BIRD IMPACT ASSESSMENT

DUNEVELD PV

Basic Assessment for the proposed construction of a Solar Photovoltaic (PV) Facility in the Northern Cape near Upington.

Report prepared for:
Duneveld PV (Pty) Ltd

Report prepared by:
Chris van Rooyen Consulting

APRIL 2020

Specialist Expertise

Curriculum vitae: Chris van Rooyen

Profession/Specialisation	:	Avifaunal Specialist
Highest Qualification	:	LLB
Nationality	:	South African
Years of experience	:	22 years

Key Experience

Chris van Rooyen has twenty two years' experience in the assessment of avifaunal interactions with industrial infrastructure. He was employed by the Endangered Wildlife Trust as head of the Eskom-EWT Strategic Partnership from 1996 to 2007, which has received international acclaim as a model of co-operative management between industry and natural resource conservation. He is an acknowledged global expert in this field and has consulted in South Africa, Namibia, Botswana, Lesotho, New Zealand, Texas, New Mexico and Florida. He also has extensive project management experience and he has received several management awards from Eskom for his work in the Eskom-EWT Strategic Partnership. He is the author and/or co-author of 17 conference papers, co-author of two book chapters, several research reports and the current best practice guidelines for avifaunal monitoring at wind farm sites. He has completed around 130 power line assessments; and has to date been employed as specialist avifaunal consultant on more than 50 renewable energy generation projects. He has also conducted numerous risk assessments on existing power lines infrastructure. He also works outside the electricity industry and he has done a wide range of bird impact assessment studies associated with various residential and industrial developments. He serves on the Birds and Wind Energy Specialist Group which was formed in 2011 to serve as a liaison body between the ornithological community and the wind industry.

Professional affiliations

I work under the supervision of and in association with Albert Froneman (MSc Conservation Biology) (SACNASP Zoological Science Registration number 400177/09) as stipulated by the Natural Scientific Professions Act 27 of 2003.

Curriculum vitae: Albert Froneman

Profession/Specialisation	:	Avifaunal Specialist
Highest Qualification	:	MSc (Conservation Biology)
Nationality	:	South African
Years of experience	:	20 years

Key Qualifications

Albert Froneman (Pr.Sci.Nat) has more than 20 years' experience in the management of avifaunal interactions with industrial infrastructure. He holds a M.Sc. degree in Conservation Biology from the University of Cape Town. He managed the Airports Company South Africa (ACSA) – Endangered Wildlife Trust Strategic Partnership from 1999 to 2008 which has been internationally recognized for its achievements in addressing airport wildlife hazards in an environmentally sensitive manner at ACSA's airports across South Africa. Albert is recognized worldwide as an expert in the field of bird hazard management on airports and has worked in South Africa, Swaziland, Botswana, Namibia, Kenya, Israel, and the USA. He has served as the vice chairman of the International Bird Strike Committee and has presented various papers at international conferences and workshops. At present, he is consulting to ACSA with wildlife hazard management on all their airports. He also an accomplished specialist ornithological consultant outside the aviation industry and has completed a wide range of bird impact assessment studies. He has co-authored many avifaunal specialist studies and pre-construction monitoring reports for proposed renewable energy developments across South Africa. He also has vast experience in using Geographic Information Systems to analyse and interpret avifaunal data spatially and derive meaningful conclusions. Since 2009 Albert has been a registered Professional Natural Scientist (Registration Number 400177/09) with The South African Council for Natural Scientific Professions, specialising in Zoological Science.

Specialist Declaration

I, Chris van Rooyen, as the appointed independent specialist, in terms of the 2014 EIA Regulations (as amended), 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 not, 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 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.

Name of Specialist: Chris van Rooyen

Signature of the specialist: ________________________________

Date: 25 March 2020

Executive Summary

This report presents the Bird Impact Assessment that was prepared by Chris van Rooyen of Chris van Rooyen Consulting as part of the Basic Assessment (BA) Process for the proposed construction of the seven Photovoltaic Facilities on the RE Farm Geel Kop Farm No 456, near Upington in the Northern Cape Province.

This report deals specifically with Project 2, known as Duneveld PV (the project).

The project is to consist of solar photovoltaic (PV) technology, fixed-tilt-, single-axis tracking- or dual-axis tracking- mounting structures, with a net generating capacity of 100 MW as well as associated infrastructure.

Avifauna

It is estimated that a total of 203 bird species could potentially occur in the broader area – Appendix 2 provides a comprehensive list of all the species, including those recorded during the pre-construction monitoring. Of the priority species potentially occurring in the broader area, 35 could potentially occur in the study area. Eight of these are South African Red Data species, and three are globally Red listed.

The proposed project will have the following potential impacts on avifauna:

- Displacement due to disturbance associated with the construction of the solar PV plant and associated infrastructure.
- Displacement due to habitat transformation associated with the construction of the solar PV plant and associated infrastructure
- Collisions with the solar panels
- Entrapment in perimeter fences
- Electrocutions in the onsite substation and inverter station
- Displacement due to disturbance associated with the decommissioning of the solar PV plant and associated infrastructure

Displacement due to disturbance associated with the construction of the solar PV plant and associated infrastructure.

The impact is assessed to be Moderate before mitigation, and Low after mitigation. Suggested mitigation measures are (a) activity should as far as possible be restricted to the footprint of the infrastructure, (b) measures to control noise and dust should be applied according to current best practice in the industry (c) maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical (d) access to the rest of the property must be restricted (e) the recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint is concerned.

Displacement due to habitat transformation associated with the construction of the solar PV plant and associated infrastructure

Priority species that could be affected by displacement due to habitat transformation are the following:

- Lanner Falcon
- Spotted Eagle-owl
- Martial Eagle

- Tawny Eagle
- Greater Kestrel
- Secretarybird
- Abdim's Stork
- Karoo Korhaan
- Kori Bustard
- Ludwig's Bustard
- Pygmy Falcon
- Black-shouldered Kite
- Booted Eagle
- Common Ostrich
- Pearl-spotted Owlet
- Rock Kestrel
- Southern Pale Chanting Goshawk
- Steppe Buzzard
- Black-eared Sparrowlark
- Fiscal Flycatcher
- Black-headed Heron.

The impact is assessed to be High before mitigation, and Moderate after mitigation. The recommendations of the botanical specialist must be strictly implemented, especially as far as limiting the vegetation clearance to what is absolutely necessary, and rehabilitation of transformed areas are concerned. Other than that, not much can be done to limit this unavoidable impact on the avifauna.

Collisions with the solar panels

The priority species which would most likely be potentially affected by this impact are mostly small birds which forage between the solar panels, and possibly raptors which prey on them:

- Lanner Falcon
- Spotted Eagle-owl
- Pygmy Falcon
- Southern Pale Chanting Goshawk
- Black-eared Sparrowlark
- Fiscal Flycatcher

The risk is assessed to be Very Low. No mitigation is required due to the very low expected magnitude.

Entrapment in perimeter fences

The priority species which could potentially be affected by this impact are most likely medium to large terrestrial species:

- Secretarybird
- Abdim's Stork
- Karoo Korhaan
- Kori Bustard
- Ludwig's Bustard

The risk is assessed to be Low, but it can be reduced to Very Low through the application of mitigation measures. Suggested mitigation is that a single perimeter fence should be used[1].

Electrocutions in the onsite substation yard and inverter station

Species potentially at risk of electrocution in the substation yard and inverter station are the following:

- Lanner Falcon
- Southern Pale Chanting Goshawk
- Spotted Eagle-Owl
- Martial Eagle
- Tawny Eagle
- Greater Kestrel
- Steppe Buzzard
- Egyptian Goose
- Barn Owl

The impact is assessed to be Low before mitigation, and Very Low after mitigation. With regards to the infrastructure within the substation yard and inverter station, the hardware is too complex to warrant any mitigation for electrocution at this stage. It is rather recommended that if any impacts are recorded once operational, site specific mitigation be applied reactively

Displacement due to disturbance associated with the decommissioning of the solar PV plant and associated infrastructure

The activities associated with the decommissioning of the solar PV plant and associated infrastructure will impact on birds through disturbance; this could lead to breeding failure if the disturbance happens during a critical part of the breeding cycle. Activities in close proximity to breeding locations could be a source of disturbance and could lead to temporary displacement. All priority species could be temporarily displaced. **The impact is assessed to be Moderate before mitigation, and Low after mitigation.** Suggested mitigation measures are (a) activity should as far as possible be restricted to the footprint of the infrastructure, (b) measures to control noise and dust should be applied according to current best practice in the industry (c) maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical (d) access to the rest of the property must be restricted (e) the recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the activity footprint is concerned.

Cumulative impacts

In the case of solar energy projects, the potentially most significant impact from an avifaunal perspective is the transformation of the natural habitat. The total footprint taken up by existing and proposed solar energy projects is approximately 12 600ha. This project comprises 260 hectares of this footprint. The total area of the 30km radius around the proposed projects equates to about 285 000ha of very similar habitat. The total combined size of the footprint taken up by solar energy projects equates to 4.4% of the available habitat in the 30km radius. The cumulative impact of the habitat transformation which will come about as a result of the proposed PV project, should therefore be **low**.

[1] In this instance, according to the design specifications, a fence will be used consisting of an outer diamond mesh fence and inner electric fence with a separation distance of approximately 100mm. This should not pose any risk of entrapment for large terrestrial species and can be considered a single fence.

Identification of Environmental Sensitivities

High sensitivity

Included are areas within 200m of water troughs and ephemeral pans[2]. These areas are highly sensitive for the following reasons:

- Surface water in this arid habitat is crucially important for priority avifauna, including several Red Data species such as Martial Eagle, Tawny Eagle, Lanner Falcon, Secretarybird and Kori Bustard, and many non-priority species. Ephemeral pans could also attract waterbirds on occasion, such as African Sacred Ibis, Black-headed Heron, Blacksmith Lapwing, Cattle Egret, Common Greenshank, Common Sandpiper, Egyptian Goose, South African Shelduck, Spur-winged Goose, Three-banded Plover, White-faced Duck, Wood Sandpiper, Yellow-billed Duck, Hamerkop. It is important to leave open space for birds to access and leave the surface water area unhindered, especially large terrestrial species. Surface water is also important area for raptors to hunt birds, and they should have enough space for fast aerial pursuit.

Medium sensitivity

The entire study area can be classified as medium sensitive, due to the fact that it is largely untransformed and potentially supports up to 35 priority species, eight of which are Red Listed.

See Appendix 4 for a sensitivity map of the development footprint.

Final Specialist Statement and Authorisation Recommendation

In terms of an average, the pre-mitigation significance of all potential impacts identified in this specialist study is assessed as halfway between **Low** and **Moderate**, and the average post-mitigation significance is assessed as Low to Very Low, leaning more towards **Very Low**. It is therefore recommended that the activity is authorised, on condition that the proposed mitigation measures as detailed in the EMPr (Appendix 4) are strictly implemented.

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[2] The 200m buffers were incorporated into the design of the layouts.

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List of Abbreviations

BA	Basic Assessment
BFD	Bird Flight Diverters
BLSA	BirdLife South Africa
DEFF	Department of Environmental Affairs and Forestry
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
EWT	Endangered Wildlife Trust
IBA	Important Bird Area
SABAP 2	Southern African Bird Atlas Project 2

Glossary

Definitions	
Broader area	The area covered by the SABAP 2 pentads where the proposed development is located.
Study area	The area taken up by the RE of Geel Kop Farm No 456
Development footprint	This includes the total footprint of PV panels, auxiliary buildings, onsite substation, inverter stations and internal roads.
Priority species	Priority solar species are defined as follows: o South African Red Data species; o South African endemics and near-endemics; o Raptors o Waterbirds
Pentad Grid	A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude

COMPLIANCE WITH THE APPENDIX 6 OF THE 2014 EIA REGULATIONS (AS AMENDED)

Requirements of Appendix 6 – GN R982	**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;	Pg. 2 - 3
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Pg.3
c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 1 and 2
(cA) an indication of the quality and age of base data used for the specialist report;	Section 2
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 4 and Section 6
d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 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 4 and Appendix 4
g) an identification of any areas to be avoided, including buffers;	Section 4 and Appendix 4
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;	Appendix 4
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 2
j) a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Section 6 and Section 10
k) any mitigation measures for inclusion in the EMPr;	Appendix 4
l) any conditions for inclusion in the environmental authorisation;	Appendix 4
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Appendix 4
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 10 and Section 11
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	Section 2
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	n/a
q) any other information requested by the competent authority.	n/a
(2) Where a government notice 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

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This report deals specifically with Project 2, known as Duneveld PV (the project).

The project is to consist of solar photovoltaic (PV) technology, fixed-tilt-, single-axis tracking- or dual-axis tracking- mounting structures, with a net generating capacity of 100 MW as well as associated infrastructure, which will include:

- On-site switching-station / substation;
- Auxiliary buildings (gate-house and security, control centre, office, warehouse, canteen & visitors centre, staff lockers etc.);
- Inverter-stations, transformers and internal electrical reticulation (underground cabling);
- Access and internal road network;
- Laydown area;
- Duneveld PV will connect from the onsite sub-stations to the Upington MTS (400/132 kV), via the 132kV Geelkop Collector Substation (this basic assessment process only includes the IPP portion of the onsite sub-station, while the remainder of the grid connection is being assessed in a separate BAR process).
- Rainwater tanks; and
- Electrified Perimeter fencing and security infrastructure.

1. Introduction and Methodology

1.1 Scope, Purpose and Objectives of this Specialist Report

The objectives of the report are to investigate the potential impacts of the proposed project on avifauna in order to assess whether the project is fatally flawed from an avifaunal impact perspective and, if not, what mitigation measures should be implemented to reduce the potential impacts.

1.2 Terms of Reference

The terms of reference for this impact assessment report are as follows:

- Describe the affected environment from an avifaunal perspective;
- Discuss gaps in baseline data and other limitations;
- List and describe the expected impacts;
- Compile a sensitivity map for the project site;
- Assess and evaluate the potential impacts;
- Recommend mitigation measures to reduce the impact of the expected impacts; and
- Provide a reasoned opinion as to whether the proposed development should proceed or not.

1.3 Assessment Details

Type of Specialist Investigation	Bird Impact Assessment Study: Solar energy facilities
Date of Specialist Site Investigation	25 February – 03 March 2020
Season	Mid-Summer
Relevance of Season	The fieldwork was timed to take place after a period of exceptional rains, resulting in optimal conditions.

2. Approach and Methodology

The survey methodology took into account the best practice guidelines for avifaunal impact studies at solar developments, compiled by BirdLife South Africa (BLSA) in 2017 (Jenkins *et al.* 2017), adapted for the specific situation[3].

- On-site surveys were conducted at the study area from 25 - 29 February and again from 02 - 03 March 2020 (7 days in total) in the following manner:
  - Twenty-one walk transects were identified within the study area, totalling 1km each, covering all the major habitat types.
  - Each transect was counted twice over a period of 7 days.
  - The observer recorded all species on both sides of the walk transect. The observer stopped at regular intervals to scan the environment with binoculars.
  - The following variables were recorded:
    - Species;
    - Number of birds;
    - Date;
    - Start time and end time;
    - Estimated distance from transect (m);
    - Wind direction;
    - Wind strength (estimated Beaufort scale 1 - 7);
    - Weather (sunny; cloudy; partly cloudy; rain; mist);
    - Temperature (cold; mild; warm; hot);
    - Behaviour (flushed; flying-display; perched; perched-calling; perched-hunting; flying-foraging; flying-commute; foraging on the ground.
- All incidental sightings of priority species in and around the proposed study areas were also recorded.
- A total of 16 focal points (FPs) were identified consisting of 15 natural pans and one borehole within the study area, and counted once in the course of 7 days.

See Appendix 1 for a map of the study area, showing the location of transects and focal points used for purposes of the surveys.

2.1 Information Sources

- Bird distribution data from the Southern African Bird Atlas Project 2 (SABAP 2) was obtained (http://sabap2.adu.org.za/), in order to ascertain which species occur in the pentads where the proposed study areas are located. A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km. In order to get a more representative impression of the birdlife, a consolidated data set was obtained for a block of 15 pentads, within which the proposed development is located, henceforth called the broader area[4]. The SABAP2 data covers the period 2007 to 2020.
- A classification of the vegetation types in the study area was obtained from the Atlas of Southern African Birds 1 (SABAP1) and the National Vegetation Map compiled by the South African National Biodiversity Institute (Mucina & Rutherford 2006).
- The national threatened status of all priority species was determined with the use of the most recent edition of the Red Data Book of Birds of South Africa, Lesotho and Swaziland (Taylor *et al.* 2015), and the latest authoritative summary of southern African bird biology (Hockey *et al.* 2005).

[3] It was decided to implement one extended survey in the peak season to take advantage of the optimal conditions, instead of doing an additional survey in sub-optimal conditions.

