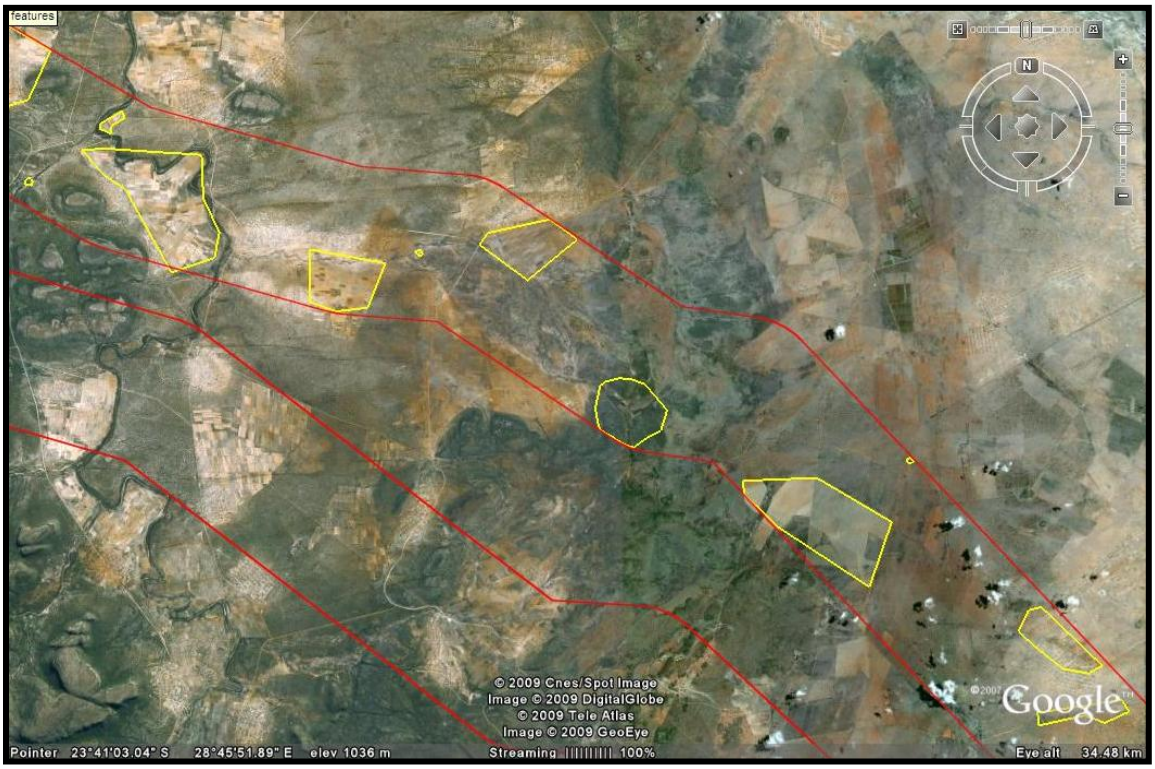

FIGURE 16: No go areas within Corridor 2 (Map D)

FIGURE 17: No go areas within Corridor 2 (Map E)

At a stakeholder meeting held in the Lephalale area in November 2009, a deviation to Corridor 8 was proposed to address the technical constraints associated with Corridor 8. This new corridor was assessed during a site visit to the study area on 4 May 2010 and results of this latest field assessment and risk analysis (TABLE 7 – highlighted in orange), revealed that the **deviation to Corridor 8 is the preferred Medupi-Mokopane alternative from an avifaunal perspective.** It must be borne in mind that the conditions pertaining to the no go areas where the deviation joins corridor 2 are still applicable - **construction within these areas must be avoided**. Again it must be noted that avoiding these areas would not preclude the marking of the proposed power lines in other areas within the deviation from Corridor 8 and Corridor 2. It is likely that extensive marking would be required within these corridors owing to the open nature of the vegetation and its ability to support the large terrestrial bird species recorded in the area. These areas will be identified during the site specific walk down during the EMP phase of the project.

Mokopane-Witkop Corridors:

As far as the Mokopane-Witkop corridors are concerned, **Corridor 6** presents itself as the preferred alternative. This is directly attributed to the presence of an existing transmission line within the corridor. This placement of the proposed Mokopane-Witkop 400kV power line within this corridor will partially mitigate for all of the impacts on avifauna, most particularly that of collision, since the more lines are placed together, the more visible the overhead cables become, and risks are kept together rather than spread out across the landscape.

Delta-Medupi Corridor:

A single Delta-Medupi corridor was assessed using field observations and high resolution Google Earth Imagery during the EIA phase. Although the corridor does not appear to contain any rivers or drainage lines, the vegetation is largely open and as a result susceptible to collision impacts. One must however consider the existing infrastructure contained within this corridor, the proposed Delta Medupi 400kV power line and future developments associated with the Medupi Power Station planned in this area which are likely to displace the Red Data species occurring there. Impacts are considered to be relatively low in contrast with the larger Medupi-Mokopane and Mokopane-Witkop corridors and can be mitigated where necessary.

