ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED SOVENTIX SOLAR PV PROJECT, DE AAR, NORTHERN CAPE:

AVIFAUNA SPECIALIST EIA REPORT

PRODUCED FOR ECOLEGES

BY

SIMON TODD CONSULTING

Simon.Todd@3foxes.co.za

Christy.Bragg@3foxes.co.za

Eric Herrmann

May 2017

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DECLARATION OF CONSULTANTS' INDEPENDENCE

- I Simon Todd, as the appointed independent specialist hereby declare that I:
- act/ed as the independent specialist in this application;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management Act;
- have and will not have no vested interest in the proposed activity proceeding;
- have disclosed, to the applicant, EAP and competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management Act;
- am fully aware of and meet the responsibilities in terms of NEMA, the Environmental Impact Assessment Regulations, 2014 (specifically in terms of regulation 12 of GN No. R. 982) and any specific environmental management Act, and that failure to comply with these requirements may constitute and result in disqualification;
- have provided the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not; and
- am aware that a false declaration is an offence in terms of regulation 48 of GN No. R. 982.

Note: The terms of reference must be attached.

Simon Todd Pr.Sci.Nat 400425/11.

May 2017

Executive Summary

Soventix South Africa (Pty) Ltd is proposing the establishment of a 225MW solar PV plant on several portions of the farm Goedehoop, Hanover District, Northern Cape. The project will include the construction of a 225MW solar photo-voltaic (PV) farm, in the form of 3 interconnected 75MW plants; connected to a sub-station that ties into the existing ESKOM 400KV overhead powerlines. The size of the proposed development footprint, is approximately 520ha. This area includes three 75MW solar PV plants (170ha each), with associated infrastructure, as well as the sub-station that will tie into the ESKOM overhead 400KV power lines.

Soventix South Africa (Pty) Ltd has appointed Ecoleges Environmental Consultants to conduct the required EIA process. As part of the specialist studies required for the EIA, Ecoleges Environmental Consultants has appointed Simon Todd Consulting to provide a specialist avifauna assessment of the development site as part of the EIA process.

The study area was visited from 1 to 3 March 2017, which coincided with late summer when conditions were particularly wet and favourable for the assessment. The objectives of the study were to 1) record avian species richness and abundance, 2) record the avian microhabitats and their importance to priority species (threatened and near-threatened), 3) to assess the threats to priority species that are of conservation concern, and 4) to provide possible mitigation measures to reduce potential impacts of the development on priority species.

An approximate total of 152 bird species have been recorded within the study area, of which 92 species were observed during the site visit. Of these, 20 species are considered endemic and 27 near-endemic to South Africa, while eight species are listed as Threatened, and a further five species are considered Near-Threatened. The main species of concern include the following red-listed collision-prone species that were commonly encountered: Blue Crane *Anthropoides paradiseus*, Ludwig's Bustard *Neotis ludwigii*, Secretarybird *Sagittarius serpentarius*, Verreaux's Eagle *Aquila verreauxii*, and the less common Tawny Eagle *Aquila rapax*. Species not seen during the site visit but are also of potential concern include Karoo Korhaan *Eupodotis vigorsii*, Black Stork *Ciconia nigra*, African Marsh Harrier *Circus ranivorus*, Lanner Falcon *Falco biarmicus*, and Greater Flamingo *Phoenicopterus ruber* and Lesser Flamingo *Phoenicopterus minor*.

There are four distinguishable habitat types within the study area, including plains with a mixed shrub and grassland, drainage lines, low dolerite ridges and water bodies (earth dams). The shrubland plains are the most dominant habitat type of the study area and support most of the priority species, while the ridges provide habitat heterogeneity and potential raptor nesting sites. Although the water bodies were inundated, no priority species

were recorded there during the site visit. They may however, support listed species such as Maccoa Duck *Oxyura maccoa*, Black Stork and flamingos during other periods. A recently active Secretarybird nest was located within the dolerite ridge habitat within the western side of the study area, while a Verreaux's Eagle nest with adults in attendance was located on a pylon of the Eskom 400 kV power line that traverses the study area.

The expected impacts of the proposed solar development within the study area include the following: 1) habitat loss and fragmentation associated with the shrubland plains habitat, 2) disturbance caused during the construction and maintenance phases, and 3) direct mortality of priority species colliding with solar panels and associated power line structures. The impacts would normally be expected to be of medium to low importance, but due to the presence of good numbers of resident priority species, impacts can be expected to be medium to high pre-mitigation.

The primary mitigation measures required to reduce the potential impacts on priority species include 1) restrict habitat destruction and disturbance to within the footprint of the proposed development, 2) the inclusion of a 1 km buffer zone around the Secretarybird and Verreaux's Eagle nest to prevent vital habitat loss close to the nests and limit disturbance, 3) exclusion of the dolerite ridge habitat and buffer zone from any development, 4) locate new power lines associated with the development in such a way as to reduce the possibility of priority species colliding with them, 5) the fitting of bird diverters on all erected power lines associated with the development to further reduce the possibility of collisions and electrocutions, and 6) adjust the spacing between solar panels to reduce the cumulative reflective potential of the arrays, which may reduce avian collisions with the panels.

With mitigation and specifically the strict avoidance of the high sensitivity areas, the identified avifaunal impacts can be reduced to an acceptable level. While there are certainly some sensitive areas at the site that need to be avoided, there are also fairly extensive areas of lower sensitivity plains present, where development should be focussed. As these plains are extensive, the extent of habitat loss resulting from the development of the PV facilities at the site is considered fairly low and would not be likely to pose a threat to the long-term persistence of any avifauna at the site. With the implementation of these mitigation measures, the impact of the development can be reduced to an acceptable level and as such there are no fatal flaws associated with the development that should prevent it from proceeding. A final caveat is however that a power line layout has not been provided for the assessment and this could potentially have a significant impact on the current assessment should a long power line be required.

1 INTRODUCTION

Soventix South Africa (Pty) Ltd is proposing the establishment of a 225MW solar PV plant on several portions of the farm Goedehoop, Hanover District, Northern Cape. The project will include the construction of a 225MW solar photo-voltaic (PV) farm, in the form of 3 interconnected 75MW plants; connected to a sub-station that ties into the existing ESKOM 400KV overhead powerlines. The size of the proposed development footprint, is approximately 520ha. This area includes three 75MW solar PV plants (170ha each), with associated infrastructure, as well as the sub-station that will tie into the ESKOM overhead 400KV power lines. Existing roads will be used for main access, which may need to be enlarged to allow large equipment to access the site during construction.

Soventix South Africa (Pty) Ltd has appointed Ecoleges Environmental Consultants to conduct the required EIA process. As part of the specialist studies required for the EIA, Ecoleges Environmental Consultants has appointed Simon Todd Consulting to provide a specialist avifauna assessment of the development site as part of the EIA process. The purpose of the avifaunal specialist scoping study is to describe and detail the avian ecological features of the proposed site, provide an assessment of the avian sensitivity of the site, identify and assess the significance of the likely impacts associated with the development on avifauna and provide measures to avoid, minimize and mitigate project related impacts on avifauna.

1.1 TERMS OF REFERENCE

The specific terms of reference for this avifaunal specialist study include the following:

- A description of the environment of the study area in terms of the avian habitats present.
- A consolidated list of bird species and priority bird species (priority species will include nationally and/or globally threatened, rare, endemic or range-restricted bird species) likely to occur within the study area and broader impact zone of the development, with information on the relative value (in terms of breeding, nesting, roosting and foraging) of the site for these birds.
- A delineation of areas that are potentially highly sensitive, no-go areas that may need to be avoided by the development.
- A description and evaluation of the environmental issues and potential impacts (including direct, indirect and cumulative impacts) that the proposed development

may have on the bird species present. Direct, indirect and cumulative impacts of the identified issues will be evaluated within the avifaunal specialist study in terms of the following criteria:

- The **nature**, which includes a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it is indicated whether the impact will be local (limited to the immediate area or site of development), regional, national or international.

- Identification and assessment of significant impacts and the details of the methodology to be adopted in assessing these impacts.
- Recommendations regarding practical mitigation measures for potentially significant impacts, for inclusion in the environmental management programme (empr).
- An indication of the extent to which the issue could be addressed by the adoption of mitigation measures.
- A description of any assumptions uncertainties and gaps in knowledge.
- An environmental impact statement which contains :
  - A summary of the key findings of the environmental impact assessment;
  - An assessment of the positive and negative implications of the proposed activity;
  - A comparative assessment of the positive and negative implications of identified alternatives.

1.2 RELEVANT ASPECTS OF THE DEVELOPMENT

The proposed development site is located on several portions of the farm Goedehoop, Hanover District, Northern Cape, between Hanover and De Aar, on the east of the N10. The proposed development footprint, is approximately 520ha, including three 75MW solar PV plants (170ha each), with associated infrastructure, as well as the sub-station that will tie into the ESKOM overhead 400KV power lines (Figure 1). Existing roads will be used for main access, which may need to be enlarged to allow large equipment to access the site during construction. Although details of the required grid connections have not been provided by the developer, there is an existing Eskom line adjacent to each site and at this time it is assumed that each site would be connected to the adjacent power line and that there would not be a significant power line constructed across the site. As birds are vulnerable to power line-related impacts, the construction of a power line at the site to connect any of the facilities to the grid would change the assessed impacts, which are currently assessed for the facility only and not a power line.

