DRAFT SCOPING REPORT

Draft Scoping Report for the proposed development of the Vhuvhili Solar Photovoltaic (PV) Facility near Secunda in the Mpumalanga Province.

APPENDIX G.4:

Avifauna Assessment

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AVIFAUNAL SPECIALIST SCOPING REPORT INPUTS:

Scoping and Environmental Impact Assessment (EIA) Processes for the Proposed Development of the 300MW Vhuvhili Solar Energy Facility and associated infrastructure, near Secunda, Mpumalanga Province

Report prepared for:	*Report prepared by:*
CSIR – Environmental Management Services	Chris van Rooyen Consulting
P O Box 320	P.O Box 2676, Fourways
Stellenbosch	2055
7599	South Africa
South Africa	

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Executive summary

The Project Applicant, Vhuvhili Solar RF (Pty) Ltd, is proposing to develop the Vhuvhili Solar Energy Facility (hereinafter referred to as Vhuvhili SEF), of 300 MW and associated electrical grid infrastructure (EGI) near Secunda in the Govan Mbeki Local Municipality of Mpumalanga. The proposed project will make use of solar Photovoltaic (PV) technology to generate electricity from energy derived from the sun. The solar PV facility will have a range of associated infrastructure, including, but not limited to, an on-site substation complex and a battery energy storage systems (BESS) and is proposed to connect to the step-down Substation at the Sasol facility via a dedicated 33/132 kV overhead power line.

The proposed PV facility will be constructed on the following farm portions:

- Farm Vlakspruit No. 292 (Portions 21 and 22)
- Farm Grootvlei No. 293 (Portions 18, 20, 21 and 23)
- RE Farm Grootvlei No.584
- RE Farm Poverty Acres No. 585
- RE Farm Fabriek No. 292

This report serves as the Avifaunal Specialist Scoping Report input that was prepared as part of the Scoping and Environmental Impact Assessment (S&EIA) for the proposed development. The associated 132 kV power line and Electrical Grid Infrastructure (EGI) components is subjected to a separate Environmental Assessment process.

Avifauna

A total of 186 species could potentially occur within the broader area where the project is located (see Appendix E). Of these, 92 are classified as priority species for solar developments. Of the 92 priority species, 47 have a medium to very high probability of occurring in the development site. Of the 47 priority species with a medium to high probability of occurrence, 34 were recorded during site surveys.

Eleven Red Data List species are associated with the broader area. Nine Red Data List species have a low probability of occurrence – African Marsh Harrier, Blue Crane, Caspian Tern, European Roller, Greater Painted Snipe, Lanner Falcon, Maccoa Duck, Pallid Harrier, and Red-footed Falcon – while two Red Data List Species have a medium to high probability of occurrence – Blue Korhaan, Greater Flamingo, and Secretarybird. Three Red Data species were recorded during the site surveys – Blue Korhaan, Greater Flamingo, and Lanner Falcon.

Identification of Potential Impacts/Risks

The potential impacts identified in the course of the study (i.e. for the Scoping Phase) are listed below.

<u>Construction phase</u>

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

Operation phase

- Displacement due to habitat transformation associated with the presence of the solar panels.
- Collisions with the solar panels.
- Entrapment in perimeter fences.
- Electrocutions in the onsite substation.

Decommissioning phase

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

Cumulative impacts

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

Sensitivities identified by the National Web-Based Environmental Screening Tool

Based on the Site Sensitivity Verification field survey conducted, habitat within the development area appears suitable for African Marsh Harrier, Secretarybird, and other Species of Conservation Concern (SCC). Therefore, the classification of **High** sensitivity for avifauna in the screening tool is therefore confirmed for the proposed developable areas.

Specialist Sensitivity Analysis and Verification

Very High sensitivity: No Go

All surface water (drainage lines, wetlands, dams, and pans) must be buffered by 200m to ensure unhindered access of priority species to the water. Surface water and wetland habitats are crucially important for priority avifauna and many non-priority species. No PV panels should be constructed in this zone.

