DEVELOPMENT OF THE HARMONY JOEL SOLAR PV FACILITY NEAR THEUNISSEN, FREE STATE PROVINCE

Avifauna Scoping Report

July 2022

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EXECUTIVE SUMMARY

Pachnoda Consulting cc was requested by Savannah Environmental (Pty) Ltd on behalf of Freegold Harmony (Pty) Ltd to compile an avifauna scoping report for the proposed Harmony Joel Solar PV facility and associated infrastructure with a contracted capacity of up to 18MW located 20km north east of the town of Theunissen, Free State Province.

The objectives of this phase of the project were to obtain a basic overview of the variation and general status of the avifaunal habitat types and expected bird species likely to be affected by the proposed project.

Three avifaunal habitat types were identified on the study site and surroundings, ranging from open savannoid grassland with bush clump mosaics, the Doring river and associated tributaries transformed areas. A total of 158 bird species have been recorded within the study area, including four Red listed species (threatened and near threatened species).

The main potential impacts associated with the proposed PV solar facility are expected to be the following:

- The loss of habitat and subsequent displacement of bird species due to the ecological footprint required during construction.
- Direct interaction (collision trauma) by birds with the surface infrastructure (photovoltaic panels) caused by polarised light pollution and/or waterbirds colliding with the panels (as they are mistaken for waterbodies).
- Collision with associated infrastructure (mainly overhead powerlines and reticulation).

In addition, a total of 41 collision-prone bird species have been recorded from the study area (*sensu* atlas data), of which 28 species were waterbird and shorebird taxa and another seven species were birds of prey. However, the respective habitat types also provided habitat for at least 30 % of the regional near-endemic bird composition.

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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 Savannah Environmental (Pty) Ltd and Freegold Harmony (Pty) Ltd.;
- 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)
25 July 2022

Lukas Niemand is registered with The South African Council for Natural Scientific Professionals (400095/06) with more than 20 years of experience in ecological-related assessments and more than 15 years in the field of bird interactions with electrical and renewable energy infrastructure. He has conducted numerous ecological and avifaunal impact assessments including Eskom Transmission projects, hydro-electric schemes, solar farms and other activities in South Africa and other African countries.

1. INTRODUCTION

1.1 Project Description

Pachnoda Consulting cc was requested by Savannah Environmental (Pty) Ltd on behalf of Freegold Harmony (Pty) Ltd to compile an avifauna scoping report for the proposed Harmony Joel Solar PV facility and associated infrastructure with a contracted capacity of up to 18MW. The Harmony Joel Solar PV facility is based approximately 2.3km north of the Harmony Joel mining operations, and located 20km north east of the town of Theunissen within the Masilonyana Local Municipality, and within the Lejweleputswa District Municipality, Free State Province.

The solar facility will be located on a 36ha development area, which will include the PV arrays, associated infrastructure and grid connection infrastructure (Figure 2). The infrastructure associated PV facility includes:

- Solar PV arrays comprising of bifacial PV modules and mounting structures, using single axis tracking technology. Once installed, it will stand up to 5m above ground level.
- Inverters and transformers, a SCADA room, and maintenance room.
- Cabling between the project components.
- Balance of Plant:
    - Existing spare switchgear panels, upgraded switchgear circuit breakers or additional switchgear panels.
    - EK self-build works as defined in the CEL.
- On-site facility substation to facilitate the connection between the solar PV facilities and Eskom electricity grid. The Size and Capacity of the on-site stations will be up to 44MW.
- An onsite Medium voltage (MV) switching station forming part of the collector substation.
- Temporary laydown areas.
- Access roads, internal roads and fencing around the development area.
- Up to 132kV Overhead Power Lines (OHPL) with a maximum of 30m height with a 30m servitude width.
- Underground LV cabling will be used on the PV sites.

The PV facility will be located on the following farm portions:

Farm Name	Portion Number
Leeuwbult 580	0
Leeuwfontein 256	0

The facility will tie-in to Shafts 1&2 HJ Joel Mining (6.6/132 kV), The grid line will have a connection capacity of up to 132kV. The line connecting the PV facility to the respective substation will be up to 44kV.

To avoid areas of potential sensitivity and to ensure that potential detrimental environmental impacts are minimised as far as possible, the developer will identify a suitable development footprint within which the infrastructure of Harmony Joel Solar PV facility and its associated infrastructure is proposed to be located and fully assessed during the EIA Phase.

1.2 Terms of Reference

The main aim of this scoping exercise was to investigate the avifaunal attributes of the proposed PV facility by means of a desktop analysis of GIS based information and third-party datasets and included a brief site visit which constituted the austral winter season sampling survey.

The terms of reference for this scoping report are to:

- conduct an assessment on a screening level based on available information pertinent to the ecological and avifaunal attributes on the study site and immediate surroundings;
- conduct an assessment of all information on a screening level in order to present the following results:
    - typify the regional vegetation and avifaunal macro-habitat parameters that will be affected by the proposed project;
    - provide an indication on the occurrence of threatened, near-threatened, endemic and conservation important bird species likely to be affected by the proposed project;
    - provide an indication of sensitive areas or bird habitat types corresponding to the study site and immediate surroundings;
    - highlight areas of concern or "hotspot" areas;
    - identify potential impacts that are considered pertinent to the proposed development;
    - highlight gaps of information in terms of the avifaunal environment; and
    - recommend further studies to be conducted as part of the Environmental Impact Assessment (EIA) phase.

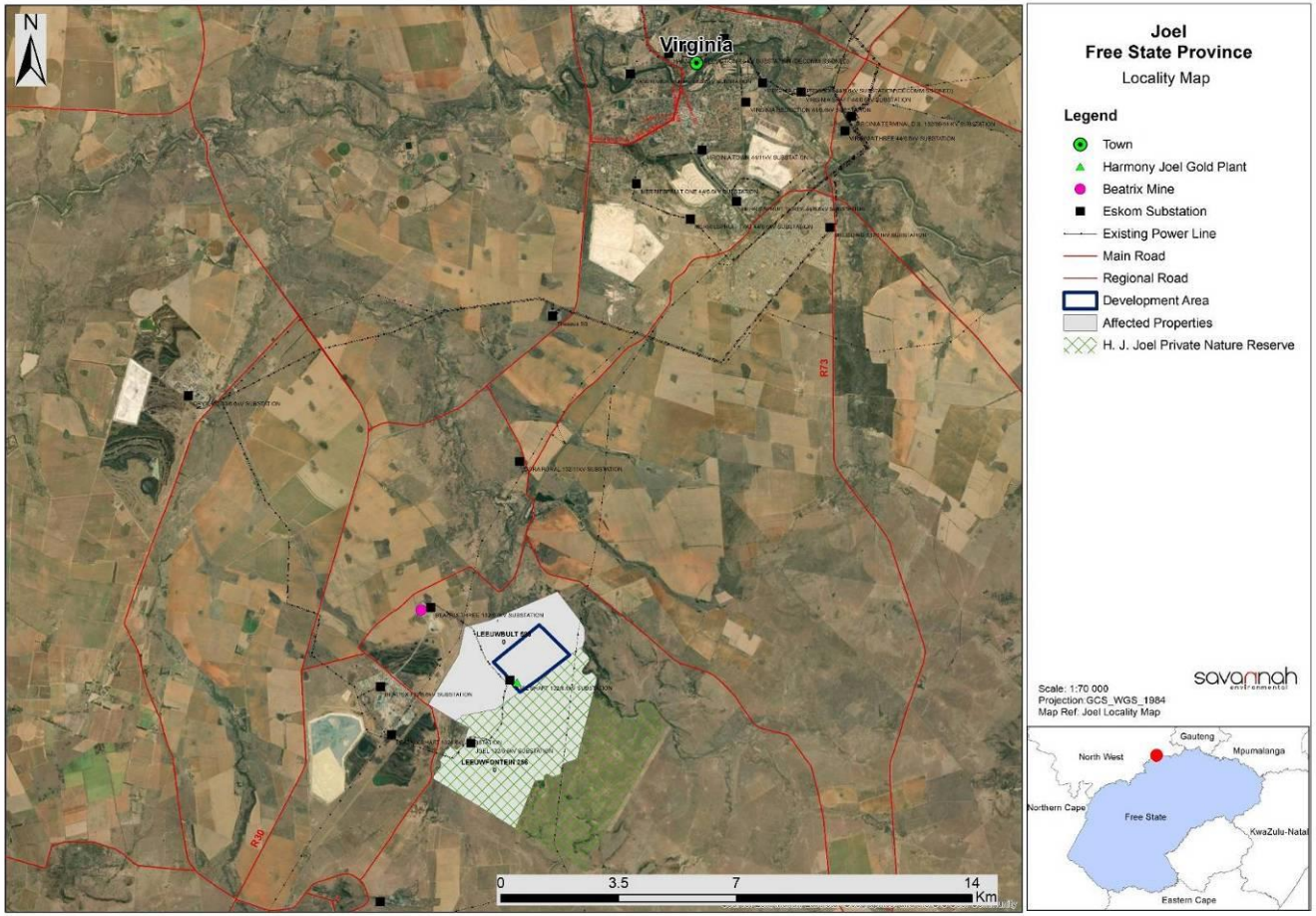

Figure 1: A map illustrating the geographic position of the proposed Harmony Joel Solar PV facility.

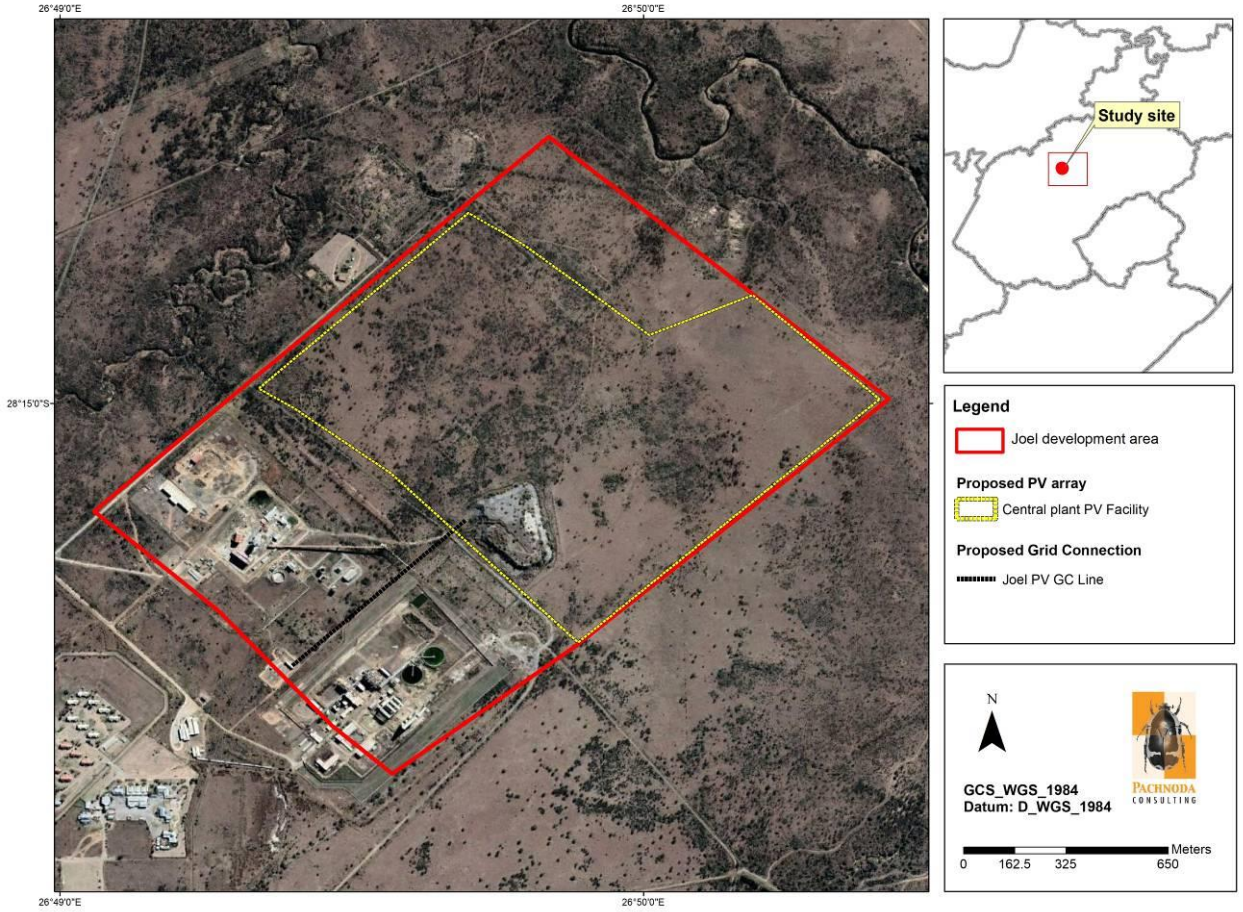

Figure 2: A satellite image illustrating the geographic position of the proposed Harmony Joel Solar PV facility.

