GROMIS-NAMA-AGGENEIS 400KV IPP INTEGRATION: ENVIRONMENTAL SCREENING

Avifaunal specialist report

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1. Executive summary

It is envisaged that the proposed Gromis-Nama-Aggeneis 400kV IPP Integration Power Line will have two major potential impacts on Red Data avifauna, namely displacement due to disturbance of breeding birds, especially breeding Martial Eagles on existing transmission lines, and mortality of large terrestrial species due to collisions with the earthwire of the proposed line. The latter impact is especially concerning as far as the Endangered Ludwig's Bustard is concerned, as the species is known to be highly susceptible to this impact, and conventional mitigation methods, i.e. the marking of the earthwire with Bird Flight Diverters, seems to have limited success in reducing mortality for this species (Shaw *et al.* 2017). It must therefore be accepted that even with current state of the art mitigation, Ludwig's Bustard collisions are likely to still take place, irrespective of which corridor is ultimately selected.

The cumulative impact of transmission lines in the Karoo as far as collision mortality of large terrestrial species is concerned is alarming, and potentially catastrophic as far as Ludwig's Bustard is concerned, with an estimated 41% of the population being killed annually, with Kori Bustards also dying in large numbers (at least 14% of the South African population killed in the Karoo alone) (Shaw 2013). The addition of another transmission line will potentially aggravate the situation further. Ludwig's Bustard migratory movements are along a broad east-west axis (Shaw 2013), which is a mitigating factor to some extent as the line also follows a broad east-west axis, and does not cut diagonally across the general flight path of this species when doing long distance migratory flights. However, research has shown that the highest collision risk occurs when birds are resident in an area between migratory movements, presumably because they fly higher during migratory flights (Shaw 2013).

No electrocution risk is envisaged as the clearances (phase – phase and phase – earth) on the proposed 400kV line are too large for any bird to physically bridge, thereby eliminating any potential for a bird causing a short circuit.

The route corridor alternatives all emerged with very similar risk scores, indicating that the expected impacts are very similar for all alternatives. However, Alternative 1 is the preferred alternative, the reason being that this alternative is situated next to the existing transmission powerline (between Aggeneis, Nama and Gromis substations) which potentially reduces the risk of collisions. Placing the new line next to an existing transmission line should reduce the risk of collisions in the long term, because 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 (Shaw 2013; APLIC 2012; Sundar & Choudhury 2005). Whereas it is acknowledged that this alternative could potentially result in significant short term temporary displacement impacts on breeding eagles on the adjoining existing transmission line during the construction phase, this should be weighed up against the reduction of the risk of long term collision impacts on large terrestrial species. In addition it is recommended that the tower placement of the new proposed line be staggered in relation to the existing line so as to increase the visibility of the line in an attempt to further mitigate the collision risk posed by the powerline (Shaw *et al.* 2017). Although Alternative 1 is preferred from an avifaunal perspective Alternative 5 can also be considered as it is the second-best option.

The proposed mitigation measures should reduce the impact of the proposed line, except for collisions in grassland and low shrubland (specifically as a result of Ludwig's Bustard), where the collision impact will remain medium, even with mitigation.

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5. Background

Eskom proposes to develop a new line from Gromis substation via Nama substation towards Aggeneis substation in the Northern Cape Province.

In order to ensure that the Namaqualand network is compliant and that there is sufficient line capacity to accommodate potential Independent Power Producers (IPPs) within the Namaqualand area, the construction of the new Gromis-Nama-Aggeneis 400 kV line and establishment of a 400/132 kV yard at Nama substation is proposed. The Screening Assessment aims to assess possible route alternatives for the proposed new power line.

5.1. Strategic Environmental Assessment for Strategic Electrical Grid Infrastructure Corridors

In 2016 a Strategic Environmental Assessment (SEA) was undertaken by CSIR. The purpose of the SEA was to identify strategic Electricity Grid Infrastructure (EGI) Corridors to support electricity transmission up to 2040. The vision for the Strategic EGI was to expand in an environmentally responsible and efficient manner that effectively meets the country's economic and social development needs.

The final EGI Power Corridors assessed as part of the 2016 EGI Strategic SEA were gazetted for implementation on 16 February 2018 in Government Gazette 41445, Government Notice R.113. One of these corridors, was the Northern Corridor – Please see Figure 1 for the Gazetted Corridors. The proposed new power line will be constructed within the Northern Corridor.

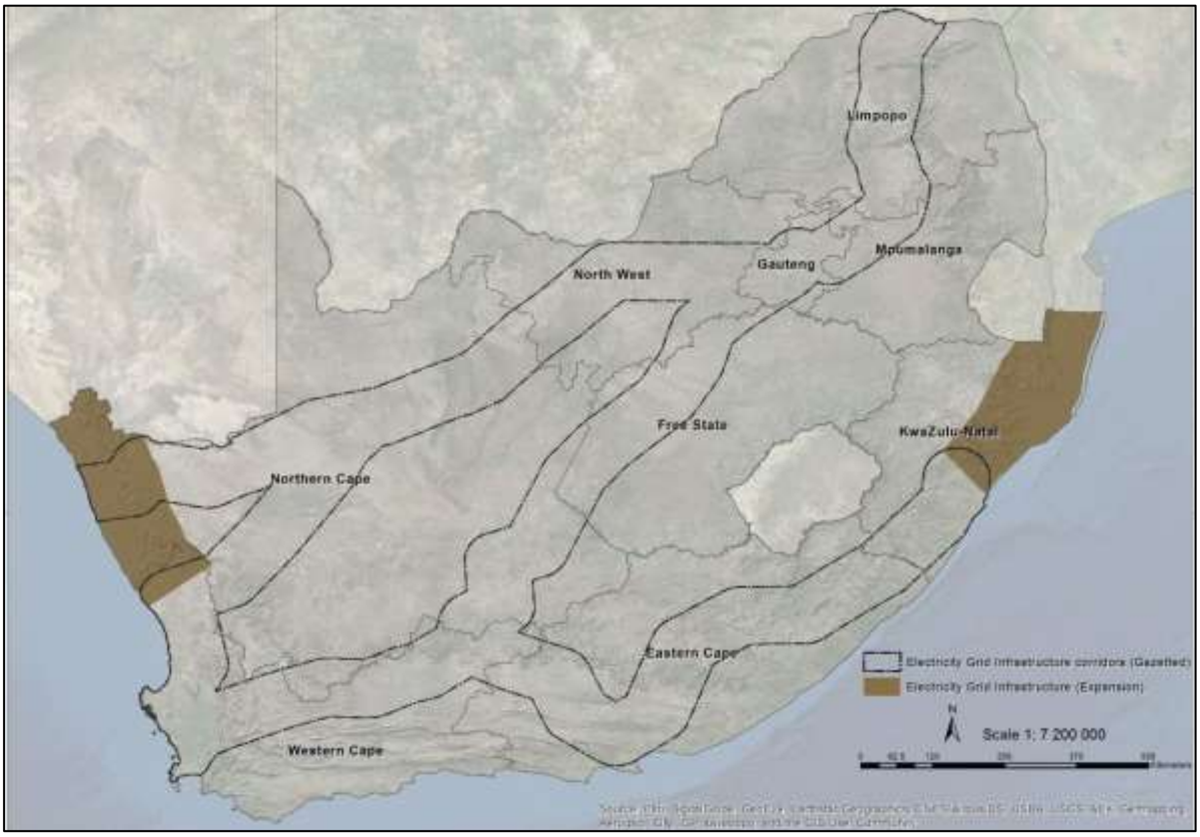

Figure 1: The final Electricity Grid Infrastructure (EGI) Power Corridors assessed as part of the 2016 EGI Strategic Environmental Assessment

5.2. Alternative Environmental Authorisation procedure to be followed

The above mentioned Gazette provided an alternative procedure to be followed when applying for Environmental Authorisation for the development of large scale electricity transmission and distribution infrastructure (identified in terms of section 24(2)(a) of the National Environmental Management Act (Act 107 of 1998, as amended) (NEMA)) when these activities fall within the identified Strategic Transmission Corridors, such as the Northern Corridor.

The development of large scale electricity transmission infrastructure triggers Listed Activity 9 of Listing Notice 2 of the 2014 Environmental Impact Assessment (EIA) Regulations (as amended), which usually would require a full Scoping and Environmental Impact Assessment. However, when such a development is to take place within a Strategic Transmission Corridor, a Basic Assessment (BA) Process in terms of the 2014 EIA Regulations (as amended) is to be followed. This speeds up the Environmental Authorisation process for EGI developments within any of the five Strategic Transmission Corridors. A pre-requisite for the BA process to be followed is however the obtaining of a servitude prior to application for environmental authorisation.

One of the objectives of this SEA process was also to provide developers with the flexibility to consider a range of route alternatives within the strategic corridors to avoid land negotiation issues and to submit a pre-negotiated route to the Competent Authority.

As noted above, this has been achieved for the development of EGI within any of the five Strategic Transmission Corridors gazetted in February 2018 (GN 113 in Government Gazette 41445), for which:

(a) a pre-negotiated route must be submitted to the Department of Environmental Affairs (DEA); and,

(b) a BA procedure needs to be followed in compliance with the 2014 EIA Regulations (as amended) instead of a full Scoping and EIA process previously triggered by such activities.

5.3. Screening of Alternative Routes

The purpose of the current Screening Assessment is to evaluate alternative routes within the Northern Corridor. As part of the Screening Assessment, a group of specialists evaluated the alternative routes according to potential sensitive environmental, social and economic issues. The findings of all the specialists will be integrated to make an informed decision on the best route alternative for the proposed power line.

This study will thus be undertaken in terms of Regulation 15 of the Environmental Impact Assessment Regulations, 2014 (Government Notice No. R 982, In the Gazette No. 38282 of 4 December 2014), that provides for the procedure to be followed in applying for environmental authorisation for large scale electricity transmission and distribution development activities identified in terms of section 24(2)(a) of the National Environmental Management Act, 1998.

Enviroworks, a professional Environmental Compliance consultancy, was appointed by Eskom to conduct the screening assessment of the alternative route options. Several specialist studies will be conducted as part of the screening process. These studies include:

- Heritage Impact Assessment
- Socio-Economic Impact Assessment
- Botanical Impact Assessment
- Fauna Impact Assessment
- Avifaunal Impact Assessment
- Visual Impact Assessment
- Agricultural Impact Assessment
- Geohydrological Impact Assessment
- Freshwater (surface watercourse) Impact Assessment

The specialist findings will be used to produce a Screening Report that will provide the best route alternative based upon NEMA Principles, the Best Available Technology principle and consultation with stakeholders such as Landowners, Organs of State , NGO's and any other Interested and Affected Parties (I&APs).

The Screening Report will then be used by Eskom to negotiate a servitude with landowners. These negotiations will take place after the Screening Assessment and will not form part of the current study. After negotiations with landowners Eskom will proceed with the next stage which is to conduct a Basic Assessment in order to obtain an Environmental Authorisation from the competent authority for the pre-negotiated route. Stakeholder consultation will be done again during this phase. Ample time will be provided for the public to comment. All information gathered during the screening process will be used in the BA process and application for authorisation.

5.4. Locality and Description Alternatives

The proposed route alternatives currently being assessed are situated within the Northern Corridor.

5.5. Need and Desirability

Electricity Grid Infrastructure (EGI) is required to provide grid access to electricity producers, in order to be able to distribute the electricity they generate to users. Independent Power Producers (IPPs) have rapidly become key electricity producers and this has increased the demand for grid access and hence the need to construct more EGI.

6. Introduction

Enviroworks was appointed by Eskom Holdings SOC Limited (Transmission) to conduct an Environmental Screening Assessment study for the proposed construction of an approximately 160km 400kV transmission powerline, infrastructures and associated auxiliary- and substation infrastructure. The powerline is planned to run from the Aggeneis Substation located near Aggeneys via the Nama substation near Springbok to the Gromis Substation close to Kleinsee in the Northern Cape Province. The proponent identified two, 2km wide alternative corridors for assessment.

Albert Froneman Consulting was appointed by Enviroworks to compile an avifaunal impact screening report, assessing the potential impacts of the proposed powerline on birds.

A full project description of the proposed infrastructure is provided in section 5 – Background above.

The most prominent direct negative impacts on birds by electricity infrastructure in South Africa are mortality through electrocution and collisions (Ledger and Annegarn 1981; Ledger 1983; Ledger 1984; Hobbs and Ledger 1986a; Hobbs and Ledger 1986b; Ledger *et al.* 1992; Verdoorn 1996; Kruger and Van Rooyen 1998; Van Rooyen 1998; Kruger 1999; Van Rooyen 1999; Van Rooyen 2000; Van Rooyen 2007; Lehman *et al.* 2007; Jenkins *et al.* 2010; Shaw 2013).

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. The electrocution risk is largely determined by the pole/tower design (APLIC 2012). In South Africa, large raptors and particularly vultures, are most prone to electrocution on electricity infrastructure (Ledger and Annergarn 1981; Ledger 1984; Verdoorn 1996; Van Rooyen 1998; Boshoff *et al.* 2011).

Collision mortality is probably the biggest threat posed by transmission lines to birds in South Africa (Van Rooyen 2004). Most heavily impacted upon are bustards, storks, cranes and various species of waterbirds (Jenkins *et al.* 2010). 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).

7. Objective of specialist study

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

- Describe the affected environment (habitat) from an avifaunal perspective.
- Identify high-risk powerline sensitive species with specific reference to Red Data species.
- Discuss gaps in baseline data.
- List and describe the potential impacts.
- Identify a preferred route corridor.
- Assess and evaluate the potential impacts (before and after mitigation).
- Recommend mitigation measures for the potential impacts.

8. Study Area description – in terms of specialist study field

Two proposed powerline route corridor alternatives have been identified for assessment between both the Aggeneis – Nama and Nama – Gromis Substations. These powerline route corridor alternatives are as follows:

From Aggeneis Substation to Nama Substation:	Alternative 1 or Alternative 5
From Nama Substation to Gromis Substation:	Alternative 1 or Alternative 4

The proposed route alternatives commence in the east near to the town of Aggeneys in the Nama-Karoo biome (summer rainfall) and extend westwards for approximately 160km into the Succulent Karoo biome (winter rainfall) via the town of Springbok (Nama Substation) towards the coast near Kleinsee at the Gromis Substation. The proposed 2km wide route corridor alternatives (see Figure 2) and their immediate surroundings were defined as the study area.