High sensitivity zones

Areas of natural and natural rocky grassland should be demarcated as high sensitivity areas wherein development should be limited where feasible. These natural grassland tracts provide suitable foraging/nesting habitat for Secretarybird (Globally Endangered, Regionally Vulnerable) and Blue Korhaan (Globally Near Threatened, Regionally Least Concern) and other SCC within the development area. However, the aforementioned species do not require specific avoidance measures because there is adequate habitat available outside the development areas.

Impact assessment summary

The overall impact significance is provided in the table below, in terms of pre- and post-mitigation.

Executive summary table: overall Impact Significance (Pre- and Post-Mitigation)

Phase	**Overall Impact Significance (Pre-Mitigation)**	**Overall Impact Significance (Post Mitigation)**
Construction	Moderate (3)	Low (4)
Operational	Low (4) to Moderate (3)	Very Low (5) to Low (4)
Decommissioning	Moderate (3)	Low (4)
Nature of Impact	**Overall Impact Significance**	**Overall Impact Significance**
Cumulative - Construction	Moderate (3)	Low (4)
Cumulative - Operational	Moderate (3) to High (2)	Low (4) to Moderate (3)
Cumulative - Decommissioning	Moderate (3)	Low (4)

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List of abbreviations

ADU	Animal Demography Unit
BLSA	BirdLife South Africa
DFFE	Department of Forestry, Fisheries and Environment
EGI	Electrical Grid Infrastructure
IBAs	Important Bird Areas
IUCN	International Union for Conservation of Nature
NEMA	National Environmental Management Act 107 of 1998 (as amended)
PV	Photovoltaic
REDZ	Renewable Energy Development Zone
S&EIA	Scoping and Environmental Impact Assessment
SABAP	South African Bird Atlas Project
SACNASP	South African Council for Natural and Scientific Professions
SANBI	South African National Biodiversity Institute
SCC	Species of Conservation Concern
SEF	Solar Energy Facility

Table 0-1: Definitions of key terminology in this scoping report

Definitions	
Priority species	South African Red Data species, South African endemics and near-endemics, raptors and waterbirds.
Broader area	The area encompassed by the six pentads where the project is located.
Development area	The area covered by the land parcels where will be located, totalling approximately 3115 hectares. This is also referred to as Study Area for Vhuvhili Solar RF in the Scoping Report and other specialist studies.
PV Developable area	The area where the actual development will be located, i.e. the footprint containing the PV solar arrays and associated infrastructure, totalling approximately 652.5 hectares.
Pentad	A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km.

Avifaunal scoping report

Vhuvhili Solar RF (Pty) Ltd is proposing to develop the Vhuvhili Solar Energy Facility (SEF) with a maximum capacity of up to 300 MW, located in the Govan Mbeki Local Municipality in the Mpumalanga Province of South Africa. The proposed SEF and associated infrastructure are subject to a full Scoping and EIA (S&EIA) process in terms of the 2014 NEMA EIA Regulations, as amended.

The proposed Vhuvhili SEF and associated infrastructure include the following components:

- Solar PV panels on a 60° rotational tracker
- Solar PV panels and tracker height of up to 6 m
- The internal cabling between project components connected to a 22V/132 kV transformer
- A workshop area for maintenance
- A 33/132 kV on-site Substation to feed electricity generated by the proposed Vhuvhili SEF into the step-down Substation at the Sasol facility. The on-site SS will accommodate 1 x 132 kV incoming feeder bay, 1 x 132 kV outgoing feeder bay and a motorised isolator with protection and metering.

The proposed electrical grid infrastructure (EGI), including the 132 kV gridline and step-down Substation at Sasol facility at the Sasol facility will be assessed as part of a separate Basic Assessment (BA) process.

Component	**Description / Dimensions**
Site coordinates (centre point)	Lat 26°33'10.33"S; Long 29°15'38.46"E
Affected farm portion/s	Farm Vlakspruit No. 292 (Portions 21 and 22) Farm Grootvlei No. 293 (Portions 18, 20, 21 and 23) RE Farm Grootvlei No.584 RE Farm Poverty Acres No. 585 RE Farm Fabriek No. 292
Application site area	Approximately 3115 ha
Total Solar Energy Facility capacity	Up to 300 MW
Proposed technology	Solar PV panels and associated infrastructure
On-site Substation area	Approximately 10 ha
Construction laydown area	Approximately 4.5 ha
Permanent laydown area	To be determined based on the final layout
O&M building area	Part of the construction laydown area
Width of internal access roads	Up to 10 m, including turning circle/bypass areas of up to 20 m. The roads and cables will be positioned within a 20 m wide corridor.
Length of internal access roads	To be determined based on the final layout
Site access	R546
Type of fencing	Galvanized steel

This report serves as the Avifaunal Specialist Scoping Report input that was prepared as part of the S&EIA for the proposed development. The EGI components are subjected to a separate Environmental Assessment process.