[4] The relevant pentads are 2825_2050,2825_2055, 2825_2100, 2825_2105, 2825_2110, 2830_2050, 2830_2055, 2830_2100, 2830_2105, 2830_2110, 2835_2050, 2835_2055, 2835_2100, 2835_2105, 2835_2110.

- The global threatened status of all priority species was determined by consulting the latest (2020.1) IUCN Red List of Threatened Species).
- The Important Bird and Biodiversity Areas of South Africa (Marnewick *et al.* 2015) was consulted for information on potentially relevant Important Bird Areas (IBAs).
- Satellite imagery (Google Earth © 2020) was used in order to view the broader area on a landscape level and to help identify bird habitat on the ground.
- The South African National Biodiversity BGIS map viewer was used to determine the locality of the study area relative to National Protected Areas, National Protected Areas Expansion Strategy (NPEAS) focus areas and Critical Biodiversity Areas in the Northern Cape.
- The DEFF National Screening Tool was used to determine the assigned avian sensitivity of the study area.
- The Strategic Environmental Assessment for Wind and Solar Photovoltaic Energy in South Africa (Solar and Wind SEA) was consulted to determine what level of avifaunal sensitivity is assigned to the study area (CSIR 2015).

2.2 Assumptions, Knowledge Gaps and Limitations

- A total of 176 SABAP 2 full protocol lists had been completed for the broader area where the proposed project is located (i.e. bird listing surveys lasting a minimum of two hours each). In addition, 97 ad hoc protocol lists (i.e. bird listing surveys lasting less than two hours but still giving useful data) and 486 incidental sightings were also recorded. The SABAP2 data was therefore regarded as a good indicator of the avifauna which could occur in the study area, and it was further supplemented by data collected during the on-site surveys.
- The focus of the study is primarily on the potential impacts on solar priority species.
- Solar priority species are defined as follows:
    - South African Red Data species;
    - South African endemics and near-endemics;
    - Raptors
    - Waterbirds
- The impact of solar installations on avifauna is a new field of study, with only one published scientific study on the impact of PV facilities on avifauna in South Africa (Visser *et al.* 2019). Strong reliance was therefore placed on expert opinion and data from existing monitoring programmes at solar facilities in the USA where monitoring has been ongoing since 2013. The pre-cautionary principle was applied throughout as the full extent of impacts on avifauna at solar facilities is not presently known.
- The assessment of impacts is based on the baseline environment as it exists at the study area when the surveys were conducted.
- Cumulative impacts include all proposed and existing renewable energy projects within a 30km radius around the study areas.
- Conclusions in this study are based on experience of these and similar species in different parts of South Africa. Bird behaviour can never be entirely reduced to formulas that will be valid under all circumstances.

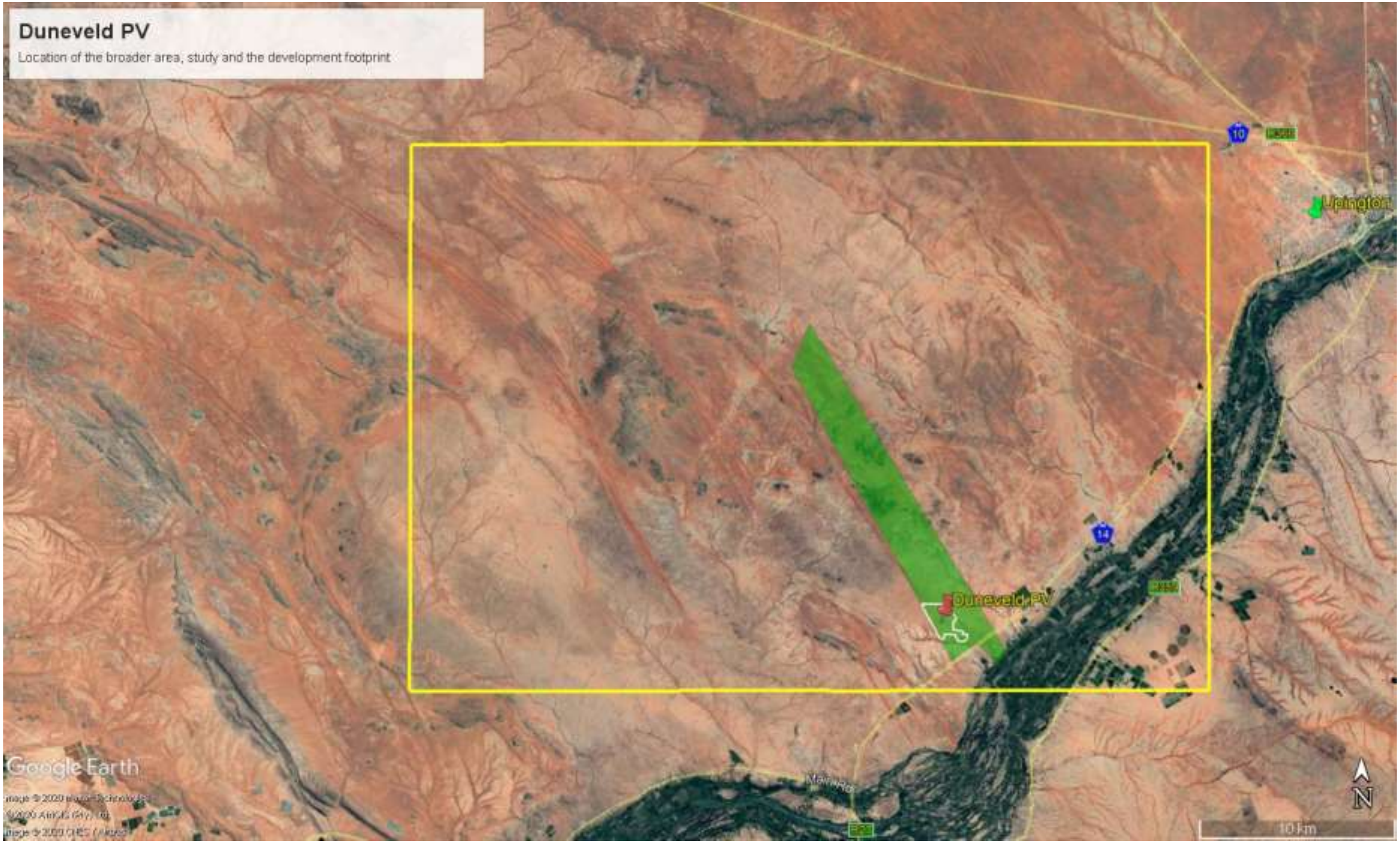

Figure 1: The location of the proposed Duneveld PV solar facility. The yellow rectangle represents the broader area, the green shaded area the study area, and the white outline the development footprint.

2.3 Consultation Processes Undertaken

The landowner was briefly consulted with regard to the birds occurring on the property.

3. Description of Project Aspects relevant to Avifaunal Impacts

The following aspects of the project is relevant to avifaunal impacts:

Solar Technology selection	Type of technology	Solar photovoltaic (PV) with either of fixed-tilt-, single-axis tracking- or dual-axis tracking- mounting structures. PV structures/ modules: up to a maximum of 210ha Laydown area: ± 3-5 ha Internal roads ± 6.5 ha Auxiliary buildings: ± 1 ha Facility substation: up to 0.5 ha
	Structure height	Solar panels a maximum of ± 3.5m from ground level
	Surface area to be covered (including associated infrastructure such as roads)	Approximately 240ha
	Structure orientation	Fixed-tilt: north-facing at a defined angle of tilt Single-axis: horizontal axis mounted in a north-south orientation, tracking from east to west
	Laydown area dimensions	Approximately 2-5ha of laydown area will be required.
Additional Infrastructure	Auxiliary buildings of approximately 1ha. The functions within these buildings include (but are not limited to) a gate house, ablutions, workshops, storage and warehousing area, site offices, and control centre. Substation Sizes: • Duneveld is 75m x 75m for the facility side, and 75m x 150m for the Eskom/Collector side. Perimeter Fencing not exceeding 3.5m in height.	
Details of access roads	The access roads will not exceed 8m in width.	
Extent of areas required for laydown of materials and equipment	Approximately 2-5ha of laydown areas will be required (laydown areas will not exceed 5ha). A permanent laydown area of a maximum of 1ha will remain.	

4. Description of the Receiving Environment

4.1 Baseline Environmental Description

4.1.1 Important Bird Areas

There are no Important Bird Areas (IBA) within a 65km radius around the proposed development. It is therefore highly unlikely that the proposed development will have a negative impact on any IBA.

4.1.2 Critical Biodiversity Area (CBA)

The majority of the study area is not classified as a CBA, but as Other Natural Areas and Ecological Support Areas. There is a portion of the development footprint, approximately 30%, which is classified as a CBA.

4.1.3 DEFF National Screening Tool

The DEFF National Screening Tool classifies the study area as medium sensitive from an avifaunal perspective.

4.1.4 National Protected Areas Expansion Strategy (NPEAS) focus areas

The study area does not form part of an NPEAS focus area.

4.1.5 Strategic Environmental Assessment for Wind and Solar Photovoltaic Energy in South Africa (Solar and Wind SEA)

The majority of the study is classified as "unknown area of medium importance" for avifauna in the Solar and Wind SEA. Three rocky outcrops in the study area is classified as "high importance" based on the potential for Verreaux's Eagle to breed on them. However, no Verreaux's Eagles were observed during the 7 days of fieldwork and the outcrops did not contain any nests, because these three outcrops do not offer suitable breeding substrate for the species. No Verreaux's Eagles were recorded by any of the SABAP2 surveys in the broader area either.

4.1.6 Habitat classes

Vegetation structure, rather than the actual plant species, is more significant for bird species distribution and abundance (Harrison *et al.* 1997). The description of the vegetation types occurring in the study area largely follows the classification system presented in the Atlas of southern African birds (Harrison *et al.* 1997). The criteria used to amalgamate botanically defined vegetation units, or to keep them separate were (1) the existence of clear differences in vegetation structure, likely to be relevant to birds, and (2) the results of published community studies on bird/vegetation associations. It is important to note that no new vegetation unit boundaries were created, with use being made only of previously published data. The description of vegetation presented in this study therefore concentrates on factors relevant to the bird species present and is not an exhaustive list of plant species present.

Whilst the distribution and abundance of the bird species in the study area are mostly associated with natural vegetation, as this comprises virtually all the habitat, it is also necessary to examine external modifications to the environment that might have relevance for priority species. Anthropogenic avifaunal-relevant habitat modifications which could potentially influence the avifaunal community that were recorded in or close to the study area are boreholes with water troughs, providing accessible surface water. These are discussed in more detail below.

- Biomes and vegetation types

The study area is situated on a vast, flat plain, with the only topographically notable features being three rocky outcrops situated in the northern half of the study area. It is located in the interface between the Nama Karoo Biome and the Savanna Biome, but the study area is predominantly Nama Karoo Biome. Two types of vegetation intermingle in the study area, namely Bushmanland Arid Grassland and Kalahari Karroid Shrubland (see Figures 2 and 3). Bushmanland Arid Grassland consists of grassland dominated by white grasses (*Stipagrostis* species) giving this vegetation type the character of semidesert 'steppe' in years of high rainfall. In places low shrubs change the vegetation structure, particularly in drainage lines. In years of abundant rainfall rich displays of annual herbs can be expected (Mucina & Rutherford, 2006). Kalahari Karroid Shrubland occurs in flat gravelly areas in the study area. The land-use in the study area is livestock farming.

Figure 2: Bushmanland Arid Grassland in the study area.

Figure 3: Kalahari Karroid Shrubland in the study area with one of the rocky outcrops in the study area in the distance.

The climate in the Upington area is arid, with high summer temperatures and mild winters. Average rainfall is around 180mm per year. Table 1 below displays the average temperatures and rainfall for Upington (climate-data.org).

Table 1: Annual temperatures and precipitation at Upington (climate-data.org)

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	26.2	25.6	23.7	19.3	14.8	11.8	11.5	13.1	17	20.1	23	25.2
Min. Temperature (°C)	17.8	17.7	15.9	11.2	6.2	3.1	2.5	3.9	7.6	11.1	14.2	16.7
Max. Temperature (°C)	34.6	33.6	31.5	27.5	23.4	20.5	20.6	22.4	26.4	29.2	31.9	33.8
Avg. Temperature (°F)	79.2	78.1	74.7	66.7	58.6	53.2	52.7	55.6	62.6	68.2	73.4	77.4
Min. Temperature (°F)	64.0	63.9	60.6	52.2	43.2	37.6	36.5	39.0	45.7	52.0	57.6	62.1
Max. Temperature (°F)	94.3	92.5	88.7	81.5	74.1	68.9	69.1	72.3	79.5	84.6	89.4	92.8
Precipitation / Rainfall (mm)	23	31	39	22	12	4	2	3	4	9	15	16

- Surface water

Surface water is of specific importance to avifauna in this semi-arid environment. The study area contains a number of open water troughs that provide drinking water to livestock. Open water troughs are important sources of surface water and could potentially be used extensively by various bird species, including large raptors, to drink and bath. There are also a total of 15 small ephemeral pans in the study area. Due to the good rains that the study area experienced immediately preceding the surveys, several pans held water (see Figure 4). Pans are attractive to various bird species, including large raptors, to drink and bath. Pans could also serve as an attraction to waterbirds when they contain water.

Figure 4: An ephemeral pan in the study area

4.2. Avifauna

4.2.1 Southern African Bird Atlas 2

The SABAP 2 data indicate that a total of 203 bird species could potentially occur in the broader area – Appendix 2 provides a comprehensive list of all the species, including those recorded during the pre-construction monitoring. Of the priority species potentially occurring in the broader area, 35 could potentially occur in the study area (see Section 4 for definition of a priority species), 8 of these are South African Red Data species, and 5 are globally Red listed. The probability of a priority species occurring in the study area is indicated in Table 2.

Table 2 below lists all the priority species and the possible impact on the respective species by the proposed solar energy infrastructure. The following abbreviations and acronyms are used:

EN = Endangered
VU = Vulnerable
NT = Near-threatened
LC = Least concern

Table 2: Priority species which could potentially occur in the study area. Red listed species are shaded in red.

		Status				Class				Habitat			Impact					
Species	Taxonomic name	SABAP2 full protocol reporting rate	Red Data Global	Red Data Regional	Endemic/near endemic - South Africa	Waterbird	Raptor	Probability of occurrence	Recorded during surveys	Arid shrubland and rocky outcrops	Arid grassland	Surface water: Pans	Collision: PV panels	Displacement: Disturbance PV	Displacement: Habitat loss PV	Entrapment in fences	Displacement: Disturbance grid construction	Electrocutions: substations and inverter stations
Abdim's Stork	*Ciconia abdimii*	9.66	LC	NT				Low		x		x		x	x	x	x	
African Sacred Ibis	*Threskiornis aethiopicus*	51.14				x		Low				x		x				
Barn Owl	*Tyto alba*	19.89					x	High		x	x			x			x	x
Black-eared Sparrowlark	*Eremopterix australis*	5.68			Near endemic			High	x	x	x	x	x	x	x			
Black-headed Heron	*Ardea melanocephala*	29.55				x		High			x	x		x	x			
Black-shouldered Kite	*Elanus caeruleus*	28.41					x	High		x	x	x		x	x		x	
Blacksmith Lapwing	*Vanellus armatus*	55.68				x		Medium				x		x				
Booted Eagle	*Aquila pennatus*	6.25					x	High		x	x	x		x	x		x	
Cattle Egret	*Bubulcus ibis*	61.36				x		Low		x	x	x		x				
Common Greenshank	*Tringa nebularia*	3.98				x		Low				x		x				
Common Ostrich	*Struthio camelus*	1.70						High		x	x	x		x	x		x	
Common Sandpiper	*Actitis hypoleucos*	2.27				x		Low				x		x				
Egyptian Goose	*Alopochen aegyptiacus*	59.66				x		High	x			x		x				x
Fiscal Flycatcher	*Sigelus silens*	15.34			Near endemic			High		x	x	x	x	x	x			
Greater Kestrel	*Falco rupicoloides*	3.98					x	High		x	x			x	x		x	x
Hamerkop	*Scopus umbretta*	31.25				x		Medium				x		x				
Karoo Korhaan	*Eupodotis vigorsii*	35.23	LC	NT				Very high	x	x	x			x	x	x	x	
Kori Bustard	*Ardeotis kori*	5.11	NT	NT				High	x	x	x	x		x	x	x	x	

		Status				Class				Habitat			Impact					
Species	Taxonomic name	SABAP2 full protocol reporting rate	Red Data Global	Red Data Regional	Endemic/near endemic - South Africa	Waterbird	Raptor	Probability of occurrence	Recorded during surveys	Arid shrubland and rocky outcrops	Arid grassland	Surface water: Pans	Collision: PV panels	Displacement: Disturbance PV	Displacement: Habitat loss PV	Entrapment in fences	Displacement: Disturbance grid construction	Electrocutions: substations and inverter stations
Lanner Falcon	*Falco biarmicus*	10.80	LC	VU			x	High		x	x	x	x	x	x		x	x
Ludwig's Bustard	*Neotis ludwigii*	3.41	EN	EN				Medium	x	x				x	x	x	x	
Martial Eagle	*Polemaetus bellicosus*	2.27	VU	EN			x	High		x	x	x		x	x		x	x
Pearl-spotted Owlet	*Glaucidium perlatum*	2.27					x	Medium			x			x	x		x	
Pygmy Falcon	*Polihierax semitorquatus*	7.39					x	High		x	x	x	x	x	x		x	
Rock Kestrel	*Falco rupicolus*	6.82					x	High		x	x			x	x		x	
Secretarybird	*Sagittarius serpentarius*	1.14	VU	VU			x	Medium		x	x	x		x	x	x	x	
South African Shelduck	*Tadorna cana*	22.73				x		Medium				x		x				
Southern Pale Chanting Goshawk	*Melierax canorus*	15.34					x	Very high	x	x	x	x	x	x	x			x
Spotted Eagle-owl	*Bubo africanus*	2.27					x	High		x	x	x	x	x	x		x	x
Spur-winged Goose	*Plectropterus gambensis*	18.18				x		Medium				x		x				
Steppe Buzzard	*Buteo vulpinus*	2.27					x	Low		x	x	x		x	x			x
Tawny Eagle	*Aquila rapax*	0.00	VU	EN			x	High	x	x	x	x		x	x		x	x
Three-banded Plover	*Charadrius tricollaris*	38.07				x		Medium				x		x				
White-faced Duck	*Dendrocygna viduata*	13.64				x		Low				x		x	x			
Wood Sandpiper	*Tringa glareola*	7.95				x		Low				x		x				
Yellow-billed Duck	*Anas undulata*	9.66				x		Low				x		x	x			

4.2.2 Pre-construction surveys

On-site surveys were conducted from 25 - 29 February and again from 02 - 03 March 2020 (7 days in total). Please see Section 2 for details of the methodology used in the surveys.

