ORYX - TETRA4 33kV POWERLINE, VIRGINIA, FREE STATE PROVINCE

Avifauna and Fauna Specialist Report

August 2020

Final Report

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EXECUTIVE SUMMARY

Pachnoda Consulting cc was contracted by Green Environment to provide a terrestrial avifauna and fauna report for the proposed self-build Oryx - Tetra4 33kV overhead powerline near Virginia, Free State Province.

The terms of reference for this assessment were to:

- provide a general description of the affected environment concerning the avifaunal and terrestrial faunal habitat types;
- conduct an assessment of all available information in order to present the following results:
    - typify the regional vegetation that will be affected by the proposed powerline;
    - provide an indication on the occurrence of threatened, near-threatened, endemic and conservation important bird or animal species likely to be affected by the proposed powerline;
    - provide an indication of sensitive bird and fauna habitat corresponding to the proposed powerline;
    - highlight areas of concern or hotspot areas;
    - identify potential impacts on the terrestrial ecological environment that are considered pertinent to the proposed powerline;
    - identify negative impacts and feasible mitigation options; and
    - provide an analysis of the deviation options regarding their feasibility from a terrestrial ecological perspective.

A site visit was conducted during 20 - 21 July 2020, whereby the physical environment of the proposed corridors was inspected by road and on foot following an evaluation of GIS-based information on the biotic and biophysical attributes of the area.

The following key considerations were identified and noted:

- The study area comprehended five broad-scale habitat types:
    - *Vachellia karoo - Themeda triandra grassland/bushveld mosaics* with a high avifaunal and faunal importance;
    - Secondary grassland with scattered *Vachellia karoo* bush clumps with a low avifaunal and faunal importance;
    - Riparian vegetation with a high avifaunal and faunal importance;
    - Azonal habitat with a high avifaunal importance; and
    - Cultivated land and pastures with a low avifaunal and faunal importance.
- The study area provided (based on known historical and extant distribution ranges) habitat for 22 mammal taxa, 20 reptile species and 8 frog species.
- The study area was likely to support three mammal species of conservation

concern (Black-footed Cat (*Felis nigripes* - Vulnerable), White-tailed Rat (*Mystromys albicaudatus* - Vulnerable) and Brown Hyaena (*Parahyaena brunnea* - Near threatened). These species have a moderate probability of occurrence owing to the presence suitable habitat although they are only known from single historical records.

- The *Themeda*-dominated grassland on Sepane and Katspruit soil forms in the northern part of the alignment provided potential habitat for the vulnerable Giant Girdled Lizard (*Smaug giganteus*). The probability that this species could occur on the study site was regarded as low-moderate.
- A total of 139 bird species have been observed in the study area (c. pentad grids 2805_2640 and 2810_2640), of which 77 bird species were observed during the site visits (representing 55.5 % of the observed SABAP2 richness).
- Approximately 52 collision-prone bird species could be present on the study area, of which 19 species were confirmed during the site visit and included the African White-backed Vulture (*Gyps africanus*) which was not previously recorded during SABAP2.
- Collision-prone bird species with the highest probability to occur along the powerline servitude included the Northern Black Korhaan (*Afrotis afraoides*), Speckled Pigeon (*Columba guinea*), Swainson's Spurfowl (*Pternistis swainsonii*), Red-knobbed Coot (*Fulica cristata*) and Black-winged Kite (*Elanus caeruleus*).
- Nine (9) of the 52 collision-prone bird species were regionally threatened and/or near threatened. Of these, both the Lesser Flamingo (*Phoeniconaias minor*) and the Greater Flamingo (*Phoenicopterus roseus*) have the highest reporting rates in the study area, although these two species are more abundant north of the study site (in the Welkom area). The occurrence of flamingo taxa on the study site was considered as irregular, and these consisted invariably of dispersing (flying) birds (although it is possible that some of these individuals could collide with the powerline infrastructure given that these birds migrate mainly at night).
- The open *Vachellia karoo - Themeda triandra* grassland/bushveld mosaics in the northern part of the study site also provided suitable foraging habitat for the collision-prone and vulnerable Secretarybird (*Sagittarius serpentarius*).
- A number of impacts and recommendations were proposed, including areas (spans) where bird deterrent devices should be fitted to the earth wires.
- Option A was found from an avifaunal risk and construction perspective to be "more feasible" than Option B.

1.

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DECLARATION OF INDEPENDENCE

I, Lukas Niemand (Pachnoda Consulting CC) declare that:

- I act as the independent specialist in this application to Green Environment;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have no vested financial, personal or any other interest in the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority; and
- All the particulars furnished by me in this form are true and correct.

Lukas Niemand (Pr.Sci.Nat)
19 August 2020

Lukas Niemand is registered with The South African Council for Natural Scientific Professionals (400095/06) with more than 15 years of experience in ecological-related assessments and more than seven years in the field of bird interactions with electrical infrastructure. He has conducted numerous ecological and avifaunal impact assessments including Eskom Transmission projects, hydro-electric schemes and other activities in South Africa and other African countries (e.g. Republic of Congo, Liberia, Burundi, Mozambique, Zambia, Lesotho, Malawi, Zambia, Tanzania and Ethiopia).

1. INTRODUCTION

The increase in human demand for space and life-supporting resources resulted in a rapid loss of natural open space in South Africa. When natural systems are rezoned for development, indigenous fauna and flora are replaced by exotic species and converted to sterile landscapes with no dynamic propensity or ecological value (Wood *et al.,* 1994). Additionally, development rarely focussed on decisive planning to conserve natural environments, while little thought was given to the consequences on the ecological processes of development in highly sensitive areas.

Transformation and fragmentation are not the only results of unplanned and intended developments, the loss of ecosystem functioning and ultimately the local extinction of species can also result. Therefore, careful planning will not only preserve rare and endemic fauna and flora, but also the ecological integrity of ecosystems of the landscape level which is imperative for the continuation of natural resources, such as fossil fuels, water and soils with agricultural potential.

In 1992, the Convention of Biological Diversity, a landmark convention, was signed by more than 90 % of all members of the United Nations. The enactment of the National Environmental Management Biodiversity Act, 2004 (Act No. 10 of 2004), together with the abovementioned treaty, focuses on the preservation of all biological diversity in its totality, including genetic variability, natural populations, communities, ecosystems up to the scale of landscapes. Hence, the local and global focus changed to the sustainable utilisation of biological diversity.

1.1 Background

Pachnoda Consulting cc was contracted by Green Environment to provide a terrestrial avifauna and fauna report for the proposed self-build Oryx - Tetra4 33kV overhead powerline near Virginia, Free State Province (Figure 1).

Two route deviations have been identified for the proposed 33kV powerline. These occur mainly on the southern part of the alignment (Option A and Option B). The alignment runs from the Tetra4 gas exploration site southwards where it feed into the Oryx substation at the Oryx (Beatrix) gold mine. The entire length of the alignment varies between 8.6 km (Option A) and 8.8 km (Option B) in length, with Option A located west of a water treatment facility, while Option B is located to the east of the treatment works.

1.2 Terms of Reference

The main aim of the assessment is to investigate the avifaunal and faunal attributes of the proposed powerline by means of a site visit and a desktop analysis of GIS-based information.

The terms of reference for this assessment are to:

- provide a general description of the affected environment concerning the avifaunal and terrestrial faunal habitat types;
- conduct an assessment of all available information in order to present the following results:
    - typify the regional vegetation that will be affected by the proposed powerline;
    - provide an indication on the occurrence of threatened, near-threatened, endemic and conservation important bird or animal species likely to be affected by the proposed powerline;
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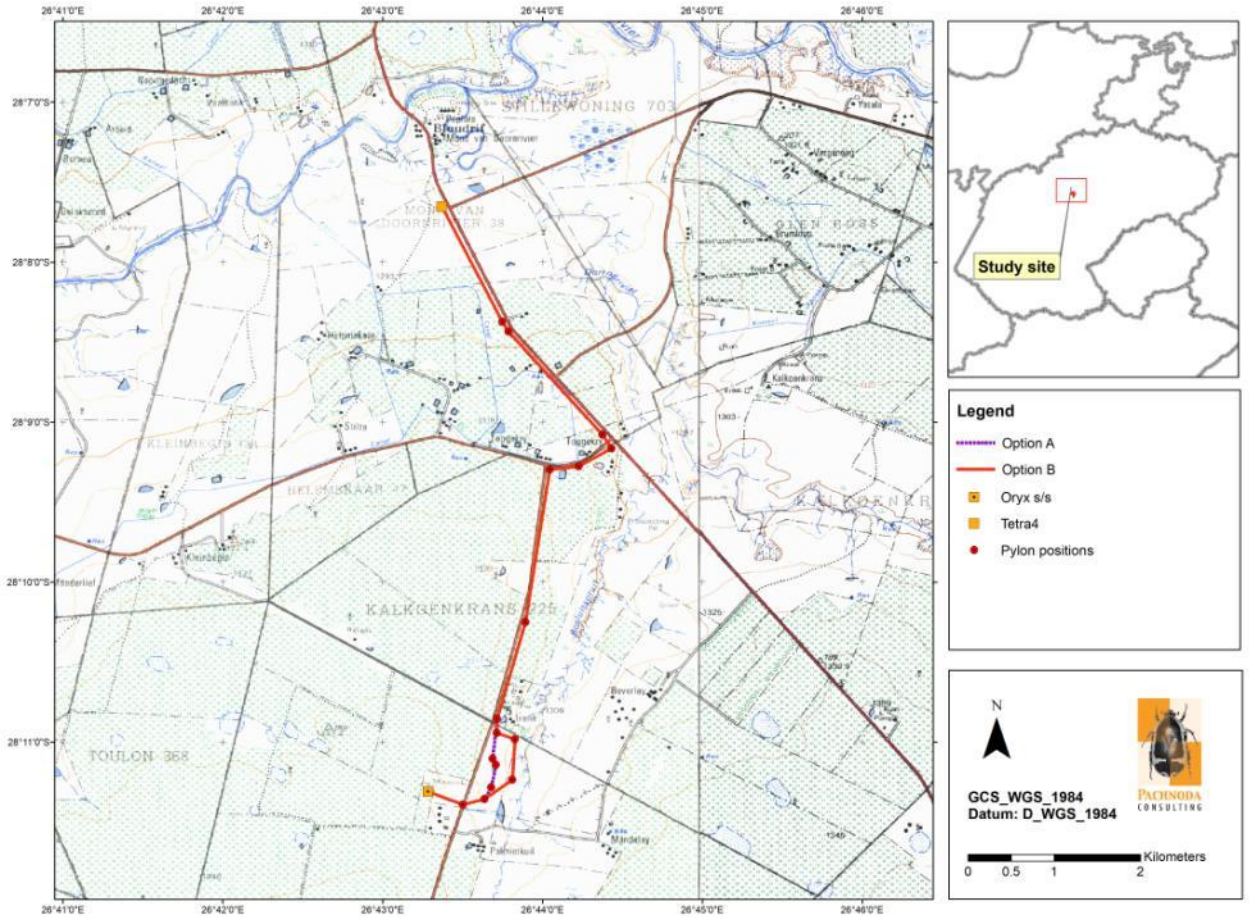

Figure 1: A topo-cadastral image illustrating the geographic position of the proposed powerline and the pylon positions.

2. METHODS & APPROACH

A site visit was conducted during 20 - 21 July 2020, whereby the physical environment of the proposed powerline alignment was inspected by road and on foot following an evaluation of GIS-based information on the biotic and biophysical attributes of the area.

Visual observations of the proposed alignment were made during the site visit. The objectives of this part of the assessment are to:

- obtain a basic overview of the variation and general status of habitat types likely to be affected by the proposed development; and
- inspect existing powerlines within the proximity of the proposed alignment to obtain an overview of the range of potential impacts and likely effects of long-term management activities on the avifauna and faunal community.

2.1 Biophysical Desktop Analysis

A desktop analysis of available biotic and biophysical attributes of the proposed study area was performed whereby the following databases were consulted:

- Regional vegetation (Mucina and Rutherford, 2006);
- 2013-2014 Land cover classes (Geoterraimage, 2015);
- Presence/absence of wetlands, rivers, drainage lines and other impoundments;
- Protected and conservation areas; and
- Settlement and transformed areas.

These databases were utilised to identify areas that constitute:

- natural vegetation;
- areas of environmental sensitivity (e.g. forests and wetland systems);
- areas likely to sustain high numbers of threatened, near threatened and endemic taxa; and
- protected areas.

2.2 Vertebrates (excluding birds) - Literature review and Fieldwork

Mammals

- The conservation status of mammal taxa was based on the IUCN Red List (2020) and Child *et al* (2016), while mammalian nomenclature was based on Child *et al* (2016), unless otherwise specified.
- The distribution of potential occurring species of conservation concern was sourced from national small-scale datasets managed by the Animal Demography Unit (ADU) and relevant citizen science projects such as MammalMap corresponding to the four quarter-degree grid cells (QDGCs) nearest to the study site (2826BA, 2826BB, 2826BC and 2826BD; Figure 2).
- The distribution of potential occurring species of conservation concern was also augmented by consulting Child *et al* (2016), Stuart & Stuart (2015), Skinner & Chimimba (2005) and Friedmann & Daly (2004).
- Actual observations of mammal taxa obtained during *ad hoc* meander walks and 10 sampling sites (see bird point count map; Figure 4).

Herpetofauna

- The conservation status of reptile taxa was chosen according to the conservation assessment conducted by Bates et al. (2014).
- The conservation status of amphibian taxa follows Measey (2010).
- The distribution of reptile and amphibian species was verified against ADU's database consisting of ReptileMap and FrogMap corresponding to the four quarter-degree grid cells (QDGCs) nearest to the study area (2826BA, 2826BB, 2826BC and 2826BD; Figure 2).
- Actual observations of herpetofauna obtained during *ad hoc* meander walks and 10 sampling sites (see bird point count map; Figure 4).

2.3 Avifaunal evaluation and desktop analysis

A number of literature and databases were consulted during the evaluation process which includes the following:

- Hockey *et al*. (2005) for general information on bird identification and life history attributes.
- Taylor *et al.,* 2015 and IUCN (2020) for information regarding the conservation status of each species.
- Marnewick *et al.* (2015) was consulted for information regarding the biogeographic affinities of bird taxa as well as the proximity of the proposed corridors to Important Bird and Biodiversity Areas (IBAs).
- Distributional data was sourced from the first South African Bird Atlas Project (SABAP1) and verified against Harrison *et al.* (1997) for species corresponding to the four quarter-degree grid cells (QDGCs) nearest to the

study area (2826BA, 2826BB, 2826BC and 2826BD; Figure 2). The SABAP1 data provides a “snapshot” of the abundance and composition of species recorded within a quarter degree grid cell (QDGC) which was the sampling unit chosen (corresponding to an area of approximately 15 min lat x 15 min long). It should be noted that the atlas data makes use of reporting rates that were calculated from observer cards submitted by the public as well as citizen scientists. It provides an indication of the thoroughness of which the QDGCs were surveyed between 1987 and 1991.

- Distributional data was also be sourced from the SABAP2 database (www.sabap2.birdmap.africa). Since bird distributions are dynamic (based on landscape changes affected by fragmentation and climate change), SABAP2 was born (and launched in 2007) from SABAP1 with the main difference being that all sampling is done at a finer scale known as pentad grids (5 min lat x 5 min long, equating to 9 pentads within a QDS). This implies that the data is more site-specific, recent and more comparable with observations made during the site visit. A total of 10 pentad grids are applicable to the study area which is centred at grids 2805_2640 and 2810_2640 (Figure 3).
- The Coordinated Waterbird Count (QWAC) datasets were obtained for the study area (if applicable).
- The choice of scientific nomenclature, taxonomy and common names are recommended by the International Ornithological Committee (the IOC World Bird Names, v.10.2), unless otherwise specified (see www.worldbirdnames.org as specified by Gill et al., 2020).
- Additional information regarding bird-power line interactions was provided by the author's own personal observations during ad hoc meander walks and 10 point counts (Figure 4). The data from the point counts is used to determine discriminant (species with high fidelity to a particular habitat unit) and dominant species, and to delineate any local bird associations that may be present. The use of point counts is advantageous since it is the preferred method to use to detect cryptic or elusive species. In addition, it is the preferred method to line transect counts where access is problematic, or when the terrain appears to be complex. It is a good method to use and very efficient for gathering a large amount of data in a short period of time (Sutherland, 2006). At each point, all the bird species seen within approximately 50 m from the centre was recorded along with their respective abundance values using Swarovski 8.5x42 EL binoculars. Each point count lasted approximately 10-20 minutes while it was slowly traversed to ensure that all the birds were detected (Sutherland et. al., 2004; Watson, 2003) within the 50 m radius. To maximise the independence of observations, points were positioned approximately 200 m apart and were chosen to represent the broad-scale habitat units on the study site.

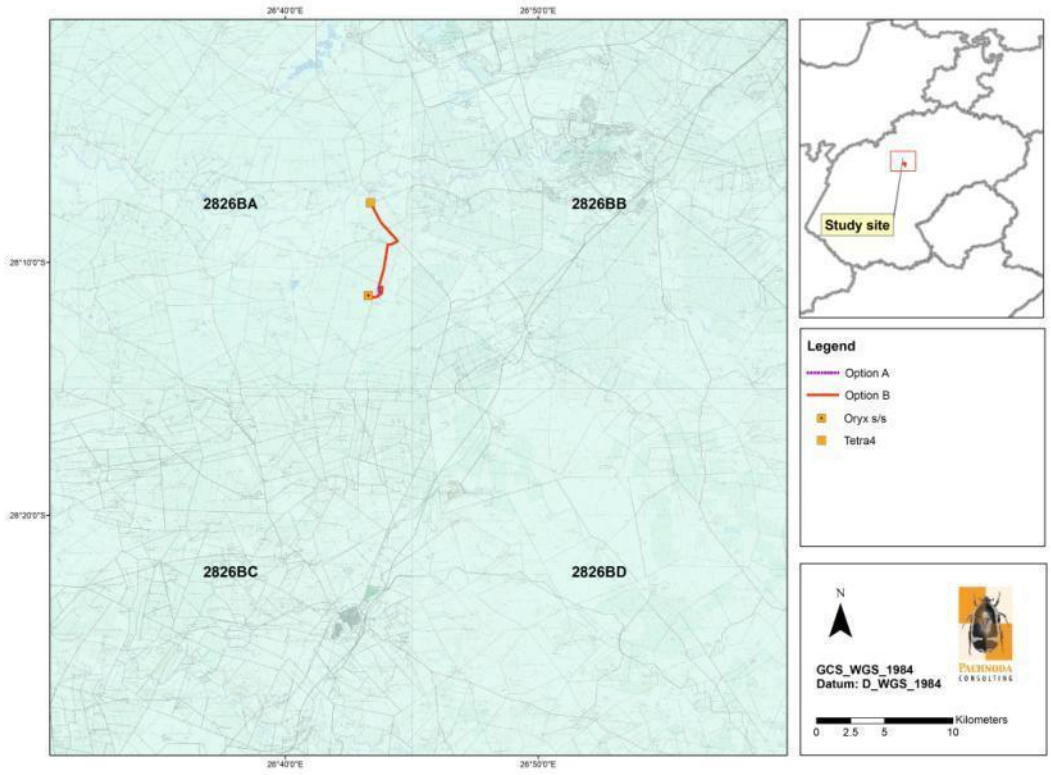

Figure 2: An image illustrating the QDS grids relevant to the study area (*sensu* ADU and SABAP1).

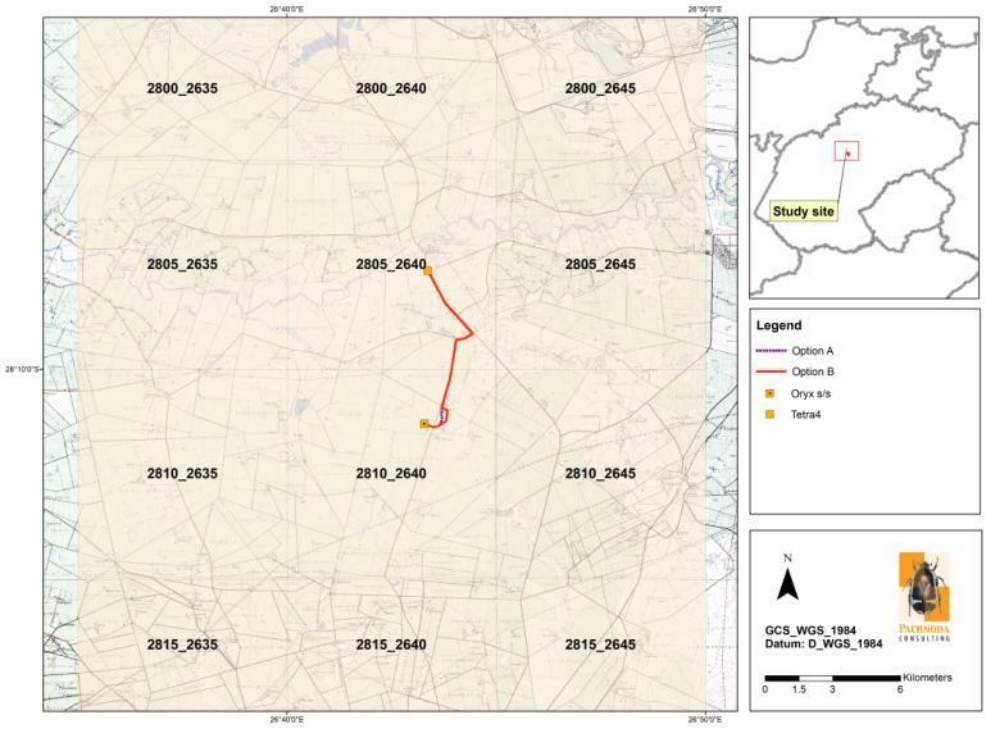

Figure 3: An image illustrating the pentad grids relevant to the study area (*sensu* SABAP2).

