BASIC ASSESSMENT FOR THE PROPOSED GEELSTERT SOLAR FACILITY 1 AND ASSOCIATED INFRASTRUCTURE:

AVIFAUNAL SPECIALIST STUDY

Red Lark *Calendulauda burra*

PRODUCED FOR SAVANNAH ENVIRONMENTAL

BY

3Foxes Biodiversity Solutions

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EXECUTIVE SUMMARY

Geelstert Solar Facility 1 (Pty) Ltd is proposing the development of a commercial solar PV facility and associated infrastructure, known as Geelstert 1, on a site located approximately 11km south-east of Aggeneys within the Khâi-Ma Local Municipality and the Namakwa District Municipality in the Northern Cape Province. As the site falls within the Springbok Renewable Energy Development Zone (REDZ), a Basic Assessment (BA) process is required for authorisation. Savannah Environmental has appointed 3Foxes Biodiversity Solutions to provide a specialist avifaunal EIA study of the project site as part of the required BA process.

A full field assessment over three 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. An approximate total of 105 bird species have been previously recorded within the broader study area, of which 54 species were observed during the three site visits, in winter (June 2018), summer (March 2019) and winter (June 2020). Eight (8) of these are red-listed as Threatened while a further four (4) are Near-threatened. One species, the Vulnerable Red Lark *Calendulauda burra*, is endemic to South Africa, while fourteen (14) other species are near-endemic. Twelve (12) species are listed as biome-restricted, and include a number of lark species in particular.

The site is located near an Important Bird Area (IBA) known as Haramoep and Black Mountain Mine. This IBA is one of only a few sites that provide protection to the globally threatened Red Lark. The IBA also supports a number of other red-listed species, while it is also important for seasonally occurring nomadic larks. The Red Lark distribution on the site does not overlap with the development area and the field surveys indicate that it is strongly associated with the red dune system of the Koa River valley at least 500m to the south of the development area.

The expected impacts of Geelstert PV1 within the project site includes 1) habitat loss and fragmentation associated with the Bushmanland Arid Grassland habitat, 2) disturbance caused during the construction and maintenance phases, and 3) direct mortality of avifauna colliding with solar panels and possible entrapment along perimeter fencing. 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 significance, but due to the low frequency of occurrence of priority red-listed species and the wide distribution and nomadic movements of many of the near-endemics and biome-restricted species, the impacts are likely to be low and no high post-mitigation impacts are expected to occur.

The primary mitigation measures required to reduce the potential impacts on priority species would include 1) restricting habitat destruction and disturbance to the footprint of the proposed development, 2) exclusion of the dune habitat with an adequate buffer zone to be avoided and excluded from any disturbance or future development, and 3) ensuring that perimeter fencing along the boundaries of the development are bird and wildlife friendly (especially for ground-dwelling species).

Considering that the project site for Geelstert PV1 supports a typical Nama-Karoo bioregional avifaunal assemblage, and that there are no known breeding or roosting sites of red-listed priority species within 3 km of the site (other than Red Lark), and that most near-endemics and biome-restricted species have wide distribution ranges, there are no impacts associated with the development that are considered to be of high significance and which cannot be mitigated to a low acceptable level. Therefore, there are no fatal flaws from an avifaunal perspective that should prevent the development from proceeding.

Cumulative impacts associated with the development may be of moderate concern due to increasing number of solar facility developments proposed for the broader Aggeneys area. Considering that the vegetation and avifauna that occur on the property are rather typical of the Nama-Karoo bioregion, the overall cumulative avifaunal impact of the development is, however, considered to be low, provided the development footprint for Geelstert PV1 remains restricted to the plains habitat of the Bushmanland Arid Grassland vegetation type.

Impact statement

The proposed site for Geelstert PV1 is considered to represent a broadly suitable environment for the location of the proposed solar PV facility. Considering that the study area supports a typical bioregional avifaunal assemblage within an extensive vegetation type, and that there are no known breeding or roosting sites of large-bodied red-listed priority species within close proximity (<3 km), 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 acceptable level. Consequently, the development can be supported from an avifaunal perspective. It is therefore the reasoned opinion of the specialist that Geelstert PV1 should be authorised, subject to the implementation of the recommended mitigation measures.

CONTENTS

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
c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 1
(cA) an indication of the quality and age of base data used for the specialist report;	Section 2.1
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 3
d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 2.2
e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 2
f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Section 3
g) an identification of any areas to be avoided, including buffers;	Section 3
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;	Section 3
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 2.4
j) a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Section 4
k) any mitigation measures for inclusion in the EMPr;	Section 5
l) any conditions for inclusion in the environmental authorisation;	Section 5
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 5
n) a reasoned opinion- i. whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities and ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 6
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, Olifantshoek. Fauna and Flora BA process. Savannah Environmental 2017.
- Gaetsewe Solar PV Facility, Kathu. Fauna and Flora EIA Process. Cape EAPrac 2018.
- Mogara Solar PV Facility, Kathu. Fauna and Flora EIA Process. Cape EAPrac 2018.
- Kathu Hyperion Solar PV Facility, Kathu. 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 Studies include the following:

- Aggeneys Solar PV Facility. Avifaunal Basic Assessment. Savannah Environmental 2018/19.
- Excelsior Wind Facility. Avifaunal pre-construction monitoring. BTE Wind Pty (Ltd). 2018/19.
- Kathu Hyperion Solar PV Facility, Kathu. Fauna and Flora EIA Process. Cape EAPrac 2018/19.
- Gaetsewe Solar PV Facility, Kathu. Avifaunal Scoping Report. Cape EAPrac 2018.
- Mogara Solar PV Facility, Kathu. Avifaunal Scoping Report. 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, Olifantshoek. Fauna and Flora BA process. Savannah Environmental 2017.

SPECIALIST DECLARATION 1

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: ____18 July 2020_____

SPECIALIST DECLARATION 2

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;
- 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: ____Eric Herrmann_____

Date: ____18 July 2020_____

1 INTRODUCTION

Geelstert Solar Facility 1 (Pty) Ltd is proposing the development of a commercial solar PV facility and associated infrastructure, known as Geelstert 1, on a site located approximately 11km south-east of Aggeneys within the Khâi-Ma Local Municipality and the Namakwa District Municipality in the Northern Cape Province. As the project site falls within a REDZ, a Basic Assessment (BA) process would be required for authorisation. A grid connection to the nearby Aggeneys Substation would also be required, but this will be assessed through a separate independent BA process. Geelstert Solar Facility 1 (Pty) Ltd has appointed 3Foxes Biodiversity Solutions to provide a specialist avifaunal BA study of the project site as part of the required BA process.

The purpose of the Geelstert Solar Facility 1 Avifaunal BA Specialist Report is to, 1) describe the avifauna and avian ecological features of the proposed PV project site, with special reference to the Red Lark *Calendulauda burra*, 2) to provide a preliminary assessment of the avian ecological sensitivity of the site, 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, minimise and mitigate project related impacts to the avifauna. Two winter (late June 2018 and 2020) site visits and a summer (late March 2019) site visit, 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. The Red Lark is a South African endemic species with a limited distribution range within the Nama-Karoo. It has reportedly suffered a dramatic range reduction (75%) in the past 100 years owing to livestock overgrazing and subsequent habitat degradation (Taylor *et al*., 2015). The global population is also estimated to be less than 10 000 individuals, while there has also been a suspected 30% decline in population size over the past three generations (Taylor *et al.,* 2015). Additionally, the species has a patchy distribution within a restricted range in the Nama-Karoo (Hockey *et al*., 2005). However, further studies on the species' distribution and habitat preferences are currently underway to provide a much needed update on its range and abundance.

This information is used to derive an avifaunal sensitivity map that presents the ecological constraints and opportunities for development at the site. The information and sensitivity map provide 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 minimised 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 Environmental Management Programme (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 326) 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.

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:

- Pre-construction and Construction Phase
- Operation Phase
- Decommissioning Phase

1.2 RELEVANT ASPECTS OF THE DEVELOPMENT

Geelstert Solar Facility 1 (Pty) Ltd is proposing the development of a commercial solar PV facility and associated infrastructure, known as Geelstert 1, on a site located approximately 11km south-east of Aggeneys within the Khâi-Ma Local Municipality and the Namakwa District Municipality in the Northern Cape Province ().

A development area (located within the study area and affected property, Remaining Extent of the Farm Bloemhoek 61) with an extent of ~578ha has been identified by Geelstert Solar Facility 1 (Pty) Ltd as a technically suitable site for the development of a solar PV facility with a contracted capacity of up to 120MW. The development footprint of Geelstert 1 will be

located within the development area. The study area is located within Focus Area 8 of the Renewable Energy Development Zones (REDZ), which is known as the Springbok REDZ. Due to the location of the study area within a REDZ, a Basic Assessment (BA) process will be undertaken in accordance with GN R114 as formally gazetted on 16 February 2018.

The development area of Geelstert 1 is proposed to accommodate the following infrastructure, which will enable the solar PV facility to generate a contracted capacity of up to 120MW:

- Bifacial or monofacial PV panels, mounted on fixed-tilt or tracking mounting structures with a maximum height of 3.5m;
- Centralised inverter stations or string inverters;
- A temporary laydown area;
- Cabling between the panels, to be laid underground where practical;
- An on-site facility substation stepping up from 22kV or 33kV to 132kV or 220kV, with an extent of up to 1ha to facilitate the connection between the solar PV facility and the grid connection solution;
- An access road to the development with a maximum width of 8m;
- Internal access roads within the PV panel array area with a maximum width of 5m;
- Operation and Maintenance buildings including a gate house and security building, control centre, offices, warehouses, a workshop and visitors centre.