Due to the similarity of the study area and the route corridors from an avifaunal perspective the below descriptions relate to the entire area rather than a per alternative description. The route corridor alternatives and related study area traverses the Succulent and Nama Karoo Biomes, and from east to west includes parts of the Bushmanland, Namaqualand Hardeveld and Namaqualand Sandveld Bioregions (Mucina & Rutherford 2006). The area supports approximately 200 species of birds, including at least 21 red-listed species, of which six are regional endemics, and commences (in the east near Aggeneys) inside of the Haramoep & Black Mountain IBA (SA035) (Marnewick *et al*. 2015).

The eastern part of the route corridor alternatives and study area features the grassy Bushmanland plains, which support a collection of endemic larks which proliferate in the area after good, autumn rainfall (Dean 2005). Vegetated, red sand dunes, which more or less coincide with the ancient course of the Koa River, form the core of the global distribution of the Red Lark (Dean *et al.* 1991), while steep-sloped inselbergs which are scattered across plains support communities of cliff-nesting raptors, including pairs of Verreaux's Eagle, Booted Eagle, Lanner Falcon and possibly Booted Eagle and Cape Eagle Owl. The open grasslands and low shrublands sustain numbers of large terrestrial birds (Ludwig's Bustard, Kori Bustard, Secretarybird). Breeding pairs of Martial Eagles use the Eskom transmission powerline structures.

The central part of the route corridor alternatives and study area is located in the hills around the town of Springbok. The hills are steep in places with exposed granite rock-faces and cliffs which support a high density of Verreaux's Eagles, as well as similarly high densities of Booted Eagle and Jackal Buzzard.

The western part of the route corridor alternatives and study area extends into the coastal plain towards the town of Kleinsee. Large influxes of Ludwig's Bustard are known to be present after winter rain, while flamingos aggregating at coastal salt pans. Black Harriers are present and breed erratically in the Buffelsrivier floodplain. Martial Eagles nest on the transmission powerline structures traversing the coastal plains (CSIR 2015).

The climate in the west, or Succulent Karoo parts, is characterised by relatively reliable, although minimal (50–400mmpa) winter rainfall (>60% arriving between May and September). The east lies in the Nama Karoo and despite receiving similar total annual rainfall comes predominately in late summer (February-April) as violent thunderstorms can be highly variable when and where it falls. The presence of the cold Atlantic Ocean in the west not only moderates temperatures throughout the Namaqualand region (mean summer temperature 30°C), but also provides an additional sources of moisture in the form of coastal fog and heavy dew experienced in winter months (SANBI 2008).

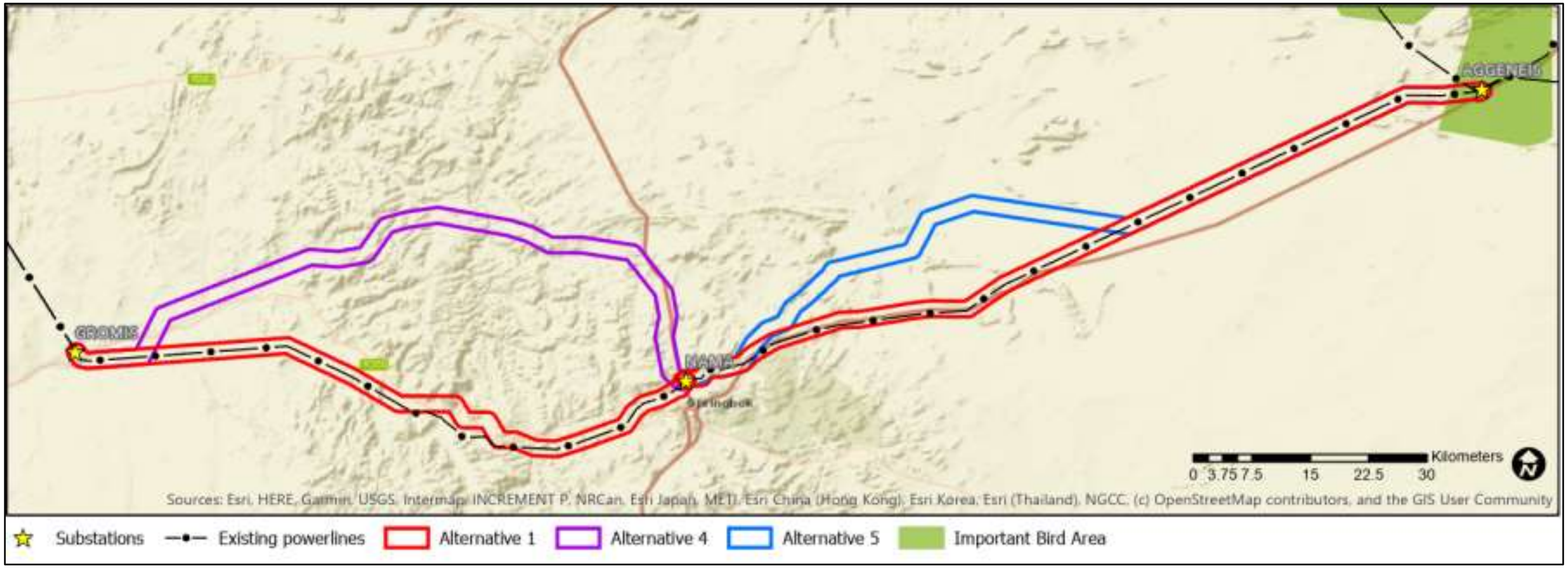

Figure 2: Proposed powerline route corridor alternatives

To define avifaunal habitat classes within the proposed alternative route corridors the existing land-cover data was used as a point of departure. Topography, biomes and vegetation types within the biomes were used to further refine the defined avifaunal habitat classes.

It is generally accepted that vegetation structure, rather than the actual plant species, influences bird species distribution and abundance (Harrison *et al.* 1997).

In order to define habitat classes in relation to the powerline sensitive red-data bird species, the generalised classification or 'parent' land-use classes (DEA 2015) were used to define the bird habitat categories described below.

8.1. Description of bird habitat classes in the study area

Whilst much of the distribution and abundance of the bird species in the study area can be explained by the composition of the natural vegetation, it is as important to also examine the modifications which have changed the natural landscape, and which may have an effect on the distribution of power line sensitive species. These are sometimes evident at a much smaller spatial scale than at the biome type level, and are determined by a host of factors such as land use, vegetation type, topography and man-made infrastructure. For purposes of the analysis in this report, the following bird habitat classes were defined from an avifaunal perspective (vegetation descriptions based largely on the aforementioned land cover classes):

8.1.1. Water & wetlands

All areas of open surface water and wetland areas that are primarily vegetated on a seasonal or permanent basis were included in this habitat class. A limited number of wetlands and water bodies are present in the very arid study area. Only a few of the wetlands and waterbodies are permanent and most are of a temporary nature and only fill up for a short period of time following good rains. Man-made dams and ephemeral pans when full attract a multitude of water birds, including both Lesser and Greater Flamingo. Dams with shallow sloping sides are also important for large raptors for bathing and drinking. The major envisaged impact is collisions with the earthwire (waterbirds, flamingos and to a lesser extent raptors), and displacement due to habitat destruction.

8.1.2. Mountainous areas

The majority of the proposed corridors are located in the topographically flat plains in the Nama- and Succulent Karoo. However, in places the proposed corridors do cross or pass by steep terrain. In the east near Aggeneys several inselbergs are present. Further to the west especially in the vicinity of the town of Springbok and west thereof towards the Gromis substation in the vicinity of the Spektakel pass, Skaap River valley and the settlements Bulletrap and Nigramoep.

Gentle slopes or plateaus in the mountainous areas are classified as grassland or low shrubland from an avifaunal habitat perspective but where steeper slopes and cliffs are present they are potentially important roosting and breeding habitat for a variety of Red Data power line sensitive species, e.g. Verreaux's Eagle, Black Stork, Lanner Falcon and the non-Red Data Peregrine Falcon *Falco peregrinus*, Jackal Buzzard *Buteo rufofuscus* and Booted Eagle *Aquila pennatus*. The major envisaged impact on these species is collisions with the proposed power line, and displacement of breeding birds due to disturbance. Steep slopes are also important in that they are generally avoided by the Red Data collision-prone Ludwig's Bustard, Karoo Korhaan and Kori Bustard, which prefer the topographically flat plains and plateaus.

The major envisaged impact is collisions with the earthwire (raptors e.g. Verreaux's Eagles against steep slopes / cliffs), and displacement due to disturbance and habitat destruction.

8.1.3. Thicket & woodland

Natural / semi-natural tree and / or bush dominated areas where typical canopy heights are between 2-5m and canopy densities are > 40%. Due to the very arid nature of the study area along the proposed route corridor alternatives the presence of thicket and woodland areas are quite restricted. In most instances thicket and woodland patches occur along ephemeral drainage lines, in some valleys in the mountainous areas and in small pockets along the Buffels River along on the western coastal plain. Thicket and woodland areas along the drainage lines are often used by large terrestrial species for shade during the midday heat. Secretarybirds may be attracted to small *Vachellia karroo* trees in the watercourses for breeding purposes. For purposes of this study, alien trees were also included under this habitat class, as these are sometimes used by raptors such as Martial Eagle, Verreaux's Eagle, Booted Eagle and Jackal Buzzard to breed in.

The major envisaged impact is collisions with the earthwire (large terrestrial species), and displacement due to disturbance and habitat destruction where species such as Secretarybirds or raptors may be nesting in trees.

8.1.4. Grassland & low shrubland

Natural / semi-natural grass or sparse low shrub areas interspersed with bare or open areas. Most of the bird habitat along the proposed route alternatives are classified as grassland and low shrubland. The open plains in the east are more grass dominated and support at times, especially following good rains, substantial numbers of the nomadic Ludwig's Bustards. Martial Eagles nest on the existing transmission powerlines that pass through the area – as an example an existing Martial Eagle nest was discovered on a transmission structure just outside the study area to the north-west of the Aggeneis sub-station at Lat: 29°13'35.80"S Long: 18°42'6.44"E - Aliénor (Eleanor) Brassine - pers. comm. Oct 2019). Southern Black Korhaan and Black Harriers favour the succulent karoo shrubland along the coastal plains to the west. Black Harriers may occasionally breed along the ephemeral Buffels River.

The major envisaged impact is collisions with the earthwire (large terrestrial species such as Ludwig's Bustard that occur in large numbers following rains in the area), and displacement due to disturbance where species such as Martial Eagles may be nesting on the existing towers of the transmission powerlines in the study area.

8.1.5. Cultivated areas

Cultivated commercial or subsistence lands used primarily for the production of crops – either rain-fed or irrigated. Due to the arid environment in which the study area is located very few cultivated areas are present. Where crops are cultivated the fields are mostly small and mostly of a subsistence nature. Large terrestrial species such as bustards may be attracted to cultivated lands to feed there. Raptors such as Lanner Falcon may hunt small birds attracted to cultivated fields.

The envisaged impact is collisions with the earthwire, especially large terrestrial species such as Ludwig's Bustard, that may be attracted to feed there.

8.1.6. Mines & Built-up areas

Mining activities are defined as bare grounds associated with extraction pits, tailings, waste dumps and associated surface infrastructure such as roads and buildings. Built-up areas are classified as either industrial areas, commercial / residential buildings or structures within towns and / or rural villages. Although most powerline sensitive Red Data species would not occur at mines or in built-up areas Lanner Falcons may hunt and even nest in disused mining quarries – they may also hunt smaller birds such as doves and pigeons in urban built-up areas.

From an avifaunal perspective the habitat characteristics of the proposed powerline route alternatives are largely similar – see Figure 3 and Figure 4. In order to arrive at a preferred route alternative, the percentage cover of the identified bird habitat classes was calculated and rated in accordance with preference by the powerline sensitive Red Data species – see section 15.