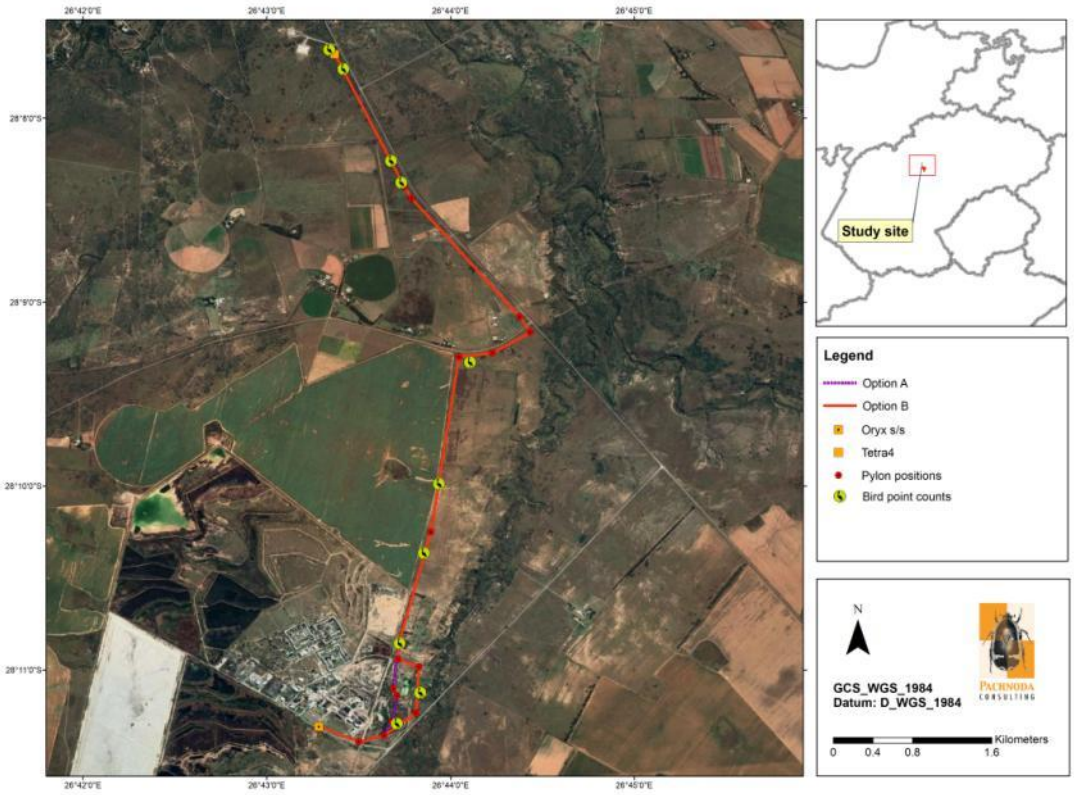

Figure 4: A satellite image of the study site illustrating the spatial position of bird point counts along the proposed powerline alignment.

2.4 Ecological Importance and Function ("sensitivity")

An ecological sensitivity map was compiled based on the outcome of a desktop analysis and fieldwork.

The ecological sensitivity of any piece of land is based on its inherent ecosystem service (e.g. wetlands) and overall preservation of biodiversity.

2.5.1 Ecological Function

Ecological function relates to the degree of ecological connectivity between systems within a landscape matrix. Therefore, systems with a high degree of landscape connectivity amongst one another are perceived to be more sensitive and will be those contributing to ecosystem service (e.g. wetlands) or the overall preservation of biodiversity.

2.4.2 Biodiversity Importance

Biodiversity importance relates to species diversity, endemism (unique species or unique processes) and the high occurrence of threatened and protected species or ecosystems protected by legislation.

2.4.3 Sensitivity Scale

- *High* – Sensitive ecosystems with either low inherent resistance or low resilience towards disturbance factors or highly dynamic systems considered important for the maintenance of ecosystem integrity. Most of these systems represent ecosystems with high connectivity with other important ecological systems OR with high species diversity and usually provide suitable habitat for a number of threatened or rare species. These areas should be protected;
- *Medium* – These are slightly modified systems which occur along gradients of disturbances of low-medium intensity with some degree of connectivity with other ecological systems OR ecosystems with intermediate levels of species diversity but may include potential ephemeral habitat for threatened species; and
- *Low* – Degraded and highly disturbed/transformed systems with little ecological function and are generally very poor in species diversity (most species are usually exotic or weeds).

2.5 Limitations

In order to obtain a comprehensive understanding of the dynamics of the faunal and avifaunal associations on the study area, as well as the status of endemic, rare or threatened species, assessments should always consider investigations at different time scales (across seasons/years) and through replication. However, due to time constraints such long-term studies are not feasible and are mostly based on instantaneous sampling bouts.

It should also be realised that animal distribution patterns, in particular that of birds fluctuate widely in response to environmental conditions, meaning that a composition noted at a particular moment in time will differ during another time period at the same locality.

The site visits were postponed due to the COVID-19 national lockdown, and thus coincided with the austral dry season which was not an optimal time of the year to conduct ecological surveys of this nature. The author and other team members were appointed during alert level 5 of the national lockdown (in April), thereby prohibiting anybody to perform work or travel across provinces. In addition, during level 4 and the early part of level 3 of the national lockdown

it was impossible to find accommodation within the study area, thereby postponing the surveys into the austral dry season. However, based on the author's experience, the current survey was considered to be sufficient since it describes approximately 70-75 % of the faunal/avifaunal richness that were expected to be present.

General assumptions include:

1. It is assumed that third party information (obtained from government, academic/research institution, non-governmental organisations) is accurate and true;
2. Some of the datasets/information is out of date and therefore some of the extant distribution ranges may have shifted/changed. However, these datasets could provide insight into the historical distribution ranges of relevant species;
3. The datasets/information bases are mainly small-scale and could not always consider azonal habitat types that may be present on the study area (e.g. presence of topographical features, depressions and lakes). In addition, these datasets encompass surface areas larger than the corridor width, thereby including habitat types and species that are not present on the study area itself. Therefore, the potential to overestimate species richness is highly likely, while it is also possible that certain cryptic or specialist species could have been overlooked in the past;
4. Some of the datasets (e.g. SABAP2) managed by the Animal Demography Unit of the University of Cape Town are current and likely to continue indefinitely;
5. The information presented in this document only has reference to the investigated study area(s) and cannot be applied to any other area without prior investigation.

3. RESULTS AND DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1 Regional Vegetation Description

The proposed powerline corresponds to the Grassland Biome and more particularly to the Dry and Mesic Highveld Grassland Bioregions as defined by Mucina & Rutherford (2006). It comprehends two ecological types namely (1) Vaal-Vet Sandy Grassland and the (2) Highveld Alluvial Vegetation (Figure 5 and Table 1).

From an avifaunal perspective it is evident that bird diversity is often positively correlated with vegetation structure. However, floristic richness is not the most important contributor of observed patterns in bird abundance and spatial distributions. Grasslands are generally poor in woody plant species, and subsequently support lower bird richness values, and for this reason considered to be an important habitat for many terrestrial bird species such as larks, pipits, korhaans, cisticolas, widowbirds including crane species. Many of these species are also endemic to South Africa or display peculiar narrow distribution ranges. Due to the restricted spatial occurrence of the Grassland Biome and severe habitat transformation, many of the bird species that are restricted to the grasslands are threatened or experience declining population sizes.

1. Vaal-Vet Sandy Grassland – This vegetation type is prominent on the study area where it occurs on the central section of the alignment. It is typical of plains and consists of low tussocky-dominated grassland with karroid elements. It is characterised by the dominance of *Themeda triandra*, although the widespread occurrence of *Aristida congesta* and *Cymbopogon pospischilii* are the result of heavy grazing and/or erratic rainfall in some areas.

The Vaal-Vet Sandy Grassland is **Endangered** and is poorly conserved in the Bloemhof Dam, Faan Meintjies, Schoonspruit, Wolvespruit and Sandveld Nature Reserves. It is transformed by cultivation and inappropriate grazing regimes.

5. Highveld Alluvial Vegetation – This vegetation type is confined to the alluvial floodplains and riparian zone of the Bosluisspruit and Doring River systems (draining into the nearby Sand River in the north). On the study area it was characterised by thickets of *Vachellia karroo*. Other noteworthy species of the riparian thickets include *Salix mucronata, Searsia lancea, Ziziphus mucronata, Searsia pyroides* and *Asparagus laricinus*. Areas of seasonal and permanent inundation is colonised by *Phragmites australis, Cyperus denudatus, C. longus, Eragrostis obtusa* and *Persicaria lapathifolia*.

This vegetation type is **Least Concern** with large parts conserved within Bloemhof Dam, Faan Meintjies, Soetdoring and Sandveld Nature Reserves. It is mainly

vulnerable to invasion by exotic weed and invader taxa such as *Salix babylonica, Melia azedarach* and *Eucalyptus camaldulensis*.

Table 1: The surface area (ha) of each regional vegetation type in relation to the approximate total surface area of the alignment options.

Vegetation Type	Option A		Option B	
	Surface Area (ha)	% of total surface area	Surface Area (ha)	% of total surface area
Vaal-Vet Sandy Grassland	109.14	71.81	103.72	66.11
Highveld Alluvial Vegetation	42.85	28.19	53.16	33.89
	151.99	**100.00%**	**156.88**	**100.00%**

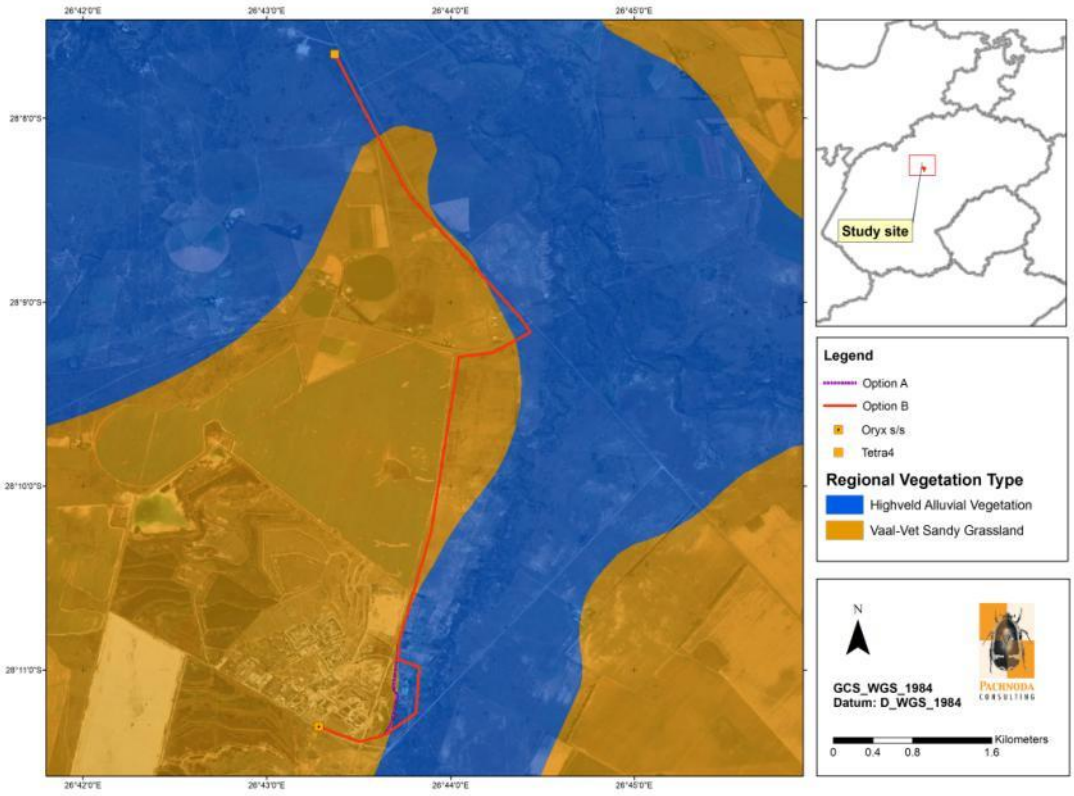

Figure 5: A satellite image illustrating the regional vegetation types traversed by the proposed powerline alignment. Vegetation type categories were chosen according to the revised National Vegetation Map of 2012 (Mucina & Rutherford, 2006).

It is evident from Table 1 that the highest percentage of threatened vegetation types (c. Vaal-Vet Sandy Grassland) is traversed by Option A. Option B traverses a higher percentage Alluvial Highveld Vegetation, and although least concern, it is an important habitat for many collision-prone bird species such as waterfowl (ducks and geese) and other waterbirds (c. cormorants and darters).

It is also evident from Figure 6 that a large section of the northern part of the alignment including parts of Option A (near the south) corresponds to the remaining extent of a threatened ecosystem (c. Vaal-Vet Sandy Grassland).

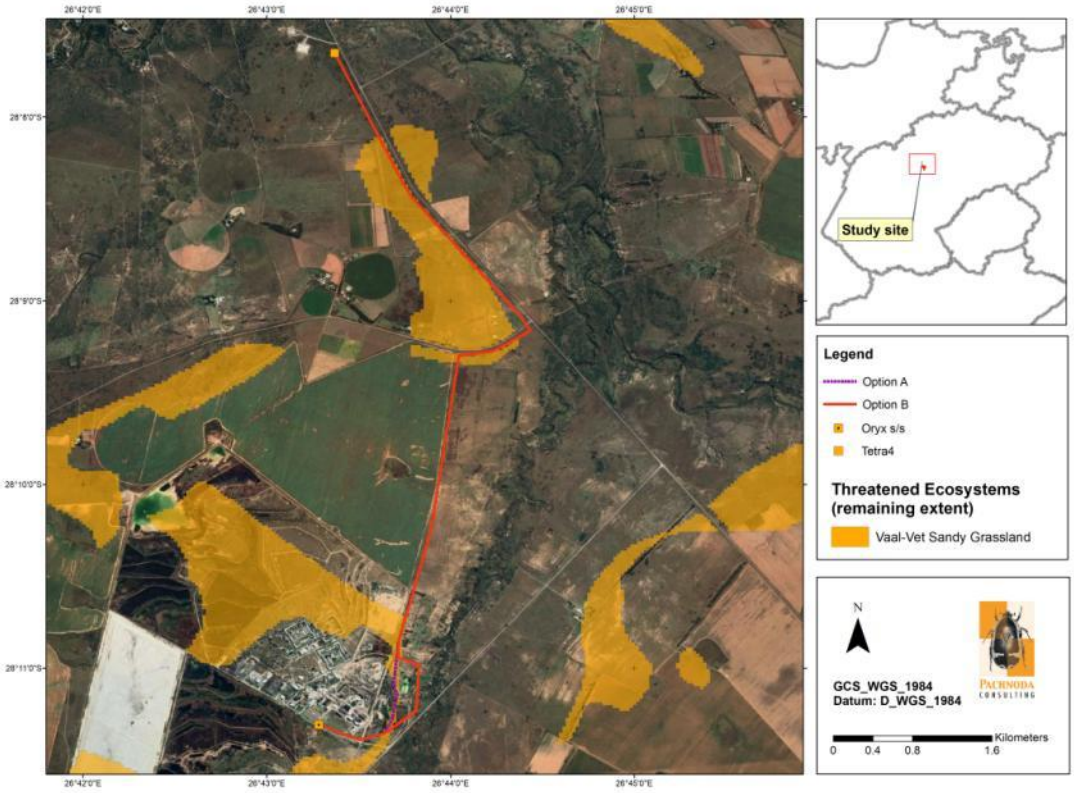

Figure 6: A satellite image illustrating the remaining extent of a threatened ecosystem (*c*. Vaal-Vet Sandy Grassland) on the study area.

3.2 Land Cover

The national land cover classes of 2013 - 2014 (Geoterraimage, 2015) on the respective options include (Figure 7; Table 2):

Natural areas:

- Natural grassland (Vaal-Vet Sandy Grassland);
- Low shrubland;
- Thicket/dense bush;
- Woodland and open bushveld; and
- Various water bodies, rivers and wetlands.

Transformed areas:

- Cultivated land;
- Mines and quarries;
- Plantations; and

- Urban/built-up areas.

From the land cover analysis it is evident that the proposed alignment is dominated by cultivation, followed by natural grassland (e.g. Vaal-Vet Sandy Grassland) (Table 2 and Figure 7). Option B holds a marginally higher proportion of natural grassland and wetland habitat, thereby consisting of a slightly higher percentage of natural land (c. 46 %) (see Table 2). Option A supports a slightly higher percentage of cultivated land (c. 55.56 %), rendering this option as a more feasible option for the construction of a powerline when compared to the other option.

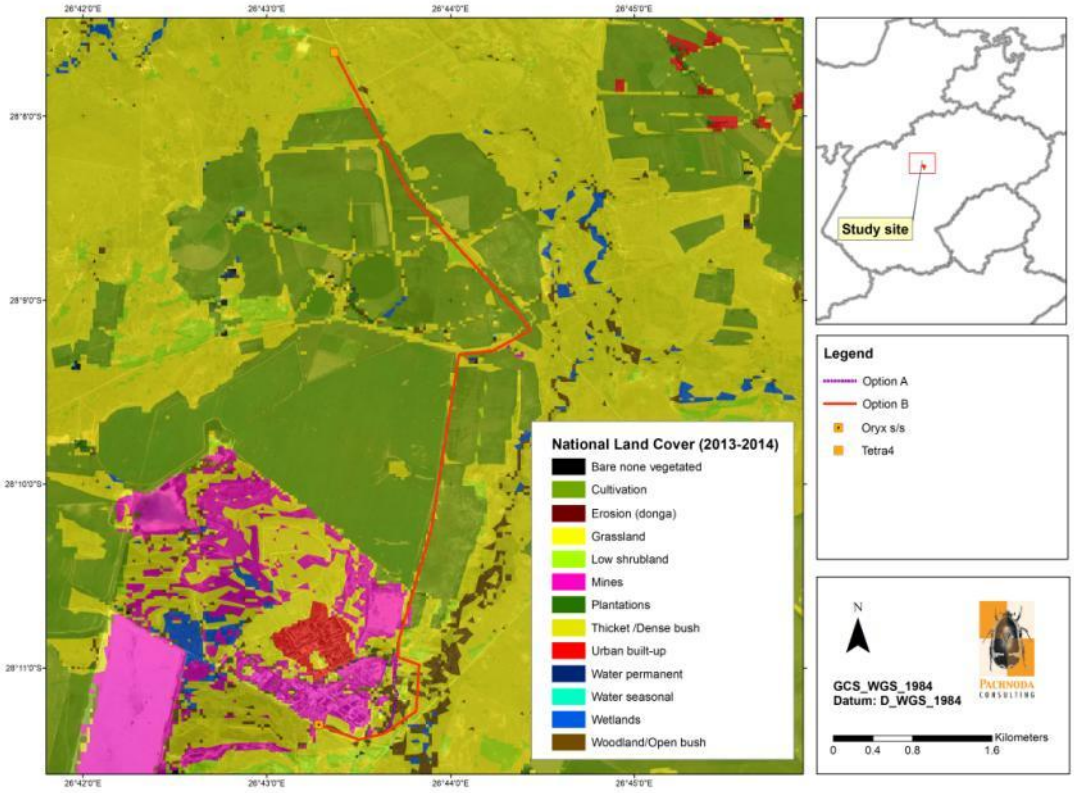

Figure 7: A map illustrating the national land cover classes of 2013 - 2014 (Geoterraimage, 2015)) corresponding to the proposed powerline.

Table 2: The respective surface area (ha) of the land cover classes, natural and transformed land cover categories on each of the proposed powerline options (based on a 200 m buffer allocated to each option and the 2013-2014 land cover dataset).

Land Cover Class	Option A		Option B	
	Surface area (ha)	Percentage total area (%)	Surface area (ha)	Percentage total area (%)
Bare (No Vegetation)	0.17	0.10	0.08	0.05
Cultivation	80.19	50.71	80.19	49.23
Grassland	52.26	33.05	57.68	35.41
Low shrubland	6.95	4.39	7.64	4.69
Mines & quarries	6.59	4.17	6.01	3.69
Plantations (alien)	0.19	0.58	0.86	0.53
Thicket/dense bush	3.54	2.24	3.26	2.00
Wetlands	-	-	0.13	0.08
Water permanent	0.25	0.16	0.25	0.15
Woodland/open bush	7.28	4.61	6.78	4.16
Natural	70.28	44.45	75.74	46.49
Transformed	87.14	55.56	87.14	53.50
Total	**157.42**	**100.00%**	**162.88**	**100.00%**

3.3 Conservation Areas and Important Bird and Biodiversity Areas (IBAs[1])

The study site does not coincide with any conservation area or Important Bird and Biodiversity Area (IBA). The nearest conservation area to the proposed powerline is the Willem Pretorius Game Reserve, which is located 42 km south-east of the study site. The Willem Pretorius Game Reserve is also a recognised IBA (SA044).

3.4 Wetlands, floodplains and depressions

The northern section of the powerline is located west of the Doring River, while the Bosluisspruit (a tributary of the Doring River) is located east at the southern part of the powerline. Part of Option B is located within 100 m of the Bosluisspruit in the south near the Oryx substation.

[1] An IBA is a geographic area that support globally significant populations of (1) threatened bird species and/or (2) biome-restricted species and/or (3) restricted-range species and/or (4) significant congregations of birds species, mainly referring to waterbirds or shorebirds.

Table 3: Summary of properties for different wetland features crossed/traversed by each proposed option.

Type	Option A	Option B
Dam/Depression	2	2
River/Stream/Tributary/Watercourse	2	3
Total	**4**	**5**

3.5 Free State Biodiversity Plan

According to the Free State Biodiversity Plan (DESTEA, 2015) it is evident that a large section of the study site is composed of a Level 2 ecological support area (ESA2) on the central part (Figure 8). A small section on the south of the study site also corresponds to a "degraded" area, while a small part in the north also corresponds to a Level 1 ecological support area (ESA1). These ESAs correspond mainly to natural habitat but does not meet the predicted biodiversity targets of the province. However, these areas are still important repositories of species and play an important role during ecological connectivity and as dispersal corridors (and therefore the main reason why they also coincide with the Alluvial Highveld Vegetation found along the Sand, Doring and Bosluisspruit rivers). In addition, a small area of natural habitat in the south, mainly along Option B, is categorized as a Level 1 Critical Biodiversity Area (CBA1). This area represents intact riparian habitat along the Bosluisspruit, which is often regarded as "irreplaceable" owing to their untransformed floristic compositions and ecological importance of the habitat. The categories (terminology) were recommended by the Government Gazette No. 32006 (16 March 2009) for use during Bioregional Plans (which require the identification of Critical Biodiversity Areas and Ecological Support Areas).