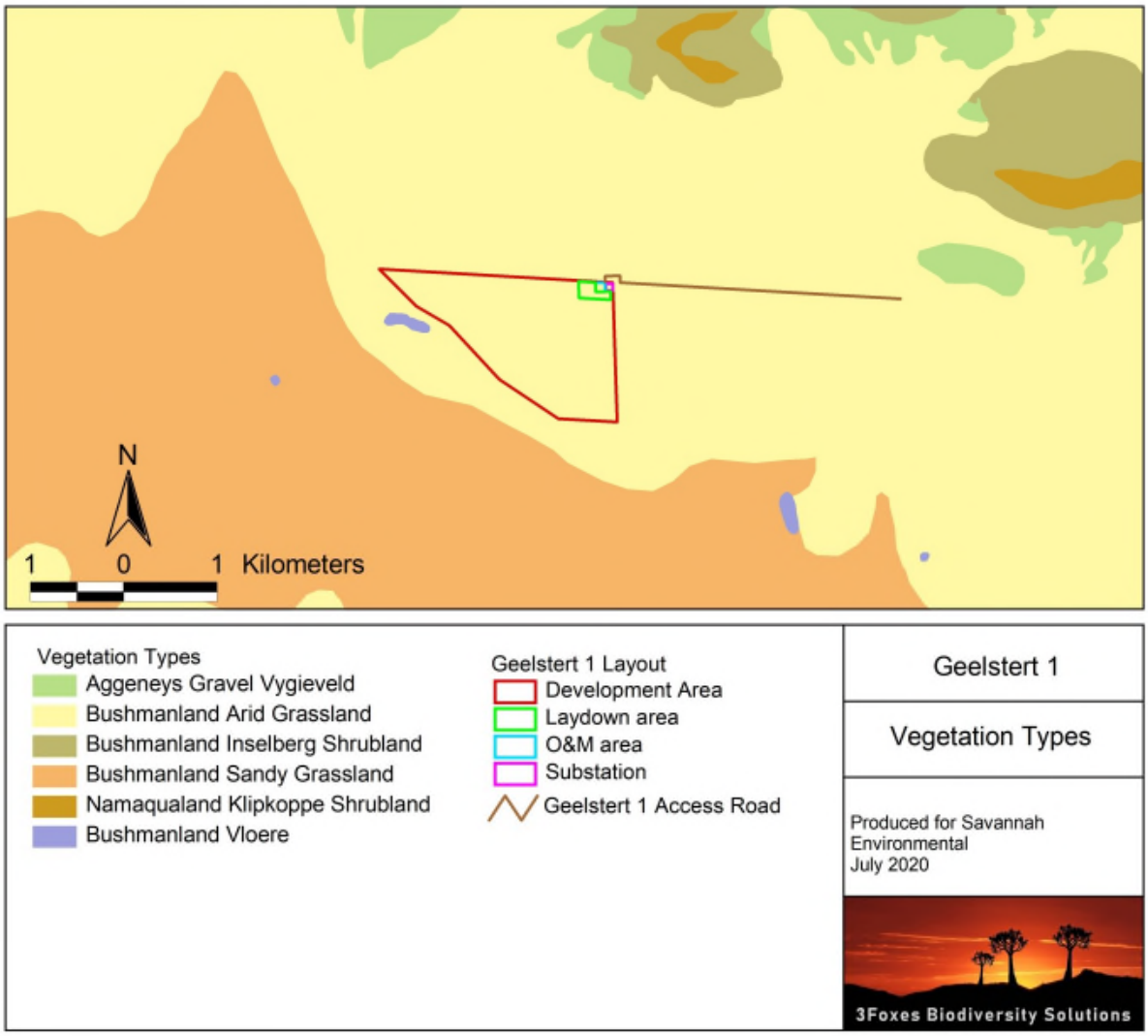

Figure 1. Locality map of the Geelstert PV1 project site in the relation to the vegetation types of the broader area (2018 VegMap).

2 METHODOLOGY

2.1 *DATA SOURCING AND REVIEW*

A full field assessment 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 site. 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 study area. The relevant quarter-degree grid cell (QDGC) that covers the study area is 2918BD (69 cards, 159 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/). SABAP 2 employs a finer resolution using the pentad scale (5' latitude x 5' longitude), with the relevant pentad code for the study area being 2915_1855 (26 cards, 72 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, and biology of all species considered likely to occur within the project site 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 is one Important Bird Area (IBA) in the vicinity of Geelstert PV1, namely the Haramoep and Black Mountain Mine IBA. Apart from this IBA, there are no other areas of conservation concern or Coordinated Avifaunal Roadcounts (CAR) routes or Coordinated Waterbird Counts (CWAC) wetlands in the vicinity of the study area.

2.2 *SITE VISIT & FIELD METHODOLOGY*

The project site was visited on three occasions for between two to three days, once in mid-winter (26 to 28 June 2018), late summer (20 to 22 March 2019) and again mid-winter (23 to 24 June 2020), to determine the *in situ* local avifauna and avian habitats present on site. Conditions for recording avifaunal species were considered optimal during the winter visit in 2018, as the area had received relatively good rains during late summer, resulting in large numbers of nomadic species occupying the study area and surrounds. In contrast, the conditions during the summer 2019 and winter 2020 surveys were extremely dry and harsh owing to very poor rainfall, resulting in very low numbers of birds being recorded. Linear transects measuring 1km in length were walked through the study area, mostly from within or near the development area into the dune system south of the development area to ensure adequate coverage of the broader area (±20km^2), both in the winter of 2018 (n =

30) and the summer of 2019 (n = 19). During the winter visit of 2020 no 1km transect were walked as birds were extremely scarce. Instead, five long (2.8 to 5.0km), mostly irregular transects were walked across the boundary area between the red dunes and the plains habitat to the north. A primary purpose of the transect approach was to inform the distribution of the Red Lark in relation to the location of the development area and ensure that any impacts on this species can be quantified and preferably avoided. The number of birds seen or heard along each transect were recorded, as well as the perpendicular distance from the transect line to each bird detection. Other variables such as time of day and weather conditions were also recorded for each transect. The relative abundance of birds (number of birds/km) was calculated for each species. The walked transects served primarily to:

- Quantify aspects of the local avifauna (such as species diversity and relative 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.

Prior to analysing the transect data for the 20018 and 2019 site visits, all records of birds that were only seen flying over the site (e.g. sandgrouse), were excluded from the database.

A list was compiled of all the avifaunal species likely to occur within the project site and the broader impact zone of the development, based on a combination of existing distributional data (SABAP 1 and SABAP 2) and species seen during the site visit. 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 any less important bird populations that may also potentially be affected.

2.3 SENSITIVITY MAPPING & ASSESSMENT

An avifaunal sensitivity map of the project site was produced by integrating the ecological and biodiversity information available in the literature and various spatial 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 on the satellite imagery and assigning likely sensitivity values to the units based on their ecological properties, conservation value and the potential presence of avifaunal species of conservation concern.

The ecological 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 low avifaunal sensitivity where there is likely to be a negligible impact on ecological processes and avifaunal biodiversity. Most development types 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 are low. These areas usually comprise the bulk of avifaunal 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 impact is anticipated due to high avifaunal diversity, sensitivity or important avifaunal habitat role of the area. These areas may contain or be important habitat for avifaunal species or provide important services such as water flow regulation for wetlands or other important avifaunal habitats. Development within these areas is undesirable and should only proceed with caution as it may not be possible to mitigate all impacts appropriately.
- **Very High** – Critical and unique avifaunal habitats that serve as habitat or nesting sites for rare/endangered species or represent other critical areas such as migration corridors. These areas are essentially no-go areas from a developmental perspective and should be avoided as much as possible.

2.4 SAMPLING LIMITATIONS AND ASSUMPTIONS

The current study consists of a relatively detailed field assessment (summer and winter surveys) as well as a desktop study, which serves to significantly reduce the limitations and assumptions of 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 solar energy facilities. Recent studies at solar facilities (all using different solar technologies) in southern California have revealed that a wide range of bird species are susceptible to morbidity and mortality, 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 facility must be assessed individually, taking all variables into account.
- Assessment of the impacts associated with bird and solar facility 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 facilities 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 study area and surrounds are now >22 years old (Harrison *et al*., 1997). However, with over 25 cards being submitted for the relevant pentad that covers the study area during SABAP 2, relatively reliable data exist with respect to species reporting rates. In an attempt to ensure a conservative approach with regards to the species included on the final avifaunal list (Annexure 1), the species list derived from the literature was obtained from an area somewhat larger than the project site, and thus likely includes a much wider array of species than what actually occurs at the site.
- Limited time in the field and seasonal spread means that important components of the local avifauna (i.e. important nest sites or localised areas of key habitats for rare or threatened species) could have been missed. However, the extent of the study area is not that large and has been well-covered. Also, as it contains no large trees, 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.

3 DESCRIPTION OF THE AFFECTED ENVIRONMENT- BASELINE

3.1 SITE CONTEXT & AVIFAUNAL MICROHABITATS OF THE SITE

The vegetation of the project site is described as Bushmanland Sandy Grassland (Mucina & Rutherford, 2006), which typically occurs on deep red sands and dunes. However, a more recent (2016) unpublished Vegmap reclassified the area which encompasses the project site as the Bushmanland Arid Grassland vegetation type. This vegetation type is considered to be more representative of the vegetation at the project site, where the soils are mostly shallow, red-yellow apedal (without structure) and freely drained. The Bushmanland Arid Grassland is the second most extensive vegetation type in South Africa, and extends from Aggeneys eastwards to Prieska. Due to the aridity of this vegetation type, it has not been significantly impacted by intensive agriculture with only 1% being transformed. The study area, which comprises mostly Bushmanland Arid Grassland, also includes a portion of typical Bushmanland Sandy Grassland which is characterised by red sand dunes. This vegetation type was also included in the avifaunal surveys, as it represents the primary habitat of the endemic and Vulnerable Red Lark within the area.