2. METHODS & APPROACH

The objectives of this phase of the project were to obtain a basic overview of the variation and general status of the avifaunal habitat types and expected bird species likely to be affected by the proposed project.

Also take note that the current report put emphasis on the avifaunal community as a key indicator group on the proposed study site and immediate surroundings, thereby aiming to describe the preliminary conservation significance of the ecosystems in the area. Therefore, the occurrence of certain bird species and their relative abundances (to be determined during the EIA although herewith deduced from reporting rates) could determine the outcome of the ecological sensitivity of the area and the subsequent layout of the proposed solar facility infrastructure.

The information provided in this report was principally sourced from the following sources/observations:

- relevant literature – see section below;
- observations made during a site visit (06 - 09 June 2022); and
- personal observations from similar habitat types in close proximity to the study area, with emphasis on assessments conducted by Pachnoda Consulting (2020).

2.1 Literature survey and Database acquisition

A desktop and literature review of the area under investigation was commissioned to collate as much information as possible prior to the detailed baseline survey. Literature consulted primarily makes use of small-scale datasets that were collected by citizen scientists and are located at various governmental and academic institutions (e.g. Animal Demography Unit & SANBI). These include (although are not limited to) the following:

- Hockey *et al*. (2005) for general information on bird identification and life history attributes.
- Marnewick *et al.* (2015) was consulted for information regarding the biogeographic affinities of selected bird species that could be present on the study area.
- The conservation status of bird species was categorised according to the global IUCN Red List of threatened species (IUCN, 2022) and the regional conservation assessment of Taylor *et al.* (2015).
- Distributional data was sourced from the South African Bird Atlas Project (SABAP1) and verified against Harrison et al. (1997) for species corresponding to quarter-degree grid cells (QDGCs) 2826BB (Virginia) and 2826BD (Theronskop) (Figure 3). The information was then modified according to the prevalent habitat types present on the study area. 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 latitude x 15 min longitude). 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 therefore provides an indication of the thoroughness of which the QDGCs were surveyed between 1987 and 1991.

- Additional distributional data was also sourced from the SABAP2 database (http://www.sabap2.birdmap.africa). The information was then modified according to the prevalent habitat types present on the study area. Since bird distributions are dynamic (based on landscape changes such as 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 latitude x 5 min longitude, equating to 9 pentads within a QDGC). Therefore, the data is more site-specific, recent and more comparable with observations made during the site visit (due to increased standardisation of data collection). The pentad grids relevant to the current project are 2810_2645, 2810_2650, 2815_2645 and 2815_2650 (although the surrounding grids were also scrutinised to obtain information relevant to the potential occurrence of threatened and near threatened species; Figure 4).
- The choice of scientific nomenclature, taxonomy and common names were recommended by the International Ornithological Committee (the IOC World Bird List v. 12.1), unless otherwise specified (see www.worldbirdnames.org as specified by Gill et al, 2022). Colloquial (common) names were used according to Hockey *et. al.* (2005) to avoid confusion.
- The best practice guidelines for assessing and monitoring the impact of solar power generating facilities on birds in southern Africa were also consulted (Jenkins *et al.,* 2017).
- Additional information regarding bird-power line interactions was provided by the author's own personal observations.

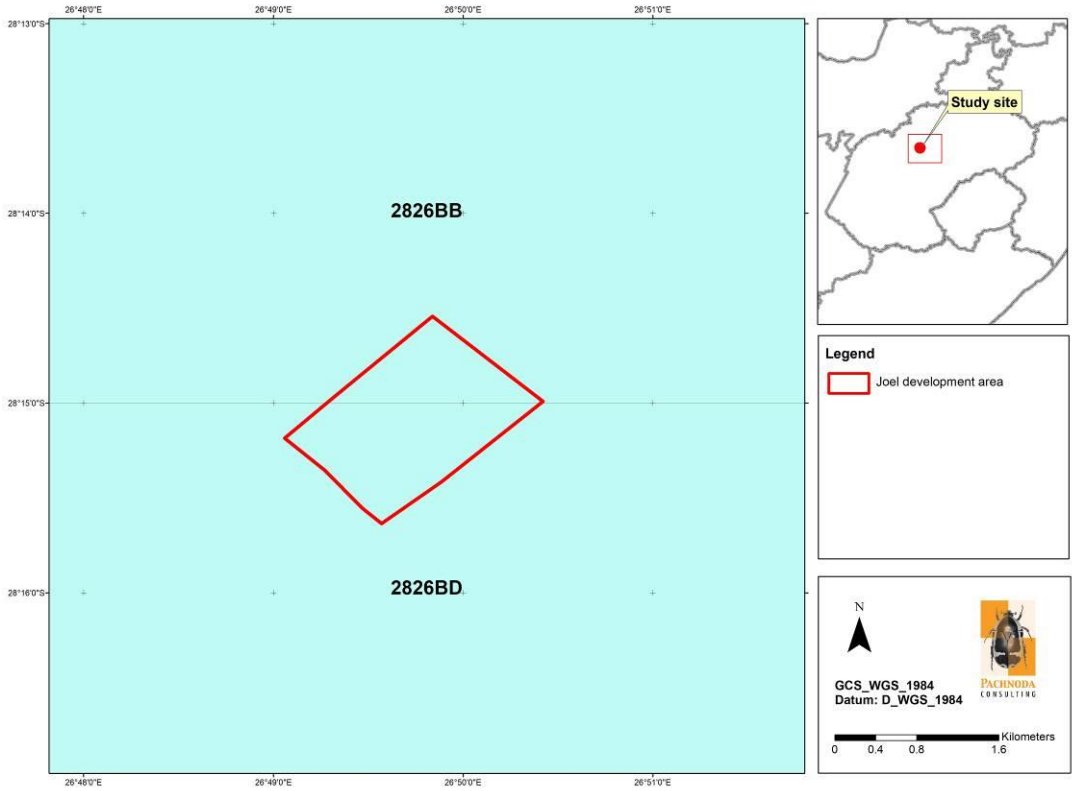

Figure 3: A map illustrating the quarter-degree grid cells that were investigated for this project.

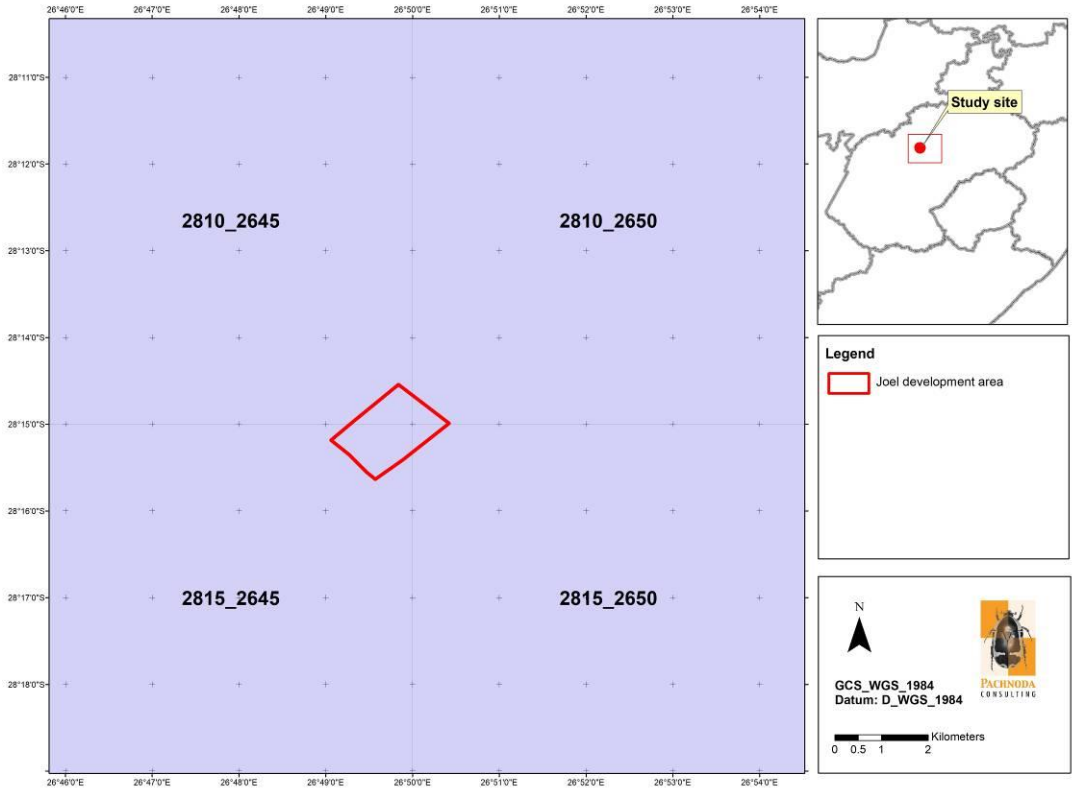

Figure 4: A map illustrating the pentad grids that were investigated for this project.

2.2 Preliminary Sensitivity Analysis

A preliminary sensitivity map was compiled based on the outcome of a desktop analysis.

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

2.3.1 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.

2.3.2 Avifaunal Importance

Avifaunal 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.

2.3.3 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 preferably 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).

2.3 Limitations

To obtain a comprehensive understanding of the diversity and dynamics of avifaunal community on the study area, as well as the status of endemic, rare or threatened species in the area, detailed assessments should always consider investigations at different time scales (across seasons/years) and through replication. However, due to the fact that the findings in this report were based on a scoping/screening assessment, long-term studies were not feasible and inferred interpretations were mostly based on ad hoc observations.

It should also be realised that bird distribution patterns fluctuate widely in response to environmental conditions (e.g. local rainfall patterns, nomadism, migration patterns, seasonality), meaning that a composition noted at a particular moment in time will differ during another time period at the same locality. For this reason two surveys will be conducted during the data collection.

Due to the scope of the work presented during a scoping assessment, a detailed investigation of the avifaunal community in the area were not possible and is not perceived as part of the Terms of Reference for a scoping/screening level exercise.

Furthermore, additional information may become known during a later stage of the process or development. This company, the consultants and/or specialist investigators do not accept any responsibility for conclusions, suggestions, limitations and recommendations made in good faith, based on the information presented to them, obtained from the surveys or requests made to them at the time of this report.

The following assumptions are relevant to the literature survey and database acquisition phase:

- It is assumed that third party information (obtained from government, academic/research institution, non-governmental organisations) is accurate and true;
- Some of the datasets are out of date and therefore extant distribution ranges may have shifted although these datasets could provide insight into historical distribution ranges of relevant species;
- The datasets are mainly small-scale and could not always consider azonal habitat types that may be present on the study area (e.g. small dams, pans and depressions). In addition, these datasets encompass surface areas larger than the study area that could include habitat types and species that is not present on the study area. 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;
- Some of the datasets (e.g. SABAP2) managed by the Animal Demography Unit of the University of Cape Town were only recently initiated and therefore incomplete; and
- In addition, the study site is under private ownership and primarily inaccessible to the public. Since most of the species distribution ranges concerning the relevant datasets are subject to observations made by the public, it is likely that many bird species are overlooked or not formally catalogued for the area.

3. PRELIMINARY RESULTS AND DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1 Locality

The proposed PV facility will be located near Harmony Joel mining operations located ~20km north east of the town of Theunissen, Free State Province (Figure 1).

3.2 Regional Vegetation Description

The proposed PV facility corresponds to the Grassland Biome and more particularly to the Dry Highveld Grassland Bioregion as defined by Mucina & Rutherford (2006). It comprehends an ecological type known as Central Free State Grassland (Mucina & Rutherford, 2006) (Figure 5).