7. RECOMMENDATIONS FOR MITIGATION

The following are recommended in order to mitigate as far as possible for the above-mentioned impacts:

7.1 Collision with earth wire

Avoid construction in the no go areas within Corridor 2 (should either this corridor or the Corridor 8 Deviation be chosen as the preferred alternative). In addition to this, the earth wire of those sections of line that cross or are in close proximity to the dams, rivers, pans, wetlands and arable lands situated along the final power line alignment must be marked with a suitable marking device according to Eskom Transmission Guidelines (APPENDIX 2). The actual areas where marking will be effected can only be demarcated once a corridor has been selected and an alignment within the corridor finalised. This exercise will have to be done during the 'walk down' of the power line once it has been pegged.

7.2 Habitat destruction during construction activities

All construction and maintenance activities should be carried out according to generally accepted environmental best practices. In particular, care should be taken in the vicinity of the river crossings and woodland areas. Existing roads must be used as far as possible for access during construction. The cutting down of large trees in woodland areas and deep riverine gorges should be avoided.

7.3. Electrocution on the power line and within the substation

Due to the large clearances on the proposed line, electrocution through conventional means is impossible. This impact is therefore insignificant and therefore no mitigation is recommended.

Often pigeons, crows and sparrows roost and nest in substation yards and as a result are occasionally electrocuted on the live hardware. Since we cannot predict with any certainty where birds are likely to nest within the substation yard coupled with the costs associated with insulating the entire substation, electrocutions will have to be mitigated using site-specific recommendations if and when they occur.

7.4 Disturbance during construction activities

It is envisaged that during the construction activities of the new power lines and substation, disturbance of nesting birds is likely to occur and could potentially have an impact on the

breeding population of large raptors and other bird species occurring in the study area (TABLE 2). The breeding season for the large raptor species is from March to November. The most critical period within this time span is from April to May in the beginning when the eggs are incubated. Another sensitive period is from October to November at the end when the young birds are almost ready to fledge. Early in the breeding season the risk of desertion by the adults if disturbed are bigger than later, when the young bird is on the nest and being fed by the adults. At the end of the breeding season the young bird may be tempted to jump out of the nest and fly prematurely if disturbed, resulting in injury or even death. Every attempt will have to be made to restrict the disturbance of raptors and other bird species to a minimum during construction. Wherever possible, nest sites will be identified during the EMP phase of the project and mitigated on a site specific basis.

7.5 Impact on the quality of supply

Both bird streamers and bird pollution occur as a result of birds perching on pylons or towers, often directly above live conductors. This impact is likely to occur on the **self supporting towers** of the Delta-Medupi, Medupi-Mokopane and Mokopane-Witkop 400kV power lines and turns-ins associated with the Mokopane Substation, particularly those towers that are located close to water sources (rivers, dams and pans). Towers requiring mitigation in the form of bird guards (APPENDIX 3), to prevent the birds from perching above critical areas, will be identified during the 'walk down' phase of the project.

8. ENVIRONMENTAL MANAGEMENT PLAN (EMP) TABLES

8.1 Collisions

Objective: Prevent the collision of large terrestrial birds with the Delta-Medupi, Medupi-Mokopane and Mokopane-Witkop 400kV power lines and turns-ins associated with the Mokopane Substation.

Project Components: Earth wires of the Delta-Medupi, Medupi-Mokopane and Mokopane-Witkop 400kV power lines and turn-ins associated with the Mokopane substation.

Potential Impact: Irreplaceable loss of Red-Data bird species (i.e. Blue Crane, Kori Bustard, Secretarybird, Southern Ground Hornbill, Southern Bald Ibis, Denham's Bustard, White-bellied Korhaan, Greater and Lesser Flamingos, various vulture and stork species.

Activity/Risk Source: Marking devices not installed at all and the incorrect application of marking devices.

Mitigation (target and objective): **Avoid construction in the no go areas within Corridor 2 (should either this corridor or the Corridor 8 Deviation be chosen as the preferred alternative)** and install approved bird flight diverters on both earth wires of the Delta-Medupi, Medupi-Mokopane and Mokopane-Witkop 400kV power lines and turn-ins associated with the Mokopane substation.

Mitigation: (Action/Control)	***Responsibility***	***Timeframe***
Approved bird flight diverters To be installed as per the Eskom Transmission Guidelines (APPENDIX 2)	Eskom Contractor ECO	Diverters to be installed during construction prior to being commissioned

Performance Indicator: No collision mortalities reported along the Delta-Medupi, Medupi-Mokopane and Mokopane-Witkop 400kV power lines and turn-ins associated with the Mokopane substation.

Monitoring: ECO to ensure that the correct earth wire spans (identified during the walk down) are marked with an approved marking device and that they are installed according to the correct specification detailed in the Eskom Transmission Guidelines (APPENDIX 2).
Collision mortalities to be reported to the EWT who will conduct an investigation and capture the relevant data into their Central Incident Register.