- Species diversity and abundance

The abundance of species recorded during the walk transects and focal points are displayed in Figures 5, 6 and 7. A total of 291 individual birds were counted at the 16 focal points in the course of the surveys.

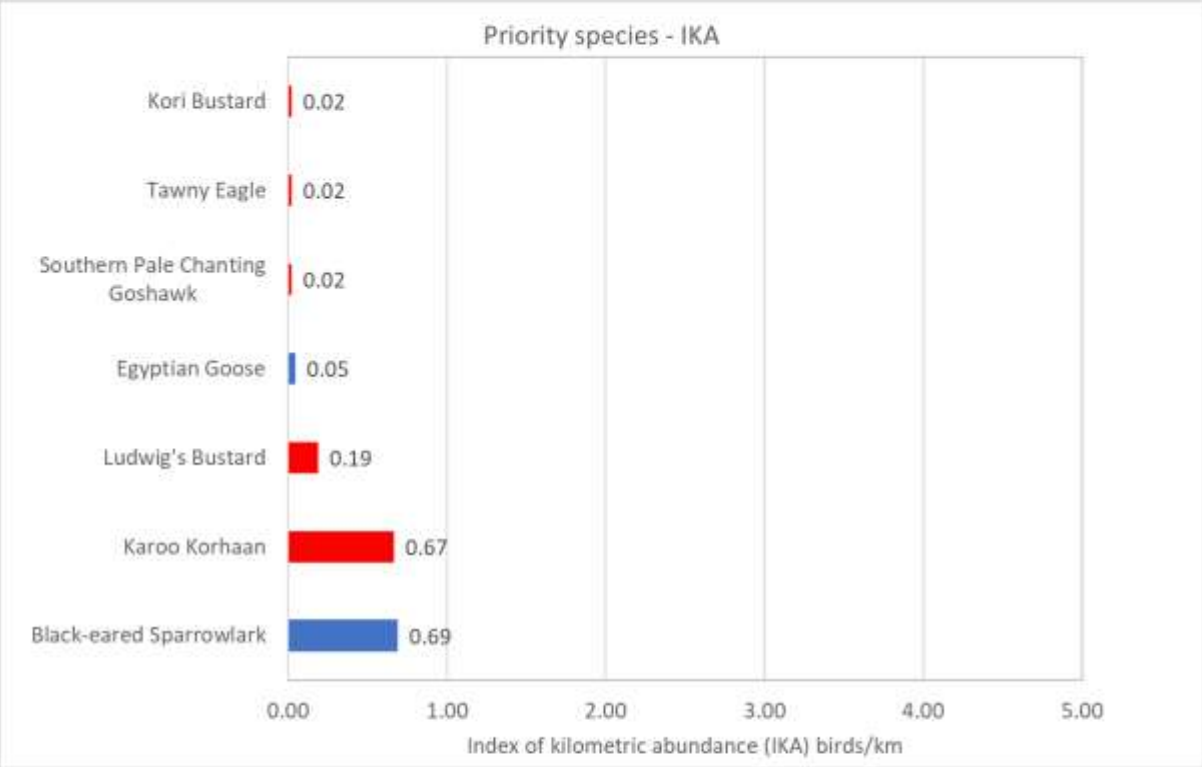

Figure 5: Index of kilometric abundance (IKA) for all priority species recorded by means of walk transects during the surveys in the study area, conducted in February and March 2020. Red Data species are indicated in red bars.

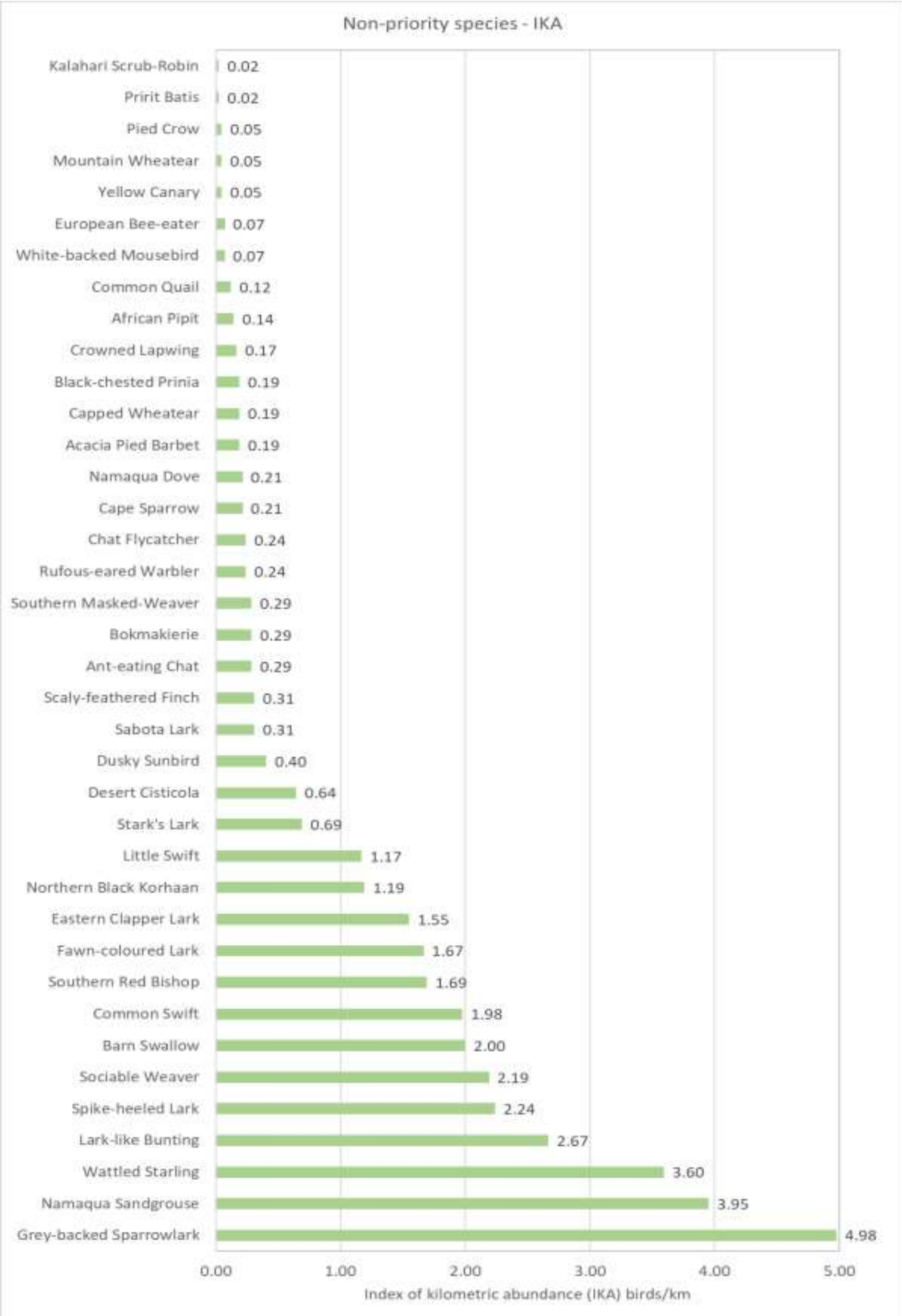

Figure 6: Index of kilometric abundance (IKA) for all non-priority species recorded by means of walk transects during the surveys, conducted in February and March 2020.

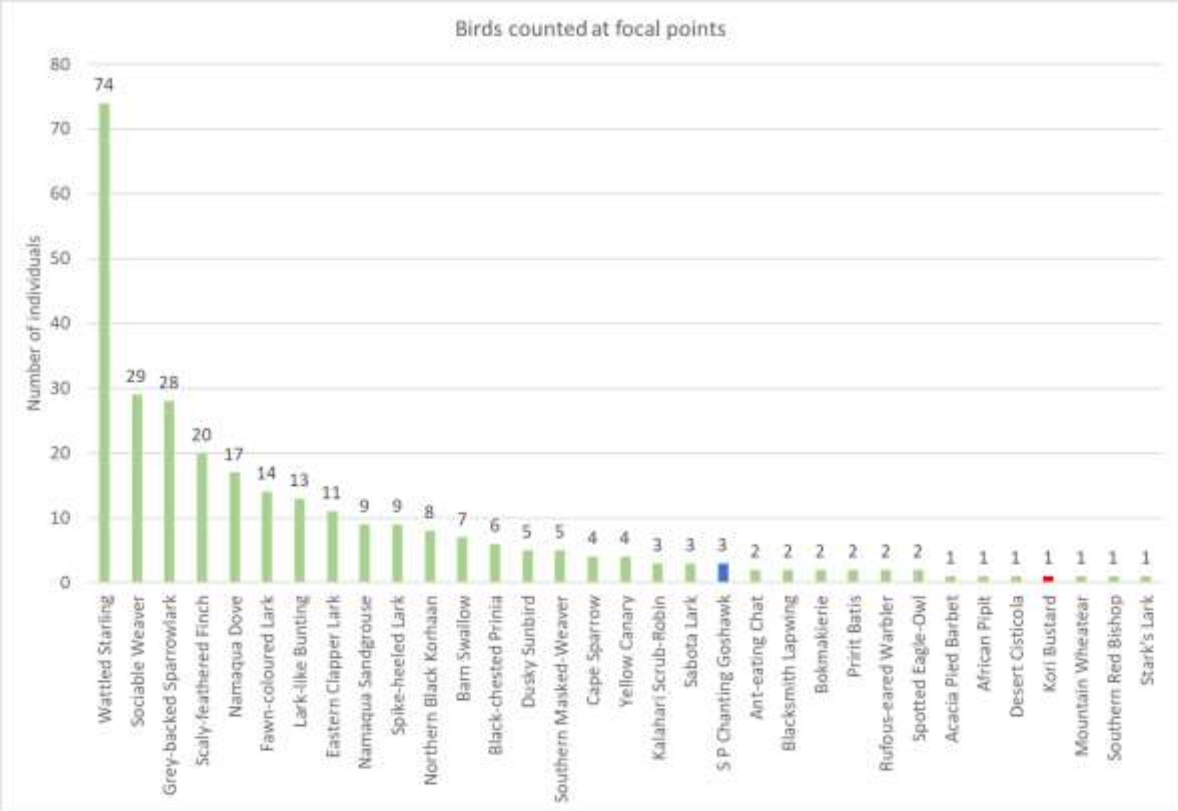

Figure 7: The variety and number of birds counted at focal points in the study area. A total of two priority species were recorded, totalling 4 individual birds (three Southern Pale Chanting Goshawks and one Red Listed Kori Bustard).

4.3 Identification of Environmental Sensitivities

4.3.1 High sensitivity

Included are areas within 200m of water troughs and ephemeral pans[5]. These areas are highly sensitive for the following reasons:

- Surface water in this arid habitat is crucially important for priority avifauna, including several Red Data species such as Martial Eagle, Tawny Eagle, Lanner Falcon, Secretarybird and Kori Bustard, and many non-priority species. Ephemeral pans could also attract waterbirds on occasion, such as African Sacred Ibis, Black-headed Heron, Blacksmith Lapwing, Cattle Egret, Common Greenshank, Common Sandpiper, Egyptian Goose, South African Shelduck, Spur-winged Goose, Three-banded Plover, White-faced Duck, Wood Sandpiper, Yellow-billed Duck, Hamerkop. It is important to leave open space for birds to access and leave the surface water area unhindered, especially large terrestrial species. Surface water is also important area for raptors to hunt birds, and they should have enough space for fast aerial pursuit.

4.3.2 Medium sensitivity

The entire study area can be classified as medium sensitive, due to the fact that it is largely untransformed and potentially supports up to 35 priority species, eight of which are Red Listed.

See Appendix 5 for a sensitivity map of the development footprint.

[5]The 200m buffers were incorporated into the design of the layouts.

5. Issues, Risks and Impacts

5.1 Summary of Issues identified during the Project Notification Phase

No issues were raised pertaining to avifauna during the Project Notification Phase.

5.2 Identification of Potential Impacts/Risks

The potential impacts identified during the BA are:

5.2.1 Construction Phase

- Displacement due to disturbance associated with the construction of the solar PV plant and associated infrastructure

5.2.2 Operational Phase

- Displacement due to habitat transformation associated with the construction of the solar PV plant and associated infrastructure
- Collisions with the solar panels
- Entrapment in perimeter fences
- Electrocutions in the on-site substation and inverter station

5.2.3 Decommissioning Phase

- Displacement due to disturbance associated with the decommissioning of the solar PV plant and associated infrastructure

5.2.4 Cumulative Impacts

- Displacement due to disturbance associated with the construction of the solar PV plant and associated infrastructure
- Displacement due to habitat transformation associated with the construction of the solar PV plant and associated infrastructure
- Collisions with the solar panels
- Entrapment in perimeter fences
- Electrocutions in on-site substation and inverter station

6. Impact Assessment

6.1 Introduction

Increasingly, human-induced climate change is recognized as a fundamental driver of biological processes and patterns. Historic climate change is known to have caused shifts in the geographic ranges of many plants and animals, and future climate change is expected to result in even greater redistributions of species (National Audubon Society 2015). In 2006 WWF Australia produced a report on the envisaged impact of climate change on birds worldwide (Wormworth, J. & Mallon, K. 2006). The report found that:

- Climate change now affects bird species' behaviour, ranges and population dynamics;
- Some bird species are already experiencing strong negative impacts from climate change;

- In future, subject to greenhouse gas emissions levels and climatic response, climate change will put large numbers bird species at risk of extinction, with estimates of extinction rates varying from 2 to 72%, depending on the region, climate scenario and potential for birds to shift to new habitat.

Using statistical models based on the North American Breeding Bird Survey and Audubon Christmas Bird Count datasets, the National Audubon Society assessed geographic range shifts through the end of the century for 588 North American bird species during both the summer and winter seasons under a range of future climate change scenarios (National Audubon Society 2015). Their analysis showed the following:

- 314 of 588 species modelled (53%) lose more than half of their current geographic range in all three modelled scenarios.
- For 126 species, loss occurs without accompanying range expansion.
- For 188 species, loss is coupled with the potential to colonize new areas.

Climate sensitivity is an important piece of information to incorporate into conservation planning and adaptive management strategies. The persistence of many birds will depend on their ability to colonize climatically suitable areas outside of current ranges and management actions that target climate change adaptation.

South Africa is among the world's top 10 developing countries required to significantly reduce their carbon emissions (Seymore *et al.* 2014), and the introduction of low-carbon technologies into the country's compliment of power generation will greatly assist with achieving this important objective (Walwyn & Brent 2015). Given that South Africa receives among the highest levels of solar radiation on earth (Fluri 2009; Munzhedi *et al.* 2009), it is clear that solar power generation should feature prominently in future efforts to convert to a more sustainable energy mix in order to combat climate change, also from an avifaunal impact perspective. However, while the expansion of solar power generation is undoubtedly a positive development for avifauna in the longer term in that it will help reduce the effect of climate change and thus habitat transformation, it must also be acknowledged that renewable energy facilities, including solar PV facilities, in themselves have some potential for negative impacts on avifauna.