Two avifaunal microhabitats were identified within the study area, and are directly associated with the two vegetation types. The Bushmanland Arid Grassland vegetation type represents the plains habitat, while the Bushmanland Sandy Grassland represents the dune habitat. Only the plains habitat lies within the project site. The plains habitat () covers the majority of the project site and features sparsely vegetated sandy flats. The dune habitat () (located well-outside of the development footprint) features deep red sand well vegetated

with tall *Stipagrostis* grasses, and is restricted to the southern and south western boundaries of the study area. This habitat appears to be the main habitat occupied by the Red Lark, based on the three field surveys.

Figure 2. Most of the study area is characterised by the plains habitat within the Bushmanland Arid Grassland vegetation type, as seen here during the mid-winter survey (June 2018) when conditions for nomadic avifaunal species were optimal. Geelstert PV1 is restricted to within this habitat.

Figure 3. The dune habitat lies within the Bushmanland Sandy Grassland vegetation type, which does not occur on the project site itself, but further to the south west within the broader study area. This is the primary habitat for the endemic and Vulnerable Red Lark.

3.2 GENERAL AVIFAUNA

The bird assemblage previously recorded (SABAP 1 & 2) within the area is typical of the Nama-Karoo bioregion. An approximate total of 105 bird species have been recorded within the study area and surrounds, of which 54 species were observed during the three site visits. Eight of these are red-listed while a further four are Near-threatened. One species (Red Lark) is endemic to South Africa, while fourteen species are near-endemic. Twelve species are listed as biome-restricted, which include a number of lark species in particular. Numerous others that have been recorded are arid-zone species, which follow either resident or nomadic life strategies.

A total of 38 bird species were recorded during the transect surveys of 2018 and 2019 during the two seasons, with 31 and 28 species recorded in winter and summer respectively, within the broader study area. Only 17 species were recorded within the study area during the site visit in June 2020. With respect to only the surveys of 2018 and 2019, small passerine species made up the majority (ca. 70%) of the species detected, compared to non-passerines. Significantly more species and birds were detected in winter compared to summer (), with the total bird abundance being five times greater. The good veld conditions that prevailed during winter (June 2018) resulted in numerous nomadic species being

attracted to the area, whereas the arid conditions in late summer (March 2019) resulted in many of these species being almost entirely absent. This illustrates the extremes in bird abundances that occur depending on local conditions and the corresponding response by nomadic bird species.

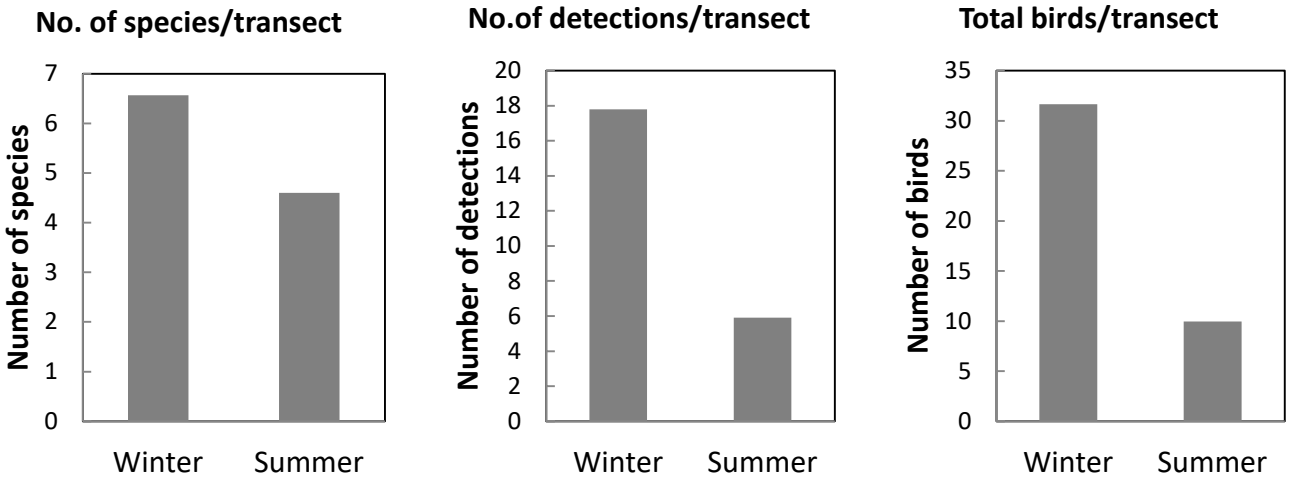

Figure 4. Comparison of transect observations during the field surveys in winter of 2018 (n = 30 transects) and summer of 2019 (n = 19 transects) at the Geelstert PV1 broader study area, with respect to the number of species seen per transect, the number of detections per transect, and the total number of birds seen per transect.

The four most abundant species recorded during the transect surveys in winter (2018) were all highly nomadic passerine species, of which the most common was the Grey-backed Sparrow-lark *Eremopterix verticalis*, with 10.8 birds/km being detected (). These highly nomadic species are known to respond to rainfall events (Dean 2000), becoming entirely absent again during unfavourably dry periods. The second and third most abundant species were Lark-like Bunting *Emberiza impetuani* and Stark's Lark *Spizocorys starki*, with 4.5 and 4.1 birds/km, respectively. The fourth most abundant species was the Black-eared Sparrow-lark *Eremopterix australis*, with 2.8 birds/km detected. All these species exhibited dramatically reduced numbers during the summer survey of 2019.

Spike-heeled Lark was the only resident species with a relatively high abundance, with 1.7 birds/km detected in winter, with a reduced detection in summer (0.7 birds/km). The chat species, represented by Karoo *Cercomela schlegelii*, Ant-eating *Myrmecocichla formicivora* and Tractrac Chat *Cercomela tractrac*, showed an increase in abundance in summer, while other resident species such as Rufous-eared warbler *Malcorus pectoralis*, Chat Flycatcher *Bradornis infuscatus*, and Red Lark remained relatively stable. The Red Lark was detected at a rate of 0.53 birds/km in winter and 0.68 birds/km in summer, although considering that it was only recorded in the dune habitat (located outside of the Geelstert PV1 footprint) and not within the plains habitat where most of the transects were walked, this relative

abundance is rather unrepresentative of the species. In winter (2018) Red Larks were recorded on six (6) of the 30 transects, with a total of 16 sightings, and exclusively within the dune habitat and adjacent sandy flats characterised by red sands, tall grasses, and interspersed tall shrubs (). In summer, Red Larks were recorded on seven (7) of the 19 transects (12 sightings), all within the same dune habitat as in winter. This suggests that the species is indeed absent from the plains habitat that characterises the majority of the study area and the Geelstert PV1 project site. Again, during the winter survey of 2020, Red Larks (though only four sightings) were recorded only within the known range in the study area, on the edge of the dune habitat ().

Table 1. Summary of dominant passerine species recorded along line transects walked throughout the broader Geelstert PV study area (including and well beyond the development footprint) during the field survey in winter of 2018 (n = 30) and summer of 2019 (n = 19), with respect to the number of detections per species, the total number of birds detected per species, and the number of birds seen per kilometer, as a measure of relative abundance.

Species	Winter			Summer		
	No. of detections	No. of birds	Birds/km	No. of detections	No. of birds	Birds/km
Bunting, Lark-like	76	135	4.50	3	3	0.16
Chat, Ant-eating	6	7	0.23	7	12	0.63
Chat, Karoo	-	-	-	7	10	0.53
Chat, Tractrac	6	7	0.23	6	7	0.37
Flycatcher, Chat	16	20	0.67	13	15	0.79
Lark, Black-eared Sparrow-	51	84	2.80	1	5	0.26
Lark, Cape Clapper	11	11	0.37	-	-	
Lark, Grey-backed Sparrow-	157	323	10.77	12	20	1.05
Lark, Red	14	16	0.53	12	13	0.68
Lark, Spike-heeled	31	51	1.70	6	14	0.74
Lark, Stark's	71	122	4.07	2	3	0.16
Warbler, Rufous-eared	10	14	0.47	6	6	0.32