1. Introduction

1.1. Scope, purpose and objectives of this specialist input to the scoping report

The purpose of the report is to determine the main issues and potential impacts of the proposed project on avifauna at a high (scoping) level, through a combination of desktop analysis and field work. The report was prepared to provide inputs to the Draft Scoping Report for the project as required by the EIA Regulations promulgated in terms of the National Environmental Management Act 107 of 1998, as amended, (NEMA).

1.2. Details of specialists

This specialist assessment has been undertaken by Jake Mulvaney, Chris van Rooyen and Albert Froneman of Chris van Rooyen Consulting. Jake Mulvaney and Chris van Rooyen work in association with, and under the supervision of, Albert Froneman, who is registered with the South African Council for Natural and Scientific Professions (SACNASP), with Registration Number 400177/09 in the field of Zoological Science.

A curriculum vitae of the team members are included in Appendix A of this specialist input report.

1.3. Terms of reference

The terms of reference for this scoping level report are as follows:

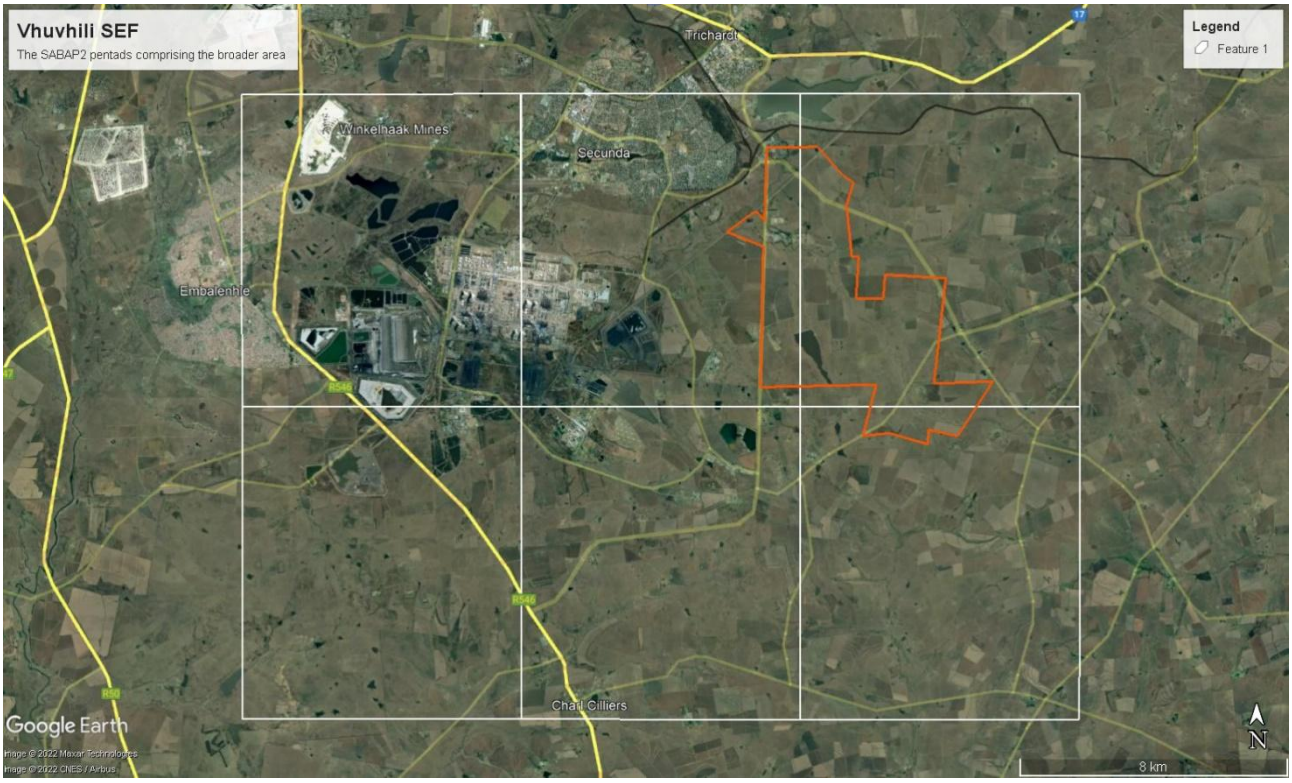
- Describe the affected environment from an avifaunal perspective;
- Discuss gaps in baseline data and other limitations and describe the expected impacts associated with the solar facilities and associated infrastructure;
- Identify potential sensitive environments and receptors that may be impacted on by the proposed facility;
- Determine the nature and extent of potential impacts;
- Identify 'No-Go' areas, where applicable;
- Summarise the potential impacts that will be considered further in the EIA Phase through specialist assessments; and
- Recommend mitigation measures to reduce the impact of the expected impacts.