A literature review reveals a scarcity of published, scientifically examined information regarding large-scale PV plants and birds. The reason for this is mainly that large-scale PV plants are a relatively recent phenomenon. The main source of information for these types of impacts are from compliance reports and a few government-sponsored studies relating to recently constructed solar plants in the south-west United States. In South Africa, only one published scientific study has been completed on the impacts of PV plants in a South African context (Visser *et al.* 2019).

6.2 Impacts associated with PV plants

6.2.1 Impact trauma (collisions)

This impact refers to collision-related fatality i.e. fatality resulting from the direct contact of the bird with a project structure(s). This type of fatality has been occasionally documented at solar projects of all technology types (McCrary *et al.* 1986; Hernandez *et al.* 2014; Kagan *et al.* 2014). In some instances, the bird is not killed outright by the collision impact, but succumbs to predation later, as it cannot avoid predators due to its injured state.

Sheet glass used in commercial and residential buildings has been well established as a hazard for birds. When the sky is reflected in the sheet glass, birds fail to see the building as an obstacle and attempt to fly through the glass, mistaking it for empty space (Loss *et al.* 2014). Although very few cases have been reported it is possible that the reflective surfaces of solar panels could constitute a similar risk to avifauna.

An extremely rare but potentially related problem is the so-called "lake effect" i.e. it seems possible that reflections from solar facilities' infrastructure, particularly large sheets of dark blue photovoltaic panels, may attract birds in flight across the open desert, who mistake the broad reflective surfaces for water (Kagan *et al.* 2014)[6]. The unusually high percentage of waterbird mortalities at the Desert Sunlight PV facility (44%) may support the "lake effect" hypothesis (West 2014). Although in the case of Desert Sunlight, the proximity of evaporation ponds may act as an additional risk increasing factor, in that birds are both attracted to the water feature and habituated to the presence of an accessible aquatic environment in the area. This may translate into the misinterpretation of diffusely reflected sky or horizontal polarised light source as a body of water. However, due to limited data it would be premature to make any general conclusions about the influence of the lake effect or other factors that contribute to fatality of water-dependent birds. The activity and abundance of water-dependent species near solar facilities may depend on other site-specific or regional factors, such as the surrounding landscape (Walston *et al.* 2015). However, until such time that enough scientific evidence has been collected to discount the "lake effect" hypothesis, it must be considered as a potential source of impacts.

Weekly mortality searches at 20% coverage were conducted at the 250MW, 1300ha California Valley Solar Ranch PV site (Harvey & Associates 2014a and 2014b). According to the information that could be sourced from the internet (two quarterly reports), 152 avian mortalities were reported for the period 16 November 2013 – 15 February 2014, and 54 for the period 16 February 2014 – 15 May 2014, of which approximately 90% were based on feather spots which precluded a finding on the cause of death. These figures give an estimated unadjusted 1 030 mortalities per year, which is obviously an underestimate as it does not include adjustments for carcasses removed by scavengers and missed by searchers. The authors stated clearly that these quarterly reports do not include the results of searcher efficiency trials, carcass removal trials, or data analyses, nor does it include detailed discussions.

In a report by the National Fish and Wildlife Forensic Laboratory (Kagan *et al.* 2014), the cause of avian mortalities was estimated based on opportunistic avian carcass collections at several solar facilities, including the 550MW, 1 600ha Desert Sunlight PV plant. Impact trauma emerged as the highest identifiable cause of avian mortality, but most mortality could not be traced to an identifiable cause.

Walston *et al.* (2015) conducted a comprehensive review of avian fatality data from large scale solar facilities (all technology types) in the USA. Collision as cause of death (19 birds) ranked second at Desert Sunlight PV plant and California Valley Solar Ranch (CVSR) PV plant, after unknown causes. Cause of death could not be determined for over 50% of the fatality observations and many carcasses included in these analyses consisted only of feather spots (feathers concentrated together in a small area) or partial carcasses, thus making determination of cause of death difficult. It is anticipated that some unknown fatalities were caused by predation or some other factor unrelated to the solar project. However, they found that the lack of systematic data collection and standardization was a major impediment in establishing the actual extent and causes of fatalities across all projects.

The only scientific investigation of potential avifaunal impacts that has been performed at a South African PV facility was completed in 2016 at the 96MW Jasper PV solar facility (28°17′53″S, 23°21′56″E) which is located on the Humansrus Farm, approximately 4 km south-east of Groenwater and 30km east of Postmasburg in the Northern Cape Province (Visser *et al.* 2019). The Jasper PV facility contains 325 360 solar panels over a footprint of 180 hectares with the capacity to deliver 180 000 MWh of renewable electricity annually. The solar panels face north at a fixed 20° angle, reaching a height of approximately

[6] This could either result in birds colliding directly with the solar panels or getting stranded and unable to take off again because many aquatic bird species find it very difficult and sometimes impossible to take off from dry land e.g. grebes and cormorants. This exposes them to predation, even if they do not get injured through direct collisions with the panels.

1.86 m relative to ground level with a distance of 3.11 m between successive rows of panels. Mortality surveys were conducted from the 14th of September 2015 until the 6th of December 2015, with a total of seven mortalities recorded among the solar panels which gives an average rate of 0.003 birds per hectare surveyed per month. All fatalities were inferred from feather spots. Extrapolated bird mortality within the solar field at the Jasper PV facility was 435 birds/yr (95% CI 133 - 805). The broad confidence intervals result from the small number of birds detected. The mortality estimate is likely conservative because detection probabilities were based on intact birds, and probably decrease for older carcasses and feather spots. The study concluded inter alia that the short study period, and lack of comparable results from other sources made it difficult to provide a meaningful assessment of avian mortality at PV facilities. It further stated that despite these limitations, the few bird fatalities that were recorded might suggest that there is no significant collision-related mortality at the study site. The conclusion was that to fully understand the risk of solar energy development on birds, further collation and analysis of data from solar energy facilities across spatial and temporal scales, based on scientifically rigorous research designs, is required (Visser *et al.* 2019).

The results of the available literature lack compelling evidence of collisions as a cause of large-scale mortality among birds at PV facilities. However, it is clear from this limited literature survey that the lack of systematic and standardised data collection is a major problem in the assessment of the causes and extent of avian mortality at all types of solar facilities, regardless of the technology employed. Until statistically tested results emerge from existing compliance programmes and more dedicated scientific research, conclusions will inevitably be largely speculative and based on professional opinion.

Based on the lack of evidence to the contrary, it is not foreseen that collisions with the solar panels at the PV facility will be a significant impact. The priority species which would most likely be potentially affected by this impact are mostly small birds which forage between the solar panels, and possibly raptors which prey on them:

- Lanner Falcon
- Black-eared Sparrowlark
- Fiscal Flycatcher
- Pygmy Falcon
- Southern Pale Chanting Goshawk
- Spotted Eagle-Owl

6.2.2 Entrapment in perimeter fences

Visser *et al.* (2019) recorded a fence-line fatality (Orange River Francolin *Scleroptila gutturalis*) resulting from the bird being trapped between the inner and outer perimeter fence of the facility. This was further supported by observations of large-bodied birds unable to escape from between the two fences (e.g. Red-crested Korhaan *Lophotis ruficrista*) (Visser *et al.* 2019). Considering that one would expect the birds to be able to take off in the lengthwise direction (parallel to the fences), it seems possible that the birds panicked when they were approached by observers and thus flew into the fence.

It is not foreseen that entrapment in perimeter fences will be a significant impact. The priority species which could potentially be affected by this impact are most likely medium to large terrestrial species:

- Secretarybird
- Abdim's Stork
- Karoo Korhaan
- Kori Bustard
- Ludwig's Bustard

6.2.3 *Displacement due to disturbance and habitat transformation associated with the construction of the solar PV facility*

Ground-disturbing activities affect a variety of processes in arid areas, including soil density, water infiltration rate, vulnerability to erosion, secondary plant succession, invasion by exotic plant species, and stability of cryptobiotic soil crusts. These processes have the ability – individually and together – to alter habitat quality, often to the detriment of wildlife, including avifauna. Any disturbance and alteration to the desert landscape, including the construction and decommissioning of utility-scale solar energy facilities, has the potential to increase soil erosion. Erosion can physically and physiologically affect plant species and can thus adversely influence primary production and food availability for wildlife (Lovich & Ennen 2011).

Solar energy facilities require substantial site preparation (including the removal of vegetation) that alters topography and, thus, drainage patterns to divert the surface flow associated with rainfall away from facility infrastructure. Channelling runoff away from plant communities can have dramatic negative effects on water availability and habitat quality in arid areas. Areas deprived of runoff from sheet flow support less biomass of perennial and annual plants relative to adjacent areas with uninterrupted water-flow patterns (Lovich & Ennen 2011).

The activities listed below are typically associated with the construction and operation of solar facilities and could have direct impacts on avifauna (County of Merced 2014):

- Preparation of solar panel areas for installation, including vegetation clearing, grading[7], cut and fill;
- Excavation/trenching for water pipelines, cables, fibre-optic lines, and the septic system;
- Construction of piers and building foundations;
- Construction of new dirt or gravel roads and improvement of existing roads;
- Temporary stockpiling and side-casting of soil, construction materials, or other construction wastes;
- Soil compaction, dust, and water runoff from construction sites;
- Increased vehicle traffic;
- Short-term construction-related noise (from equipment) and visual disturbance;
- Degradation of water quality in drainages and other water bodies resulting from project runoff;
- Maintenance of fire breaks and roads; and
- Weed removal, brush clearing, and similar land management activities related to the ongoing operation of the project.

These activities could have an impact on birds breeding, foraging and roosting in or in close proximity through disturbance and transformation of habitat, which could result in temporary or permanent displacement.

In a study comparing the avifaunal habitat use in PV arrays with adjoining managed grassland at airports in the USA, DeVault *et al.* (2014) found that species diversity in PV arrays was reduced compared to the grasslands (37 vs 46), supporting the view that solar development is generally detrimental to wildlife on a local scale.

In order to identify functional and structural changes in bird communities in and around the development footprint, Visser *et al.* (2019) gathered bird transect data at the 180 hectares, 96MW Jasper PV solar facility in the Northern Cape, representing the solar development, boundary, and untransformed landscape. The study found both bird density and diversity per unit area was higher in the boundary and untransformed landscape, however, the extent therefore was not considered to be statistically significant. This indicates that the PV facility matrix is permeable to most species. However, key environmental features, including available habitat and vegetation quality are most likely the overriding

[7] In this instance, this will be limited to specific problem areas

factors influencing species' occurrence and their relative density within the development footprint. Her most significant finding was that the distribution of birds in the landscape changed, from a shrubland to open country and grassland bird community, in response to changes in the distribution and abundance of habitat resources such as food, water and nesting sites. These changes in resource availability patterns were detrimental to some bird species and beneficial to others. Shrubland specialists appeared to be negatively affected by the presence of the PV facility. In contrast, open country/grassland and generalist species, were favoured by its development (Visser *et al.* 2019).
As far as disturbance is concerned, it is likely that all the avifauna, including all the priority species, will be temporarily displaced in the footprint area, either completely or more likely partially (reduced densities) during the construction phase, due to the disturbance associated with the construction activities.

As far as displacement, either completely or partially (reduced densities) due to habitat loss is concerned, it is highly likely that the same pattern of reduced avifaunal densities and possible changes in densities and composition favouring grassland species will manifest itself at the proposed PV facility. In addition, raptors, large terrestrial species and waterbirds are also likely to be impacted. Species that could be affected by displacement due to habitat loss are listed below:

- Secretarybird
- Abdim's Stork
- Karoo Korhaan
- Kori Bustard
- Ludwig's Bustard
- Lanner Falcon
- Black-eared Sparrowlark
- Fiscal Flycatcher
- Pygmy Falcon
- Southern Pale Chanting Goshawk
- Spotted Eagle-owl
- Black-headed Heron
- White-faced Duck
- Yellow-billed Duck
- Martial Eagle
- Tawny Eagle
- Black-shouldered Kite
- Booted Eagle
- Common Ostrich
- Greater Kestrel
- Pearl-spotted Owlet
- Rock Kestrel
- Steppe Buzzard

6.3 Impacts associated with onsite substations and inverter stations

Negative impacts on birds by electricity infrastructure generally take two principal forms, namely electrocution and collisions (Ledger & Annegarn 1981; Ledger 1983; Ledger 1984; Hobbs and Ledger 1986a; Hobbs & Ledger 1986b; Ledger, Hobbs & Smith, 1992; Verdoorn 1996; Kruger & Van Rooyen 1998; Van Rooyen 1998; Kruger 1999; Van Rooyen 1999; Van Rooyen 2000; Van Rooyen 2004; Jenkins *et al.* 2010). Birds also impact on the infrastructure through nesting and streamers, which can cause interruptions in the electricity supply (Van Rooyen *et al.* 2002). During the construction phase of power lines and substations, displacement of birds can also happen due to disturbance and habitat transformation.

6.3.1 *Electrocutions*

Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2004). The electrocution risk is largely determined by the design of the electrical hardware. There could be an electrocution risk to certain species, mostly raptors, but also some waterbirds, in the substation yard of the onsite substation and the inverter station. This is however unlikely to be a major problem to the larger Red Listed species, as it is not envisaged that they will frequently perch in the substation or inverter station area.

Species potentially at risk of electrocution in the substation yard and inverter station are the following:

- Lanner Falcon
- Southern Pale Chanting Goshawk
- Spotted Eagle-Owl
- Martial Eagle
- Tawny Eagle
- Greater Kestrel
- Steppe Buzzard
- Egyptian Goose
- Barn Owl

6.4 Cumulative impacts

Cumulative effects are commonly understood to be impacts from different projects that combine to result in significant change, which could be larger than the sum of all the individual impacts. The assessment of cumulative effects therefore needs to consider all renewable energy developments within at least a 30km radius of the proposed site. The locality renewable projects which are planned, authorised or have been constructed already are displayed in Figure 8 and listed in Appendix 3.

In the case of solar energy projects, the potentially most significant impact from an avifaunal perspective is the transformation of the natural habitat. The total footprint taken up by existing and proposed solar energy projects is approximately 12 600ha. This project comprises 220 hectares of this footprint. The total area of the 30km radius around the proposed projects equates to about 285 000ha of very similar habitat. The total combined size of the footprint taken up by solar energy projects equates to 4.4% of the available habitat in the 30km radius. The cumulative impact of the habitat transformation which will come about as a result of the proposed PV project, should therefore be **low**.

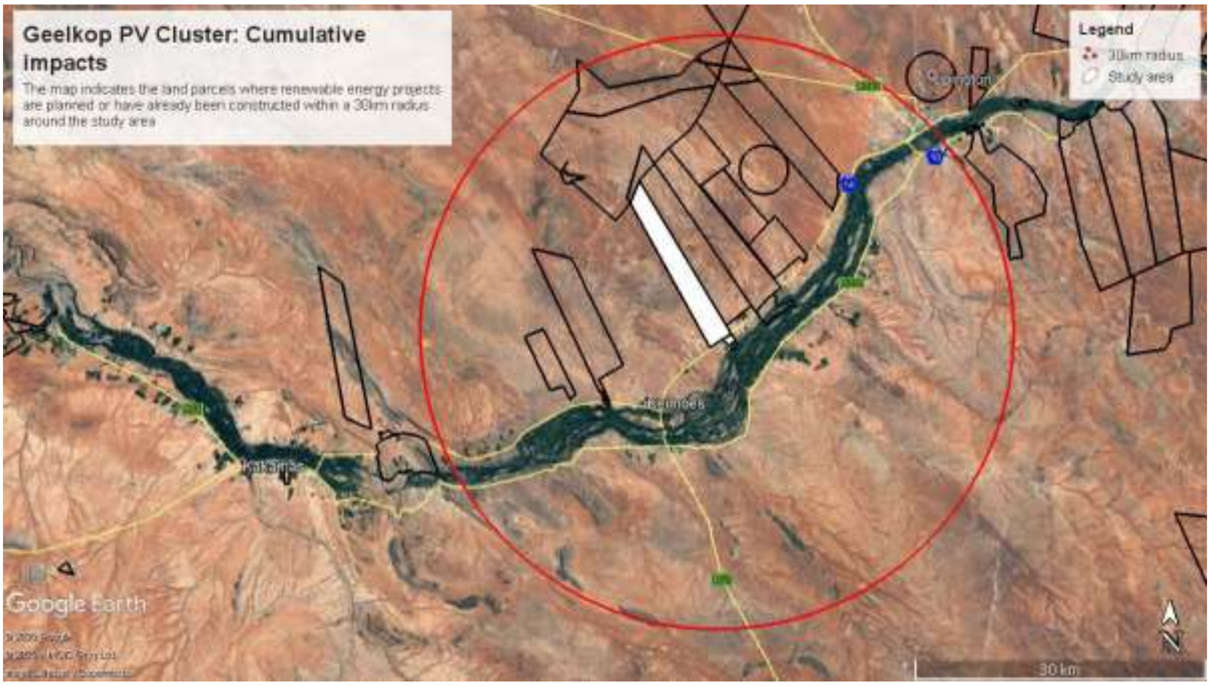

Figure 8: Map showing location of land parcels with planned or constructed solar energy projects within a 30km radius around the study area.