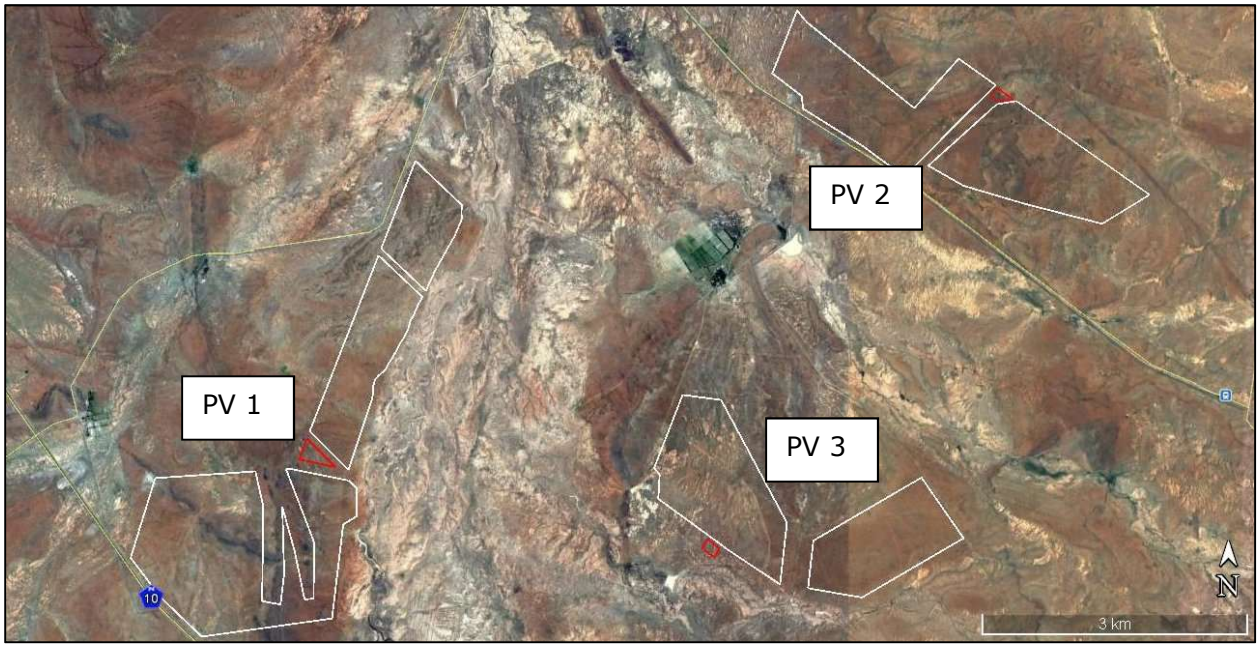

Figure 1. Satellite image of the Soventix solar development site, illustrating the proposed development areas, with the substation sites in red and the three PV sites (labelled 1,2 and 3) in white.

1.3 Relevant Legislation and Guidelines

The following Acts, legislation and guidelines are applicable to the proposed development:

The Convention on Biological Diversity

The Convention on Biological Diversity (CBD) is an international convention (to which South Africa is a signatory) and represents a commitment to sustainable development. The Convention has three main objectives: the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits from the use of genetic resources (http://cbd.int/convention/guide/). Although the convention does not include specific recommendations or guidelines pertaining to birds and energy infrastructure interactions and impacts, it does make provisions for keeping and restoring biodiversity.

The Convention on the Conservation of Migratory Species of Wild Animals

The Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or the Bonn Convention) is an intergovernmental treaty and is the most appropriate instrument to deal with the conservation of terrestrial, aquatic and avian migratory species.

The convention includes policy and guidelines with regards to the impact associated with man-made infrastructure. CMS requires that parties (South Africa is a signatory) take measures to avoid migratory species from becoming endangered (Art II, par. 1 and 2) and to make every effort to prevent the adverse effects of activities and obstacles that seriously impede or prevent the migration of migratory species i.e. power lines (Art 111, par. 4b and 4c).

The Agreement on the Convention of African-Eurasian Migratory Water Birds

The Agreement on the Conservation of African-Eurasian Migratory Water birds (AEWA) is an intergovernmental treaty dedicated to the conservation of migratory waterbirds and their habitat across Africa, Europe, the Middle East Central Asia, Greenland and the Canadian Archipelago. The AEWA covers 255 species of birds ecologically dependent on wetlands for at least part of their annual cycle and is a legally binding agreement by all contracting parties (South Africa included) to guarantee the conservation of migratory waterbirds within their national boundaries through species and habitat protection and the management of human activities.

The National Environmental Management: Biodiversity Act

The National Environmental Management: Biodiversity Act (No. 10 of 2004, NEMBA) regulations on Threatened and Protected Species (TOPS) provides for the consolidation of biodiversity legislation through establishing national norms and standards for the management of biodiversity across all sectors and by different management authorities. The national Act and several sets of provincial conservation legislation provide for among other things, the management and conservation of South Africa's biodiversity; protection of species and ecosystems that necessitate national protection and the sustainable use of indigenous biological resources.

Guidelines to minimise the impacts on birds of Solar Facilities and Associated Infrastructure in South Africa

The "Guidelines to minimise the impact on birds of Solar Facilities and Associated Infrastructure in South Africa" (Smit, 2012) is perhaps the most important (although not legally binding) document from an avifaunal impact perspective currently applicable to solar development in South Africa. The guidelines are published by BirdLife South Africa (BLSA) and detail the recommended procedure for conducting an avifaunal specialist study as well as list all of the potential impacts of interactions between birds and solar facilities and associated infrastructure. We are aware of changes to the BirdLife South Africa best-practise guidelines recently published at the Birds and Renewable Energy Forum in Johannesburg (2015) and although the revised requirements are still a work in progress and have not yet been ratified, they will inform this assessment where applicable.

2 METHODOLOGY

2.1 APPROACH

The avifaunal specialist study included the following steps:

- A review of all available published and unpublished literature pertaining to bird interactions with SEFs and their associated power infrastructure, summarising the issues involved and the current level of knowledge in the field. Various information sources including data on the local avifauna of the area and previous studies of bird interactions with SEFs and their associated power infrastructure were be examined.

- A site visit of 4 days to the study area (during the late wet season 1 to 3 March 2017) to determine the *in situ* local avifauna and avian habitats present on site to:
    - Quantify aspects of the local avifauna (such as species diversity and abundance);
    - Identify important avian features present on site (such as nesting and roosting sites);
    - Confirm the presence, abundance, habitat preference and movements of priority species;
    - Identify important flyways across the site; and
    - Delineate any obvious, highly sensitive, no-go areas to be avoided by the development.

- All distinguishable avian microhabitats were identified while traversing the study site, and evaluated in terms of their importance to the avifauna for foraging, nesting and roosting. A total of forty-three 500m transects were walked through the proposed PV sites, mostly in a zig-zag formation to ensure adequate coverage under the time constraints. Transects were conducted mostly during the mornings and afternoons. All bird species detected during these transect walks were recorded, as well as the number of birds per detection. All sightings of red-listed (priority) species were recorded with respect to coordinates, time of sighting, number of birds per sighting, and weather conditions. An attempt was made, where possible, to identify the movement patterns of priority species and any highly sensitive areas that are to be avoided by the proposed development.

- The compilation of a consolidated and annotated list of the avifauna likely to occur within the study area and the broader impact zone of the development based on a combination of existing distributional data, species seen during the site visit and previous experience of the avifauna of the area.

- The compilation of a short-list of priority bird species (including nationally and/or globally threatened, rare, endemic or range-restricted bird species) which could be affected by the proposed development. These species will subsequently be considered as adequate surrogates for the local avifauna in general, and mitigation of impacts on these species will be considered likely to accommodate any less important bird populations that may also potentially be affected.

- An avian site sensitivity map was generated by integrating avian microhabitats present on site and avifaunal information collected during the site visit. The avian sensitivity of the different units identified in the mapping procedure were rated according to the following scale:

    - *Low:* Areas of natural or transformed habitat with a low sensitivity where there is likely to be a negligible impact on avifauna.

    - *Medium*: Areas of natural or previously transformed land where the impacts are likely to be largely local. These areas usually comprise the bulk of habitats within an area. Development within these areas can proceed with relatively low avian impacts provided that appropriate mitigation measures are taken.

    - *High:* Areas of natural or transformed land where a high avifaunal impact is anticipated due to the high sensitivity or important habitat value of the area. Development within these areas is undesirable and should only proceed with caution as it may not be possible to mitigate all impacts appropriately.

    - *Very High:* Critical and unique avifaunal habitats that serve as habitat for rare, threatened, endemic or range-restricted species and/or perform critical ecological roles. These areas are essentially no-go areas from a development perspective and should be avoided as much as possible.

- The construction of a matrix of potential impacts of the development on the local avifauna is drawn up and the significance of these impacts assessed.

- A final statement on the overall significance of the potential impacts of the development on the avifauna of the area.

2.2 DATA SOURCING AND REVIEW

Data sources from the literature consulted and used where necessary in the study includes the following:

- The Southern African Bird Atlas Project 1 (SABAP 1; Harrison et al., 1997), which obtained bird distribution data between 1987 and 1992, was consulted to determine the bird species likely to occur within the study area. The relevant quarter-degree grid cell (QDGC) that covers the study area is 3024CD (23 cards, 131 species). More recent bird distribution data were also obtained from the second bird atlas project, which has been on-going since 2007 (SABAP 2; http://sabap2.adu.org.za/index.php). SABAP2 employs a finer resolution using the pentad scale (5' latitude x 5' longitude), with the relevant pentad code for the study area being 3050_2415 (2 cards, 65 species). These were consulted to determine the bird species likely to occur within the study area and the broader impact zone of the development.

- The Important Bird Areas of South Africa (IBA; Marnewick et al., 2015) was consulted to determine the location of the nearest IBAs to the study area. The extensive Platberg-Karoo Conservancy encompasses the study area, while no other IBAs are located nearby.

- The data from the Coordinated Avifaunal Roadcounts (CAR; Young et al., 2003) were consulted to determine the location of the nearest CAR routes to the study area. Three CAR routes (NK042, NK043 and NK044) occur within the broader impact zone of the proposed development.

- The data from the Coordinated Waterbird Counts (CWAC; Taylor et al., 1999) were consulted to determine the location of the nearest CWAC sites to the study area. No CWAC sites occur within the study area, although one site (CWAC site code: 30552416) is located about 1 km to the south west of the study area.

- The conservation status, endemism and biology of all species considered likely to occur within the study area was then determined from Hockey *et al.* (2005) and Taylor *et al.* (2015).

- The South African National Vegetation Map (Mucina & Rutherford, 2006) was consulted in order to determine the vegetation types and their conservation status that occur within the study area.

2.3 LIMITATIONS AND ASSUMPTIONS

The specialist made the assumption that the sources of information used in the compilation of this report are reliable. However, it must be noted that there are limiting factors and these could detract from the accuracy of the predicted results:

- There is a scarcity of published, scientifically vetted information regarding the avifaunal impacts at existing SEFs. Recent studies at SEFs (all using different solar

technologies) in southern California have revealed that a wide range of bird species are susceptible to morbidity and mortality at SEFs, regardless of the type of technology employed. It must however be noted, that facility related factors could influence impacts and mortality rates and as such, each SEF must be assessed individually, taking all variables into account.