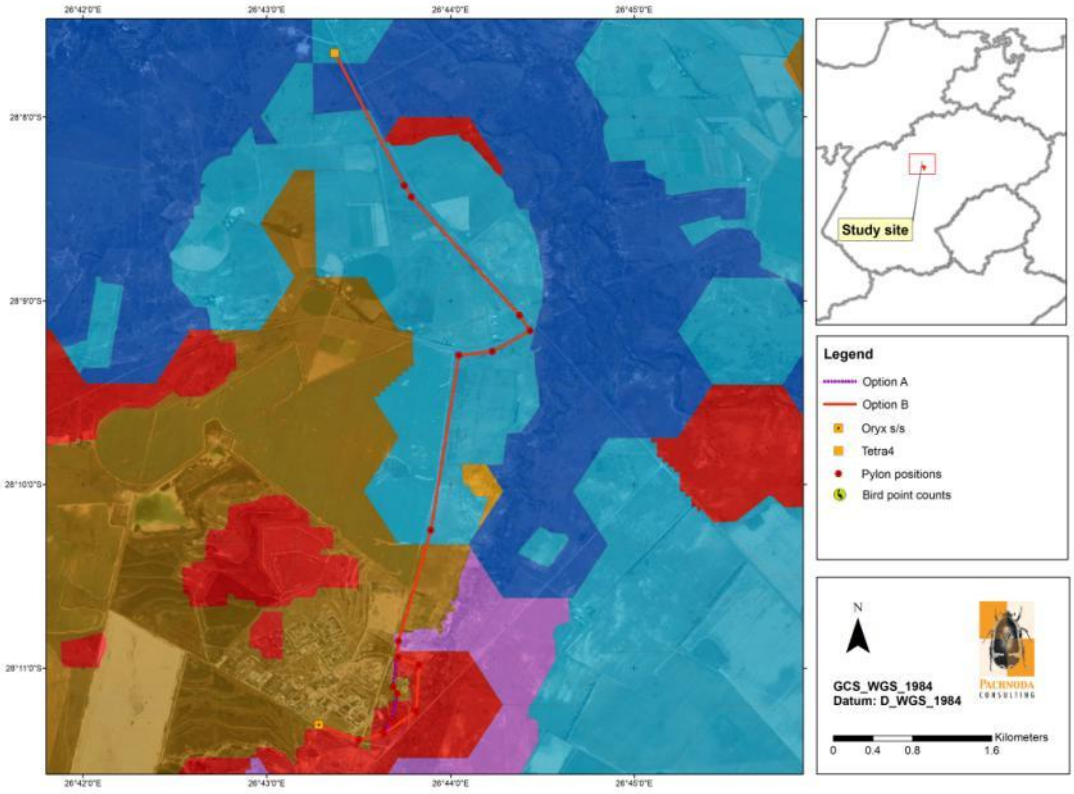

Figure 8: A map illustrating the local conservation categories based on the Free State Biodiversity Plan (2015).

3.6 Conservation Important Faunal Taxa[2]

The proposed alignment will traverse through natural habitat consisting of open *Vachellia (=Acacia) karoo* bushveld interspersed by open *Themeda triandra* grassland in the north and modified habitat consisting of old agricultural land covered by secondary grassland dominated by *Eragrostis curvula, Cynodon dactylon, Asparagus laricinus* and *Pseudognaphalium luteo-album*. The southern section, especially along Option B corresponds to *V. karroo* and *Searsia lancea* thickets associated with the riparian vegetation of the Bosluisspruit River. The study area supports (based on known historical and extant distribution ranges) habitat for 22 mammal taxa, 20 reptile species and 8 frog species (in addition to 13 documented dung beetle taxa (Scarabaeinae), one mygalomorph spider taxa (c. *Harpactira hamiltoni*) and 41 documented diurnal butterfly species).

3.6.1 Mammals

According to the presence of suitable habitat and the extant (or known) distribution ranges of mammal taxa in the study area (sensu MammalMap), the expected

[2] Please note that the avifauna is excluded from this section and will be dealt with under a separate section in the report.

mammal richness on the study site is low with approximately 22 species (excluding introduced game and or escapees) (Table 4) of which only five species have so far been documented for the QDS cells sympatric to the study site. It implies that the mammal richness on the study site is relatively poorly known and not well documented given that two widespread species (c. Aardvark *Orycteropus afer* and South African Ground Squirrel *Xerus inauris*) was also confirmed in habitat associated with the alignment during the site visits which was not previously recorded from the QDS cells.

Approximately 14 species (63 % of the expected richness) have a high probability to be present on the study area, of which five of these species (35 % of species with a high probability of occurrence) were confirmed during the surveys (Table 4). In addition, seven (7) of the expected species have a moderate to moderate-high probability of occurrence (32 %), while one of the expected species have a low probability of occurrence. The latter species (species with low and moderate probabilities of occurrence) either share distribution ranges that are peripheral to the study site, or ecological information on their life histories and taxonomy are scant, thereby rendering their presence on the site as uncertain or questionable even though suitable habitat is present.

According to Table 5, it was evident that the Yellow Mongoose (*Cynictis penicillata*) was the mammal species with the highest *observed* frequency of occurrence (40 %) and the most widespread *observed* mammal species observed on the study site. Other widespread taxa included the Highveld Mole-rat (*Cryptomys cf. pretoriae*) and the African Savanna Hare (*Lepus cf. victoriae*). Other common species according to reporting rates obtained from MammalMap included two small bovines, namely the Steenbok (*Raphicerus campestris*) and the Common Duiker (*Sylvicapra grimmia*).

Table 4: An inventory of expected mammalian taxa recorded for the study area corresponding to QDS 2826BA and 2826BB (sensu MammalMap), including species confirmed during the site visit and professional judgement.

Family	Scientific name	Common name	Conservation Status	Confirmed in 2826BA & 2826BB (sensu MammalMap)	Probability of occurrence
Bovidae	*Raphicerus campestris*	Steenbok	Least Concern	X	High
Bovidae	*Sylvicapra grimmia*	Common Duiker	Least Concern	X	High
Canidae	*Vulpes chama*	Cape Fox	Least Concern		High
Herpestidae	*Suricata suricatta*	Suricate	Least Concern		High
Hystricidae	*Hystrix africaeaustralis*	Cape Porcupine	Least Concern		High
Muridae	*Gerbilliscus brantsii*	Highveld Gerbil	Least Concern		High

Family	Scientific name	Common name	Conservation Status	Confirmed in 2826BA & 2826BB (sensu MammalMap)	Probability of occurrence
Muridae	*Mastomys coucha*	Multimammate Mouse	Least Concern		High
Muridae	*Rhabdomys cf. pumilio (sensu lato)*	Four-striped Grass Mouse	Least Concern		High
Mustelidae	*Ictonyx striatus*	Striped Polecat	Least Concern		High
Bathyergidae	*Cryptomys cf. pretoriae*	Highveld Mole-rat	Least Concern		High (confirmed)
Herpestidae	*Cynictis penicillata*	Yellow Mongoose	Least Concern	X	High (confirmed)
Leporidae	*Lepus cf. victoriae*	African Savanna Hare	Least Concern		High (confirmed)
Orycteropidae	*Orycteropus afer*	Aardvark	Least Concern		High (confirmed)
Sciuridae	*Xerus inauris*	South African Ground Squirrel	Least Concern		High (confirmed)
Bovidae	*Pelea capreolus*	Vaal Rhebok	Near Threatened		Low (probably absent)
Bovidae	*Redunca arundinum*	Southern Reedbuck	Least Concern	X	Moderate
Felidae	*Felis nigripes*	Black-footed Cat	Vulnerable		Moderate
Hyaenidae	*Parahyaena brunnea*	Brown Hyena	Near Threatened		Moderate
Hyaenidae	*Proteles cristata*	Aardwolf	Least Concern		Moderate
Nesomyidae	*Mystromys albicaudatus*	African White-tailed Rat	Vulnerable		Moderate
Suidae	*Phacochoerus africanus*	Common Warthog	Least Concern	X	Moderate-High
Thryonomyidae	*Thryonomys swinderianus*	Greater Cane Rat	Least Concern		Moderate-High

Table 5: The frequency of occurrence of mammal species observed on the study site (based on 10 sampling plots).

Scientific name	Common name	Number of occurrences (out of 10 plots)	Frequency of occurrence (%)
Cynictis penicillata	Yellow Mongoose	4	40.00%
Cryptomys cf. pretoriae	Highveld Mole-rat	3	30.00%
Lepus victoriae	African Savanna Hare	2	20.00%
Xerus inauris	South African Ground Squirrel	2	20.00%
Pseudaspis cana	Mole snake	1	10.00%

The study area is likely to support four mammal species of conservation concern (Table 6 and Figure 9): Black-footed Cat (*Felis nigripes* - Vulnerable), White-tailed Rat (*Mystromys albicaudatus* - Vulnerable), Brown Hyaena (*Parahyaena brunnea* - Near threatened) and Vaal Rhebok (*Pelea capreolus* - Near threatened). Most of these species (with the exception of the Vaal Rhebok) have a moderate probability of occurrence owing to the presence suitable habitat although they are only known from single historical records (mainly from QD squares adjacent to the study site). However, the presence of *Themeda*-dominated grassland on Sepane and Katspruit soil forms between the Tetra4 offices and the area 760 m south of Tetra4 in the northern part of the alignment provides good habitat for White-tailed Rat (*Mystromys albicaudatus*) and the Brown Hyaena (*Parahyaena brunnea*) to occur. In addition, the Black-footed Cat (*Felis nigripes*) could also be present across most of the study site. The latter is a stenotropic species of open, short grassland that sustain high densities of small murid prey (especially during the reproductive season) and ground-roosting birds (e.g. larks; Sliwa, 1994; 2008). However, very little information exists about distribution of this species in the study region besides that it makes use of termitaria and the burrow systems of other mammal species for roosting sites. Considering the widespread availability of such roosting sites on the study site, the probability that this species could occur on the study site is increased even though it is a poorly known and shy species that is seldom observed. The near threatened Vaal Rhebok (*Pelea capreolus*) is probably absent on the study site given the absence of suitable habitat (e.g. rocky grassland in hilly or mountainous terrain).

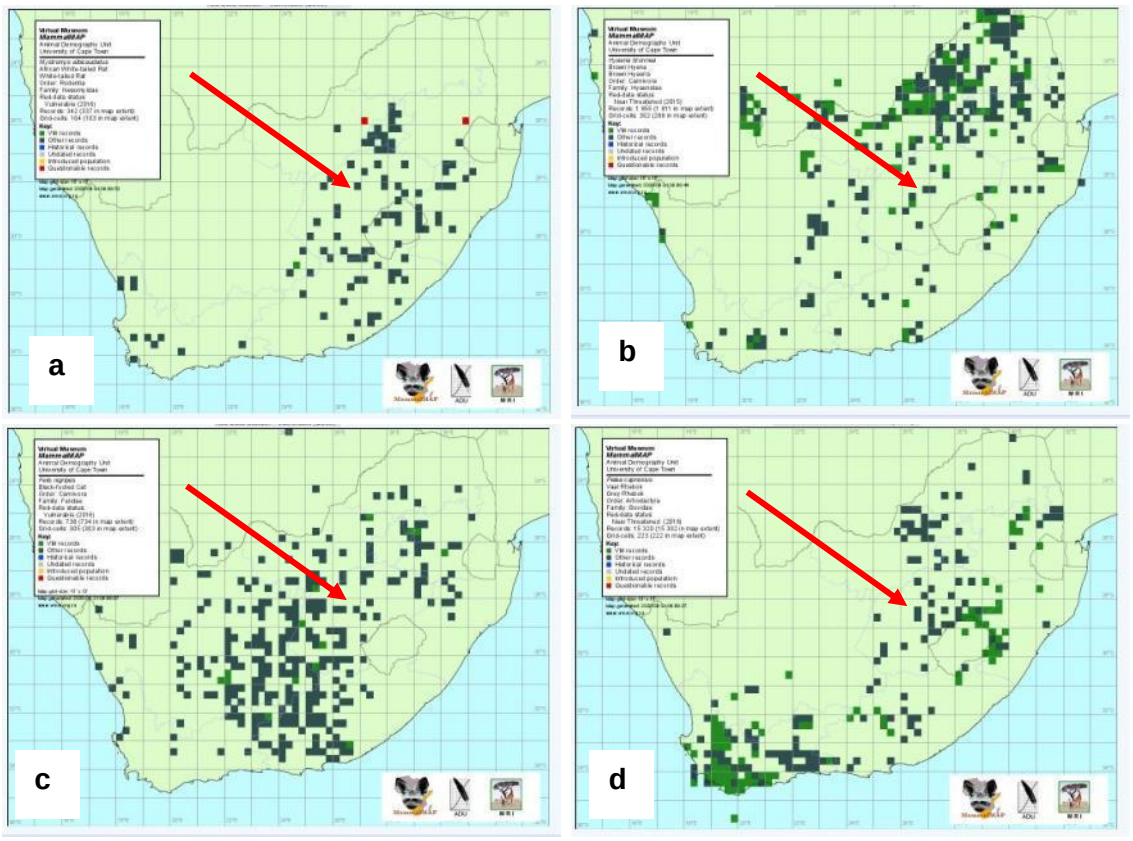

Figure 9: The extant distribution range of the (a) White-tailed Rat (*Mystromys albicaudatus* - Vulnerable), (b) Brown Hyaena (*Parahyaena brunnea* - near threatened), (c) Black-footed Cat (*Felis nigripes* - Vulnerable) and (d) Vaal Rhebok (*Pelea capreolus* - Near threatened) relative to the study site (see red arrow) (Map courtesy and the copyright of the ADU and MammalMap).

3.6.2 Amphibians

Eight (8) frog species are known to be sympatric to the study area (sensu FrogMap; Table 6). Seven (7) of the expected species have a high probability of occurrence on the study site based on their widespread distribution ranges and their ability to breed in temporary rain-filled depressions and roadside verges. In addition, the presence of the Bosluisspruit also provides additional breeding and foraging habitat, especially for species that depends on surface water for extended time periods (e.g. Delalande's River Frog *Amietia delalandii* and Common Platanna *Xenopus laevis*).

According to Minter et al. (2004), the amphibian richness on the study site is low (c. 6-10 species) with a low prevalence of endemic species (c. one species). Therefore, the study site is not considered as an important amphibian diversity hotspot. The species with the highest frequency of occurrence are Delalande's River Frog (*Amietia delalandii*), Common Caco (*Cacosternum boettgeri*) and the Bubbling Kassina (*Kassina senegalensis*).

None of the expected amphibian species are threatened or near threatened.

Table 6: A list of amphibian/frog species known from recent observations (*sensu* FrogMap) and historical distributional records corresponding to the study area and their probability of occurrence.

Family	Scientific name	Common name	Conservation Status	Confirmed in 2826BA & 2826BB (sensu MammalMap)	Probability of occurrence
Bufonidae	*Sclerophrys capensis*	Raucous Toad	Least Concern		High
Bufonidae	*Sclerophrys gutturalis*	Raucous Toad	Least Concern		High
Bufonidae	*Sclerophrys poweri*	Power's Toad	Least Concern		Low (peripheral)
Hyperoliidae	*Kassina senegalensis*	Bubbling Kassina	Least Concern	X	High
Pipidae	*Xenopus laevis*	Common Platanna	Least Concern		High
Pyxicephalidae	*Amietia delalandii*	Delalande's River Frog	Least Concern	X	High (confirmed)
Pyxicephalidae	*Cacosternum boettgeri*	Common Caco	Least Concern		High
Pyxicephalidae	*Tomopterna cryptotis*	Tremelo Sand Frog	Least Concern	X	High

3.6.3 Reptiles

A total of 20 reptile taxa are known to be sympatric to the study area (according to ReptileMap; *sensu* Bates *et a*l., 2014; Table 7). According to the habitat types present, the expected reptile richness on the study site is low (Bates *et al*., 2014).

However, 14 (70 %) of the expected richness show a high probability of occurrence, while two species have a moderate and moderate- high probability of occurrence, while four species have a low and low-moderate probability of occurrence and their status on the study site remains uncertain. Species with low and low-moderate probabilities of occurrence are intrinsically rare and contains subpopulations that are severely fragmented and or occur at the extreme edge (peripheral) of their known distribution ranges.

The south-western distribution range of the vulnerable Giant Girdled Lizard (*Smaug giganteus*) corresponds to the study site (although currently only known from adjacent QD squares to the north and east of the study site; see Figure 10). This species was not confirmed on the study site, although the *Themeda*-dominated grassland on Sepane and Katspruit soil forms between the Tetra4 offices and the area 760 m south of Tetra4 in the northern part of the alignment provides potential habitat. The probability that this species could occur on the study site was regarded as low-moderate.

Table 7: A list of reptile species known from recent observations (*sensu* ReptileMap) and historical distributional records corresponding to the study site and their probability of occurrence.

Family	Scientific name	Common name	Conservation Status	Confirmed in 2826BA & 2826BB (sensu MammalMap)	Probability of occurrence
Agamidae	*Agama atra*	Southern Rock Agama	Least Concern		High
Colubridae	*Dasypeltis scabra*	Rhombic Egg-eater	Least Concern		High
Cordylidae	*Smaug giganteus*	Giant Girdled Lizard	Vulnerable		Low-Moderate
Gekkonidae	*Pachydactylus capensis*	Cape Gecko	Least Concern		High
Gerrhosauridae	*Gerrhosaurus flavigularis*	Yellow-throated Plated Lizard	Least Concern		High
Lacertidae	*Nucras holubi*	Holub's Sandveld Lizard	Least Concern		Moderate
Lacertidae	*Pedioplanis burchelli*	Burchell's Sand Lizard	Least Concern		High
Lamprophiidae	*Aparallactus capensis*	Black-headed Centipede-eater	Least Concern		High
Lamprophiidae	*Boaedon capensis*	Brown House Snake	Least Concern		High
Lamprophiidae	*Psammophis trinasalis*	Fork-marked Sand Snake	Least Concern		Moderate-High
Lamprophiidae	*Psammophylax rhombeatus*	Spotted Grass Snake	Least Concern		High
Lamprophiidae	*Pseudaspis cana*	Mole Snake	Least Concern		High (confirmed)
Scincidae	*Acontias gracilicauda*	Thin-tailed Legless Skink	Least Concern		Low
Scincidae	*Panaspis wahlbergi*	Wahlberg's Snake-eyed Skink	Least Concern	X	High
Scincidae	*Trachylepis capensis*	Cape Skink	Least Concern		High
Scincidae	*Trachylepis punctatissima*	Speckled Rock Skink	Least Concern		High
Scincidae	*Trachylepis varia*	Common Variable	Least Concern	X	High

	(sensu lato)	Skink Complex			
Testudinidae	*Homopus femoralis*	Greater Padloper	Least Concern		Low
Testudinidae	*Stigmochelys pardalis*	Leopard Tortoise	Least Concern		High
Typhlopidae	*Rhinotyphlops lalandei*	Delalande's Beaked Blind Snake	Least Concern		Low-Moderate

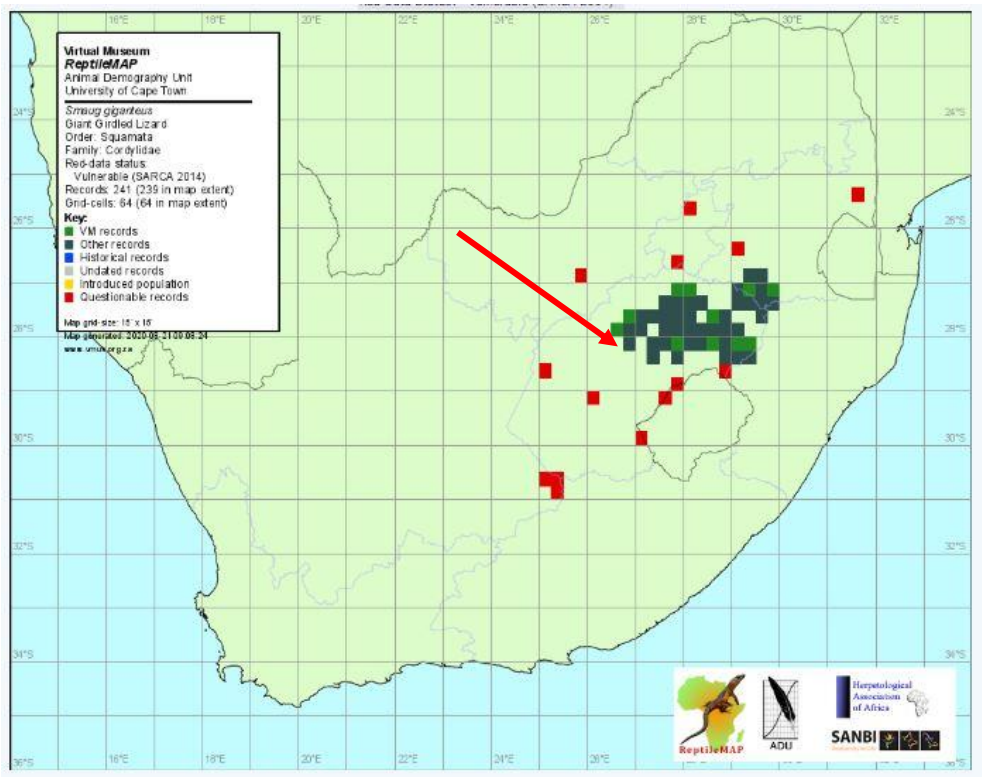

Figure 10: The extant distribution range of the vulnerable Giant Girdled Lizard (*Smaug giganteus*) relative to the study site (see red arrow) (Map courtesy and the copyright of the ADU, SARCA and ReptileMap).

3.6.4 Overview of potential impacts (excluding bird impacts)

Most mammal species are in general highly mobile (except those that live in burrows, disused termitaria or dens, or those with small body size) and therefore able to vacate areas should adverse environmental conditions prevail. Therefore, direct impacts associated with construction activities on adult mortality are less likely to occur (except for possible snaring and hunting), although indirect impacts will have consequences on their "fitness" (e.g. the ability of a species to reproduce). However, persistent disturbances across extended temporal scales will eventually affect any population's ability to sustain itself, and will more than likely result in the abandoning of a particular area. Species most likely to be affected are habitat specialists and or fossorial species e.g. those species closely associated with the termitaria and the *Themeda* dominated grassland and bushveld in the north, such as *Smaug giganteus* and *Felis nigripes* (if present).

Faunal compositions are believed to remain the same irrespective of the intensity of the construction activities (e.g. access roads and stringing operations) associated with the powerline, but the distribution and abundance of species could effectively change. Many habitat specialists could suffer mortalities during the construction of the pylons, whereby it is strongly recommended that a "walk-down" of the alignment be walked on foot to identify possible burrows of *Smaug giganteus* and *Felis nigripes* (if present).

In addition, construction activities go hand in hand with ambient noise. Although the construction phase is considered to be of short duration, many of the larger terrestrial species will vacate the study site during the construction phase and will become temporarily displaced.

The following impacts are anticipated during the *construction* phase:

Loss of Highveld alluvial vegetation and Themeda dominated grassland habitat: It is anticipated that the construction and the placement of tower structures, stringing operations and access roads could alter the ecological condition of the vegetation composition and structure along with the faunal species specific to it (e.g. fossorial species). However, considering that the alignment is mainly located adjacent to existing infrastructure (mainly roads) and will have smaller pylon footprint when compared to transmission lines, the impacts associated with the loss Highveld alluvial vegetation and *Themeda* dominated grassland habitat is regarded as minimal.