6.5 No-go option

The no-go option will result in no additional impacts on avifauna and will result in the ecological status quo being maintained (as described in Section 4 of this report), which will be to the advantage of the avifauna.

6.6 Potential Impacts during the Construction Phase

Aspect/Activity	Construction of the solar PV plant and associated infrastructure
Type of Impact (i.e. Impact Status)	Direct
Potential Impact	The noise and movement associated with the construction activities at the development footprint will be a source of disturbance which would lead to the displacement of avifauna from the area. Priority species potentially affected are: ▪ All priority species
Status	Negative
Mitigation Required	▪ Activity should as far as possible be restricted to the footprint of the infrastructure. ▪ Measures to control noise and dust should be applied according to current best practice in the industry. ▪ Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical. ▪ Access to the rest of the property must be restricted. ▪ The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint is concerned.
Impact Significance (Pre-Mitigation)	Moderate (Level 3)
Impact Significance (Post-Mitigation)	Low (Level 4)
I&AP Concern	No

6.7 Potential Impacts during the Operational Phase

Aspect/Activity	The vegetation clearance and presence of the solar arrays and associated infrastructure amounts to habitat transformation in the development footprint
Type of Impact (i.e. Impact Status)	Direct
Potential Impact	Total or partial displacement of avifauna due to habitat transformation associated with the vegetation clearance and the presence of the solar PV plant and associated infrastructure. Priority species potentially affected are the following: ▪ Lanner Falcon ▪ Spotted Eagle-owl ▪ Martial Eagle ▪ Tawny Eagle ▪ Greater Kestrel ▪ Secretarybird ▪ Abdim's Stork ▪ Karoo Korhaan ▪ Kori Bustard ▪ Ludwig's Bustard ▪ Pygmy Falcon ▪ Black-shouldered Kite ▪ Booted Eagle ▪ Common Ostrich ▪ Pearl-spotted Owlet ▪ Rock Kestrel ▪ Southern Pale Chanting Goshawk ▪ Steppe Buzzard ▪ Black-eared Sparrowlark ▪ Fiscal Flycatcher ▪ Black-headed Heron
Status	Negative
Mitigation Required	The recommendations of the botanical specialist must be strictly implemented, especially as far as limiting the vegetation clearance to what is absolutely necessary, and rehabilitation of transformed areas are concerned.
Impact Significance (Pre-Mitigation)	High (Level 2)
Impact Significance (Post-Mitigation)	Moderate (Level 3)
I&AP Concern	No

Aspect/Activity	The presence of the PV solar arrays will lead to collisions with the reflective solar panels in the PV footprint
Type of Impact (i.e. Impact Status)	Direct
Potential Impact	Birds will get killed or injured through collisions with the solar panels. Priority species potentially affected are: ▪ Lanner Falcon ▪ Spotted Eagle-owl ▪ Pygmy Falcon ▪ Southern Pale Chanting Goshawk ▪ Black-eared Sparrowlark ▪ Fiscal Flycatcher
Status	Negative
Mitigation Required	No mitigation is required due to the very low expected magnitude.
Impact Significance (Pre-Mitigation)	Very Low (Level 5)
Impact Significance (Post-Mitigation)	Very Low (Level 5)
I&AP Concern	No

Aspect/Activity	The presence of a double perimeter fence could lead to entrapment of birds between the fences
Type of Impact (i.e. Impact Status)	Direct
Potential Impact	Entrapment of medium and large terrestrial birds between the perimeter fences, leading to mortality. Priority species that could potentially be affected are: ▪ Secretarybird ▪ Abdim's Stork ▪ Karoo Korhaan ▪ Kori Bustard ▪ Ludwig's Bustard
Status	Negative
Mitigation Required	A single perimeter fence should be used[8].
Impact Significance (Pre-Mitigation)	Low (Level 4)
Impact Significance (Post-Mitigation)	Very Low (Level 5)
I&AP Concern	No

Aspect/Activity	Electrocution in the onsite substation and inverter station
Type of Impact (i.e. Impact Status)	Direct
Potential Impact	Electrocution of priority species. Potential priority species which could be affected are: ▪ Lanner Falcon ▪ Spotted Eagle-owl ▪ Southern Pale Chanting Goshawk ▪ Martial Eagle ▪ Tawny Eagle ▪ Greater Kestrel ▪ Steppe Buzzard ▪ Barn Owl ▪ Egyptian Goose
Status	Negative
Mitigation Required	▪ With regards to the infrastructure within the substation yard and inverter station, the hardware is too complex to warrant any mitigation for electrocution at this stage. It is rather recommended that if any impacts are recorded once operational, site specific mitigation be applied reactively.
Impact Significance (Pre-Mitigation)	Low (Level 4)
Impact Significance (Post-Mitigation)	Very Low (Level 5)
I&AP Concern	No

6.8 Potential Impacts during the Decommissioning Phase

Aspect/Activity	Decommissioning of the solar PV plant and associated infrastructure
Type of Impact (i.e. Impact Status)	Direct
Potential Impact	The noise and movement associated with the activities at the study area will be a source of disturbance which would lead to the displacement of avifauna from the area. Priority species potentially affected are: ▪ All priority species

[8] In this instance, according to the design specifications, a fence will be used consisting of an outer diamond mesh fence and inner electric fence with a separation distance of approximately 100mm. This should not pose any risk of entrapment for large terrestrial species and can be considered a single fence.

Status	Negative
Mitigation Required	▪ Activity should as far as possible be restricted to the footprint of the infrastructure. ▪ Measures to control noise and dust should be applied according to current best practice in the industry. ▪ Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical. ▪ Access to the rest of the property must be restricted. ▪ The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the activity footprint is concerned.
Impact Significance (Pre-Mitigation)	Moderate (Level 3)
Impact Significance (Post-Mitigation)	Low (Level 4)
I&AP Concern	No

6.9 Cumulative Impacts

Aspect/Activity	The incremental impact of the proposed PV facility and grid connection on priority avifauna, added to the impacts of other past, present or reasonably foreseeable future activities.
Type of Impact (i.e. Impact Status)	Direct
Potential Impact	▪ Displacement due to disturbance associated with the construction of the solar PV plant and associated infrastructure ▪ Displacement due to habitat transformation associated with the construction of the solar PV plant and associated infrastructure ▪ Collisions with the solar panels ▪ Entrapment in perimeter fences ▪ Electrocutions in the onsite substation yard and inverter station.
Status	Negative
Mitigation Required	Please refer to all the proposed mitigation measures as listed in the preceding tables in Section 6 for all the impacts and all the phases
Impact Significance (Pre-Mitigation)	Low (4)
Impact Significance (Post-Mitigation)	Very Low (5)
I&AP Concern	None to date

7. Impact Assessment Tables

The assessment of impacts and recommendation of mitigation measures as discussed above are collated in Tables 1 to 4 below. An explanation of the assessment criteria is provide in Appendix 6.

Table 1: Impact Assessment Summary Table for the Construction Phase

Aspect/ Impact Pathway	Nature of Potential Impact/ Risk	Status	Spatial Extent	Duration	Consequence	Probability	Reversibility of Impact	Irreplaceability	Potential Mitigation Measures	Significance of Impact and Risk: Without Mitigation/ Management	Significance of Impact and Risk: With Mitigation/ Management (Residual Impact/ Risk)	Ranking of Residual Impact/ Risk	Confidence Level
Construction Phase													
Direct Impacts													
Construction of the solar PV plant and associated infrastructure.	The noise and movement associated with the construction activities at the PV footprint will be a source of disturbance which would lead to the displacement of avifauna from the area.	Negative	Site specific	Short term	Substantial	Very likely	high	Low	▪ Activity should as far as possible be restricted to the footprint of the infrastructure. ▪ Measures to control noise and dust should be applied according to current best practice in the industry. ▪ Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical. ▪ Access to the rest of the property must be restricted. ▪ The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint is concerned.	Moderate (3)	Low (4)	Low (4)	High

Table 2: Impact Assessment Summary Table for the Operational Phase

Aspect/ Impact Pathway	Nature of Potential Impact/ Risk	Status	Spatial Extent	Duration	Consequence	Probability	Reversibility of Impact	Irreplaceability	Potential Mitigation Measures	Significance of Impact and Risk		Ranking of Residual Impact/ Risk	Confidence Level
Operational Phase													
Direct Impacts													
										Without Mitigation/ Management	**With Mitigation/ Management (Residual Impact/ Risk)**		
The vegetation clearance and presence of the solar arrays and associated infrastructure amounts to habitat transformation in the PV footprint.	Total or partial displacement of avifauna due to habitat transformation associated with the presence of the solar PV plant and associated infrastructure.	Direct	Site specific	Long term	Severe	Very likely	High	Low	The recommendations of the botanical specialist must be strictly implemented, especially as far as limiting the vegetation clearance to what is absolutely necessary, and rehabilitation of transformed areas are concerned.	High (2)	Moderate (3)	Moderate (3)	Medium
The presence of the PV solar arrays will lead to collisions with the reflective solar panels in the PV footprint.	Birds will get killed or injured through collisions with the solar panels.	Direct	Site specific	Long term	Slight	Unlikely	High	Low	No mitigation is required due to the very low significance.	Very low (5)	Very low (5)	Very low (5)	Medium
The presence of a double perimeter fence could lead to entrapment of birds between the fences.	Entrapment of medium and large terrestrial birds between the perimeter fences, leading to mortality.	Direct	Site specific	Long term	Moderate	Likely	High	Low	A single perimeter fence should be used.	Low (4)	Very low (5)	Very low (5)	High

On-site substation and inverter station could be a source of electrocutions of priority species	Electrocution of priority species.	Direct	Local	Long term	Severe	Likely	High	Low	▪ With regards to the infrastructure within the substation yard and inverter station, the hardware is too complex to warrant any mitigation for electrocution at this stage. It is rather recommended that if any impacts are recorded once operational, site specific mitigation be applied reactively.	Low	Very low (5)	Very low (5)	High

Table 3: Impact Assessment Summary Table for the Decommissioning Phase

Decommissioning Phase													
Direct Impacts													
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence**	**Probability**	**Reversibility of Impact**	**Irreplaceability**	**Potential Mitigation Measures**	**Significance of Impact and Risk**		**Ranking of Residual Impact/ Risk**	**Confidence Level**
										Without Mitigation/ Management	**With Mitigation/ Management (Residual Impact/ Risk)**		
Decommissioning of the solar PV plant and associated infrastructure	The noise and movement associated with the activities at the study area will be a source of disturbance which would lead to the displacement of avifauna from the area.	Direct	Site specific	Short term	Substantial	Very likely	High	Low	▪ Activity should as far as possible be restricted to the footprint of the infrastructure. ▪ Measures to control noise and dust should be applied according to current best practice in the industry. ▪ Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical. ▪ The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the activity footprint is concerned.	Moderate (3)	Low (4)	Very low (5)	High

Table 4: Cumulative Impact Assessment Summary Table

Cumulative Impacts (Construction, Operational and Decommissioning Phases)													
Direct Impacts													
Aspect/ Impact Pathway	**Nature of Potential Impact/ Risk**	**Status**	**Spatial Extent**	**Duration**	**Consequence**	**Probability**	**Reversibility**	**Irreplaceability**	**Potential Mitigation Measures**	**Significance of Impact and Risk**		**Ranking of Residual Impact/ Risk**	**Confidence Level**
										Without Mitigation/ Management	**With Mitigation/ Management (Residual Impact/ Risk)**		
The incremental impact of the proposed PV facility and grid connection on priority avifauna, added to the impacts of other past, present or reasonably foreseeable future activities.	▪ Displacement due to disturbance associated with the construction of the solar PV plant and associated infrastructure ▪ Displacement due to habitat transformation associated with the construction of the solar PV plant and associated infrastructure ▪ Collisions with the solar panels ▪ Entrapment in perimeter fences ▪ Electrocutions in the onsite substation yard and inverter station.	Direct	Local	Long term	Substantial	Very likely	High	Low	See all the proposed mitigation measures as listed in the preceding tables in Section 6 for all the impacts and all the phases	Low (4)	Very low (5)	Very low (5)	Medium

7.1 Impact Assessment Summary

Table 3 below provides an indication of the overall impact significance with the implementation of mitigation measures for the various phases.

Table 3:Overall Impact Significance (Post Mitigation)

Phase	Overall Impact Significance
Construction	Low (Level 4)
Operational	Very Low (Level 5) to Moderate (Level 3)
Decommissioning	Low (Level 4)
Cumulative	Very Low (5)

8. Legislative and Permit Requirements

8.1 Legislative Framework

There is no legislation pertaining specifically to the impact of solar facilities and associated electrical infrastructure on avifauna. There are best practice guidelines available which were compiled under the auspices of Birdlife South Africa (BLSA) i.e. Jenkins, A.R., Ralston-Patton, Smit- Robinson, A.H. 2017. Guidelines for assessing and monitoring the impact of solar power generating facilities on birds in southern Africa. BirdLife South Africa.

8.1.1 Agreements and conventions

Table 4: International agreements and conventions which South Africa is party to and which is relevant to the conservation of avifauna.

Convention name	Description	Geographic scope
African-Eurasian Waterbird Agreement (AEWA)	The Agreement on the Conservation of AEWA is an intergovernmental treaty dedicated to the conservation of migratory waterbirds and their habitats across Africa, Europe, the Middle East, Central Asia, Greenland and the Canadian Archipelago. Developed under the framework of the Convention on Migratory Species (CMS) and administered by the United Nations Environment Programme (UNEP), AEWA brings together countries and the wider international conservation community in an effort to establish coordinated conservation and management of migratory waterbirds throughout their entire migratory range.	Regional
Convention on Biological Diversity (CBD), Nairobi, 1992	The Convention on Biological Diversity (CBD) entered into force on 29 December 1993. It has 3 main objectives: The conservation of biological diversity; The sustainable use of the components of biological diversity; and The fair and equitable sharing of the benefits arising out of the utilization of genetic resources.	Global
Convention on the Conservation of Migratory Species of Wild Animals, (CMS), Bonn, 1979	As an environmental treaty under the aegis of the UNEP, CMS provides a global platform for the conservation and sustainable use of migratory animals and their habitats. CMS brings together the States through which migratory animals pass, the Range States, and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range.	Global

Convention name	Description	Geographic scope
Convention on the International Trade in Endangered Species of Wild Flora and Fauna, (CITES), Washington DC, 1973	CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.	Global
Ramsar Convention on Wetlands of International Importance, Ramsar, 1971	The Convention on Wetlands, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.	Global
Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia	The Signatories will aim to take co-ordinated measures to achieve and maintain the favourable conservation status of birds of prey throughout their range and to reverse their decline when and where appropriate.	Regional

8.1.2 National legislation

8.1.2.1 Constitution of the Republic of South Africa, 1996

The Constitution of the Republic of South Africa provides in the Bill of Rights that: Everyone has the right –

(a) to an environment that is not harmful to their health or well-being; and
(b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that –
  (i) prevent pollution and ecological degradation;
  (ii) promote conservation; and
  (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

8.1.2.2 The National Environmental Management Act 107 of 1998

The National Environmental Management Act 107 of 1998 (as amended) (NEMA) creates the legislative framework for environmental protection in South Africa, and is aimed at giving effect to the environmental right in the Constitution. It sets out a number of guiding principles that apply to the actions of all organs of state that may significantly affect the environment. Sustainable development (socially, environmentally and economically) is one of the key principles, and internationally accepted principles of environmental management, such as the precautionary principle and the polluter pays principle, are also incorporated.

NEMA also provides that a wide variety of listed developmental activities (via the promulgation of the EIA Regulations (2014, as amended), which may significantly affect the environment, may be performed only after an EIA has been done and authorisation has been obtained from the relevant authority. Many of these listed activities can potentially have negative impacts on bird populations in a variety of ways. The clearance of natural vegetation, for instance, can lead to a loss of habitat and may depress prey populations, while erecting structures needed for generating and distributing energy, communication, and so forth can cause mortalities by collision or electrocution.

8.1.2.3 The National Environmental Management: Biodiversity Act 10 of 2004 and the Threatened or Protected Species Regulations, February 2007

The most prominent statute containing provisions directly aimed at the conservation of birds is the National Environmental Management: Biodiversity Act (Act 10 of 2004, as amended) read with the Threatened or Protected Species Regulations, February 2007 (TOPS Regulations). Chapter 1 sets out the objectives of the Act, and they are aligned with the objectives of the Convention on Biological Diversity, which are the conservation of biodiversity, the sustainable use of its components, and the fair and equitable sharing of the benefits of the use of genetic resources. The Act also gives effect to CITES, the Ramsar Convention, and the Bonn Convention on Migratory Species of Wild Animals (as noted in Table 4 above). The State is endowed with the trusteeship of biodiversity and has the responsibility to manage, conserve and sustain the biodiversity of South Africa.