- Assessment of the impacts associated with bird-SEF interactions is problematic due to: (i) limitations on the quality of information available describing the composition, abundance and movements of the local avifauna, and (ii) the complete absence of any local, empirical data describing the known impacts of existing SEFs on birds (Jenkins, 2011).

- Limited time in the field and no seasonal spread means that important components of the local avifauna (i.e. nest sites or localised areas of key habitats for rare or threatened species) could have been missed. However, the development area does not contain many large trees, so it is highly unlikely that there are any significant nesting sites of larger species present within the affected area that would not have been observed.

The site visit as well as personal experience of the avifauna of the area and of similar species in different parts of South Africa, through the specialist's experience working across the country, goes some way to remedying any knowledge deficiencies.

3 DESCRIPTION OF THE AFFECTED ENVIRONMEN

3.1 AVIAN MICROHABITATS

The landscape of the broader study area is dominated by extensive flat to gently undulating plains, which are interspersed by mostly low dolerite ridges and ephemeral water bodies (earth dams). These constitute the three most prominent microhabitats, of which the shrubland plains habitat is the most prominent within the proposed PV sites.

Shrubland plains

The plains support a complex mix of grasses and dwarf shrubs known as the Northern Upper Karoo vegetation type (Mucina and Rutherford, 2006). This vegetation type is widespread and dominants most of the study area and the proposed PV sites (Figure 3). The Brak River, with its extensive alluvial plains, passes through the centre of the study area but lies beyond the PV sites. The vegetation structure of its alluvial plains is similar to the surrounding plains, though mostly taller. The shrubland plains habitat is considered to be of

medium sensitivity as it is the most widespread habitat type throughout the region and appears to be mostly untransformed through current land use. This habitat does, however, support most of the red-listed avian species within the study area, such as large terrestrial birds and raptors.

Figure 3. Typical shrubland plains habitat within the study area, comprising mainly dwarf shrubs and grasses. The 400 kV power line that traverses the study area supports a Verreaux's Eagle nest along the boundary of the PV3 site.

Dolerite ridges

The dolerite ridges lie in the east, central and west of the study area, and are included to some extent within the footprint of the proposed PV sites (Figure 4). Although these rocky ridges are mostly rather low, they do support a different assemblage of birds than the shrubland plains habitat. This habitat is considered to be of high sensitivity, as it provides heterogeneity within the otherwise homogenous plains landscape, and may also serve as a refuge for certain bird species. The ridges also support a few large shrubs (*Diospyros*, *Searsia*, *Maytenus*), which provide potential nesting sites for raptor species.

Figure 4. The low dolerite ridges within the western part of the study area. These ridges provide heterogeneity within the otherwise homogenous landscape, and provide potential foraging habitat and nesting sites for raptors.

Water bodies

The water bodies noted within the study area are mostly man-made earth dams. One dam is located to the east of the Goedehoop homestead, while another much larger dam is located about 1 km to the south-west of the study area. Although this second dam is not within the study area, it is considered here because of its large size and closeness to some of the PV sites. These dams are ephemeral in nature and may be completely dry for extended periods, although both were full at the time of the site visit due to good summer rains. During periods of inundation they may support certain red-listed species such as flamingos, large numbers of congregatory species, and potentially provide nocturnal roosting sites for Blue Cranes. These water bodies are therefore considered to be of medium-high sensitivity, despite being artificial habitats and ephemeral in nature.

Figure 5. Most of the water-bodies at the site are man-made such as this small earth dam near PV2, and usually only hold water seasonally.

3.2 Listed and Protected Avifauna Species

An approximate total of 152 bird species are known to occur in the study area and surrounds (Appendix 1), of which 20 species are considered endemic and 27 near-endemic to South Africa. Eight species are listed as threatened, while a further five species are considered Near-Threatened (Taylor *et al.*, 2015). During the site visit for this study (1 to 3 March 2017), a total of 92 bird species were recorded within the study area. The red-listed species (Table 1) are considered fundamental to this study, because of their susceptibility to the various threats posed by solar facilities and associated infrastructures.

It should be noted from the onset that the study area falls within an Important Bird Area (IBA) known as the Platberg-Karoo Conservancy (Figure 6), which encompasses the entire districts of De Aar, Hanover and Philipstown (Marnewick *et al.*, 2015). Although this is not a formal conservation area, the IBA was established specifically due to the presence of several globally and regionally threatened species of large terrestrial birds and raptors, certain biome-restricted passerines, and congregatory species. Besides the presence of large resident raptors, the area also holds nearly 10% of the global population of migratory Lesser Kestrels *Falco naumanni* in summer.

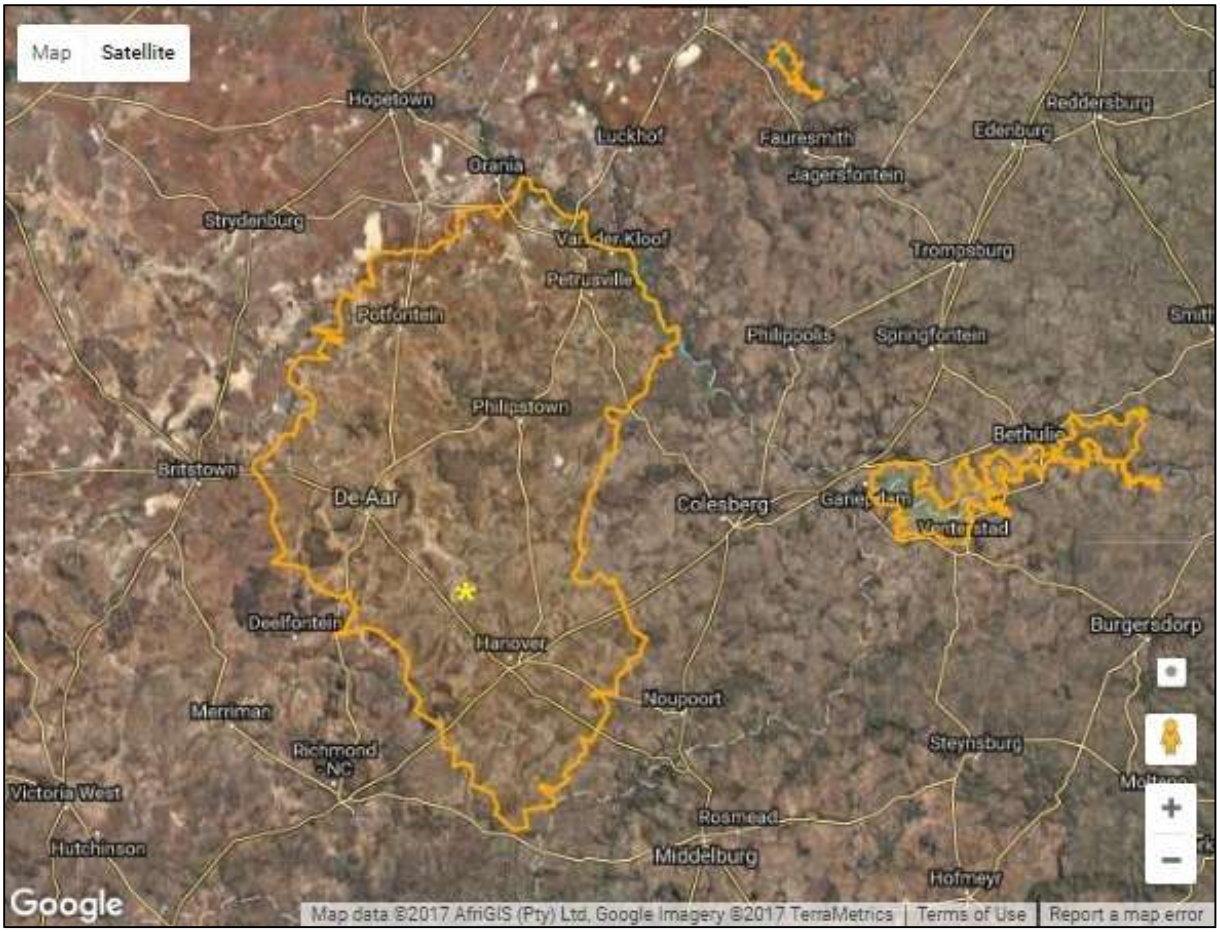

Figure 5. The Platberg-Karoo Conservancy with the Soventix study area marked as a yellow asterix, taken from the online IBA directory (Platberg-Karoo Conservancy, 2015). The two smaller IBAs to the east (Kalkfontein Dam Nature Reserve and Upper Orange River IBAs) are unrelated to this study.

3.3 AVIFAUNA OF THE SHRUBLAND PLAINS

The shrubland plains habitat supports a relatively low diversity of bird species (ca. 67) comprising both small passerines (ca. 35 species) and non-passerines (ca. 32 species). While none of these passerines are red-listed, eight species are endemic and 13 near-endemic to South Africa (Taylor *et al.*, 2015). The passerine species assemblage of the shrubland plains habitat is rather typical of similar areas in the Nama Karoo Biome, with the most commonly encountered species being Eastern Clapper Lark *Mirafra fasciolata*, Spike-heeled Lark *Chersomanes albofasciata*, African Pipit *Anthus cinnamomeus*, Rufous-eared Warbler *Malcorus pectoralis*, Desert Cisticola *Cisticola aridulus*, and Large-billed Lark *Galerida magnirostris*.

Among the 32 non-passerine species that occupy the shrubland plains habitat, six are endemic and only three near-endemic. However, eight of the non-passerines are red-listed, thereby highlighting the importance of the shrubland plains habitat for large terrestrial birds and raptors. Some of the more commonly encountered species that are not red-listed include Northern Black Korhaan *Afrotis afraoides*, Lesser Kestrel, Double-banded Courser *Rhinoptilus africanus*, and Namaqua Sandgrouse *Pterocles namaqua*.