From an avifaunal perspective it is evident that bird diversity is positively correlated with vegetation structure, and floristic richness is not often regarded to be a significant contributor of patterns in bird abundance and their spatial distributions. Although grasslands are generally poor in woody plant species, and subsequently support lower bird richness values, it is often considered as an important habitat for many terrestrial bird species such as larks, pipits, korhaans, cisticolas, widowbirds including large terrestrial birds such as Secretarybirds, cranes and storks. Many of these species are also endemic to South Africa and display particularly 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 also threatened or experiencing declining population sizes.

This vegetation type is confined the Free State Province and marginally also into Gauteng, where it is typical of the undulating plains from Sasolburg in the north to Dewetsdorp in the south. It is typified by short grassland dominated by *T. triandra*, while *Eragrostis curvula* and *E. chloromelas* tend to dominate areas where degradation is evident. Areas with high clay content are often earmarked by the occurrence of *Vachellia (=Acacia) karroo*.

The Central Free State Grassland is **Vulnerable** with small sections conserved in the Willem Pretorius and Koppies Dam Nature Reserves. It is transformed by cultivation and large sections are lost due to inundation during the construction of large reservoirs.

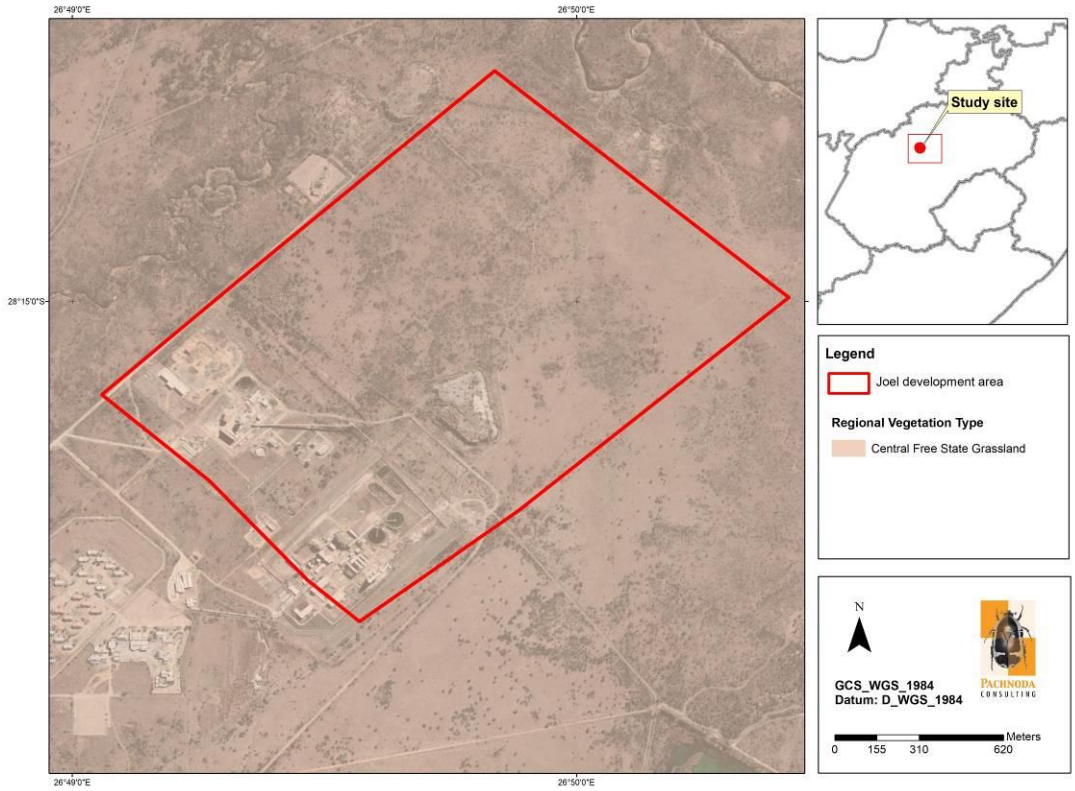

Figure 5: A satellite image illustrating the regional vegetation type corresponding to the study site and immediate surroundings. Vegetation type categories were defined by Mucina & Rutherford (2006; updated 2012).

3.3 Land cover, land use and existing infrastructure.

According to the South African National dataset of 2013-2014 (Geoterrainimage, 2015) the study site comprehends the following land cover categories (Figure 7):

Natural areas:

- Grassland;
- Low shrubland; and
- Open bush;

Transformed areas:

- Mines and quarries.

From the land cover dataset it is evident that most of the study site is predominantly covered in natural grassland which is part of the Central Free State Grassland vegetation type. However, mining activities and mine-related infrastructure occurs on the western and southern section of the study site. The majority of the study site (consisting of natural grassland) is primarily vacant and used for livestock grazing.

Note that the Doring rive and one of its tributaries are located north of the study site (within 200m from the study site boundary).

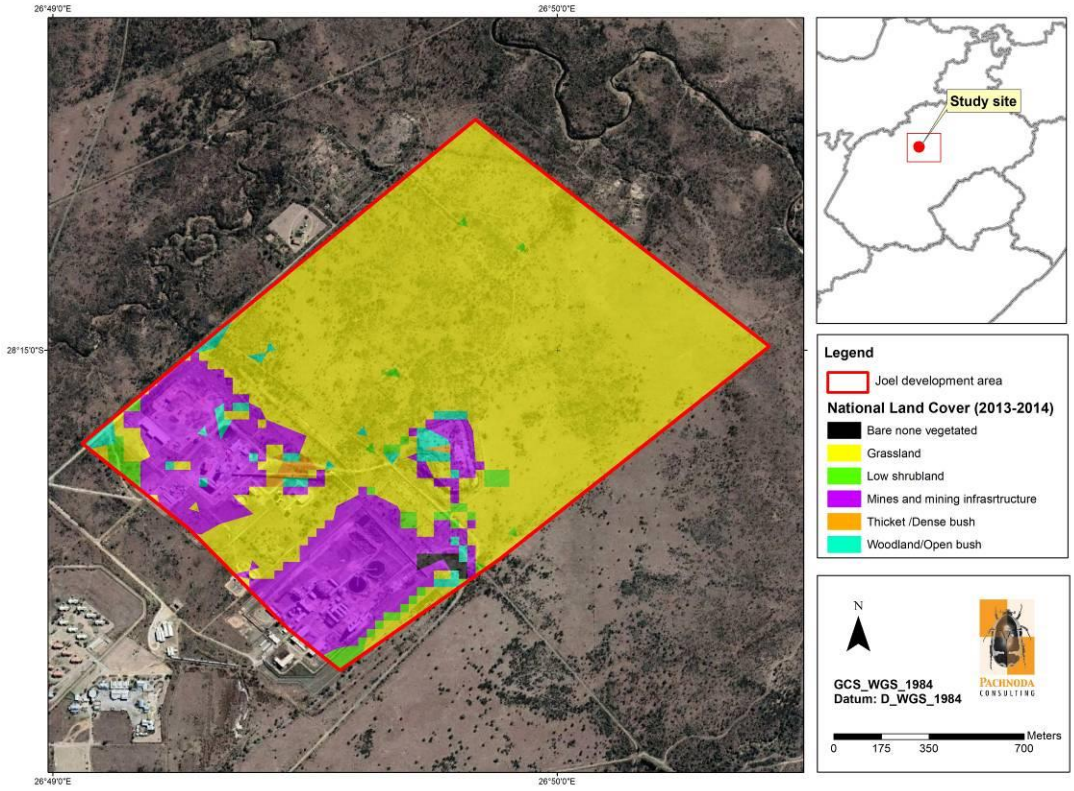

Figure 6: A map illustrating the land cover classes (Geoterrainimage, 2015) corresponding to the proposed study site.

3.4 Conservation Areas, Protected Areas and Important Bird Areas

The study site does not coincide with any statutory/formal conservation area or Important Bird and Biodiversity Area (IBA). The nearest formal conservation area to the proposed study site is the Willem Pretorius Game Reserve, which is located 28 km east of the study site. The Willem Pretorius Game Reserve is also a recognised IBA (SA044). However, the H.J. Joel Private Nature Reserve is located adjacent to the eastern boundary of the study site (see Figure 1).

3.5 Annotations on the National Web-Based Environmental Screening Tool

Regulation 16(1)(v) of the Environmental Impact Assessment Regulations, 20145 (EIA Regulations) provides that an applicant for Environmental Authorisation is required to submit a report generated by the Screening Tool as part of its application. On 5 July 2019, the Minister of Environmental Affairs, Forestry and Fisheries published a notice in the Government Gazette giving notice that the use of the Screening Tool is compulsory for all applicants to submit a report generated by the Screening Tool from 90 days of the date of publication of that notice.

The Screening Tool is intended to allow for pre-screening of sensitivities in the landscape to be assessed within the EA process. This assists with implementing the mitigation hierarchy by allowing developers to adjust their proposed development footprint to avoid sensitive areas. The Screening Tool report will indicate the (preliminary) environmental sensitivities that intersect with the proposed development footprint as defined by the applicant as well as the relevant Protocols.

As the Screening Tool contains datasets that are mapped at a national scale, there may be areas where the Screening Tool erroneously assigns, or misses, environmental sensitivities because of mapping resolution and a high paucity of available and accurate data. Broad-scale site investigations will provide for an augmented and site-specific evaluation of the accuracy and 'infilling' of obvious and large-scale inaccuracies. Information extracted from the National Web-based Environmental Screening Tool (Department of Environmental Affairs, 2020), indicated that the study site and immediate surroundings hold a **high** sensitivity with respect to the relative animal species protocol (Figure 7) (report generated 25/04/2022):

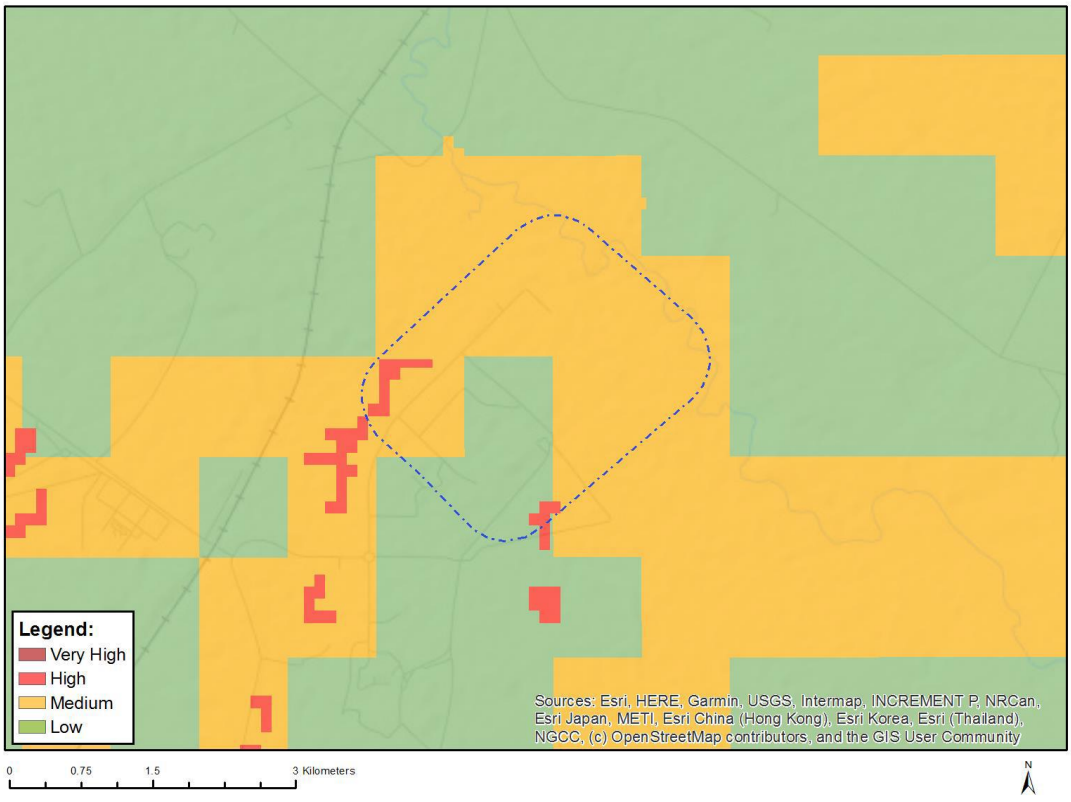

Figure 7: The animal species sensitivity of the study site and immediate surroundings according (500m buffer added to the site boundary) to the Screening Tool.