8.1.2.4 Provincial legislation

The Northern Cape Nature Conservation Act No 9 of 2009 was enacted to provide for the sustainable utilisation of wild animals, aquatic biota and plants; to provide for the implementation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora; to provide for offences and penalties for contravention of the Act; to provide for the appointment of nature conservators to implement the provisions of the Act; to provide for the issuing of permits and other authorisations, and to provide for matters connected therewith.

There are no specific sections dealing with the protection of avifauna, except to classify birds in general as specially protected species which require a permit to be hunted, imported, exported, transported, kept, possessed, bred or traded in. The act therefore does not apply in situations where birds are unintentionally killed as a by-product of an industrial activity. It also does not place restrictions on the removal of bird nests, should that become necessary because they are impacting on sensitive equipment.

9. Environmental Management Programme Inputs

Refer to Appendix 4 for the EMPr inputs. It is important to note that a comprehensive EMPr is included in the BA Report, which includes input from all specialists in this regard.

10. Summary of Findings and Recommendations

It is estimated that a total of 203 bird species could potentially occur in the broader area – Appendix 2 provides a comprehensive list of all the species, including those recorded during the pre-construction monitoring. Of the priority species potentially occurring in the broader area, 35 could potentially occur in the study area. Eight of these are South African Red Data species, and three are globally Red listed.

The proposed project will have the following potential impacts on avifauna:

- Displacement due to disturbance associated with the construction of the solar PV plant and associated infrastructure.
- Displacement due to habitat transformation associated with the construction of the solar PV plant and associated infrastructure
- Collisions with the solar panels
- Entrapment in perimeter fences
- Electrocutions in the onsite substation and inverter station
- Displacement due to disturbance associated with the decommissioning of the solar PV plant and associated infrastructure

10.1 Displacement due to disturbance associated with the construction of the solar PV plant and associated infrastructure.

The construction activities associated with the construction of the solar PV plant and associated infrastructure could impact on birds through disturbance; this could lead to breeding failure if the disturbance happens during a critical part of the breeding cycle. Construction activities in close proximity to breeding locations could be a source of disturbance and could lead to temporary displacement. All priority species could temporarily be displaced due to disturbance associated with the construction of the PV facility and associated infrastructure. **The impact is assessed to be Moderate before mitigation, and Low after mitigation**. Suggested mitigation measures are (a) activity should as far as possible be restricted to the footprint of the infrastructure, (b) measures to control noise and dust should be applied according to current best practice in the industry (c) maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical (d) access to the rest of the property must be restricted (e) the recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint is concerned.

10.2 Displacement due to habitat transformation associated with the construction of the solar PV plant and associated infrastructure

Indications are that the PV facility matrix is permeable to most species. However, key environmental features, including available habitat and vegetation quality are most likely the overriding factors influencing species' occurrence and their relative density within the development footprint. The most significant aspect is that the distribution of birds in the landscape could change, from a shrubland to open country and grassland bird community, in response to changes in the distribution and abundance of habitat resources such as food, water and nesting sites. Shrubland specialists appear to be negatively affected by the presence of the PV facility. In contrast, open country/grassland and generalist species, are favoured by its development (Visser et al. 2019). Species that could be affected by displacement due to habitat transformation are the following:

- Lanner Falcon
- Spotted Eagle-owl
- Martial Eagle
- Tawny Eagle
- Greater Kestrel
- Secretarybird
- Abdim's Stork
- Karoo Korhaan
- Kori Bustard
- Ludwig's Bustard
- Pygmy Falcon
- Black-shouldered Kite
- Booted Eagle
- Common Ostrich
- Pearl-spotted Owlet
- Rock Kestrel
- Southern Pale Chanting Goshawk
- Steppe Buzzard
- Black-eared Sparrowlark
- Fiscal Flycatcher
- Black-headed Heron.

The impact is assessed to be High before mitigation, and Moderate after mitigation. The recommendations of the botanical specialist must be strictly implemented, especially as far as limiting the vegetation clearance to what is absolutely necessary, and rehabilitation of transformed areas are concerned. Other than that, not much can be done to limit this unavoidable impact on the avifauna.

10.3 Collisions with the solar panels

The results of the available literature lack compelling evidence of collisions as a cause of large-scale mortality among birds at PV facilities. However, it is clear that the lack of systematic and standardised data collection is a major problem in the assessment of the causes and extent of avian mortality at all types of solar facilities, regardless of the technology employed. Until statistically tested results emerge from existing compliance programmes and more dedicated scientific research, conclusions will inevitably be largely speculative and based on professional opinion. It is not foreseen that collisions with the solar panels at the PV facility will be a significant impact. The priority species which would most likely be potentially affected by this impact are mostly small birds which forage between the solar panels, and possibly raptors which prey on them:

- Lanner Falcon
- Spotted Eagle-owl
- Pygmy Falcon
- Southern Pale Chanting Goshawk
- Black-eared Sparrowlark
- Fiscal Flycatcher

The risk is assessed to be Very Low. No mitigation is required due to the very low expected magnitude.

10.4 Entrapment in perimeter fences

Visser *et al.* (2019) recorded a fence-line fatality resulting from the bird being trapped between the inner and outer perimeter fence of the facility. This was further supported by observations of large-bodied birds unable to escape from between the two fences (Visser *et al.* 2019). It is not foreseen that entrapment in perimeter fences will be a significant impact. The priority species which could potentially be affected by this impact are most likely medium to large terrestrial species:

- Secretarybird
- Abdim's Stork
- Karoo Korhaan
- Kori Bustard
- Ludwig's Bustard

The risk is assessed to be Low, but it can be reduced to Very Low through the application of mitigation measures. Suggested mitigation is that a single perimeter fence should be used[9].

10.5 Electrocutions in the onsite substation yard and inverter station

Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2004). The electrocution risk is largely determined by the design of the electrical hardware. There could be an electrocution risk to certain

[9] In this instance, according to the design specifications, a fence will be used consisting of an outer diamond mesh fence and inner electric fence with a separation distance of approximately 100mm. This should not pose any risk of entrapment for large terrestrial species and can be considered a single fence.

species, mostly raptors, but also some waterbirds, in the substation yard of the onsite substation and inverter station. This is however unlikely to be a major problem to the larger Red Listed species, as it is not envisaged that they will frequently perch in the substation or inverter station area.

Species potentially at risk of electrocution in the substation yard or inverter station are the following:

- Lanner Falcon
- Southern Pale Chanting Goshawk
- Spotted Eagle-Owl
- Martial Eagle
- Tawny Eagle
- Greater Kestrel
- Steppe Buzzard
- Egyptian Goose
- Barn Owl

The impact is assessed to be Low before mitigation, and Very Low after mitigation. With regards to the infrastructure within the substation yard or inverter station, the hardware is too complex to warrant any mitigation for electrocution at this stage. It is rather recommended that if any impacts are recorded once operational, site specific mitigation be applied reactively

10.6 Displacement due to disturbance associated with the decommissioning of the solar PV plant and associated infrastructure

The activities associated with the decommissioning of the solar PV plant and associated infrastructure will impact on birds through disturbance; this could lead to breeding failure if the disturbance happens during a critical part of the breeding cycle. Activities in close proximity to breeding locations could be a source of disturbance and could lead to temporary displacement. All priority species could be temporarily displaced. **The impact is assessed to be Moderate before mitigation, and Low after mitigation.** Suggested mitigation measures are (a) activity should as far as possible be restricted to the footprint of the infrastructure, (b) measures to control noise and dust should be applied according to current best practice in the industry (c) maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical (d) access to the rest of the property must be restricted (e) the recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the activity footprint is concerned.

10.5 Cumulative impacts

In the case of solar energy projects, the potentially most significant impact from an avifaunal perspective is the transformation of the natural habitat. The total footprint taken up by existing and proposed solar energy projects is approximately 12 600ha. This project comprises 260 hectares of this footprint. The total area of the 30km radius around the proposed projects equates to about 285 000ha of very similar habitat. The total combined size of the footprint taken up by solar energy projects equates to 4.4% of the available habitat in the 30km radius. The cumulative impact of the habitat transformation which will come about as a result of the proposed PV project, should therefore be **low**.

Table 5 below provides a summary of the respective significance ratings, and an average overall rating before and after mitigation.

Table 5: Overall impact significance rating

Impact	Rating pre-mitigation	Rating post-mitigation
Displacement due to disturbance associated with the construction of the solar PV plant and associated infrastructure.	Moderate (3)	Low (4)
Displacement due to habitat transformation associated with the construction of the solar PV plant and associated infrastructure[10]	High (2)	Moderate (3)
Collisions with the solar panels	Very Low (5)	Very Low (5)
Entrapment in perimeter fences	Low (4)	Very Low (5)
Electrocutions in the onsite substation yard or inverter station	Low (4)	Very low (5)
Displacement due to disturbance associated with the decommissioning of the solar PV plant and associated infrastructure	Moderate (3)	Low (4)
Cumulative impacts	Low (4)	Very Low (5)
Average:	**Moderate (3.5)**	**Low – Very Low (4.4)**

11. Final Specialist Statement and Authorisation Recommendation

In terms of an average, the pre-mitigation significance of all potential impacts identified in this specialist study is assessed as halfway between **Low** and **Moderate**, and the post-mitigation significance is assessed as Low to Very Low, leaning more towards **Very Low** (i.e. average of 4.4, as shown in Table 5 above). It is therefore recommended that the activity is authorised, on condition that the proposed mitigation measures as detailed in the EMPr (Appendix 4) are strictly implemented.

11.1. EA Condition Recommendations

The proposed mitigation measures are detailed in the EMPr (Appendix 4)

12. References

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[10] Due to the nature of the habitat, displacement due to habitat destruction associated with the proposed grid connection is likely to be negligible, therefore this is not listed as an impact.

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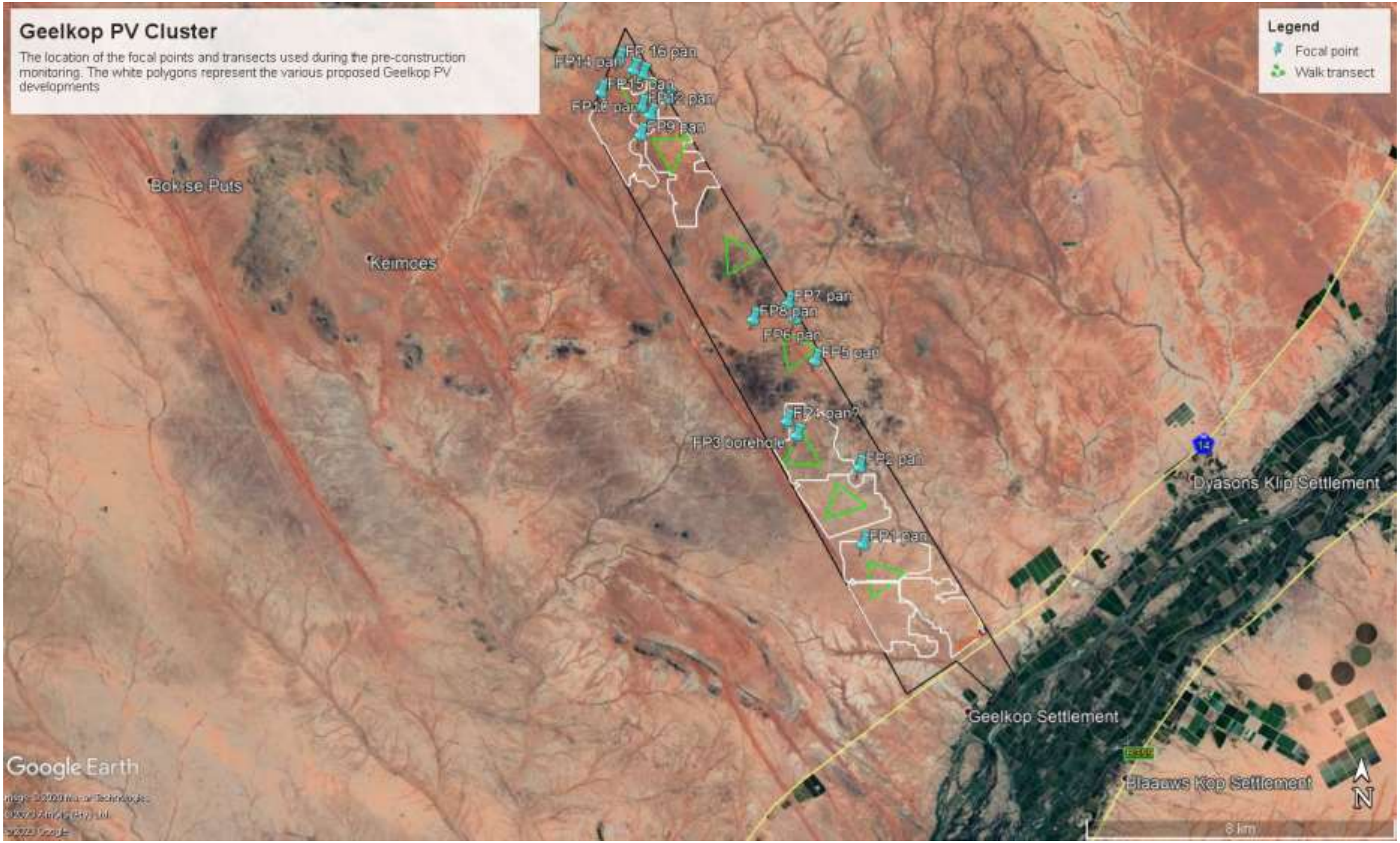
APPENDIX 1: PRE-CONSTRUCTION MONITORING



APPENDIX 2: SPECIES OCCURING IN THE BROADER AREA

Family	Species	Taxonomic name	SABAP2 full protocol reporting rate	Recorded during surveys
Barbet	Acacia Pied Barbet	*Tricholaema leucomelas*	59.66	x
Barbet	Black-collared Barbet	*Lybius torquatus*	1.14	
Barbet	Crested Barbet	*Trachyphonus vaillantii*	48.86	
Batis	Pririt Batis	*Batis pririt*	35.80	x
Bee-eater	European Bee-eater	*Merops apiaster*	21.02	x
Bee-eater	Swallow-tailed Bee-eater	*Merops hirundineus*	30.68	
Bee-eater	White-fronted Bee-eater	*Merops bullockoides*	22.16	
Bishop	Southern Red Bishop	*Euplectes orix*	64.20	x
Bittern	Little Bittern	*Ixobrychus minutus*	13.64	
Bokmakierie	Bokmakierie Bokmakierie	*Telophorus zeylonus*	50.00	x
Brubru	Brubru Brubru	*Nilaus afer*	25.00	
Bulbul	African Red-eyed Bulbul	*Pycnonotus nigricans*	73.86	
Bunting	Cinnamon-breasted Bunting	*Emberiza tahapisi*	1.14	
Bunting	Lark-like Bunting	*Emberiza impetuani*	41.48	x
Bustard	Kori Bustard	*Ardeotis kori*	5.11	x
Bustard	Ludwig's Bustard	*Neotis ludwigii*	3.41	x
Buzzard	Jackal Buzzard	*Buteo rufofuscus*	0.57	
Buzzard	Steppe Buzzard	*Buteo vulpinus*	2.27	
Canary	Black-throated Canary	*Crithagra atrogularis*	39.77	
Canary	White-throated Canary	*Crithagra albogularis*	3.98	
Canary	Yellow Canary	*Crithagra flaviventris*	43.18	x
Chat	Anteating Chat	*Myrmecocichla formicivora*	21.59	x
Chat	Familiar Chat	*Cercomela familiaris*	28.41	
Chat	Karoo Chat	*Cercomela schlegelii*	0.57	x
Chat	Tractrac Chat	*Cercomela tractrac*	1.14	
Cisticola	Desert Cisticola	*Cisticola aridulus*	13.64	x
Cisticola	Grey-backed Cisticola	*Cisticola subruficapilla*	3.41	
Cisticola	Levaillant's Cisticola	*Cisticola tinniens*	40.34	
Cisticola	Zitting Cisticola	*Cisticola juncidis*	38.07	
Cliff-swallow	South African Cliff-swallow	*Hirundo spilodera*	13.64	
Coot	Red-knobbed Coot	*Fulica cristata*	3.98	
Cormorant	Reed Cormorant	*Phalacrocorax africanus*	41.48	
Cormorant	White-breasted Cormorant	*Phalacrocorax carbo*	39.77	
Coucal	Burchell's Coucal	*Centropus burchellii*	33.52	
Courser	Double-banded Courser	*Rhinoptilus africanus*	3.98	
Crake	Black Crake	*Amaurornis flavirostris*	11.36	
Crombec	Long-billed Crombec	*Sylvietta rufescens*	14.20	
Crow	Pied Crow	*Corvus albus*	33.52	x
Cuckoo	Diderick Cuckoo	*Chrysococcyx caprius*	24.43	
Cuckoo	Jacobin Cuckoo	*Clamator jacobinus*	1.70	
Darter	African Darter	*Anhinga rufa*	45.45	
Dove	Laughing Dove	*Streptopelia senegalensis*	75.57	
Dove	Namaqua Dove	*Oena capensis*	47.73	x
Dove	Red-eyed Dove	*Streptopelia semitorquata*	62.50	
Dove	Rock Dove	*Columba livia*	3.41	
Duck	African Black Duck	*Anas sparsa*	14.20	
Duck	Maccoa Duck	*Oxyura maccoa*	0.57	
Duck	White-faced Duck	*Dendrocygna viduata*	13.64	
Duck	Yellow-billed Duck	*Anas undulata*	9.66	