Thirteen red-listed species (Table 1) have been recorded in the study area, of which seven were recorded during the site visit (1 to 3 March 2017). The most commonly encountered red-listed species, as recorded during the site visit, include the Near-Threatened Blue Crane (16 sightings, 38 individuals), the Endangered Ludwig's Bustard (11 sightings, 13 individuals), and less frequently, the Vulnerable Secretarybird (3 sightings in same area near a nest), Verreaux's Eagle (several sightings of same pair near a pylon nest), Burchell's Courser *Cursorius rufus* (2 sightings, 5 individuals), and the Endangered Tawny Eagle (1 sighting, 1 individual). The Endangered Martial Eagle *Polemaetus bellicosus* was not recorded during any of the surveys within the study area, but has a high probability of occurring due to its presence in neighbouring QDGCs (SABAP1) and pentads (SABAP2).

In addition to these red-listed species, Blue Korhaan *Eupodotis caerulescens* (Least Concern) was also recorded (2 sighting, 4 individuals), as well as numerous Lesser Kestrels (42 sightings, 211 individuals) foraging over the open shrubland plains habitat. Data obtained from CAR surveys (Young *et al.,* 2003) corroborate the presence of most of the large terrestrial birds recorded in the study area, and that these occur in the broader impact zone in good numbers throughout the year. This highlights the importance of the study area and the broader area for these species.

3.4 AVIFAUNA OF THE DOLERITE RIDGES

The dolerite ridges support about 15 species almost exclusively, of which four are endemic and seven near-endemic to South Africa. Although none of these are red-listed, some of these are biome- and habitat-restricted species, such as Karoo Long-billed Lark *Certhilauda subcoronata*, Layard's Tit-babbler *Sylvia Layardi*, Pale-winged Starling *Onychognathus nabouroup*, Sabota Lark *Calendulauda sabota*, Karoo Scrub-Robin *Cercotrichas coryphoeus*, Grey Tit *Melaniparus afer*, Mountain Wheatear *Oenanthe monticola*, and Grey-winged Francolin *Scleroptila afra*. A number of raptors also use the ridges on a regular basis in addition to the plains, including the Vulnerable Verreaux's Eagle and Lanner Falcon, and non-red listed Booted Eagle *Aquila pennatus* and Rock Kestrel *Falco rupicolus.* On one occasion during the site visit, an immature Verreaux's eagle, an immature Pale Chanting Goshawk *Melierax canorus* and a Steppe (Common) Buzzard *Buteo buteo*, were recorded together, perched on boulders and presumably attracted to a food source.

3.5 WATERBIRDS

Although the water bodies within and beyond the study area are ephemeral, they all contained water following the recent good rains. Despite this abundance of water, the number of water-dependant birds at the dams surveyed was rather low. A maximum of 70 individuals of seven species were recorded during one of two counts at the dam near the Goedehoop homestead. This can be expected due to the abundant surface water available throughout the region at the time of the site visit, resulting in birds being widely dispersed (Dodman & Diagana, 2007). The most common species recorded at the dam within the study area included the following, with maximum numbers recorded in parentheses: the endemic South African Shelduck *Tadorna cana* (15), the near-endemic Cape Shoveler *Anas smithii* (10), Red-billed Teal *Anas erythrorhyncha* (14), Black-winged Stilt *Himantopus himantopus* (11), Blacksmith Lapwing *Vanellus armatus* (15), and African Sacred Ibis *Threskiornis aethiopicus* (3). Palearctic shorebirds (waders) such as Little Stint *Calidris minuta* (29) and Ruff *Philomachus pugnax* (18) were also recorded. Although no red-listed water-dependant species were recording during the site visit, avian species assemblages may change over time due to changes in habitat characteristics and other variables (Froneman *et al.*, 2001, González-Gajardo *et al.*, 2009).

Long-term data on waterbird numbers are available for the dam located outside the study area, which is listed as a CWAC site centred at S 30° 55' E 24° 16' (CWAC site code: 30552416). These data reveal that most red-listed water-dependant species appear to occur infrequently at low densities in the area. Such red-listed species, with maximum numbers recorded in parentheses, include the Vulnerable Black Stork (3), the Near-Threatened Maccoa Duck (6) and Lesser Flamingo *Phoenicopterus minor* (2). The low numbers of Lesser Flamingo can be attributed to this species' preference for saline wetlands such as salt pans (Hockey *et al.*, 2005), which do not occur within the study area. The Near-Threatened Greater Flamingo *Phoenicopterus ruber*, however, has reached numbers of up to 226 individuals, indicating that this species most likely uses water bodies in the region to a fair extent. Congregatory species that are not red-listed but have been recorded in high numbers at this water body include: Yellow-billed Duck *Anas undulata* (310), Egyptian Goose *Alopochen aegyptiacus* (230), Spur-winged Goose *Plectropterus gambensis* (105), Cape Shoveler (209), South African Shelduck (133), and Palearctic waders such as Ruff (203) and Little Stint (275). Although the water bodies are sufficiently far enough away from the proposed PV sites (> 1 km) so that water birds should not be directly affected, they are important focal areas for congregatory species during times when they are inundated with water.

3.6 BREEDING AND NEST RECORDS

The site visit coincided with late summer when many bird species were still breeding. Displaying Eastern Clapper Larks and Northern Black Korhaans, in particular, were abundant throughout the study area. Of the red-listed species recorded in the study area, at least three species can be confirmed as local breeders, namely Blue Crane, Secretarybird and Verreaux's Eagle. Blue Crane pairs with single offspring were recorded on a number of occasions within PV sites along the western side of the study area, while two nests of red-listed raptor species were also found in close proximity to the proposed PV sites. A Secretarybird nest was located on the eastern edge of the PV1 site (Figure 7). Though the nest was empty (young had already fledged), the presence of decaying prey remains around the nest and the single bird seen twice in the vicinity suggest that the nest was used during the last breeding season. A Verreaux's Eagle nest was located on a pylon along the 400 kV transmission line that passes along the western side of PV3 (Figure 8 and 9). Both adult birds were seen perched on or near the nest on a few occasions, but it could not be determined whether the nest held any young. The presence of the adult birds is sufficient evidence to suggest that the nest is a focal point for the eagle pair. It can be expected that other red-listed species also breed in the area, such as Tawny Eagle (most likely on large pylons) and species typical of the shrubland plains habitat, such as Ludwig's Bustard, Karoo Korhaan, Blue Korhaan and Burchell's Courser.

Figure 7. A Secretarybird nest constructed on top of a *Diospyros* shrub within the dolerite ridges habitat. Nests such as these are considered highly sensitive sites and require a buffer zone to avoid habitat loss and disturbances near the nest.

Figure 8. A Verreaux's Eagle nest constructed on a pylon of the 400 kV power line that traverses the PV3 study area. As with the Secretarybird nest, this eagle nest is also considered as a highly sensitive site, and will require a buffer zone to avoid disturbances near the nest.

Figure 9. A close up of the Verreaux's Eagle nest constructed within the trellis structure of the pylon.

In essence, much of the avifauna within the study area appears similar to that found across much of the Nama Karoo Biome. However, the location of the study area close to the eastern extremes of the biome, bordering on the Grassland Biome, results in a somewhat richer avifauna. Peripheral areas of the Karoo tend to be species richer due to higher precipitation compared to the arid centre (Dean 2000). Further, the study area supports seemingly large and healthy populations of red-listed non-passerine species such as raptors and large terrestrial birds (cranes, bustards and korhaans). Hence the sensitivity of the study area in general can be considered to be of moderate to high significance with respect to avifauna.

3.7 SITE SENSITIVITY ASSESSMENT

An avian sensitivity map was compiled to highlight important and sensitive avifaunal habitats within the study area (Table 1, Figure 10). This map provides a guideline for minimising the potential negative impacts of the proposed development on the local avifauna, by taking cognisance of the distribution of sensitive avian microhabitats, breeding sites of red-listed species, and areas that support large numbers of foraging or nesting birds, and potential flyways.

The entire study area is classified according to four levels of avifaunal sensitivity, ranging from medium to very high sensitivity. No areas within the study area were identified as low sensitivity with respect to avifauna. Besides livestock grazing that may affect vegetation structure and plant species composition to some extent, little habitat transformation has occurred within the study area. Much of the study area therefore represents suitable habitat to a wide range of avifaunal species, especially the sensitive large terrestrial birds and some raptors species.

Overall, the three habitat types (Table 2) including the shrubland plains, dolerite ridges and water bodies are generally ranked as medium, high and medium-high sensitivity respectively. Most of the study area (shrubland plains habitat) is classified as medium sensitivity since this habitat is widespread within the region and supports breeding and foraging red-listed species. Development in this habitat could therefore proceed, but with caution and the recommended mitigation and avoidance measures implemented.

Table 2. The avian sensitivity ratings for the three avifaunal microhabitats in the study area.

Habitat	Avian Sensitivity	Rationale for sensitivity rating
Shrubland plains	Medium	Widespread and dominant, but supports many priority species such as cranes and bustards
Dolerite ridges	High	Localised and provides habitat heterogeneity, and foraging and nesting sites for raptors
Water bodies	Medium-High	Artificial, but supports large numbers of congregatory waterbirds at times
Drainage Systems	Medium-High	Greater structural diversity due to presence of trees which also represent nesting sites. Important habitat for many species.

An exception to the above sensitivity are the plains habitat in the south-west of the study area within PV1, where sensitivity is ranked as high due to the presence of a number of breeding Blue Cranes recorded in this area during the site visit. It is uncertain whether this area is used yearly by Blue Cranes for breeding compared to other areas, but it is recommended that the precautionary principle be applied in this case. Furthermore, a number of observations of low-flying Ludwig's Bustards were made in this area, suggesting that it may also be an important flyway for this species. Hence, this area should be excluded from the development footprint.

The dolerite ridges are classified as high sensitivity, due to this habitat's role in providing habitat heterogeneity within the broader landscape, and as a potential refuge for biome-restricted and raptor species. The presence of small trees and large shrubs in this habitat may also provide suitable nesting locations for raptors, as in the case with the Secretarybird nest, thereby further enhancing the sensitivity status of this habitat. No development should be permitted within or adjoining this habitat.

