ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED HYPERION SOLAR DEVELOPMENT 2 AND ASSOCIATED INFRASTRUCTURE, KATHU, NORTHERN CAPE:

AVIFAUNAL SPECIALIST IMPACT ASSESSMENT REPORT

Lilac-breasted Roller *Coracias caudatus*

PRODUCED FOR SAVANNAH ENVIRONMENTAL

BY

3Foxes Biodiversity Solutions

Simon.Todd@3foxes.co.za

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EXECUTIVE SUMMARY

Hyperion Solar Development 2 (Pty) Ltd is proposing the establishment of a 75MW commercial Photovoltaic (PV) solar energy facility (SEF) and associated infrastructure, called Hyperion Solar Development 2 (proposed development), on the Remainder of the Farm Lyndoch 432, situated north of Kathu in the Gamagara Local Municipality, Northern Cape Province. Three additional 75MW SEFs and associated infrastructure are proposed within the same property (project site) and will be submitted as separate projects. This report has been compiled specifically for the Hyperion Solar Development 2 including associated infrastructure. The proposed development is currently in the EIA Phase and Hyperion Solar Development 2 (Pty) Ltd has appointed 3Foxes Biodiversity Solutions to provide a specialist avifaunal impact study of the project site as part of the Environmental Impact Assessment (EIA) process.

A full field assessment over two seasons as well as a desktop review of the available avifaunal information for the area was conducted in order to identify and characterise the avifaunal features of the project site. The avifauna is considered typical of the Kalahari bioregion. An approximate total of 220 bird species have been recorded within the broader project site, of which 97 species were observed during the field surveys. Very few of the species are listed as endemic (one species) and near-endemic (five species) or biome-restricted (five species). There are no known Important Bird Areas (IBAs) within the vicinity of the project site, while there are also no known wetlands of significant avifaunal importance.

Fourteen (14) red-listed species are known to occur in the broader area or are likely to occur at the project site. Of these, ten (10) species are listed as threatened, while four (4) others are considered Near-Threatened. However, only one of these (Kori Bustard *Ardeotis kori*) was recorded during the summer site visit while none have been reported during recent atlas surveys. For the majority of these species their populations are considered to be marginal to the area and of low local significance. The Critically Endangered White-backed Vulture *Gyps africanus*, the Endangered Martial Eagle *Polemaetus bellicosus*, the Vulnerable Lanner Falcon *Falco biarmicus* and the Near-Threatened Kori Bustard are considered the most important priority species in the area. Although they are not known to breed in the area, the bustard is perhaps more regularly observed in the area than any of the others. Further, no sensitive breeding or roosting sites of any red-listed species were observed at the project site during the field surveys.

The expected impacts of the proposed solar development within the project site include 1) habitat loss and fragmentation associated with the Kathu Bushveld habitat, 2) disturbance caused during the construction and maintenance phases, 3) direct mortality of avifauna colliding with solar panels and potential entrapment and electrocutions along perimeter fencing (only where double-fence designs are employed), and 4) cumulative habitat loss at

a broader scale from renewable energy developments in the broader area The species that will be the most negatively impacted by the proposed development include mostly small passerines, ground-dwelling non-passerines and large raptors and terrestrial birds that occasionally use the area for foraging. The impacts on the avifauna would normally be expected to be of medium importance, but due to the low frequency of occurrence of priority species, the impacts are likely to be low and no high post-mitigation impacts are expected.

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) exclusion of the dry riverbed of the Vlermuisleegte River from any development, and 3) ensure that perimeter fencing along the boundaries of the development are bird (especially ground-dwelling species) and wildlife friendly.

Cumulative impacts associated with the development area (approximately 200ha in extent) together with other similar developments are a concern due to the increasing number of solar facility developments proposed for the broader Kathu area. Considering that vegetation and avifauna that occur on the property are typical of the Kalahari bioregion, the overall cumulative avifaunal impact of the development is still considered likely to be relatively low, provided that suitable ecological corridors within the broader area are identified and maintained. This is to ensure that ecological connectivity between areas of higher conservation value is preserved.

Impact Statement

Considering that the broader project site supports a typical bioregional avifaunal assemblage, and that there are no known breeding or roosting sites of red-listed priority species on the site, there are no impacts associated with the development that are considered to be of high significance and which cannot be mitigated to a low level. Consequently, the development can be supported from an avifaunal perspective. It is therefore the reasoned opinion of the specialist that the Hyperion Solar Development 2 project should be authorised, subject to the implementation of the recommended mitigation measures.

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COMPLIANCE WITH APPENDIX 6 OF THE 2014 EIA REGULATIONS, AS AMENDED

Requirements of Appendix 6 – GN R326 2014 EIA Regulations, 7 April 2017	**Addressed in the Specialist Report**
1. (1) A specialist report prepared in terms of these Regulations must contain- a) details of- i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	6-8
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	9-10
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(cA) an indication of the quality and age of base data used for the specialist report;	15-18
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	29-35
d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	15-18
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g) an identification of any areas to be avoided, including buffers;	26-28
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	27
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j) a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	18-28
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o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	See Main Report
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	See Main Report
q) any other information requested by the competent authority.	
2) Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	N/A

SHORT CV/SUMMARY OF EXPERTISE

Simon Todd

Simon Todd is Director and principal scientist at 3Foxes Biodiversity Solutions and has over 20 years of experience in biodiversity measurement, management and assessment. He has provided specialist ecological input on more than 200 different developments distributed widely across the country. This includes input on the Wind and Solar SEA (REDZ) as well as the Eskom Grid Infrastructure (EGI) SEA and Karoo Shale Gas SEA. He is on the National Vegetation Map Committee as representative of the Nama and Succulent Karoo Biomes. Simon Todd is a recognised ecological expert and is a past chairman and current deputy chair of the Arid-Zone Ecology Forum. He is registered with the South African Council for Natural Scientific Professions (No. 400425/11).

Skills & Primary Competencies

- Research & description of ecological patterns & processes in Nama Karoo, Succulent Karoo, Thicket, Arid Grassland, Fynbos and Savannah Ecosystems.
- Ecological Impacts of land use on biodiversity
- Vegetation surveys & degradation assessment & mapping
- Long-term vegetation monitoring
- Faunal surveys & assessment.
- GIS & remote sensing

Tertiary Education:

- 1992-1994 – BSc (Botany & Zoology), University of Cape Town
- 1995 – BSc Hons, Cum Laude (Zoology) University of Natal
- 1996-1997- MSc, Cum Laude (Conservation Biology) University of Cape Town

Employment History

- 2009 – Present – Sole Proprietor of Simon Todd Consulting, providing specialist ecological services for development and research.
- 2007 Present – Senior Scientist (Associate) – Plant Conservation Unit, Department of Botany, University of Cape Town.

- 2004-2007 – Senior Scientist (Contract) – Plant Conservation Unit, Department of Botany, University of Cape Town
- 2000-2004 – Specialist Scientist (Contract) - South African National Biodiversity Institute
- 1997 – 1999 – Research Scientist (Contract) – South African National Biodiversity Institute

A selection of recent work is as follows:

Strategic Environmental Assessments

Co-Author. Chapter 7 - Biodiversity & Ecosystems - Shale Gas SEA. CSIR 2016.

Co-Author. Chapter 1 Scenarios and Activities – Shale Gas SEA. CSIR 2016.

Co-Author – Ecological Chapter – Wind and Solar SEA. CSIR 2014.

Co-Author – Ecological Chapter – Eskom Grid Infrastructure SEA. CSIR 2015.

Contributor – Ecological & Conservation components to SKA SEA. CSIR 2017.

Recent Specialist Ecological Studies in the Vicinity of the Current Site

- Kathu Solar PV Facility. Fauna and Flora EIA Process. Cape EAPrac 2015.
- Mogobe Solar PV Facility. Fauna and Flora EIA Process. Cape EAPrac 2015.
- Legoko Solar PV Facility. Fauna and Flora EIA Process. Cape EAPrac 2015.
- RE Capital 10 Solar Power Plant, Postmasburg. Fauna and Flora EIA Proces. Cape EAPrac 2015.
- Walk-through study of Kumba Iron Ore expansion area at Dingleton, Northern Cape. MSA Group. 2017.
- Adams PV Project – EIA process and follow-up vegetation survey. Aurora Power Solutions. 2016.
- Mamatwane Compilation Yard. Fauna and Flora EIA process. ERM. 2013.
- Olifantshoek-Emil 132kV power line. Fauna and Flora BA process. Savannah Environmental 2017.
- Gaetsewe Solar PV Facility. Fauna and Flora EIA Process. Cape EAPrac 2018.
- Mogara Solar PV Facility. Fauna and Flora EIA Process. Cape EAPrac 2018.
- Hotazel Solar PV Facility. Fauna and Flora EIA Process. Cape EAPrac 2018.

Eric Herrmann

Eric Herrmann is an avifaunal specialist with over 15 years of experience in biodiversity research and conservation in the Northern Cape. He completed a B.Tech Degree in Nature Conservation (1999) at the Cape Technikon, followed by a Masters in Conservation Ecology at the University of Stellenbosch (2004). He has worked as a research assistant for the Endangered Wildlife Trust (1999-2001) in the Kgalagadi Transfrontier Park, and then for the Percy FitzPatrick Institute of African Ornithology (University of Cape Town) as project manager of a field research centre near Kimberley (2003 to 2006). In 2006 he joined the provincial Department of Environment and Nature Conservation (DENC) in Kimberley as a faunal

scientist until 2012. Since 2016 he has been working independently as an avifaunal specialist largely on wind and solar energy projects in the Western and Northern Cape.

Tertiary Education:

- 1994 - 1997 – National Diploma: Nature Conservation (cum laude), Cape Technikon
- 1998 - 1999 – B.Tech Degree: Nature Conservation (cum laude), Cape Technikon
- 2000 - 2004 – MFor: Conservation Ecology (cum Laude), University of Stellenbosch

Employment History

- 2016 - Present – Independent contractor, avifaunal specialist for renewable energy projects.
- 2006 - 2012 – Senior Conservation Scientist, Department of Environment and Nature Conservation, Kimberley.
- 2003 - 2006 – Research Assistant and Field Projects Manager, Percy Fitzpatrick Institute of African Ornithology, Cape Town
- 2001 - 2002 – Field Researcher, Deciduous Fruit Producers Trust, Stellenbosch.
- 1999 - 2001 – Research Assistant, Endangered Wildlife Trust, Johannesburg.

Recent Specialist Avifaunal projects related to Solar and Wind energy or transmission infrastructure:

- Dassieklip Wind Facility. Avifaunal post-construction monitoring. BTE Wind Pty (Ltd). 2018/19.
- Excelsior Wind Facility. Avifaunal pre-construction monitoring. BTE Wind Pty (Ltd). 2018/19.
- Gaetsewe Solar PV Facility. Avifaunal Scoping Report. Cape EAPrac 2018.
- Mogara Solar PV Facility. Avifaunal Scoping Report. Cape EAPrac 2018.
- Hotazel Solar PV Facility. Fauna and Flora EIA Process. Cape EAPrac 2018.
- Mamre Wind Facility. Avifaunal pre-construction monitoring. Mulilo Renewable Project Developments. 2017.
- Soventix Solar PV Facility (De Aar). Avifaunal Specialist Scoping and EIA Reports. Ecoleges. 2017.
- Olifantshoek-Emil 132kV power line. Ecological Basic Assessment Report. Savannah Environmental. 2016.
- Klondike (Vryburg) Solar PV Facility. Ecological Specialist Report for EIA. Cape EAPrac 2016.