Common_group	Species	Taxonomic name	SABAP2 full protocol reporting rate	Recorded during surveys
Eagle	Booted Eagle	*Aquila pennatus*	6.25	
Eagle	Martial Eagle	*Polemaetus bellicosus*	2.27	
Eagle	Tawny Eagle	*Aquila rapax*	0.00	x
Eagle-owl	Spotted Eagle-owl	*Bubo africanus*	2.27	
Egret	Cattle Egret	*Bubulcus ibis*	61.36	
Egret	Little Egret	*Egretta garzetta*	14.20	
Eremomela	Yellow-bellied Eremomela	*Eremomela icteropygialis*	14.77	
Falcon	Lanner Falcon	*Falco biarmicus*	10.80	
Falcon	Peregrine Falcon	*Falco peregrinus*	1.70	
Falcon	Pygmy Falcon	*Polihierax semitorquatus*	7.39	
Finch	Red-headed Finch	*Amadina erythrocephala*	4.55	
Finch	Scaly-feathered Finch	*Sporopipes squamifrons*	26.70	x
Firefinch	Red-billed Firefinch	*Lagonosticta senegala*	17.61	
Fiscal	Common (Southern) Fiscal	*Lanius collaris*	77.27	
Fish-eagle	African Fish-eagle	*Haliaeetus vocifer*	32.39	
Flamingo	Greater Flamingo	*Phoenicopterus ruber*	0.57	
Flycatcher	Chat Flycatcher	*Bradornis infuscatus*	20.45	x
Flycatcher	Fairy Flycatcher	*Stenostira scita*	1.14	
Flycatcher	Fiscal Flycatcher	*Sigelus silens*	15.34	
Flycatcher	Spotted Flycatcher	*Muscicapa striata*	2.27	
Goose	Egyptian Goose	*Alopochen aegyptiacus*	59.66	x
Goose	Spur-winged Goose	*Plectropterus gambensis*	18.18	
Goshawk	Southern Pale Chanting Goshawk	*Melierax canorus*	15.34	x
Grebe	Little Grebe	*Tachybaptus ruficollis*	15.34	
Greenshank	Common Greenshank	*Tringa nebularia*	3.98	
Guineafowl	Helmeted Guineafowl	*Numida meleagris*	46.59	
Hamerkop	Hamerkop Hamerkop	*Scopus umbretta*	31.25	
Harrier	Montagu's Harrier	*Circus pygargus*	1.70	
Harrier	Pallid Harrier	*Circus macrourus*	0.57	
Harrier-Hawk	African Harrier-Hawk	*Polyboroides typus*	0.00	
Heron	Black Heron	*Egretta ardesiaca*	0.57	
Heron	Black-headed Heron	*Ardea melanocephala*	29.55	
Heron	Goliath Heron	*Ardea goliath*	19.32	
Heron	Green-backed Heron	*Butorides striata*	1.70	
Heron	Grey Heron	*Ardea cinerea*	39.77	
Heron	Purple Heron	*Ardea purpurea*	7.95	
Heron	Squacco Heron	*Ardeola ralloides*	5.68	
Honeyguide	Lesser Honeyguide	*Indicator minor*	13.64	
Hoopoe	African Hoopoe	*Upupa africana*	43.18	
Hornbill	African Grey Hornbill	*Tockus nasutus*	0.57	
Ibis	African Sacred Ibis	*Threskiornis aethiopicus*	51.14	
Ibis	Glossy Ibis	*Plegadis falcinellus*	1.14	
Ibis	Hadeda Ibis	*Bostrychia hagedash*	73.30	
Jacana	African Jacana	*Actophilornis africanus*	0.57	
Kestrel	Greater Kestrel	*Falco rupicoloides*	3.98	
Kestrel	Lesser Kestrel	*Falco naumanni*	0.57	
Kestrel	Rock Kestrel	*Falco rupicolus*	6.82	
Kingfisher	Brown-hooded Kingfisher	*Halcyon albiventris*	4.55	
Kingfisher	Giant Kingfisher	*Megaceryle maximus*	33.52	
Kingfisher	Malachite Kingfisher	*Alcedo cristata*	13.07	
Kingfisher	Pied Kingfisher	*Ceryle rudis*	27.84	

Common_group	Species	Taxonomic name	SABAP2 full protocol reporting rate	Recorded during surveys
Kingfisher	Striped Kingfisher	*Halcyon chelicuti*	0.57	
Kite	Black-shouldered Kite	*Elanus caeruleus*	28.41	
Korhaan	Karoo Korhaan	*Eupodotis vigorsii*	35.23	x
Korhaan	Northern Black Korhaan	*Afrotis afraoides*	34.09	x
Korhaan	Red-crested Korhaan	*Lophotis ruficrista*	0.57	
Lapwing	Blacksmith Lapwing	*Vanellus armatus*	55.68	
Lapwing	Crowned Lapwing	*Vanellus coronatus*	21.59	x
Lark	Eastern Clapper Lark	*Mirafra fasciolata*	19.32	x
Lark	Fawn-coloured Lark	*Calendulauda africanoides*	38.07	x
Lark	Karoo Long-billed Lark	*Certhilauda subcoronata*	6.25	
Lark	Pink-billed Lark	*Spizocorys conirostris*	2.84	
Lark	Red-capped Lark	*Calandrella cinerea*	0.57	
Lark	Sabota Lark	*Calendulauda sabota*	36.36	x
Lark	Spike-heeled Lark	*Chersomanes albofasciata*	29.55	x
Lark	Stark's Lark	*Spizocorys starki*	9.09	x
Lovebird	Rosy-faced Lovebird	*Agapornis roseicollis*	0.57	
Martin	Brown-throated Martin	*Riparia paludicola*	50.57	
Martin	Rock Martin	*Hirundo fuligula*	34.66	
Masked-weaver	Southern Masked-weaver	*Ploceus velatus*	75.00	x
Moorhen	Common Moorhen	*Gallinula chloropus*	11.93	
Mousebird	Red-faced Mousebird	*Urocolius indicus*	50.00	
Mousebird	White-backed Mousebird	*Colius colius*	69.32	x
Night-Heron	Black-crowned Night-Heron	*Nycticorax nycticorax*	5.11	
Nightjar	Rufous-cheeked Nightjar	*Caprimulgus rufigena*	7.95	
Ostrich	Common Ostrich	*Struthio camelus*	1.70	
Owl	Barn Owl	*Tyto alba*	19.89	
Owlet	Pearl-spotted Owlet	*Glaucidium perlatum*	2.27	
Palm-swift	African Palm-swift	*Cypsiurus parvus*	52.27	
Penduline-tit	Cape Penduline-tit	*Anthoscopus minutus*	1.70	
Pigeon	Speckled Pigeon	*Columba guinea*	59.09	
Pipit	African Pipit	*Anthus cinnamomeus*	28.98	x
Plover	Kittlitz's Plover	*Charadrius pecuarius*	0.57	
Plover	Three-banded Plover	*Charadrius tricollaris*	38.07	
Prinia	Black-chested Prinia	*Prinia flavicans*	84.66	x
Pytilia	Green-winged Pytilia	*Pytilia melba*	0.57	
Quail	Common Quail	*Coturnix coturnix*	1.14	x
Quelea	Red-billed Quelea	*Quelea quelea*	52.84	
Reed-warbler	African Reed-warbler	*Acrocephalus baeticatus*	26.14	
Reed-warbler	Great Reed-warbler	*Acrocephalus arundinaceus*	0.57	
Robin-chat	Cape Robin-chat	*Cossypha caffra*	55.11	
Rock-thrush	Short-toed Rock-thrush	*Monticola brevipes*	0.57	
Ruff	Ruff Ruff	*Philomachus pugnax*	1.70	
Sandgrouse	Burchell's Sandgrouse	*Pterocles burchelli*	0.57	
Sandgrouse	Namaqua Sandgrouse	*Pterocles namaqua*	47.16	x
Sandpiper	Common Sandpiper	*Actitis hypoleucos*	2.27	
Sandpiper	Wood Sandpiper	*Tringa glareola*	7.95	
Scimitarbill	Common Scimitarbill	*Rhinopomastus cyanomelas*	7.95	
Scrub-robin	Kalahari Scrub-robin	*Cercotrichas paena*	10.23	x
Scrub-robin	Karoo Scrub-robin	*Cercotrichas coryphoeus*	41.48	
Secretarybird	Secretarybird Secretarybird	*Sagittarius serpentarius*	1.14	
Shelduck	South African Shelduck	*Tadorna cana*	22.73	

Common_group	Species	Taxonomic name	SABAP2 full protocol reporting rate	Recorded during surveys
Shoveler	Cape Shoveler	*Anas smithii*	1.70	
Shrike	Lesser Grey Shrike	*Lanius minor*	2.27	
Shrike	Red-backed Shrike	*Lanius collurio*	0.57	
Sparrow	Cape Sparrow	*Passer melanurus*	77.27	x
Sparrow	House Sparrow	*Passer domesticus*	59.66	
Sparrow	Southern Grey-headed Sparrow	*Passer diffusus*	18.75	
Sparrowlark	Black-eared Sparrowlark	*Eremopterix australis*	5.68	x
Sparrowlark	Grey-backed Sparrowlark	*Eremopterix verticalis*	19.32	x
Sparrow-weaver	White-browed Sparrow-weaver	*Plocepasser mahali*	34.09	
Spoonbill	African Spoonbill	*Platalea alba*	0.57	
Spurfowl	Cape Spurfowl	*Pternistis capensis*	1.14	
Starling	Cape Glossy Starling	*Lamprotornis nitens*	53.98	
Starling	Pale-winged Starling	*Onychognathus nabouroup*	2.27	
Starling	Wattled Starling	*Creatophora cinerea*	26.14	x
Stilt	Black-winged Stilt	*Himantopus himantopus*	18.18	
Stork	Abdim's Stork	*Ciconia abdimii*	9.66	
Stork	White Stork	*Ciconia ciconia*	0.57	
Stork	Yellow-billed Stork	*Mycteria ibis*	2.27	
Sunbird	Dusky Sunbird	*Cinnyris fuscus*	58.52	x
Sunbird	Marico Sunbird	*Cinnyris mariquensis*	3.41	
Swallow	Barn Swallow	*Hirundo rustica*	35.23	x
Swallow	Greater Striped Swallow	*Hirundo cucullata*	42.05	
Swallow	White-throated Swallow	*Hirundo albigularis*	44.89	
Swamp-warbler	Lesser Swamp-warbler	*Acrocephalus gracilirostris*	42.61	
Swift	Alpine Swift	*Tachymarptis melba*	1.70	
Swift	Common Swift	*Apus apus*	10.80	x
Swift	Little Swift	*Apus affinis*	64.20	x
Swift	White-rumped Swift	*Apus caffer*	26.70	
Teal	Cape Teal	*Anas capensis*	5.68	
Teal	Red-billed Teal	*Anas erythrorhyncha*	18.75	
Thick-knee	Spotted Thick-knee	*Burhinus capensis*	21.59	
Thrush	Karoo Thrush	*Turdus smithi*	52.27	
Tit	Ashy Tit	*Parus cinerascens*	9.09	
Tit-babbler	Chestnut-vented Tit-babbler	*Parisoma subcaeruleum*	28.41	
Tit-babbler	Layard's Tit-babbler	*Parisoma layardi*	1.14	
Turtle-dove	Cape Turtle-dove	*Streptopelia capicola*	66.48	
Wagtail	African Pied Wagtail	*Motacilla aguimp*	22.16	
Wagtail	Cape Wagtail	*Motacilla capensis*	64.77	
Warbler	Icterine Warbler	*Hippolais icterina*	1.14	
Warbler	Namaqua Warbler	*Phragmacia substriata*	35.80	
Warbler	Rufous-eared Warbler	*Malcorus pectoralis*	39.77	x
Warbler	Willow Warbler	*Phylloscopus trochilus*	2.27	
Waxbill	Black-faced Waxbill	*Estrilda erythronotos*	1.70	
Waxbill	Common Waxbill	*Estrilda astrild*	27.27	
Weaver	Sociable Weaver	*Philetairus socius*	43.18	x
Wheatear	Capped Wheatear	*Oenanthe pileata*	15.34	x
Wheatear	Mountain Wheatear	*Oenanthe monticola*	1.14	x
White-eye	Orange River White-eye	*Zosterops pallidus*	61.36	
Whydah	Pin-tailed Whydah	*Vidua macroura*	17.05	
Wood-hoopoe	Green Wood-hoopoe	*Phoeniculus purpureus*	0.57	
Woodpecker	Cardinal Woodpecker	*Dendropicos fuscescens*	11.93	
Woodpecker	Golden-tailed Woodpecker	*Campethera abingoni*	23.30	

APPENDIX 3: RENEWABLE ENERGY PROJECTS WITHIN A 30KM RADIUS AROUND THE STUDY AREA

PROJECT TITLE	FOOTPRINT	TECHNOLOGY	MW	EA STATUS
Bloemsmond 1	280	PV	75	Authorised
Bloemsmond 2	275	PV	75	Authorised
Bloemsmond 3	310	PV	100	Authorised
Bloemsmond 4	360	PV	100	Authorised
Bloemsmond 5	390	PV	100	Authorised
Dyasonsklip 1 Solar	209	PV	86	Constructed
Dyasonsklip 2 Solar	210	PV	75	Constructed
RE Capital 3 C Solar	166	PV	75	Authorised
Dyasonsklip 5	280	PV	100	In process
Sirius Solar 1	244	PV	75	Constructed
Sirius Solar 2	254	PV	75	Authorised
Sirius Solar 3	280	PV	100	In process
Sirius Solar 4	280	PV	100	In process
Khi Solar 1 CSP	600	CSP	110	Constructed
McTaggarts Camp PV 1	190	PV	75	Authorised
McTaggarts Camp PV 2	173	PV	75	Authorised
McTaggarts Camp PV 3	210	PV	75	Authorised
Klip Punt PV 1	200	PV	75	Authorised
Bushmanland PV	260	PV	100	In process
Duneveld PV	240	PV	100	In process
Gordonia Solar PV	250	PV	100	In process
Hari PV	240	PV	100	In process
Karroid PV	240	PV	100	In process
Shrubland PV	245	PV	100	In process
GK Solar PV	260	PV	100	In process
Ofir-Zx Photovoltaic	400	PV	200	Authorised
Eenduin PV	210	PV	75	In process
Upington Solar Park	5 000	CSP/PV	1000	In process
Solis 1 CSP	400	CSP	125	Authorised

APPENDIX 4: ENVIRONMENTAL MANAGEMENT PROGRAMME

Management Plan for the Planning and Design Phase

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	***Frequency***	***Responsibility***
Avifauna: Entrapment					
Entrapment of medium and large terrestrial birds between the perimeter fences, leading to mortality.	Prevent mortality of avifauna	1. A single perimeter fence should be used[11].	Design the facility with a single perimeter fence.	Once-off during the planning phase.	Project Developer

[11] In this instance, according to the design specifications, a fence will be used consisting of an outer diamond mesh fence and inner electric fence with a separation distance of approximately 100mm. This should not pose any risk of entrapment for large terrestrial species and can be considered a single fence.

Management Plan for the Construction Phase (Including pre- and post-construction activities)

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	*Frequency*	*Responsibility*
Avifauna: Disturbance					
The noise and movement associated with the construction activities at the development footprint will be a source of disturbance which would lead to the displacement of avifauna from the area	Prevent unnecessary displacement of avifauna by ensuring that contractors are aware of the requirements of the Construction Environmental Management Programme (CEMPr.)	A site-specific CEMPr must be implemented, which gives appropriate and detailed description of how construction activities must be conducted. All contractors are to adhere to the CEMPr and should apply good environmental practice during construction. The CEMPr must specifically include the following: 1. No off-road driving; 2. Maximum use of existing roads; 3. Measures to control noise and dust according to latest best practice; 4. Restricted access to the rest of the property; 5. Strict application of all recommendations in the botanical specialist report pertaining to the limitation of the footprint.	1. Implementation of the CEMPr. Oversee activities to ensure that the CEMPr is implemented and enforced via site audits and inspections. Report and record any non-compliance. 2. Ensure that construction personnel are made aware of the impacts relating to off-road driving. 3. Construction access roads must be demarcated clearly. Undertake site inspections to verify. 4. Monitor the implementation of noise control mechanisms via site inspections and record and report non-compliance. 5. Ensure that the construction area	1. On a daily basis 2. Weekly 3. Weekly 4. Weekly 5. Weekly	1. Contractor and ECO 2. Contractor and ECO 3. Contractor and ECO 4. Contractor and ECO 5. Contractor and ECO

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	***Frequency***	***Responsibility***
			is demarcated clearly and that construction personnel are made aware of these demarcations. Monitor via site inspections and report non-compliance.		