Loss of conservation important faunal species: During the construction phase, it is possible that areas corresponding to the footprint of the proposed tower structures could provide habitat for threatened or near threatened fauna species, especially if the habitat corresponds to termitaria or burrow systems (e.g. *S. giganteus* - if present). However, it is also possible that burrowing or fossorial taxa could be excavated during construction of the pylon foundations and support structures. Given the moderate probability that these species (*Smaug giganteus* and *Felis nigripes*) could be present, the impact on the loss of conservation important faunal species is regarded as low if emphasis is placed on the preservation of termitaria and mammal burrow systems.

The following impacts are anticipated during the *operational/maintenance* phase:

Disturbances associated with maintenance procedures: Maintenance procedures (e.g. pruning of trees, fault detection) are generally believed to produce lower ambient noise levels in contrast to those experienced during the construction phase. The impact related to disturbances on fauna species is regarded to be low.

Maintenance of the vegetation below the power line servitude: Fires are detrimental to the proper functioning of powerlines, which necessitates the early burning of the

graminoid cover and pruning of emergent trees when corresponding to wooded grassland and swamp forest types. The removal of woody vegetation below the power line servitude and persistent burning of grassland units could change the floristic properties (both structurally and compositionally) of the vegetation sere along the servitude, although the impact is believed to be of low significance.

Increased hunting and poaching: It is possible that the labour force could engage in activities that could lead to the hunting of localised game for food or medicinal purposes. In addition, the removal of trees for firewood could alter the natural structure of the vegetation, which could eventually lead to shifts in the natural faunal species composition, spread of alien plant species and increased competition between species for resources.

Table 8: A list of threatened, near threatened and conservation important faunal species likely to occur in the study area (excluding introduced game). The conservation status and distribution of mammal, amphibian and reptile taxa was based on IUCN Red List (2020), Child et al (2016), Measey (2010) and Bates et al. (2014) respectively. MammalMap, ReptileMap and FrogMap projects that are administered by the Animal Demography Unit were also consulted.

Scientific Name	Common Name	Global Conservation Status	National Conservation Status	Probability of Occurrence	Habitat
Mammals					
Pelea capreolus	Vaal Rhebok	-	Near threatened	Low, probably absent owing to the absence of suitable habitat. Considered to be rare in the wider study region (single confirmed record from adjacent QDS).	Rocky grassland associated with ridges, hills and mountains
Felis nigripes	Black-footed Cat	Vulnerable	Vulnerable	Moderate, could occur given the occurrence of suitable habitat (occurrence of termitaria as refugia). Only known from a single dated record from adjacent QDS (1977; sensu MammalMap).	A habitat specialist occurring in open short grassland with a high abundance of rodent prey and shelter (termitaria and the dens and burrow structures of other medium-sized mammals).
Parahyaena brunnea	Brown Hyaena	Near threatened	Near threatened	Moderate, could occur. Known from a single record from an adjacent QDS (1972; sensu MammalMap).	Widespread and varied. Occurs in semi-desert, open shrub to open savanna areas, but have a strong association towards rock cover in bushveld areas.
Mystromys albicaudatus	White-tailed Rat	Vulnerable	Vulnerable	Moderate, could occur in the northern part of the alignment (section of *Themeda*-dominated grassland between Tetra4 and the area 760m south of Tetra4). Known from a single historic	Grassland, especially grassland dominated by *Themeda triandra* with calcrete soils. They also tolerate disturbed and heavily grazed areas and open secondary grasslands. They also occur in dense grassland associated with rocky areas. They avoid completely transformed areas such as cultivated land.

Scientific Name	Common Name	Global Conservation Status	National Conservation Status	Probability of Occurrence	Habitat
				record dating to 1969 from an adjacent QDS (sensu MammalMap).	
Reptiles					
Smaug gigianteus	Large-scaled Grass Lizard	Vulnerable	Vulnerable	Low-Moderate, could occur in the northern part of the alignment (section of *Themeda*-dominated grassland between Tetra4 and the area 760m south of Tetra4). Only known from two historical records (ca. 1974) from an adjacent QDS (sensu ReptileMap). However, it is also known from recent (post-2007) records from the Welkom area north of the study site. Therefore, the study site is considered to be peripheral to the extant distribution range of this species.	Highveld grassland of northern Free State and south-western Mpumalanga, especially *Themeda triandra* grassland on sandy to loamy soils which conforms locally to untransformed Vaal-Vet Sandy Grassland.

3.7 Avifauna

3.7.1 Important avifaunal habitat types

The composition and distribution of the vegetation communities on the study area are a consequence of a combination of factors simulated by floristic structure (secondary grassland vs. untransformed *Vachellia - Themeda* grassland/bushveld mosaics), agricultural activities and the presence of azonal habitat (Figure 11 and Figure 12):

1. *Vachellia (=Acacia) karoo - Themeda triandra grassland/bushveld mosaics:* This habitat unit is located on the northern part of the study site, where it coincides with untransformed open grassland-bushveld mosaics on Katspruit and Sepane soil forms. It is characterised by open grassland dominated by *Themeda triandra* and *Panicum coloratum* interspersed by bush clumps composed of short to medium *Vachellia karoo* and *Asparagus laricinus*. The avifaunal composition consists of a typical thornveld association such as Black-chested Prinia (*Prinia flavicans*), Southern Fiscal (*Lanius collaris*), Southern Masked Weaver (*Ploceus velatus*), Chestnut-vented Warbler (*Sylvia subcaerulea*), Neddicky (*Cisticola fulvicapilla*) and Ring-necked Dove (*Streptopelia capicola*). In terms of collision-prone bird species (species with a high probability to interact with the powerline infrastructure), this habitat unit provides also habitat for the Northern Black Korhaan (*Afrotis afraoides*) and potentially also the vulnerable Secretarybird (*Sagittarius serpentarius*). Other noteworthy bird species restricted to this habitat include the Cape Penduline Tit (*Anthoscopus minutus*), Kalahari Scrub-robin (*Cercotrichas paena*), Dusky Sunbird (*Cinnyris fuscus*), Brown-crowned Tchagra (*Tchagra australis*) and Sabota Lark (*Calendulauda sabota*).

2. *Secondary grassland with scattered Vachellia karoo bush clumps:* This unit is dominant on the central part of the study site, and primarily confined to old agricultural fields or over-utilised natural grassland (e.g. overgrazed). The floristic composition is dominated by secondary graminoids such as *Melinis repens, Eragrostis curvula, Digitaria eriantha* (pasture relicts) and *Cynodon dactylon*, while certain parts are extensively encroached by *Asparagus laricinus, V. karroo, Lycium sp., Salsola kali* and *Pseudognaphalium luteo-album*. Typical bird species confined to this habitat include (mainly granivores) such as Laughing Dove (*Spilopelia senegalensis*), Red-capped Lark (*Calandrella cinerea*), Red-billed Quelea (*Quelea quelea* - large flocks), African Stonechat (*Saxicola torquata*), Southern Red Bishop (*Euplectes orix*), Cape Sparrow (*Passer melanurus*), Yellow Canary (*Crithagra flaviventris*) and Northern Black Korhaan (*Afrotis afraoides*). Species restricted to this habitat also include Wattled Starling (*Creatophora cinerea* - especially near cattle kraals), Crowned Lapwing (*Vanellus coronatus*), White-backed Mousebird (*Colius colius*) and Ant-eating Chat (*Myrmecocichla formicivora*).

3. *Riparian Vegetation:* This unit is restricted to the extreme southern part of the study site along Option B near the Bosluisspruit River. It consists of a well-defined tree layer dominated by *Vachellia karroo* and *Searsia lancea* with dense stands of *Phragmites australis* bordering the river. This is an important daily flyway for many waterbird species in the region, while the prominent *V. karoo* layer that is bordering these systems increases the local vertical heterogeneity and niche space which is directly proportional to avifaunal richness, especially for "bushveld" birds. The Bosluisspruit River (is important foraging habitat for piscivorous bird taxa such as the Reed Cormorant (*Microcarbo africanus*) and African Darter (*Anhinga rufa*), while the vegetation provides roosting habitat for large flocks of Southern Masked Weaver (*Ploceus velatus*) and Southern Red Bishop (*Euplectes orix*). Other noteworthy bird species confined to the riparian vegetation are the Lesser Swamp Warbler (*Acrocephalus gracilirostris*), Orange River White-eye (*Zosterops pallidus*), Karoo Scrub-robin (*Cercotrichas coryphoeus*), Acacia Pied Barbet (*Tricholaema leucomelas*), Pririt Batis (*Batis pririt*), Common Waxbill (Estrilda *astrild*), Yellow-crowned Bishop (*E. afer*) and Red-eyed Dove (*Streptopelia semitorquata*).

4. *Azonal habitat - manmade dams, effluent ponds, water treatment works and depressions*: These represent water bodies of variable size which were mainly created to act as ponds to treat mine water before being released into the Bosluisspruit. They have undoubtedly benefit the colonisation and range expansion of waterbird species that favours open water habitat (e.g. Red-knobbed Coot *Fulica cristata*, Egyptian Goose *Alopochen aegyptiaca*, South African Shelduck *Tadorna cana*, Red-billed Teal *Anas erythrorhyncha* and Hadeda Ibis *Bostrychia hagedash*). These water bodies provide a safe refuge for waterbird species. Most of these species are also prone towards collisions with powerlines.

5. *Cultivated land and pastures*: These are cultivated land or planted pastures consisting of mono-stands of *Digitaria eriantha* or *Eragrostis curvula*. When fallow, the arable land and pastures provide ephemeral foraging habitat for large terrestrial taxa such as the White Stork (*Ciconia ciconia*), Egyptian Goose (*A. aegyptiaca*), Spur-winged Goose (*Plectropterus gambiensis*) and Helmeted Guineafowl (*Numida meleagris*).


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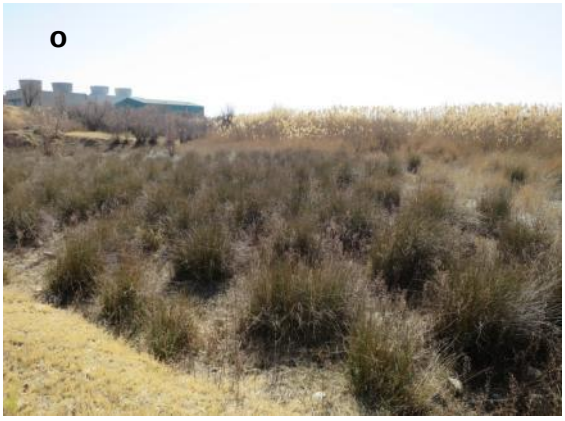
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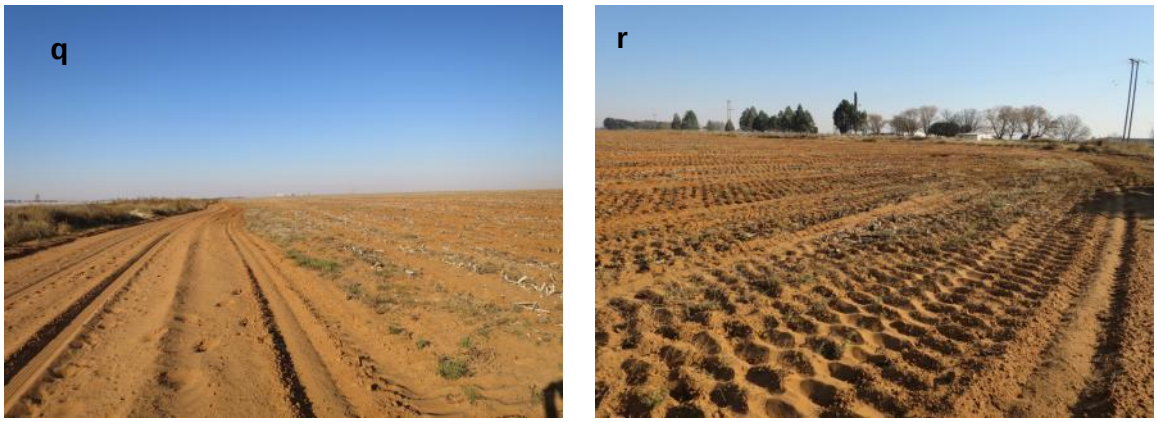

Figure 11: A collage of examples of the habitat types on the study area: (a - d) *Vachellia karoo - Themeda triandra* grassland/bushveld mosaics, (e - h) secondary grassland, (i - l) riparian vegetation along the Bosluisspruit, (m - p) azonal habitat and (q - r) cultivated land.

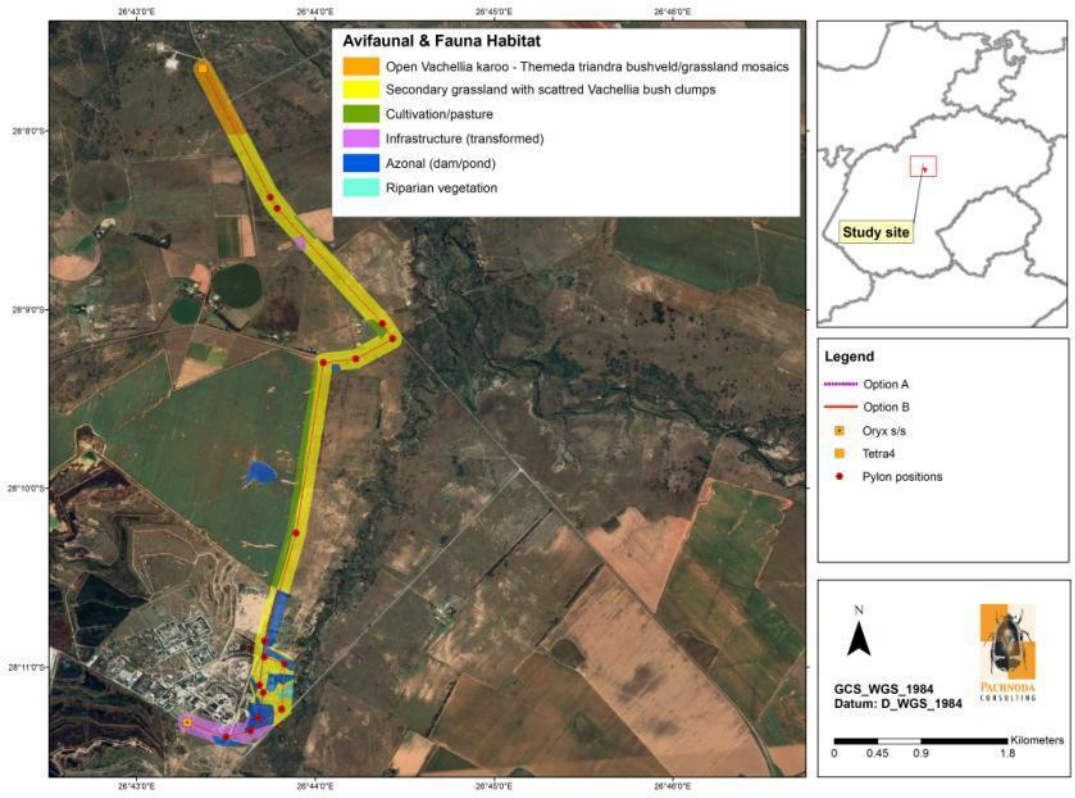

Figure 12: A map of the study site illustrating the spatial position of the dominant avifaunal (and faunal) habitat units.

3.7.2 General Composition, Dominance and Richness

Overview of General Bird Richness

A total of 139 bird species have been observed in the study area (c. pentad grids 2805_2640 and 2810_2640; *sensu* SABAP2; Appendix 1), of which 77 bird species were observed during the site visit (representing 55.5 % of the observed SABAP2 richness) (Appendix 2). However, the mean SABAP2 richness statistic (www.sabap2.birdmap.africa) for a single full protocol card prior to the site visit (corresponding to observations conducted over a period of two hours or more) on the study site was 55.5 bird species (range: 40-73 species), while the mean richness obtained during the site visit was 52.5 bird species (range: 50-55), which is similar the SABAP2 statistic. It implies that the observed richness provides a realistic indication of the thoroughness and general coverage of natural habitat units on the study site during the site visit. Two of the observed species during the site visit represent "additional" (so-called "out of range bird species") that were not previously recorded in the two pentad grids corresponding to the powerline alignment. These include the critically endangered African White-backed Vulture (*Gyps africanus*) and the Cape Penduline Tit (*Anthoscopus minuta*).

Dominance and typical bird species - point count data

A total of 55 bird species and 974 individuals were recorded from 10 bird point counts. A mean of 13.7 species and 97.4 individuals were recorded per point count. The highest number of species recorded from a point count was 21 species and the lowest was nine species. The highest number of individuals recorded per point count was 324 individuals, and the lowest was 17 individuals. The exceptional high number of individuals refers to flocks of Red-billed Quelea (*Quelea quelea*) observed from the secondary grassland, especially along the edges of cultivated land. The highest bird richness occurs on the southern part of the study site, especially in the vicinity of surface water (riparian vegetation and secondary grassland associated with azonal habitat; Figure 13 and Table 9), while the highest number of bird individuals occur along the edges of cultivated land (mainly flocks of granivores such as Red-billed Quelea (*Q. quelea*) (Figure 14). A high number of bird individuals is also evident (see Figure 14) on untransformed grassland and bushveld mosaics at the northern part of the study site, which infer the importance of untransformed natural habitat in sustaining a balanced composition of both insectivorous and granivore bird taxa.

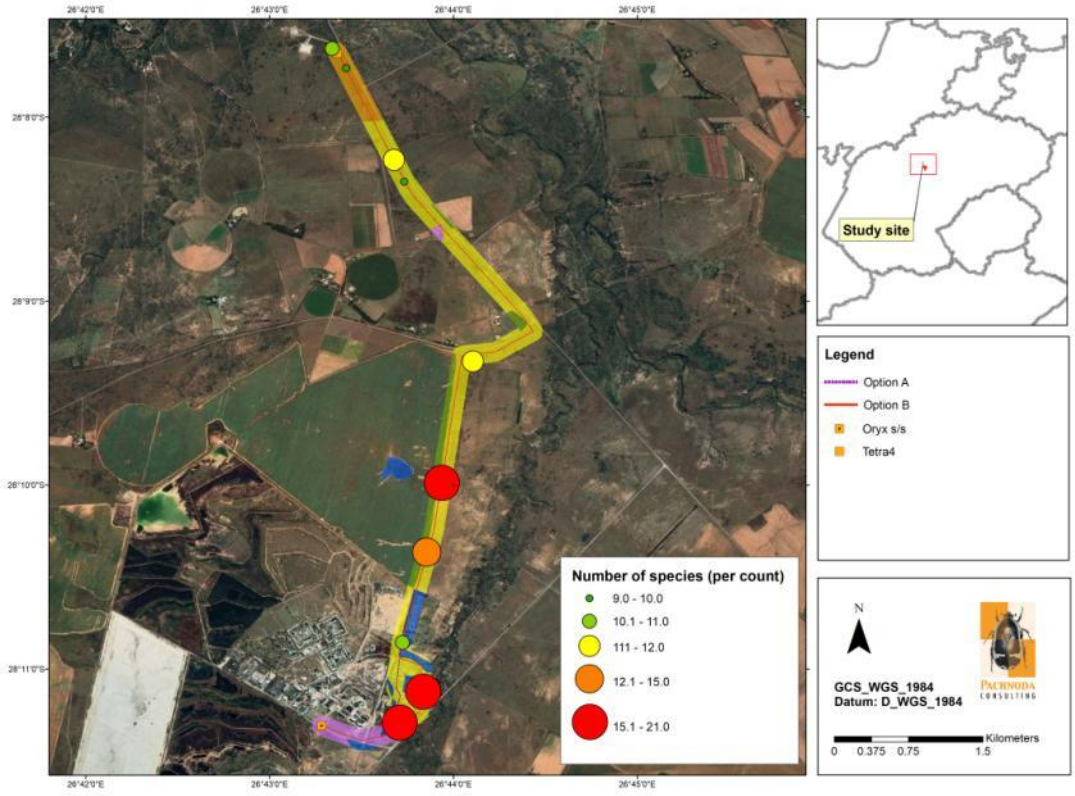

Figure 13: A map of the study site illustrating the number of bird species (richness) per point count.

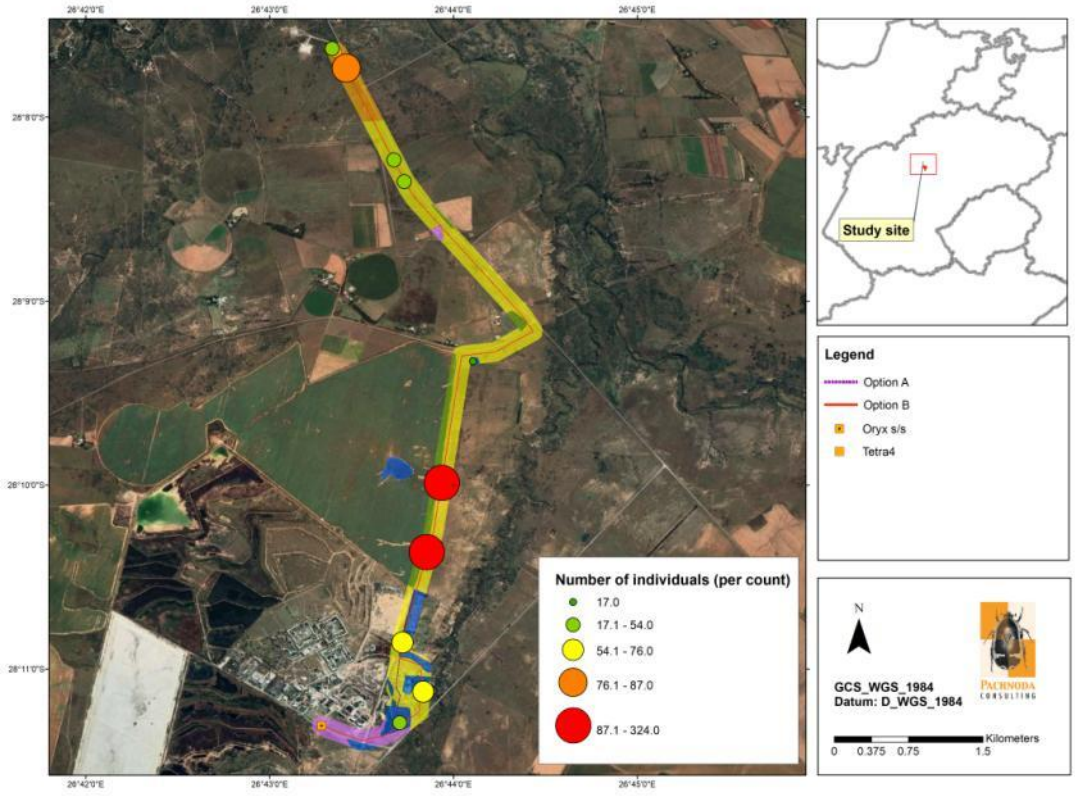

Figure 14: A map of the study site illustrating the number of bird individuals (abundance) per point count.