SPECIALIST DECLARATION

I, ..Simon Todd....., as the appointed independent specialist, in terms of the 2014 EIA Regulations, hereby declare that I:

- I act as the independent specialist in this application;
- I 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;
- 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, 2014 and any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- 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;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the specialist: 

Name of Specialist: ____Simon Todd_____

Date: ____27 March 2019_____

SPECIALIST DECLARATION

I, ..Eric Herrmann....., as the appointed independent specialist, in terms of the 2014 EIA Regulations, hereby declare that I:

- I act as the independent specialist in this application;
- I 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;
- 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, 2014 and any specific environmental management Act;
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- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the specialist: 

Name of Specialist: ____Eric Herrmann_____

Date: ____27 March 2019_____

1 INTRODUCTION

Hyperion Solar Development 2 (Pty) Ltd is proposing the establishment of a 75MW commercial Photovoltaic (PV) solar energy facility (SEF) and associated infrastructure, called Hyperion Solar Development 2 (proposed development), on the Remainder of the Farm Lyndoch 432, situated north of Kathu in the Gamagara Local Municipality, Northern Cape Province. Three additional 75MW SEFs and associated infrastructure are proposed within the same property and will be submitted as separate projects. This report has been compiled specifically for the Hyperion Solar Development 2 including associated infrastructure. The proposed development is currently in the EIA Phase and Hyperion Solar Development 2 (Pty) Ltd has appointed 3Foxes Biodiversity Solutions to provide a specialist avifaunal impact assessment of the development site as part of the EIA process.

The purpose of the Hyperion Solar Development 2 Avifaunal Specialist Report is to 1) describe the avian ecological features of the proposed PV project site, 2) to provide a preliminary assessment of the avian ecological sensitivity of the project site and development area, and 3) identify and assess the significance of the likely impacts on the avifauna associated with the development of the site as a solar PV facility, and 4) to provide measures to avoid, minimize and mitigate project related impacts to the avifauna. A three-day site visit in winter (13 to 16 August 2018) and summer (29 to 31 January 2019), as well as a desktop review of the available literature for the area was conducted in order to identify and characterise the local avifauna at the site.

This information is used to derive an avifaunal sensitivity map that presents the ecological constraints and opportunities for development at the project site. The information and sensitivity map presented here provides an avifaunal baseline that has been used in the planning phase of the development to ensure that the potential negative avifaunal impacts associated with the development have been minimized within the site as far as possible. Impacts are assessed for the pre-construction, construction, operation, and decommissioning phases of the development. A variety of avoidance and mitigation measures associated with each identified impact are recommended to reduce the likely impact of the development, which should be included in the EMPr for the development. The full scope of study is detailed below.

1.1 SCOPE OF STUDY

The assessment is conducted according to the 2014 EIA Regulations (Government Notice Regulation 982, as amended) in terms of the National Environmental Management Act (Act 107 of 1998) as amended (NEMA), as well as best-practice guidelines and principles for avifaunal assessment within solar energy facilities as outlined by Birdlife South Africa (Jenkins *et al.*, 2017).

The scope of the study includes the following activities:

- a description of the avifauna that may be affected by the activity and the manner in which the avifauna may be affected by the proposed project
- a description and evaluation of environmental issues and potential impacts on the avifauna (including using direct, indirect and cumulative impacts) that have been identified
- a statement regarding the potential significance of the identified issues based on the evaluation of the issues/impacts
- an indication of the methodology used in determining the significance of potential impacts on the avifauna
- an assessment of the significance of direct indirect and cumulative impacts in terms of the following criteria:
    - the nature of the impact, which shall include a description of what causes the effect, what will be affected, and how it will be affected
    - the extent of the impact, indicating whether the impact will be local (limited to the immediate area or site of development), regional, national or international
    - the duration of the impact, indicating whether the lifetime of the impact will be of a short-term duration (0-5 years), medium-term (5-15 years), long-term (> 15 years, where the impact will cease after the operational life of the activity), or permanent
    - the probability of the impact, describing the likelihood of the impact actually occurring, indicated as improbable (low likelihood) probable (distinct possibility), highly probable (most likely), or definite (Impact will occur regardless of any preventable measures)
    - the severity/beneficial scale indicating whether the impact will be very severe/beneficial (a permanent change which cannot be mitigated/permanent and significant benefit with no real alternative to achieving this benefit), severe/beneficial (long-term impact that could be mitigated/long-term benefit), moderately severe/beneficial (medium- to long-term impact that could be mitigated/ medium- to long-term benefit), slight, or have no effect
    - the significance which shall be determined through a synthesis of the characteristics described above and can be assessed as low medium or high
    - 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

- a description and comparative assessment of all alternatives
- 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 positive and negative implications of the proposed activity;
    - a comparative assessment of the positive and negative implications of identified alternatives.

General Considerations:

- Disclose any gaps in information or assumptions made.
- Identify recommendations for mitigation measures to minimise impacts.
- Outline additional management guidelines.
- Provide monitoring requirements, mitigation measures and recommendations in a table format as input into the Environmental Management Plan (EMP) for avifaunal related issues.

A description of the potential impacts of the development and recommended mitigation measures are to be provided, which will be separated into the following project phases:

- Preconstruction
- Construction
- Operational
- Decommissioning

1.2 RELEVANT ASPECTS OF THE DEVELOPMENT

The proposed development is located on the Remainder of the Farm Lyndoch 432, situated north of Kathu in the Gamagara Local Municipality, Northern Cape Province. (**Error! Reference source not found.**). Hyperion Solar Development 2 is to consist of solar photovoltaic (PV) technology with fixed, single and double axis tracking mounting structures, with a net generation (contracted) capacity of 75 MW_{AC}, as well as associated infrastructure, which will include:

- Several arrays of photovoltaic solar panels;
- Mounting structures to support the PV panels;
- Cabling between the project components, to be laid underground where practical;
- On-site inverters to convert the power from a direct current to an alternating current;

- An on-site substation to facilitate the connection between the solar energy facility and the Eskom electricity grid;
- A new 132kV power line between the on-site substation and the existing Ferrum Substation[1];
- Battery storage facilities;
- Water purification plant;
- Site Offices and Maintenance Buildings, including workshop areas for maintenance and storage;
- Batching plant;
- Temporary laydown areas;
- Internal access roads and fencing around the development area;
- Access road from the project site to the N14. Four access road alternatives will be considered:
    - Alternative 1: This alternative formed part of the Scoping Phase and entails the upgrade of approximately 3.6km of the existing T26 gravel road situated between the project site and the N14 national road. The existing road will be upgraded from approximately 5m to 9m in width and will traverse four properties; the Remaining Extent of the Farm Lyndoch 432; Portion 1, 2 and the Remaining Extent of the Farm Cowley 457.
    - Alternative 2: This is a new alternative identified for consideration in the EIA process. Alternative 2 entails the establishment of a new access road approximately 3.6km in length and 9m in width. The new access road is proposed to be located adjacent to the existing T26 gravel road and will traverse four properties; the Remaining Extent of the Farm Lyndoch 432, Portion 1, 2 and the Remaining Extent of the Farm Cowley 457.
    - Alternative 3: Alternative 3 entails the establishment of a new access road approximately 5.1km in length and 9m in width and the upgrade of approximately 10.3km of the existing T25 gravel road from approximate 5m in width to 9m in width. This alternative was previously known as Alternative 2 in the Scoping Phase and was realigned in order to avoid the protected Kathu Forest. Alternative 3 will traverse five properties; the Remaining Extent of the Farm Lyndoch 432, Portion 1 of the Farm Selsden 464, the Remaining Extent of the Farm Kathu 465, Portion 1 of the Farm Halliford 466 and the Remaining Extent of the Farm Marsh 467.
    - Alternative 4: Access Road Alternative 4 entails the establishment of a new access road approximately 6.2km in length and 9m in width situated between the western boundary of the project site and the R380 regional road. This alternative was proposed by the DAFF as an additional alternative which will

[1] The construction of the 132kV overhead power line will be assessed as part of a separate Basic Assessment process and do not form part of this assessment.

traverse four properties; the Remaining Extent of the Farm Lyndoch 432, Portion 1 and the Remaining Extent of the Farm Selsden 464 and the Remaining Extent of the Farm Halliford 466.

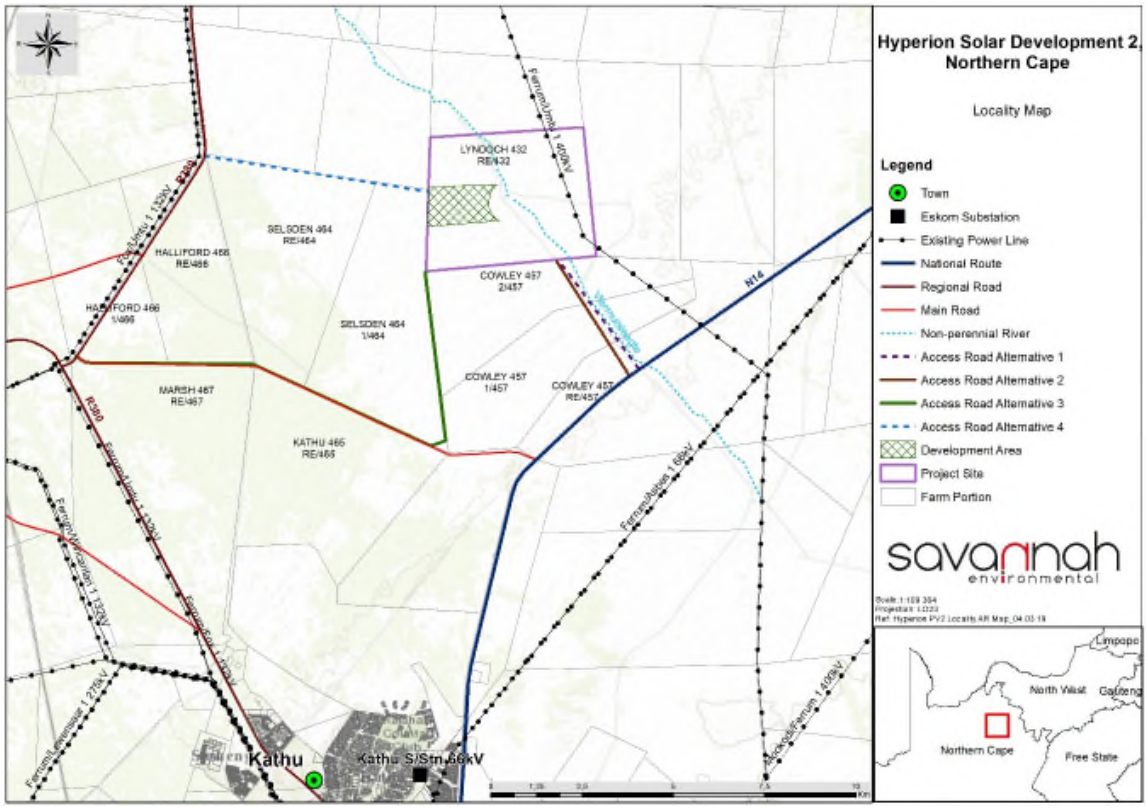

Figure 1. Map showing the location of the Hyperion Solar PV development site in relation to Kathu and the four access road alternatives.

2 METHODOLOGY

2.1 DATA SOURCING AND REVIEW

Data sources from the literature consulted and used where necessary in the study include 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 project site. The relevant quarter-degree grid cell (QDGC) that covers the study area is 2723CA (51 cards, 211 species). More recent bird distribution data were also obtained from the second bird atlas project, which has been on-going since its inception in 2007 (SABAP 2; http://sabap2.adu.org.za/). SABAP2 employs a finer resolution using the pentad

scale (5' latitude x 5' longitude), with the relevant pentad codes for the study area being 2730_2300 (3 cards, 73 species) and 2730_2305 (3 cards, 90 species). These were consulted to determine the bird species likely to occur within the project site 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 project site.
- 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 project site.
- 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 project site.
- The conservation status, endemism and biology of all species considered likely to occur within the study area were 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 project site.

The literature review revealed that there are no Important Bird Areas (IBAs), Coordinated Avifaunal Roadcounts (CAR) routes, or Coordinated Waterbird Counts (CWAC) wetlands in the vicinity of the broader project site.