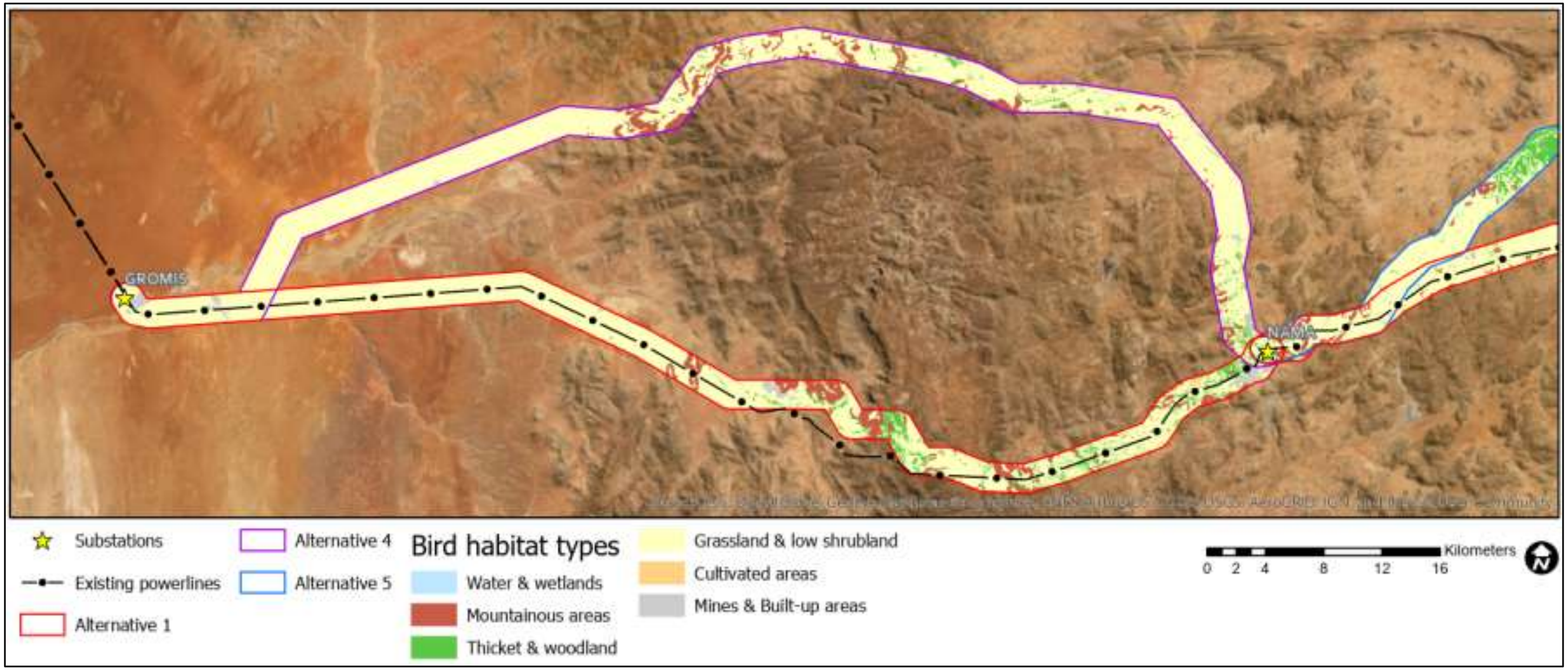

Figure 3: Bird habitats: Gromis - Nama route alternatives

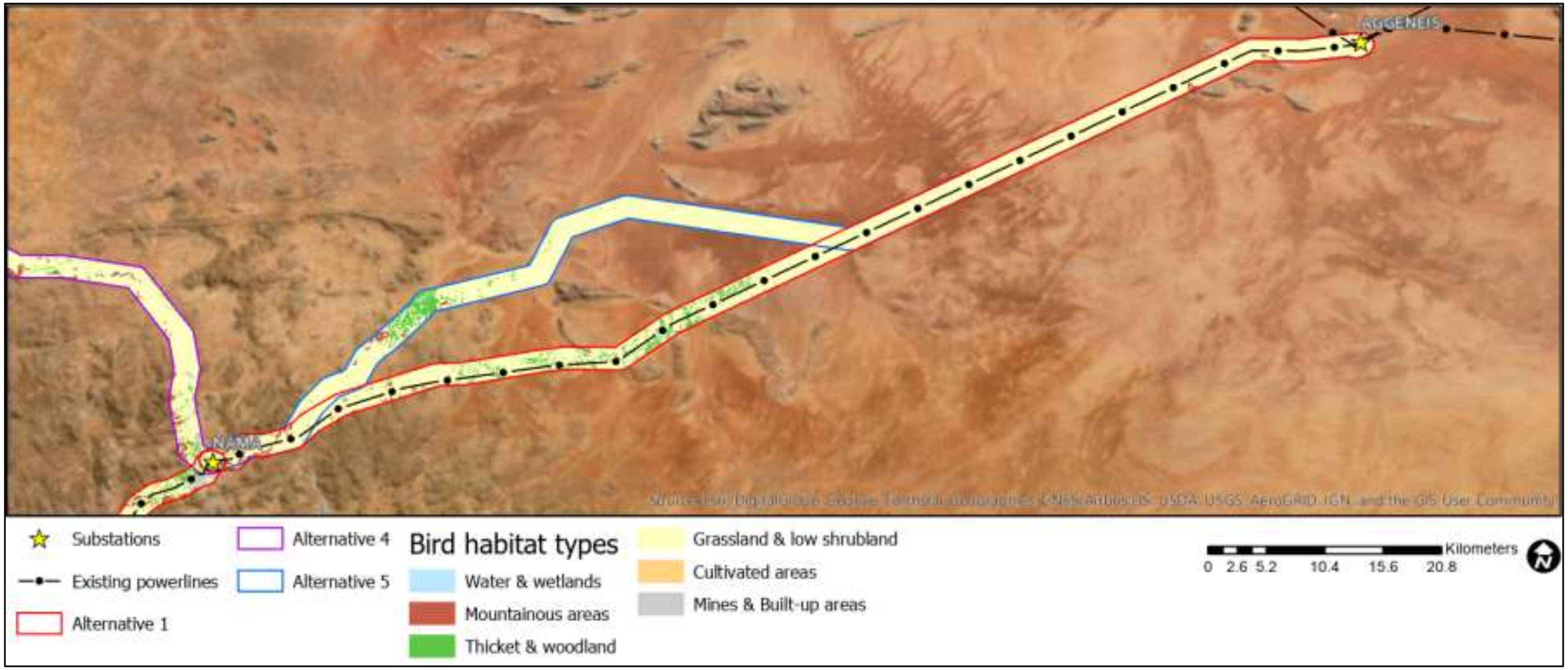

Figure 4: Bird habitats: Nama - Aggeneis route alternatives

9. Methods

9.1. Data sources *(including description of scale, source and limitations)*

The study made use of the following data sources:

- Bird distribution data of the Southern African Bird Atlas Project 1 (SABAP1) and 2 (SABAP 2) were obtained in order to ascertain which species occur in the study area.
  - The Southern African Bird Atlas 1 (SABAP1) - Animal Demography Unit, University of Cape Town, 1997. The Southern African Bird Atlas Project (SABAP) was conducted between 1987 and 1991. Because a new bird atlas was started in southern Africa in 2007, the earlier project is now referred to as SABAP1. SABAP1 covered six countries: Botswana, Lesotho, Namibia, South Africa, Swaziland and Zimbabwe. At the time, Mozambique was engulfed in a civil war, and had to be excluded. The resolution for SABAP1 was the quarter degree grid cell (QDGC), 15 minutes of latitude by 15 minutes of longitude, 27.4 km north-south and about 25 km east-west, an area of about 700 km². Fieldwork was conducted mainly in the five-year period 1987–1991, but the project coordinators included all suitable data collected from 1980–1987. In some areas, particularly those that were remote and inaccessible, data collection continued until 1993. Fieldwork was undertaken mainly by citizen scientists/bird watchers, and most of it was done on a volunteer basis. Fieldwork consisted of compiling bird lists for the QDGCs. All the checklists were fully captured into a database.
  - The Southern African Bird Atlas 2 (SABAP2) - Animal Demography Unit, University of Cape Town, 1 July 2007 to present, ongoing. SABAP2 is the follow-up project to the Southern African Bird Atlas Project (for which the acronym was SABAP, and which is now referred to as SABAP1). The second bird atlas project started on 1 July 2007 and plans to run indefinitely. SABAP2 is based at the University of Cape Town and is funded by the FitzPatrick Institute of African Ornithology and the South African National Biodiversity Institute. The project is actively supported by BirdLife South Africa and BirdLasser. The project aims to map the distribution and relative abundance of birds in southern Africa and the atlas area includes South Africa, Lesotho and Swaziland. The unit of data collection is the pentad, five minutes of latitude by five minutes of longitude, squares with sides of roughly 9km.
- The Important Bird Areas project data was consulted to get an overview of important bird areas and species diversity in the study area (Marnewick *et al.* 2015).
- The power line bird mortality incident database of the Endangered Wildlife Trust (1996 to 2014) was consulted to determine which of the species occurring in the study area are typically impacted upon by power lines (EWT unpublished data 2014).
- 2013 - 2014 South African National Land-Cover Dataset - DEA, February 2015 (https://egis.environment.gov.za/). The 2013-14 South African National Land-cover dataset produced by GEOTERRAIMAGE as a commercial data product has been generated from digital, multi-seasonal Landsat 8 multispectral imagery, acquired between April 2013 and March 2014. The data set was procured by the Department of Environmental Affairs for public use. In excess of 600 Landsat images were used to generate the land-cover information, based on an average of 8 different seasonal image acquisition dates, within each of the 76 x image frames required

to cover South Africa. The land-cover dataset, which covers the whole of South Africa, is presented in a map-corrected, raster format, based on 30x30m cells equivalent to the image resolution of the source Landsat 8 multi-spectral imagery. The dataset contains 72 x land cover / use information classes, covering a wide range of natural and man-made landscape characteristics. Each data cell contains a single code representing the dominant land-cover class (by area) within that 30x30m unit, as determined from analysis of the multi-date imagery acquired over that image frame.

- The biomes and bioregions of South Africa as contained in the National Vegetation Map of South Africa (2018) - The Vegetation Map of South Africa, Lesotho and Swaziland by Mucina and Rutherford (eds.), 2006, with the spatial product updated in 2018. The descriptions of vegetation types are given for each biome and include a general introduction to each biome, details about how each vegetation type relates to previously published vegetation maps, distribution, vegetation and landscape features, geology and soils, climate, important taxa, biogeographically important taxa, endemic taxa, conservation, and remarks.
- Data on the alignment of existing high voltage lines were obtained from Eskom.
- 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 *et al.* 2015), the 2019.2 IUCN Red List of Birds (https://www.iucnredlist.org/) and the most recent and comprehensive summary of southern African bird biology (Hockey *et al.* 2005).
- Personal observations have also been used to supplement the data that is available from SABAP, and has been used extensively in forming a professional opinion of likely bird/habitat associations.

9.2. Assessment methodology

One of the main objectives of this screening study is to arrive at a preferred corridor for the proposed transmission power lines, from an avifaunal interaction perspective. Section 8 above provides a description of the various 2km wide corridor alternatives that were considered for this study (see also Figure 2, Figure 3 and Figure 4). The methodology that was followed to select a preferred corridor alternative is outlined below.

The potential for interaction with the proposed power line was assessed for each of the Red Data species listed in Table 1: Red data species recorded by SABAP1 and SABAP2 in the study area.Table 1. This was done by assessing the probability of each potential impact (collisions and displacement due to habitat destruction or disturbance – see Section 11 below for more details of the anticipated impacts) occurring, for each species, within each of the identified habitat classes. The following probability scale was used: 1 = low, 2 = medium, 3 = high (see Table **12**). Each habitat class therefore received a risk score for each species. The total risk score for a habitat class was calculated as the sum of the various individual species scores for that habitat class.

The identified avifaunal impacts were also rated according to a standardised impact rating methodology for each of the respective proposed corridor alternatives to further substantiate the findings of the risk rating assessment based on the avifaunal habitat classes.

9.3. Desktop assessment

The desktop assessment involved sourcing the SABAP1 and SABAP2 data for the Quarter Degree Grid Cells (QDGCs) and pentads bisected by the proposed powerline route alternatives. A consolidated list of species occurring in the study area along the proposed route alternatives were compiled and 21 Red Data species identified. From these, a list of 15 powerline sensitive Red Data species were extracted for further assessment.

9.3.1. Power line sensitive species occurring in the study area

A total of 21 Red Data species have been recorded by SABAP1 and SABAP2 in the QDGCs and pentads that are bisected by the various corridors (see Table 1). Vagrants are indicated with an asterisk. For each species, the potential for occurring in a specific habitat class was indicated, as well as the potential impact most likely associated with this specific species.

9.3.2. Land use / Land cover assessment to determine avifaunal habitat classes

The 2013 - 2014 South African National Land-Cover Dataset - DEA, February 2015 (https://egis.environment.gov.za/) was used to determine current land use in the study area along the proposed route alternatives. Six avifaunal habitat classes were identified according to broad land uses classes which would also inform the presence and abundance of the powerline sensitive Red Data species in the study area.

The following habitat classes relevant to avifauna were identified:

- Water & wetlands
- Mountainous
- Thicket woodland
- Grassland low shrubland
- Cultivated
- Mines & Built-up

See section 8 above for a more detailed description of the habitat classes.

Table 1: Red data species recorded by SABAP1 and SABAP2 in the study area.

NT=Near threatened VU=Vulnerable EN = Endangered LC = Least Concerned

Name	Taxonomic name	Regional Status (Taylor *et al.* 2015)	Global Status IUCN 2019-2	Powerline sensitive species	Habitat class						Potential impact		
					Water & Wetlands	Mountainous areas	Thicket & woodland	Grassland & low shrubland	Cultivated areas	Mines & built-up areas	Collisions	Displacement through disturbance	Displacement through habitat destruction
Black Harrier	*Circus maurus*	EN	EN	Yes				x			x	x	
Black Stork	*Ciconia nigra*	VU	LC	Yes	x	x					x		
Great White Pelican*	*Pelecanus onocrotalus*	VU	LC	Yes	x						x	x	
Greater Flamingo	*Phoenicopterus roseus*	NT	LC	Yes	x						x	x	
Karoo Korhaan [1]	*Eupodotis vigorsii*	NT	LC	Yes				x			x	x	
Kori Bustard	*Ardeatis kori*	NT	NT	Yes				x	x		x		
Lanner Falcon [1]	*Falco biarmicus*	VU	LC	Yes	x	x	x	x	x	x		x	
Lesser Flamingo	*Phoenicopterus minor*	NT	NT	Yes	x						x		
Ludwig's Bustard	*Neotis ludwigii*	EN	EN	Yes				x	x		x		
Maccoa Duck	*Oxyura maccoa*	NT	VU	Yes	x								
Marabou Stork*	*Leptoptilos crumeniferus*	NT	LC	Yes	x						x		

Name	Taxonomic name	Regional Status (Taylor *et al.* 2015)	Global Status IUCN 2019-2	Powerline sensitive species	Habitat class						Potential impact		
					Water & Wetlands	**Mountainous areas**	**Thicket & woodland**	**Grassland & low shrubland**	**Cultivated areas**	**Mines & built-up areas**	**Collisions**	**Displacement through disturbance**	**Displacement through habitat destruction**
Martial Eagle	*Polemaetus bellicosus*	EN	VU	Yes	x	x	x	x	x		x	x	
Secretarybird	*Sagittarius serpentarius*	VU	VU	Yes			x	x			x	x	x
Southern Black Korhaan [1]	*Afrotis afra*	VU	VU	Yes				x			x	x	
Verreaux's Eagle [1]	*Aquila verreauxii*	VU	LC	Yes		x					x		
African Rock Pipit	*Anthus crenatus*	NT	NT	-		x							
Barlow's Lark	*Calendulauda barlowi*	NT	LC	-				x					
Chestnut-banded Plover	*Charadrius pallidus*	NT	NT	-	x								
Sclater's Lark	*Spizocorys sclateri*	NT	NT	-				x					
Burchell's Courser	*Cursorius rufus*	VU	LC	-				x					
Red Lark	*Calendulauda burra*	VU	VU	-				x					

* - Vagrant; [1] - Recorded during site visit

9.4. Site visit – field verification assessment

The area along the route alternatives or immediate surroundings where similar habitat occurs was inspected in November 2019, and the bird habitats types identified during the desktop assessment were verified and photographically recorded. Because it is not possible to travel along each corridor all the way, spot checks were made where access to the corridor was possible, and representative habitat was recorded in the greater study area to form a general impression of the identified bird habitats. 58 bird species were recorded during the site visit of which 4 were powerline sensitive Red Data species.

9.5. Impact rating

For each potential impact, the DURATION (time scale), EXTENT (spatial scale), IRREPLACEABLE loss of resources, REVERSIBILITY of the potential impacts, MAGNITUDE of negative or positive impacts, and the PROBABILITY of occurrence of potential impacts must be assessed. The assessment of the above criteria was used to determine the significance of each impact, with and without the implementation of the proposed mitigation measures. The scales to be used to assess these variables and to define the rating categories are tabulated in Table 2 and Table 3 below.