The water body within the study area and the larger dam to the south west are ranked as areas of medium-high sensitivity. Although these are modified habitats, when inundated these water bodies may attract large numbers of congregatory water birds, including the red-listed Greater and Lesser Flamingo, Maccoa Duck and Black Stork. A buffer zone with a minimum radius of 1 km should therefore be maintained around these water bodies to avoid any potential impacts related to habitat destruction and disturbance.

The nest sites of two red-listed species sites (Secretarybird and Verreaux's Eagle) are considered to be areas of very high sensitivity. The nest of the Verreaux's Eagle pair

appears to be in use, and the nest of the Secretarybird appears to have been used during the past breeding season. A buffer zone with a radius of 1km around the nests is therefore allocated to both nest sites. This is to ensure that essential habitat surrounding the nests are not disturbed or transformed and that the birds are not disturbed during any construction or maintenance activities associated with the proposed development. These buffer zones are therefore considered a no-go zone, and hence any vehicle tracks, roads, power lines or any other infrastructure should be excluded from these at all costs.

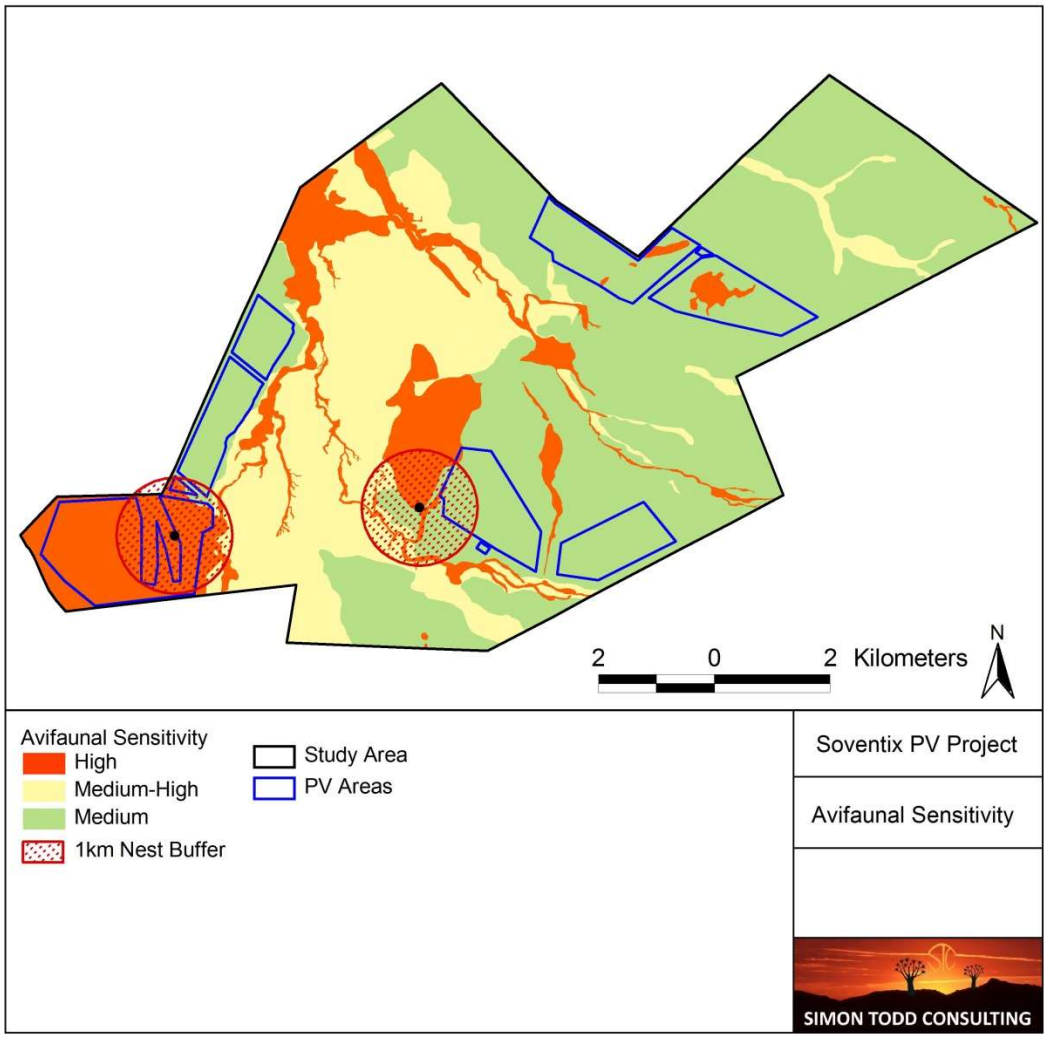

Figure 10. Avifaunal sensitivity map of the Soventix PV site, including the 1km nest buffers around the Secretarybird and Verreaux's eagle nests.

4 IDENTIFICATION & NATURE OF IMPACTS

In this section, the potential impacts and associated risk factors that may be generated by the development are identified.

According to a position statement by Birdlife South Africa, the main concerns with PV facilities are the following:

- Displacement or the exclusion of nationally and/or globally threatened, rare, endemic, or range-restricted bird species from important habitats.
- Loss of habitat and disturbance of resident bird species caused by construction, operation and maintenance activities.
- Collision with the solar panels, which may be mistaken for water bodies.
- Collision and electrocution caused when perching on or flying into power line infrastructure.
- Habitat destruction and disturbance/exclusion of avifauna through construction (short-term) and maintenance (long-term) of new power line infrastructure.
- Habitat destruction and disturbance of birds caused by the construction and maintenance of new roads and other infrastructure.

The proposed Soventix solar development will cover an area of up to 520 ha, located primarily within the shrubland plains habitat of the study area. Although this habitat is the most dominant of the three habitats identified in the study area (shrubland plains, dolerite ridges and water bodies), the development may have an impact on a number of endemic, near-endemic and biome-restricted passerines and, mostly importantly, several red-listed large terrestrial birds and raptors. A number of bird assemblages are expected to be impacted to varying degrees based on their life-history strategies, abundance and general susceptibility to collisions with infrastructures such as power lines. While habitat loss can be quantified by extent of the development footprint, other impacts such as direct mortalities caused by collisions with solar panels are still poorly understood.

Data on estimates of birds killed at solar facilities as a direct result of collisions with associated infrastructure are limited, especially in South Africa. A recent study at a large solar facility in the Northern Cape (Visser, 2016) provides the first estimates of the potential impact on birds within the region, with direct mortalities amounting to 4.5 birds/MW/year. This short term study also concluded, however, that there was no significant association with collision-related mortality at that study site, and that further studies were required. Most injuries that were recorded were related to species such as francolin colliding with the underside of panels, and korhaans becoming entrapped along the perimeter fencing, between the mesh and electrical strands (Visser, 2016). A PV solar facility in the United States is reported to result in the deaths of 0.5 birds/MW/year as a direct result of the collisions with infrastructure (Walston et al., 2016).

4.1 IDENTIFICATION OF IMPACTS

In this section each of the potential impacts on avifauna associated with the development is explored in more detail with reference to the features and characteristics of the site and the likelihood that each impact would occur given the characteristics of the site and the extent and nature of the development. While renewable energy sources, such as solar energy, are important to the future development of power generation and hold great potential to alleviate the dependence on fossil fuels, they are not without their environmental risks and negative impacts. Poorly sited or designed SEFs can have negative impacts on not only vulnerable species and habitats, but also on entire ecosystem functioning. These impacts are extremely variable, differing from site to site, and are dependent on numerous contributing factors which include the design and specifications of the development, the importance and sensitivity of avian microhabitats present on site and the diversity and abundance of the local avifauna.

Habitat loss

This is potentially the most significant impact, dependent on location and scale of the development, associated with the construction and operation (maintenance) of SEFs. Extensive areas of vegetation (habitat) are cleared to accommodate the considerable amount of infrastructure required at these facilities, reducing the amount of habitat available to birds for foraging, roosting and breeding (Smallie, 2013). This impact is likely to affect smaller bird species (e.g., larks) with small home ranges, as entire territories could be removed during construction activities.

Disturbance and displacement

Construction of SEFs requires a significant amount of machinery and labour to be present on site for a period of time. For shy, sensitive species or ground-nesting birds resident in the area, construction activities are likely to cause a temporary disturbance or even result in displacement from the site entirely. In addition, species commuting around the site may become disorientated by the reflected light and consequently fly longer distances to avoid the area, potentially resulting in displacement and energy implications (Smallie, 2013). Similarly, but to a lesser extent, ongoing maintenance activities at the operational facility are likely to cause some degree of disturbance to birds in the general vicinity.

Mortality

Bird mortality has been shown to occur due to direct collisions with solar panels. Species affected include waterbirds, small raptors, doves, sparrows and warblers (Kagan et al., 2014). The reflective surfaces of PV panels may confuse approaching birds and in some cases act as an attractant, being mistaken for large water bodies, resulting in injuries

and/or mortalities when birds attempt to land on the installations. Although this is a documented impact elsewhere it is not yet well documented in South Africa and it is uncertain

Collisions with power line infrastructure

Power lines pose a significant collision risk to birds, affecting a particular suite of collision prone species. These are mostly heavy-bodied birds such as bustards, cranes, storks, large eagles and various species of waterbirds that have limited manoeuvrability in flight, which makes it difficult for them to take the necessary evasive action to avoid colliding with power lines (Anderson, 2001; van Rooyen 2004a; Jenkins *et al.,* 2010). As there are apparently no power lines associated with the development, this impact is not assessed.

Electrocutions on power line and power infrastructure

Avian electrocutions occur when a bird perches or attempts to perch on an electrical structure and causes an electrical short circuit by physically bridging the gap between live components and/or live and earthed components (van Rooyen, 2004b; Lehman *et al.,* 2007). Electrocution risk is strongly influenced by the power line voltage and the design of the pole structure and mainly affects larger, perching species such as vultures, eagles and storks that are capable of spanning the spaces between energised components. As there are apparently no power lines associated with the development, this impact is not assessed.

Habitat destruction and disturbance associated with the construction and maintenance of power lines, substations and services roads

During the construction phase and maintenance of power lines, substations and service roads, some habitat destruction and alteration inevitably takes place. These activities have an impact on birds breeding, foraging and roosting in close proximity to the servitude through the modification of habitats and disturbance, particularly during breeding activities. As there are apparently no power lines associated with the development, this impact is not assessed.