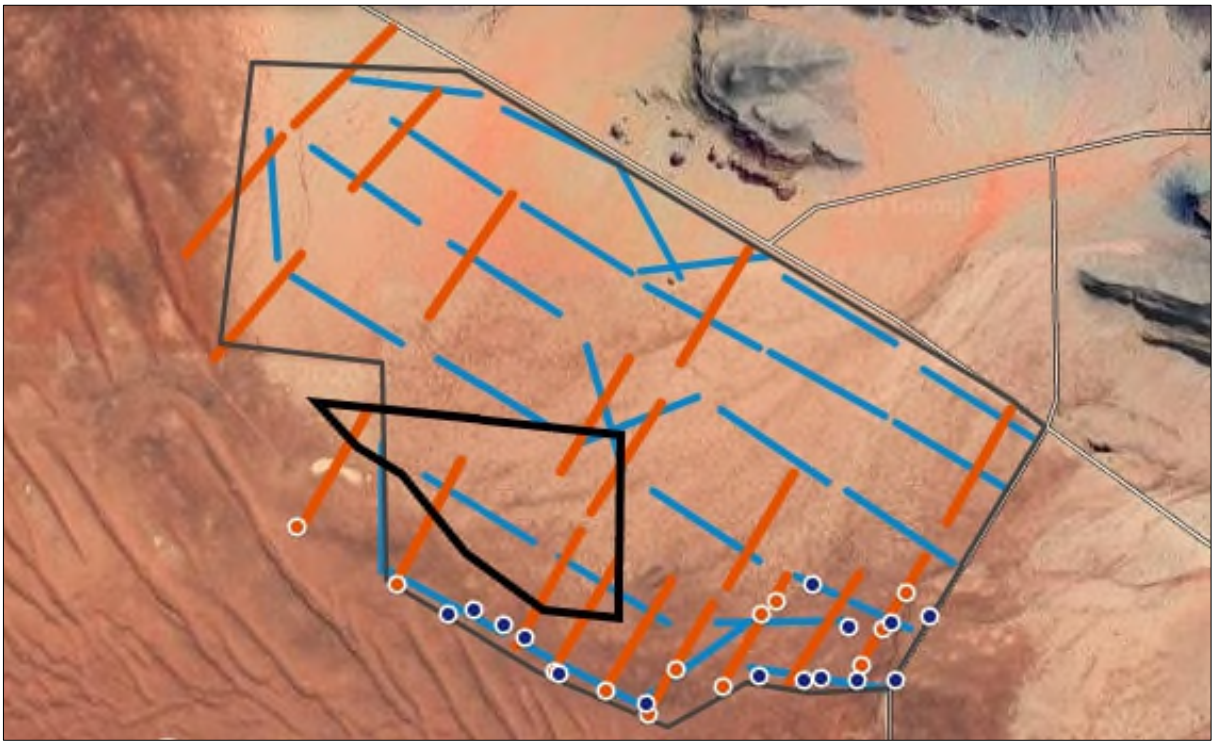

Figure 5. The distribution of 1km transects walked across the broader study area (grey border), showing the Geelstert PV1 project site (black border), the transects that were surveyed in the winter of 2018 (blue lines) and summer of 2019 (red lines), and Red Lark sightings in winter (blue dots) and summer (orange dots). Red Larks were clearly restricted to the dune habitat while being completely absent from the plains habitat in both seasons.

Other red-listed passerine species that have been recorded in the greater area, but only during the SABAP 1 atlas period, include the Sclater's Lark *Spizocorys sclateri* and the African Rock Pipit *Anthus crenatus.* Neither species were recorded during the site visits, nor have they been detected during SABAP 2. Sclater's Lark prefers quartz or stony gravel plains which are courser than the sandy plains of the project site. African Rock Pipit prefers more mountainous terrain and would most likely be restricted to the neighbouring Gamsberg inselberg, if it is present in the area. Both species are therefore unlikely to occur on the project site based on their habitat preferences, which is corroborated by the absence of SABAP 2 sightings for both these species within the pentad that covers the project site.

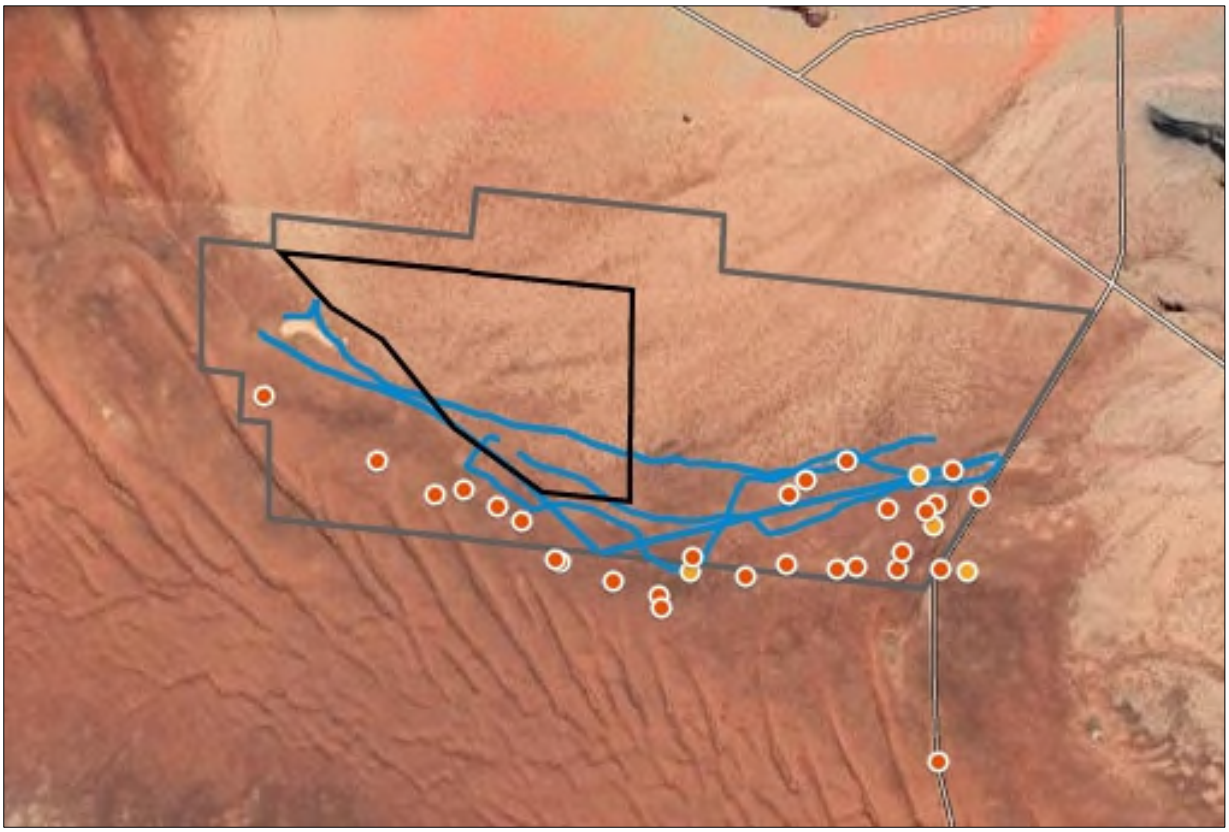

Figure 6. The distribution of five irregular transects (blue lines) of variable length across the southern portion of the broader Geelstert study area (grey border) during the winter survey of 2020, showing the proposed Geelstert PV1 project site (black border), with Red Lark sightings of 2018 and 2019 (red dots) and more recently in June 2020 (yellow dots).

Amongst the non-passerines, only Namaqua Sandgrouse *Pterocles namaqua*, Northern Black Korhaan *Afrotis afraoides* and Greater Kestrel *Falco rupicoloides* were detected with similar frequency across the seasons, whereas other species were present in only one season (). For example, Namaqua Dove *Oena capensis* and Ludwig's Bustard *Neotis ludwigii* were present only in winter (2018). Rates of detection for other species were far too low to make meaningful deductions regarding seasonal changes.

Other biome-restricted species which occurred within the project site include Tractrac Chat, Sociable Weaver *Philetairus socius*, Karoo Chat, and Karoo Long-billed Lark *Certhilauda subcoronata*. However, most of these species were marginal to the site, being recorded more frequently on the north eastern boundary of the broader study area that borders the Loop 10 road.

Table 2. Summary of non-passerines recorded along line transects walked throughout the broader Geelstert PV1 study area during the field survey in the winter of 2018 (n = 30) and the summer of 2019 (n = 19), with respect to the number of detections per species, total number of birds detected per species, and number of birds seen per kilometer, as a measure of relative abundance.

Species	Winter			Summer		
	No. of detections	No. of birds	Birds/km	No. of detections	No. of birds	Birds/km
Bustard, Ludwig's	2	2	0.07	-	-	-
Courser, Burchell's	-	-	-	1	3	0.16
Courser, Double-banded	1	2	0.07	-	-	-
Dove, Namaqua	9	20	0.67	-	-	-
Eagle, Black-chested Snake	-	-	-	1	1	0.05
Eagle, Martial	1	1	0.03	1	1	0.05
Eagle, Verreaux's	1	1	0.03	-	-	-
Kestrel, Greater	4	6	0.20	2	3	0.16
Korhaan, Karoo	-	-	-	1	2	0.11
Korhaan, Northern Black	13	14	0.47	5	6	0.32
Sandgrouse, Namaqua	9	15	0.50	7	39	2.05

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 nine red-listed non-passerine species have been reported for the area during SABAP 1 and the SABAP 2 period. Of these, seven are listed as threatened and two as Near-Threatened (). The most important of these include Martial Eagle *Polemaetus bellicosus* (Endangered), Ludwig's Bustard (Endangered) and Verreaux's Eagle *Aquila verreauxii* (Vulnerable), all of which are considered to have local populations of moderate importance. These species are also considered prone to collisions with power line structures, and hence may be susceptible to increased developments in the area that involve the erection of power lines. Ludwigs's Bustard and Martial Eagle were both seen foraging within the area, while Verreaux's Eagle was seen directly adjacent to the project site. An adult Martial Eagle was also seen roosting on the pylon structure of the large power line that traverses the study area during both the winter (2018) and summer (2019) field survey. Two separate Martial Eagle nests were located on pylons to the west and east of the project site, though only the nest to the west has been used in recent years (2018 and 2020). This nest is located approximately 9.0km from the centre of the project site (), while the apparently unused nest to the east is over 6.5km from the project site. Both these nests are considered sufficiently far enough away (>3km) so as not to be significantly impacted by the proposed development.

Figure 7. Location of two Martial Eagle nests (red markers) in relation to the Geelstert PV1 project site (black border, centered). The active nest to the west is approximately 9.0km from the center of the project site while the apparently unused nest to the east is 6.5km from the project site. Both nests are therefore considered to be sufficiently far enough away (>3km) from the proposed development.

Species of secondary importance include Secretarybird *Sagittarius serpentarius* (Vulnerable), Lanner Falcon *Falco biarmicus* (Vulnerable), and Karoo Korhaan *Eupodotis vigorsii* (Near-Threatened). The species have populations of low local importance due to their wide geographical distributions, but have a moderate to high probability of occurring at the project site. Of these only Karoo Korhaan was recorded on one occasion during the summer survey. The species is considered to be scarce in the study area as it is generally readily detected in other areas. Species that have a low probability of occurring at the project site include the near-endemic Black Harrier *Circus maurus* (Endangered), Burchell's Courser *Cursorius rufus* (Vulnerable), and Kori Bustard *Ardeotis kori* (Near-Threatened). None of these species have been reported during SABAP 2, while their populations are considered to be of low importance locally due to their scarcity in the area. However, of these species, Burchell's Courser (1 sighting, 3 individuals) was recorded during the summer survey in west of the study area near the small ephemeral pan.