2.2 SITE VISIT & FIELD METHODOLOGY

A site visit of three full days was made to the project site in both winter (13 to 16 August 2018) and summer (29 to 31 Jan 2019), to determine the *in situ* local avifauna and avian habitats present on site. The timing of the winter survey corresponds to a dry-season assessment, while the summer survey corresponds to a wet-season assessment when most migratory bird species are present. Environmental conditions during the summer survey where, however, hot and dry, with the region experiencing late summer rains. The field approach is informed by the *Birds and Solar Energy Best Practice Guidelines* (Jenkins *et al*., 2017) issued by Birdlife South Africa. In terms of these guidelines, the project is seen to fall within the Regime 2 assessment protocol in terms of the extent of the site and the avifaunal sensitivity.

The current field assessment consisted of point counts (n = 51) and 1km linear transects (n = 16), distributed throughout the study area to obtain preliminary data on presence/absence of species. All birds detected by sight or sound were recorded over a 10-minute period at each point count, while only large non-passerine species were recorded along the 1km line transects, lasting between 30 to 40 minutes. The number of birds and their distance from the observer was recorded for all detections made at point counts and along line transects. These surveys served 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.

A list was compiled of all the avifaunal species likely to occur within the broader project site, based on a combination of existing distributional data (SABAP 1 and SABAP 2) and species seen during the two seasonal site visits. 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 was also compiled. 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 other bird populations that may be affected.

2.3 SENSITIVITY MAPPING & ASSESSMENT

An avifaunal sensitivity map of the project site was produced by integrating the available ecological and biodiversity information available in the literature and various avifaunal databases with mapping based on the satellite imagery of the site as well as personal knowledge of the site. This includes delineating different habitat units identified in the field and assigning likely sensitivity values to the units based on their characteristics, conservation value and the potential presence of avifaunal species of conservation concern. The avifaunal sensitivity of the different units identified in the mapping procedure was 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 avifaunal biodiversity. Most types of development can proceed within these areas with little ecological impact.
- **Medium**- Areas of natural or previously transformed land where the impacts are likely to be largely local and the risk of secondary impacts on avifaunal would be low. These areas usually comprise the bulk of habitats within an area. Development within these areas can proceed with relatively little avifaunal impact 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 avifaunal biodiversity value, sensitivity or important role of the area for avifauna. These areas may contain or be important habitat for avifaunal species or provide important habitat or ecological services such as water flow regulation or breeding habitat. 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 habitats that serve as habitat for rare/endangered avifaunal species or perform critical ecological roles. These areas are essentially no-go areas from a developmental perspective and should be avoided as much as possible.

A sensitivity map for the site is provided in Figure 5.

2.4 SAMPLING LIMITATIONS AND ASSUMPTIONS

The current study consisted of a detailed field assessment (summer and winter) as well as a desktop study, which serves to significantly reduce the limitations and assumptions required for the study. 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 assessed 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 lack of local, empirical data describing the known impacts of existing SEFs on birds (Jenkins, 2011). A more recent study (Venter, 2016; Visser *et al*., 2018), however, provides some preliminary data within the South African context.
- The SABAP 1 data for the relevant quarter degree squares covering the proposed development area are now >21 years old (Harrison *et al*., 1997), while there are presently only six (6) SABAP 2 atlas cards recorded for the two relevant pentads combined. No more reliable and/or more recent formal data on bird species distribution in the study area are available. In an attempt to reduce this limitation, and ensure a conservative approach, the species list derived from the literature was obtained from an area somewhat larger than the study site, and thus likely includes a much wider array of species than what actually occurs at the site. Aquatic species that were included on the original SABAP1 list for the area, but are largely restricted to permanent water bodies, were excluded from the final list compiled (Appendix 1).
- Limited time in the field and 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 extent of the project site is not that large and thus it is highly unlikely that there are any significant nesting sites of larger species present within the affected area that would not have been detected.

- During point counts and walking transects many birds were heard but not seen, which made it difficult to estimate the number of individuals present per detection. However, considering that the same observer was responsible for recording all detections, it is assumed that sampling error would be distributed evenly across all samples.

3 DESCRIPTION OF THE AFFECTED ENVIRONMENT- AVIFAUNAL BASELINE

3.1 SITE CONTEXT & AVIFAUNAL MICROHABITATS OF THE SITE

Broad-scale vegetation patterns influence the distribution and abundance of bird species holistically, while vegetation structure, rather than plant species composition, has a greater influence on local avifauna populations and species assemblages (Harrison *et al*., 1997). The property lies within one vegetation type, the Kathu Bushveld, and supports four avifaunal microhabitats, namely 1) *Tarchonanthus camphoratus* dominated scrubland, 2) *Vachellia erioloba* woodland, 3) dense *Vachellia mellifera* savanna, and 4) arid riparian grassland associated with the Vlermuisleegte River that traverses the project site. A few dense stands of *Terminalia sericea* trees also occur and are generally associated with the *Vachellia erioloba* woodland. The *Tarchonanthus camphoratus* scrubland (Figure 2) dominates the western half of the property and the entire project site, and is the result of a devastating veld fire in 2009 that transformed an open *Vachellia erioloba* woodland to a scrubland. The remaining *Vachellia erioloba* woodland occurs on the eastern half of the property (Figure 3), together with extensive *Vachellia mellifera* dominated savanna. The ephemeral Vlermuisleegte River (Figure 4) traverses the centre of the property, separating the *Tarchonanthus* scrubland to the west from the *Vachellia* savannas to the east. The *Tarchonanthus camphoratus* scrubland is considered to be of Medium Sensitivity, as the area does support a low density of *Vachellia erioloba* trees and a high density of *Vachellia haematoxylon* trees. The *Vachellia erioloba* woodland has a markedly higher density of large *Vachellia erioloba* trees interspersed with patches of *Vachellia mellifera*, giving rise to higher structural diversity, with a combined High Sensitivity (refer to Figure 5). The drainage line supports an almost pan-like habitat that may support a different assemblage of bird species compared to the scrub and woodland, and hence is considered to be of Very High Sensitivity (refer to Figure 5).

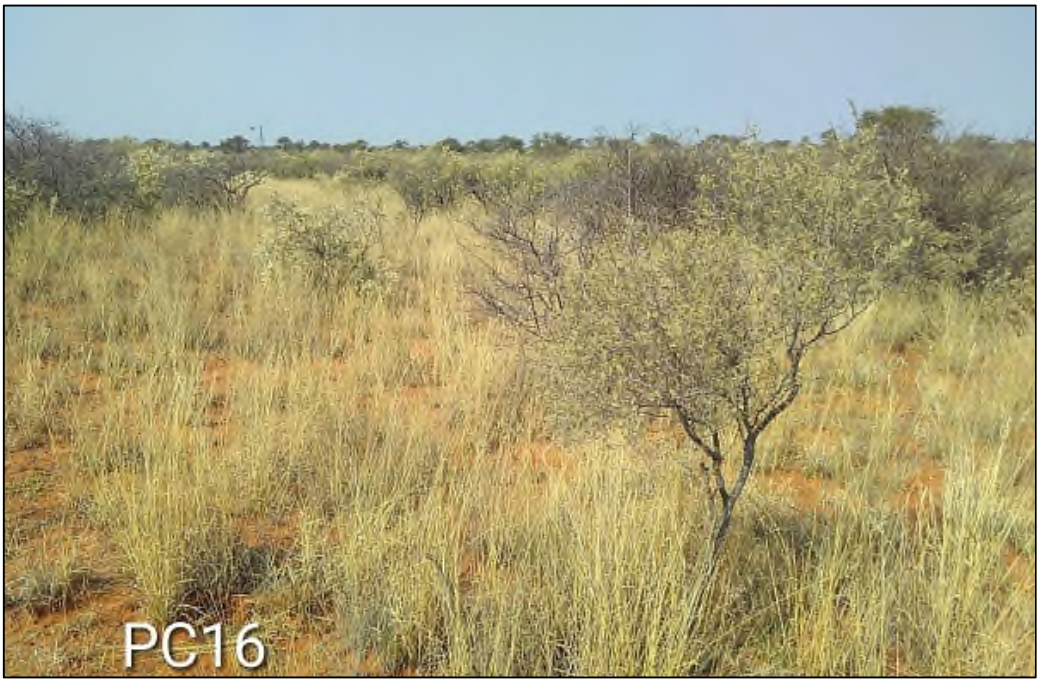

Figure 2. *Tarchonanthus camphoratus* scrubland within the western half of the property, at the project site. The habitat does support some large *Vachellia erioloba* trees, but these occur at a much lower density compared to the eastern half of the property.

Figure 3. *Vachellia erioloba* woodland in the eastern half of the property. The habitat is interspersed with patches of *Vachellia mellifera* and *Terminalia sericea,* hence supporting a

higher structural diversity with respect to vegetation.

Figure 4. Open grassland associated with the dry bed of the Vlermuisleegte River that bisects the property. This habitat is considered highly sensitive as it represents a 'pan-like' habitat that may support a unique assemblage of bird species not found in the surrounding habitats.

3.2 General Avifauna

Approximately 220 bird species are known to occur in the broader project site and surrounds (Annexure 1), of which 97 species were recorded on site during the two seasonal field surveys. Fourteen (14) red-listed species have been recorded in the broader area since SABAP1, and may possibly occur at the study site. Of these, ten (10) species are listed as threatened, while four (4) others are considered Near-Threatened. Several other species are listed as endemic (one (1) species), near-endemic (five (5) species) or biome-restricted (five (5) species).

The bird assemblage recorded within the project site is typical of the Kalahari bioregion. Of the 97 species recorded on site, 81 species were detected during point counts and line transects (77 species in summer and 47 in winter). An average of 9.8±4 species were recorded per point count in summer, with an average of 16.0±12 individual birds, which is almost twice as much as in winter when an average of 4.9±3 species were recorded per point count, with an average of 8.9±7 individual birds. Small passerines species made up the majority (±70%) of the species detected in both seasons, compared to non-passerines (±30%).

The five near-endemic species reported for the broader study area include Fiscal Flycatcher *Sigelus silens,* Karoo Thrush *Turdus smithi*, Fairy Flycatcher *Stenostira scita,* Black-headed Canary *Serinus alario* and Black Harrier *Circus maurus*, of which only the former two widespread species are relatively common in the broader area. The endemic Pied Starling *Lamprotornis bicolor* is considered an uncommon species in the area, occurring more regularly to the east near Kuruman. The two biome-restricted species that occur in the area, namely, the Kalahari Scrub-robin *Cercotrichas paena*, and Burchell's Sandgrouse *Pterocles burchelli,* are common and have widespread distributions through the bioregion.

The most abundant species recorded during point counts at the broader project site include Scaly-feathered Finch *Sporopipes squamifrons*, Black-chested Prinia *Prinia flavicans,* Kalahari Scrub-robin, and Chestnut-vented Warbler *Sylvia subcaeruleum* (Table 1). Scaly-feathered Finch showed a marked decline in detectability in summer, whereas the other three species showed the converse. The remaining species had significantly lower encounter rates, with the most common of these being Violet-eared Waxbill *Granatina granatina*, Ant-eating Chat *Myrmecocichla formicivora*, Fork-tailed Drongo *Dicrurus adsimilis*, Yellow Canary *Crithagra flaviventris*, and Brown-crowned Tchagra *Tchagra australis.* During summer the avifauna of the site was augmented with several migratory species such as cuckoos, shrikes, swallows, bee-eaters, nightjars and buttonquails, amongst others. The majority of these species had low detection rates as they are widely distributed across the landscape.

Table 1. The most commonly detected bird species during point counts in winter (n = 51) and summer (n = 48), across the Hyperion Solar Development 2 project site and broader area, with the number of birds seen per point count as a measure of relative abundance.