Table 2: Evaluation components, ranking scales and descriptions (criteria).

Evaluation component	Ranking scale and description (criteria)
DURATION	**5 - Permanent** **4 - Long term**: Impact ceases after operational phase/life of the activity (> 20 years). **3 - Medium term**: Impact might occur during the operational phase/life of the activity (5 to 20 years). **2 - Short term**: Impact might occur during the construction phase (< 5 years). **1 - Immediate**
EXTENT (or spatial scale/influence of impact)	**5 - International: Beyond National boundaries.** **4 - National: Beyond Provincial boundaries and within National boundaries.** **3 - Regional: Beyond 5 km of the proposed development and within Provincial boundaries.** **2 - Local: Within 5 km of the proposed development.** **1 - Site-specific: On site or within 100 m of the site boundary.** **0 - None**
IRREPLACEABLE loss of resources	**5 – Definite** loss of irreplaceable resources. **4 – High** potential for loss of irreplaceable resources. **3 – Moderate** potential for loss of irreplaceable resources. **2 – Low** potential for loss of irreplaceable resources. **1 – Very low** potential for loss of irreplaceable resources. **0 - None**
REVERSIBILITY of impact	**5 –** Impact **cannot** be reversed. **4 – Low** potential that impact might be reversed. **3 – Moderate** potential that impact might be reversed. **2 – High** potential that impact might be reversed. **1 –** Impact **will be** reversible. **0 –** No impact.
MAGNITUDE of NEGATIVE IMPACT (at the indicated spatial scale)	**10 - Very high**: Bio-physical and/or social functions and/or processes might be severely altered. **8 - High**: Bio-physical and/or social functions and/or processes might be considerably altered. **6 - Medium**: Bio-physical and/or social functions and/or processes might be notably altered. **4 - Low** : Bio-physical and/or social functions and/or processes might be slightly altered. **2 - Very Low**: Bio-physical and/or social functions and/or processes might be negligibly altered. **0 - Zero**: Bio-physical and/or social functions and/or processes will remain unaltered.
MAGNITUDE of POSITIVE	**10 - Very high (positive)**: Bio-physical and/or social functions and/or processes might be substantially enhanced. **8 - High (positive)**: Bio-physical and/or social functions and/or processes might be considerably enhanced.

Evaluation component	Ranking scale and description (criteria)
IMPACT (at the indicated spatial scale)	**6 - Medium (positive)**: Bio-physical and/or social functions and/or processes might be notably enhanced. **4 - Low (positive)**: Bio-physical and/or social functions and/or processes might be slightly enhanced. **2 - Very Low (positive)**: Bio-physical and/or social functions and/or processes might be negligibly enhanced. **0 - Zero (positive)**: Bio-physical and/or social functions and/or processes will remain unaltered.
PROBABILITY (of occurrence)	**5 - Definite**: >95% chance of the potential impact occurring. **4 - High probability**: 75% - 95% chance of the potential impact occurring. **3 - Medium probability**: 25% - 75% chance of the potential impact occurring **2 - Low probability**: 5% - 25% chance of the potential impact occurring. **1 - Improbable**: <5% chance of the potential impact occurring.
CUMULATIVE impacts	**High**: The activity is one of several similar past, present or future activities in the same geographical area, and might contribute to a very significant combined impact on the natural, cultural, and/or socio-economic resources of local, regional or national concern. **Medium**: The activity is one of a few similar past, present or future activities in the same geographical area, and might have a combined impact of moderate significance on the natural, cultural, and/or socio-economic resources of local, regional or national concern. **Low**: The activity is localised and might have a negligible cumulative impact. **None**: No cumulative impact on the environment.

Once the evaluation components have been ranked for each potential impact, the significance of each potential impact will be assessed (or calculated) using the following formula:

SP (significance points) = (duration + extent + irreplaceable + reversibility + magnitude) x probability

The maximum value is 150 SP (significance points). The unmitigated and mitigated scenarios for each potential environmental impact should be rated as per Table 3 below.

Table 3: Definition of significance ratings (positive and negative).

Significance Points	Environmental Significance	Description
100 – 150	**High (H)**	An impact of high significance which could influence a decision about whether or not to proceed with the proposed project, regardless of available mitigation options.
40 – 99	**Moderate (M)**	If left unmanaged, an impact of moderate significance could influence a decision about whether or not to proceed with a proposed project.
<40	**Low (L)**	An impact of low is likely to contribute to positive decisions about whether or not to proceed with the project. It will have little real effect and is unlikely to have an influence on project design or alternative motivation.
+	**Positive impact (+)**	A positive impact is likely to result in a positive consequence/effect, and is likely to contribute to positive decisions about whether or not to proceed with the project.

(**Note:** Evaluation components: M – Magnitude; D – Duration; E – Extent; R - Reversibility; I - Irreplaceable; P – Probability; S - Significance)

10. Assumptions and limitations of study

It should be noted that the following factors may potentially detract from the accuracy of the predicted results:

- As the South African National Land-Cover Dataset dates from 2013-14, the land cover situation on the ground may have changed in places since then. However, given the arid nature of the study area and the low human population, it can safely be assumed that no major changes have taken place in the study area, which would have affected bird distribution significantly. The vast majority of the habitat in the study area is still untransformed natural habitat where extensive livestock farming has been practised for many decades.
- Different levels of survey effort for QDGCs in both the SABAP1 and SABAP2 coverage means that the reporting rates of species may not be an accurate reflection of relative densities in QDGCs and pentads that were sparsely covered to date. The reporting rates were therefore not treated as a realistic reflection of the actual densities, but merely as a guideline for the potential presence or absence of a specific species. Strong reliance was placed on professional judgment (see 9.1 above).
- 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 assessment is made on the basis of baseline conditions as it currently stands. Future potential changes in land use were not take on into account.
- Emphasis was placed on the potential impact on powerline sensitive Red Data species.

11. Results

11.1. Description of alternatives (site findings & desktop)

The below series of tables provide a breakdown of the percentage surface area of the bird habitat types identified as part of the desktop analysis in each of the respective corridor alternatives.

11.1.1. Alternative 1

Alternative 1 follows the existing transmission line from the Aggeneis substation via the Nama substation to the Gromis substation.

Table 4: Percentage cover of avifaunal habitat types in route alternative 1.

Alternative corridor	Avifaunal habitat class	Percentage of surface area in corridor
Alt 1 Gromis – Nama	Water & wetlands	0.002%
	Mountainous	8.3%
	Thicket & woodland	7.9%
	Grassland low shrubland	80.8%
	Cultivated	0.3%
	Mines & Built-up	2.6%
Alt 1 Nama – Aggeneys	Mountainous	2.4%
	Thicket & woodland	6.1%
	Grassland low shrubland	91.1%
	Cultivated	0.01%
	Mines & Built-up	0.5%

11.1.2. Alternative 4

Route alternative 4 passes through the mountainous terrain to the north of Springbok through largely undisturbed natural vegetation.

Table 5: Percentage cover of avifaunal habitat types in route alternative 4.

Alternative corridor	Avifaunal habitat class	Percentage of surface area in corridor
Alt 4 Gromis – Nama	Water & wetlands	0.001%
	Mountainous	7.8%
	Thicket & woodland	3.8%
	Grassland low shrubland	87.0%
	Mines & Built-up	1.4%

11.1.3. Alternative 5

Route alternative 5 largely follows alternative 1 from Aggeneis to Nama with some deviations closer to Springbok.

Table 6: Percentage cover of avifaunal habitat types in route alternative 5.

Alternative corridor	Avifaunal habitat class	Percentage of surface area in corridor
Alt 5 Nama – Aggeneys	Mountainous	2.3%
	Thicket & woodland	4.2%
	Grassland low shrubland	93.2%
	Mines & Built-up	0.3%

12. Identified impacts

The Generic Environmental Management Programme (EMPr) for the development and expansion of infrastructure for the overhead transmission and distribution of electricity document (https://cer.org.za/wp-content/uploads/2019/03/Generic-EMPR-Substations-and-Overhead-electricty-transmission-and-distribution-infrastructure.pdf) unfortunately does not list all the relevant impacts of powerlines on birds – for a detailed description of the envisaged impacts see below.

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; Verdoorn 1996; Kruger and Van Rooyen 1998; Van Rooyen 1998; Kruger 1999; Van Rooyen 1999; Van Rooyen 2000; van Rooyen 2004, Jenkins & Smallie 2009; Jenkins *et al*. 2010; Shaw 2013).

12.1. 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. Potential tower types that could be utilised are self-supporting towers, cross-rope suspension towers and guyed-V towers. The topography will largely dictate the type of tower that will be used. **Due to the large size of the clearances on overhead lines of 400kV, electrocutions are ruled out as even the largest birds cannot physically bridge the gap between energised and/or energised and earthed components.** The risk of electrocution posed to Red Data species by the proposed new power line infrastructure is therefore likely to be negligible, irrespective of which design is used, and therefore need not be investigated further.

12.2. Collisions

Collisions are probably 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).

In a 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 2012). 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 2012, 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 2012).

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. 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 from 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).

A significant impact that is foreseen is collisions with the earth wire of the proposed line. Quantifying this impact in terms of the likely number of birds that will be impacted, is very difficult because such a huge number of variables play a role in determining the risk, for example weather, rainfall, wind, age, flocking behaviour, power line height, light conditions, topography, population density and so forth. However, from incidental record keeping by the Endangered Wildlife Trust, it is possible to give a measure of what species are likely to be impacted upon (see **Error! Reference source not found.** below - EWT unpublished data). 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.

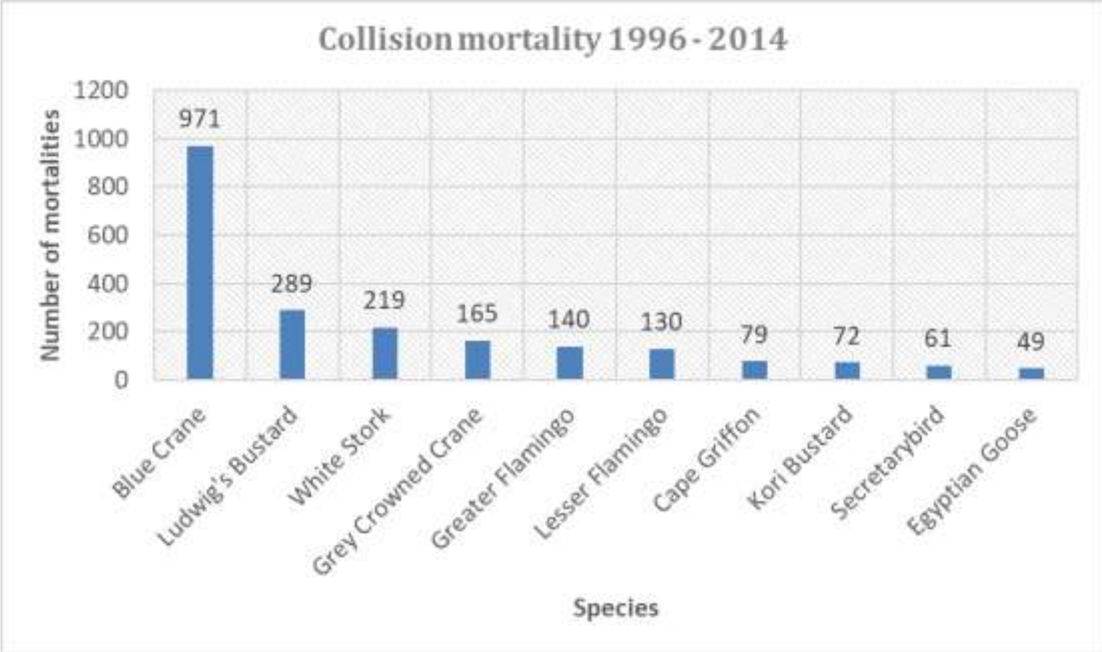

Figure 5: The top ten collision prone bird species in South Africa, in terms of reported incidents contained in the Eskom/EWT Strategic Partnership central incident register 1996 - 2014 (EWT unpublished data 2014)

The most likely candidates for collision mortality on the proposed power lines are Ludwig's Bustard, Kori Bustard, Karoo Korhaan, Southern Black Korhaan and Secretarybird.

For Ludwig's Bustard, this risk is particularly relevant in the Succulent- and Nama-Karoo plains, as that is the preferred habitat for the species. Ludwig's Bustard is highly vulnerable to power line collisions (Jenkins & Smallie 2009; Jenkins et *al.* 2010; Shaw 2013). Ludwig's Bustard will be at risk, based on the species flight characteristics and tendency to fly long distances between foraging and roosting areas and when migrating. Movements by this species are triggered by rainfall (Allan 1994; Shaw 2013), and so are inherently erratic and unpredictable in this arid environment, where the quantity and timing of rains are highly variable between years. Hence, it is difficult to anticipate the extent to which Ludwig's Bustard may be exposed to collision risk, but the corridors cross suitable habitat and the species is likely to be present in varying numbers, depending on foraging conditions. Ludwig's Bustard migratory movements are along a broad east-west axis (Shaw 2013), which is a mitigating factor to some extent as the line also follows a broad east-west axis, and does not cut diagonally across the general flight path of this species when doing long distance migratory flights. However, research has proven that the highest risk occurs when birds are resident in an area between migratory movements, presumably because they fly higher during migratory flights (Shaw 2013).

It is not possible to link the risk to Secretarybirds to any specific habitat of behaviour; they could be at risk anywhere in flat areas in their foraging range. Lanner Falcon and Verreaux's Eagle will be most at risk on slopes containing cliffs, as would Peregrine Falcon, Booted Eagle and Jackal Buzzard.

12.3. 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 Data species due to **habitat destruction** is likely to be fairly limited, given the nature of the habitat. The biggest risk is likely to be where the line crosses ephemeral rivers or alien trees planted for shade or wind breaks, which could potentially result in the removal of trees, which are important breeding substrate for a number of species.

Apart from direct habitat destruction, the above-mentioned construction and maintenance activities also impact on birds through **disturbance**, particularly during breeding activities. This could lead to breeding failure if the disturbance happens during a critical part of the breeding cycle. As far as disturbance is concerned, a specific situation may arise if the line is constructed near an existing transmission line. As mentioned earlier in this report, transmission lines are highly sought after by large raptors, particularly Martial Eagles, for roosting and breeding purposes. Construction activities in close proximity could be a source of disturbance and could lead to temporary breeding failure or even permanent abandonment of nests. Disturbance may also occur where the line traverses steep cliff faces where Verreaux's Eagle, Booted Eagle, Jackal Buzzard, Lanner Falcon, Peregrine Falcon or Black Stork could be breeding or roosting.