During the walking transects regular scans were made to detect any large flying birds to establish the presence of flight paths across the study area. Large raptors that have been

seen foraging over the site include Martial Eagle (three occasions), Black-chested Snake-eagle (one occasion) and Verreaux's Eagle (one occasion). No other red-list species were seen using the site or flying routine flight paths. This may be due to the apparent absence of communal roosting and breeding sites, and hence birds may be traversing the site on an ad hoc basis. Besides the absence of communal nest sites, no individual nests were located during the field surveys within the project site and the study area. However, it may be possible that species such as Secretarybird may use solitary *Boscia* or other tree species on the outskirts of the study area for nesting, which may have been missed during the surveys.

A literature review revealed that there is one Important Bird Area (IBA) in close proximity to the site, namely the Haramoep and Black Mountain Mine, which lies to the west of the project site. Besides this IBA, no Coordinated Avifaunal Roadcounts (CAR) routes, or Coordinated Waterbird Counts (CWAC) wetlands occur in the vicinity. The presence of the Haramoep and Black Mountain Mine IBA, however, highlights the need to investigate the cumulative impact of future solar energy developments in the broader area, as this IBA's potential connectivity with other IBAs to the south should not be compromised by possible future expansions of the proposed development or other additional solar energy projects. Marnewick *et al.*, (2015) points out that the particular threats facing this IBA include overgrazing by livestock and subsequent habitat degradation, mining, climate change, and additional power and transmission lines from the solar facilities to substations.

In essence, much of the avifauna within the project site appears similar to that found across the Nama-Karoo bioregion of the Northern Cape. Although a relatively high proportion of near-endemic and biome-restricted species occur at the site, many of these have wide ranges or are highly nomadic within the bioregion. The only passerine species of particular concern is the Red Lark, which appears to only occupy the red dune habitat and adjoining sandy flats within a restricted part of the study area. While a fair number of red-listed species also occur, most of these also have wide ranges across much of the bioregion and beyond, while none appear to be resident breeders on the site. Some species, such as the large eagles and bustards, may use the area on occasion as part of their large ranges. However, since the project site appears to not directly support communally nesting red-listed species, the sensitivity of the broader study area (including the project site) in general can be considered to be of medium significance with respect to avifauna.

Table 3. Red-listed species recorded at the broader Geelstert PV1 study area during SABAP 1 (1987-1992), SABAP 2 (2007 on-going) and the mid-winter (26 to 28 June 2018 and 23 to 24 June 2020) and late summer (20 to 22 March 2019) site visit, ranked according to their red-list status. Twelve species have been recorded during the bird atlasing periods, of which six species have been recorded during the three field surveys.

English name	Taxonomic name	Red-list status	Regional endemism	Estimated importance of local population	Preferred habitat	Probability of occurrence	Threats
Bustard, Ludwig's	***Neotis ludwigii***	**Endangered**	**-**	**Low**	**Semi-arid shrublands**	**Recorded**	**Habitat loss/Disturbance Collisions**
Eagle, Martial	***Polemaetus bellicosus***	**Endangered**	**-**	**Moderate**	**Savanna & shrublands**	**Recorded**	**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**	**Low**	**Habitat loss/Disturbance**
Red Lark	***Calendulauda burra***	**Vulnerable**	**Endemic**	**High**	**Red dunes & sandy plains**	**Recorded**	**Habitat loss, degradation & fragmentation**
Eagle, Verreaux's	***Aquila verreauxii***	**Vulnerable**	**-**	**Moderate**	**Mountainous and rocky areas**	**Recorded**	**Habitat loss/Disturbance Collisions/Electrocution**
Falcon, Lanner	*Falco biarmicus*	Vulnerable	-	Low	Widespread	High	Habitat loss/Disturbance Collisions/Electrocution
Secretarybird	*Sagittarius serpentarius*	Vulnerable	-	Low	Open savanna & grassland	Moderate	Habitat loss/Disturbance Collisions
Sclater's Lark	*Spizocorys sclateri*	Near-threatened	Near-endemic	Low	Quartz gravel or stony plains	Low	Habitat loss, degradation & fragmentation
Karoo Korhaan	***Eupodotis vigorsii***	**Near-threatened**	**-**	**Low**	**Karoo shrubland**	**Moderate**	**Habitat loss/Disturbance Collisions**
Bustard, Kori	*Ardeotis kori*	Near-threatened	-	Low	Open savanna	Low	Habitat loss/Disturbance Collisions
African Rock Pipit	*Anthus crenatus*	Near-threatened	-	Low	Arid koppies & mountains	Low	Habitat loss, degradation & fragmentation

3.4 CURRENT BASELINE & CUMULATIVE IMPACT

There are a number of proposed and approved solar energy developments in the Aggeneys area, concentrated mainly along the N14 road. The potential for cumulative impact in the area is therefore a potential concern given the large number of different proposed renewable energy developments in the area and the status of the area as a REDZ. Although there are currently few preferred bidders, the projects are concentrated around the Aggeneys area and in the longer-term a node of development is likely to occur in this area (). The total estimated direct footprint of the existing approved projects is estimated as much as 9000ha, should all proposed projects in the area be established. This is largely concentrated within the plains habitat of the Bushmanland Arid Grassland vegetation type, which is a widespread habitat with relatively low avifaunal diversity. As Bushmanland Arid Grassland is one of the most extensive vegetation types in South Africa, the loss of 9000ha of this vegetation type is not significant regionally and the major concern would be with respect to the impacts on landscape connectivity more locally. The location of the current project near to the Loop 10 road is a partially mitigating circumstance that would serve to reduce the cumulative impact associated with the development as the Loop 10 road is a source of existing noise and disturbance in the area. The project site is located approimately 250m to the nearest Red Lark sightings in the study area, and at least 500m from the nearest dunes, and should therefore have no negative impact on the Red Lark or its distribution within the area. No further developments should however be considered between the current proposed development and the dune habitat, as this area serves as a buffer zone for the Red Lark population residing in the dune habitat. In addition, the major corridors of the area, such as the Koa River valley south of the project site and the mountain chain north of the site would not be impacted by the current development and are also still largely free from development impact more generally. As the broader area is now to be occupied by a number of developments (Aggeneys PV1 & 2, and now Geelstert PV1 & 2), the capacity of the immediate area to support future developments is considered low. However, given the broad-scale that most ecological processes in this area operate over, the current levels of habitat fragmentation are still considered low and not a threat to ecological processes and avifauna in the area. The contribution of the current project at 250ha is considered relatively low and would result in a low to moderate additional contribution to the cumulative impact in the area and as such is considered acceptable.

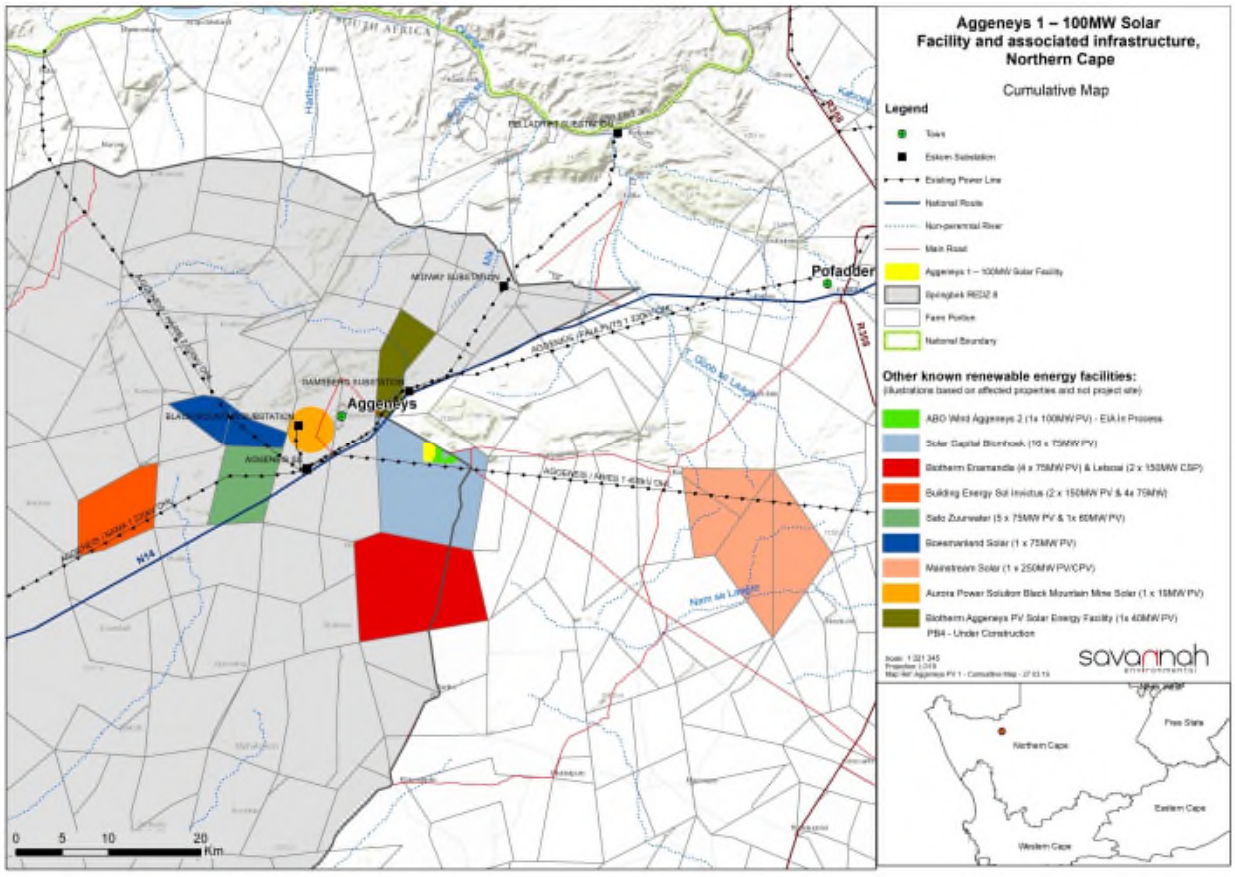

Figure 8. Map of authorised renewable energy development facilities as well as current applications for the wider area. It is important to note that the map indicates the affected properties and not the extent of the facilities themselves.