Table 9: The number of bird species, mean number of individuals and Shannon-Wiener diversity index (H'($\log_e$)) for birds observed on each of the respective habitat units.

Habitat Unit	Number of species	Mean number of individuals	Shannon-Wiener Index
Secondary grassland	32	140.80	2.10
Riparian	21	70.50	1.91
Secondary grassland/Azonal	18	76.00	2.39
Vachellia-Themeda grassland/bushveld mosaic	17	26.50	2.36

The dominant and typical species on the study site are presented in Table 10. Only those species that cumulatively contributed to more than 90% to the overall similarity between the point counts are presented. The three typical bird species with the highest frequency of occurrence on the study site include the Southern Masked Weaver (*Ploceus velatus*), Laughing Dove (*Spilopelia senegalensis*) and Ring-necked Dove (*Streptopelia capicola*). The dominant species with high numbers recorded are the Southern Red Bishop (*E. orix*), Cape sparrow (*Passer melanurus*) and Red-billed Quelea (*Quelea quelea*). The typical species forms part of nearly every bird assemblage and habitat unit on the study site, and are considered widespread species. Approximately 70 % of the typical species consists of granivores

(mainly of the lower strata or ground gleaners) while the remaining 30% consists of insectivores.

Table 10: Typical bird species observed on the study site.

Species	Average abundance	Consistency	% Contribution	Primary Trophic Guild
Southern Masked Weaver (*Ploceus velatus*)	13.40	1.68	18.38	Granivore: Ground to undergrowth gleaner
Laughing dove (*Spilopelia senegalensis*)	3.60	1.84	16.27	Granivore: Ground gleaner
Ring-necked Dove (*Streptopelia capicola*)	1.30	1.79	13.92	Granivore: Ground gleaner
Black-chested Prinia (*Prinia flavicans*)	1.80	0.89	9.45	Insectivore: Upper canopy foliage gleaner
African Stonechat (*Saxicola torquata*)	0.80	0.68	5.98	Insectivore: Upper canopy foliage gleaner
Southern Red Bishop (*Euplectes orix*)	4.00	0.51	5.65	Granivore: Ground to undergrowth gleaner
Red-capped Lark (*Calandrella cinerea*)	1.90	0.52	4.12	Granivore: Ground gleaner
Cape Sparrow (*Passer melanurus*)	6.20	0.52	3.95	Granivore: Ground to undergrowth gleaner
Northern Black Korhaan (*Afrotis afraoides*)	0.40	0.38	2.55	Insectivore: Ground gleaner
Red-billed Quelea (*Quelea quelea*)	35.00	0.26	2.54	Granivore: Ground to undergrowth gleaner

3.7.3 General Impacts associated with powerlines

Birds are impacted in three ways by means of powerlines. It is however a common rule that large and heavy-bodied terrestrial bird species are more at risk of being affected in a negative way when interacting with powerlines. These include the following:

- *Electrocution*

Electrocution happens when a bird bridges the gap between the live components or a combination of a live and earth component of a powerline, thereby creating a short circuit. This happens when a bird, mainly a species with a fairly large wingspan attempts to perch on a tower or attempts to fly-off a tower. Many of these species include vultures (of the genera *Gyps, Torgos* and *Trigonoceps*) as well as other large birds of prey such as the Martial Eagle (*Polemaetus bellicosus*) (Ledger & Annegarn, 1981; Kruger, 1999; Van Rooyen, 2000). These species will also attempt to roost and even breed on the tower structures if available nesting platforms are a scarce commodity. Other types of electrocutions happen by means of so-called “bird-streamers”. This happens when a bird, especially when taking off, excretes and thereby causing a short-circuit through the fluidity excreta (Van Rooyen & Taylor, 1999). This method of electrocution is however a rare phenomena. Most of these species are uncommon to rare in the study area and the impact more likely to occur

to other species that are prone towards roosting on pylons such as Black-headed Heron (*Ardea cinerea*) and Egyptian Goose (*Alopochen aegyptiacus*).

Large transmission lines (from 220 kV to 765 kV) are seldom a risk of electrocution, although smaller distribution lines (1 – 132kV) pose a higher risk, especially powerline between 1-60kV. Most electrocutions (> 95%) in the South African context occur at four types of powerline structures represented by 22 kV wooden T-structures, 88kV steel kite transmission towers, the terminal H-frame wood structures and Delta suspension structures. However, for this project, the design of the pylon is an important consideration in preventing bird electrocutions. **Therefore, the proposed pylon design must incorporate the following design parameters**:

- The clearances between the live components should exceed the wingspan of large bird species; (> 1.4m but preferably 1.8m where vultures occur);
- The length of the stand-off insulators should be of sufficient length (e.g. >1m) and the energised parts adjacent of the insulators should be insulated/covered with appropriate materials (polymers) to prevent incidental contact by birds. The length of the insulators should exceed 0.7m.
- The height of the tower should allow for unrestricted movement of terrestrial birds between successive pylons;
- "Bird streamers" should be eliminated by discouraging birds from perching directly above the conductors.

It is therefore recommended that the pylon design incorporates "features" as illustrated by Figure 15[3].

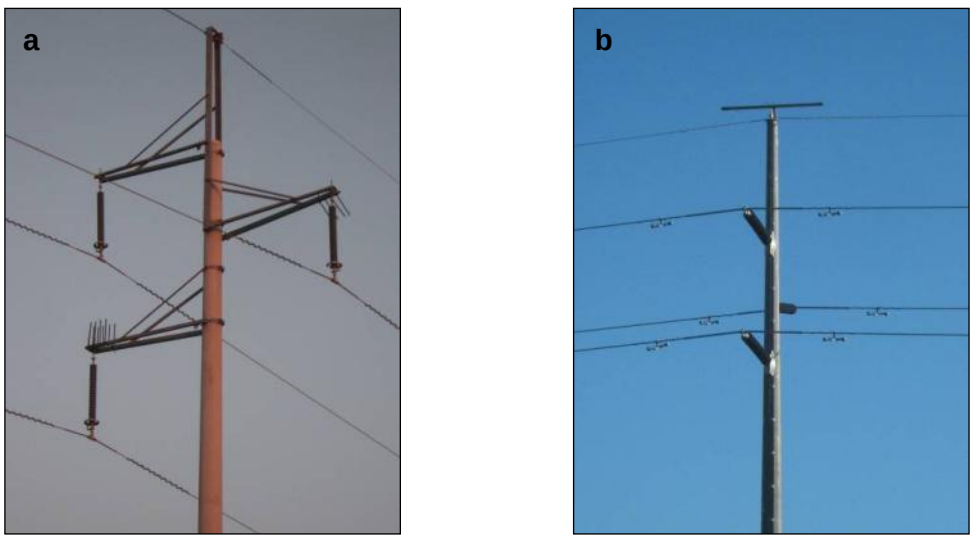

Figure 15: Two bird-friendly pylon designs.

[3] Please note that these are examples of recommended pylon designs. These are taken from steel monopole pylons.

From Figure 15 it is clear that both designs allow for **enough clearance between the live conductors** (being positioned in an off-set manner to each other) to eliminate the risk of electrocution. In addition, **perching is discouraged** by the addition of diagonal crossbars (Figure 15:a) or by doing away with the crossbars that holds the conductors in place (Figure 15:b). Bird "streamers" are also eliminated by fitting the poles with **bird guards/spikes** above the conductors (Figure 15:a). However, safe perching is facilitated by the fitment of a horizontal bar on top of the pole structure (Figure 15:b) without the risk of electrocution (due to the perpendicular orientation of the bar relative to the conductors).The distance between the perch pole and the nearest energised part should preferable exceed 1.8 m.

The current project will make use of the steel monopole design which is regarded to be safe for birds, and also allows for safe perching by adding a horizontal bird perch to the top of the pole (Figure 16).

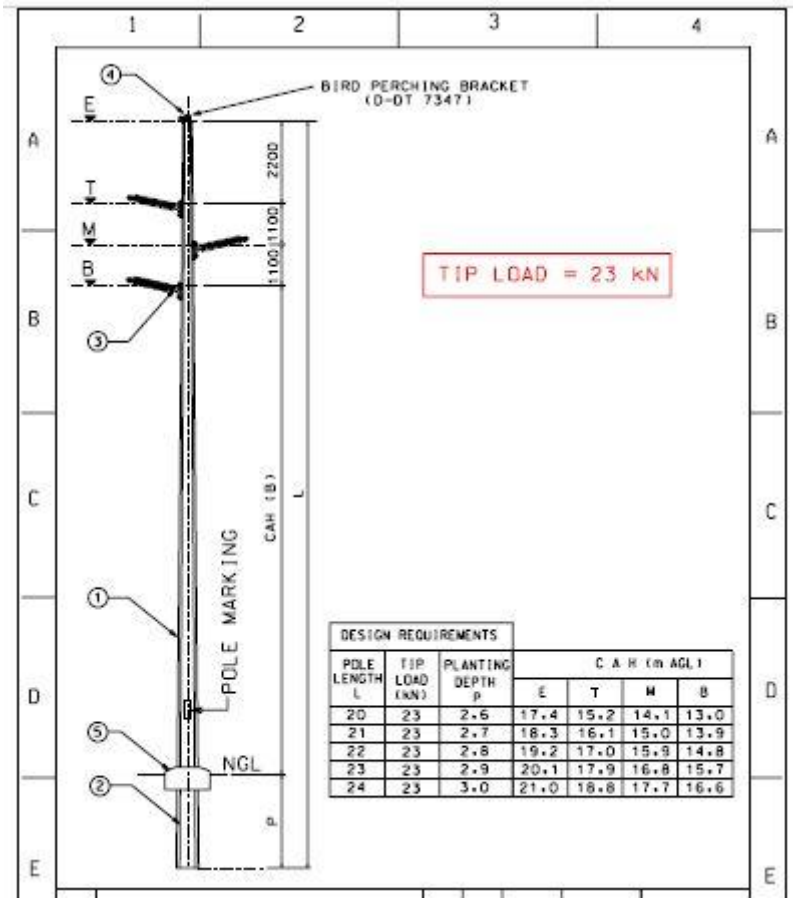

Figure 16: The monopole tower design that will be used for the project.

Collision

Collisions with earth wires have probably accounted for most bird-powerline interactions in South Africa. In general, the earth wires are much thinner in diameter when compared to the live components, and therefore less visible to approaching

birds. Many of the species likely to be affected include heavy, large-bodied terrestrial species such as cranes, storks, flamingos and a variety of waterbirds that are not very agile or manoeuvrable once airborne. These species, especially those with the habit of flying with outstretched necks (e.g. most species of storks and flamingos) find it difficult to make a sudden change in direction while flying – resulting in the bird flying into the earth wires.

Areas where bird collisions are likely to be high could be ameliorated by marking the lines with bird devices such as “bird diverters” and “flappers” to increase the visibility of the lines. For the current project it is proposed that all river, stream and azonal habitat (wetland habitat, including spans across untransformed grassland/bushveld mosaics be fitted with one of the following "Bird Flight Diverters" (BFDs) (see Figure 18 – Figure 19). These devices range from static diverters such as the "Double Loop Bird Flight Diverter" or dynamic devices such as the "Viper live bird flapper".

The proposed powerline could pose a potential threat to the local avifaunal community due to possible collisions with the earth wire, especially concerning passing flamingo species (this species is more prominent north of the study site near Welkom), Northern Black Korhaan, Secretarybirds and waterbirds (e.g. waterfowl).

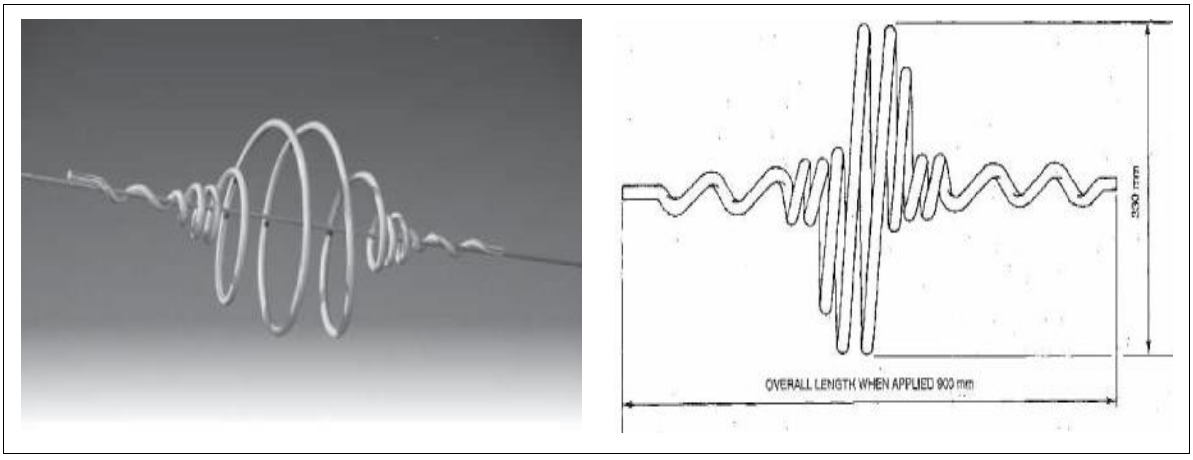

Figure 17: The Double Loop Bird Flight Diverter (copyright Preformed Line Products, www. preformedsa.co.za) to be used.

Figure 18: An example of a Double Loop Bird Flight Diverter fitted to the earth wire (in this example to a 400 kV transmission line).

Figure 19: Examples of bird flight diverters to be used on the power lines: Double loop bird flight diverter (left) and Viper live bird flapper (right).

- *Physical disturbances and habitat destruction caused during construction and maintenance*

It is anticipated that a number of access roads, pylon structures and laydown camps need to be constructed.

The placement of pylons, access roads and laydown camps on or next to habitat features with a high probability of sustaining waterbird species (e.g. azonal habitat) and rivers is likely to disrupt the natural movement of bird species or it could result in the abandoning of these areas. Therefore, special care should be taken near drainage lines, rivers and dams as not to disturb the bird community or the vegetation structure.

In addition, construction activities go hand in hand with ambient noise levels. Although construction is considered temporary, many species will vacate the study area during the construction phase and will become temporarily displaced, especially when construction activities correspond to azonal and riparian habitat units.

3.7.4 Priority Bird species likely to be impacted

Approximately 52 collision-prone species could be present on the study area based on reporting rates obtained from corresponding pentad grids (Table 11). These include species with a high probability to occur based on the presence of suitable habitat along the powerline servitude and according to their known distribution ranges.

Nineteen (19) of the 52 species (*c*. 36 %) were observed during the site visit, and includes the African White-backed Vulture (*Gyps africanus*) which was not previously recorded during SABAP2. Collision-prone species with the highest probability to occur along the powerline servitude includes the Northern Black Korhaan (*Afrotis afraoides*), Speckled Pigeon (*Columba guinea*), Swainson's Spurfowl (*Pternistis swainsonii*), Red-knobbed Coot (*Fulica cristata*) and Black-winged Kite (*Elanus caeruleus*).

In addition, nine (9) of the 52 species are regionally threatened and/or near threatened. Of these, both the Lesser Flamingo (*Phoeniconaias minor*) and the Greater Flamingo (*Phoenicopterus roseus*) have the highest reporting rates in the study area (c. 16.67 %) although these two species are more prominent on the large pans and wetland features north of the study site at Welkom. Their occurrence on the study site are considered as irregular, and will mainly consist of dispersing (flying) birds although it is possible that some of these individuals could collide with the powerline infrastructure given that these birds migrate mainly at night. Figure 20 and Figure 21 show the occurrence of flamingos based on reporting rates for Lesser and Greater Flamingos on the study site, with high reporting rates for both species reported near Welkom north of the study site. The open *Vachellia karoo - Themeda*

triandra grassland/bushveld mosaics in the northern part of the study site also provide suitable foraging habitat for the collision-prone Secretarybird (*Sagittarius serpentarius*). Although Secretarybirds have not been documented on the study site, they could occur considering their widespread occurrence in the wider study area (see Figure 22). Their apparent absence in the study site is best explained by the low number of observed cards submitted to SABAP2 (by citizen scientists). However, the remaining threatened and near threatened species are highly irregular and have low reporting rates of <11.00 %.

A number of other non-threatened bird species are also likely to be affected by the proposed powerline and include collision-prone species (according to SABAP2 reporting rates >30 % and personal observations; Table 11) such as the Spur-winged Goose (*Plectropterus gambiensis*), Hadeda Ibis (*Bostrychia hagedash*), Egyptian Goose (*Alopochen aegyptiacus*), Black-headed Heron (*Ardea melanocephala*), Grey Heron (*Ardea cinerea*), Yellow-billed Duck (*Anas undulata*), Red-billed Teal (*Anas erythrorhyncha*), Reed Cormorant (*Microcarbo africanus*) and Giant Kingfisher (*Megaceryle rudis*).

Table 11: Priority bird species (threatened, near threatened and collision-prone bird species) that have been recorded in the study area based on their conservation status and their ecological importance on the study area (*sensu* SABAP2 and personal observations). * - Taylor *et al* (2015), ** - IUCN (2020).

Common Name		Scientific Name		Regional Conservation status* (Global Conservation Status)**	Average reporting rate at study site (n=5 cards)	Average reporting rate at wider study area (n=55 cards)	Risk posed by Activity		
							Collision	Electrocution	Loss of habitat/ Displacement
Korhaan	Northern Black	*Afrotis*	*afraoides*		100	83.9286	High	Low	Moderate
Pigeon	Speckled	*Columba*	*guinea*		66.67	87.5	Moderate	Low	Low
Guineafowl	Helmeted	*Numida*	*meleagris*		66.67	78.5714	Moderate	Low	Low
Spurfowl	Swainson's	*Pternistis*	*swainsonii*		66.67	75	Moderate	Low	Low
Coot	Red-knobbed	*Fulica*	*cristata*		66.67	58.9286	Low	Low	Low
Kite	Black-winged	*Elanus*	*caeruleus*		66.67	57.1429	Moderate	Low	Low
Egret	Western Cattle	*Bubulcus*	*ibis*		50	76.7857	Moderate	Low	Low
Goose	Egyptian	*Alopochen*	*aegyptiacus*		50	75	High	Moderate	Low
Ibis	Hadeda	*Bostrychia*	*hagedash*		50	71.4286	Moderate	Low	Low
Heron	Black-headed	*Ardea*	*melanocephala*		50	42.8571	High	Moderate	Low
Heron	Grey	*Ardea*	*cinerea*		50	37.5	High	Low	Moderate
Duck	Yellow-billed	*Anas*	*undulata*		33.33	69.6429	Moderate	Low	Low
Teal	Red-billed	*Anas*	*erythrorhyncha*		33.33	64.2857	Moderate	Low	Moderate
Cormorant	Reed	*Microcarbo*	*africanus*		33.33	39.2857	Moderate	Low	Moderate
Kingfisher	Giant	*Megaceryle*	*maximus*		33.33	7.1429	Moderate	Low	Moderate
Goose	Spur-winged	*Plectropterus*	*gambensis*		16.67	60.7143	High	Low	Low
Ibis	Glossy	*Plegadis*	*falcinellus*		16.67	60.7143	Moderate	Low	Moderate
Flamingo	Greater	*Phoenicopterus*	*roseus*	Near threatened	16.67	58.9286	High	Low	Low
Shelduck	South African	*Tadorna*	*cana*		16.67	50	Moderate	Low	Moderate
Flamingo	Lesser	*Phoeniconaias*	*minor*	Near threatened (Near threatened)	16.67	48.2143	High	Low	Low

Common Name		Scientific Name		Regional Conservation status* (Global Conservation Status)**	Average reporting rate	Average reporting rate at	Risk posed by Activity		
Heron	Goliath	*Ardea*	*goliath*		16.67	41.0714	High	Low	Moderate
Egret	Little	*Egretta*	*garzetta*		16.67	30.3571	Moderate	Low	Moderate
Duck	African Black	*Anas*	*sparsa*		16.67	5.3571	Moderate	Low	Moderate
Owl	Marsh	*Asio*	*capensis*		16.67	5.3571	Moderate	Low	Moderate
Spurfowl	Natal	*Pternistis*	*natalensis*		16.67	3.5714	Moderate	Low	Low
Goshawk	Gabar	*Melierax*	*gabar*		16.67	1.7857	Low	Low	Low
Harrier-Hawk	African	*Polyboroides*	*typus*		16.67	1.7857	Low	Low	Low
Kestrel	Rock	*Falco*	*rupicolus*		16.67	1.7857	Moderate	Low	Low
Vulture	African White-backed	*Gyps*	*africanus*	Critically Endangered (Critically Endangered)	1		High	Moderate	Low
Duck	White-faced	*Dendrocygna*	*viduata*		0	66.0714	Moderate	Low	Low
Shoveler	Cape	*Anas*	*smithii*		0	60.7143	Moderate	Low	Moderate
Teal	Cape	*Anas*	*capensis*		0	57.1429	Moderate	Low	Moderate
Gull	Grey-headed	*Chroicocephalus*	*cirrocephalus*		0	48.2143	Moderate	Low	Low
Pochard	Southern	*Netta*	*erythrophthalma*		0	48.2143	Moderate	Low	Moderate
Duck	Maccoa	*Oxyura*	*maccoa*	Near threatened (Vulnerable)	0	42.8571	Moderate	Low	Low
Ibis	African Sacred	*Threskiornis*	*aethiopicus*		0	37.5	Moderate	Low	Low
Duck	White-backed	*Thalassornis*	*leuconotus*		0	8.9286	Low	Low	Low
Night-Heron	Black-crowned	*Nycticorax*	*nycticorax*		0	7.1429	Moderate	Low	Moderate
Egret	Great	*Ardea*	*alba*		0	5.3571	Moderate	Low	Moderate
Falcon	Peregrine	*Falco*	*peregrinus*		0	0	Moderate	Low	Low
Cormorant	White-breasted	*Phalacrocorax*	*carbo*		0		Moderate	Low	Moderate
Eagle	Booted	*Hieraaetus*	*pennatus*		0		Moderate	Low	Low
Darter	African	*Anhinga*	*rufa*			28.5714	Moderate	Low	Moderate
Heron	Purple	*Ardea*	*purpurea*			28.5714	Moderate	Low	Moderate