4.2 IDENTIFICATION OF PROJECT-SPECIFIC IMPACTS

Habitat loss and disturbance of small passerines

For the smaller passerine species the most important impacts will involve displacement from the area encompassed by the development footprint as a result of habitat destruction. The loss of habitat will be permanent while disturbance may be continuous during the operational phase of the solar facility. Other impacts such as disturbances caused by reflective panels and grid connecting power lines are not likely to have any appreciable impact on these small species. The impacts in general can be expected to be minimal as

these smaller species are far less susceptible to the associated impacts than larger species. Small passerine species that are likely to be impacted by the development to some extent, due to habitat destruction and displacement, include the following endemic and near-endemic species characteristic of the shrubland plains habitat: Anteating Chat *Myrmecocichla formicivora*, Sickle-winged Chat *Cercomela sinuata*, Rufous-eared Warbler *Malcorus pectoralis*, Pied Starling *Lamprotornis bicolor*, Pink-billed Lark *Spizocorys conirostris*, Eastern Clapper Lark *Mirafra fasciolata*, Spike-heeled Lark *Chersomanes albofasciata*, Large-billed Lark *Galerida magnirostris*, Black-eared Sparrowlark *Eremopterix australis*, Black-headed Canary *Serinus alario* and Cape Penduline Tit *Anthoscopus minutus*.

Habitat loss, disturbance and collision risk of small to medium terrestrial birds and raptors

Small to medium sized non-passerines that may be impacted to some extent due to habitat loss and displacement include resident and migratory raptors such as Jackal Buzzard *Buteo rufofuscus*, Pale Chanting Goshawk, Booted Eagle, Amur Falcon *Falco amurensis*, Lanner Falcon, Greater Kestrel *Falco rupicoloides*, and Lesser Kestrel, the ground-dwelling Namaqua Sandgrouse, Grey-winged Francolin*,* Northern Black Korhaan, Double-banded Courser, and the Vulnerable Burchell's Courser. These species may also be susceptible to collisions with associated infrastructure such as the PV panels and power lines, but this is not expected to have a major impact on most of these species. Grey-winged Francolin and the korhaan species may, however, be at more risk based on the recent research (Visser, 2016).

Habitat loss, disturbance and collision risk of large terrestrial birds and raptors

The group of primary concern is the medium to large non-passerines, which include the large terrestrial birds and diurnal raptors. Many of these are also red-listed, such as Ludwig's Bustard, Blue Crane, Karoo Korhaan, Tawny Eagle, Verreaux's Eagle, and Secretarybird. Besides the loss of habitat that these species will experience, disturbances during construction and maintenance of the facility is also expected to have a negative impact. In addition, most of these species are also highly susceptible to collisions with power lines owing to reduced ability to see the power lines and reduced manoeuvrability in flight to avoid collisions (Martin and Shaw, 2010; Jenkins *et al.*, 2010). All large terrestrial birds, including the red-listed species, are killed in substantial numbers by existing and newly erected power lines in the country (Jenkins *et al.*, 2010; Jenkin *et al*., 2011; Shaw, 2013). An additional threat faced by the large raptors is electrocution when perched or attempting to perch on power line structures (Lehman *et al*., 2007).

Collision risk and disturbance of waterbirds

Waterbirds are not expected to lose any habitat due to the proposed development, but they may be susceptible to other threats while commuting between water bodies. Waterbirds are known to collide with solar panels when mistaking the large reflective areas for water (Kagan *et al.*, 2014), while they are also susceptible to collisions with power lines (Jenkins *et al*., 2010). Water birds that may commute through the area between water bodies are therefore at some risk, such as the red-listed Greater Flamingo, Lesser Flamingo, Maccoa Duck and Black Stork, and the endemic South African Shelduck and Cape Shoveler. Disorientation caused by the reflective PV panels may be an additional disturbance to birds commuting through the area. Birds may also actively avoid the PV facility due to the reflective PV panels, flying further to do so and thereby using more energy (Smallie, 2013).
The anticipated impacts of the proposed development on the avifauna are considered to be of moderate to high significance, pre-mitigation. With effective implementation of mitigation measures the impacts could be reduced to a low level although this is highly dependent on the final footprint and the extent to which it impinges on higher sensitivity areas. Although habitat loss is the primary impact which will affect most species, it is the large non-passerines which will most likely be impacted the most. These species are not only susceptible to habitat loss and disturbances, but also to collisions with associated infrastructures such as power lines.

4.3 ASSESSMENT METHODOLOGY

Direct, indirect and cumulative impacts of the issues identified above, are assessed according to the following standard methodology:

- The **nature** which shall include a description of what causes the effect what will be affected and how it will be affected.

- The **extent** wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):

- The **duration** wherein it will be indicated whether:

    - the lifetime of the impact will be of a very short duration (0- 1 years).
    - the lifetime of the impact will be of a short duration (2-5 years).
    - medium-term (5-15 years).
    - long term (> 15 years); or
    - permanent

- The **magnitude** quantified as small and will have no effect on the environment, minor and will not result in an impact on processes, low and will cause a slight impact on processes, moderate and will result in processes continuing but in a

modified way, high (processes are altered to the extent that they temporarily cease) and very high and results in complete destruction of patterns and permanent cessation of processes.

- The **probability** of occurrence, which shall describe the (likelihood of the impact actually occurring. Probability will be estimated as very improbable (probably will not happen), improbable (some possibility, but of low likelihood), probable (distinct possibility), highly probable (most likely) and definite (impact will occur regardless of any prevention measures).

The **significance** which shall be determined through a synthesis of the characteristics described above and will be assessed as follows:

- **No significance**: the impacts do not influence the proposed development and/or environment in any way.
- **Low significance**: the impacts will have a minor influence on the proposed development and/or environment. These impacts require some attention to modification of the project design where possible, or alternative mitigation.
- **Moderate significance**: the impacts will have a moderate influence on the proposed development and/or environment. The impact can be ameliorated by a modification in the project design or implementation of effective mitigation measures.
- **High significance**: the impacts will have a major influence on the proposed development and/or environment and will result in the "no-go" option on the development or portions of the development regardless of any mitigation measures that could be implemented. This level of significance must be well motivated.

and;
the status, which will be described as either positive, negative or neutral.
the degree to which the impact can be reversed.
the degree to which the impact may cause irreplaceable loss of resources.
the degree to which the impact can be mitigated.

5 Assessment Of Impacts

The following assessed impacts are for the planning and construction, operational and decommissioning phases of the development. It is important to note that no assessment of power line impacts has been provided as no power line details or layout has been provided for the assessment.

Planning & Construction Phase

Nature of impact	PV Plant	Spatial Extent	Duration	Magnitude	Probability	Reversibility	Significance and Status		Confidence level
							Without Mitigation	With Mitigation	
Avifaunal Habitat loss impacts	PV1	Local	Long-Term	High	Definite	Low	V High Negative	Medium-Low Negative	High
	PV2	Local	Long-Term	High	Definite	Low	High Negative	Medium-Low Negative	High
	PV3	Local	Long-Term	High	Definite	Low	High Negative	Medium-Low Negative	High

Mitigation/Management Actions

- Avoid the high sensitive portions of the layout for each PV Plant site as indicated in the sensitivity map, such as the dolerite ridges, water bodies and raptor nests. The destruction of habitat during construction should also be strictly contained within the direct footprint of the development. Water bodies and nests should be buffered by 1km radius.
- The use of lay-down areas within the footprint of the development should be used where feasible during construction, to avoid habitat loss and disturbance to adjoining areas.
- All building waste produced during the construction phase should be removed from the development site and be disposed of at a designated waste management facility. Similarly, all liquid wastes should be contained in appropriately sealed vessels/ponds within the footprint of the development, and be disposed of at a designated waste management facility after use. Any liquid and chemical spills should be dealt with accordingly to avoid contamination of the environment.
- Only existing roads should be used as far as possible to avoid the unnecessary construction of new roads.
- Preconstruction environmental induction for all construction staff on site to ensure that basic environmental principles are adhered to. This includes awareness as to no littering, appropriate handling of pollution and chemical spills, avoiding fire hazards, minimizing wildlife interactions, remaining within demarcated construction areas etc.
- All construction vehicles should adhere to clearly defined and demarcated roads. No off-road driving to be allowed outside of the construction area.
- The number of vehicle using access and maintenance roads should also be minimised, in an attempt to keep disturbances to an absolute minimum.
- Sensitive microhabitats should be avoided, such as nesting sites during the breeding season of large terrestrial birds (generally during summer; Hockey et al., 2005).

Nature of impact	PV Plant	Spatial Extent	Duration	Magnitude	Probability	Reversibility	Significance and Status		Confidence level
							Without Mitigation	With Mitigation	
Disturbance impacts on avifauna and listed bird species during Construction	PV1	Local	Short- Term	Medium	Probable	High	Medium Negative	Low Negative	High
	PV2	Local	Short- Term	Medium	Probable	High	Medium Negative	Low Negative	High
	PV3	Local	Short- Term	Medium	Probable	High	Medium Negative	Low Negative	High
Mitigation/Management Actions									
• No construction activity should occur near to active raptor nests. If there are active nests near construction areas, they should be monitored until the birds have finished nesting and the fledglings left the nest. • All personnel should undergo environmental induction with regards to fauna and in particular awareness about not harming species such as owls which are often persecuted out of superstition. • All construction vehicles should adhere to a low speed limit to avoid collisions. • All hazardous materials should be stored in the appropriate manner to prevent contamination of the site. Any accidental chemical, fuel and oil spills that occur at the site should be cleaned up in the appropriate manner as related to the nature of the spill.									