Sensitive features include the following:

Sensitivity	Feature(s)
High	Aves-*Circus ranivorus*
Low	Low sensitivity
Medium	Aves-*Circus ranivorus*
Medium	Mammalia-*Hydrictis maculicollis*

According to the results of the screening tool, a high probability of occurrence is evident for the endangered African Marsh Harrier (*Circus ranivorus*), which could potentially occur along a tributary of the Doring river. The probability for this species to occur along the Doring river systems, as well as the study site will be assessed during a detailed baseline (EIA) survey.

It is evident that the study site and immediate surroundings correspond to a **low** avian theme sensitivity (see Figure 8).

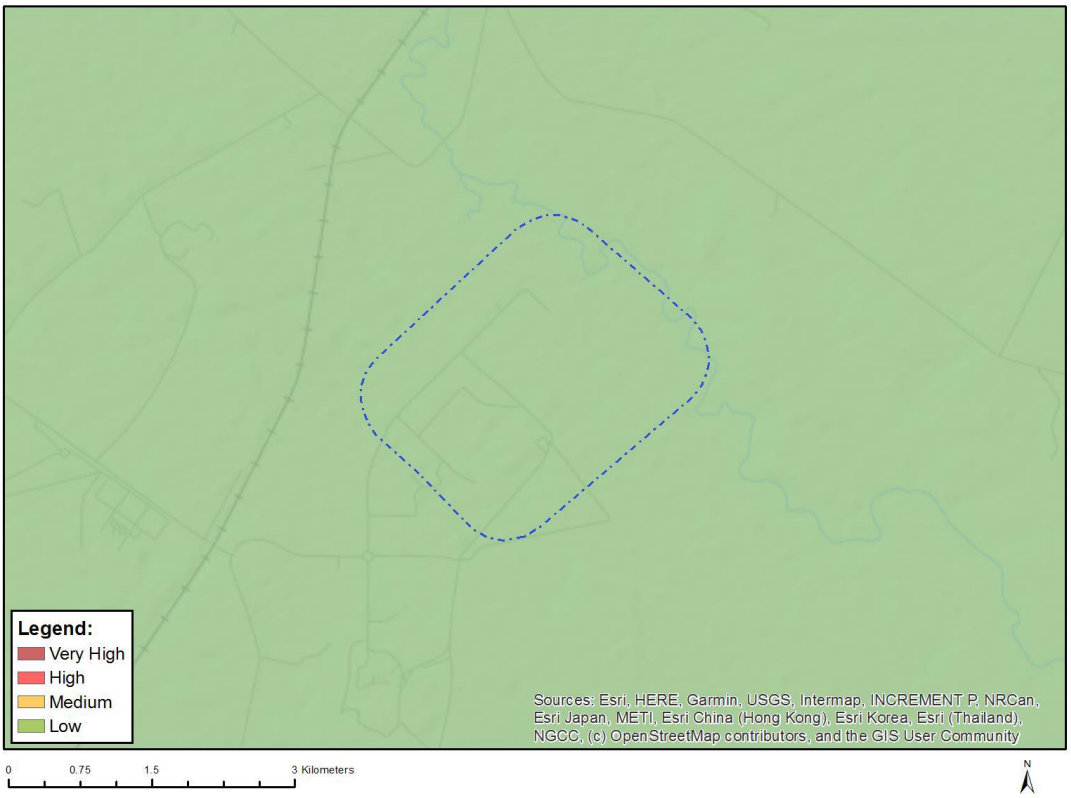

Figure 8: The relative avian sensitivity of the study site and immediate surroundings (500m buffer added to the site boundary) according to the Screening Tool.

Sensitive features include the following:

Sensitivity	Feature(s)
Low	Low sensitivity

However, the study site and immediate surroundings hold a **very high** sensitivity with respect to the relative terrestrial biodiversity theme (Figure 9):

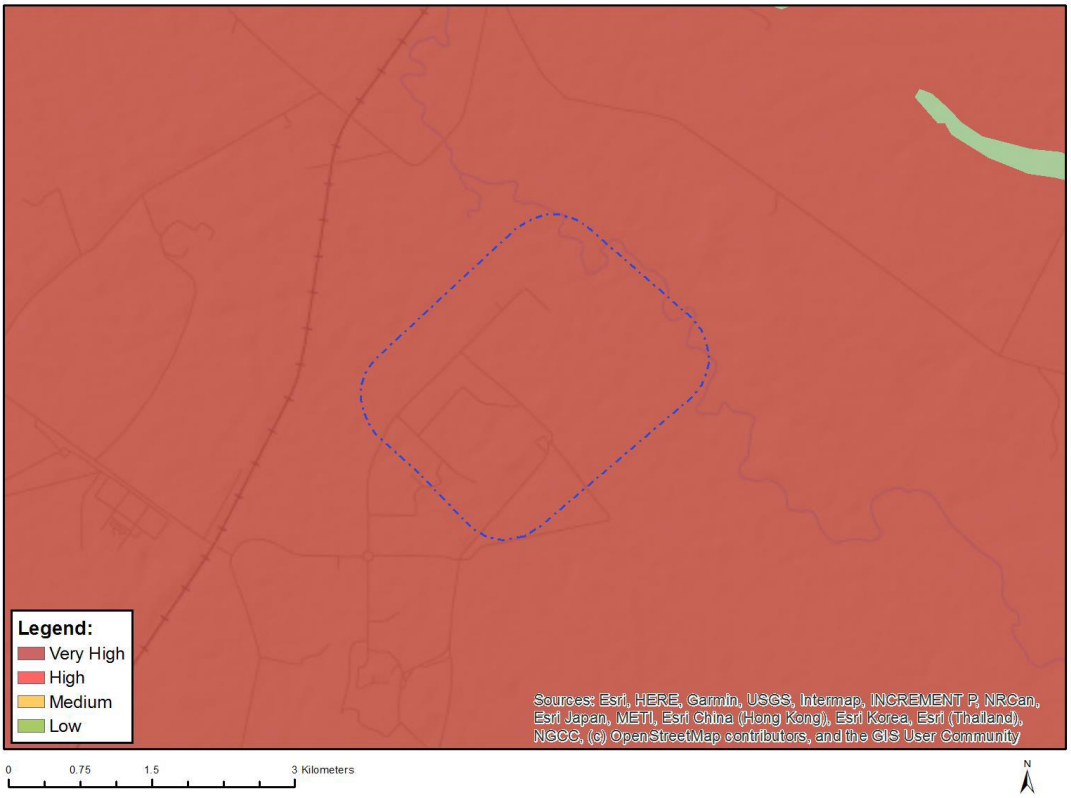

Figure 9: The relative terrestrial biodiversity sensitivity of the study site and immediate surroundings (500m buffer added to the site boundary) according to the Screening Tool.

Sensitive features include the following:

Sensitivity	Feature(s)
Very High	Critical Biodiversity Area 1
Very High	Critical Biodiversity Area 12
Very High	Ecological Support Area 1
Very High	Ecological Support Area 2
Very High	Protected Areas Expansion Strategy
Very High	H.J. Joel Private Nature Reserve

It is evident from the results of the Screening Tool report that part of the entire study area coincides with a Critical Biodiversity Area 1 and 2 (CBA 1 & 2) and an Ecological Support Are 1 and 2 (ESA 1 & 2) as per the Free State Biodiversity Plan (DESTEA, 2015). In addition, the study site is also located adjacent to the H. J. Joel Private Nature Reserve which is proposed to be included as part of the protected areas expansion strategy.

3.6 Preliminary avifaunal habitat types

Apart from the regional vegetation type, the local composition and distribution of the vegetation associations on the study area are a consequence of a combination of factors simulated by soil type, anthropogenic activities and grazing intensity

(presence of livestock) which have culminated in three major broad-scale habitat units that deserve further discussion (Figure 9 and Figure 10):

1. *Open savannoid grassland with bush clumps:* This unit is dominant on the study site and covers a significant extent in surface area of the proposed PV facility. It is represented by two discrete floristic variations which also provide habitat for two discrete avifaunal associations. The first floristic variation consists of open grazed Central Free State Grassland dominated by *Themeda triandra*. It is occupied by a grassland bird composition dominated by insectivorous and granivore passerine bird species such as Desert Cisticola, (*Cisticola aridulus*), Ant-eating Chat and Cape Longclaw (*Macronyx capensis*). The overall bird richness was low.

   The bush clumps form a prominent mosaic characterised by the dominance of a woody layer of *Vachellia karoo* on clay soils. The eminent increase in vertical heterogeneity provided by the woody layer is colonised by a "Bushveld" bird association consisting of insectivorous passerines such as Black-chested Prinia (*Prinia flavicans*), Chestnut-vented Warbler (*Curruca subcoerulea*), Kalahari Scrub Robin (*Cercotrichas paena*), Neddicky (*Cisticola fulvicapilla*), African Red-eyed Bulbul (*Pycnonotus nigricans*), Orange-river White-eye (*Zosterops pallidus*) as well as granivores such as Yellow Canary (*Crithagra flaviventris*), Blue Waxbill (*Uraeginthus angolensis*) and Black-faced Waxbill (*Brunhilda erythronotos*). Non-passerine bird taxa are represented by Ring-necked Dove (*Streptopelia capicola*), Acacia Pied Barbet (*Tricholaema leucomelas*) and White-backed Mousebird (*Colius colius*).

2. *Transformed areas*: These areas are represented by build-up land and mining infrastructure. These features are invariably artificial and present an urban and industrial landscape which is colonised by generalist bird taxa such as Speckled Pigeon (*Columba guinea*), House Sparrow (*Passer domesticus*) and Cape Sparrow (*Passer melanurus*).

3. *Doring river and associated tributaries*: The perennial Doring River and one of its tributaries occur north of the study site (approximately 200m from the study site boundaries). The system is characterised by a very narrow marginal and floodplain zone, and relatively deeply incised banks. Therefore, the marginal zone is often colonised by a variety of facultative wetland vegetation which include amongst others taxa such as *Imperata cylindrica, Pennisetum* spp., Miscanthus cf. junceus, while the riverbanks are covered on vegetation that is similar to the savannoid grassland habitat although the prevalence of woody vegetation is higher and dense (e.g. *Asparagus laricinus*). The marginal zone provides potential habitat for bird species such as the Levaillant's Cisticola (*Cisticola tinniens*) and African Stonechat (*Saxicola torquatus*), while the river it canal itself (open surface water) provides foraging habitat for waterfowl such as the Yellow-billed Duck (*Anas undulata*), South African Shelduck (*Tadorna cana*) and Egyptian Goose (*Alopochen aegyptiacus*).

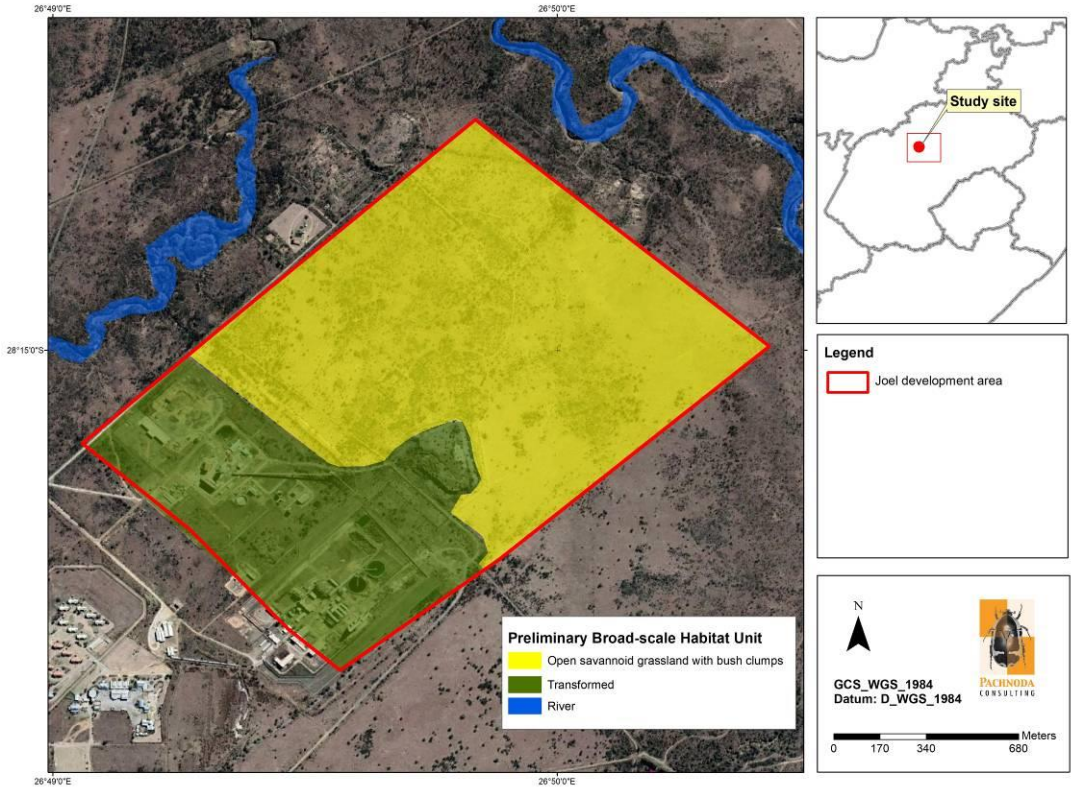

Figure 10: A preliminary habitat map illustrating the avifaunal habitat types on the study site and immediate surroundings (the habitat types are subject to change pending the outcome of a detailed baseline surveys).