Species	Winter			Summer		
	No. of detections	No. of birds	Birds/Point count	No. of detections	No. of birds	Birds/Point count
Scaly-feathered Finch	46	102	2.00	10	42	0.88
Black-chested Prinia	35	43	0.84	48	79	1.65
Kalahari Scrub-robin	35	39	0.76	49	63	1.31
Chestnut-vented Warbler	24	26	0.51	37	50	1.04
Violet-eared Waxbill	8	21	0.41	3	5	0.10
Ant-eating Chat	11	17	0.33	10	18	0.38
Fork-tailed Drongo	14	17	0.33	10	16	0.33
Yellow Canary	7	14	0.27	5	22	0.46
African Red-eyed Bulbul	6	13	0.25	8	15	0.31
Cape Glossy Starling	4	12	0.24	6	8	0.17
Brown-crowned Tchagra	5	7	0.14	18	18	0.38
Golden-breasted Bunting	6	7	0.14	5	5	0.10
Crimson-breasted Shrike	6	6	0.12	16	20	0.42
Tinkling Cisticola	4	6	0.12	8	12	0.25

Very few species and individuals were recorded along the walked line transects in both winter and summer, and included the following species, Burchell's Sandgrouse, Red-crested Korhaan *Lophotis ruficrista*, Orange River Francolin *Scleroptila gutturalis*, Gabar Goshawk *Micronisus gabar,* and Pale Chanting Goshawk *Melierax canorus*. Due to the low detection rates of these species, no seasonal patterns in detectability were discernable.

There was a marked difference in the number of birds detected between the western (38 species) and eastern (62 species) side of the property. The western half, which is dominated by *Tarchonanthus* scrub and a very low density of *Vachellia erioloba* trees, supports a lower structural diversity of vegetation as opposed to the eastern side. Some species also showed rather clear preferences for parts of the broader project site. Fawn-coloured Lark *Calendulauda africanoides,* Ant-eating Chat *Myrmecocichla formicivora,* Brown-crowned Tchagra *Tchagra australis* and Tinkling Cisticola *Cisticola rufilatus* were found more commonly in the western half of the property. Species that were mostly recorded in the eastern half of the study area, with a higher density of *Vachellia erioloba* trees, include species which generally favour developed woodland, such as Crimson-breasted Shrike *Laniarius atrococcineus*, Neddicky *Cisticola fulvicapilla*, African Grey Hornbill *Tockus nasutus*, Southern Yellow-billed Hornbill *Tockus leucomelas*, Southern Pied Babbler

Turdoides bicolor, White-browed Sparrow-weaver *Plocepasser mahali*, Golden-tailed Woodpecker *Campethera abingoni*, Common Scimitarbill *Rhinopomastus cyanomelas*, Pearl-spotted Owlet *Glaucidium perlatum*, and a number of migratory species including cuckoos. Noticeable observations made in exclusively in the east side of the study area include Verreaux's Eagle-Owl *Bubo lacteus* (one) perched in a very large *Vachellia erioloba*, and a pair of Southern White-crowned Shrike *Eurocephalus anguitimens*, which is well outside the species' normal known distribution.

The Vlermuisleegte River, which is characterised by both large *Vachellia* trees as well as open grassland, supports a diverse bird assemblage similar to that found to the east of the river. During the summer survey it was evident that raptors, such as the migratory Common Buzzard *Buteo buteo*, use the river valley and adjoining areas for foraging. This highlights the value of this unique habitat type to both local and migrating bird species.

3.3 RED-LISTED SPECIES

Red-listed species are considered fundamental to this study, because of their susceptibility to the various threats posed by solar facilities and associated infrastructures. A total of 10 species that have been recorded in the broader area are threatened, while four (4) other species are considered Near-Threatened (Table 2). However, none of these species have been reported from the area during the current atlas period (SABAP2), most likely due to very poor atlas coverage. Only the Near-Threatened Kori Bustard *Ardeotis kori* was seen on three (3) occasions during the summer survey.

The most important of all the red-listed species is the Critically Endangered White-backed Vulture *Gyps africanus*, which is presumably uncommon in the area based on atlas records dating back to SABAP1. The species' low reporting rate (14%) during SABAP1 and absence during SABAP2 seems to be corroborated by local knowledge, claiming that the species is only occasionally seen flying over the project site. White-backed Vultures therefore do not appear to use the study area to any appreciable extent, whether for roosting, breeding or foraging.

For the majority of the red-listed species it appears that their populations are marginal to the area, and therefore of low local significance. Besides White-backed Vulture, the Endangered Martial Eagle *Polemaetus bellicosus* and Vulnerable Lanner Falcon *Falco biarmicus* are considered the most important priority species in the area, although they are not known to breed nor be frequently observed in the area on a regular bases based on atlas records. Further, no sensitive breeding or roosting sites of any red-listed species were observed at the site during the field surveys.

Other species that may occur at the project site include the European Roller *Coracias garrulus* (Near-Threatened), which favours savannah habitat, and the Burchell's Courser *Cursorius rufus* (Vulnerable), which may occupy the open areas of the Vlermuisleegte River that traverses the centre of the property. Similarly, the Secretarybird *Sagittarius serpentarius* (Vulnerable) may also prefer to forage within the grassland habitat of the river compared to the scrub and dense woodlands. Red-listed species which may occur with negligible frequency and therefore are of less concern include the Ludwig's Bustard *Neotis ludwigii* (Endangered), Black Stork *Ciconia nigra* (Vulnerable), Abdim's Stork *Ciconia abdimii*, (Near-Threatened), and Maccoa Duck *Oxyura maccoa* (Near-Threatened). The lack of suitable microhabitats will in all likelihood exclude these species from the site. With the exception of the Maccoa Duck, these species may occupy the grassland habitat in the drainage line when conditions are favourable, but probably only in very low numbers.

During the walking transects regular scans were made to detect any large flying birds to establish the presence of flight paths across the broader project site. No large terrestrial birds or raptors were seen other than Kori Bustard in summer, and the most common birds of prey, namely Pale Chanting Goshawk and Gabar Goshawk. No nest or communal nesting sites of red-listed species were found in the broader project site during the site visit, which could be due to the absence of suitably large trees in the area. These observations seem to suggest that red-listed or large communal species are not currently using the project site or parts thereof for roosting or nesting.

In essence, much of the avifauna within the study area appears similar to that found across the Kalahari bioregion of the Northern Cape. The apparent lack of red-listed species in the area could be attributed to their naturally low densities and large ranges, the absence of suitable habitat (Black Stork, Abdim's Stork, Maccoa Duck) and nesting/roosting trees (White-backed Vulture). However, certain species may use the project site on occasion, such as Martial Eagle, Lanner Falcon, and European Roller and possibly Secretarybird. However, since the broader project site appears not to directly support large and healthy populations of red-listed species, the sensitivity of the area in general can be considered to be of medium significance with respect to avifauna.

Table 2. Red-listed species recorded in the broader study area during SABAP1 (1987-1991), ranked according to their red-list status. No species have been reported during SABAP2 (2007 on-going), most likely due to poor coverage in the area. Only Kori Bustard (3 sightings, 4 individuals) has been recorded at the study site, during the summer survey (29 to 31 January 2019).

English name	Taxonomic name	Red-list status	Regional endemism	Estimated importance of local population	Preferred habitat	Probability of occurrence	Threats
Vulture, White-backed	*Gyps africanus*	Critically Endangered	-	Low	Savanna	Moderate	Habitat loss/Disturbance Collisions/Electrocution
Bateleur	*Terathopius ecaudatus*	Endangered	-	Low	Savanna	Low	Habitat loss/Disturbance Collisions/Electrocution
Bustard, Ludwig's	*Neotis ludwigii*	Endangered	-	Low	Semi-arid shrublands	Low	Habitat loss/Disturbance Collisions
Eagle, Martial	*Polemaetus bellicosus*	Endangered	-	Low	Savanna & shrublands	Moderate	Habitat loss/Disturbance Collisions/Electrocution
Harrier, Black	*Circus maurus*	Endangered	Near-endemic	Low	Fynbos, Karoo & grassland	Low	Habitat loss/Disturbance/Collisions
Courser, Burchell's	*Cursorius rufus*	Vulnerable	-	Low	Shrubland plains	Moderate	Habitat loss/Disturbance
Eagle, Verreaux's	*Aquila verreauxii*	Vulnerable	-	Low	Mountainous and rocky areas	Low	Habitat loss/Disturbance Collisions/Electrocution
Falcon, Lanner	*Falco biarmicus*	Vulnerable	-	Moderate	Widespread	High	Habitat loss/Disturbance Collisions/Electrocution
Secretarybird	*Sagittarius serpentarius*	Vulnerable	-	Low	Open savanna & grassland	Low	Habitat loss/Disturbance Collisions
Stork, Black	*Ciconia nigra*	Vulnerable	-	Low	Water bodies	Low	Collisions
Bustard, Kori	***Ardeotis kori***	**Near-threatened**	**-**	**Moderate**	**Open savanna**	**Moderate**	**Habitat loss/Disturbance Collisions**
Duck, Maccoa	*Oxyura maccoa*	Near-Threatened	-	Low	Water bodies	Low	Habitat loss/Disturbance
Roller, European	*Coracias garrulus*	Near-Threatened	-	Low	Open savanna	Moderate	Habitat loss/Disturbance
Stork, Abdim's	*Ciconia abdimii*	Near-threatened	-	Low	Grassland & savanna	Low	Collisions

3.4 AVIAN SENSITIVITY ASSESSMENT

Important avian microhabitats in the project site play an integral role within the landscape, providing nesting, foraging and reproductive benefits to the local avifauna. In order to ensure that the development does not have a long-term negative impact on the local avifauna, it is important to delineate these avian microhabitats within the project site. To this end an avian sensitivity map (Figure 5) was generated by integrating avian microhabitats present on the site and avifaunal information collected during the site visits.

Much of the property to the west of the Vlermuisleegte River, which traverses the project site, consists of *Tarchonanthus camphoratus* scrub, considered to be of Medium Sensitivity. It is host to the typical avifauna of the Kalahari bioregion. This is the lowest sensitivity part of the site and the development should preferably be restricted to this habitat type. It is however important to recognise the long-term temporal aspect of vegetation dynamics at the site. This area experienced a devastating fire in 2009, which destroyed many of the large *Vachellia* trees as now only found to the east of the Vlermuisleegte River. Hence, with time (several decades), large *Vachellia erioloba* trees may again become prominent across the *Tarchonanthus* scrub. As such the sensitivity is a reflection of the current vegetation composition and not the long-term potential.

The *Vachellia erioloba* woodland to the east of the Vlermuisleegte is considered to be of High Sensitivity with respect to avifauna, as it supports large *Vachellia* trees interspersed with patches of *Vachellia mellifera* and *Terminalia sericea*, which contribute towards higher habitat heterogeneity and a wider array of nesting sites, resulting in an overall greater diversity of avifauna. Data obtained from the current field study is insufficient to conclusively demonstrate differences in avifaunal assemblages between the *Vachellia* woodland to the east, and the *Tarchonanthus* scrub to the west of the drainage line. However, indications from the site visit suggest that it is likely to be more diverse and this is a reasonable assumption as there is a known relationship between habitat heterogeneity and species richness (Harrison *et al*., 1997). The area to the east of the Vlermuisleegte is thus considered High Sensitivity and largely unsuitable for development.

The open grassland that occupies the bed of the dry Vlermuisleegte River is considered to be of Very High Sensitivity, as this is a restricted habitat that has elements similar to that of pans, which are generally regarded as very high sensitivity areas due to their high use and specialised avifauna that is usually associated with these features. This drainage line may therefore support a very different assemblage of birds compared to the scrub and woodland habitat and may even support red-listed species under favourable conditions, such as Burchell's Courser and Ludwig's Bustard. No additional development or transformation within this area is recommended. The continued use of the current access road is considered acceptable provided that no large raptor nests of species of concern are found in the trees near the road. Although no such nests were seen during the winter and summer

surveys, the potential for a nest to remain undetected may exist. Provided that this condition can be met, then the existing access road would be the preferred access route to the site. The alternative access routes are not recommended as it would open up a new disturbance path through habitat that is currently little disturbed.