8.2 Habitat destruction

Objective: Minimise the habitat destruction impact associated with the construction of the Mokopane Substation and associated turn-ins, the Delta-Medupi, Medupi-Mokopane and Mokopane-Witkop 400kV power lines.

Project Components: Levelling of the Mokopane Substation yard and the clearing of servitudes for the Delta-Medupi, Medupi-Mokopane, Mokopane-Witkop 400kV power lines and turn-ins associated with the Mokopane Substation.

Potential Impact: Irreplaceable loss of pristine woodland and riparian vegetation.

Activity/Risk Source: Indiscriminate bush clearing beyond the required 55m for each of the power lines associated with the project, particularly in riparian and woodland areas.

Mitigation (target and objective): All construction and maintenance activities should be carried out according to generally accepted environmental best practices.

Performance Indicator: No unnecessary bush clearing beyond the required 55m, particularly in riparian and woodland areas (micro habitats to be identified during the 'walk down). Existing roads to be used for access during construction and maintenance.

Mitigation: (Action/Control)	***Responsibility***	***Timeframe***
Construction and maintenance activities to be carried out according to generally accepted	Eskom Contractor ECO	During construction and maintenance activities.

environmental best practices.
Cutting down of large trees in riparian
and pristine woodland areas must be avoided
Existing roads to be used during construction
and maintenance activities.

Monitoring: ECO to ensure that bush clearing is kept to a minimum and that the cutting down of large trees in riparian vegetation and deep riverine gorges be avoided. These sensitive micro habitats will be identified during the 'walk down'.

8.3 Electrocution within the Mokopane Substation yard

Objective: Prevent the electrocution of birds within the Mokopane Substation yard

Project Components: Construction and commissioning of the Mokopane Substation

Potential Impact: Significant bird mortalities and an impact on the quality of electrical supply as a result of repeated faulting associated with the electrocutions.

Activity/Risk Source: The design of the live hardware within the substation yard.

Mitigation (target and objective): To prevent electrocutions within the Mokopane substation yard by ensuring that the nests of breeding sparrows, crows and geese are managed effectively and that perching spaces are kept to a minimum.

Performance Indicator: No electrocutions and no faulting associated with the electrocution or nesting material.

Mitigation: (Action/Control)	***Responsibility***	***Timeframe***
Eskom to contact the EWT for site specific recommendations as the need arises	Eskom Transmission	After commissioning during maintenance activities

Monitoring: Electrocution mortalities and repeated faulting associated with nesting birds within the substation yard must be reported to the EWT who will conduct an investigation and provide site specific recommendations

8.4 Disturbance

Objective: Minimise the disturbance impact (associated with the construction of the Mokopane Substation and the Delta-Medupi, Medupi-Mokopane, Mokopane-Witkop 400kV power lines and turn-ins associated with the Mokopane Substation) on breeding raptors, large terrestrial birds and water dependent species.

Project Components: Construction of the Mokopane Substation and turn-ins and the Delta-Medupi, Medupi-Mokopane, Mokopane-Witkop 400kV power lines.

Potential Impact: Disturbance of nesting birds will impact on the breeding success of various bird species.

Activity/Risk Source: Vehicle and pedestrian traffic associated with the construction of the Mokopane Substation and turn-ins and the Delta-Medupi, Medupi-Mokopane, Mokopane-Witkop 400kV power lines.

Mitigation (target and objective): To limit the disturbance impact as a result of excessive vehicle and pedestrian traffic associated with the construction of the Mokopane Substation and turn-ins and the Delta-Medupi, Medupi-Mokopane, Mokopane-Witkop 400kV power lines.

Performance Indicator: No impact on the breeding activities of the various birds present in the area. Breeding sites (TABLE 2) remain active and viable.

Mitigation: (Action/Control)	***Responsibility***	***Timeframe***
Nest sites will be identified during the EMP phase of the project and mitigated on a site specific basis.	Eskom Contractor ECO	During construction activities

Monitoring: ECO to monitor active nesting sites during construction activities and limit access to the nest. ECO to ensure that the amount of vehicle and pedestrian traffic is minimal in close proximity to the nest.

8.4 Impact on the *quality of supply*

Objective: Prevent an impact on the quality of the electrical supply

Project Components: Self supporting towers of the Delta-Medupi, Medupi-Mokopane, Mokopane-Witkop 400kV power lines and the turn-ins associated with the Mokopane Substation.

Potential Impact: Repeated electrical faulting resulting in a poor quality of supply to the end user.

Activity/Risk Source: Streamers from large raptors, vultures, storks and herons.

Mitigation (target and objective): To prevent repeated electrical faulting on the Delta-Medupi, Medupi-Mokopane, Mokopane-Witkop 400kV power lines and the turn-ins associated with the Mokopane Substation.

Performance Indicator: No electrical faulting.