3.5 *AVIAN SENSITIVITY ASSESSMENT*

Important avian microhabitats in the study area 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 study area. To this end an avian sensitivity map () was generated by integrating avian microhabitats present on the project site and avifaunal information collected during the site visits.

The dune habitat to the south and west of the project site is considered to be of Very High sensitivity, as this supports a healthy resident population of the Vulnerable Red Lark. The adjoining sandy flats with red soils also support Red Lark, and hence much of this area comprises the buffer zone between the Geelstert PV1 project site and the dune habitat. This buffer area is considered High sensitivity and is not considered suitable for PV development. The plains habitat further north of the sandy flats does not currently appear to support any Red Larks based on the three field surveys, and since it is a widely

distributed habitat, it is considered to have a Low sensitivity. A small ephemeral pan to the west of the project site has Very High sensitivity as it provides a unique habitat within the plains habitat, but lies outside of the development footprint of Geelstert PV1.

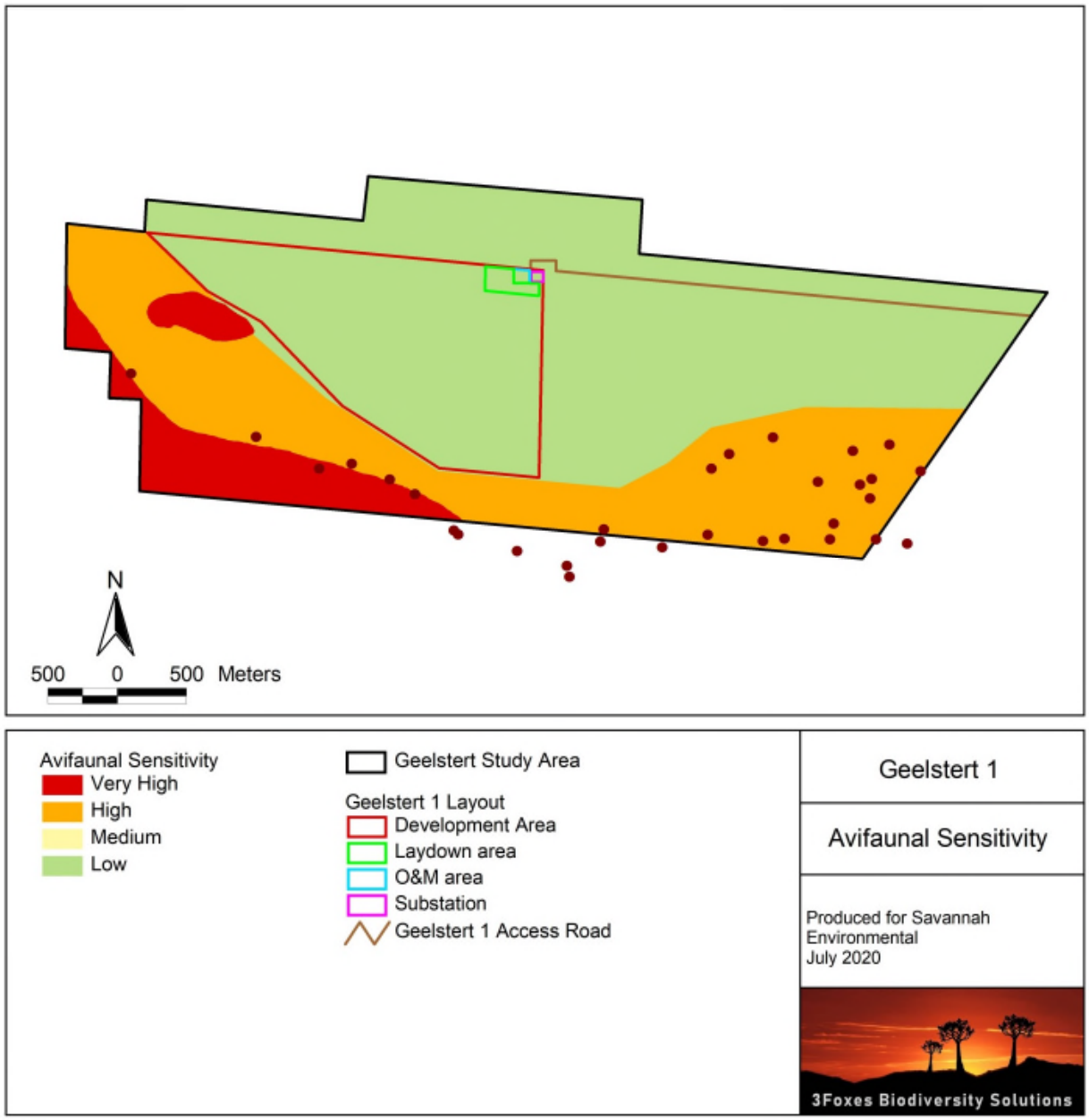

Figure 9. Avifaunal sensitivity map for the Geelstert PV1 project site.

It is likely that development of the solar PV facility in the plains habitat with low sensitivity would generate the least impact on the avifauna, provided suitable mitigation measures are employed during construction and operation of the proposed facility. While the development of this Low sensitivity plains habitat would result in some habitat loss for several species of

widely occurring avifauna of local significance, it will not necessarily impact negatively on red-listed avifaunal species, which appear to occur sparsely within the broader project site.

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. The relevance and applicability of each potential impact to the current situation are then examined in more detail in the next section.

The major threats posed to avifauna by solar energy facilities include direct habitat loss, fragmentation and displacement of birds (Lovich & Ennen, 2011). 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 is assessed under a separate application and is not covered here)
- 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.

Geelstert PV1 will cover an area of approximately up to 250ha within the Bushmanland Arid Grassland vegetation type, which is a rather widespread vegetation type in the northern Nama-Karoo. Of the twelve red-listed species that have been reported from the broader project site, six were seen during the site visits. A further fourteen species are near-endemics, while twelve are biome-restricted species. Many of these species occur throughout much of the vegetation type, except for the Red Lark and Sclater's Lark which have more specific habitat requirements (Hockey *et al*., 2005). While the development may have an insignificant impact on most of the species with wide-ranging populations, it will nevertheless result in habitat loss for the 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 recent study at a large solar facility in the Northern Cape (Visser, 2016) provides the first estimates of the potential impact on birds within the region, with direct mortalities amounting to 4.5 birds/MW/year. This short term study also concluded, however, that there was no significant association with collision-related mortality at that study site, and that further studies were required. Most injuries that were recorded were related to species such as francolin colliding with the underside of PV panels, and korhaans becoming entrapped along the perimeter fencing, between the mesh and electrical strands (Visser, 2016). A PV solar facility in the United States is reported to result in the deaths of 0.5 birds/MW/year as a direct result of the collisions with infrastructure (Walston *et al*., 2016).

4.1 IDENTIFICATION OF 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 project 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 some environmental risks and negative impacts. Poorly sited or designed facilities 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 Geelstert PV1 would stem from a variety of different activities and risk factors associated with the pre-construction, construction and operation phases of the project including the following:

Pre-construction Phase

- Human presence and uncontrolled access to the site may result in negative impacts on the avifauna through disturbance and specimen abstraction due to poaching and uncontrolled collection of all fauna and flora for traditional medicine or other purpose.
- 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 solar 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 (especially larger avifaunal species) and other forms of disturbance such as fire.

Operation Phase

- The operation of the facility will generate minor disturbances which may deter some avifauna from the project site, especially red-listed avifaunal species which are less tolerant to disturbances. Such indirect impacts are still largely understudied and poorly understood, 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 erosion, alien plant invasion and contamination from pollutants, herbicides or pesticides.

Cumulative Impacts

- The loss of unprotected vegetation types on a cumulative basis from the broader area may impact avifauna, as habitat loss is a major contributor to declines in avifauna (Birdlife International, 2018). The aggregation of numerous solar facilities in a region has the potential to compound environmental impacts, 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 and impair their ability to respond to environmental fluctuations. 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 involve displacement from the area encompassed by the development footprint as a result of habitat destruction. While numerous species will be impacted, all of these species have large distribution ranges and will therefore only experience population declines on the project site and the development footprint, and not regionally or nationally. Some of the most abundant species which will be impacted, and which are also common in neighbouring habitats, include Spike-heeled Lark, Rufous-eared Warbler, Chat Flycatcher, and Tractrac Chat. The loss of habitat will be permanent while disturbance may be continuous during the operation phase of the solar PV facility. Other impacts such as disturbances caused by reflective panels are not likely to have any appreciable impact on these small species. The impacts in general can be expected to be minimal as these smaller species are far less susceptible to the associated impacts than larger species. The Red Lark has not been recorded in this plains habitat during the three site visits and hence it is not expected to experience any loss of habitat. If birds are expected to occupy some of the plains habitat bordering the red dune areas and adjoining sandy flats, as determined through recent habitat modelling (Robin Colyn, *pers comm*., 2020), it would nevertheless be consider marginal to this plains habitat. A buffer of *ca*. 250M, between the edge of the proposed development and the nearest recorded sightings of Red Larks on the sandy flats adjoining the dune habitat, is considered sufficient enough to ensure that the species will not be negatively impacted by the development.