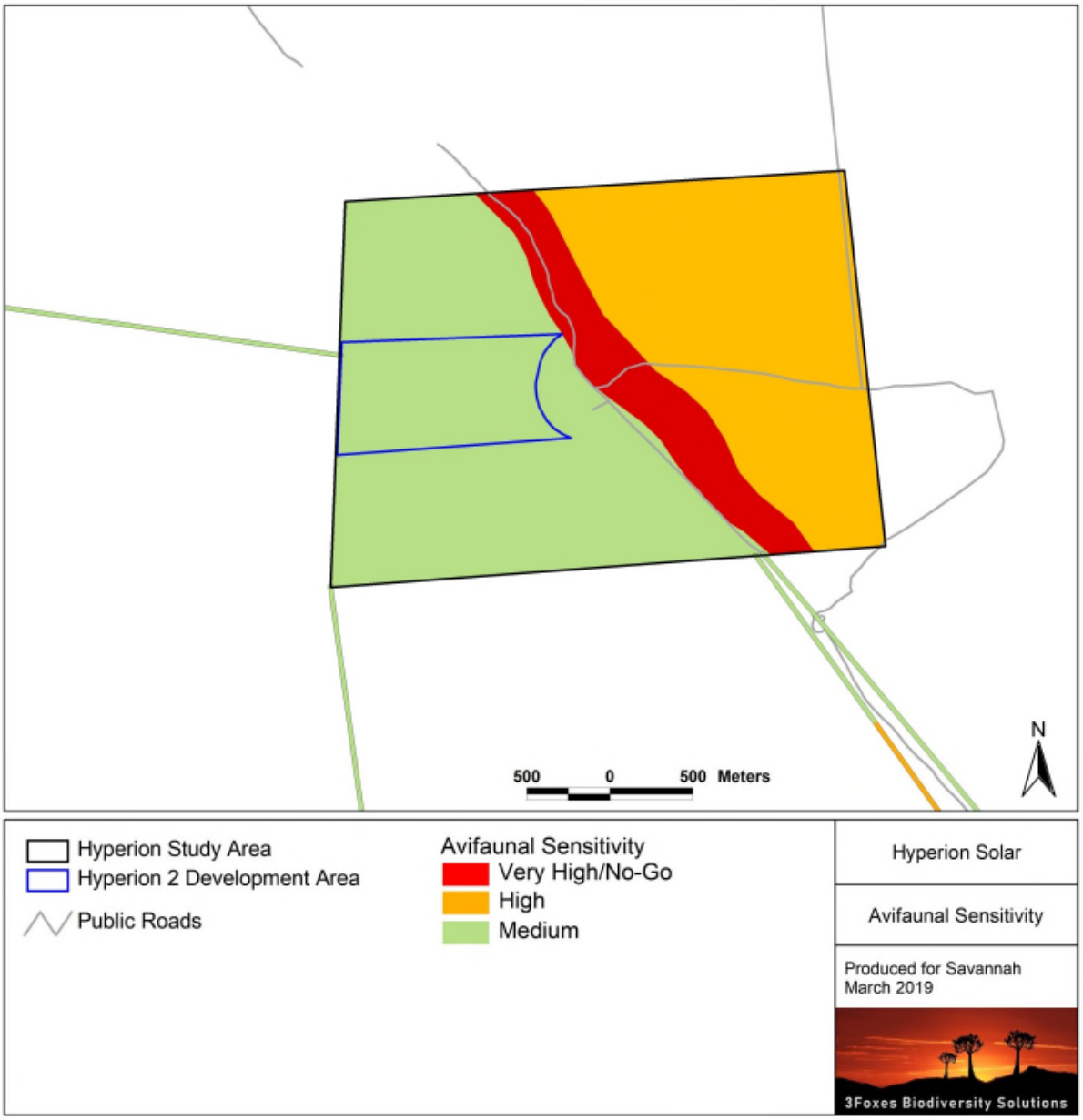

Figure 5. Avifaunal Sensitivity map for the Hyperion Solar Development 2 development area and the broader project site. There is High Sensitivity *Vachellia erioloba* woodland to the east of the Vlermuiseleegte, which is considered to be Very High sensitivity, and Medium Sensitivity *Tarchonanthus* scrubland to the west.

In terms of the four proposed access road alternatives, the existing access which runs adjacent to the dry bed of the Vlermuisleegte River, is in a potentially sensitive area. However, the use of this road must be weighed up against the likely avifaunal habitat loss and disturbance generated by the construction and use of the alternative access routes, which require the construction of new roads. As the existing road is currently used to access the site and is a large road that would require minimal additional work, this is seen as preferred alternative from an avifaunal perspective. In terms of the other three Alternatives, Alternative 2 is considered generally undesirable from an avifaunal perspective as it would impact the Vlermuisleegte River corridor which has been identified as an important area for avifauna in the area. Alternative 3 is also considered undesirable as it traverses several areas with high *Vachellia erioloba* density and which are of high avifaunal value due to the their structural diversity and possible presence of raptor nesting sites. Alternative 4 to the west is considered potentially acceptable as it is relatively short and does not traverse a large extent of high value habitat.

4 IDENTIFICATION & NATURE OF IMPACTS

In this section, the potential impacts and associated risk factors that may be generated by the development are identified. In order to ensure that the impacts identified are broadly applicable and inclusive, all the likely or potential impacts that may be associated with the development are listed below. The relevance and applicability of each potential impact to the current situation are then examined in more detail in the next section.

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 associated power line infrastructure. (The power line infrastructure of the current project will be assessed under a separate application)
- 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 Hyperion Solar Development 2 will cover an area of approximately 180ha, located within Kathu Bushveld and should all four (4) plants planned for the site be

constructed, this would result in more than 700ha of habitat loss. This habitat represents the typical vegetation of the broader area, but supports a homogenous scrubland dominated by *Tarchonanthus camphoratus* in the western half, and a more heterogeneous *Vachellia* woodland in the eastern half of the property. Only one of the 14 red-listed avifaunal species that are known to occur in the broader area were recorded during the field survey (summer), while only two (2) near-endemic species and two (2) biome-restricted species occur regularly in the area. While the development may have an insignificant impact on these species, it will nevertheless impact on common local bird assemblages primarily through direct habitat loss and displacement. Species are expected to be impacted to varying degrees based on their life-history strategies, abundance and general susceptibility to the threats posed by PV facilities. While habitat loss can be quantified by extent of the development footprint, there are other impacts such as direct mortalities caused by collisions with solar panels, which 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 fairly recent study at a large solar facility in the Northern Cape (Visser, 2016, Visser *et al*., 2018) 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 PV panels when startled, 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 Potential Impacts and Damaging Activities

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.

Potential avifaunal impacts resulting from the development of the Hyperion Solar Development 2 would stem from a variety of different activities and risk factors associated with the preconstruction, construction, operational and decommissioning phases of the project including the following:

Preconstruction Phase

- Human presence and uncontrolled access to the site may result in negative impacts on the avifauna through poaching and disturbance.
- Site clearing and exploration activities for site establishment may have a negative impact on avifauna if this is not conducted in a sensitive manner.

Construction Phase

- Vegetation clearing for the PV field, access roads, site fencing and associated infrastructure will impact the local avifauna directly through habitat loss. Vegetation clearing will therefore lead potentially to the loss of avifaunal species, habitats and ecosystems as birds are displaced from their habitat.
- Presence and operation of construction machinery on site. This will create a physical impact as well as generate noise, pollution and other forms of disturbance at the site.
- Increased human presence can lead to poaching, illegal fauna collecting and other forms of disturbance such as fire.

Operational Phase

- The operation of the facility will generate noise and disturbance which may deter some avifauna from the area, especially red-listed avifaunal species which are less tolerant of disturbances. Such indirect impacts are still largely understudied, but preliminary data suggest that bird communities can be altered by solar PV facilities (DeVault *et al*., 2014, Smith & Dwyer, 2016).
- Mortality among the local avifauna may result due to direct collisions with solar panels (Kagan *et al*., 2014) or entrapment along the fenced boundaries of the facility (Visser, 2016).
- The areas inside the facility will require management and if this is not done appropriately, it could impact adjacent intact areas through impacts such as erosion, alien plant invasion and contamination from pollutants, herbicides or pesticides.

Decommissioning Phase

- Vegetation loss due to removal and clearing of the solar field and associated infrastructure will impact the local avifauna directly through habitat loss. Vegetation clearing will therefore lead potentially to the loss of avifaunal species, habitats and ecosystems as birds are displaced from their habitat.

- Presence and operation of heavy machinery on site. This will create a physical impact as well as generate noise, pollution and other forms of disturbance at the site.
- Increased human presence can lead to poaching, illegal fauna collecting and other forms of disturbance such as fire.

Cumulative Impacts

- The loss of unprotected vegetation types on a cumulative basis from the broader area may impact the country's ability to meet its conservation targets. The aggregation of numerous SEFs in a region has the potential to compound environmental impacts generally and on avifauna, and because this impact has been mostly understudied, it should be considered during the early stages of land use planning (Moore-O'Leary *et al*., 2017).
- Transformation of intact habitat would contribute to the fragmentation of the landscape and would potentially disrupt the connectivity of the landscape for avifauna. This is particularly a concern with regards to species and ecosystems with limited geographical distributions (Rudman *et al.*, 2017).

Project specific impacts on particular groups of avifauna are as follows:

Habitat loss and disturbance of small passerines

For the smaller passerine species, the most important impacts will include 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. The impacts in general can be expected to be minimal as the populations of these smaller species are far less susceptible to the associated impacts than larger species.

Habitat loss, disturbance and collision risk of 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 raptors such as Gabar Goshawk, Pale Chanting Goshawk, and the ground-dwelling Burchell's Sandgrouse, Orange River Francolin and Red-crested Korhaan. These species may also be susceptible to collisions with associated infrastructure such as the PV panels and site fencing, but this is not expected to have a major impact on most of these species. Red-crested Korhaan and Orange River Francolin may, however, be at more risk based on the recent research (Visser, 2016).

Habitat loss and disturbance 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 White-backed Vulture, Martial eagle, Verreaux's Eagle, Kori Bustard, and Secretarybird. Besides the loss of potential habitat that these species will experience, disturbances during construction and maintenance of the facility is also expected to have a negative impact.

5 ASSESSMENT OF IMPACTS

The various identified avifaunal impacts are assessed below for the different phases of the development.

5.1 HYPERION SOLAR DEVELOPMENT 2

The following is an assessment of the Hyperion Solar Development 2, for the planning, construction, operational and decommissioning phases of the development. The construction phase will result in the direct loss of habitat due to clearing of vegetation and avifaunal microhabitats for the solar fields, road infrastructure, perimeter fencing, auxiliary buildings and associated infrastructure. Disturbances will be caused by increased traffic of vehicles, and particularly heavy machinery used for clearing vegetation and road construction. During the operational phase the impacts that can be expected include direct bird mortalities through collisions with PV panels and entrapment along perimeter fencing, and disturbances in the form of vehicular and personnel traffic during maintenance of solar fields and other infrastructure. Night lighting may also disturb nocturnal birds, those attracted to the facility to prey on insects drawn to lights, and those flying over the facility at night.