Operational Phase

Nature of impact	PV Plant	Spatial Extent	Duration	Magnitude	Probability	Reversibility	Significance and Status		Confidence level
							Without Mitigation	With Mitigation	
Avifauna collisions with PV panels	PV1	Local	Long-term	Medium-Low	Improbable	Low	Medium-Low Negative	Low Negative	Medium
	PV2	Local	Long-term	Medium-Low	Improbable	Low	Medium-Low Negative	Low Negative	Medium
	PV3	Local	Long-term	Medium-Low	Improbable	Low	Medium-Low Negative	Low Negative	Medium

Nature of impact	PV Plant	Spatial Extent	Duration	Magnitude	Probability	Reversibility	Significance and Status		Confidence level
							Without Mitigation	With Mitigation	
Mitigation/Management Actions									
• The layout of solar arrays should be placed so as to avoid bird flight paths between focal points such as water bodies, foraging and roosting sites. • It has been suggested by Visser (2016) that collision mortality could be reduced at solar facilities by using 28 cm-spaced contrasting bands or 10 cm spatial gaps between solar panels. This enables birds, particularly waterbirds, to differentiate the expansive layout of panels as a solid structure, reducing the likelihood that they may try to land and collide with the panels. These recommendations should therefore be incorporated into new solar facilities until further research into panel design and layout suggests otherwise. • All incidents of collision with panels should be recorded as meticulously as possible, including data related to the species involved, the exact location of collisions within the facility, and suspected cause of death. Post-construction monitoring with the aid of video surveillance should be considered, as this will contribute towards understanding bird interactions with solar panels.									
Avifaunal impacts from disturbance and operational activities	PV1	Local	Long-term	Low	Probable	High	Low Negative	V Low-Negative	High
	PV2	Local	Long-term	Low	Probable	High	Low Negative	V Low-Negative	High
	PV3	Local	Long-term	Low	Probable	High	Low Negative	V Low-Negative	High
Mitigation/Management Actions									
• If birds are nesting on the infrastructure of the facility and cannot be tolerated due to operational risks of fire, electrical short, soiling of panels or other problems, birds should be prevented from accessing nesting sites by using mesh or other manner of excluding them. Birds should not be shot, poisoned or harmed as this is not an effective control method and has negative ecological consequences. Birds already with eggs and chicks should be allowed to fledge their chicks before nests are removed. • If there are any persistent problems with avifauna, then an avifaunal specialist should be consulted for advice on further mitigation. • All food waste and litter at the site should be placed in bins with lids and removed from the site on a regular basis. • If the site must be lit at night for security purposes, this should be done with downward-directed low-UV type lights (such as most LEDs), which do not attract insects. The use of lighting at night should be kept to a minimum, so as not to unnecessarily attract invertebrates to the solar facility and possibly their avian predators, and to minimise disturbance to birds flying over the facility at night. • Any movements by vehicle and personnel should be limited to within the footprint of power lines and other associated infrastructure, especially during routine maintenance procedures. Utmost care should be taken to not disturb nests that may be constructed on power line structures. • All hazardous materials should be stored in the appropriate manner to prevent contamination of the site. Any accidental chemical, fuel and oil spills that occur at the site should be cleaned up in the appropriate manner as related to the nature of the spill. • All vehicles accessing the site should adhere to a low speed limit (30km/h max) to avoid collisions with susceptible species.									

Decommissioning Phase

Nature of impact	PV Plant	Spatial Extent	Duration	Magnitude	Probability	Reversibility	Significance and Status		Confidence level
							Without Mitigation	With Mitigation	
Avifauna impact from disturbance	PV1	Local	Short-term	Medium-Low	Probable	High	Medium-Low Negative	Low-Negative	High
	PV2	Local	Short-term	Medium-Low	Probable	High	Medium-Low Negative	Low-Negative	High
	PV3	Local	Short-term	Medium-Low	Probable	High	Medium-Low Negative	Low-Negative	High
Mitigation/Management Actions									
• All personnel should undergo environmental induction with regards to avifauna and in particular not disturbing or harming birds. • If there are active nests at the site at decommissioning, these should be left along until the birds have finished breeding. • All construction vehicles should adhere to a low speed limit (50km/h) to avoid collisions with susceptible species. • All litter and rubble from decommissioning should be cleaned up and removed from the site. • All hazardous materials should be stored in the appropriate manner to prevent contamination of the site. Any accidental chemical, fuel and oil spills that occur at the site should be cleaned up in the appropriate manner as related to the nature of the spill.									

Cumulative Impacts

The following are the cumulative impacts that are assessed as being a likely consequence of the development.

Nature of impact	PV Plant	Spatial Extent	Duration	Intensity	Probability	Reversibility	Significance and Status		Confidence level
							Without Mitigation	With Mitigation	

Nature of impact	PV Plant	Spatial Extent	Duration	Intensity	Probability	Reversibility	Significance and Status		Confidence level
							Without Mitigation	With Mitigation	
Habitat fragmentation and negative impacts on IBAs	PV1	Regional	Long-Term	Medium	Improbable	Low	Medium-High Negative	Low Negative	Moderate-High
	PV2	Regional	Long-Term	Medium	Improbable	Low	Medium-High Negative	Low Negative	Moderate-High
	PV3	Regional	Long-Term	Medium	Improbable	Low	Medium-High Negative	Low Negative	Moderate-High
Mitigation/Management Actions									
• Development in the higher sensitivity areas and habitats must be avoided. • Impacts on avifauna must be monitored and reported to authorities on an annual basis. • If all three PV developments are constructed, then an offset area at the site should be identified and set aside for conservation-orientated use. It is recommended that this could be the western-most section of the site including the plains along the N10 and the adjacent dolerite hills.									

6 CONCLUSION & RECOMMENDATIONS

The study area lies within the eastern extreme of the Nama Karoo Biome, where this meets the ecotone with the Grassland Biome. Although this region appears typical of much of the upper Nama Karoo, it supports populations of several red-listed species. Many of these are medium to large terrestrial birds (cranes, bustards, korhaans) and large raptors which occur in good numbers throughout the year. The study area and broader impact zone of the proposed development are therefore considered important for the conservation of these species.

The proposed Soventix solar facility has the potential to have a medium to high impact on the avifauna of the study area. The priority species in particular are at risk since most of these are susceptible to associated threats. The primary impacts that the proposed development will have include 1) a medium displacement impact caused by habitat loss and disturbance associated with construction and maintenance activities, 2) a medium impact related to avian collisions with solar panels and power line infrastructure, and 3) a medium to low impact related to cumulative habitat loss at a broader scale from renewable energy development in the wider area.

Several mitigation measures can be implemented during the construction and maintenance phase of the proposed development to reduce the impacts on the avifauna. Mitigation measures may assist in reducing the impacts associated with power line electrocutions and collisions with solar panels and power line infrastructure, and should be implemented as far as possible. Regular monitoring of these impacts should be undertaken to determine high risk areas where further mitigation can be implemented, and to contribute to a better understanding of the interactions between birds and solar facilities.

Some protected species are present but these are relatively widespread species and the impact on these species could be reduced by the proposed mitigation meausres, specifically buffering nests, water bodies and avoiding rocky outcrops and other higher sensitivity areas, as well as ensuring bird-friendly PV layouts and fixing bird flappers onto powerlines where present. The development is likely to have an impact on avifauna, especially during the construction phase, but in the long term, it is likely that most species will be able to continue to utilise the site and any impacts on avifauna would be of local significance only.

The broad area around the site has a large amount of renewable energy development, from both wind and solar development, increasing the potential significance of cumulative impacts at the site. However, the plains around the site are still largely undeveloped and the three proposed development areas are separated by some distance, which would facilitate movement of avifauna and allow for use of the intervening areas. The overall

impact on landscape connectivity is likely to be low, especially given the largely intact nature of the surrounding landscape.

With mitigation and specifically the strict avoidance of the high sensitivity areas, the identified avifaunal impacts can be reduced to an acceptable level. While there are certainly some sensitive areas at the site that need to be avoided, there are also fairly extensive areas of lower sensitivity plains present, where development should be focussed. As these plains are extensive, the extent of habitat loss resulting from the development of the PV facilities at the site is considered fairly low and would not be likely to pose a threat to the long-term persistence of any avifauna at the site. With the implementation of these mitigation measures, the impact of the development can be reduced to an acceptable level and as such there are no fatal flaws associated with the development that should prevent it from proceeding. A final caveat is however that a power line layout has not been provided for the assessment and this could potentially have a significant impact on the current assessment should a long power line be required.

7 REFERENCES

Dean, W.R.J. 2000. Factors affecting bird diversity patterns in the Karoo, South Africa. South African Journal of Science 96: 609-616.

Dodman, T. & Diagana, C.H. 2007. Movements of waterbirds within Africa and their conservation implications. Ostrich 78: 149-154.

Froneman, A., Mangnall, M., Little, R. & Crowe, T. 2001. Waterbird assemblages and associated habitat characteristics of farm ponds in the Western Cape, South Africa. Biodiversity and Conservation 10: 251-270.

González-Gajardo, A., Victoriano Sepúlveda, P., & Schlatter, R. 2009. Waterbird assemblages and habitat characteristics in wetlands: Influence of temporal variability on species-habitat relationships. Waterbirds 32(2): 225-233.

Harrison, J.A., Allan, D.G., Underhill, L.G., Herremans, M., Tree, A.J., Parker, V. & Brown, C.J. (eds). 1997. The atlas of southern African birds. Vol. 1 & 2. BirdLife South Africa, Johannesburg.

Hockey, P.A.R., Dean, W.R.J. & Ryan, P.G. (eds). 2005. Roberts Birds of Southern Africa, 7th edition. The Trustees of the John Voelcker Bird Book Fund, Cape Town.

Jenkins, A.R., Ralston-Paton, S. & Smit-Robinson, H.A. 2016. Birds and solar energy best practice guidelines. Birdlife South Africa, Johannesburg.

Jenkins, A.R., Shaw, J.M., Smallie, J.J., Gibbons, B., Visagie, R. & Ryan, P.G. 2011. Estimating the impacts of power line collisions on Ludwig's Bustards Neotis ludwigii. Bird Conservation International 21: 303–310.

Jenkins, A.R., Smallie, J.J. & Diamond, M. 2010. Avian collisions with power lines: a global review of causes and mitigation with a South African perspective. Bird Conservation International 20: 263-278.

Kagan, R.A., Verner, T.C., Trail, P.W. & Espinoza, E.O. 2014. Avian mortality at solar energy facilities in southern California: a preliminary analysis. Unpublished report National Fish & Wildlife Forensics Laboratory, USA.

Lehman, R.N., Kennedy, P.L. & Savidge, J.A. 2007. The state of the art in raptor electrocution research: A global review. Biological Conservation 136: 159-174.