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 Greater Kestrel *Falco rupicoloides*, and the ground-dwelling Namaqua Sandgrouse*,* Karoo Korhaan and Double-banded Courser *Rhinoptilus africanus*. These species may also be susceptible to collisions with associated infrastructure such as the PV panels, but this is not expected to have a major impact on most of these species. The Karoo Korhaan, though seemingly scarce at the project site, 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 Martial eagle, Ludwig's Bustard, Verreaux's Eagle, and Secretarybird. Besides the loss of foraging habitat that these species will experience, disturbances during construction and operation 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 proposed development. It is important to note that this is contingent on the development being located within the assessed area as provided and any changes to the layout or project description would potentially invalidate the assessment.

5.1 GEELSTERT PV1

The following is an assessment of the avifaunal impacts expected to occur with the development of Geelstert PV1 and associated the infrastructure, for the planning, construction and operation phase 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 operation 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 including– habitat loss and disturbance due to vegetation clearing and the operation of heavy machinery on the site and the increased human presence		
	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 can only be mitigated to a limited extent as the loss of habitat is unavoidable and is a definite outcome of the development.	
Mitigation	• Laydown areas must be placed within the development footprint to avoid habitat loss and disturbance to adjoining areas. The laydown area in particular should be located	

	as far as possible away from the dune areas. • The red sand dunes to the south of the project site should be considered a no-go area apart from where there are already existing access roads through this area. • 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 must be undertaken 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 to no littering, appropriate handling of pollution and chemical spills, avoiding fire hazards, minimising 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 or appropriately qualified environmental officer. • Should any water storage reservoirs be required, these 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 active raptor nests should these be discovered prior to or during the construction phase. If active nests are discovered near construction areas, these should be reported to the ECO and should be monitored until the birds have finished nesting and the fledglings have 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 Operation Phase Impacts

Impact Nature: Avifaunal impacts due to operational activities – collisions with PV panels, 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 bird-friendly 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. (The use of site security video surveillance records could be used if available, as this will contribute towards understanding bird interactions with solar panels.) • The red sand dunes to the south of the project site should be considered to be a no-go area to avoid disturbance to avifauna, apart from where there are already existing access roads. • 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 the solar field and other associated infrastructure, especially during routine maintenance procedures. • Should any open reservoirs be required, these should be covered with fine mesh or other exclusion material in order to prevent birds from accessing the water and from falling in and drowning. • 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 likely mortality associated with the perimeter fencing.

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 – due to disturbance, noise and the operation of heavy machinery. Avifaunal disturbance due to decommissioning will extend beyond the footprint and impact adjacent areas to some degree. This will however be transient and restricted to the period while machinery is operational. In the long term, decommissioning should restore the ecological functioning and at least some habitat value to the affected areas.

	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Short-term (2)	Short-term (2)
Magnitude	Moderate (4)	Low to Moderate (3)
Probability	Definite (5)	Definite (5)
Significance	Medium (35)	Medium (30)
Status	Negative	Negative
Reversibility	Moderate	Moderate
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Although the noise and disturbance generated at the site during decommissioning is largely unavoidable, this will be transient and ultimately the habitat should be restored to a state that will be usable by the local avifauna.	
Mitigation	• All infrastructure should be removed from the development site and disposed of in the appropriate manner. • 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 to no littering, appropriate handling of pollution and chemical spills, avoiding fire hazards, minimising wildlife interactions, remaining within demarcated decommissioning areas. • All waste produced during decommissioning must be disposed of at a designated and licensed waste management facility. • All hazardous materials should be stored in the appropriate manner to prevent contamination of the site and ultimately be removed from the site as part of decommissioning. Any accidental chemical, fuel and oil spills that occur at the site should be cleaned up in the appropriate manner as related to the nature of the spill. • All vehicles 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. • All 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. • Any avifauna threatened by the activities should be removed to safety by the EO 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. • The site should be rehabilitated with locally occurring plant species to restore ecosystem structure and function, to allow local avifauna to use the area after	

	rehabilitation.
Cumulative Impacts	During the decommissioning phase, the associated disturbance would contribute to cumulative avifauna disturbance and disruption in the area, but this would be transient and not of long-term impact.
Residual Risks	Disturbance during the decommissioning phase is an unavoidable consequence, but will have low residual impact with implementation of the recommended mitigation measures. The sensitivity of the affected habitat is however low and the overall residual impact on avifaunal habitat loss remains low.

5.1.4 Cumulative Impacts

The following are the cumulative impacts that are assessed as being a likely consequence of the development of Geelstert PV1. These are assessed in context of the extent of the current site, other solar energy developments in the area as well as general habitat loss and transformation resulting from other activities in the area.

Impact Nature: The development of Geelstert PV1 and other solar energy developments will contribute to cumulative habitat loss and other cumulative impacts in the wider Aggeneys area.

	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	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 mitigated	

Mitigation:

- Minimise the development footprint 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 seasonal 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.
- 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. In addition, there should not be electrified ground-strands present within 30cm of the ground and the electrified strands should be located on the inside of the fence and not the outside. Furthermore, the fence should preferably be a single-design fence and not a double-design fence (with a 1 m space between the mesh and electric fence components). Images of suitable fencing types from existing PV facilities are available on request.

6 CONCLUSION & RECOMMENDATIONS

The current study is based on three site visits (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 study area lies within the Nama-Karoo bioregion and supports the typical avifaunal assemblage expected for the area. Although eight Threatened and four Near-threatened species have been reported for the area, most of these are not common in the area and probably occur in low numbers. However, species such as Martial Eagle, Verreaux's Eagle and Ludwig's Bustard appear to frequent the site fairly regularly as suitable habitat exists through the area. The project site supports few species or features of concern, such as communal nesting or roosting sites of red-listed species. The Vulnerable Red Lark occurs within the broader study area, particularly within the red sand dune habitat which is located at a distance of at least 500m from the periphery of the project site. This sensitive habitat is therefore considered to be adequately buffered from the proposed development. Overall, the impacts on avifauna with the development on the Geelstert PV1 site are likely to be medium and no high post-mitigation impacts are likely.

The expected impacts of the development of Geelstert PV1 will include the following, 1) habitat loss and fragmentation associated with the Bushmanland Arid Grassland, 2) disturbance and displacement caused during the construction and operation and maintenance phases, 3) direct mortality of avifauna colliding with solar panels, and 4) a potential cumulative habitat loss at a broader scale from potential future renewable energy developments in the wider area, as well as current mining operations (e.g. Gamsberg). 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 sandgrouse). Large-bodied Red-listed species will be impacted by the loss of foraging habitat and disturbances and human presence. However, given the extensive national ranges of these species, the impact of the development on habitat loss for these

species would be minimal and a long-term impact unlikely provided mitigation measures are taken.

Cumulative impacts in the area are a concern due to the proliferation of solar energy development in the Aggeneys area. In terms of habitat loss, the affected Bushmanland Arid Grassland vegetation type is still approximately 99% intact, while it has an extensive range within the bioregion. The transformation and loss of 250ha of this habitat is not considered highly significant. In terms of potential losses to landscape connectivity, the site is not considered to lie within an area that is considered a likely avifaunal movement corridor or along an important avifaunal habitat gradient. However, the presence of an IBA to the west of the project site, namely the Haramoep and Black Mountain Mine, is a concern. Any future solar developments proposed for the broader area should be steered away from this IBA, so as not to intercept the corridor between this IBA and two other IBAs in the region, namely the Bitterputs Conservation Area to the south of Aggeneys, and the Mattheus-Gat Conservation Area to the east of Pofadder. Hence it is essential that the cumulative impact of further solar developments are carefully considered.

Several mitigation measures can be implemented during the construction and operation and maintenance phases of the proposed development to reduce the impacts on the avifauna. During the construction phase, mitigation measures may assist in reducing displacement and disturbance by restricting habitat loss and disturbance strictly to within the footprint of the development. Identified sensitive habitat and buffer areas, such as the dune habitat and adjoining sandy flats, which serves as important habitat for the Vulnerable Red Lark, should be excluded from any form of disturbance or future development. During the operational phase, impacts will be significantly reduced, but by ensuring that interaction between the PV facility and avifauna is reduced as much as possible, the long-term impacts on avifauna will be low. With the implementation of the 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.

The on-site substation location proposed as part of the development footprint is located within the plains habitat with low avifauna sensitivity, and is therefore considered to be acceptable from an avifaunal perspective.

The development area is therefore considered favourable and there are no known impacts associated with the development that are considered to be of high significance and which cannot be mitigated to a low level. Therefore, based on the results of this assessment, there are no reasons to indicate that the development should not proceed.

Avifaunal Impact Statement:

The Geelstert PV1 project site is considered to represent a broadly suitable environment for the location of the proposed solar PV development. Considering that the study area supports a typical bioregional avifaunal assemblage, and that there are no known breeding or roosting sites of large-bodied 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 Geelstert PV1 should therefore be authorised, subject to the implementation of the recommended mitigation measures and in particular, the Red Lark buffer zone.

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 Geelstert PV1 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 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 that 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 PV 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.

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 vegetation: » 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 open reservoirs.		
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
» Laydown areas must be placed within the development footprint 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. » Any open reservoirs required should be covered with fine mesh or other exclusion material in order to exclude birds. » The fence around the facility should be designed to be bird friendly, to prevent entrapment and electrocutions of ground-dwelling birds. Double-fence		Contractor	Construction

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. 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. » 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 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 and nestlings). » Any avifauna threatened or injured by the construction activities should be removed to safety by the ECO or appropriately qualified environmental officer. » If active nests are discovered 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. » 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 and nestlings) 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. » Open reservoirs on site are covered with mesh to exclude birds. » 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 post-fledging period.