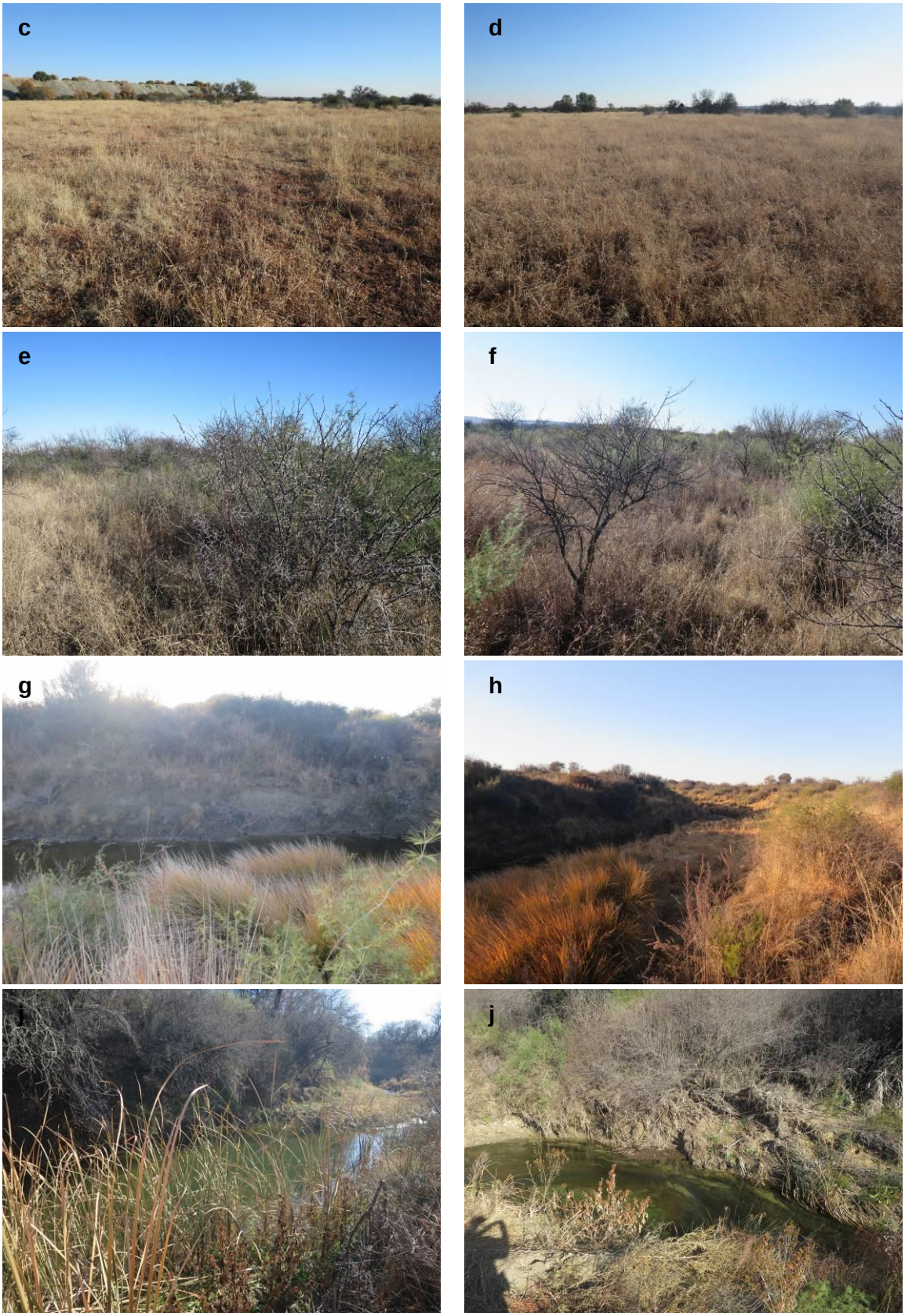

Figure 11: A collage of images illustrating examples of natural avifaunal habitat types observed on the study area: (a - f) Open savannoid grassland with bush clumps and (g - j) the nearby Doring river and associated tributaries.

3.7 Species Richness and Predicted summary statistics

Approximately ~158 bird species have been recorded within the study area refer to (Appendix 1 & Table 1), although it is more likely that between 90-100 bird species could occur within the physical boundaries of the study site (according to the habitat types and the ecological condition thereof). The richness was inferred from the South African Bird Atlas Project (SABAP2)[1] (Harrison et al., 1997; www.sabap2.birdmap.africa) and the presence of suitable habitat in the study area. This equates to 16 % of the approximate 987[2] species listed for the southern African subregion[3] (and approximately 18 % of the 871 species recorded within South Africa[4]). However, the species richness obtained from the pentad grids corresponding to the study area (c. 2810_2645, 2810_2650, 2815_2645 and 2815_2650) range between 73 and 132 species, with an average number of 46.5 species for each full protocol card submitted (for observation of two hours or more; range= 19-79 species).

According to Table 1, the study area is poorly represented by biome-restricted[5] (see Table 2) and local endemic and near-endemic bird species. It supports *ca*. 30 % of the near -endemic species present in the subregion.

Table 1: A summary table of the total number of species, Red listed species (according to Taylor et al., 2015 and the IUCN, 2022), endemics and biome-restricted species (Marnewick et al., 2015) expected (*sensu* SABAP2) to occur in the study site and immediate surroundings.

Description	Expected Richness Value
Total number of species*	158 (18 %)
Number of Red Listed species*	4 (3 %)
Number of biome-restricted species – Namib-Karoo and Kalahari-Highveld Biomes)*	2 (7 %)
Number of local endemics (BirdLife SA, 2022)*	2 (5 %)
Number of local near-endemics (BirdLife SA, 2022)*	5 (16 %)
Number of regional endemics (Hockey *et al.,* 2005)**	13 (12 %)
Number of regional near-endemics (Hockey *et al.,* 2005)**	18 (30 %)

* only species in the geographic boundaries of South Africa (including Lesotho and eSwatini) were considered.

** only species in the geographic boundaries of southern Africa (including Namibia, Botswana, Zimbabwe and Mozambique south of the Zambezi River) were considered

*** Percentage values in brackets refer to totals compared against the South African avifauna (*sensu* BirdLife SA, 2022).

[1] The expected richness statistic was derived from pentad 2810_2645, 2810_2650, 2815_2645 and 2815_2650 totalling 158 bird species (based on 21 full protocol cards).

2 *sensu* www.zestforbirds.co.za (Hardaker, 2020), including four recently confirmed bird species (vagrants.

3 A geographical area south of the Cunene and Zambezi Rivers (includes Namibia, Botswana, Zimbabwe, southern Mozambique, South Africa, eSwatini and Lesotho).

4 With reference to South Africa (including Lesotho and eSwatini (BirdLife South Africa, 2022).

[5] A species with a breeding distribution confined to one biome. Many biome-restricted species are also endemic to southern Africa.

Table 2: Expected biome-restricted species (Marnewick *et al*, 2015) likely to occur on the study site and immediate surroundings.

Species	Kalahari-Highveld	Namib-Karoo	Expected Frequency of occurrence
Kalahari Scrub-robin (*Cercotrichas paena)*	X		Common
Sickle-winged Chat (*Emarginata sinuata*)		X	Vagrant and highly nomadic (known from a single record during 22 April 2022; sensu SABAP2)

3.8 Bird species of conservation concern

Table 3 provides an overview of bird species of conservation concern that could occur on the study site and immediate surroundings based on their historical distribution ranges and the presence of suitable habitat. According to Table 3, a total of four species could occur on the study area which include two globally threatened species and two regionally threatened species.

It is evident from Table 3 that the occurrence of threatened species on the study site was low (sensu SABAP2). It is evident that suitable habitat for the occurrence of the globally endangered Maccoa Duck (Oxyura maccoa) and the regionally endangered African Marsh Harrier (Circus ranivorus) was absent, thereby suggesting that the probability that these species could occur within the physical boundaries of the study site is low.

In addition, the open grassland-bush clump mosaics provides ephemeral foraging habitat for the occurrence of the globally endangered Secretarybird (*Sagittarius serpentarius*) and the regionally vulnerable Lanner Falcon (*Falco biarmicus*). The former species was probably displaced from the study site due to livestock farming regimes and mining activities although suitable habitat was observed approximately 5 km south-east of the study site at the border between Farm Leeuwfontein 256 and Farm Schoemanskop 654. The latter species is regarded as an occasional foraging visitor to the study site.

Table 3: Bird species of conservation concern that could utilise the study site based on their historical distribution range and the presence of suitable habitat. Red list categories according to the IUCN (2022)* and Taylor et al. (2015)**.

Species	Global Conservation Status*	National Conservation Status**	SABAP2 reporting rate	Preferred Habitat	Potential Likelihood of Occurrence
Circus ranivorus (African Marsh Harrier)	-	Endangered	11.11 (ad hoc record)	Restricted to permanent wetlands with extensive reedbeds.	Probably absent from the study site and adjacent Doring river due to the absence of extensive floodplains and reedbeds (suitable habitat absent) Only known from a single old observation during 2008 (sensu SABAP2). in the study region.
Falco biarmicus (Lanner Falcon)	-	Vulnerable	Not observed/recorded	Varied, but prefers to breed in mountainous areas although also using old disused mine voids.	Could be an occasional foraging visitor to the study site..
Oxyura maccoa (Maccoa Duck)	Endangered	Vulnerable	11.11 (ad hoc record)	Large saline pans and shallow impoundments.	Probably absent on the physical study site due to the absence of suitable habitat. It was last recorded during 07 April 2008 on the wider study region (sensu SABAP2).

Species	Global Conservation Status*	National Conservation Status**	SABAP2 reporting rate	Preferred Habitat	Potential Likelihood of Occurrence
Sagittarius serpentarius (Secretarybird)	Endangered	Endangered	9.5	Prefers open grassland or lightly wooded habitat.	An irregular foraging visitor to the study site. Historically displaced due to agricultural and mining activities. It is known from two records obtained from grid 2815_2650, where optimal habitat was observed approx. 5km south-east of the study site at the border between Farm Leeuwfontein 256 and Farm Schoemanskop 654.

3.9 Preliminary avifaunal sensitivity

A preliminary sensitivity map was compiled, illustrating habitat units comprising of potential sensitive elements based on the following arguments (Figure 12):

Areas of high sensitivity

Areas of high sensitivity include the nearby Doring River and its tributaries and the proposed buffer zones (500m).

The Doring River system provides foraging habitat for a number of waterbird taxa (mainly waterfowl of the genera *Anas, Alopochen, Tadorna* and *Plectropterus*), of which these taxa may collide with the proposed PV panels and infrastructure when dispersing (especially when dispersing towards nearby impoundments, dams and inundated wetland features). More importantly, the linear configuration of the Doring River and its associated tributaries are important flyways for waterbird taxa in the region, and should preferably be buffered by at least 500m to avoid or minimise the risk of these bird interacting with the proposed PV infrastructure.

Areas of medium sensitivity

Areas of medium sensitivity represent habitat units of open savannoid grassland and bush clump mosaics. These habitat types provide ephemeral foraging habitat for certain threatened bird species (e.g. Secretarybird), as well as terrestrial bird species (e.g. Northern Black Korhaan) with the potential to interact (e.g. collide) with the proposed electrical infrastructure. However, reporting rates for threatened bird species was relatively low, thereby suggesting a medium sensitivity rating instead of a high sensitivity even though the majority of the habitat units is natural.