13. Mitigation measures for identified impacts

Any attempt at quantifying the potential bird impacts for the proposed development would entail the collection of significant amounts of quantitative data, for example one would have to establish how many pairs of a given species are using a particular area of habitat and document the potential breeding failure through disturbance that could occur if a transmission line is constructed through that area of habitat. Then the influence of this impact on the ability of the local, regional or even national population to persist would have to be documented and quantified. Clearly such detailed studies fall outside the scope of this report. The fact that impacts such as habitat destruction and disturbance could be significant but difficult to quantify, requires that all possible mitigation measures should be implemented on the basis of the pre-cautionary principle. The World Charter for Nature, which was adopted by the UN General Assembly in 1982, was the first international endorsement of the precautionary principle. The principle was implemented in an international treaty as early as the 1987 Montreal Protocol and among other international treaties and declarations is reflected in the 1992 Rio Declaration on Environment and Development. Principle 15 of the Rio Declaration 1992 states that: "in order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, **lack of full scientific certainty shall be not used as a reason for postponing cost-effective measures to prevent environmental degradation."**.

There are many methods that can be used to mitigate avian power line interactions (see for example, APLIC 2012) and several investigations dealing with the collision problem have focused on finding suitable mitigation measures (see APLIC 2012 for an overview). The most proactive measures are power line route planning (and the subsequent avoidance of areas with a high potential for bird strikes) and the modification of power line designs (this option includes line relocations, underground burial of lines, removal of over-head ground wires, and the marking of ground wires to make them more visible to birds in flight). In many instances, decisions on power line placement and possible mitigation measures are however eventually based on economic factors.

The relocation of an existing line is the last option that is usually considered when trying to mitigate avian collisions. The huge expense of creating a new line and servitude usually cannot be justified unless there are biologically significant mortalities. Underground burial of power lines is another option available to utility companies in areas of high collision risk. This will obviously eliminate collisions, but the method has many drawbacks. The costs of burying lines can be from 20 – 30 times (or more) higher than constructing overhead lines, and such costs are related to the line voltage, type and length of cable, cable insulation, soil conditions, local regulations, reliability requirements, and requirement of termination areas. Limitations of cable burial include: no economically feasible methods of burying extra high voltage lines have been developed, there is a potential to contaminate underground water supplies if leakage of oil used in insulating the lines occurs, and extended outage risks due to the difficulty in locating cable failures (APLIC 2012).

Since most strikes involve earth-wires (more than 80% of observed bird collisions), the removal of these wires would decrease the number of collisions. It is assumed that the large number of earth-wire collisions is because birds react to the more visible conductors by flaring and climbing and then collide with the thinner earth-wires (Anderson 2001). Earth-wire removal is, however, not a simple matter. Due to the need for lightning protection and other types of electricity overload, it is only possible on lower-voltage power lines (where polymer lightning arresters can be used). The marking of overhead earth-wires to increase their visibility is usually considered to be the most economical mitigation option for reducing collision mortality (APLIC 2012). This is particular so for the thousands of kilometres of established power lines through areas of high potential for avian interaction which cannot be rerouted.

Despite doubts about the efficacy of line marking to reduce the collision risk for bustards (Jenkins *et al.* 2010; Martin *et al.* 2010, Shaw *et al.* 2017), there are many studies which prove that marking a line with PVC spiral type Bird Flight Diverters (BFDs) generally reduce mortality rates significantly (e.g. Sporer *et al*. 2013; Barrientos *et al.* 2011; Jenkins *et al.* 2010; Alonso & Alonso 1999; Koops & De Jong 1982), but less so for bustards (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 study (Barrientos *et al.* 2011) 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). 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%. Barrientos *et al.* (2012) found that larger BFDs were more effective in reducing Great Bustard collisions than smaller ones.

The use of BFDs to reduce collision mortality on powerlines in South Africa has also been tested scientifically. Using a controlled experiment spanning a period of nearly eight years (2008 to 2016), the effectiveness of two types of line markers, namely the EBM Bird Flapper and EBM helical BFD in reducing power line collision mortalities of large birds were tested on three 400kV transmission lines near Hydra substation in the Karoo. Marking was highly effective for Blue Cranes, resulting in a 92% reduction in mortality. Large birds in general also benefited from the marking, with a 56% reduction in mortality. Unfortunately, the marking did not prove to be effective for Ludwig's Bustard. The two different marking devices were approximately equally effective (Shaw *et al*. 2017).

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). In the case of nocturnal collisions, e.g. flamingos roosting or flying in or out of a dam, the option of using the recently developed Viper LED bird flight diverter should be explored.

It is not the objective of this report to attempt to demarcate all sections of power line for all the alternative corridors that would need to be mitigated for potential collisions or disturbance of Red Data breeding species. This can only be done through a walk-through exercise once the final alignment has been selected and tower positions have been finalized.

See the section 14 below and Appendix C for proposed mitigation measures recommended for each alternative.

In terms of collision mitigation on all alternative alignments the following measures are recommended:

- Once the final alignments and tower positions have been selected, the sections of the line that would need the application of Bird Flight Diverters to mitigate for potential collisions should be indicated by the avifaunal specialist. This walk-through exercise should be informed by an analysis of satellite imagery supplemented by on site ground-truthing.
- In the case of nocturnal collisions, e.g. flamingos flying from / to a dam, the recently developed Viper LED bird flight diverter should be employed.
- See Appendix C for the recommended Bird Flight Diverter and spacing.

14. Impact rating results

Table 7: Alternative 1 Gromis - Nama Impact rating table (#1 Water & wetlands; #2 Mountainous areas; #3 Thicket & Woodland; #4 Grassland & Low shrubland; #5 Cultivated areas; #6 Mines & Built-up areas).

PROJECT ALTERNATIVE	POTENTIAL ENVIRONMENTAL IMPACT / NATURE OF IMPACT		ENVIRONMENTAL SIGNIFICANCE																		MITIGATION
			BEFORE MITIGATION									AFTER MITIGATION									
		Homogenous area identifier	Duration	Extent	Irreplaceable	Reversibility	Magnitude	Probability	TOTAL (SP)	Significance	CUMULATIVE	Duration	Extent	Irreplaceable	Reversibility	Magnitude	Probability	TOTAL (SP)	Significance	CUMULATIVE	
	Potential Impacts on avifauna																				
Alt 1 Gromis Nama	Collisions	#1	4	2	1	2	2	2	22	L	L	4	2	1	2	2	2	22	L	L	See below.
		#2	4	2	2	3	4	3	45	M	M	4	2	1	3	4	2	28	L	L	
		#3	4	2	2	3	2	2	26	L	L	4	2	2	2	2	2	24	L	L	
		#4	4	2	4	3	6	4	76	M	M	4	2	2	3	4	3	45	M	L	
		#5	4	2	1	2	4	2	26	L	L	4	2	1	2	4	2	26	L	L	
		#6	4	2	1	2	2	1	11	L	-	4	2	1	2	2	1	11	L	-	
Alt 1 Gromis Nama	Displacement due to habitat destruction and disturbance	#1	2	2	1	1	2	2	16	L	L	2	2	1	1	2	2	16	L	L	See below.
		#2	2	2	2	3	4	3	39	L	L	2	2	2	3	4	3	39	L	L	
		#3	2	2	2	2	2	2	20	L	L	2	2	2	2	2	2	20	L	L	
		#4	2	2	3	2	4	3	39	L	L	2	2	2	2	4	2	24	L	L	
		#5	2	2	1	1	2	1	8	L	L	2	2	1	1	2	1	8	L	L	
		#6	2	2	1	1	0	1	6	L	L	2	2	1	1	0	1	6	L	L	

Mitigation collisions:

- Alternative 1 emerged with the lowest overall significance point and consequently the lowest collision risk to birds. It is therefore recommended that this corridor is selected. This decision is further substantiated by the powerline sensitive Red Data species habitat preference risk rating analysis (see section 15 below).
- Once the final alignments and tower positions have been selected, the sections of the line that would need the application of Bird Flight Diverters to mitigate for potential collisions should be indicated by the avifaunal specialist. This walk-through exercise should be informed by an analysis of satellite imagery supplemented by on site ground-truthing.
- In the case of nocturnal collisions, e.g. flamingos flying from / to a dam, the recently developed Viper LED bird flight diverter should be employed.

- See Appendix C for the recommended Bird Flight Diverter and spacing.

Mitigation displacement:

- Restrict the construction activities to the construction footprint area.
- Do not allow any access to the remainder of the property during the construction period.
- 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 specialist ecological study must be strictly adhered to, especially as far as rehabilitation of vegetation is concerned.
- Prior to construction commencing a helicopter inspection should be conducted in order for the avifaunal specialist to record any large raptor nests on existing transmission lines that could be impacted by the construction of the proposed line.
- Should any nests be recorded, it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the avifaunal specialist, and the Environmental Control Officer. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule which will enable them to ascertain when, and where breeding Red Data eagles 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.

Table 8: Alternative 4 Gromis - Nama Impact rating table (#1 Water & wetlands; #2 Mountainous areas; #3 Thicket & Woodland; #4 Grassland & Low shrubland; #5 Cultivated areas; #6 Mines & Built-up areas).

PROJECT ALTERNATIVE	POTENTIAL ENVIRONMENTAL IMPACT / NATURE OF IMPACT		ENVIRONMENTAL SIGNIFICANCE																		MITIGATION
			BEFORE MITIGATION									AFTER MITIGATION									
		Homogenous area identifier	Duration	Extent	Irreplaceable	Reversibility	Magnitude	Probability	TOTAL (SP)	Significance	CUMULATIVE	Duration	Extent	Irreplaceable	Reversibility	Magnitude	Probability	TOTAL (SP)	Significance	CUMULATIVE	
	Potential Impacts on avifauna																				
Alt 4 Gromis Nama	**Collisions**	#1	4	2	1	2	2	1	11	L	L	4	2	1	2	2	1	11	L	L	See below.
		#2	4	2	2	3	4	4	60	M	M	4	2	2	3	4	2	30	L	L	
		#3	4	2	2	3	2	2	26	L	L	4	2	2	2	2	2	24	L	L	
		#4	4	2	4	3	6	4	76	M	M	4	2	2	3	4	3	45	M	L	
		#6	4	2	1	2	2	1	11	L	-	4	2	1	2	2	1	11	L	-	
Alt 4 Gromis Nama	**Displacement due to habitat destruction and disturbance**	#1	2	2	1	1	2	2	16	L	L	2	2	1	1	2	2	16	L	L	See below.
		#2	2	2	2	3	4	3	39	L	L	2	2	2	3	4	3	39	L	L	
		#3	2	2	2	2	2	2	20	L	L	2	2	2	2	2	2	20	L	L	
		#4	2	2	3	2	4	3	39	L	L	2	2	2	2	4	2	24	L	L	
		#6	2	2	1	1	0	1	6	L	L	2	2	1	1	0	1	6	L	L	

Mitigation collisions:

- Once the final alignments and tower positions have been selected, the sections of the line that would need the application of Bird Flight Diverters to mitigate for potential collisions should be indicated by the avifaunal specialist. This walk-through exercise should be informed by an analysis of satellite imagery supplemented by on site ground-truthing.
- In the case of nocturnal collisions, e.g. flamingos flying from / to a dam, the recently developed Viper LED bird flight diverter should be employed.
- See Appendix C for the recommended Bird Flight Diverter and spacing.

Mitigation displacement:

- Restrict the construction activities to the construction footprint area.
- Do not allow any access to the remainder of the property during the construction period.
- 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 specialist ecological study must be strictly adhered to, especially as far as rehabilitation of vegetation is concerned.
- Sections of this alternative which runs next to the existing powerline must be inspected for raptor nests.
- 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 them to ascertain when, and where breeding Red Data eagles 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.

Table 9: Alternative 1 Nama – Aggeneis Impact Rating Table (#1 Water & wetlands; #2 Mountainous areas; #3 Thicket & Woodland; #4 Grassland & Low shrubland; #5 Cultivated areas; #6 Mines & Built-up areas).

PROJECT ALTERNATIVE	POTENTIAL ENVIRONMENTAL IMPACT / NATURE OF IMPACT		ENVIRONMENTAL SIGNIFICANCE																		MITIGATION
			BEFORE MITIGATION									AFTER MITIGATION									
		Homogenous area identifier	Duration	Extent	Irreplaceable	Reversibility	Magnitude	Probability	TOTAL (SP)	Significance	CUMULATIVE	Duration	Extent	Irreplaceable	Reversibility	Magnitude	Probability	TOTAL (SP)	Significance	CUMULATIVE	
	Potential Impacts on avifauna																				
Alt 1 Nama Aggeneis	Collisions	#2	4	2	1	3	4	3	42	M	M	4	2	1	2	4	2	26	L	L	See below.
		#3	4	2	1	3	2	2	24	L	L	4	2	1	2	2	1	11	L	L	
		#4	4	2	4	3	6	4	76	M	M	4	2	2	3	4	3	45	M	L	
		#5	4	2	1	2	4	2	26	L	L	4	2	1	2	4	2	26	L	L	
		#6	4	2	1	2	2	1	11	L	-	4	2	1	2	2	1	11	L	-	
Alt 1 Nama Aggeneis	Displacement due to habitat destruction and disturbance	#2	2	2	2	3	4	3	39	L	L	2	2	2	3	4	2	26	L	L	See below.
		#3	2	2	2	2	2	2	20	L	L	2	2	2	2	2	2	20	L	L	
		#4	2	2	3	2	4	3	39	L	L	2	2	2	2	4	2	24	L	L	
		#5	2	2	1	1	2	1	8	L	L	2	2	1	1	2	1	8	L	L	
		#6	2	2	1	1	0	1	6	L	L	2	2	1	1	0	1	6	L	L	

Mitigation collisions:

- Alternative 1 emerged as the with the lowest overall significance point and consequently the lowest collision risk to birds. It is therefore recommended that this corridor is selected. This decision is further substantiated by the powerline sensitive Red Data species habitat preference risk rating analysis (see section 15 below).
- Once the final alignments and tower positions have been selected, the sections of the line that would need the application of Bird Flight Diverters to mitigate for potential collisions should be indicated by the avifaunal specialist. This walk-through exercise should be informed by an analysis of satellite imagery supplemented by on site ground-truthing.
- In the case of nocturnal collisions, e.g. flamingos flying from / to a dam, the recently developed Viper LED bird flight diverter should be employed.
- See Appendix C for the recommended Bird Flight Diverter and spacing.