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 operation 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 during the operation phase.	
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.	EO	Operation
» 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	Contractors	Operation

(though not recommended). » Any movements by vehicle and personnel should be limited to within the footprint of the 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. » Any open water storage reservoirs should be covered with fine mesh or other exclusion material in order to prevent all birds from attempting to drink water from these features, which may potentially be contaminated, and to prevent them from falling in and drowning. » 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. » 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, if present (i.e. no nest abandonment due to disturbance). » No disturbance of red-listed avifaunal species perched or foraging in the vicinity of the project site. » No poaching or collecting of avifauna or their products (e.g. eggs and nestlings) by maintenance personnel. » Removal to safety of entrapped/injured avifauna encountered during routine maintenance. » Low impact on nocturnal and crepuscular species along roads.
Monitoring	EO to monitor operation phase to ensure that: » No birds or eggs are disturbed or removed by personnel. » Perimeter fencing is maintained in a 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 post-fledging period. » Any open reservoirs on site are covered with mesh to exclude birds.

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, where required.		
Potential Impact	Disturbance and loss of avifaunal microhabitats, leading to displacement and loss of resident avifaunal species.		
Activity/risk source	» Clearing and removal of solar field and other infrastructure. » 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 impact on avifauna and avifaunal habitats. » Low disturbance and impact on red-listed avifaunal species.		
Mitigation: Action/control		Responsibility	Timeframe
» The removal and clearing of the solar field and other associated infrastructure (buildings, 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 active raptor nests, should these be discovered prior to or during the decommissioning phase, until such as time as the nests are not active.		Contractor	Decommissioning
» Environmental induction for all personnel regarding basic environmental principles. » ECO to monitor and enforce ban on hunting and		ECO	Decommissioning

	collecting of avifauna or their products (e.g. eggs and nestlings). » Any avifauna threatened or injured by the construction activities should be removed to safety by the ECO or appropriately qualified 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, eggs or nestlings 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 Geelstert PV1 project site and broader study area, including records from SABAP1, SABAP2 and three site visits, and includes red-list status (Taylor *et al.*, 2015), regional endemism (Taylor *et al.*, 2015), and SABAP2 reporting rates. 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.

Common name	Taxonomic name	Red-list status	Regional endemism	Reporting Rate (%)
Barbet, Acacia Pied	***Tricholaema leucomelas***			**11.5**
Batis, Pririt	*Batis pririt*			3.9
Bee-eater, European	*Merops apiaster*			0
Bokmakierie	***Telophorus zeylonus***			**50.0**
Bulbul, African Red-eyed	*Pycnonotus nigricans*			0
Bunting, Cape	*Emberiza capensis*			38.5
Bunting, Lark-like	***Emberiza impetuani***			**65.4**
Bustard, Kori	*Ardeotis kori*	Near-Threatened		0
Bustard, Ludwig's	***Neotis ludwigii***	**Endangered**		**11.5**
Buzzard, Jackal	***Buteo rufofuscus***		**Near-endemic**	**3.9**
Buzzard, Common	*Buteo vulpinus*			0
Canary, Black-headed	***Serinus alario***		**Near-endemic**	**15.4**
Canary, Black-throated	*Crithagra atrogularis*			0
Canary, White-throated	***Crithagra albogularis***			**69.2**
Canary, Yellow	***Crithagra flaviventris***			**19.2**
Chat, Anteating	***Myrmecocichla formicivora***			**96.2**
Chat, Familiar	***Cercomela familiaris***			**26.9**
Chat, Karoo	***Cercomela schlegelii***			**61.5**
Chat, Sickle-winged	*Cercomela sinuata*		Near-endemic	15.4
Chat, Tractrac	***Cercomela tractrac***			**15.4**
Cisticola, Desert	*Cisticola aridulus*			3.9
Cisticola, Grey-backed	***Cisticola subruficapilla***			**34.6**
Courser, Burchell's	***Cursorius rufus***	**Vulnerable**		**3.9**
Courser, Double-banded	***Rhinoptilus africanus***			**3.9**
Crombec, Long-billed	*Sylvietta rufescens*			7.7
Crow, Cape	*Corvus capensis*			11.5
Crow, Pied	***Corvus albus***			**61.5**
Dove, Laughing	*Streptopelia senegalensis*			15.4
Dove, Namaqua	***Oena capensis***			**38.5**

Eagle, Booted	*Aquila pennatus*			7.7
Eagle, Martial	***Polemaetus bellicosus***	**Endangered**		**3.9**
Eagle, Verreaux's	***Aquila verreauxii***	**Vulnerable**		**3.9**
Eremomela, Karoo	*Eremomela gregalis*		Near-endemic	3.9
Eremomela, Yellow-bellied	***Eremomela icteropygialis***			**23.1**
Falcon, Lanner	*Falco biarmicus*	Vulnerable		3.9
Falcon, Pygmy	***Polihierax semitorquatus***			**19.2**
Finch, Red-headed	***Amadina erythrocephala***			**23.1**
Finch, Scaly-feathered	***Sporopipes squamifrons***			**76.9**
Fiscal, Southern	***Lanius collaris***			**61.5**
Flycatcher, Chat	***Bradornis infuscatus***			**76.9**
Flycatcher, Fairy	*Stenostira scita*		Near-endemic	0
Goshawk, Pale Chanting	***Melierax canorus***			**61.5**
Harrier, Black	*Circus maurus*	Endangered	Near-endemic	0
Kestrel, Greater	***Falco rupicoloides***			**19.2**
Kestrel, Rock	***Falco rupicolus***			**42.3**
Kite, Yellow-billed	*Milvus aegyptius*			0
Korhaan, Karoo	***Eupodotis vigorsii***	**Near-Threatened**		**15.4**
Korhaan, Northern Black	***Afrotis afraoides***			**46.2**
Lapwing, Crowned	*Vanellus coronatus*			3.9
Lark, Cape Clapper	***Mirafra apiata***		**Near-endemic**	**15.4**
Lark, Fawn-coloured	***Calendulauda africanoides***			**38.5**
Lark, Karoo Long-billed	***Certhilauda subcoronata***			**65.4**
Lark, Large-billed	*Galerida magnirostris*		Near-endemic	0
Lark, Pink-billed	*Spizocorys conirostris*			0
Lark, Red	***Calendulauda burra***	**Vulnerable**	**Endemic**	**69.2**
Lark, Red-capped	*Calandrella cinerea*			7.7
Lark, Sabota	*Calendulauda sabota*			26.9
Lark, Sclater's	*Spizocorys sclateri*	Near-Threatened	Near-endemic	0
Lark, Spike-heeled	***Chersomanes albofasciata***			**65.4**
Lark, Stark's	***Spizocorys starki***			**7.7**
Martin, Rock	***Hirundo fuligula***			**80.8**
Masked-weaver, Southern	*Ploceus velatus*			3.9
Mousebird, Red-faced	*Urocolius indicus*			0
Mousebird, White-backed	*Colius colius*			0
Owl, Barn	*Tyto alba*			0
Owl, Cape Eagle-	*Bubo capensis*			0

Owl, Spotted Eagle-	***Bubo africanus***			**3.9**
Penduline-tit, Cape	*Anthoscopus minutus*			0
Pigeon, Speckled	***Columba guinea***			**50.0**
Pipit, African	*Anthus cinnamomeus*			0
Pipit, African Rock	*Anthus crenatus*	Near-Threatened		0
Pipit, Long-billed	*Anthus similis*			0
Plover, Three-banded	*Charadrius tricollaris*			0
Prinia, Black-chested	*Prinia flavicans*			19.2
Prinia, Karoo	*Prinia maculosa*		Near-endemic	0
Quail, Common	***Coturnix coturnix***			0
Sandgrouse, Namaqua	***Pterocles namaqua***			**88.5**
Scrub-robin, Karoo	***Cercotrichas coryphoeus***			**46.2**
Secretarybird	*Sagittarius serpentarius*	Vulnerable		0
Shelduck, South African	*Tadorna cana*			3.9
Shrike, Lesser Grey	*Lanius minor*			0
Snake-eagle, Black-chested	***Circaetus pectoralis***			**11.5**
Sparrow, Cape	***Passer melanurus***			**76.9**
Sparrow, House	*Passer domesticus*			0
Sparrow-weaver, White-browed	*Plocepasser mahali*			11.5
Sparrowlark, Black-eared	***Eremopterix australis***		**Near-endemic**	**19.2**
Sparrowlark, Grey-backed	***Eremopterix verticalis***			**76.9**
Starling, Pale-winged	***Onychognathus nabouroup***			**80.8**
Starling, Wattled	*Creatophora cinerea*			0
Sunbird, Dusky	***Cinnyris fuscus***			**23.1**
Sunbird, Southern Double-collared	*Cinnyris chalybeus*		Near-endemic	3.9
Swallow, Barn	***Hirundo rustica***			**26.9**
Swift, Alpine	*Tachymarptis melba*			7.7
Swift, Bradfield's	*Apus bradfieldi*			0
Swift, Common	*Apus apus*			0
Swift, Little	*Apus affinis*			3.9
Thick-knee, Spotted	*Burhinus capensis*			0
Turtle-dove, Cape	***Streptopelia capicola***			**15.4**
Wagtail, Cape	*Motacilla capensis*			0
Warbler, Cinnamon-breasted	*Euryptila subcinnamomea*		Near-endemic	0
Warbler, Rufous-eared	***Malcorus pectoralis***			**73.1**
Warbler, Layard's	*Sylvia layardi*		Near-endemic	0
Weaver, Sociable	***Philetairus socius***			**80.8**

Wheatear, Capped	***Oenanthe pileata***	**11.5**
Wheatear, Mountain	***Myrmecocichla monticola***	**73.1**