Common Name		Scientific Name		Regional Conservation status* (Global Conservation Status)**	Average reporting rate	Average reporting rate at	Risk posed by Activity		
Eagle-owl	Spotted	*Bubo*	*africanus*			17.8571	Moderate	Low	Low
Fish-eagle	African	*Haliaeetus*	*vocifer*			12.5	High	Low	Moderate
Stork	Yellow-billed	*Mycteria*	*ibis*	Endangered		10.7143	High	Low	Moderate
Buzzard	Steppe	*Buteo*	*vulpinus*			7.1429	Moderate	Low	Low
Falcon	Lanner	*Falco*	*biarmicus*	Vulnerable		1.7857	Moderate	Low	Low
Secretarybird	Secretarybird	*Sagittarius*	*serpentarius*	Vulnerable (Vulnerable)		1.7857	High	Low	High
Stork	Abdim's	*Ciconia*	*abdimii*	Near threatened		1.7857	High	Low	Moderate
Stork	Black	*Ciconia*	*nigra*	Vulnerable		0	High	Low	Moderate

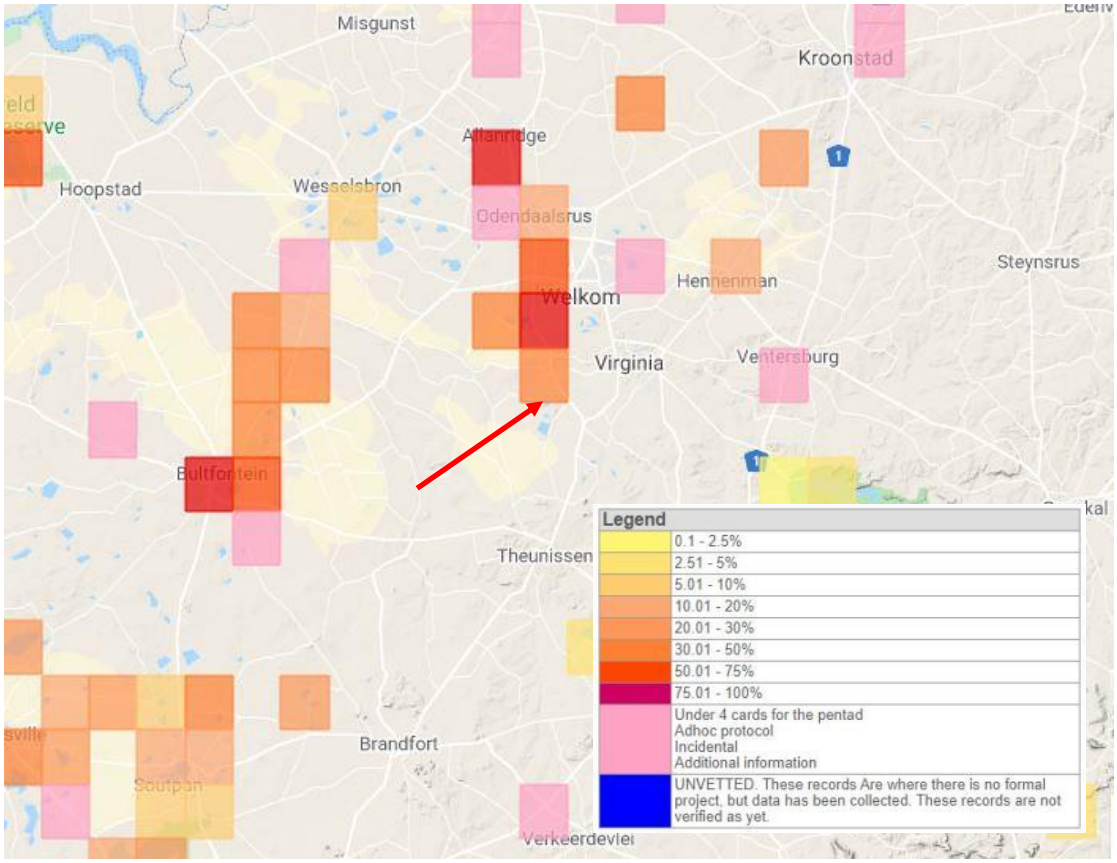

Figure 20: The distribution range of Lesser Flamingo (*Phoeniconaias minor*) (*sensu* SABAP2) in the study region (map courtesy and copyright of the ADU and SABAP2). The arrow shows the approximate locality of the study site.

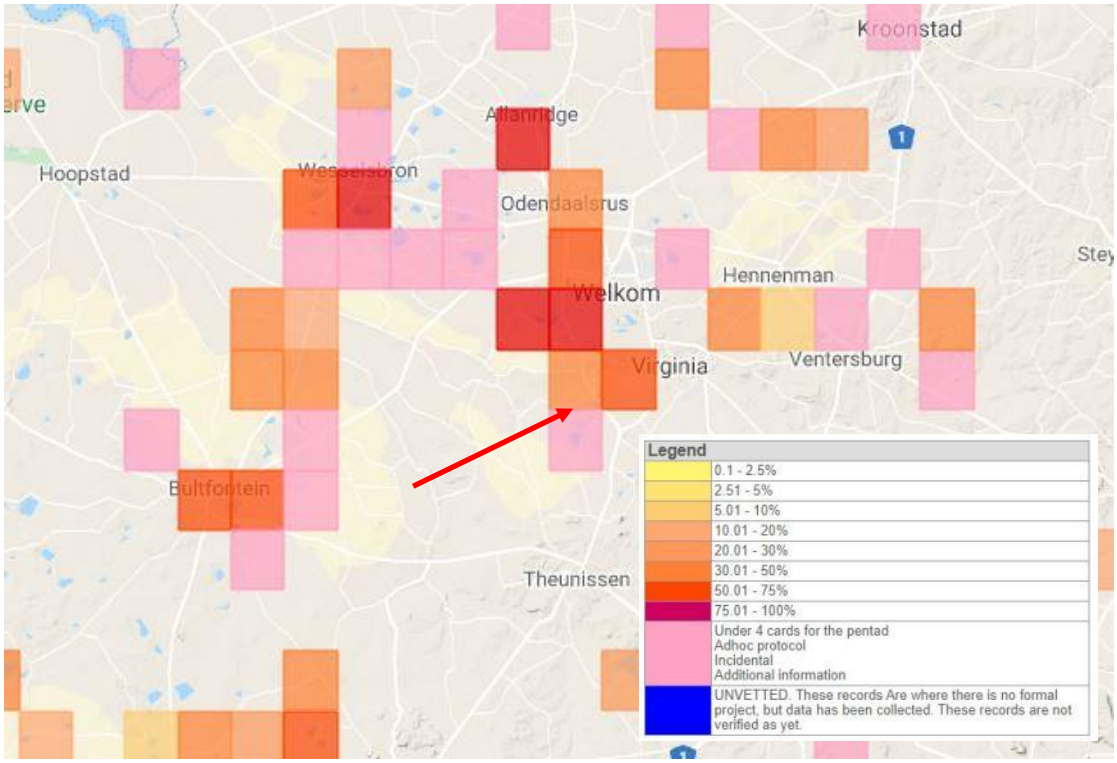

Figure 21: The distribution range of Greater Flamingo (*Phoenicopterus roseus*) (*sensu* SABAP2) in the study region (map courtesy and copyright of the ADU and SABAP2). The arrow shows the approximate locality of the study area.

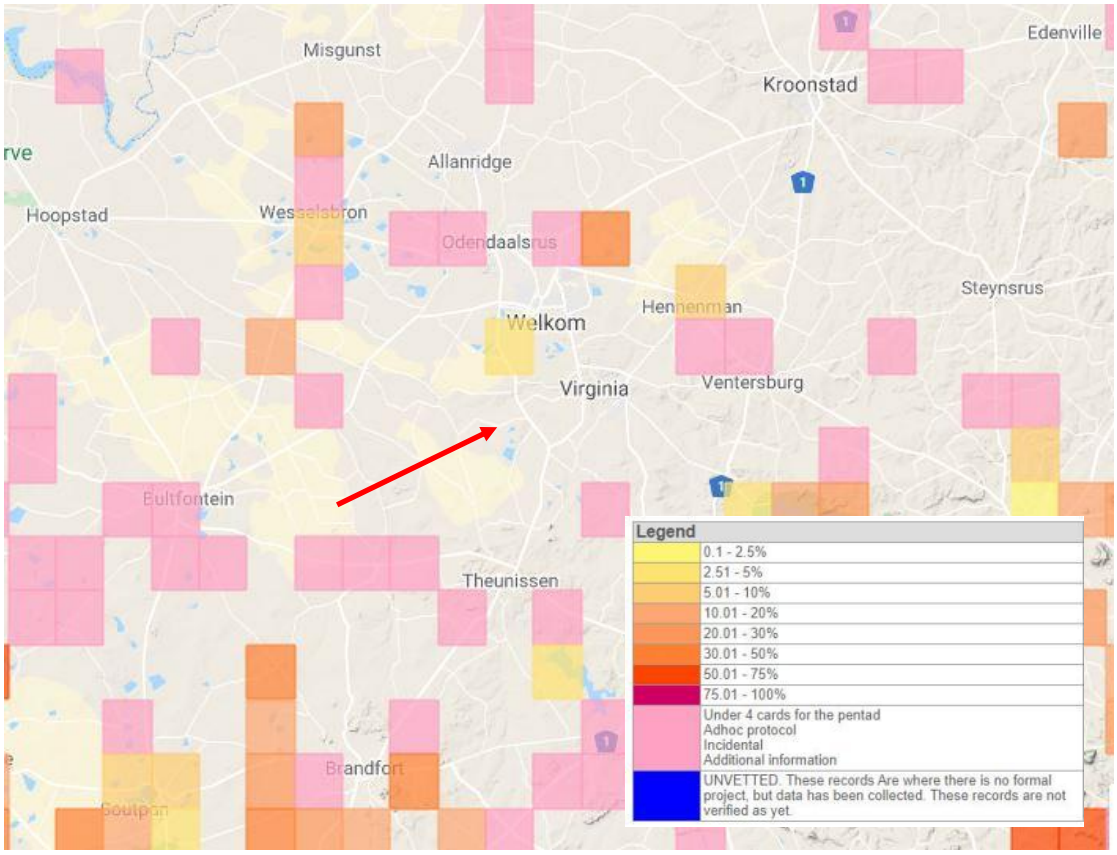

Figure 22: The distribution range of Secretarybird (*Sagittarius serpentarius*) (*sensu* SABAP2) in the study region (map courtesy and copyright of the ADU and SABAP2). The arrow shows the approximate locality of the study area.

3.7.5 Bird impacts

Potential bird impacts regarding the proposed powerline project comprise of electrocution, collision and disturbances caused during the construction and maintenance of powerlines.

- *Electrocution*

The recommended pylon design poses little electrocution risk due to the large clearances between the live components and the safe distance between the perch pole and the nearest energised parts. Electrocution by means of bird streaming is also less likely to occur due to an absence of suitable perching areas above the insulators and by adding a horizontal bird perch to the top of the pole (that is not aligned with the insulators).

- *Collision*

The following bird species, based on the availability of habitat types and their densities in the area, could potentially collide with the earth wires of the proposed powerlines:

- *Crossing open grassland (untransformed and secondary)*: Helmeted Guineafowl, Northern Black Korhaan, Swanson's Spurfowl, Secretarybird, Spur-winged Goose, Hadeda Ibis, Black-headed Heron and Egyptian Goose.
- *Azonal habitat and stream crossings*: African Fish Eagle, Lesser and Greater Flamingo, including a number of wading birds (herons), waterfowl (Egyptian Goose and anatid ducks) and waterbirds such as cormorants, darters, coots and ibises.

The impact due to the risk of birds colliding with the powerline is reduced by fitment of suitable bird deterrent devices.

- *Loss of habitat*

Habitat destruction is not considered to be a major impact since many of the bird species will temporarily vacate the area during the construction phase. It is inevitable that most bird species (including the smaller passerines) will be affected by access road construction, the construction of pylons and stringing operations. However, the impact is considered to be more intense within or in close proximity to riparian vegetation. The significance of the impact on the loss of habitat is regarded as low.

- *Disturbances caused by construction/decommissioning activities and maintenance of the powerline servitude*

It is inevitable that disturbances during construction and maintenance will occur. Although it is not anticipated to pose a significant impact on bird species, special care should be exercised during the crossing of azonal habitat and rivers/streams to prevent unnecessary disturbances caused to potential breeding and roosting species. The significance of the impact on disturbances is regarded as low.

3.8. Ecological Importance

An ecological importance ("sensitivity") map was compiled, illustrating areas comprising of potential sensitive elements based on the land cover categories (Figure 23):

All habitat types relevant to (1) untransformed *Vachellia karoo - Themeda triandra* grassland/bushveld mosaics, (2) azonal habitat and (3) riparian vegetation are regarded as sensitive habitat units. These areas consisted of high fauna/avifauna richness, and provided habitat for collision-prone bird species.

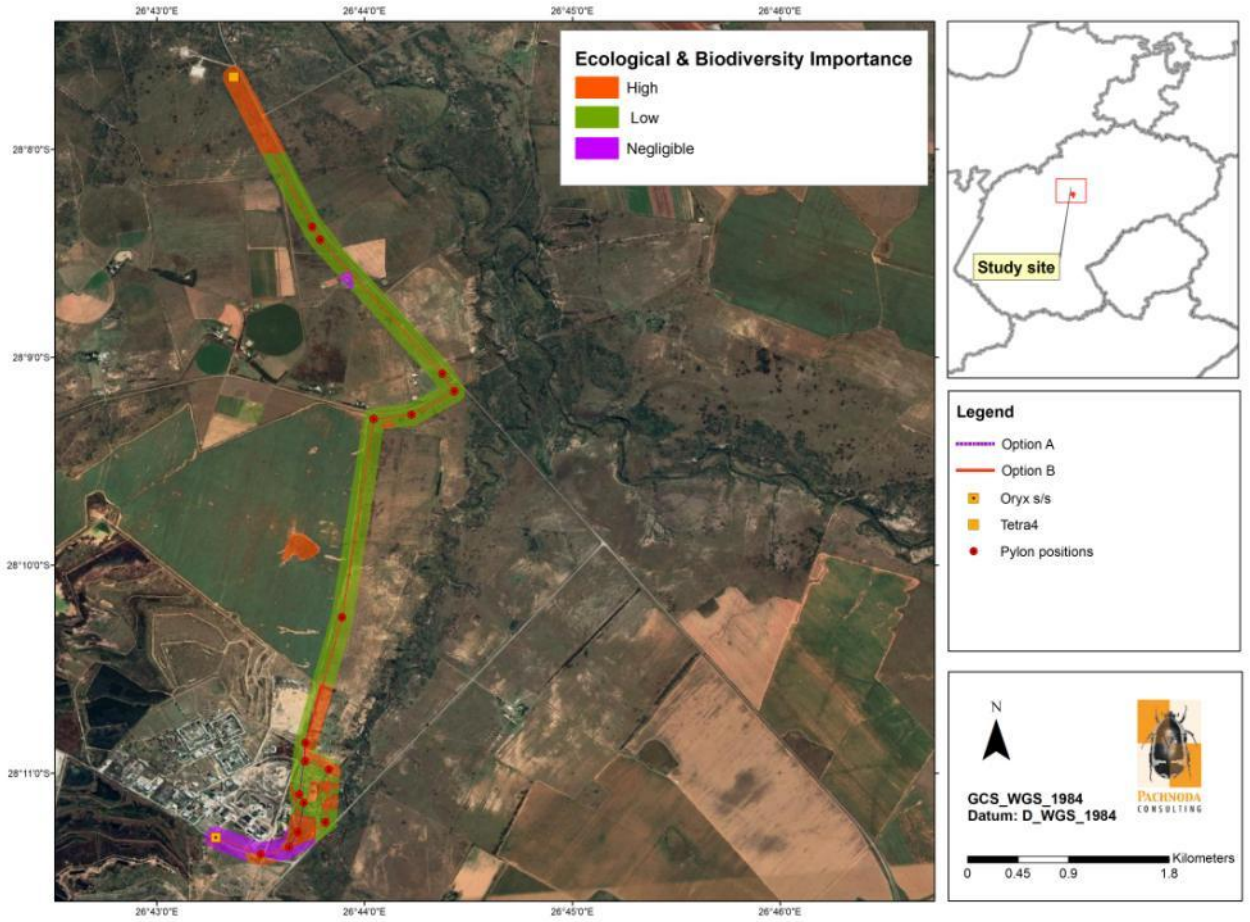

Figure 23: A map illustrating the ecological importance of the area based on habitat types supporting important bird and faunal assemblages.

4. ANALYSIS OF PROPOSED OPTIONS & AN OPINION REGARDING THE FEASIBILITY OF THE PROJECT (AS PER APPENDIX 6)

As per Appendix 6 of the Environmental Impact Assessment Regulations of 2014 (No. R. 982) of the National Environmental Management Act (Act No. 107 of 1998) a reasoned opinion should be provided as to whether the proposed activity or portions thereof should be authorised:

4.1 Analysis of Options

From a bird impact perspective, for any powerline to be regarded as a suitable candidate it must (a) traverse the least number natural habitat types, in particular vegetation in pristine/untransformed condition, (b) traverse the least number of wetland/azonal features and or drainage lines/rivers (c) correspond to an area with low reporting rates for bird species considered to be threatened or near threatened, and (d) follow existing powerline servitudes.

Both Option A and B occur in close proximity to azonal habitat that may be utilised by collision-prone waterbird taxa. However, Option B is located between azonal habitat and the Bosluisspruit River, thereby increasing the risk of birds colliding with the powerline when commuting between these habitat units. It also crosses over an artificial effluent pond which may provide ephemeral habitat for certain waterbird taxa. On the other hand, Option A traverses marginally onto an artificial wet area consisting mainly of dense *Phragmites* stands and is the preferred option over Option B.

4.2 Recommendations & mitigation measures

4.2.1 Avifauna

There are many ways to ameliorate or mitigate bird impacts imposed by powerline interactions. Probably the best way is to proactively avoid areas where the potential for bird interaction is evident, is by means of subsequent route deviations, re-alignments or modifications. However, route deviations/re-alignments are not always financially plausible unless significant bird mortalities or habitat destruction is inevitable. An option to overcome bird collisions is to replace overhead lines with underground cables. This method does come at a huge expense, and construction activities could irreparably damage sensitive habitat types. It is also more time-consuming to repair faults on underground *versus* overhead cables.

The following obligatory recommendations are applicable to the project:

1. The following areas as shown on Figure 24 should be marked with bird deterrent devices:
    - The span between pylons AB14-AB15 (see Figure 24);
    - The spans between pylons AB2-AB8 for Option A when selected (c. AB2-AB3-A4-A5-A6-AB7-AB8) or spans from pylons AB2-AB8 for Option B if selected (c. AB2-AB3-B4-B5-B6-AB7-AB8 - the least preferred option) (see Figure 24);
    - All intact grassland/bushveld mosaics, rivers/streams and azonal crossings should by default be marked.
    - Default marking devices to be used should include the Double Loop Bird Flight Diverters and dynamic devices (e.g. the "Viper Live bird Flapper"). The Double Loop Bird Flight Diverters should be applied in a staggered fashion to the earth wires while alternating between black and white diverters. The maximum distance between the diverters should not exceed 5 m. For dynamic devices, flappers should be applied to earth wires while alternating between different colours (e.g. between black and yellow or black and red) and should be fitted to the middle 60 % of the span (corresponding to the lower part of the span). All flappers should be spaced at 5 m intervals from each other.

2. Mandatory measures to be implemented during the construction phase:
    - All construction sites must be confined to disturbed areas or area with low ecological importance. All construction sites must be demarcated on site layout plans (preferably), and no construction personnel or vehicles may leave the demarcated area except those authorised to do so. Those areas surrounding the construction sites that are not part of the demarcated development area should be considered as “no-go” areas for employees, machinery or even visitors.
    - All road networks must be planned with care to minimize dissection or fragmentation of important avifaunal habitat type. Where possible, the use of existing roads is encouraged. Access must be determined during the “walk-through” process.
    - Open fires are strictly prohibited and only allowed at designated areas.
    - Killing or poaching of any bird species should be avoided by means of awareness programs presented to the labour force. The labour force should be made aware of the conservation issues pertaining to the bird taxa occurring on the study area. Any person found deliberately harassing any bird species in any way should face disciplinary measures, following the possible dismissal from the site.

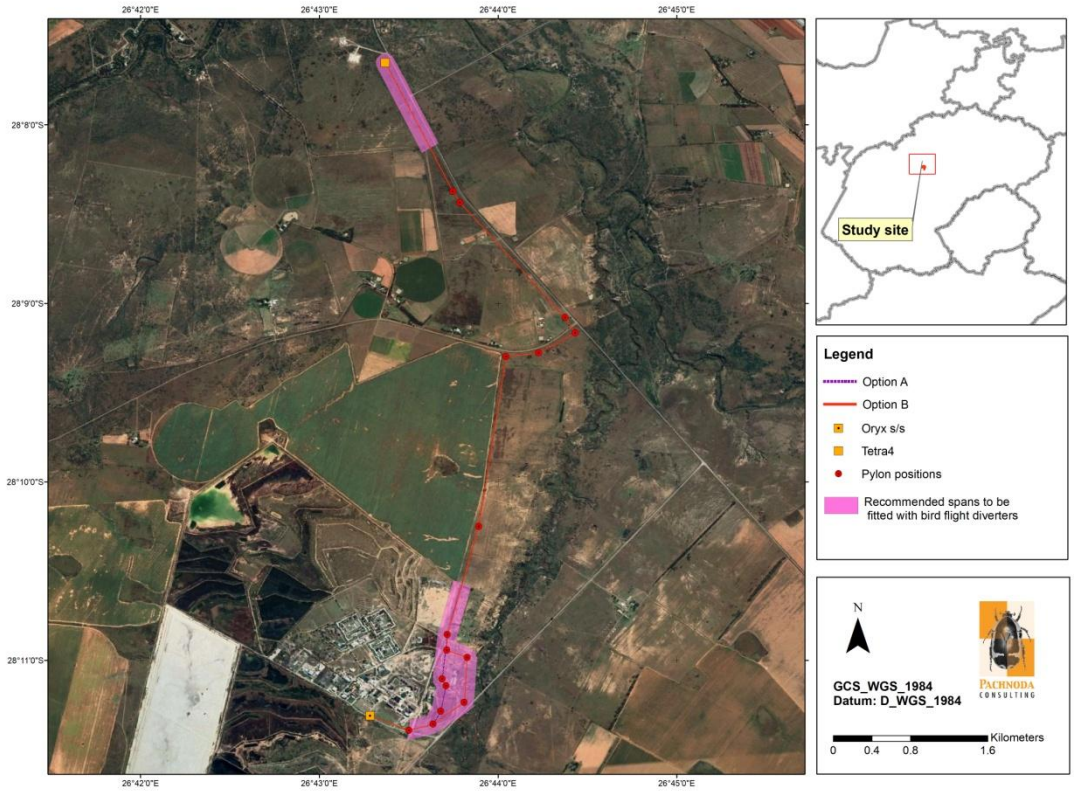

Figure 24: The spans recommended for the fitment of bird flight diverters.