Mitigation displacement:

- Restrict the construction activities to the construction footprint area.
- Do not allow any access to the remainder of the property during the construction period.
- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum.
- The recommendations of the specialist ecological study must be strictly adhered to, especially as far as rehabilitation of vegetation is concerned.
- Prior to construction commencing a helicopter inspection should be conducted in order for the avifaunal specialist to record any large raptor nests on existing transmission lines that could be impacted by the construction of the proposed line.
- Should any nests be recorded, it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the avifaunal specialist, and the Environmental Control Officer. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule which will enable them to ascertain when, and where breeding Red Data eagles 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.

Table 10: Alternative 5 Nama – Aggeneis Impact Rating Table (#1 Water & wetlands; #2 Mountainous areas; #3 Thicket & Woodland; #4 Grassland & Low shrubland; #5 Cultivated areas; #6 Mines & Built-up areas).

PROJECT ALTERNATIVE	POTENTIAL ENVIRONMENTAL IMPACT / NATURE OF IMPACT		ENVIRONMENTAL SIGNIFICANCE																		MITIGATION
			BEFORE MITIGATION									AFTER MITIGATION									
		Homogenous area identifier	Duration	Extent	Irreplaceable	Reversibility	Magnitude	Probability	TOTAL (SP)	Significance	CUMULATIVE	Duration	Extent	Irreplaceable	Reversibility	Magnitude	Probability	TOTAL (SP)	Significance	CUMULATIVE	
	Potential Impacts on avifauna																				
Alt 5 Nama Aggeneis	**Collisions**	#2	4	2	1	3	4	3	42	M	M	4	2	1	2	4	2	26	L	L	See below.
		#3	4	2	2	3	2	2	26	L	L	4	2	2	2	2	1	12	L	L	
		#4	4	2	4	3	6	4	76	M	M	4	2	3	3	4	3	48	M	L	
		#6	4	2	1	2	2	1	11	L	-	4	2	1	2	2	1	11	L	-	
Alt 5 Nama Aggeneis	**Displacement due to habitat destruction and disturbance**	#2	2	2	2	3	4	3	39	L	L	2	2	2	3	4	2	26	L	L	See below.
		#3	2	2	2	2	2	2	20	L	L	2	2	2	2	2	2	20	L	L	
		#4	2	2	3	2	4	3	39	L	L	2	2	2	2	4	2	24	L	L	
		#6	2	2	1	1	0	1	6	L	L	2	2	1	1	0	1	6	L	L	

Mitigation collisions:

- Once the final alignments and tower positions have been selected, the sections of the line that would need the application of Bird Flight Diverters to mitigate for potential collisions should be indicated by the avifaunal specialist. This walk-through exercise should be informed by an analysis of satellite imagery supplemented by on site ground-truthing.
- In the case of nocturnal collisions, e.g. flamingos flying from / to a dam, the recently developed Viper LED bird flight diverter should be employed.
- See Appendix C for the recommended Bird Flight Diverter and spacing.

Mitigation displacement:

- Restrict the construction activities to the construction footprint area.
- Do not allow any access to the remainder of the property during the construction period.
- 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 specialist ecological study must be strictly adhered to, especially as far as rehabilitation of vegetation is concerned.
- Sections of this alternative which runs next to the existing powerline must be inspected for raptor nests.
- 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 them to ascertain when, and where breeding Red Data eagles 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.

Table 11: "No-go" Alternative.

PROJECT ALTERNATIVE	POTENTIAL ENVIRONMENTAL IMPACT / NATURE OF IMPACT		ENVIRONMENTAL SIGNIFICANCE																		MITIGATION
			BEFORE MITIGATION									AFTER MITIGATION									
		Homogenous area identifier	Duration	Extent	Irreplaceable	Reversibility	Magnitude	Probability	TOTAL (SP)	Significance	CUMULATIVE	Duration	Extent	Irreplaceable	Reversibility	Magnitude	Probability	TOTAL (SP)	Significance	CUMULATIVE	
	Potential Impacts on avifauna																				
"No-go" alternative	**None**		5	0	0	0	0	1	5	L	L	5	0	0	0	0	1	5	L	L	None.

15. Comparison of alternatives and preferred alternative recommendation

The potential for interaction with the proposed power line was assessed for each of the Red Data species listed in Table 1. This was done by assessing the probability of each potential impact (collisions and displacement due to habitat destruction or disturbance – see section 12 above for more details of the anticipated impacts) occurring, for each species, within each of the identified habitat classes. The following probability scale was used: 1 = low, 2 = medium, 3 = high (see Table 12 below). Each habitat class therefore received a risk score for each species. The total risk score for a habitat class was calculated as the sum of the various individual species scores for that habitat class. Table 12 below gives the risk scores for each of the habitat classes as well the individual species ratings for the impacts in the respective habitat classes.

Table 12: Avifaunal habitat class risk scores and underlying Red Data species ratings for the impacts in the respective habitat classes.

	Water & wetlands	Mountainous areas	Thicket & woodland	Grassland & Low shrubland	Cultivated areas	Mines Built-up areas
Risk score:	37	16	12	35	12	4
Black Harrier						
Collision				2		
Displacement				2		
Ludwig's Bustard						
Collision				3	3	
Displacement				2	2	
Martial Eagle						
Collision	2	2	2	2	2	
Displacement	2	2	2	2	1	
Greater Flamingo						
Collision	3					
Displacement	2					
Karoo Korhaan						
Collision				2		
Displacement				2		
Kori Bustard						
Collision				3		
Displacement				2		
Lesser Flamingo						
Collision	3					
Displacement	2					
Maccoa Duck						
Collision	3					
Displacement	2					
Marabou Stork						
Collision	3					
Displacement	2					
Black Stork						
Collision	2	2				
Displacement	2	2				
Great White Pelican						
Collision	3					
Displacement	2					
Lanner Falcon						
Collision	2	2	2	2	2	2
Displacement	2	2	2	2	2	2
Secretarybird						
Collision			2	3		
Displacement			2	2		
Southern Black Korhaan						
Collision				2		
Displacement				2		
Verreaux's Eagle						
Collision		2				
Displacement		2				

Table 13: Risk scores for each habitat class.

Avifaunal habitat class	Risk score	Avifaunal habitat class	Risk score
Waterbodies & wetlands	37	Grassland & low shrubland	35
Mountainous areas	16	Cultivated areas	12
Thicket & woodland	12	Mines & built-up areas	4

The risk scores in Table 13 were incorporated into a formula to arrive at a risk rating for each 2km wide corridor alternative. The surface area of a corridor that intersected with an avifaunal habitat class was calculated.

The risk rating for a power line corridor alternative was calculated by multiplying the percentage that each avifaunal habitat class constitute of the total surface area of the 2km wide corridor with the risk score for that habitat class, and then adding up the totals. The risk ratings of the respective corridors are listed in Table 14 below.

Table 14: Alternative risk ratings based on habitat risk scores multiplied by the surface area percentages.

Alternative corridor	Avifaunal habitat class	Habitat risk score	Percentage of surface area in corridor	Risk rating
Alt 1 Gromis – Nama	Water & wetlands	37	0.002%	0.1
	Mountainous	16	8.3%	133.1
	Thicket & woodland	12	7.9%	94.8
	Grassland low shrubland	35	80.8%	2829.5
	Cultivated	12	0.3%	3.5
	Mines & Built-up	4	2.6%	10.6
			Total:	**3071.5**
Alt 4 Gromis – Nama	Water & wetlands	37	0.001%	0.0
	Mountainous	16	7.8%	125.1
	Thicket & woodland	12	3.8%	45.5
	Grassland low shrubland	35	87.0%	3045.1
	Mines & Built-up	4	1.4%	5.6
			Total:	**3221.3**
Alt 1 Nama – Aggeneys	Mountainous	16	2.4%	38.3
	Thicket & woodland	12	6.1%	72.8
	Grassland low shrubland	35	91.1%	3187.0
	Cultivated	12	0.01%	0.2
	Mines & Built-up	4	0.5%	1.9
			Total:	**3300.1**
Alt 5 Nama – Aggeneys	Mountainous	16	2.3%	36.8
	Thicket & woodland	12	4.2%	50.4
	Grassland low shrubland	35	93.2%	3261.1
	Mines & Built-up	4	0.3%	1.3
			Total:	**3349.6**

The route corridor alternatives all emerged with very similar risk scores, indicating that the expected impacts are very similar for all three alternatives. However, Alternative 1 is the preferred alternative, the reason being that this alternative is situated next to the existing transmission powerline (between Aggeneis, Nama and Gromis substations) which potentially reduces the risk of collisions. Placing the new line next to an existing transmission line should reduce the risk of collisions in the long term, because 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 (Shaw 2013; APLIC 2012; Sundar & Choudhury 2005). Whereas it is acknowledged that this alternative could potentially result in significant short term temporary displacement impacts on breeding eagles on the adjoining existing transmission line during the construction phase, this should be weighed up against the reduction of the risk of long term collision impacts on large terrestrial species.

In addition, it is recommended that the tower placement of the new proposed line be staggered in relation to the existing line so as to increase the visibility of the line in an attempt to further mitigate the collision risk posed by the powerline. It has been proven that when only the centre 60% of the span is marked, as is currently the Eskom practice, that birds tend to fly into the unmarked sections of the span (Shaw *et al.* 2017). By staggering the towers, this problem can be addressed as this results in continuous overlap of marked sections on parallel lines.

16. Recommended 'no-go areas'

Although no specific no-go areas were identified from an avifaunal perspective, it is recommended that all the proposed mitigation measures be implemented to minimise the impacts as far as is practically possible.

17. Recommendations for further investigation during BA process

Once the final alignments and tower positions have been selected, the sections of the line that would need the application of Bird Flight Diverters to mitigate for potential collisions should be indicated by the avifaunal specialist. This walk-through exercise should be informed by an analysis of satellite imagery supplemented by on site ground-truthing.

Prior to construction commencing an inspection, preferably by helicopter if possible, should be conducted in order for the avifaunal specialist to record any large raptor nests on existing transmission lines that could be impacted by the construction of the proposed line.

18. How does your recommendations tie into existing and future (at least next 5 years) spatial/spatial-planning frameworks?

The expansion of electricity grid infrastructure in the Northern Cape Province is being accelerated due to the expansion of renewable energy facilities – especially solar and wind energy facilities that are being constructed (in excess of 15 renewable energy developments with an approved Environmental Authorisation or applications under consideration are located within 30 km of the proposed route alternatives – DEA screening tool results). It is therefore inevitable that additional powerlines would be required to evacuate the generated electricity and feed that into the existing grid and to expand the existing grid infrastructure. It is known that electricity grid infrastructure poses significant risks to Red Data birds occurring in the study area (CSIR, 2015).

The cumulative impact of transmission lines in the Karoo and Northern Cape as far as collision mortality of large terrestrial species is concerned is alarming, and potentially catastrophic as far as Ludwig's Bustard is concerned, with an estimated 41% of the population being killed annually, with Kori Bustards also dying in large numbers (at least 14% of the South African population killed in the Karoo alone) (Shaw 2013). The addition of another transmission line will potentially aggravate the situation further. Ludwig's Bustard migratory movements are along a broad east-west axis (Shaw 2013), which is a mitigating factor to some extent as the line also follows a broad east-west axis, and does not cut diagonally across the general flight path of this species when doing long distance migratory flights. However, research has shown that the highest collision risk occurs when birds are resident in an area between migratory movements, presumably because they fly higher during migratory flights (Shaw 2013).

19. Summary of recommended mitigation measures

Recommended mitigation measures to reduce collisions:

- Alternative 1 emerged as the alternative with the lowest overall significance point and consequently the lowest collision risk to birds. It is therefore recommended that this corridor is selected. This decision is further substantiated by the powerline sensitive Red Data species habitat preference risk rating analysis (see section 15 above).
- Once the final alignments and tower positions have been selected, the sections of the line that would need the application of Bird Flight Diverters to mitigate for potential collisions should be indicated by the avifaunal specialist. This walk-through exercise should be informed by an analysis of satellite imagery supplemented by on site ground-truthing.
- In the case of nocturnal collisions, e.g. flamingos roosting or flying from / to a dam, the recently developed Viper LED bird flight diverter should be employed.
- See Appendix C for the recommended Bird Flight Diverter and spacing.
- It is recommended that the tower placement of the new proposed line be staggered in relation to the existing line so as to increase the visibility of the line in an attempt to further mitigate the collision risk posed by the powerline (If Alternative 1 is chosen).

Recommended mitigation measures to reduce displacement due to habitat destruction and disturbance:

- Restrict the construction activities to the construction footprint area.
- Do not allow any access to the remainder of the property during the construction period.
- 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 specialist ecological study must be strictly adhered to, especially as far as rehabilitation of vegetation is concerned.
- Prior to construction commencing an inspection, preferably by helicopter if possible, should be conducted in order for the avifaunal specialist to record any large raptor nests on existing transmission lines that could be impacted by the construction of the proposed line.
- Should any nests be recorded, it would require management of the potential impacts on the breeding birds once construction commences, which would necessitate the involvement of the avifaunal specialist, and the Environmental Control Officer. An effective communication strategy should be implemented whereby the avifaunal specialist is provided with a construction schedule

which will enable them to ascertain when, and where breeding Red Data eagles 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.

20. Recommended monitoring requirements

It is recommended that quarterly carcass inspections are conducted along the entire line to establish if there are any collision hot-spots that need to be marked with Bird Flappers or BFDs, and to assess the efficacy of the Bird Flappers or BFDs already applied to selected sections of the line. Scavenger removal trials conducted by Shaw (2013) has established that large carcasses in the Karoo are still detectable up to three months after the collision event.

21. Final specialist recommendations & Conclusion

It is envisaged that the proposed Gromis-Nama-Aggeneis 400kv IPP Integration Power Line will have two major potential impacts on Red Data avifauna, namely displacement due to disturbance of breeding birds, especially breeding Martial Eagles on existing transmission lines, and mortality of large terrestrial species due to collisions with the earthwire of the proposed line. The latter impact is especially concerning as far as the Endangered Ludwig's Bustard is concerned, as the species is known to be highly susceptible to this impact, and conventional mitigation methods, i.e. the marking of the earthwire with Bird Flight Diverters, seems to have limited success in reducing mortality for this species (Shaw *et al.* 2017). It must therefore be accepted that even with current state of the art mitigation, Ludwig's Bustard collisions are likely to still take place, irrespective of which corridor is ultimately selected.