Marnewick, M.D., Retief, E.F., Theron, N.T., Wright, D.R. & Anderson, T.A. 2015. Important Bird and Biodiversity Areas of South Africa. Birdlife South Africa, Johannesburg.

Martin, G.R. & Shaw, J.M. 2010. Bird collisions with power lines: Failing to see the way ahead? Biological Conservation 143: 2695-2702.

Mucina L. & Rutherford M.C. (eds) 2006. *The Vegetation of South Africa, Lesotho and Swaziland*. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

Mucina, L. & Rutherford, C. 2006. The Vegetation of South Africa, Lesotho and Swaziland. South African National Biodiversity Institute, Pretoria.

Platberg-Karoo Conservancy. 2015. http://www.birdlife.org.za/conservation/important-bird-areas/iba-directory/item/178-sa037-platberg-karoo-conservancy

Shaw, J.M. 2013. Power line collisions in the Karoo: conserving Ludwig's Bustard. Unpublished PhD thesis, University of Cape Town, Cape Town.

Smallie, J.J. 2013. Common bird interactions with wind and solar energy facilities. Unpublished Wildskies report.

Smit, H.A. 2012. Guidelines to minimise the impacts on birds of solar facilities and associated infrastructure in South Africa. Birdlife South Africa, Johannesburg.

Southern African Bird Atlas Project 2 (SABAP2). http://sabap2.adu.org.za Accessed 7 March 2017.

Taylor, M.R., Peacock, F. & Wanless, R.W. (eds) 2015. The 2015 Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland. Birdlife South Africa, Johannesburg.

Taylor, P.B., Navarro, R.A., Wren-Sargent, M., Harrison, J.A. & Kieswetter, S.L. (eds) 1999. TOTAL CWAC Report: Coordinated Waterbird Counts in South Africa, 1992-1997. Avian Demography Unit, University of Cape Town, Cape Town.

Visser, E. 2016. The impact of South Africa's largest photovoltaic solar energy facility on birds in the Northern Cape, South Africa. Unpublished MSc thesis, University of Cape Town, Cape Town.

Walston, L.J, Rollins, K.E, LaGory, K.E., Smith, K.P. & Meyers, S.A. 2016. A preliminary assessment of avian mortality at utility-scale solar energy facilities in the United States. Renewable Energy 92: 405-414.

Young, D.J., Harrison, J.A., Navarro, R.A., Anderson, M.A. & Colahan, B.D. 2003. Big birds on farms: Mazda CAR report 1993-2001. Avian Demography Unit, Cape Town.

ANNEX 1. LIST OF BIRDS

List of birds which are likely to occur in the vicinity of the Soventix PV project site, according to the SABAP 2 database for pentad 3050_2415 (QDGC: 3024CD). South African conservation status from the list of threatened birds (2016) available from the Bird Life South Africa website, http://www.birdlife.org.za.

Common name	Taxon name	Conservation Status
Avocet, Pied	*Recurvirostra avosetta*	LC
Barbet, Acacia Pied	*Tricholaema leucomelas*	LC
Bee-eater, European	*Merops apiaster*	LC
Bishop, Southern Red	*Euplectes orix*	LC
Bokmakierie, Bokmakierie	*Telophorus zeylonus*	LC
Bulbul, African Red-eyed	*Pycnonotus nigricans*	LC
Bunting, Cape	*Emberiza capensis*	LC
Bunting, Cinnamon-breasted	*Emberiza tahapisi*	LC
Bunting, Lark-like	*Emberiza impetuani*	LC
Bustard, Ludwig's	*Neotis ludwigii*	EN
Buzzard, Jackal	*Buteo rufofuscus*	LC
Canary, Black-throated	*Crithagra atrogularis*	LC
Canary, White-throated	*Crithagra albogularis*	LC
Canary, Yellow	*Crithagra flaviventris*	LC
Chat, Anteating	*Myrmecocichla formicivora*	LC
Chat, Familiar	*Cercomela familiaris*	LC
Chat, Karoo	*Cercomela schlegelii*	LC
Chat, Sickle-winged	*Cercomela sinuata*	LC

Common name	Taxon name	Conservation Status
Cisticola, Grey-backed	*Cisticola subruficapilla*	LC
Cliff-swallow, South African	*Hirundo spilodera*	LC
Coot, Red-knobbed	*Fulica cristata*	LC
Crane, Blue	*Anthropoides paradiseus*	NT
Crombec, Long-billed	*Sylvietta rufescens*	LC
Crow, Pied	*Corvus albus*	LC
Cuckoo, Diderick	*Chrysococcyx caprius*	LC
Dove, Laughing	*Streptopelia senegalensis*	LC
Dove, Red-eyed	*Streptopelia semitorquata*	LC
Drongo, Fork-tailed	*Dicrurus adsimilis*	LC
Duck, Yellow-billed	*Anas undulata*	LC
Eagle, Booted	*Aquila pennatus*	LC
Eagle-owl, Spotted	*Bubo africanus*	LC
Eremomela, Yellow-bellied	*Eremomela icteropygialis*	LC
Fiscal, Common (Southern)	*Lanius collaris*	LC
Fish-eagle, African	*Haliaeetus vocifer*	LC
Flamingo, Greater	*Phoenicopterus ruber*	NT
Flycatcher, Fairy	*Stenostira scita*	LC
Flycatcher, Fiscal	*Sigelus silens*	LC
Francolin, Grey-winged	*Scleroptila africanus*	LC
Goose, Egyptian	*Alopochen aegyptiacus*	LC
Goose, Spur-winged	*Plectropterus gambensis*	LC
Goshawk, Southern Pale Chanting	*Melierax canorus*	LC

Common name	Taxon name	Conservation Status
Grebe, Black-necked	*Podiceps nigricollis*	LC
Grebe, Little	*Tachybaptus ruficollis*	LC
Greenshank, Common	*Tringa nebularia*	LC
Guineafowl, Helmeted	*Numida meleagris*	LC
Heron, Black-headed	*Ardea melanocephala*	LC
Honeyguide, Lesser	*Indicator minor*	LC
Hoopoe, African	*Upupa africana*	LC
Ibis, Hadeda	*Bostrychia hagedash*	LC
Kestrel, Greater	*Falco rupicoloides*	LC
Kestrel, Lesser	*Falco naumanni*	LC
Korhaan, Blue	*Eupodotis caerulescens*	Global=NT
Korhaan, Karoo	*Eupodotis vigorsii*	NT
Korhaan, Northern Black	*Afrotis afraoides*	LC
Lapwing, Blacksmith	*Vanellus armatus*	LC
Lapwing, Crowned	*Vanellus coronatus*	LC
Lark, Eastern Clapper	*Mirafra fasciolata*	LC
Lark, Karoo Long-billed	*Certhilauda subcoronata*	LC
Lark, Large-billed	*Galerida magnirostris*	LC
Lark, Spike-heeled	*Chersomanes albofasciata*	LC
Martin, Brown-throated	*Riparia paludicola*	LC
Martin, Rock	*Hirundo fuligula*	LC
Masked-weaver, Southern	*Ploceus velatus*	LC
Mousebird, Red-faced	*Urocolius indicus*	LC

Common name	Taxon name	Conservation Status
Mousebird, White-backed	*Colius colius*	LC
Ostrich, Common	*Struthio camelus*	LC
Owl, Barn	*Tyto alba*	LC
Pigeon, Speckled	*Columba guinea*	LC
Pipit, African	*Anthus cinnamomeus*	LC
Pipit, African Rock	*Anthus crenatus*	NT
Pipit, Long-billed	*Anthus similis*	LC
Pipit, Plain-backed	*Anthus leucophrys*	LC
Plover, Kittlitz's	*Charadrius pecuarius*	LC
Plover, Three-banded	*Charadrius tricollaris*	LC
Pochard, Southern	*Netta erythrophthalma*	LC
Prinia, Karoo	*Prinia maculosa*	LC
Quailfinch, African	*Ortygospiza atricollis*	LC
Quelea, Red-billed	*Quelea quelea*	LC
Robin-chat, Cape	*Cossypha caffra*	LC
Ruff, Ruff	*Philomachus pugnax*	LC
Sandpiper, Curlew	*Calidris ferruginea*	Global=NT
Scrub-robin, Karoo	*Cercotrichas coryphoeus*	LC
Secretarybird, Secretarybird	*Sagittarius serpentarius*	VU
Shelduck, South African	*Tadorna cana*	LC
Shoveler, Cape	*Anas smithii*	LC
Sparrow, Cape	*Passer melanurus*	LC
Sparrow, House	*Passer domesticus*	LC

Common name	Taxon name	Conservation Status
Sparrowlark, Grey-backed	*Eremopterix verticalis*	LC
Spoonbill, African	*Platalea alba*	LC
Starling, Cape Glossy	*Lamprotornis nitens*	LC
Starling, Pied	*Spreo bicolor*	LC
Starling, Red-winged	*Onychognathus morio*	LC
Stilt, Black-winged	*Himantopus himantopus*	LC
Stint, Little	*Calidris minuta*	LC
Stonechat, African	*Saxicola torquatus*	LC
Swallow, Barn	*Hirundo rustica*	LC
Swallow, Greater Striped	*Hirundo cucullata*	LC
Swallow, White-throated	*Hirundo albigularis*	LC
Swift, Little	*Apus affinis*	LC
Swift, White-rumped	*Apus caffer*	LC
Teal, Cape	*Anas capensis*	LC
Teal, Red-billed	*Anas erythrorhyncha*	LC
Thick-knee, Spotted	*Burhinus capensis*	LC
Thrush, Karoo	*Turdus smithi*	LC
Tit, Grey	*Parus afer*	LC
Tit-babbler, Chestnut-vented	*Parisoma subcaeruleum*	LC
Tit-babbler, Layard's	*Parisoma layardi*	LC
Turtle-dove, Cape	*Streptopelia capicola*	LC
Wagtail, Cape	*Motacilla capensis*	LC
Warbler, Rufous-eared	*Malcorus pectoralis*	LC

Common name	Taxon name	Conservation Status
Wheatear, Capped	*Oenanthe pileata*	LC
Wheatear, Mountain	*Oenanthe monticola*	LC
White-eye, Orange River	*Zosterops pallidus*	LC
Whydah, Pin-tailed	*Vidua macroura*	LC