Management Plan for the Operational Phase

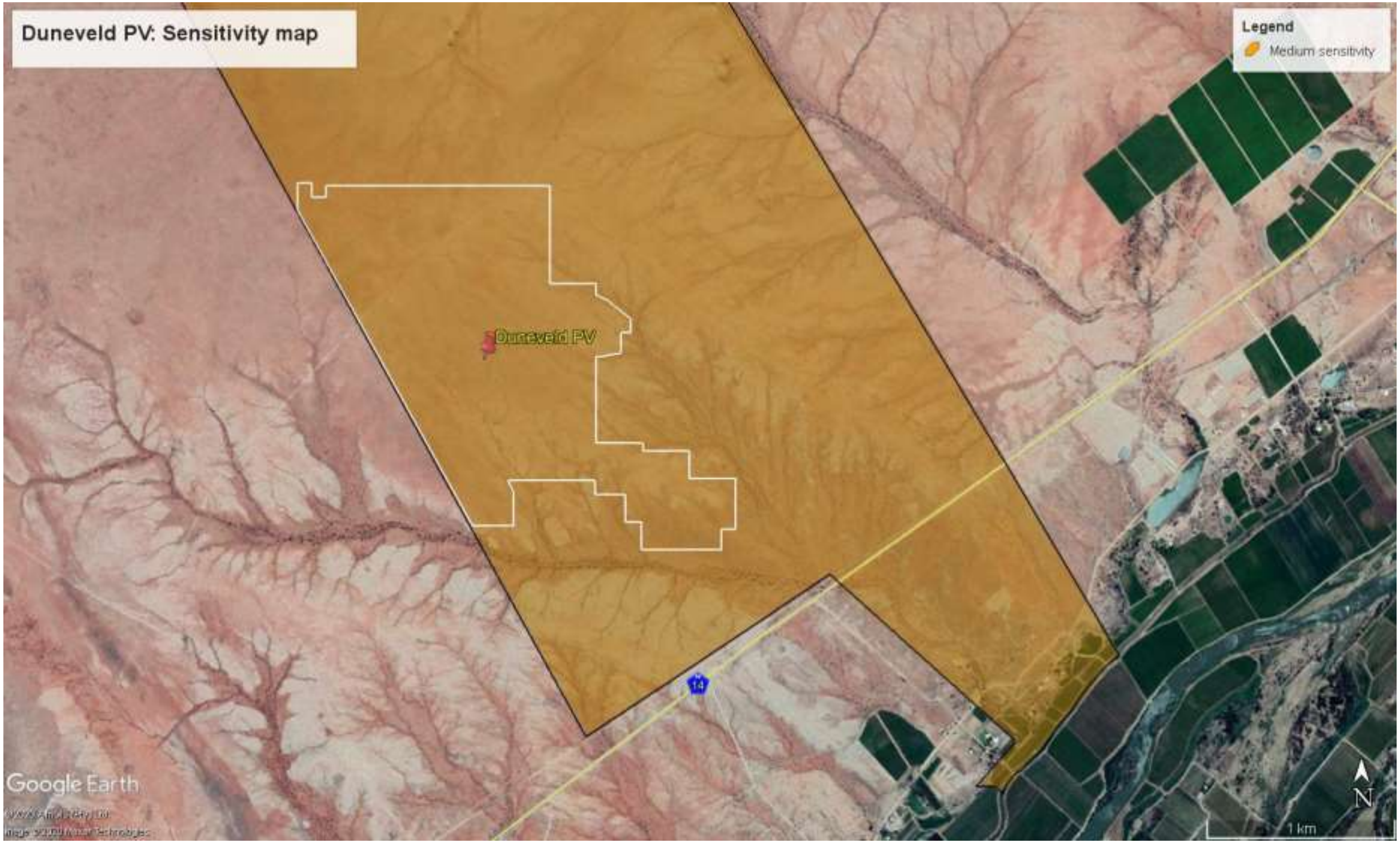
Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	***Frequency***	***Responsibility***
Avifauna: Displacement due to habitat transformation					
Total or partial displacement of avifauna due to habitat transformation associated with the vegetation clearance and the presence of the solar PV plant and associated infrastructure.	Prevent unnecessary displacement of avifauna by ensuring that the rehabilitation of transformed areas is implemented by an appropriately qualified rehabilitation specialist, according to the recommendations of the botanical specialist study.	1. Develop a Habitat Restoration Plan (HRP) and ensure that it is approved. 2. Monitor rehabilitation via site audits and site inspections to ensure compliance. Record and report any non-compliance.	1. Appointment of rehabilitation specialist to develop Habitat Restoration Plan (HRP). 2. Site inspections to monitor progress of HRP. 3. Adaptive management to ensure HRP goals are met.	1. Once-off 2. Once a year 3. As and when required	1. Project developer 2. Facility Environmental Manager 3. Project developer and facility operational manager
Avifauna: Mortality due to electrocution					
Electrocution of priority avifauna in the onsite substation or inverter station.	Prevention of ongoing electrocution of avifauna through reactive mitigation if necessary, depending on the gravity of the problem.	Implementation of mitigation measures such as insulation of live parts to prevent further electrocutions.	1. Site investigation to determine causes of the mortality. 2. Implementation of appropriate measures e.g. insulation of live parts with appropriate products.	As and when required	1. Facility Environmental Manager 2. Facility operational manager

Management Plan for the Decommissioning Phase

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	***Frequency***	***Responsibility***
Avifauna: Displacement due to disturbance					
The noise and movement associated with the construction activities at the PV footprint will be a source of disturbance which would lead to the displacement of avifauna from the area	Prevent unnecessary displacement of avifauna by ensuring that contractors are aware of the requirements of the CEMPr.	A site-specific CEMPr must be implemented, which gives appropriate and detailed description of how construction activities must be conducted. All contractors are to adhere to the CEMPr and should apply good environmental practice during construction. The CEMPr must specifically include the following: 1. No off-road driving; 2. Maximum use of existing roads; 3. Measures to control noise and dust according to latest best practice; 4. Restricted access to the rest of the property; 5. Strict application of all recommendations in the botanical specialist report pertaining to the limitation of the footprint.	1. Implementation of the CEMPr. Oversee activities to ensure that the CEMPr is implemented and enforced via site audits and inspections. Report and record any non-compliance. 2. Ensure that construction personnel are made aware of the impacts relating to off-road driving. 3. Construction access roads must be demarcated clearly. Undertake site inspections to verify. 4. Monitor the implementation of noise control mechanisms via site inspections and record and report non-compliance. 5. Ensure that the construction area	1. On a daily basis 2. Weekly 3. Weekly 4. Weekly 5. Weekly	1. Contractor and ECO 2. Contractor and ECO 3. Contractor and ECO 4. Contractor and ECO 5. Contractor and ECO

Impact	Mitigation/Management Objectives and Outcomes	Mitigation/Management Actions	Monitoring		
			Methodology	***Frequency***	***Responsibility***
			is demarcated clearly and that construction personnel are made aware of these demarcations. Monitor via site inspections and report non-compliance.		

APPENDIX 5: SENSITIVITY MAP



APPENDIX 6: ASSESSMENT CRITERIA

The identification of potential impacts includes impacts that may occur during the construction, operational and decommissioning phases of the proposed development. The assessment of impacts includes direct, indirect as well as cumulative impacts.

In order to identify potential impacts (both positive and negative) it is important that the nature of the proposed activity is well understood so that the impacts associated with the activity can be understood. The process of identification and assessment of impacts will include:

- Determine the current environmental conditions in sufficient detail so that there is a baseline against which impacts can be identified and measured;
- Determine future changes to the environment that will occur if the activity does not proceed;
- An understanding of the activity in sufficient detail to understand its consequences; and
- The identification of significant impacts which are likely to occur if the activity is undertaken.

The impact assessment methodology has been aligned with the requirements for BA Reports as stipulated in Appendix 1 (3) (j) of the 2014 EIA Regulations (as amended), which states the following:

"A BA Report must contain the information that is necessary for the Competent Authority to consider and come to a decision on the application, and must include an assessment of each identified potentially significant impact and risk, including –

- (i) cumulative impacts;
- (ii) the nature, significance and consequences of the impact and risk;
- (iii) the extent and duration of the impact and risk;
- (iv) the probability of the impact and risk occurring;
- (v) the degree to which the impact and risk can be reversed;
- (vi) the degree to which the impact and risk may cause irreplaceable loss of resources; and
- (vii) the degree to which the impact and risk can be mitigated".

As per DEA *Guideline 5: Assessment of Alternatives and Impacts* the following methodology is to be applied to the prediction and assessment of impacts. Potential impacts should be rated in terms of the direct, indirect and cumulative:

- **Direct impacts** are impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity. These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable.

- **Indirect impacts** of an activity are indirect or induced changes that may occur as a result of the activity. These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken or which occur at a different place as a result of the activity.

- **Cumulative impacts** are impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities. Cumulative impacts can occur from the collective impacts of individual minor actions over a period of time and can include both direct and indirect impacts.

- **Nature of impact** - this reviews the type of effect that a proposed activity will have on the environment and should include "what will be affected and how?"

- **Spatial extent** – The size of the area that will be affected by the risk/impact:
    - Site specific;

- Local (<10 km from site);
- Regional (<100 km of site);
- National; or
- International (e.g. Greenhouse Gas emissions or migrant birds).

- **Duration** – The timeframe during which the risk/impact will be experienced:
  - Very short term (instantaneous);
  - Short term (less than 1 year);
  - Medium term (1 to 10 years);
  - Long term (the impact will cease after the operational life of the activity (i.e. the impact or risk will occur for the project duration)); or
  - Permanent (mitigation will not occur in such a way or in such a time span that the impact can be considered transient (i.e. the impact will occur beyond the project decommissioning)).

- **Reversibility of impacts** - the extent to which the impacts/risks are reversible assuming that the project has reached the end of its life cycle (decommissioning phase) will be:
  - High reversibility of impacts (impact is highly reversible at end of project life, i.e. this is the most favourable assessment for the environment. For example, the nuisance factor caused by noise impacts associated with the operational phase of an exporting terminal can be considered to be highly reversible at the end of the project life);
  - Moderate reversibility of impacts;
  - Low reversibility of impacts; or
  - Impacts are non-reversible (impact is permanent, i.e. this is the least favourable assessment for the environment. The impact is permanent. For example, the loss of a palaeontological resource on the site caused by building foundations could be non-reversible).

- **Irreplaceability of resource loss caused by impacts** – the degree to which the impact causes irreplaceable loss of resources assuming that the project has reached the end of its life cycle (decommissioning phase) will be:
  - High irreplaceability of resources (project will destroy unique resources that cannot be replaced, i.e. this is the least favourable assessment for the environment. For example, if the project will destroy unique wetland systems, these may be irreplaceable);
  - Moderate irreplaceability of resources;
  - Low irreplaceability of resources; or
  - Resources are replaceable (the affected resource is easy to replace/rehabilitate, i.e. this is the most favourable assessment for the environment).

Using the criteria above, the impacts will further be assessed in terms of the following:

- **Probability** – The probability of the impact occurring:
  - Extremely unlikely (little to no chance of occurring);
  - Very unlikely (<30% chance of occurring);
  - Unlikely (30-50% chance of occurring)
  - Likely (51 – 90% chance of occurring); or
  - Very Likely (>90% chance of occurring regardless of prevention measures).

- **Consequence** – The anticipated severity of the impact:
  - Extreme (extreme alteration of natural systems, patterns or processes, i.e. where environmental functions and processes are altered such that they permanently cease);
  - Severe (severe alteration of natural systems, patterns or processes, i.e. where environmental functions and processes are altered such that they temporarily or permanently cease);

- Substantial (substantial alteration of natural systems, patterns or processes, i.e. where environmental functions and processes are altered such that they temporarily or permanently cease);
- Moderate (notable alteration of natural systems, patterns or processes, i.e. where the environment continues to function but in a modified manner); or
- Slight (negligible alteration of natural systems, patterns or processes, i.e. where no natural systems/environmental functions, patterns, or processes are affected).

- **Significance** – To determine the significance of an identified impact/risk, the consequence is multiplied by probability (qualitatively as shown in Figure 6 below). The approach incorporates internationally recognised methods from the Intergovernmental Panel on Climate Change (IPCC) (2014) assessment of the effects of climate change and is based on an interpretation of existing information in relation to the proposed activity, to generate an integrated picture of the risks related to a specified activity in a given location, with and without mitigation. Risk is assessed for each significant stressor (e.g. physical disturbance), on each different type of receiving entity (e.g. the municipal capacity, a sensitive wetland), qualitatively (very low, low, moderate, high, very high) against a predefined set of criteria (as shown in Figure 1 below). The significance is rated qualitatively as follows against a predefined set of criteria (i.e. probability and consequence) as indicated in Figure 1:

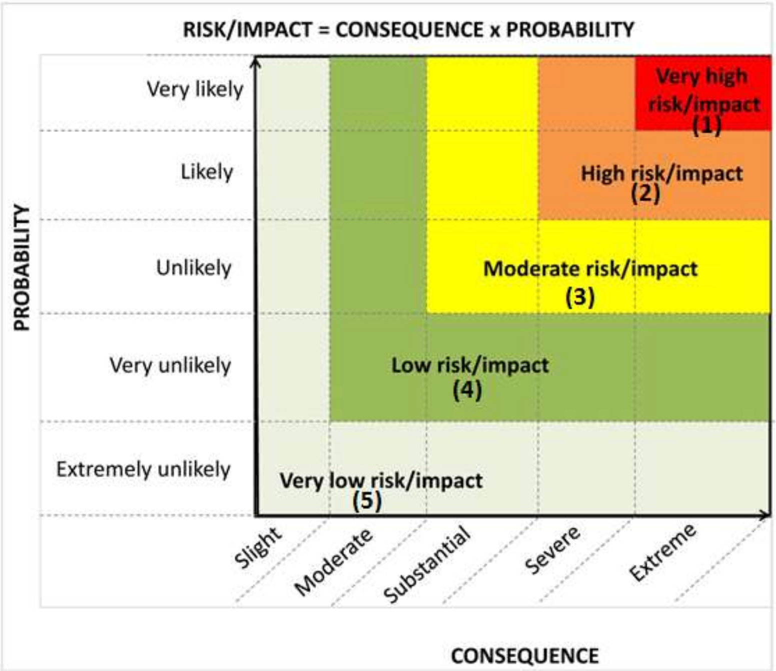


Figure 1: Guide to assessing risk/impact significance as a result of consequence and probability.

- **Significance** – Will the impact cause a notable alteration of the environment?
  - Very low (the risk/impact may result in very minor alterations of the environment and can be easily avoided by implementing appropriate mitigation measures, and will not have an influence on decision-making);
  - Low (the risk/impact may result in minor alterations of the environment and can be easily avoided by implementing appropriate mitigation measures, and will not have an influence on decision-making);
  - Moderate (the risk/impact will result in moderate alteration of the environment and can be reduced or avoided by implementing the appropriate mitigation measures, and will only have an influence on the decision-making if not mitigated);

- High (the risk/impacts will result in a major alteration to the environment even with the implementation on the appropriate mitigation measures and will have an influence on decision-making); or
- Very high (the risk/impacts will result in very major alteration to the environment even with the implementation on the appropriate mitigation measures and will have an influence on decision-making (i.e. the project cannot be authorised unless major changes to the engineering design are carried out to reduce the significance rating)).

The above assessment must be described in the text (with clear explanation provided on the rationale for the allocation of significance ratings) and summarised in an impact assessment Table in a similar manner as shown in the example below (Table 1).

With the implementation of mitigation measures, the residual impacts/risks must be ranked as follows in terms of significance:

- Very low = 5;
- Low = 4;
- Moderate = 3;
- High = 2; and
- Very high = 1.

- **Status** - Whether the impact on the overall environment (social, biophysical and economic) will be:
  - Positive - environment overall will benefit from the impact;
  - Negative - environment overall will be adversely affected by the impact; or
  - Neutral - environment overall will not be affected.

- **Confidence** – The degree of confidence in predictions based on available information and specialist knowledge:
  - Low;
  - Medium; or
  - High.

Impacts will then be collated into an EMPr and these will include the following:

- Management actions and monitoring of the impacts;
- Identifying negative impacts and prescribing mitigation measures to avoid or reduce negative impacts; and
- Positive impacts will be identified and enhanced where possible.

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