4.2.2 General considerations for fauna

The following obligatory recommendations are applicable to the project area:

1. *A "walk-through" of the selected route must be conducted prior to the construction phase*:

- The "walk-through" will aim to identify areas where conservation-dependant species are likely to occur (e.g. burrows or dens of *Smaug giganteus* and *Felis nigripes*[4])
- When a threatened or near threatened faunal species/population is identified, a pylon deviation (e.g. moving the pylon forward or backward in line with the current alignment) is advised to minimise the interference of the pylon footprint on the respective faunal species/population.

2. Mandatory measures to be implemented during the construction and operational phases:

- The construction of "new" access roads should be limited, and existing roads are encouraged for use during the construction phase.

[4] Please note that the probability that these species could occur is low-moderate and that the mitigation options are recommended based on the precautionary principle.

- The extent of the construction sites and access roads should be demarcated on site layout plans and should be restricted to disturbed areas or those with low ecological importance. Therefore, no construction personnel or vehicle may leave the demarcated area except those authorised to do so. Those areas surrounding the construction site that are not part of the demarcated development area should be considered as “no-go” areas for employees, machinery or even visitors.
- Termitaria (active or dysfunctional) should be retained *in situ* (protected)
- Open fires are strictly prohibited and only allowed at designated areas.
- Harvesting of firewood or any plant material (for medicinal or cultural purpose) during the construction phase is strictly prohibited. Labour or personnel shall only assist with the removal of plant matter if requested to do so by the ECO;
- Hunting/snaring is strictly prohibited. Any person found hunting or in the possession of any indigenous animal should face disciplinary measures, following the possible dismissal from the site.
- Intentional killing of any faunal species (in particular snakes) should be avoided by means of awareness programs presented to the labor force. The labor force should be made aware of the conservation issues pertaining to the taxa occurring on the study area. Any person found deliberately harassing any animal in any way should face disciplinary measures, following the possible dismissal from the site.
- If any subterranean/fossorial reptile, scorpion, amphibian or mammal species is recovered during the construction phase, this species must be relocated to the nearest area or natural open space with suitable habitat for the particular species to continue its life history. If accidentally killed, then this species should be adequately preserved as a “voucher” specimen (with the assistance and knowledge of the ECO). These specimens may contribute towards a better understanding of biogeography and animal systematics.

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6. APPENDICES

Appendix 1: A shortlist of bird species that have been observed on the study area (sensu SABAP2) on pentad grids 2805_2640 and 2810_2640. # refers to SABAP2 numbers. Scientific names and colloquial names were used according to Gill et al. (2020).

#	Common Name		Scientific Name		SABAP2 Reporting Rates			
					Full Protocol (%)	Full Protocol Number of cards	Ad hoc Protocol (%)	Ad hoc Protocol Number of cards
432	Barbet	Acacia Pied	*Tricholaema*	*leucomelas*	83.33	5	0	0
431	Barbet	Black-collared	*Lybius*	*torquatus*	16.67	1	0	0
439	Barbet	Crested	*Trachyphonus*	*vaillantii*	16.67	1	0	0
674	Batis	Pririt	*Batis*	*pririt*	16.67	1	0	0
409	Bee-eater	White-fronted	*Merops*	*bullockoides*	50.00	3	0	0
808	Bishop	Southern Red	*Euplectes*	*orix*	83.33	5	0	0
812	Bishop	Yellow-crowned	*Euplectes*	*afer*	16.67	1	0	0
722	Bokmakierie	Bokmakierie	*Telophorus*	*zeylonus*	50.00	3	25	1
544	Bulbul	African Red-eyed	*Pycnonotus*	*nigricans*	50.00	3	0	0
872	Bunting	Cinnamon-breasted	*Emberiza*	*tahapisi*	16.67	1	0	0
860	Canary	Black-throated	*Crithagra*	*atrogularis*	83.33	5	0	0
866	Canary	Yellow	*Crithagra*	*flaviventris*	100.00	6	0	0
575	Chat	Anteating	*Myrmecocichla*	*formicivora*	50.00	3	0	0
570	Chat	Familiar	*Oenanthe*	*familiaris*	16.67	1	0	0
630	Cisticola	Desert	*Cisticola*	*aridulus*	16.67	1	0	0
646	Cisticola	Levaillant's	*Cisticola*	*tinniens*	66.67	4	25	1
504	Cliff-swallow	South African	*Petrochelidon*	*spilodera*	33.33	2	50	2
212	Coot	Red-knobbed	*Fulica*	*cristata*	66.67	4	25	1

#	Common Name		Scientific Name		SABAP2 Reporting Rates			
					Full Protocol (%)	Full Protocol Number of cards	Ad hoc Protocol (%)	Ad hoc Protocol Number of cards
50	Cormorant	Reed	*Microcarbo*	*africanus*	33.33	2	0	0
47	Cormorant	White-breasted	*Phalacrocorax*	*carbo*	0.00	0	25	1
278	Courser	Double-banded	*Rhinoptilus*	*africanus*	0.00	0	25	1
317	Dove	Laughing	*Spilopelia*	*senegalensis*	100.00	6	25	1
318	Dove	Namaqua	*Oena*	*capensis*	50.00	3	50	2
314	Dove	Red-eyed	*Streptopelia*	*semitorquata*	50.00	3	25	1
940	Dove	Rock	*Columba*	*livia*	33.33	2	0	0
95	Duck	African Black	*Anas*	*sparsa*	16.67	1	0	0
103	Duck	Maccoa	*Oxyura*	*maccoa*	0.00	0	25	1
104	Duck	White-backed	*Thalassornis*	*leuconotus*	0.00	0	25	1
100	Duck	White-faced	*Dendrocygna*	*viduata*	0.00	0	25	1
96	Duck	Yellow-billed	*Anas*	*undulata*	33.33	2	25	1
139	Eagle	Booted	*Hieraaetus*	*pennatus*	0.00	0	25	1
61	Egret	Western Cattle	*Bubulcus*	*ibis*	50.00	3	25	1
58	Egret	Great	*Ardea*	*alba*	0.00	0	25	1
59	Egret	Little	*Egretta*	*garzetta*	16.67	1	0	0
113	Falcon	Peregrine	*Falco*	*peregrinus*	0.00	0	25	1
820	Finch	Red-headed	*Amadina*	*erythrocephala*	16.67	1	0	0
789	Finch	Scaly-feathered	*Sporopipes*	*squamifrons*	50.00	3	0	0
835	Firefinch	Jameson's	*Lagonosticta*	*rhodopareia*	16.67	1	0	0
837	Firefinch	Red-billed	*Lagonosticta*	*senegala*	50.00	3	0	0
707	Fiscal	Southern	*Lanius*	*collaris*	100.00	6	25	1
86	Flamingo	Greater	*Phoenicopterus*	*roseus*	16.67	1	25	1
87	Flamingo	Lesser	*Phoeniconaias*	*minor*	16.67	1	0	0

#	Common Name		Scientific Name		SABAP2 Reporting Rates			
					Full Protocol (%)	Full Protocol Number of cards	Ad hoc Protocol (%)	Ad hoc Protocol Number of cards
678	Flycatcher	Fairy	*Stenostira*	*scita*	16.67	1	0	0
665	Flycatcher	Fiscal	*Melaenornis*	*silens*	33.33	2	0	0
89	Goose	Egyptian	*Alopochen*	*aegyptiacus*	50.00	3	25	1
88	Goose	Spur-winged	*Plectropterus*	*gambensis*	16.67	1	25	1
162	Goshawk	Gabar	*Melierax*	*gabar*	16.67	1	0	0
5	Grebe	Black-necked	*Podiceps*	*nigricollis*	0.00	0	25	1
6	Grebe	Little	*Tachybaptus*	*ruficollis*	66.67	4	25	1
263	Greenshank	Common	*Tringa*	*nebularia*	0.00	0	25	1
192	Guineafowl	Helmeted	*Numida*	*meleagris*	66.67	4	25	1
288	Gull	Grey-headed	*Chroicocephalus*	*cirrocephalus*	0.00	0	25	1
171	Harrier-Hawk	African	*Polyboroides*	*typus*	16.67	1	0	0
55	Heron	Black-headed	*Ardea*	*melanocephala*	50.00	3	0	0
56	Heron	Goliath	*Ardea*	*goliath*	16.67	1	0	0
54	Heron	Grey	*Ardea*	*cinerea*	50.00	3	25	1
418	Hoopoe	African	*Upupa*	*africana*	16.67	1	0	0
424	Hornbill	African Grey	*Tockus*	*nasutus*	16.67	1	0	0
81	Ibis	African Sacred	*Threskiornis*	*aethiopicus*	0.00	0	25	1
83	Ibis	Glossy	*Plegadis*	*falcinellus*	16.67	1	25	1
84	Ibis	Hadeda	*Bostrychia*	*hagedash*	50.00	3	25	1
851	Indigobird	Village	*Vidua*	*chalybeata*	33.33	2	0	0
123	Kestrel	Rock	*Falco*	*rupicolus*	16.67	1	0	0
395	Kingfisher	Giant	*Megaceryle*	*maximus*	33.33	2	25	1
130	Kite	Black-shouldered	*Elanus*	*caeruleus*	66.67	4	0	0
1035	Korhaan	Northern Black	*Afrotis*	*afraoides*	100.00	6	25	1

#	Common Name		Scientific Name		SABAP2 Reporting Rates			
					Full Protocol (%)	Full Protocol Number of cards	Ad hoc Protocol (%)	Ad hoc Protocol Number of cards
245	Lapwing	Blacksmith	*Vanellus*	*armatus*	100.00	6	25	1
242	Lapwing	Crowned	*Vanellus*	*coronatus*	100.00	6	25	1
1183	Lark	Eastern Clapper	*Mirafra*	*fasciolata*	16.67	1	0	0
488	Lark	Red-capped	*Calandrella*	*cinerea*	50.00	3	25	1
458	Lark	Rufous-naped	*Mirafra*	*africana*	66.67	4	25	1
460	Lark	Sabota	*Calendulauda*	*sabota*	16.67	1	0	0
703	Longclaw	Cape	*Macronyx*	*capensis*	66.67	4	0	0
509	Martin	Brown-throated	*Riparia*	*paludicola*	33.33	2	25	1
506	Martin	Rock	*Ptyonoprogne*	*fuligula*	16.67	1	0	0
803	Masked-weaver	Southern	*Ploceus*	*velatus*	100.00	6	25	1
210	Moorhen	Common	*Gallinula*	*chloropus*	33.33	2	25	1
392	Mousebird	Red-faced	*Urocolius*	*indicus*	33.33	2	25	1
390	Mousebird	Speckled	*Colius*	*striatus*	50.00	3	0	0
391	Mousebird	White-backed	*Colius*	*colius*	83.33	5	0	0
734	Myna	Common	*Acridotheres*	*tristis*	33.33	2	0	0
637	Neddicky	Neddicky	*Cisticola*	*fulvicapilla*	33.33	2	0	0
69	Night-Heron	Black-crowned	*Nycticorax*	*nycticorax*	0.00	0	25	1
1	Ostrich	Common	*Struthio*	*camelus*	33.33	2	0	0
361	Owl	Marsh	*Asio*	*capensis*	16.67	1	0	0
311	Pigeon	Speckled	*Columba*	*guinea*	66.67	4	25	1
692	Pipit	African	*Anthus*	*cinnamomeus*	83.33	5	0	0
694	Pipit	Plain-backed	*Anthus*	*leucophrys*	16.67	1	0	0
531	Penduline Tit	Cape	*Anthoscopus*	*minutus*	1.00	1		
237	Plover	Kittlitz's	*Charadrius*	*pecuarius*	0.00	0	25	1

#	Common Name		Scientific Name		SABAP2 Reporting Rates			
					Full Protocol (%)	Full Protocol Number of cards	Ad hoc Protocol (%)	Ad hoc Protocol Number of cards
238	Plover	Three-banded	*Charadrius*	*tricollaris*	33.33	2	25	1
102	Pochard	Southern	*Netta*	*erythrophthalma*	0.00	0	25	1
650	Prinia	Black-chested	*Prinia*	*flavicans*	83.33	5	25	1
844	Quailfinch	African	*Ortygospiza*	*atricollis*	33.33	2	25	1
805	Quelea	Red-billed	*Quelea*	*quelea*	100.00	6	25	1
581	Robin-chat	Cape	*Cossypha*	*caffra*	33.33	2	25	1
256	Ruff	Ruff	*Philomachus*	*pugnax*	0.00	0	25	1
251	Sandpiper	Curlew	*Calidris*	*ferruginea*	0.00	0	25	1
586	Scrub-robin	Kalahari	*Cercotrichas*	*paena*	83.33	5	0	0
583	Scrub-robin	Karoo	*Cercotrichas*	*coryphoeus*	16.67	1	0	0
90	Shelduck	South African	*Tadorna*	*cana*	16.67	1	0	0
94	Shoveler	Cape	*Anas*	*smithii*	0.00	0	25	1
786	Sparrow	Cape	*Passer*	*melanurus*	100.00	6	25	1
784	Sparrow	House	*Passer*	*domesticus*	66.67	4	0	0
4142	Sparrow	Southern Grey-headed	*Passer*	*diffusus*	16.67	1	0	0
780	Sparrow-weaver	White-browed	*Plocepasser*	*mahali*	100.00	6	25	1
484	Sparrowlark	Chestnut-backed	*Eremopterix*	*leucotis*	16.67	1	0	0
183	Spurfowl	Natal	*Pternistis*	*natalensis*	16.67	1	0	0
185	Spurfowl	Swainson's	*Pternistis*	*swainsonii*	66.67	4	25	1
737	Starling	Cape Glossy	*Lamprotornis*	*nitens*	50.00	3	0	0
746	Starling	Pied	*Spreo*	*bicolor*	50.00	3	25	1
735	Starling	Wattled	*Creatophora*	*cinerea*	66.67	4	25	1
270	Stilt	Black-winged	*Himantopus*	*himantopus*	16.67	1	25	1
253	Stint	Little	*Calidris*	*minuta*	0.00	0	25	1

#	Common Name		Scientific Name		SABAP2 Reporting Rates			
					Full Protocol (%)	Full Protocol Number of cards	Ad hoc Protocol (%)	Ad hoc Protocol Number of cards
576	Stonechat	African	*Saxicola*	*torquatus*	83.33	5	25	1
764	Sunbird	Dusky	*Cinnyris*	*fuscus*	16.67	1	0	0
493	Swallow	Barn	*Hirundo*	*rustica*	16.67	1	25	1
502	Swallow	Greater Striped	*Cecropis*	*cucullata*	16.67	1	0	0
604	Swamp-warbler	Lesser	*Acrocephalus*	*gracilirostris*	50.00	3	25	1
208	Swamphen	African	*Porphyrio*	*madagascariensis*	0.00	0	25	1
385	Swift	Little	*Apus*	*affinis*	16.67	1	50	2
383	Swift	White-rumped	*Apus*	*caffer*	16.67	1	0	0
714	Tchagra	Brown-crowned	*Tchagra*	*australis*	16.67	1	0	0
98	Teal	Cape	*Anas*	*capensis*	0.00	0	25	1
97	Teal	Red-billed	*Anas*	*erythrorhyncha*	33.33	2	25	1
275	Thick-knee	Spotted	*Burhinus*	*capensis*	16.67	1	0	0
658	Warbler	Chestnut-vented	*Sylvia*	*subcaerulea*	100.00	6	0	0
316	Dove	Ring-necked	*Streptopelia*	*capicola*	100.00	6	25	1
107	Vulture	African White-backed	*Gyps*	*africanus*	1.00	1		
686	Wagtail	Cape	*Motacilla*	*capensis*	66.67	4	0	0
839	Waxbill	Blue	*Uraeginthus*	*angolensis*	33.33	2	0	0
843	Waxbill	Common	*Estrilda*	*astrild*	16.67	1	0	0
838	Waxbill	Orange-breasted	*Amandava*	*subflava*	33.33	2	0	0
1171	White-eye	Orange River	*Zosterops*	*pallidus*	50.00	3	0	0
846	Whydah	Pin-tailed	*Vidua*	*macroura*	16.67	1	0	0
818	Widowbird	Long-tailed	*Euplectes*	*progne*	50.00	3	25	1
814	Widowbird	White-winged	*Euplectes*	*albonotatus*	33.33	2	0	0
450	Woodpecker	Cardinal	*Dendropicos*	*fuscescens*	16.67	1	0	0

#	Common Name		Scientific Name		SABAP2 Reporting Rates			
					Full Protocol (%)	Full Protocol Number of cards	Ad hoc Protocol (%)	Ad hoc Protocol Number of cards
453	Wryneck	Red-throated	*Jynx*	*ruficollis*	16.67	1	0	0

Appendix 2: A list of bird species confirmed form the study site during the site visit. Coordinates indicate the initial spatial locality where each species was observed or heard.

Common Name	Scientific Name	Latitude	Longitude
Acacia Pied Barbet	*Tricholaema leucomelas*	-28.1900	26.7253
African Pipit	*Anthus cinnamomeus*	-28.1678	26.7319
African Stonechat	*Saxicola torquatus*	-28.1364	26.7270
Ant-eating Chat	*Myrmecocichla formicivora*	-28.1556	26.7357
Black-chested Prinia	*Prinia flavicans*	-28.1275	26.7229
Blacksmith Lapwing	*Vanellus armatus*	-28.1901	26.7252
Black-throated Canary	*Crithagra atrogularis*	-28.1662	26.7322
Black-winged Kite	*Elanus caeruleus*	-28.1364	26.7270
Bokmakierie	*Telophorus zeylonus*	-28.1673	26.7329
Brown-crowned Tchagra	*Tchagra australis*	-28.1280	26.7226
Cape Longclaw	*Macronyx capensis*	-28.1364	26.7270
Cape Penduline Tit	*Anthoscopus minutus*	-28.1291	26.7236
Cape Robin-Chat	*Cossypha caffra*	-28.1850	26.7316
Cape Sparrow	*Passer melanurus*	-28.1270	26.7227
Cape Starling	*Lamprotornis nitens*	-28.1810	26.7284
Cape Wagtail	*Motacilla capensis*	-28.1904	26.7252
Chestnut-vented Warbler	*Sylvia subcoerulea*	-28.1280	26.7226
Common Moorhen	*Gallinula chloropus*	-28.1842	26.7298
Common Myna	*Acridotheres tristis*	-28.1904	26.7252
Crowned Lapwing	*Vanellus coronatus*	-28.1383	26.7290
Desert Cisticola	*Cisticola aridulus*	-28.1302	26.7227

Common Name	Scientific Name	Latitude	Longitude
Egyptian Goose	*Alopochen aegyptiaca*	-28.1900	26.7254
Fairy Flycatcher	*Stenostira scita*	-28.1850	26.7316
Fiscal Flycatcher	*Melaenornis silens*	-28.1899	26.7254
Gabar Goshawk	*Micronisus gabar*	-28.1391	26.7282
Giant Kingfisher	*Megaceryle maxima*	-28.1180	26.7189
Goliath Heron	*Ardea goliath*	-28.1903	26.7253
Greater Flamingo	*Phoenicopterus roseus*	-28.1553	26.7343
Hadada Ibis	*Bostrychia hagedash*	-28.1546	26.7339
Helmeted Guineafowl	*Numida meleagris*	-28.1279	26.7229
House Sparrow	*Passer domesticus*	-28.1904	26.7252
Kalahari Scrub Robin	*Cercotrichas paena*	-28.1279	26.7229
Karoo Scrub Robin	*Cercotrichas coryphoeus*	-28.1857	26.7300
Laughing Dove	*Spilopelia senegalensis*	-28.1283	26.7225
Lesser Flamingo	*Phoeniconaias minor*	-28.1553	26.7343
Lesser Swamp Warbler	*Acrocephalus gracilirostris*	-28.1834	26.7322
Levaillant's Cisticola	*Cisticola tinniens*	-28.1557	26.7357
Little Egret	*Egretta garzetta*	-28.1903	26.7253
Long-tailed Widowbird	*Euplectes progne*	-28.1646	26.7324
Dusky Sunbird	*Cinnyris fuscus*	-28.1279	26.7229
Marsh Owl	*Asio capensis*	-28.1391	26.7282
Namaqua Dove	*Oena capensis*	-28.1306	26.7259
Neddicky	*Cisticola fulvicapilla*	-28.1275	26.7229
Northern Black Korhaan	*Afrotis afraoides*	-28.1279	26.7229
Orange River White-eye	*Zosterops pallidus*	-28.1280	26.7226
Orange-breasted Waxbill	*Amandava subflava*	-28.1553	26.7343

Common Name	Scientific Name	Latitude	Longitude
Pied Starling	*Lamprotornis bicolor*	-28.1831	26.7300
Pririt Batis	*Batis pririt*	-28.1857	26.7300
Red-billed Quelea	*Quelea quelea*	-28.1763	26.7296
Red-billed Teal	*Anas erythrorhyncha*	-28.1809	26.7296
Red-capped Lark	*Calandrella cinerea*	-28.1373	26.7278
Red-eyed Dove	*Streptopelia semitorquata*	-28.1882	26.7284
Red-knobbed Coot	*Fulica cristata*	-28.1842	26.7298
Red-throated Wryneck	*Jynx ruficollis*	-28.1548	26.7338
Ring-necked Dove	*Streptopelia capicola*	-28.1279	26.7229
Rock Dove	*Columba livia*	-28.1896	26.7256
Sabota Lark	*Calendulauda sabota*	-28.1290	26.7233
Scaly-feathered Weaver	*Sporopipes squamifrons*	-28.1838	26.7302
South African Shelduck	*Tadorna cana*	-28.1726	26.7306
Southern Fiscal	*Lanius collaris*	-28.1279	26.7229
Southern Masked Weaver	*Ploceus velatus*	-28.1283	26.7225
Southern Red Bishop	*Euplectes orix*	-28.1364	26.7270
Speckled Mousebird	*Colius striatus*	-28.1373	26.7278
Speckled Pigeon	*Columba guinea*	-28.1900	26.7253
Spotted Thick-knee	*Burhinus capensis*	-28.1673	26.7329
Spur-winged Goose	*Plectropterus gambensis*	-28.1899	26.7254
Swainson's Spurfowl	*Pternistis swainsonii*	-28.1573	26.7334
Three-banded Plover	*Charadrius tricollaris*	-28.1838	26.7303
Wattled Starling	*Creatophora cinerea*	-28.1824	26.7280
White-backed Mousebird	*Colius colius*	-28.1391	26.7282
White-backed Vulture	*Gyps africanus*	-28.1316	26.7247

Common Name	Scientific Name	Latitude	Longitude
White-browed Sparrow-Weaver	*Plocepasser mahali*	-28.1283	26.7225
White-fronted Bee-eater	*Merops bullockoides*	-28.1181	26.7190
White-winged Widowbird	*Euplectes albonotatus*	-28.1662	26.7322
Yellow Canary	*Crithagra flaviventris*	-28.1364	26.7270
Yellow-billed Duck	*Anas undulata*	-28.1842	26.7298
Yellow-crowned Bishop	*Euplectes afer*	-28.1878	26.7293

Appendix 3: CV of specialist.