The cumulative impact of transmission lines in the Karoo as far as collision mortality of large terrestrial species is concerned is alarming, and potentially catastrophic as far as Ludwig's Bustard is concerned, with an estimated 41% of the population being killed annually, with Kori Bustards also dying in large numbers (at least 14% of the South African population killed in the Karoo alone) (Shaw 2013). The addition of another transmission line will potentially aggravate the situation further. Ludwig's Bustard migratory movements are along a broad east-west axis (Shaw 2013), which is a mitigating factor to some extent as the line also follows a broad east-west axis, and does not cut diagonally across the general flight path of this species when doing long distance migratory flights. However, research has shown that the highest collision risk occurs when birds are resident in an area between migratory movements, presumably because they fly higher during migratory flights (Shaw 2013).

No electrocution risk is envisaged as the clearances (phase – phase and phase – earth) on the proposed 400kV line are too large for any bird to physically bridge, thereby eliminating any potential for a bird causing a short circuit.

The route corridor alternatives all emerged with very similar risk scores, indicating that the expected impacts are very similar for all alternatives. However, Alternative 1 is the preferred alternative, the reason being that this alternative is situated next to the existing transmission powerline (between Aggeneis, Nama and Gromis substations) which potentially reduces the risk of collisions. Placing the new line next to an existing transmission line should reduce the risk of collisions in the long term, because 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 (Shaw 2013; APLIC 2012; Sundar & Choudhury 2005). Whereas it is acknowledged that this alternative could potentially result in significant short term temporary displacement impacts on breeding eagles on the adjoining existing transmission line during the construction phase, this should be weighed up against the reduction of the risk of long term collision impacts on large terrestrial species. In addition it is recommended that the tower placement of the new proposed line be staggered in relation to the existing line so as to increase the visibility of the line in an attempt to further mitigate the collision risk posed by the powerline (Shaw *et al.* 2017). Although Alternative 1 is preferred from an avifaunal perspective Alternative 5 can also be considered as it is the second-best option.

The proposed mitigation measures should reduce the impact of the proposed line, except for collisions in grassland and low shrubland (specifically as a result of Ludwig's Bustard), where the collision impact will remain medium, even with mitigation.

22. References

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

Common name	Taxonomic name	Regional Red Data status	Global Red Data status	Powerline sensitive species	Recorded during site visit	SABAP1 average reporting rate	SABAP2 Full protocol reporting rate
Black Harrier	*Circus maurus*	EN	EN	YES		0.54	0.87
Black Stork	*Ciconia nigra*	VU	LC	YES		0.16	
Great White Pelican	*Pelecanus onocrotalus*	VU	LC	YES		0.23	
Greater Flamingo	*Phoenicopterus ruber*	NT	LC	YES		0.35	
Karoo Korhaan	*Eupodotis vigorsii*	NT	LC	YES	1	0.64	1.74
Kori Bustard	*Ardeotis kori*	NT	NT	YES		18.84	0.00
Lanner Falcon	*Falco biarmicus*	VU	LC	YES	1	0.75	8.70
Lesser Flamingo	*Phoenicopterus minor*	NT	NT	YES		0.53	
Ludwig's Bustard	*Neotis ludwigii*	EN	EN	YES		0.43	7.83
Maccoa Duck	*Oxyura maccoa*	NT	VU	YES		0.75	6.96
Marabou Stork	*Leptoptilos crumeniferus*	NT	LC	YES		0.02	
Martial Eagle	*Polemaetus bellicosus*	EN	VU	YES		1.23	5.22
Secretarybird	*Sagittarius serpentarius*	VU	VU	YES		1.28	
Southern Black Korhaan	*Afrotis afra*	VU	VU	YES	1	0.22	0.00
Verreaux's Eagle	*Aquila verreauxii*	VU	LC	YES	1	0.47	20.87
African Rock Pipit	*Anthus crenatus*	NT	NT			1.45	
Barlow's Lark	*Calendulauda barlowi*	NT	LC			0.28	0.00
Chestnut-banded Plover	*Charadrius pallidus*	NT	NT			1.45	
Sclater's Lark	*Spizocorys sclateri*	NT	NT			0.85	
Burchell's Courser	*Cursorius rufus*	VU	LC			7.25	2.61
Red Lark	*Calendulauda burra*	VU	VU			1.99	8.70
Acacia Pied Barbet	*Tricholaema leucomelas*				1	0.82	48.70
African Harrier-Hawk	*Polyboroides typus*						0.87
African Hoopoe	*Upupa africana*				1	0.83	8.70
African Palm-swift	*Cypsiurus parvus*						3.48
African Pied Wagtail	*Motacilla aguimp*					1.45	
African Pipit	*Anthus cinnamomeus*				1	2.22	5.22
African Red-eyed Bulbul	*Pycnonotus nigricans*				1	3.23	31.30
African Reed-warbler	*Acrocephalus baeticatus*					0.16	1.74
African Sacred Ibis	*Threskiornis aethiopicus*				1	0.32	16.52
African Stonechat	*Saxicola torquatus*					0.21	
Alpine Swift	*Tachymarptis melba*				1	0.44	5.22

Common name	Taxonomic name	Regional Red Data status	Global Red Data status	Powerline sensitive species	Recorded during site visit	SABAP1 average reporting rate	SABAP2 Full protocol reporting rate
Anteating Chat	*Myrmecocichla formicivora*					1.25	46.09
Barn Owl	*Tyto alba*					0.21	1.74
Barn Swallow	*Hirundo rustica*				1	1.22	6.09
Black-chested Prinia	*Prinia flavicans*				1	0.93	1.74
Black-chested Snake-eagle	*Circaetus pectoralis*				1	1.05	3.48
Black-eared Sparrowlark	*Eremopterix australis*					1.18	1.74
Black-headed Canary	*Serinus alario*					0.51	18.26
Black-headed Heron	*Ardea melanocephala*				1	1.29	9.57
Black-necked Grebe	*Podiceps nigricollis*					0.09	
Black-shouldered Kite	*Elanus caeruleus*				1	0.46	3.48
Blacksmith Lapwing	*Vanellus armatus*				1	1.98	29.57
Black-throated Canary	*Crithagra atrogularis*					1.89	1.74
Black-winged Stilt	*Himantopus himantopus*					2.24	10.43
Bokmakierie	*Telophorus zeylonus*				1	1.14	73.91
Booted Eagle	*Aquila pennatus*				1	0.13	8.70
Bradfield's Swift	*Apus bradfieldi*					3.28	2.61
Brown-throated Martin	*Riparia paludicola*					2.21	7.83
Cape Bulbul	*Pycnonotus capensis*					0.35	34.78
Cape Bunting	*Emberiza capensis*				1	0.69	72.17
Cape Clapper Lark	*Mirafra apiata*					0.45	5.22
Cape Crow	*Corvus capensis*				1	1.14	13.04
Cape Eagle-owl	*Bubo capensis*					0.18	0.87
Cape Glossy Starling	*Lamprotornis nitens*				1	0.36	23.48
Cape Long-billed Lark	*Certhilauda curvirostris*					0.95	2.61
Cape Penduline-tit	*Anthoscopus minutus*					0.15	2.61
Cape Robin-chat	*Cossypha caffra*				1	0.14	20.87
Cape Shoveler	*Anas smithii*					0.41	6.09
Cape Sparrow	*Passer melanurus*				1	1.50	81.74
Cape Spurfowl	*Pternistis capensis*					0.04	
Cape Teal	*Anas capensis*					2.86	13.04
Cape Turtle-dove	*Streptopelia capicola*				1	1.00	53.04
Cape Wagtail	*Motacilla capensis*				1	1.32	40.87
Cape Weaver	*Ploceus capensis*				1	0.40	46.09
Capped Wheatear	*Oenanthe pileata*					0.65	12.17
Cardinal Woodpecker	*Dendropicos fuscescens*					0.25	1.74

Common name	Taxonomic name	Regional Red Data status	Global Red Data status	Powerline sensitive species	Recorded during site visit	SABAP1 average reporting rate	SABAP2 Full protocol reporting rate
Cattle Egret	*Bubulcus ibis*				1	0.46	5.22
Chat Flycatcher	*Bradornis infuscatus*					0.93	8.70
Chestnut-vented Tit-babbler	*Parisoma subcaeruleum*					0.25	3.48
Cinnamon-breasted Warbler	*Euryptila subcinnamomea*					0.60	8.70
Common (Southern) Fiscal	*Lanius collaris*				1	1.30	76.52
Common Greenshank	*Tringa nebularia*					0.32	1.74
Common House-martin	*Delichon urbicum*					0.05	
Common Moorhen	*Gallinula chloropus*					0.06	4.35
Common Ostrich	*Struthio camelus*					1.93	10.43
Common Quail	*Coturnix coturnix*					7.25	0.87
Common Ringed Plover	*Charadrius hiaticula*					0.31	
Common Sandpiper	*Actitis hypoleucos*					1.86	0.87
Common Starling	*Sturnus vulgaris*					0.55	0.87
Common Swift	*Apus apus*					33.33	0.00
Common Waxbill	*Estrilda astrild*					0.31	7.83
Crowned Lapwing	*Vanellus coronatus*				1	0.16	
Damara Canary	*Serinus leucolaema*						0.87
Double-banded Courser	*Rhinoptilus africanus*					0.65	2.61
Double-banded Sandgrouse	*Pterocles bicinctus*					1.45	
Dusky Sunbird	*Cinnyris fuscus*				1	0.86	36.52
Egyptian Goose	*Alopochen aegyptiacus*					1.39	27.83
European Bee-eater	*Merops apiaster*				1	0.37	12.17
Fairy Flycatcher	*Stenostira scita*					0.27	8.70
Familiar Chat	*Cercomela familiaris*					0.87	44.35
Fawn-coloured Lark	*Calendulauda africanoides*					13.17	
Fiscal Flycatcher	*Sigelus silens*						0.00
Freckled Nightjar	*Caprimulgus tristigma*					0.05	
Gabar Goshawk	*Melierax gabar*					0.45	
Greater Kestrel	*Falco rupicoloides*				1	1.30	14.78
Greater Striped Swallow	*Hirundo cucullata*					0.01	
Grey Heron	*Ardea cinerea*					1.69	2.61
Grey Tit	*Parus afer*					0.30	23.48
Grey-backed Cisticola	*Cisticola subruficapilla*					0.41	41.74

Common name	Taxonomic name	Regional Red Data status	Global Red Data status	Powerline sensitive species	Recorded during site visit	SABAP1 average reporting rate	SABAP2 Full protocol reporting rate
Grey-backed Sparrowlark	*Eremopterix verticalis*					1.05	8.70
Grey-winged Francolin	*Scleroptila africanus*					0.06	0.87
Ground Woodpecker	*Geocolaptes olivaceus*					0.16	0.87
Hadeda Ibis	*Bostrychia hagedash*				1		12.17
Hamerkop	*Scopus umbretta*					0.07	0.87
Helmeted Guineafowl	*Numida meleagris*					0.04	2.61
House Sparrow	*Passer domesticus*				1	1.06	41.74
Jackal Buzzard	*Buteo rufofuscus*				1	0.89	32.17
Karoo Chat	*Cercomela schlegelii*				1	0.97	41.74
Karoo Eremomela	*Eremomela gregalis*					0.25	7.83
Karoo Lark	*Calendulauda albescens*					0.28	26.09
Karoo Long-billed Lark	*Certhilauda subcoronata*				1	0.95	10.43
Karoo Prinia	*Prinia maculosa*					0.44	53.04
Karoo Scrub-robin	*Cercotrichas coryphoeus*					0.39	48.70
Karoo Thrush	*Turdus smithi*					0.98	22.61
Kittlitz's Plover	*Charadrius pecuarius*					68.12	
Large-billed Lark	*Galerida magnirostris*				1	0.34	31.30
Lark-like Bunting	*Emberiza impetuani*					1.05	13.91
Laughing Dove	*Streptopelia senegalensis*				1	1.39	47.83
Layard's Tit-babbler	*Parisoma layardi*					0.39	26.09
Lesser Grey Shrike	*Lanius minor*					11.59	
Lesser Kestrel	*Falco naumanni*						0.00
Lesser Swamp-warbler	*Acrocephalus gracilirostris*					1.45	
Little Bittern	*Ixobrychus minutus*					0.33	
Little Egret	*Egretta garzetta*					0.58	
Little Grebe	*Tachybaptus ruficollis*					2.12	17.39
Little Swift	*Apus affinis*				1	1.12	15.65
Long-billed (Split, see Nicholson's and Long-billed) Pipit	*Anthus similis*					4.35	5.22
Long-billed Crombec	*Sylvietta rufescens*				1	0.25	14.78
Longbilled Lark	*Mirafra curvirostris*					0.19	
Malachite Kingfisher	*Alcedo cristata*					0.23	
Malachite Sunbird	*Nectarinia famosa*					0.31	44.35
Marsh Warbler	*Acrocephalus palustris*						0.00

Common name	Taxonomic name	Regional Red Data status	Global Red Data status	Powerline sensitive species	Recorded during site visit	SABAP1 average reporting rate	SABAP2 Full protocol reporting rate
Mountain Wheatear	*Oenanthe monticola*					1.39	74.78
Namaqua Dove	*Oena capensis*					1.15	11.30
Namaqua Sandgrouse	*Pterocles namaqua*				1	0.96	15.65
Namaqua Warbler	*Phragmacia substriata*					0.19	6.09
Northern Black Korhaan	*Afrotis afraoides*					4.35	2.61
Orange River White-eye	*Zosterops pallidus*					1.20	15.65
Pale-winged Starling	*Onychognathus nabouroup*				1	1.37	50.43
Pied Avocet	*Recurvirostra avosetta*					0.60	1.74
Pied Crow	*Corvus albus*				1	1.43	84.35
Pied Kingfisher	*Ceryle rudis*					0.58	
Pied Starling	*Spreo bicolor*					0.31	3.48
Pink-billed Lark	*Spizocorys conirostris*					1.45	
Plain-backed Pipit	*Anthus leucophrys*						0.87
Pririt Batis	*Batis pririt*					0.15	9.57
Pygmy Falcon	*Polihierax semitorquatus*					59.42	0.00
Red-billed Quelea	*Quelea quelea*					17.52	0.87
Red-billed Teal	*Anas erythrorhyncha*					0.88	1.74
Red-capped Lark	*Calandrella cinerea*					0.54	6.96
Red-eyed Dove	*Streptopelia semitorquata*				1		14.78
Red-faced Mousebird	*Urocolius indicus*					0.18	6.09
Red-headed Finch	*Amadina erythrocephala*					13.17	3.48
Red-knobbed Coot	*Fulica cristata*					1.55	16.52
Red-necked Falcon	*Falco chicquera*					5.80	
Rock Dove	*Columba livia*				1	1.32	6.09
Rock Kestrel	*Falco rupicolus*				1	1.24	25.22
Rock Martin	*Hirundo fuligula*				1	1.28	67.83
Rufous-eared Warbler	*Malcorus pectoralis*					0.67	27.83
Sabota Lark	*Calendulauda sabota*					3.11	0.87
Scaly-feathered Finch	*Sporopipes squamifrons*					2.60	2.61
Sickle-winged Chat	*Cercomela sinuata*				1	0.37	5.22
Sociable Weaver	*Philetairus socius*				1	6.19	9.57
South African Shelduck	*Tadorna cana*					1.51	24.35
Southern Double-collared Sunbird	*Cinnyris chalybeus*					0.54	40.00