5.1.1 PLANNING & CONSTRUCTION PHASE IMPACTS

Impact Nature: Direct avifaunal impacts during construction – habitat loss and disturbance due to vegetation clearing. Loss of natural habitat and displacement of birds through physical transformation, modifications, removals and land clearance. The loss of habitat will be permanent while disturbance may be continuous during the operational phase of Hyperion Solar Development 2		
	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Short-term (2)	Short-term (2)
Magnitude	Moderate (6)	Low to Moderate (5)
Probability	Definite (5)	Definite (5)
Significance	Medium (45)	Medium (40)

Status	Negative	Negative
Reversibility	Moderate	Moderate
Irreplaceable loss of resources	Low	Low
Can impacts be mitigated?	This impact cannot be well mitigated because the loss of habitat is unavoidable and is a definite outcome of the development.	
Mitigation	• The use of laydown areas within the footprint of the development should be used where feasible, to avoid habitat loss and disturbance to adjoining areas. • The bed of the Vlermuisleegte River should be considered to be a no-go area for infrastructure apart from where there are already existing access roads through this area which can be used for access. • 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. • Pre-construction environmental induction for all construction staff on site to ensure that basic environmental principles are adhered to, and awareness about not harming or hunting ground-dwelling species (e.g. bustards, korhaans, thick-knees and coursers), and owls, which are often persecuted out of superstition. • This induction should also include 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. • All construction vehicles should adhere to a low speed limit (40km/h on site) to avoid collisions with susceptible species such nocturnal and crepuscular species (e.g. nightjars, thick-knees and owls) which sometimes forage or rest along roads. • Any avifauna threatened by the construction activities should be removed to safety by the ECO, EO or appropriately qualified environmental officer. • Reservoirs or ponds (evaporative or other) should be covered with fine mesh or other exclusion material in order to exclude and prevent birds from accessing potentially contaminated water	

	contained therein. • If holes or trenches need to be dug, these should not be left open for extended periods of time as ground-dwelling avifauna or their flightless young may fall in and become trapped in them. Holes should only be dug when they are required and should be used and filled shortly thereafter. • No construction activity should occur near to active raptor nests should these be discovered prior to or during the construction phase. If there are active nests near construction areas, these should be reported to the ECO and should be monitored until the birds have finished nesting and the fledglings left the nest. • The perimeter fence around the facility should be designed with potential impacts on ground-dwelling avifauna in mind. Double-fence designs where the inner electric fence is positioned within one (1) meter of the outer mesh fence may result in medium-sized non-passerine species colliding with either fence when trapped between these (Visser, 2016). Single-fence designs, whereby the electrical fencing component is attached to the inside of the mesh fence, are considered preferable as ground-dwelling birds cannot be trapped between these components.
Cumulative Impacts	The development will contribute to cumulative impacts on avifaunal habitat loss and transformation in the area.
Residual Risks	As the loss of currently intact habitat is an unavoidable consequence of the development, the habitat loss associated with the development remains a residual impact even after mitigation and avoidance of more sensitive areas. The sensitivity of the affected habitat is however low and the overall residual impact on avifaunal habitat loss remains low.

5.1.2 OPERATIONAL PHASE IMPACTS

Impact Nature: Avifaunal Impacts due to operational activities – Resident raptors such as Pale Chanting Goshawk, and the Red-crested Korhaan may also be susceptible to collisions with PV panels, potential entrapment along perimeter fencing, and disturbance due to traffic and night lighting.		
	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low to Moderate (5)	Low (4)
Probability	Highly Probable (4)	Probable (3)
Significance	Medium (40)	Low (27)
Status	Negative	Negative
Reversibility	Moderate	Moderate

Irreplaceable loss of resources	Low	Low
Can impacts be mitigated?	Yes to a large degree, but it may be more difficult to prevent collisions and impacts related to the perimeter fence where double-fencing is used as opposed to single-fencing.	
Mitigation	• 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. • The bed of the Vlermuisleegte River should be considered to be a no-go area to avoid disturbance to avifauna, apart from where there are already existing access roads through this area which can be used for access. The area to the east of the river should also be avoided so as to limit disturbance to avifauna. • 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. • If birds nest on the infrastructure of the facility and cannot be tolerated due to operational risks of fire, electrical shorts, soiling of panels or other concerns, 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 with eggs or nestlings should be allowed to fledge their young before nests are removed. • If there are any persistent problems with avifauna, then an avifaunal specialist should be consulted for advice on further mitigation. • Any movements by vehicle and personnel should be limited to within the footprint of solar field and other associated infrastructure, especially during routine maintenance procedures. • Reservoirs or ponds (evaporative or other) should be covered with fine mesh or other exclusion material in order to exclude and prevent birds from accessing potentially contaminated water contained therein. • All vehicles accessing the site should adhere to a low speed limit (40km/h max) to avoid collisions with susceptible species such	

	nocturnal and crepuscular species (e.g. nightjars, thick-knees and owls) which sometimes forage or rest on roads at night. • Maintenance of the perimeter fencing must ensure that it minimises impacts on ground-dwelling species susceptible to entrapment between the fencing components, where double-fence designs are used (though not recommended). If double-fence designs must be used instead of preferred single-fence designs, the space between the outer mesh fence and inner electrical fence should be kept clear of vegetation which may attract ground-dwelling species to forage there, while also ensuring that there are no gaps/holes in these fences that will allow ground-dwelling birds to enter the space between the two fences.
Cumulative Impacts	The development will contribute to cumulative impacts on avifaunal habitat loss and transformation in the area, as well as minor disturbances (traffic and night lighting).
Residual Risks	Although high rates of mortality due to collisions have not been recorded in South Africa, there is some risk that this may occur, in addition to some potential mortality associated with entrapment of ground-dwelling birds along perimeter fencing (double-fence designs only).

5.1.3 DECOMMISSIONING PHASE IMPACTS

The decommissioning phase will result in disturbance and loss of avifaunal microhabitats due to removal and clearing of the solar field and associated infrastructure. Disturbances will be caused by increased traffic of vehicles, and particularly heavy machinery used for clearing the infrastructure.

Impact Nature: Avifaunal impacts due to decommissioning activities – habitat loss due to clearing of solar field, and disturbance due to traffic and presence of personnel.		
	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Short-term (2)	Short-term (2)
Magnitude	Low (4)	Minor to Low (3)
Probability	Definite (5)	Definite (5)
Significance	Medium (35)	Medium (30)
Status	Negative	Negative
Reversibility	Moderate	Moderate
Irreplaceable loss of resources	Low	Low

Can impacts be mitigated?	The disturbance impact can be mitigated to an extent as it will be transient and have no long term impact.
Mitigation	• All infrastructure should be removed from the development site and disposed of in the appropriate manner. • All waste produced during decommissioning must be disposed of at a designated waste management facility. • Environmental induction for all personnel on site to ensure that basic environmental principles are adhered to, and awareness about not harming or hunting ground-dwelling species (e.g. bustards, korhaans, thick-knees and coursers), and owls, which are often persecuted out of superstition. • This induction should also include awareness as to no littering, appropriate handling of pollution and chemical spills, avoiding fire hazards, minimizing wildlife interactions, and remaining within demarcated decommissioning areas. • All decommissioning vehicles should adhere to clearly defined and demarcated roads. No off-road driving to be allowed in undisturbed natural areas outside of the decommissioning area. • The bed of the Vlermuisleegte River should be considered to be a no-go area to avoid disturbance to avifauna, apart from where there are already existing access roads through this area which can be used for access. The area to the east of the river should also be avoided so as to limit disturbance to avifauna. • All vehicles should adhere to a low speed limit (40km/h on site) to avoid collisions with susceptible species such nocturnal and crepuscular species (e.g. nightjars, thick-knees and owls) which sometimes forage or rest along roads. • Any avifauna threatened by the activities should be removed to safety by the Environmental Officer or appropriately qualified environmental officer. • If holes or trenches need to be dug, these should not be left open for extended periods of time as ground-dwelling avifauna or their flightless young may become entrapped in them. Holes should only be dug when they are required and should be used and filled shortly thereafter. • No activity should occur near to active raptor nests should these be discovered prior to or during the decommissioning phase. If there are active nests near the decommissioning areas, these should be reported to the EO and should be monitored until the birds have finished nesting and the fledglings left the nest.
Cumulative Impacts	There are no cumulative impacts associated with the decommissioning of the project site.
Residual Risks	Disturbance during the decommissioning phase is an unavoidable consequence, but will have low residual impact with implementation of the mitigations. The sensitivity of the affected habitat is however low

	and the overall residual impact on avifaunal habitat loss remains low.

5.2 CUMULATIVE IMPACTS

The following are the cumulative impacts that are assessed as being a likely consequence of the development of the Hyperion Solar Development 2. These are assessed in context of the extent of the current site, other developments in the area as well as general habitat loss and transformation resulting from other activities in the area.

Impact Nature: Impact on avifaunal habitats, migration routes and nesting areas due to cumulative loss and fragmentation of habitat.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (1)	Local (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Low to Moderate (5)
Probability	Improbable (2)	Probable (3)
Significance	Low (18)	Medium (33)
Status	Negative	Negative
Reversibility	Moderate	Moderate
Irreplaceable loss of resources	Low	Low
Can impacts be mitigated	Impacts can be mitigated to some degree, but the majority of the long-term impact results from the presence of the facility and other developments in the area which cannot be well mitigated.	

Mitigation:

- Minimise the development footprint of each facility as far as possible. A cover of indigenous grasses should be encouraged and maintained within the facility. This prevents the invasion of weeds and is the easiest to manage in the long-term. Furthermore, the grasses can be maintained low through livestock (sheep) grazing which is being successfully used at existing PV facilities. This will assist in maintaining natural vegetative cover which may support avifaunal population, as opposed to complete clearing of all vegetation which is undesirable.
- Ensure that suitable ecological corridors within the broader area are identified and maintained, whereby ecological connectivity between areas of higher conservation value are preserved.
- The facility should be fenced off in a manner which allows small fauna to pass through the facility, but that does not result in ground-dwelling avifauna (e.g. bustards, korhaan, thick-knees,

coursers) being trapped and electrocuted along the boundary fences (Venter, 2016). In practical terms this means that the facility should be fenced-off to include only the developed areas and should include as little undeveloped ground or natural veld as possible. Single-fence designs (with the electrical fencing attached to the inside) as opposed to double-fence designs are preferred so as to avoid ground-dwelling birds becoming entrapped in the space between the two fences. In addition, there should be no electrified ground-strands present within 30cm of the ground, while the electrified strands should also be located on the inside of the fence and not the outside. Images of suitable fencing types from existing PV facilities are available on request.

6 CONCLUSION & RECOMMENDATIONS

The current study is based on two seasons of detailed field assessment of the proposed development area. Consequently, the impact assessment and sensitivity map presented herein are based on detailed on-site information and as such have a relatively high degree of confidence and are considered reliable and comprehensive.

The project site lies within the Kalahari bioregion and supports the typical avifaunal assemblage expected for the area. Although ten (10) threatened and four (4) Near-Threatened species are known to occur within the broader project area, most of these appear to be uncommon in the area and probably occur in low numbers. Further, the vegetation of the project site supports few species or features of concern, such as nesting of roosting sites of red-listed species. The potential impacts on avifauna with the development on this site are therefore likely to be medium to low and no high post-mitigation impacts are likely.

The expected impacts of the proposed solar development area will include the following, 1) habitat loss and fragmentation associated with the loss of the *Tarchonanthus scrub* habitat to the SEF, 2) disturbance and displacement caused during the construction and maintenance phases, 3) possible direct mortality of avifauna colliding with solar panels and associated structures, and entrapment along perimeter fencing if a double-fence design is employed, and 4) a cumulative habitat loss at a broader scale from renewable energy developments in the broader area. Habitat loss and disturbance during the construction phase of the development will impact mostly small passerine species and medium-sized non-passerines, with consequences restricted to the local area only. Impacts related to collisions with PV panels and associated infrastructure (such as fencing) will impact mostly medium-sized non-passerines (e.g. korhaans and francolin). Red-listed species will be impacted primarily by the loss of foraging habitat and disturbances. However, given the extensive national ranges of these species and their apparently infrequent use of the project site the impact of the development on habitat loss for these species would be minimal and a long-term impact unlikely.

The most important mitigation measure that can be implemented at the current stage to ensure that impacts on avifauna are minimised is to ensure that the development is restricted to the lower sensitivity parts of the property. Identified sensitive habitats, such as the *Vachellia erioloba* woodland to the east of the Vlermuisleegte, and the drainage line itself, should be excluded from the development footprint (as is currently proposed) apart from the main access road which could potentially still be used to access the site. With the implementation of the suggested 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.

Cumulative impacts in the area are a concern due to the proliferation of solar energy development in the Kathu area. In terms of habitat loss, the affected Kathu Bushveld vegetation type is still approximately 90% intact, and while this is not a very extensive vegetation type, the loss of 200ha of habitat for the facility is not considered highly significant as there are still fairly extensive tracts of undisturbed similar habitat available in the area. In terms of potential losses to landscape connectivity, the ecological context of the site indicates that it does not seem likely to lie within an area that is an important avifaunal movement corridor or along an important ecological gradient. As such, the overall cumulative impact of the development is considered likely to be low for each 75MW plant individually, but moderate overall for all four (4) plants should all the plants planned for the site be built.