Areas of low sensitivity

Areas of low sensitivity include habitat units represented by transformed types and mining infrastructure, thereby contributing little towards local biodiversity.

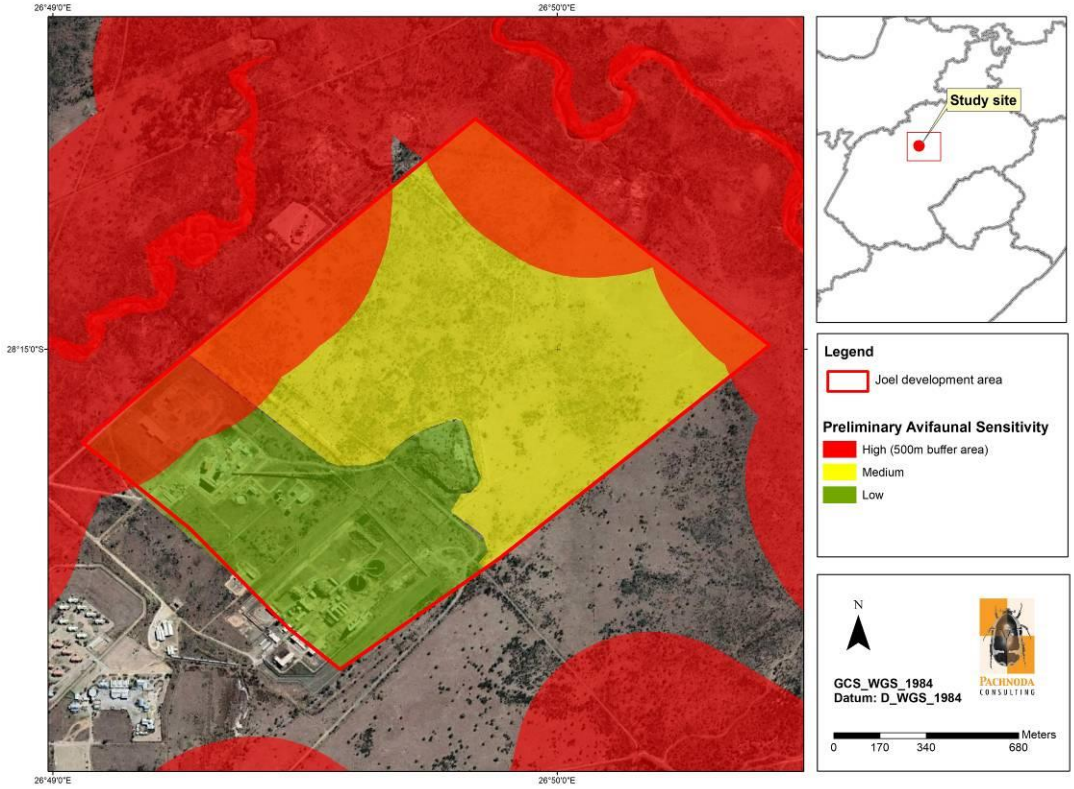

Figure 12: A map illustrating the preliminary avifaunal sensitivity of the area based on habitat types supporting bird taxa of conservation concern and important ecological function.

3.10 Overview of Avian Impacts at Solar Facilities

Table 4 provides a preliminary summary of the impacts anticipated and a preliminary quantification thereof.

3.10.1 Background to solar facilities and their impact on birds

Birds are mobile, and are therefore also more readily affected by solar facilities than other taxonomic groups (e.g. mobile mammals that could move away from the facilities due to displacement). In fact, birds are also vulnerable to impacts caused by other types of energy facilities such as overhead power lines and wind farms. Little information is available on the impacts of solar energy facilities on birds although Gunerhan *et al.* (2009), McCrary *et al.* (1986), Tsoutsos *et al.* (2005) and the recent investigation reports on bird fatalities in the USA by Kagen *et al*. (2014) and Walston *et al*. (2016) provide discussions thereof. These studies have shown that avian fatalities vary greatly between the geographic positions of the solar facilities and also depend on the type of solar facility. In addition, very few of the large solar facilities in operation undertake systematic monitoring of avian fatalities, which explains the lack of detailed information of avian impacts. According to these studies conducted at both Concentrated Solar Power (CSP) and PV facilities, avian incidental fatalities

range from 14 to over 180 birds which were summarised over a survey period conducted during one to three years. According to the Walston *et al.* (2016) assessment, the average annual mortality rate for known utility-scale solar facilities (the annual number of estimated bird deaths per megawatt of electrical capacity) is 2.7, and 9.9 for known and unknown fatalities (which include carcasses found on the project site of which the death is not known). McCrary *et al.* (1986) found an average rate of mortality of 1.9-2.2 birds per week affecting 0.6-0.7 % of the local bird population. However, most of the avian fatalities at these solar facilities are also probably underestimated since 10-30 % of dead birds are removed by scavengers before being noted.. From these analyses and assessments it was evident that:

- Medium levels of bird fatalities occur at PV sites when compared to CSP sites (when taking powerline collisions into account).
- Approximately 81 % of all avian mortalities were caused by collisions, including collisions with electrical distribution lines.
- Most of the mortalities were small passerines (especially swallows).
- Fatalities at these solar facilities also include waterbirds (e.g. grebes, herons and gulls) which were probably attracted by the apparent "lake effect" caused by the reflective surface of the PV panels.
- Approximately 10-11 % of the fatalities consists of waterbirds, but could be as high as 49 % at certain facilities.
- It is unclear if the "lake effect" caused by the panels (at PV facilities) or mirrors (at CSP facilities) are the main cause of birds colliding or interacting with the infrastructure (since both waterbirds and other passerines are colliding with the infrastructure).
- Most of the fatalities are of resident birds as opposed to migratory species.

In a review report by Harrison *et al.* (2016), an attempt was made to provide evidence of the impacts caused by solar PV facilities alone (not combined with CSP facilities) on birds in the UK. These authors reviewed approximately 420 scientific documents, including 37 so-called "grey" literature from non-government and government organisations for any evidence relating to the ecological impacts of solar PV facilities. Their main findings were as follows:

- The majority of the documents were not relevant and peer-reviewed documents of experimental scientific evidence on avian fatalities were non-existent.
- Results based on carcass searches suggest that the bird collision risk at PV developments are low, although these studies did not take collision by overhead power lines into account.
- Many of the documents recommended that PV developments in close proximity to protected areas should be avoided.
- The PV panels reflect polarised light, which can attract polarotactic insects with potential impact to their reproductive biology. In addition, the polarising

effect of the PV panels may also induce drinking behaviour in some birds, which may mistake the panels for water.

They conclude that impact assessment reports should consider taxon-specific requirements of birds and their guilds.

3.10.2 Potential impacts of PV solar facilities on birds

The magnitude and significance of impacts to birds caused by solar facilities will depend on the following factors:

- The geographic locality of the planned solar facility;
- The size or surface extent of the solar facility;
- The type of solar facility (according to the technologies applied, e.g. PV or Concentrated Solar Power (CSP)); and
- The occurrence of collision-prone bird species (which are often closely related to the locality of the solar facility).

Any planned solar facility corresponding to an area with many threatened, range-restricted or collision-prone species will have a higher impact on these birds. In addition, any planned solar facility located in close proximity to important flyways, wetland systems or roosting/nesting sites used by the aforementioned species will have a higher impact.

The main impacts associated with PV solar facilities include (Jenkins *et al*., 2017):

- The loss of habitat and subsequent displacement of bird species due to the ecological footprint required during construction;
- Disturbances caused to birds during construction and operation;
- Direct interaction (collision trauma) by birds with the surface infrastructure (photovoltaic panels) caused by polarised light pollution and/or waterbirds colliding with the panels (as they are mistaken for waterbodies);
- Collision with associated infrastructure (mainly overhead powerlines and reticulation);
- Attracting novel species to the area (owing to the artificial provision of new habitat such as perches and shade) which could compete with the residing bird population.

3.11 Potential Impacts associated with the proposed PV Solar Facility

3.11.1 Loss of habitat and displacement of birds

Approximately 36ha study site will cleared of vegetation and habitat to accommodate the panel arrays and associated infrastructure. Clearing of vegetation will inevitably result in the loss of habitat and displacement of bird species. From the preliminary results it is evident that smaller passerine species are likely more likely to become displaced as opposed to small passerine species. It is particularly endemic species

that are likely to become displaced, as well as habitat specialists (e.g. grassland specialists) which will disappear from the area.

To quantify the impact it is necessary to calculate the number of birds (density) lost or displaced by the activity, including estimated density values of important species per unit area of habitat. This will be conducted during a baseline survey of the proposed study area. From a preliminary analysis, the following bird species are most likely to be impacted by the loss of habitat due to their habitat requirements, fecundity and conservation status (although not limited to) due to the proposed development:

- Cloud Cisticola (*Cisticola textrix*);
- White-backed Mousebird (*Colius colius*);
- Kalahari Scrub Robin (*Cercotrichas paena*); and to a lesser extent also
- Northern Black Korhaan (*Afrotis afraoides*).

3.11.2 Collision trauma caused by photovoltaic panels (the "lake-effect")

The presence of the Doring river system, as well as a number of dams and impoundments in close proximity to the study site increase the risk of waterbirds and shorebird taxa interacting with the PV panels. A number of species were observed with a high frequency of occurrence which dispersed along the nearby Doring river system on a daily basis which could also potentially interact with the PV panels.

The fitment of bird deterrent devices such as a combination of rotating flashers/reflectors are proposed, including devices which emit light during nigh time to increase the visibility of the infrastructure for birds such as flamingos which tend to disperse during the night are highly recommended. Post construction monitoring to quantify mortalities will is also recommended, especially during to early operational phase in order to determine "hotspot" areas which may require additional mitigation measures.

Desktop results and site observations show that the following species could interact with the panel infrastructure:

- South African Shelduck (*Tadorna cana*);
- Egyptian Goose (*Alopochen aegyptiaca*);
- Spur-winged Goose (*Plectropterus gambiensis*);
- Hamerkop (*Scopus umbretta*);
- Yellow-billed Duck (*Anas undulata*);
- White-faced Duck (*Dendrocygna viduata*);
- Red-billed Teal (*Anas erythrorhynchus*);
- Cape Teal (*Anas capensis*);
- African Black Duck (*Anas sparsa*);
- Cape Shoveller (*Anas smithii*);
- Glossy Ibis (*Plegadis falcinellus*);

- Black-winged Stilt (*Himantopus himantopus*);
- Three-banded Plover (*Charadrius tricollaris*); and potentially also
- Greater Flamingo (*Phoenicopterus roseus*);
- Lesser Flamingo (*Phoeniconaias minor*);
- White-breasted Cormorant (*Phalacrocorax lucidus*)
- Reed Cormorant (*Microcarbo africanus*);
- African Sacred Ibis (*Threskiornis aethiopicus*) and potentially also
- Little Grebe (*Tachybaptus ruficollis*);
- Blue-winged Teal (*Spatula hottentota*);
- Black-headed Heron (*Ardea melanocephala*);
- Red-knobbed Coot (*Fulica cristata*);
- Grey Heron (*Ardea cinerea*);
- African Darter (*Anhinga rufa*);
- Common Moorhen (*Gallinula chloropus*)

3.11.3 Interaction with overhead powerlines and reticulation

A 132kV overhead powerline is proposed to tie-in to Shafts 1&2 HJ Joel Mining (6.6/132 kV) substation. The proposed overhead power line will traverse habitat of low avifaunal sensitivity (e.g. transformed habitat), whereby the anticipated impact will be reduced.

Birds are impacted in three ways by means of overhead powerlines (described below). 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 in general. 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 power line, 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* and *Torgos*) 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 attempt to roost and even breed on the tower structures if available nesting platforms are a scarce commodity in the area. Other types of electrocutions happen by means of so-called “bird-streamers”. This happens when a bird, especially when taking off, excretes and thereby causes a short-circuit through the fluidity excreta (Van Rooyen & Taylor, 1999).

Large transmission lines (from 220 kV to 765 kV) are seldom a risk of electrocution, although smaller distribution lines (88 – 132kV) pose a higher risk. However, for this project, the design of the pylon is an important consideration in preventing bird

electrocutions. **The proposed pylon design should incorporate the following design parameters**:

- The clearances between the live components should exceed the wingspan of any bird species;
- The height of the tower should allow for unrestricted movement of terrestrial birds between successive pylons;
- The live components should be "bundled" to increase the visibility for approaching birds;
- "Bird streamers" should be eliminated by discouraging birds from perching above the conductors.