Common name	Taxonomic name	Regional Red Data status	Global Red Data status	Powerline sensitive species	Recorded during site visit	SABAP1 average reporting rate	SABAP2 Full protocol reporting rate
Southern Grey-headed Sparrow	*Passer diffusus*					37.68	0.87
Southern Masked-weaver	*Ploceus velatus*				1	0.79	29.57
Southern Pale Chanting Goshawk	*Melierax canorus*				1	1.09	24.35
Southern Pochard	*Netta erythrophthalma*					2.90	0.87
Southern Red Bishop	*Euplectes orix*				1	0.86	5.22
Speckled Mousebird	*Colius striatus*						0.87
Speckled Pigeon	*Columba guinea*				1	0.99	50.43
Spike-heeled Lark	*Chersomanes albofasciata*				1	0.86	25.22
Spotted Eagle-owl	*Bubo africanus*					0.69	3.48
Spotted Flycatcher	*Muscicapa striata*					0.16	
Spotted Prinia	*Prinia hypoxantha*					0.43	
Spotted Thick-knee	*Burhinus capensis*					1.18	3.48
Spur-winged Goose	*Plectropterus gambensis*					1.45	
Stark's Lark	*Spizocorys starki*					0.89	2.61
Steppe Buzzard	*Buteo vulpinus*					1.17	0.00
Swallow-tailed Bee-eater	*Merops hirundineus*				1		0.87
Three-banded Plover	*Charadrius tricollaris*					1.47	19.13
Tractrac Chat	*Cercomela tractrac*					0.45	16.52
Water Thick-knee	*Burhinus vermiculatus*					0.05	
Wattled Starling	*Creatophora cinerea*					0.22	0.87
White-backed Mousebird	*Colius colius*				1	1.67	53.04
White-browed Sparrow-weaver	*Plocepasser mahali*					1.45	
White-necked Raven	*Corvus albicollis*						4.35
White-rumped Swift	*Apus caffer*					0.09	1.74
White-throated Canary	*Crithagra albogularis*				1	0.89	56.52
White-throated Swallow	*Hirundo albigularis*					0.49	1.74
Wood Sandpiper	*Tringa glareola*					0.17	1.74
Yellow Bishop	*Euplectes capensis*					0.09	7.83
Yellow Canary	*Crithagra flaviventris*					0.48	25.22
Yellow-bellied Eremomela	*Eremomela icteropygialis*					0.48	1.74
Yellow-billed Duck	*Anas undulata*					0.31	10.43
Yellow-billed Egret	*Egretta intermedia*					17.39	
Yellow-billed Kite	*Milvus aegyptius*					0.46	1.74
Zitting Cisticola	*Cisticola juncidis*					0.16	

Appendix B: Bird habitat types – photographic record

1. Water & wetlands

Windmill and associated water trough near Aggeneys (Alternative 1 & 5)

Shallow depression which following good rains will fill with runoff water near Springbok (Alternative 1)

Wetland area along drainage line north of Springbok (Alternative 4)

Open water near Springbok (Alternative 4)

Dry Buffels River valley (Alternative 4)

2. Mountainous areas

Inselbergs in the open plains near Aggeneys (Alternative 2 & 3)

Inselbergs near Springbok (Alternative 1, 2 & 3)

Steep boulder strewn hillsides near Springbok (Alternative 5)

Cliffs along the Skaap River valley north west of Springbok (Alternative 4)

Cliffs along the Skaap River valley north west of Springbok (Alternative 4)

3. Thicket & woodland

Thicket and woodland along a drainage line north of Springbok (Alternative 4)

Woodland areas north west of Springbok (Alternative 4)

Thicket areas north west of Springbok (Alternative 4)

Woodland near Springbok (Alternative 4)

Woodland on dunes towards the Gromis substation along the Buffels River valley. (Alternative 1,2 & 4)

Woodland east of Springbok (Alternative 5)

4. Grassland & low shrubland

Open plains near Aggeneis – very dry conditions currently prevail in the area (Alternative 5)

Low shrubland and grass on dunes near Aggeneis (Alternative 3)

Low shrubland on plains east of Springbok (Alternative 1)

Open plains east of Springbok (Alternative 1)

Low shrubland north of Springbok (Alternative 4)

Low shrubland on mountain plateau areas north west of Springbok (Alternative 4)

Low shrubland on gentle slopes of mountainous areas north west of Springbok (Alternative 4)

Low shrubland on slopes west of Springbok under existing transmission powerline (Alternative 1)

Low shrubland on coastal plains near to Gromis substation (Alternative 1, 2 & 4)

Low shrubland around the Gromis substation (Alternative 1, 2 & 4)

5. Cultivated

Cultivated field north west of Springbok (between Alternative 2 & 4)

Cultivated field north west of Springbok (between Alternative 2 & 4)

Cultivated field west of Springbok (between Alternative 1)

Cultivated field north west of Springbok (Alternative 1)

Cultivated field north west of Springbok (Alternative 1)

6. Mines & built-up

Built-up areas – Springbok (Alternative 1, 2 & 4)

Disused mine north west of Springbok (between Alternative 2 & 4)

Disused mine north west of Springbok (between Alternative 2 & 4)

Mine north west of Springbok at Nababeep (between Alternative 2 & 4)

Mine west of Springbok (Alternative 1)

Mine west of Springbok (Alternative 1 & 2)

7. Existing sub-stations

Aggeneis substation

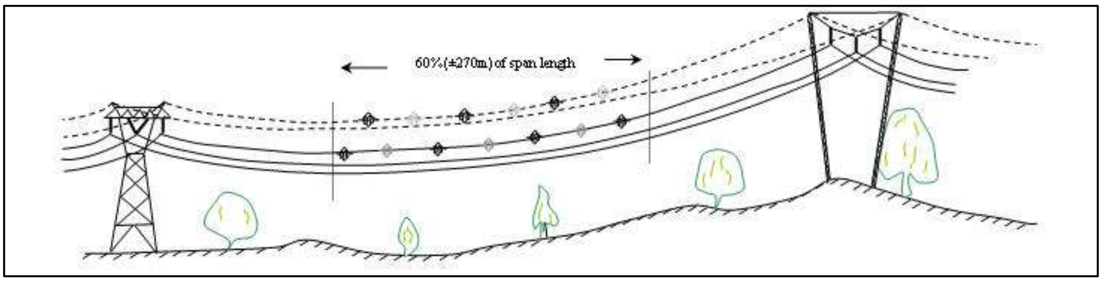
Aggeneis substation

Nama Substation

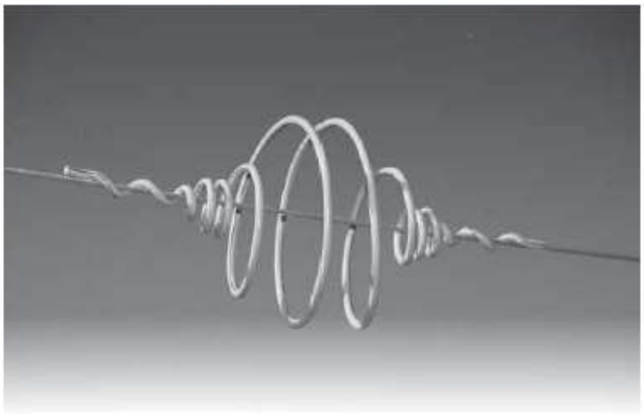
Nama Substation

Gromis Substation

Appendix C: Recommended bird flight diverters and spacing.



Double Loop Bird Flight Diverter



General Recommendation

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

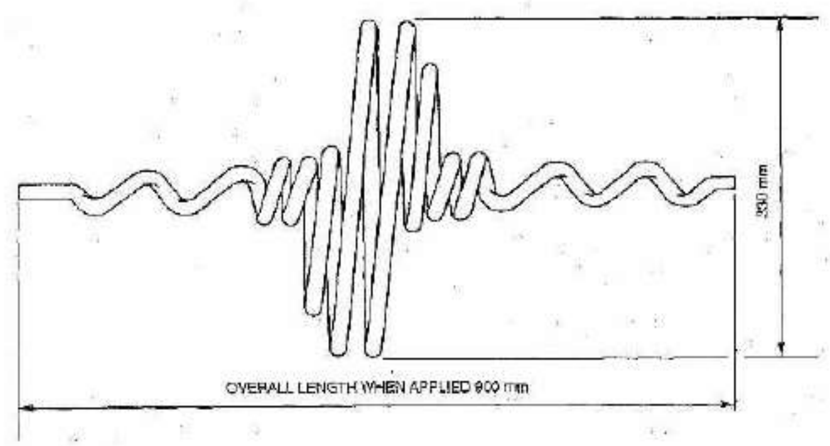
The fitting is light in weight, offers little wind resistance and is easily and quickly applied. The positive grip of the fitting on the conductor ensures that it remains in the applied position and cannot move along the span under vibration.

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

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

We recommend generally a spacing of 10 or 15 metres.

Double Loop Bird Flight Diverter

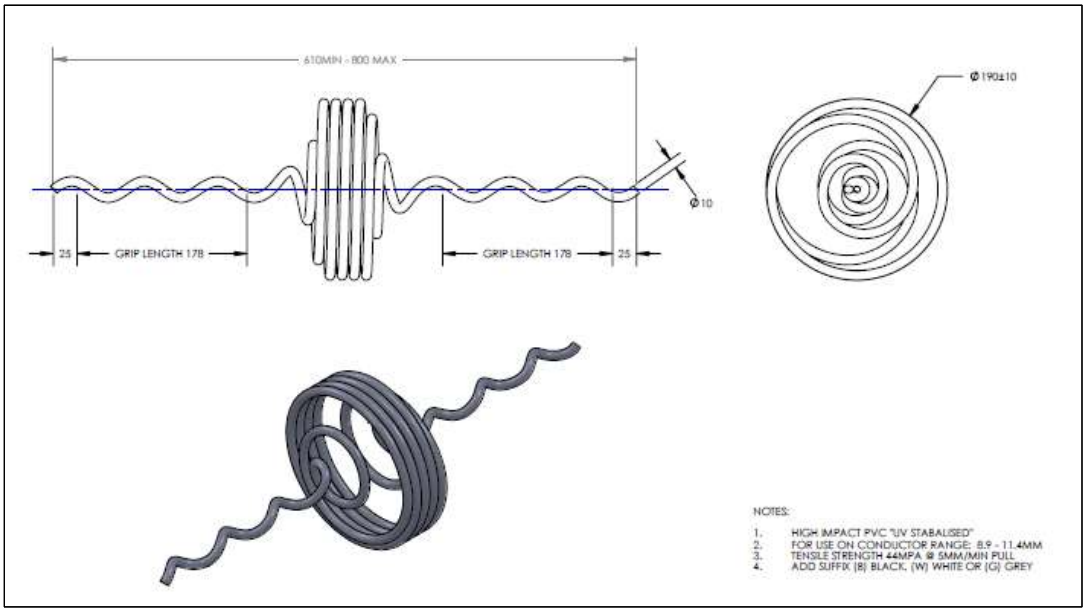


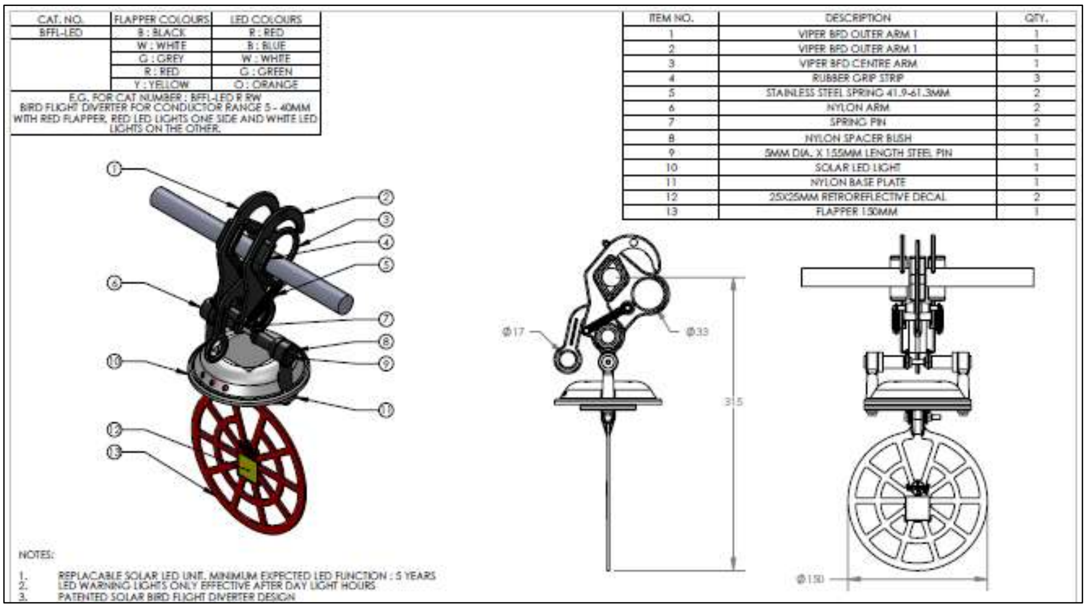
Material Used: Manufactured from rigid solid high impact polyvinyl chloride, possessing excellent chemical and strength properties and which will retain good physical characteristics within the range of extreme temperatures. Outdoor aging tests indicate that the material does not deteriorate in function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

Colour: White or Black

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

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





*Note – all the above bird flight diverter diagrams are for reference / illustration purposes only. Source of diagrams – Preformed Line Products – www.preformedsa.co.za