Avifaunal Impact Statement:

The Hyperion Solar Development 2 site is considered to represent a broadly suitable environment for the location of the proposed solar development. Considering that the broader project site supports a typical bioregional avifaunal assemblage, and that there are no known breeding or roosting sites of red-listed priority species, there are no impacts associated with the development that are considered to be of high residual significance and which cannot be mitigated to a low level. Consequently, the development can be supported from an avifaunal perspective. It is therefore the reasoned opinion of the specialist that the Hyperion Solar Development 2 project should be authorised, subject to the implementation of the recommended mitigation measures.

7 ACTIVITIES FOR INCLUSION IN DRAFT EMPR

An Environmental Management Programme (EMPr) provides a link between the predicted impacts and mitigation measures recommended within the EIA and the implementation and operational activities of a project. As the construction and operation of the Hyperion Solar One development may impact the environment, activities which pose a threat should be managed and mitigated so that unnecessary or preventable environmental impacts do not result. The primary objective of the EMPr is to detail actions required to address the impacts identified in the EIA during the establishment, operation and rehabilitation of the proposed infrastructure. The EMPr provides an elaboration of how to implement the mitigation measures documented in the EIA. As such the purpose of the EMPr can be outlined as follows:

- To outline mitigation measures and environmental specifications which are required to be implemented for the planning, establishment, rehabilitation and operation/maintenance phases of the project in order to minimise and manage the extent of environmental impacts.
- To ensure that the establishment and operation phases of the solar facility do not result in undue or reasonably avoidable adverse environmental impacts, and ensure that any potential environmental benefits are enhanced.
- To identify entities who will be responsible for the implementation of the measures and outline functions and responsibilities.
- To propose mechanisms for monitoring compliance, and preventing long-term or permanent environmental degradation.
- To facilitate appropriate and proactive response to unforeseen events or changes in project implementation that were not considered in the EIA process

Below are the ecologically-orientated measures that should be implemented as part of the EMPr for the development to reduce the significance or extent of the above impacts. The measures below do not exactly match with the impacts that have been identified, as certain mitigation measures, such as limiting the loss of vegetation may be effective at combating several other impacts.

7.1 CONSTRUCTION PHASE ACTIVITIES

Objective: Limit disturbance and loss of avifaunal microhabitats during construction			
Project component/s	All infrastructure and activities which result in disturbance and loss of intact habitat: » Vegetation clearing for establishment of solar field » Vegetation clearing for construction camps & other temporary infrastructure. » Vegetation clearing for access roads. » Human presence. » Operation of heavy machinery.		
Potential Impact	Disturbance and loss of avifaunal microhabitats, leading to displacement and loss of resident avifaunal species.		
Activity/risk source	» Clearing for solar field and infrastructure construction » Clearing for laydown areas and construction camps. » Clearing for construction of access roads. » Presence of construction crews. » Operation of heavy vehicles. » Birds drinking from reservoirs or ponds containing contaminated water.		
Mitigation: Target/Objective	» Low footprint and low impact on avifaunal habitats. » Low disturbance of avifauna during construction. » Low disturbance and impact on red-listed avifaunal species.		
Mitigation: Action/control		Responsibility	Timeframe
» Pre-construction environmental induction for all construction personnel regarding basic environmental principles.		ECO	Pre-construction
» The use of laydown areas within the footprint of the development should be used where feasible, to avoid habitat loss and disturbance to adjoining areas. » All construction vehicles should adhere to clearly defined and demarcated roads. » All construction vehicles should adhere to a low speed limit (40km/h on site) to avoid collisions with susceptible species such nocturnal and crepuscular species, as well as reduce dust. » Reservoirs or ponds (evaporative or other) should be covered with fine mesh or other exclusion material in order to exclude and prevent birds from accessing potentially contaminated water		Contractor	Construction

contained therein. » The fence around the facility should be designed to be bird friendly, to prevent entrapment and electrocutions of ground-dwelling birds. In practical terms this means that the perimeter fence of the facility should only include the developed areas and as little undeveloped ground or natural veld as possible. All electrified strands should be located on the inside of the fence and not the outside, while there should be no electrified ground-strands present within a 30cm height from the ground. Furthermore, the fence should be a single-layer fence and not a double fence with a large space between, which can cause ground-dwelling birds to become entrapped between these. » If holes or trenches are to be dug, these should not be left open for extended periods of time as ground-dwelling avifauna may become entrapped therein. » No construction activity should occur near to active raptor nests should these be discovered prior to or during the construction phase.		
» ECO to monitor and enforce ban on hunting and collecting of avifauna or their products (e.g. eggs). » Any avifauna threatened or injured by the construction activities should be removed to safety by the ECO or appropriately qualified environmental officer. » If there are active nests near construction areas, these should be reported to ECO and should be monitored until the birds have finished nesting and the fledglings have left the nest.	ECO	Construction

Performance Indicator	» Avifaunal microhabitat loss restricted to infrastructure footprint. » Low disturbance and impact on red-listed avifaunal species. » Avifauna do not have access to water contained in reservoirs or ponds used on site. » Low mortality of avifauna due to construction machinery and activities. » No disturbance of breeding raptors (i.e. no nest abandonment due to disturbance). » No poaching or collecting of avifauna or their products (e.g. eggs) by construction personnel. » Removal to safety of entrapped/injured avifauna encountered during construction.
Monitoring	ECO to monitor construction to ensure that: » Vegetation is cleared only within footprint areas during construction. » Perimeter fencing is constructed in a manner that is considered bird friendly, especially with respect to ground-dwelling birds. » Reservoirs and/or ponds on site are covered with mesh to exclude birds from any potentially contaminated water. » No birds or eggs are disturbed or removed by construction personnel. » Any raptor nests (especially of red-listed species) discovered on site or nearby, are monitored weekly until the post-fledging period.

***7.2** OPERATION PHASE ACTIVITIES*

OBJECTIVE: Limit direct and indirect impacts and disturbances of avifauna during operation	
Project component/s	All activities which result in disturbance of avifauna, including: » Avifaunal collisions with PV panels » Human presence » Vehicle traffic
Potential Impact	» Mortality and disturbance of avifauna within and beyond the footprint of the facility due to collisions with solar panels, presence of personnel and vehicle traffic.
Activity/risk source	» Avifaunal collisions with PV panels. » Presence of operational phase personnel. » Presence of personnel during solar field, road and fence maintenance activities. » Birds drinking from reservoirs or ponds containing contaminated water. » Birds entrapped along perimeter fencing.
Mitigation: Target/Objective	Low disturbance and impact of avifauna and low collision rates of avifauna with PV panels and power line during operation.

Mitigation: Action/control	Responsibility	Timeframe
» All incidents of collision with PV 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, in accordance with suggestions made by Visser (2016).	ECO	Operation
» Maintenance of the perimeter fencing must ensure that it fulfils the guidelines (Visser, 2016) to minimise impacts on species susceptible to entrapment. » The power line should be monitored on a regular basis to determine potential areas of high collision rates, especially involving red-listed species (e.g. Ludwig's Bustard). Bird diverters should be fitted to the power line in areas where high collisions rates are detected. » Any movements by vehicle and personnel should be limited to within the footprint of solar field and other associated infrastructure, especially during routine maintenance procedures. » All vehicles accessing the site should adhere to a low speed limit (40km/h max) to avoid collisions with susceptible species such nocturnal and crepuscular species. » Reservoirs or ponds (evaporative or other) should be covered with fine mesh or other exclusion material in order to exclude and prevent birds from accessing potentially contaminated water contained therein. » If birds nesting on infrastructure cannot be tolerated due to operational risks, birds should be prevented from accessing nesting sites using exclusion methods. An avifaunal specialist should be consulted for advice on further mitigation if problems persist.	Contractors	Operation

	» All night-lighting should use low-UV type lights (such as most LEDs), which do not attract insects, and be directed downwards.		
Performance Indicator	» No disturbance of breeding raptors (i.e. no nest abandonment due to disturbance). » No disturbance of red-listed avifaunal species perched or foraging in the vicinity of the solar field. » No poaching or collecting of avifauna or their products (e.g. eggs) by maintenance personnel. » Removal to safety of entrapped/injured avifauna encountered during routine maintenance. » Avifauna do not have access to water contained in reservoirs or ponds used on site. » Low impact on nocturnal and crepuscular species along roads. » Low impact on large raptors and terrestrial birds (e.g. bustards) along the power line corridor.		
Monitoring	ECO to monitor operational phase to ensure that: » No birds or eggs are disturbed or removed by maintenance personnel. » Perimeter fencing is maintained in manner that ensures it is bird friendly, with respect to ground-dwelling species. » Any raptor nests (especially of red-listed species) discovered on site or nearby, are monitored weekly until the post-fledging period. » Power line infrastructure and corridor is monitored weekly to determine potential areas of collisions and electrocutions. » Reservoirs and/or ponds on site are covered with mesh to exclude birds from any potentially contaminated water.		

7.3 *DECOMMISSIONING PHASE ACTIVITIES*

Objective: Limit disturbance and loss of avifaunal microhabitats during decommissioning.	
Project component/s	All infrastructure and activities which result in transformation and loss of intact or rehabilitated avifauna microhabitats: » Removal and clearing of solar field and other infrastructure. » Removal and clearing of camps & other temporary infrastructure. » Removal of access roads.
Potential Impact	Disturbance and loss of avifaunal microhabitats, leading to displacement and loss of resident avifaunal species.
Activity/risk	» Clearing and removal of solar field and other infrastructure.

source	» Clearing and removal of camps and other temporary infrastructure. » Removal of access roads. » Presence of decommissioning crews. » Operation of heavy vehicles.
Mitigation: Target/Objective	» Low disturbance and low impact on avifauna and avifaunal habitats. » Low disturbance and impact on red-listed avifaunal species.

Mitigation: Action/control	Responsibility	Timeframe
» The use of laydown areas within the footprint of the development should be used where feasible, to avoid habitat loss and disturbance to adjoining areas » The removal and clearing of the solar field and other associated infrastructure (buildings, reservoirs, ponds, fencing etc) should be done in such a manner that does not cause destruction and pollution of rehabilitated habitats on site or adjoining natural areas. » All vehicles should adhere to clearly defined and demarcated roads. » All vehicles on site should adhere to a low speed limit (40km/h) to avoid collisions with susceptible species such nocturnal and crepuscular species, as well as reduce dust. » If holes or trenches are to be dug, these should not be left open for extended periods of time as ground-dwelling avifauna may become entrapped therein. » No decommissioning activity should occur near to active raptor nests, should these be discovered prior to or during the decommissioning phase.	Contractor	Decommissioning
» Environmental induction for all personnel regarding basic environmental principles. » ECO to monitor and enforce ban on hunting and collecting of avifauna or their products (e.g. eggs). » Any avifauna threatened or injured by the decommissioning activities should be removed to safety by the ECO or appropriately qualified	ECO	Decommissioning

environmental officer.			
Performance Indicator	» Avifaunal microhabitat loss restricted to infrastructure footprint. » Low disturbance of avifauna within footprint and adjacent areas.		
Monitoring	ECO to monitor construction to ensure that: » Vegetation clearing is limited as far as possible within footprint and adjoining areas during decommissioning. » No birds or eggs are disturbed or removed by personnel. » Any raptor nests (especially of red-listed species) discovered on site or nearby, are monitored weekly to ensure zero disturbances.		

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9 ANNEX 1. LIST OF AVIFAUNA

A consolidated avifaunal list for the Kathu Hyperion project site and surrounds, including records from SABAP1, SABAP2 and the two site visits, and includes red-list status (Taylor *et al.*, 2015), regional endemism (Taylor *et al.*, 2015), and SABAP2 reporting rates (based on four cards submitted for the two relevant pentads). Species with a zero reporting rate were only recorded during SABAP1 and not SABAP2. Species highlighted in bold text were recorded during the site visits.