It is therefore recommended that the pylon design incorporates "features as illustrated by Figure 13[6].

From Figure 13 it is clear that perching of birds is discouraged by the addition of diagonal crossbars or by doing away with the crossbars that holds the conductors in place. Bird "streamers" are also eliminated by fitting the poles with bird guards/spikes above the conductors. However, safe perching is facilitated by the fitment of a horizontal bar on top of the pole structure without the risk of electrocution (due to the perpendicular orientation of the bar relative to the conductors).

Figure 13: Two bird-friendly tower designs to be used for the current 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

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

species such as bustards, korhaans 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) 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 appropriate bird deterrent devices such as “bird diverters” and “flappers” to increase the visibility of the lines. For the current project it is proposed that the overhead powerlines (including existing lines) also consider the fitment of dynamic devices such as the "Viper live bird flapper" and nocturnal LED solar-charged bird diverters owing to the potential nocturnal flyovers by certain bird taxa (e.g. flamingo taxa) (see Figure 14).

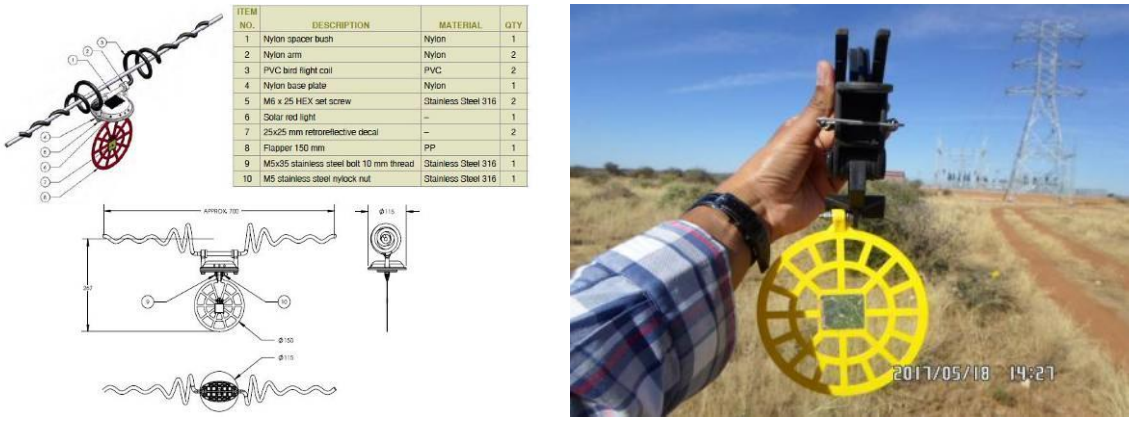

Figure 14: Examples of bird flight diverters to be used on the power lines: Nocturnal LED solar-charged bird diverter (left) and Viper live bird flapper (right).

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

It is anticipated that part of the powerline line servitude will be cleared of vegetation. In addition, construction activities go hand in hand with high ambient noise levels. Although construction is considered temporary, many species will vacate the area during the construction phase and will become temporarily displaced.

Table 4: A preliminary summery of impacts associated with the proposed PV facility and its infrastructure.

Issue 1	**Nature of Impact**	**Extent**	**No-Go Areas**
Impact: Losses of natural habitat and displacement of birds through physical transformation, modifications, removals and land clearance. This impact is mainly restricted to the construction phase and is permanent.			
Habitat destruction and disturbance and/or displacement of birds	Negative, especially for endemic species.	Local	N/a
Description of expected significance of impact: The impact will be of a long duration, (prior to mitigation). The impact is expected to have a low significance after proposed mitigation suggestions. It is recommended that development does not overspill into any of the proposed buffer areas.			
Gaps in knowledge and recommendations for further study: A baseline survey to determine relative bird densities and distribution ranges.			

Issue 2	**Nature of Impact**	**Extent**	**No-Go Areas**
Impact: Avian collision impacts related to the PV facility during the operational phase (collision with the PV panels).			
Potential collision of birds with the PV panel structures	Negative, especially for waterbirds and shorebird taxa.	Local and immediate surrounding area.	Potentially the northern part of the study area in close proximity to the Doring River and associated tributaries.
Description of expected significance of impact: The impact will be of a long duration (prior to mitigation) and is probable with a moderate significance. The placement of PV arrays and appropriate mitigation and monitoring protocols (to be assessed during the EIA phase) are recommended.			
Gaps in knowledge and recommendations for further study: A baseline survey to determine relative waterbird distribution ranges.			

Issue 3	**Nature of Impact**	**Extent**	**No-Go Areas**
Impact: Avian collision impacts related to the powerline reticulation and new distribution lines during operation.			
Potential collision due to electrical overhead distribution lines	Negative, especially for large-bodied species	Site.	N/a
Description of expected significance of impact: The impact will be of a long duration (prior to mitigation) and probable with a low significance, as per recommended mitigation measures (to be assessed during the EIA phase).			
Gaps in knowledge and recommendations for further study: A baseline survey is proposed to determine occurrence of collision prone bird species.			

3.12 Collision-prone bird species

A total of 41 collision-prone bird species have been recorded from the study area, of which 28 species are waterbird taxa and seven species are birds of prey (Table 5). According to Table 5, it is evident that species with reporting rates of 15% of more have a high probability to occur on the study site and immediate surroundings.

Table 5: Collision-prone bird species and Red listed species (in red) expected to be present on the study site and immediate surroundings inferred from the South African Atlas Project (SABAP2).

Common Name	Scientific Name	SABAP2 Reporting Rate			
		Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
African Black Duck	*Anas sparsa*	9.52	2	0.00	0
African Darter	*Anhinga rufa*	9.52	2	0.00	0
African Fish Eagle	*Haliaeetus vocifer*	4.76	1	0.00	0
African Marsh Harrier	*Circus ranivorus*	0.00	0	11.11	1
African Sacred Ibis	*Threskiornis aethiopicus*	9.52	2	0.00	0
Amur Falcon	*Falco amurensis*	4.76	1	0.00	0
Black-crowned Night Heron	*Nycticorax nycticorax*	9.52	2	0.00	0
Black-headed Heron	*Ardea melanocephala*	33.33	7	11.11	1
Black-necked Grebe	*Podiceps nigricollis*	4.76	1	11.11	1
Black-winged Kite	*Elanus caeruleus*	57.14	12	33.33	3
Black-winged Stilt	*Himantopus himantopus*	0.00	0	11.11	1
Blue-billed Teal	*Spatula hottentota*	0.00	0	11.11	1
Cape Shoveler	*Spatula smithii*	0.00	0	11.11	1
Common Moorhen	*Gallinula chloropus*	9.52	2	11.11	1
Egyptian Goose	*Alopochen aegyptiaca*	42.86	9	22.22	2
Glossy Ibis	*Plegadis falcinellus*	14.29	3	11.11	1
Hadada Ibis	*Bostrychia hagedash*	80.95	17	22.22	2
Hamerkop	*Scopus umbretta*	4.76	1	0.00	0
Helmeted Guineafowl	*Numida meleagris*	66.67	14	0.00	0
Intermediate Egret	*Ardea intermedia*	0.00	0	11.11	1
Little Grebe	*Tachybaptus ruficollis*	19.05	4	22.22	2
Maccoa Duck	*Oxyura maccoa*	0.00	0	11.11	1
Marsh Owl	*Asio capensis*	4.76	1	22.22	2
Natal Spurfowl	*Pternistis natalensis*	4.76	1	0.00	0
Northern Black Korhaan	*Afrotis afraoides*	47.62	10	22.22	2
Pale Chanting Goshawk	*Melierax canorus*	14.29	3	11.11	1
Pied Crow	*Corvus albus*	9.52	2	0.00	0
Purple Heron	*Ardea purpurea*	4.76	1	0.00	0
Red-billed Teal	*Anas erythrorhyncha*	19.05	4	11.11	1
Red-knobbed Coot	*Fulica cristata*	14.29	3	11.11	1
Reed Cormorant	*Microcarbo africanus*	47.62	10	11.11	1
Secretarybird	*Sagittarius serpentarius*	9.52	2	0.00	0

Common Name	Scientific Name	SABAP2 Reporting Rate			
		Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
South African Shelduck	*Tadorna cana*	38.10	8	11.11	1
Southern Pochard	*Netta erythrophthalma*	9.52	2	11.11	1
Speckled Pigeon	*Columba guinea*	66.67	14	11.11	1
Spur-winged Goose	*Plectropterus gambensis*	28.57	6	0.00	0
Western Cattle Egret	*Bubulcus ibis*	61.90	13	22.22	2
Whiskered Tern	*Chlidonias hybrida*	9.52	2	0.00	0
White-breasted Cormorant	*Phalacrocorax lucidus*	4.76	1	0.00	0
White-faced Whistling Duck	*Dendrocygna viduata*	19.05	4	0.00	0
Yellow-billed Duck	*Anas undulata*	28.57	6	22.22	2

4. PLAN OF STUDY FOR THE EIA PHASE

Due to the limited level of detail that is normally implemented during a scoping assessment, it is imperative that detailed avifaunal investigations be conducted on the study area at an appropriate season.

4.1 Proposed approach and methods

The following methods are proposed during an austral summer season survey:

- Active searching and the compilation of a bird inventory while traversing much of the available habitat types;
- The determination of the occurrence of Red Data species and collision-prone bird species;
- The identification and mapping of suitable habitat for species of conservation concern while focussing on structural and topographical cues;
- A landscape analysis of important flyways or daily flight paths corresponding to important landscape features; and
- Density estimates will be collected by means of point counts to evaluate the dominant/typical species and their respective relative densities at each site. At each point the number of bird species seen will be recorded, as well as their respective abundances and distance from the observer (by means of a rangefinder). The data generated from the point counts will be analysed according to Clarke & Warwick (1994) based on the computed percentage contribution (%) of each species including the consistency (calculated as the similarity coefficient/standard deviation) of its contribution to the each habitat type.
- Suitable bird repelling structures and bird diverters will be provided to avoid collision of birds with the PV facility and associated powerlines.

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Appendix 1: A shortlist of bird species recorded on the study area and immediate surroundings. The list provides an indication of the species occurrence according to SABAP2 reporting rates.

#	Common Name	Scientific Name	SABAP2 Reporting Rate			
			Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
432	Acacia Pied Barbet	*Tricholaema leucomelas*	66.67	14	0.00	0
95	African Black Duck	*Anas sparsa*	9.52	2	0.00	0
52	African Darter	*Anhinga rufa*	9.52	2	0.00	0
149	African Fish Eagle	*Haliaeetus vocifer*	4.76	1	0.00	0
418	African Hoopoe	*Upupa africana*	4.76	1	0.00	0
167	African Marsh Harrier	*Circus ranivorus*	0.00	0	11.11	1
387	African Palm Swift	*Cypsiurus parvus*	38.10	8	0.00	0
692	African Pipit	*Anthus cinnamomeus*	57.14	12	11.11	1
544	African Red-eyed Bulbul	*Pycnonotus nigricans*	80.95	17	0.00	0
81	African Sacred Ibis	*Threskiornis aethiopicus*	9.52	2	0.00	0
576	African Stonechat	*Saxicola torquatus*	80.95	17	22.22	2
208	African Swamphen	*Porphyrio madagascariensis*	0.00	0	11.11	1
119	Amur Falcon	*Falco amurensis*	4.76	1	0.00	0
575	Ant-eating Chat	*Myrmecocichla formicivora*	80.95	17	11.11	1
514	Ashy Tit	*Melaniparus cinerascens*	9.52	2	0.00	0
493	Barn Swallow	*Hirundo rustica*	38.10	8	11.11	1
159	Black Sparrowhawk	*Accipiter melanoleucus*	4.76	1	0.00	0
650	Black-chested Prinia	*Prinia flavicans*	85.71	18	11.11	1
69	Black-crowned Night Heron	*Nycticorax nycticorax*	9.52	2	0.00	0
841	Black-faced Waxbill	*Brunhilda erythronotos*	14.29	3	0.00	0
55	Black-headed Heron	*Ardea melanocephala*	33.33	7	11.11	1