LUKAS JURIE NIEMAND
Company: Pachnoda Consulting cc (Director)
Date of Birth: 1974-03-12
Nationality: South African
Languages: English and Afrikaans

EDUCATIONAL QUALIFICATIONS

1992	Hoërskool Hartbeespoort, Hartbeespoort - Senior Certificate.
1996	University of Pretoria, Pretoria - B.Sc. (Zoology and Entomology).
1997	University of Pretoria, Pretoria - B.Sc. (Hons) (Entomology).
2001	University of Pretoria, Pretoria - M.Sc. (Restoration Ecology/Zoology).

MEMBERSHIP IN PROFESSIONAL SOCIETY

- Professional Natural Scientist (Pr. Sci. Nat.) (Reg. no. 400095/06)
- BirdLife South Africa
- Hartbeespoort Natural Heritage Society

EXPERIENCE
A. Work conducted in South Africa

1. General Ecological Assessments (Fauna, Flora and Red Data Scans, including both functional and compositional aspects):

- Belvedere Trust, Proposed retirement village on Amorosa Agricultural Holdings, Roodepoort, Gauteng (2004);
- City of Joburg Property Development Company, Proposed upgrade and development of the Orlando Dam Intersection, Soweto, Gauteng (2004);
- PDNA, Proposed NASREC development, Johannesburg, Gauteng (2004);
- 17 Shaft Conference and Education Centre, Proposed establishment of the Veteran's Heritage Education Centre, Crown Mines, Gauteng (2004);
- GAUTRANS, Proposed re-alignment of Road D781 and construction of a road bridge over the Rietvleispruit, Kempton Park, Gauteng (2004);
- Mr. N. Lang, Ecological Opinion on the proposed establishment of a township, Muldersdrift, Gauteng (2004);
- AGES, Proposed Equestrian Centre, Leeufontein 299 IR, Gauteng (2004);
- PDNA, Proposed new bridge and re-alignment of a portion of provincial road P101-2 (R51), Laversburg, Gauteng (2004);
- Blenneerville Investment (Pty) Ltd, Proposed construction of a residential and commercial development on of Paradiso Estate, Tweefontein 372 JR, Gauteng (2004);

- Les Roches (Pty) Ltd, Proposed zoning of holdings 1, 2 & 3 of Hyde Park Agricultural Holdings, Gauteng (2004);
- Transnet Limited, Terrestrial Faunal Ecological Opinion: Phase 1B expansion of the Sishen-Saldanha Iron ore export corridor, Saldanha Bay, Western Cape (2005);
- Celebration North Riding (Pty) Ltd, Proposed mixed land-use development, North Riding, Gauteng (2005);
- Wilderness Safaris, Proposed upgrade of the Manzengwenya Dive Camp, Greater St. Lucia Wetlands Park, KwaZulu-Natal (2005);
- Wilderness Safaris, Proposed upgrade of the Rocktail Bay Camp, Greater St. Lucia Wetlands Park, KwaZulu-Natal (2005);
- GAEA Projects, Corridor Assessment for the proposed Sibaya Precinct, KwaZulu-Natal (2005);
- Computer Domain Holdings (Pty) Ltd, Red Data Floral Scan on portion 3 of the farm Elandshoek, portions 12 & 27 of the farm Groot Suikerboschkop, and portions 5 & 10 of the farm Palmietfontein, Dullstroom (2005);
- Zong's Property Investments, Proposed establishment of a residential development on a portion of Pomona Estates Agricultural Holdings, Pomona, Gauteng (2005);
- GJ van Zyl Trust, Proposed development of a resort on the Farm Witpoort 216 JS, Mpumalanga (2005);
- Mr. Howard Walker, Proposed subdivision of the Farm Lunsklip 105 JT, and the Farm Morgenzon 122 JT, for the establishment of a private resort, Dullstroom, Mpumalanga (2005);
- Lavender Manor cc, Proposed establishment of a retail, commercial and Lavender Manor Township on part of farm Rietfontein 189 IQ, Muldersdrift, Gauteng (2005);
- Geo Pollution Technologies, Proposed establishment of a residential development: Noordwyk Ext 65 & 80 on Erand Agricultural Holdings, Midrand, Gauteng (2005);
- Mr. A. Le Roux, Proposed Cradle View Country Estate, Muldersdrift, Gauteng (2006);
- Viking Bay Development Company (Pty) Ltd, Proposed Viking Bay freshwater marina and hotel development, Vaal Dam, Gauteng (2006);
- Land for Africa (Pty) Ltd, Ecological Opinion for the proposed establishment of a residential township on holding 122 Erand Agricultural Holding Extension 1, Halfway House, Midrand, Gauteng (2006);
- Brickot Developments cc, Ecological opinion for the proposed Bethal Retirement Village on the remainder of portion 3 of the farm Mooifontein 108 IS, Bethal, Mpumalanga (2006);
- Brawild (Pty) Ltd, Red Data Scan for the proposed Annlin Ex 117, Pretoria, Gauteng (2006);
- Mbombela Local Municipality, Ecological Opinion for the proposed extension of the Lowveld Botanical Gardens, Nelspruit, Mpumalanga (2006);
- Natural Scientific Services cc, Botanical survey for the SASOL Mafutha coal project near Lephalale, Limpopo Province, RSA (2008);
- SRK Consulting, Ecological assessment on Vlakfontein area, NW of Ogies, Mpumalanga. Report compiled in association with EkoInfo (2009); and
- Aurecon, Desktop biodiversity assessment and wetland scan: upgrade of the River View waste water treatment works, eMalahleni, Mpumalanga province. Report compiled in association with Imperata Consulting (2009).

- **2. Mining and Industrial related projects (ecological)**:
- Lonmin Platinum (Western Platinum Limited), Ecological Assessment for the proposed MK3 Shaft Complex on the farm Wonderkop 400 JQ, Rustenburg, North West Province (2004);
- Impala Platinum Limited, Ecological Assessment for prospecting SEMPs on the farms Buffelshoek 386 KT, Kalkfontein 367 KT, Spitskop 333 KT, Steelpoortpark 366 Kt and Tweefontein 360 KT and Hackney 116 KT (all Sekhukhuneland), Mpumalanga and Limpopo Province (2004);
- Trans-Caledon Tunnel Authority (TCTA), Ecological Assessment for borrow pit SEMPs on the TCTA pipeline, Vaal Marina to Secunda (2005);
- Boynton Platinum (Pty) Ltd, Ecological Assessment for the proposed establishment of platinum mines on the farms Tuschenkomst 135 JP, Witkleifontein 136 JP and Ruighoek 169 JP, North West Province (2005);
- Impala Platinum Holdings, Ecological Assessment for prospecting SEMPs on the Impala Platinum Bafokeng Mining Complex, North West Province (2005);
- Ceramic Industries Limited, Ecological Assessment of the Rietspruit Clay Quarries, Vanderbijlpark, Gauteng (2005);
- Ekurhuleni Metropolitan Municipality, Ecological Assessment Report for the proposed GLB Landfill Site on the farm Zesfontein 27 IR, Benoni, Gauteng (peer reviewed, 2006);
- Ceramic Industries Limited, Ecological Assessment of the Leeukuil Clay Quarries, Vanderbijlpark, Gauteng (2006);
- Council for Geoscience, Habitat sensitivity assessment scoping report for Bon Accord quarry on a portion of the farm de Onderstepoort 300-JR, Tshwane, Gauteng (2007);
- Fraser Alexander, Biodiversity action plan for Lonmin Limpopo & Platinum, North West & Limpopo Province, RSA (2008-2009);
- Envirolution Consulting (Pty) Ltd., Ecological screening report and site selection process for an Eskom general landfill and hazardous waste storage facility near Lephalale, Limpopo Province, RSA (2009);
- Envirolution Consulting (Pty) Ltd., Ecological assessment for the proposed construction of an Eskom general landfill and hazardous waste storage facility at the Matimba Power Station, Limpopo Province, RSA (2009);
- Shangoni/Vergenoeg Mining Company, Ecological assessment for the proposed construction of a slurry pipeline and waste rock dump at the Vergenoeg Mine, Gauteng (2011);
- ENVASS, An ecological evaluation (vertebrate & avifaunal component) for the proposed alternative energy plant on Portion 3, 4 & 5 of the Farm Groenwater 453, Northern cape (2012); and
- ENVASS, Ecological evaluation (vertebrate & avifaunal component) for the proposed alternative energy plant on !xun & khwe, Northern cape (2012).

3. Avifaunal and Invertebrate Assessments:

- Lavender Manor cc, Red Data Bird Assessment for the proposed establishment of a retail, commercial and Lavender Manor Township on part of the farm Rietfontein 189 IQ, Muldersdrift, Gauteng (2004);
- Helga Schneider & Associates, Avifaunal & Invertebrate Red Data Assessment for the proposed rezoning & subdivision on Erf 6486 Orange Farm Ext 2, Johannesburg, Gauteng (2005);

- TOWNDEV, Avifaunal and Arachnid Assessment for the proposed subdivision of Grootfontein 349 JR, Rievlei Dam, Gauteng (2006);
- Prof. Van Rensburg, Red Data Invertebrate Scan for the proposed Rietvalleirand Extension 59, Gauteng (2006);
- Group Five Property Development, Invertebrate Assessment for the proposed Buccleuch Ex 1, Gauteng (2006);
- Zong's Property Investments, Avifaunal and *Metisella meninx* assessment for the establishment of a residential development on a portion of Pomona Estates Agricultural Holdings, Pomona, Gauteng (2006);
- Waterval Islamic Institute, Avifaunal and Invertebrate Assessment for the proposed Northern Golf Course Development, Midrand, Gauteng (2006);
- Ekurhuleni Metropolitan Municipality, Avifaunal & Invertebrate Red Data Assessment for the proposed low-cost housing development on Olifantsfontein 410 JR, Gauteng (2006);
- City of Tshwane Metropolitan Municipality, Invertebrate Red Data Scan for the proposed flood remediation and river upgrade at Soshanguve, Gauteng (2006);
- AGES, Invertebrate assessment for the proposed mining activities on the farm Thorncliffe 374 KT, Xstrata Eastern Mines, Mpumalanga (2007)
- AGES, Mammal and invertebrate assessment for the proposed Kalplats project, Stella, North West Province (2007)
- Exigent Engineering Consultants, Invertebrate assessment for the proposed Derdepoort X 11, Derdepoort, Gauteng (2007);
- Exigent Engineering Consultants, Invertebrate and Avifaunal scan for the proposed Cutty Sark hotel extension, Scottburgh, Kwazulu-Natal (2007);
- Strategic Environmental Focus, African Grass Owl assessment on the proposed Cradle View country estate on portion 60 of the farm Driefontein 179 IQ, Muldersdrift, Gauteng (2007);
- GEOLAB, Ecological assessment for the West Rand Gold Operations (WERGO) Witfontein tailings disposal facility, Mintails, Gauteng, RSA (2008);
- Coastal Environmental Services, Avifaunal Assessment for the proposed mining of heavy minerals at Port Durnford (Exxaro KZN-Sands), KwaZulu-Natal (2008);
- SRK & Natural Scientific Services cc, A feasibility study for the mining of coal north of the Limpopo Province. Avifaunal & invertebrate assessment, Rio Tinto Exploration, Limpopo Province, RSA (2009);
- Eskom/Baagi Environmental, An environmental management plan (avifaunal & faunal component) for the proposed Dinaledi - Spitskop 400 kV transmission line, North West Province (2010);
- Eskom/Baagi Environmental, An avifaunal impact report for the proposed 400 kV Ariadne-Venus transmission line between Estcourt and Pietermaritzburg, KwaZulu-Natal (2010);
- Eskom/Baagi Environmental, An avifaunal impact assessment report for a 275 kV power line between the substations of Glockner and Kookfontein, Vanderbijlpark, Gauteng (2010);
- Groundwater Consulting Services (Pty) Ltd/EkoInfo, An invertebrate and avifaunal specialist report for the proposed expansion of Exxaro's Glisa coal mine, Belfast, Mpumalanga (2010);
- Eskom/Baagi Environmental, An environmental management plan (avifauna component) for the proposed 400 kV Medupi-Massa transmission lines, Limpopo Province (2011);
- Eskom/Baagi Environmental, An avifaunal and fauna impact assessment report for the proposed 400 kV Arnott-Gumeni transmission line, Mpumalanga Province (2012);

- Eskom/Baagi Environmental, An environmental management plan (avifaunal component) for the proposed 400 kV Ngwedi transmission line and substation, North West Province (2012);
- Exxaro/EkoInfo, An avifaunal and invertebrate assessment (as part of a Biodiversity Assessment and action plan) for the Gravelotte MagVanTi Mining Area, Limpopo Province (2012);
- Groundwater Consulting Services (Pty) Ltd/EkoInfo, An invertebrate and avifaunal specialist report for the proposed Paardeplaats coal mine area, Belfast, Mpumalanga (2012);
- Groundwater Consulting Services (Pty) Ltd/EkoInfo, An invertebrate and avifaunal specialist report for the proposed Leeuwpan coal mine area, Belfast, Mpumalanga (2013);
- Eskom/Baagi Environmental, An environmental management plan (avifaunal component) for the proposed Medupi - Borutho 400 kV transmission line, Limpopo Province (2012);
- Eskom/Baagi Environmental, An environmental management plan (avifaunal component) for the proposed Gromis - Oranjemund 400 kV transmission line, Northern Cape (2013);

- **4. Other Assessments**:
- Facilitation, project management and conduction of environmental scoping exercises, Environmental Impact Assessments, Environmental Management Plans, Feasibility Reports, for a range of projects and issues such as:
    - Housing Projects (West Rand Housing Projects) for the Gauteng Department of Housing;
    - Planning and facilitation of environmental awareness workshops (Winterveltd Workshops for the Department of Environmental Affairs and Tourism);
    - Compilation and evaluation of EIA reports and Environmental Management Plans (EMPs) for both the private and public sector (e.g. Scoping Report for the relocation of oxidation ponds for the Moqhaka Local Municipality and the installation of an underground additive tank for Sasol Oil (Pty) Ltd).
    - Urban Renewal Projects: Bekkersdal Urban Renewal Project and the Greater Evaton Urban Renewal Project for the Gauteng Department of Housing.
- Douglas Collieries (Inkwe Collieries), Biodiversity Assessment and database compilation of the Douglas Collieries (2005);
- Orion Group, Ecological Sensitivity Map for the proposed golf course and related facilities, Mont-Aux-Sources (2005);
- City of Joburg Property Development Company, Specialist *Lepidium mossii* assessment for the proposed upgrade and development of the Orlando Dam intersection, Soweto, Gauteng (2005);
- Johannesburg Roads Agency, Alien Eradication and Rehabilitation Programme for the proposed upgrade of 14th Avenue, Randburg, Gauteng (2006);
- City of Joburg Property Development Company, Ecological Management Plan for the Orlando Dam intersection, Soweto, Gauteng (2006);
- GJ van Zyl Trust, Alien Eradication Programme for the proposed development of a resort on the Farm Witpoort 216 JS, Mpumalanga (2006);
- GJ van Zyl Trust, Fire Management Plan for the proposed development of a resort on the Farm Witpoort 216 JS, Mpumalanga (2006); and
- Khutala Collieries (Inkwe Collieries), Biodiversity Assessment and database compilation (2006)

- **5. Linear Assessments**:

- Johannesburg Roads Agency, Ecological Assessment for the Proposed upgrade of 14th Avenue, Randburg, Gauteng (2004).
- Trans-Caledon Tunnel Authority (TCTA), Proposed Vaal River Eastern Subsytem Augmentation (VRESAP) pipeline from Vaal Marina to Secunda (2005);
- PBA International (in association with Bathusi EC), Ecological Scoping Report for the proposed Eskom Delta-Epsilon 765 kV Transmission lines (2007);
- Bohlweki Environmental (in association with Bathusi EC), Ecological Scoping Report for the proposed Eskom Malelane-Boulders 132 kV Distribution line (2007);
- Bohlweki Environmental (in association with Bathusi EC), Ecological Scoping Report for the proposed Eskom Marathon-Delta 132 kV Distribution line (2007);
- Strategic Environmental Focus, Avifaunal EIA Report for the proposed Eskom Hendrina-Prairie-Marathon 400 kV Transmission line, Mpumalanga (2007);
- Natural Scientific Services cc, Botanical survey for the proposed upgrade of the Transnet railway line between Hotazel, Northern Cape and the Port of Ngqura, Eastern Cape, RSA (2008);
- Envirolution Consulting (Pty) Ltd, Ecological Report for the proposed Eskom Apollo-Lepini 400kV transmission line (2009);
- Arcus Gibb, An ecological investigation for the Tumelo 132 kV distribution line and power line near Kagiso, Gauteng (2010);
- Ekoinfo/SANRAL, Faunal investigation for the upgrade of the N3 highway (2011); and
- Aurecon (Pty) Ltd, Baseline vegetation survey for the Mokolo – Crocodile River Augmentation Project (MCWAP) pipeline from Mokolo Dam to Thabazimbi (2011).

B. Work conducted in other African countries:

- Rural Maintenance, Invertebrate study for four mini-hydroelectric generation plants, Northern Malawi, Africa (2010);
- Impacto, An avifaunal study (Phase 1) for the proposed Mpanda Nkwua Dam in the Zambezi River, Mozambique, Tete Province (2010);
- Conseil Régional des Pays de la Loire, An avifaunal investigation of the Rusizi and Ruvubu National Parks (Burundi), and the feasibility of establishing an avi-tourism network with specific emphasis on the protection of important flyways used by Palearctic birds - of - prey (2010);
- Impacto, An avifaunal study (Phase 2) for the proposed Mpanda Nkwua Dam in the Zambezi River, Mozambique, Tete Province (2011);
- Rural Maintenance, Invertebrate scan for the expansion of coal mining activities at Kayelekera, Northern Malawi, Africa (2011);
- Rural Maintenance, Invertebrate study for a mini-hydroelectric plant at the Chisanga Falls, Nyika National Park, Malawi (2011);
- Impacto/ERM/Enviro-Insight, Avifaunal investigation for the proposed Ncondezi Coal Mine, Tete Province, Mozambique (2011);
- Enviro-Insight, Avifaunal investigation for the Riversdale Coal Mine complex, Tete Province, Monzambique (2011);
- Anadarko Petroleum/ERM/Enviro-Insight, Avifaunal investigation for the proposed Anadarko Mozambique Area 1 Liquefied Natural Gas plant in northern Mozambique, Cabo Delgado Province, Mozambique (2012);
- Coffey Environments/EkoInfo, Avifaunal investigation for the mining of iron ore by Baobab Resources, Tete Province, Mozambique (a scoping-level assessment); and

- SRK/Flora, Fauna and Man Ecological Services, An avifaunal and invertebrate assessment for the establishment of a potash mine at Konkoati, Republic of the Congo (2012);
- China Union/ERM/Enviro-Insight, Avifaunal investigation for the proposed mining of iron ore in Bong County, Liberia (2012);
- SRK/Flora, Fauna and Man Ecological Services, An invertebrate assessment for the mining of iron ore by DMC Congo Mining/Exxaro at Mayoko, Republic of the Congo (2012);
- Western Cluster/ERM/Enviro-Insight, Avifaunal investigation for the proposed mining of iron ore at Bomi Hills, ,Bomi County, Liberia (2013);
- SRK/Flora, Fauna and Man Ecological Services, An invertebrate assessment for the establishment of an ecological offset for the DMC Congo Mining/Exxaro Iron Ore Mine at Mayoko, Republic of the Congo (2013);
- Western Cluster/ERM/Enviro-Insight, Avifaunal investigation for the proposed mining of iron ore at Bea Mountain, Grand Cape Mount County, Liberia (2013);
- Western Cluster/ERM/Enviro-Insight, Avifaunal investigation for the proposed mining of iron ore at Mano River, Grand Cape Mount County, Liberia (2013); and
- WSP/Flora, Fauna and Man Ecological Services, An invertebrate assessment for the establishment of a phosphate mine, Hinda Phosphate Project, Republic of the Congo (current); and
- Aureus Mine/Enviro-Insight, An avifaunal investigation for the proposed mining of gold at the New Liberty Gold Mine, Liberia (current)

C. Additional Experience:

- Monitoring and evaluation of the rehabilitation programme for the mining company Richards Bay Minerals (RBM) with special reference to vegetation, bird, small mammal and millipede assemblages.
- Other responsibilities include assessment of the ecological standard operating procedures (SOP) according to RBM's environmental management programme in compliance with ISO 14001 environmental standards accreditation process.
- Participated in the annual relief programme on the S.A Agulhas voyage to Subantarctic Marion Island (Prins Edward group). Took part in the research to estimate the population dynamics and demography of the alien house mouse (*Mus musculus*) on the island (under supervision of the University of Pretoria).
- Participated in the preparation of a conservation management plan for a game and trout farm in conjunction with Mpumalanga Parks Board (in charge of the bird section) for the farm Nu-Scotland Bavaria.
- Lead a successful professional bird tour (party of 12) to the Eastern Zimbabwean highlands and adjacent Mashonaland Plato (10 days).
- Lead a successful professional bird tour (party of 9) to the Cape Peninsula, Karoo and West Coast (10 days).
- Lead a successful professional bird tour (party of 12) to the Swaziland and Northern Zululand (10 days).
- Lead a successful professional bird tour (party of 15) to the Namibia (10 days).
- Lead a successful professional bird tour (party of 14) to the Eastern Drakensberg and Lesotho (10 days).

Employment History:

March 2007 – Current: of Director of Pachnoda Consulting cc

2004- January 2007: Strategic Environmental Focus (Pty) - Terrestrial Ecologist

2003 – 2004: Enviro-Afrik (Pty) Ltd– Environmental Consultant

2001 – 2003: University of Pretoria - Research Assistant

PUBLICATIONS:

- McEWAN, K.L., ALEXANDER, G.J., NIEMAND, L.J. & BREDIN, I.P. 2007. The effect of land transformation on diversity and abundance of reptiles. Paper presented at the 50th Anniversary Conference of the Zoological Society of Southern Africa.

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PRESENTATIONS:

- Co-presenter at the Wetland Training Course (30 July – 3 August 2007) entitled: “Wetland-associated fauna”. University of Pretoria, Pretoria.
- Co-presenter and lecturer of the pre-conference training course (entitled "Can rehabilitation contribute towards biodiversity?") at the 3rd Annual LaRSSA (Land Rehabilitation Society of Southern Africa) Conference (8-11 September 2015), Glenburn Lodge, Muldersdrift, Gauteng.