Species name	Taxonomic name	Red-list Status	Regional Endemism	Reporting rate (%)
Avocet, Pied	*Recurvirostra avosetta*			0
Babbler, Southern Pied	***Turdoides bicolor***			**75**
Barbet, Acacia Pied	***Tricholaema leucomelas***			**100**
Barbet, Crested	***Trachyphonus vaillantii***			**25**
Bateleur	*Terathopius ecaudatus*	Endangered		0
Batis, Pririt	***Batis pririt***			**75**
Bee-eater, European	***Merops apiaster***			**25**
Bee-eater, Swallow-tailed	***Merops hirundineus***			**75**
Bishop, Southern Red	*Euplectes orix*			0
Bishop, Yellow-crowned	*Euplectes afer*			0
Bittern, Little	*Ixobrychus minutus*			0
Bokmakierie	***Telophorus zeylonus***			**25**
Brubru	***Nilaus afer***			**50**
Buffalo-weaver, Red-billed	***Bubalornis niger***			**25**
Bulbul, African Red-eyed	***Pycnonotus nigricans***			**75**
Bunting, Cape	*Emberiza capensis*			0
Bunting, Golden-breasted	***Emberiza flaviventris***			**75**
Bunting, Lark-like	*Emberiza impetuani*			0
Bustard, Kori	***Ardeotis kori***	**Near-Threatened**		**0**
Bustard, Ludwig's	*Neotis ludwigii*	Endangered		0
Buttonquail, Common	***Turnix sylvaticus***			**0**
Buzzard, Common	***Buteo vulpinus***			**0**
Canary, Black-headed	*Serinus alario*		Near-endemic	0
Canary, Black-throated	***Crithagra atrogularis***			**0**
Canary, Yellow	***Crithagra flaviventris***			**100**
Chat, Anteating	***Myrmecocichla formicivora***			**25**
Chat, Familiar	***Cercomela familiaris***			**25**
Cisticola, Desert	***Cisticola aridulus***			**25**
Cisticola, Levaillant's	*Cisticola tinniens*			0
Cisticola, Tinkling	***Cisticola rufilatus***			**50**

Cisticola, Zitting	*Cisticola juncidis*			0
Courser, Burchell's	*Cursorius rufus*	Vulnerable		0
Courser, Double-banded	*Rhinoptilus africanus*			0
Crombec, Long-billed	***Sylvietta rufescens***			**50**
Crow, Cape	*Corvus capensis*			0
Crow, Pied	***Corvus albus***			**0**
Cuckoo, African	*Cuculus gularis*			0
Cuckoo, Black	***Cuculus clamosus***			**0**
Cuckoo, Diderick	*Chrysococcyx caprius*			0
Cuckoo, Great Spotted	***Clamator glandarius***			**0**
Cuckoo, Jacobin	***Clamator jacobinus***			**0**
Dove, Laughing	***Streptopelia senegalensis***			**75**
Dove, Namaqua	***Oena capensis***			**100**
Dove, Red-eyed	*Streptopelia semitorquata*			0
Dove, Rock	*Columba livia*			0
Drongo, Fork-tailed	***Dicrurus adsimilis***			**75**
Duck, Maccoa	*Oxyura maccoa*	Near-Threatened		0
Eagle, Martial	*Polemaetus bellicosus*	Endangered		0
Eagle, Verreaux's	*Aquila verreauxii*	Vulnerable		0
Eagle-owl, Spotted	*Bubo africanus*			0
Eagle-owl, Verreaux's	***Bubo lacteus***			**25**
Egret, Western Cattle	*Bubulcus ibis*			0
Egret, Little	*Egretta garzetta*			0
Eremomela, Yellow-bellied	***Eremomela icteropygialis***			**75**
Falcon, Lanner	*Falco biarmicus*	Vulnerable		0
Finch, Red-headed	***Amadina erythrocephala***			**25**
Finch, Scaly-feathered	***Sporopipes squamifrons***			**75**
Firefinch, Red-billed	*Lagonosticta senegala*			0
Fiscal, Southern	***Lanius collaris***			**25**
Flycatcher, Chat	*Bradornis infuscatus*			0
Flycatcher, Fairy	*Stenostira scita*		Near-endemic	0
Flycatcher, Fiscal	***Sigelus silens***		**Near-endemic**	**50**
Flycatcher, Marico	***Bradornis mariquensis***			**100**
Flycatcher, Spotted	***Muscicapa striata***			**0**
Francolin, Orange River	***Scleroptila levaillantoides***			**25**
Goose, Egyptian	*Alopochen aegyptiacus*			0
Goose, Spur-winged	*Plectropterus gambensis*			0
Goshawk, Gabar	***Melierax gabar***			**75**
Goshawk, Pale Chanting	***Melierax canorus***			**50**
Grebe, Little	*Tachybaptus ruficollis*			0
Greenshank, Common	*Tringa nebularia*			0

Guineafowl, Helmeted	***Numida meleagris***			**50**
Harrier, Black	*Circus maurus*	Endangered	Near-endemic	0
Heron, Black-headed	*Ardea melanocephala*			0
Honeyguide, Greater	*Indicator indicator*			0
Hoopoe, African	***Upupa Africana***			**75**
Hornbill, African Grey	***Tockus nasutus***			**25**
Hornbill, Southern Yellow-billed	***Tockus leucomelas***			**75**
Ibis, Hadeda	*Bostrychia hagedash*			0
Kestrel, Greater	*Falco rupicoloides*			0
Kestrel, Lesser	*Falco naumanni*			0
Kestrel, Rock	*Falco rupicolus*			0
Kite, Black	*Milvus migrans*			0
Kite, Black-shouldered	*Elanus caeruleus*			0
Kite, Yellow-billed	*Milvus aegyptius*			0
Korhaan, Northern Black	*Afrotis afraoides*			0
Korhaan, Red-crested	***Lophotis ruficrista***			**50**
Lapwing, Blacksmith	*Vanellus armatus*			0
Lapwing, Crowned	***Vanellus coronatus***			**75**
Lark, Eastern Clapper	***Mirafra fasciolata***			**50**
Lark, Fawn-coloured	***Calendulauda africanoides***			**75**
Lark, Grey-backed Sparrow-	*Eremopterix verticalis*			0
Lark, Monotonous	***Mirafra passerine***			**17**
Lark, Red-capped	*Calandrella cinerea*			0
Lark, Sabota	*Calendulauda sabota*			0
Lark, Spike-heeled	*Chersomanes albofasciata*			0
Martin, Brown-throated	*Riparia paludicola*			0
Martin, Rock	***Hirundo fuligula***			**25**
Mousebird, Red-faced	***Urocolius indicus***			**100**
Mousebird, White-backed	***Colius colius***			**75**
Neddicky	***Cisticola fulvicapilla***			**25**
Nightjar, European	*Caprimulgus europaeus*			0
Nightjar, Rufous-cheeked	***Caprimulgus rufigena***			**0**
Oriole, Eurasian Golden	*Oriolus oriolus*			0
Ostrich, Common	*Struthio camelus*			0
Owl, Barn	*Tyto alba*			0
Owlet, Pearl-spotted	***Glaucidium perlatum***			**25**
Penduline-tit, Cape	***Anthoscopus minutus***			**25**
Pigeon, Speckled	***Columba guinea***			**25**
Pipit, African	***Anthus cinnamomeus***			**25**
Pipit, Buffy	***Anthus vaalensis***			**25**
Plover, Three-banded	*Charadrius tricollaris*			0

Prinia, Black-chested	***Prinia flavicans***			**100**
Pytilia, Green-winged	***Pytilia melba***			**50**
Quail, Common	*Coturnix coturnix*			0
Quailfinch, African	*Ortygospiza atricollis*			0
Quelea, Red-billed	***Quelea quelea***			**50**
Robin, Kalahari Scrub	***Cercotrichas paean***			**100**
Robin, Karoo Scrub	*Cercotrichas coryphoeus*			0
Robin-chat, Cape	*Cossypha caffra*			0
Rock-thrush, Short-toed	*Monticola brevipes*			0
Roller, European	*Coracias garrulous*	Near-Threatened		0
Roller, Lilac-breasted	***Coracias caudatus***			**25**
Roller, Purple	***Coracias naevius***			**50**
Sandgrouse, Burchell's	***Pterocles burchelli***			**50**
Sandgrouse, Namaqua	***Pterocles namaqua***			**25**
Scimitarbill, Common	***Rhinopomastus cyanomelas***			**50**
Scops-owl, Southern White-faced	*Ptilopsus granti*			0
Secretarybird	*Sagittarius serpentarius*	Vulnerable		0
Shelduck, South African	*Tadorna cana*			0
Shoveler, Cape	*Anas smithii*			0
Shrike, Crimson-breasted	***Laniarius atrococcineus***			**75**
Shrike, Lesser Grey	***Lanius minor***			**0**
Shrike, Red-backed	***Lanius collurio***			**0**
Shrike, Southern White-crowned	***Eurocephalus anguitimens***			**0**
Snake-eagle, Brown	*Circaetus cinereus*			0
Sparrow, Cape	***Passer melanurus***			**25**
Sparrow, Great	*Passer motitensis*			0
Sparrow, House	*Passer domesticus*			0
Sparrow, Southern Grey-headed	***Passer diffuses***			**50**
Sparrow-weaver, White-browed	***Plocepasser mahali***			**75**
Spoonbill, African	*Platalea alba*			0
Spurfowl, Red-billed	*Pternistis adspersus*			0
Starling, Cape Glossy	***Lamprotornis nitens***			**100**
Starling, Pale-winged	*Onychognathus nabouroup*			0
Starling, Pied	*Lamprotornis bicolor*		Endemic	0
Starling, Wattled	***Creatophora cinerea***			**25**
Stonechat, African	*Saxicola torquatus*			0
Stork, Abdim's	*Ciconia abdimii*	Near-Threatened		0
Stork, Black	*Ciconia nigra*	Vulnerable		0
Sunbird, Dusky	*Cinnyris fuscus*			0
Sunbird, Marico	***Cinnyris mariquensis***			**50**
Sunbird, White-bellied	*Cinnyris talatala*			0

Swallow, Barn	***Hirundo rustica***			**0**
Swallow, Greater Striped	***Cecropis cucullata***			**25**
Swallow, Red-breasted	*Hirundo semirufa*			0
Swallow, White-throated	***Hirundo albigularis***			**25**
Swift, African Palm	***Cypsiurus parvus***			**33**
Swift, Alpine	*Tachymarptis melba*			0
Swift, Bradfield's	***Apus bradfieldi***			**17**
Swift, Common	***Apus apus***			**0**
Swift, Little	***Apus affinis***			**0**
Swift, White-rumped	*Apus caffer*			0
Tchagra, Brown-crowned	***Tchagra australis***			**75**
Thick-knee, Spotted	***Burhinus capensis***			**50**
Thrush, Groundscraper	***Psophocichla litsipsirupa***			**50**
Thrush, Karoo	*Turdus smithi*		Near-endemic	0
Tit, Ashy	***Parus cinerascens***			**75**
Turtle-dove, Cape	***Streptopelia capicola***			**100**
Vulture, White-backed	*Gyps africanus*	Critically Endangered		0
Wagtail, Cape	***Motacilla capensis***			**25**
Warbler, African Reed	*Acrocephalus baeticatus*			0
Warbler, Chestnut-vented	***Sylvia subcaeruleum***			**100**
Warbler, Lesser Swamp	*Acrocephalus gracilirostris*			0
Warbler, Rufous-eared	*Malcorus pectoralis*			0
Warbler, Willow	*Phylloscopus trochilus*			0
Waxbill, Black-faced	***Estrilda erythronotos***			**50**
Waxbill, Common	*Estrilda astrild*			0
Waxbill, Violet-eared	***Granatina granatina***			**100**
Weaver, Sociable	*Philetairus socius*			0
Weaver, Southern Masked	***Ploceus velatus***			**50**
Wheatear, Capped	*Oenanthe pileata*			0
Wheatear, Mountain	*Oenanthe monticola*			0
White-eye, Orange River	*Zosterops pallidus*			0
Whydah, Pin-tailed	*Vidua macroura*			0
Whydah, Shaft-tailed	***Vidua regia***			**75**
Woodpecker, Cardinal	***Dendropicos fuscescens***			**17**
Woodpecker, Golden-tailed	***Campethera abingoni***			**25**