#	Common Name	Scientific Name	SABAP2 Reporting Rate			
			Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
5	Black-necked Grebe	*Podiceps nigricollis*	4.76	1	11.11	1
245	Blacksmith Lapwing	*Vanellus armatus*	71.43	15	22.22	2
860	Black-throated Canary	*Crithagra atrogularis*	14.29	3	11.11	1
130	Black-winged Kite	*Elanus caeruleus*	57.14	12	33.33	3
270	Black-winged Stilt	*Himantopus himantopus*	0.00	0	11.11	1
839	Blue Waxbill	*Uraeginthus angolensis*	33.33	7	11.11	1
99	Blue-billed Teal	*Spatula hottentota*	0.00	0	11.11	1
722	Bokmakierie	*Telophorus zeylonus*	19.05	4	0.00	0
714	Brown-crowned Tchagra	*Tchagra australis*	23.81	5	0.00	0
402	Brown-hooded Kingfisher	*Halcyon albiventris*	9.52	2	0.00	0
509	Brown-throated Martin	*Riparia paludicola*	23.81	5	0.00	0
4131	Burchell's Coucal	*Centropus burchellii*	4.76	1	0.00	0
703	Cape Longclaw	*Macronyx capensis*	52.38	11	22.22	2
581	Cape Robin-Chat	*Cossypha caffra*	38.10	8	11.11	1
94	Cape Shoveler	*Spatula smithii*	0.00	0	11.11	1
786	Cape Sparrow	*Passer melanurus*	80.95	17	22.22	2
737	Cape Starling	*Lamprotornis nitens*	42.86	9	0.00	0
316	Ring-necked Dove	*Streptopelia capicola*	85.71	18	11.11	1
686	Cape Wagtail	*Motacilla capensis*	33.33	7	11.11	1
568	Capped Wheatear	*Oenanthe pileata*	4.76	1	0.00	0
450	Cardinal Woodpecker	*Dendropicos fuscescens*	9.52	2	0.00	0
484	Chestnut-backed Sparrow-Lark	*Eremopterix leucotis*	4.76	1	0.00	0
658	Chestnut-vented Warbler	*Curruca subcoerulea*	80.95	17	11.11	1
872	Cinnamon-breasted Bunting	*Emberiza tahapisi*	23.81	5	11.11	1

#	Common Name	Scientific Name	SABAP2 Reporting Rate			
			Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
631	Cloud Cisticola	*Cisticola textrix*	19.05	4	0.00	0
154	Common Buzzard	*Buteo buteo*	9.52	2	0.00	0
210	Common Moorhen	*Gallinula chloropus*	9.52	2	11.11	1
734	Common Myna	*Acridotheres tristis*	23.81	5	0.00	0
1	Common Ostrich (introduced)	*Struthio camelus*	33.33	7	11.11	1
421	Common Scimitarbill	*Rhinopomastus cyanomelas*	9.52	2	11.11	1
843	Common Waxbill	*Estrilda astrild*	19.05	4	11.11	1
439	Crested Barbet	*Trachyphonus vaillantii*	38.10	8	0.00	0
242	Crowned Lapwing	*Vanellus coronatus*	90.48	19	11.11	1
630	Desert Cisticola	*Cisticola aridulus*	23.81	5	0.00	0
352	Diederik Cuckoo	*Chrysococcyx caprius*	42.86	9	0.00	0
278	Double-banded Courser	*Rhinoptilus africanus*	14.29	3	0.00	0
89	Egyptian Goose	*Alopochen aegyptiaca*	42.86	9	22.22	2
404	European Bee-eater	*Merops apiaster*	23.81	5	22.22	2
678	Fairy Flycatcher	*Stenostira scita*	19.05	4	0.00	0
570	Familiar Chat	*Oenanthe familiaris*	23.81	5	0.00	0
665	Fiscal Flycatcher	*Melaenornis silens*	76.19	16	11.11	1
83	Glossy Ibis	*Plegadis falcinellus*	14.29	3	11.11	1
502	Greater Striped Swallow	*Cecropis cucullata*	47.62	10	11.11	1
419	Green Wood Hoopoe	*Phoeniculus purpureus*	9.52	2	0.00	0
830	Green-winged Pytilia	*Pytilia melba*	14.29	3	11.11	1
288	Grey-headed Gull	*Chroicocephalus cirrocephalus*	9.52	2	11.11	1
84	Hadeda Ibis	*Bostrychia hagedash*	80.95	17	22.22	2
72	Hamerkop	*Scopus umbretta*	4.76	1	0.00	0

#	Common Name	Scientific Name	SABAP2 Reporting Rate			
			Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
192	Helmeted Guineafowl	*Numida meleagris*	66.67	14	0.00	0
784	House Sparrow	*Passer domesticus*	47.62	10	0.00	0
60	Intermediate Egret	*Ardea intermedia*	0.00	0	11.11	1
835	Jameson's Firefinch	*Lagonosticta rhodopareia*	9.52	2	0.00	0
586	Kalahari Scrub Robin	*Cercotrichas paena*	61.90	13	0.00	0
583	Karoo Scrub Robin	*Cercotrichas coryphoeus*	4.76	1	0.00	0
1104	Karoo Thrush	*Turdus smithi*	14.29	3	0.00	0
317	Laughing Dove	*Spilopelia senegalensis*	90.48	19	33.33	3
706	Lesser Grey Shrike	*Lanius minor*	9.52	2	0.00	0
125	Lesser Kestrel	*Falco naumanni*	9.52	2	0.00	0
604	Lesser Swamp Warbler	*Acrocephalus gracilirostris*	4.76	1	11.11	1
646	Levaillant's Cisticola	*Cisticola tinniens*	42.86	9	11.11	1
413	Lilac-breasted Roller	*Coracias caudatus*	4.76	1	0.00	0
6	Little Grebe	*Tachybaptus ruficollis*	19.05	4	22.22	2
385	Little Swift	*Apus affinis*	71.43	15	22.22	2
852	Long-tailed Paradise Whydah	*Vidua paradisaea*	19.05	4	0.00	0
818	Long-tailed Widowbird	*Euplectes progne*	52.38	11	22.22	2
103	Maccoa Duck	*Oxyura maccoa*	0.00	0	11.11	1
397	Malachite Kingfisher	*Corythornis cristatus*	9.52	2	11.11	1
361	Marsh Owl	*Asio capensis*	4.76	1	22.22	2
564	Mountain Wheatear	*Myrmecocichla monticola*	9.52	2	11.11	1
318	Namaqua Dove	*Oena capensis*	66.67	14	22.22	2
183	Natal Spurfowl	*Pternistis natalensis*	4.76	1	0.00	0
637	Neddicky	*Cisticola fulvicapilla*	52.38	11	11.11	1

#	Common Name	Scientific Name	SABAP2 Reporting Rate			
			Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
1035	Northern Black Korhaan	*Afrotis afraoides*	47.62	10	22.22	2
1171	Orange River White-eye	*Zosterops pallidus*	38.10	8	11.11	1
838	Orange-breasted Waxbill	*Amandava subflava*	4.76	1	0.00	0
165	Pale Chanting Goshawk	*Melierax canorus*	14.29	3	11.11	1
498	Pearl-breasted Swallow	*Hirundo dimidiata*	4.76	1	0.00	0
522	Pied Crow	*Corvus albus*	9.52	2	0.00	0
394	Pied Kingfisher	*Ceryle rudis*	9.52	2	11.11	1
746	Pied Starling	*Lamprotornis bicolor*	38.10	8	11.11	1
846	Pin-tailed Whydah	*Vidua macroura*	14.29	3	11.11	1
694	Plain-backed Pipit	*Anthus leucophrys*	4.76	1	0.00	0
674	Pririt Batis	*Batis pririt*	19.05	4	0.00	0
57	Purple Heron	*Ardea purpurea*	4.76	1	0.00	0
844	Quailfinch	*Ortygospiza atricollis*	28.57	6	11.11	1
642	Rattling Cisticola	*Cisticola chiniana*	4.76	1	0.00	0
708	Red-backed Shrike	*Lanius collurio*	4.76	1	0.00	0
837	Red-billed Firefinch	*Lagonosticta senegala*	23.81	5	0.00	0
805	Red-billed Quelea	*Quelea quelea*	80.95	17	33.33	3
97	Red-billed Teal	*Anas erythrorhyncha*	19.05	4	11.11	1
488	Red-capped Lark	*Calandrella cinerea*	28.57	6	11.11	1
314	Red-eyed Dove	*Streptopelia semitorquata*	52.38	11	11.11	1
392	Red-faced Mousebird	*Urocolius indicus*	47.62	10	0.00	0
820	Red-headed Finch	*Amadina erythrocephala*	19.05	4	0.00	0
212	Red-knobbed Coot	*Fulica cristata*	14.29	3	11.11	1
50	Reed Cormorant	*Microcarbo africanus*	47.62	10	11.11	1

#	Common Name	Scientific Name	SABAP2 Reporting Rate			
			Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
940	Rock Dove	*Columba livia*	33.33	7	0.00	0
506	Rock Martin	*Ptyonoprogne fuligula*	4.76	1	0.00	0
256	Ruff	*Calidris pugnax*	0.00	0	11.11	1
458	Rufous-naped Lark	*Mirafra africana*	33.33	7	0.00	0
460	Sabota Lark	*Calendulauda sabota*	9.52	2	0.00	0
789	Scaly-feathered Weaver	*Sporopipes squamifrons*	52.38	11	11.11	1
105	Secretarybird	*Sagittarius serpentarius*	9.52	2	0.00	0
847	Shaft-tailed Whydah	*Vidua regia*	4.76	1	0.00	0
572	Sickle-winged Chat	*Emarginata sinuata*	4.76	1	0.00	0
504	South African Cliff Swallow	*Petrochelidon spilodera*	52.38	11	11.11	1
90	South African Shelduck	*Tadorna cana*	38.10	8	11.11	1
707	Southern Fiscal	*Lanius collaris*	80.95	17	22.22	2
4142	Southern Grey-headed Sparrow	*Passer diffusus*	47.62	10	11.11	1
803	Southern Masked Weaver	*Ploceus velatus*	100.00	21	33.33	3
102	Southern Pochard	*Netta erythrophthalma*	9.52	2	11.11	1
808	Southern Red Bishop	*Euplectes orix*	57.14	12	11.11	1
390	Speckled Mousebird	*Colius striatus*	14.29	3	0.00	0
311	Speckled Pigeon	*Columba guinea*	66.67	14	11.11	1
474	Spike-heeled Lark	*Chersomanes albofasciata*	28.57	6	0.00	0
654	Spotted Flycatcher	*Muscicapa striata*	4.76	1	0.00	0
88	Spur-winged Goose	*Plectropterus gambensis*	28.57	6	0.00	0
185	Swainson's Spurfowl	*Pternistis swainsonii*	71.43	15	0.00	0
277	Temminck's Courser	*Cursorius temminckii*	4.76	1	0.00	0
238	Three-banded Plover	*Charadrius tricollaris*	28.57	6	22.22	2

#	Common Name	Scientific Name	SABAP2 Reporting Rate			
			Full Protocol (%)	Number of cards	Ad hoc Protocol (%)	Number of cards
851	Village Indigobird	*Vidua chalybeata*	14.29	3	0.00	0
840	Violet-eared Waxbill	*Granatina granatina*	4.76	1	0.00	0
735	Wattled Starling	*Creatophora cinerea*	52.38	11	0.00	0
61	Western Cattle Egret	*Bubulcus ibis*	61.90	13	22.22	2
305	Whiskered Tern	*Chlidonias hybrida*	9.52	2	0.00	0
391	White-backed Mousebird	*Colius colius*	57.14	12	11.11	1
47	White-breasted Cormorant	*Phalacrocorax lucidus*	4.76	1	0.00	0
780	White-browed Sparrow-Weaver	*Plocepasser mahali*	95.24	20	0.00	0
100	White-faced Whistling Duck	*Dendrocygna viduata*	19.05	4	0.00	0
409	White-fronted Bee-eater	*Merops bullockoides*	4.76	1	0.00	0
383	White-rumped Swift	*Apus caffer*	23.81	5	11.11	1
495	White-throated Swallow	*Hirundo albigularis*	23.81	5	11.11	1
814	White-winged Widowbird	*Euplectes albonotatus*	14.29	3	0.00	0
866	Yellow Canary	*Crithagra flaviventris*	61.90	13	11.11	1
96	Yellow-billed Duck	*Anas undulata*	28.57	6	22.22	2
812	Yellow-crowned Bishop	*Euplectes afer*	9.52	2	0.00	0
629	Zitting Cisticola	*Cisticola juncidis*	9.52	2	0.00	0