2. Approach and methodology

The following methods were used to compile this report:

- Bird distribution data of the South African Bird Atlas 2 (SABAP 2) was obtained from the Animal Demography Unit (ADU) of the University of Cape Town (ADU 2020), as a means to ascertain which species occurs within the broader area i.e. within a block consisting of six pentad grid cells each within which the proposed projects are situated (see Figure 1). A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km. From 2011 to date, a total of 82 full protocol lists (i.e. surveys lasting a minimum of two hours each) have been completed for this area. In addition, 34 *ad hoc* protocol lists (i.e. surveys lasting less than two hours but still yielding valuable data) have been completed.

- 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 (Taylor et al., 2015), and the latest authoritative summary of southern African bird biology (Hockey et al., 2005).
- The global threatened status of all priority species was determined by consulting the (2021.2) International Union for Conservation of Nature (IUCN) Red List of Threatened Species (http://www.iucnredlist.org/).
- A classification of the habitat in the development area was obtained from the Atlas of Southern African Birds 1 (SABAP 1) (Harrison et al., 1997a, 1997b) and the National Vegetation Map (2012 beta2) from the South African National Biodiversity Institute (SANBI) website (Mucina & Rutherford, 2006; SANBI, 2018). Development area is the area covered by the land parcels where the PV facility will be located.
- The Important Bird Areas of Southern Africa (Marnewick et al., 2015) was consulted for information on potentially relevant Important Bird Areas (IBAs).
- Satellite imagery (Google Earth ©2021) was used in order to view the broader development area on a landscape level and to help identify sensitive bird habitat.
- Priority solar species were defined as follows: South African Red Data species, South African endemics and near-endemics, raptors and waterbirds.
- The SANBI BGIS map viewer (http://bgisviewer.sanbi.org) was used to determine the locality of the proposed site relative to National Protected Areas and National Protected Areas Expansion Strategy (NPAES) focus areas.
- The Department of Forestry, Fisheries and the Environment (DFFE) National Screening Tool was used to determine the assigned avian sensitivity of the proposed development areas.
- Data collected during previous site visits to the broader area was also considered as far as habitat classes and the occurrence of priority species are concerned.
- The following sources were used to determine the investigation protocol that is required for the site:
    - Procedures for the Assessment and Minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of NEMA when applying for Environmental Authorisation (Gazetted October 2020);
    - Guidelines for the Implementation of the Terrestrial Flora & Terrestrial Fauna Species Protocols for EIAs in South Africa produced by the SANBI on behalf of the Department of Environment, Forestry and Fisheries (2020); and
    - The BirdLife South Africa (BLSA) Guidelines for assessing and monitoring the impact of solar power generating facilities on birds in southern Africa. BirdLife South Africa by (Jenkins et al., 2017) – hereafter referred to as the 'Solar Guidelines' – were consulted to determine the level of survey effort that is required.
- The main source of information on the avifaunal diversity and abundance at the project site and development area is an integrated pre-construction monitoring programme which was implemented at the project site in 2021 - 2022.The pre-construction avifaunal monitoring programme is following an adapted Regime 2 protocol as defined in the Solar Guidelines which requires a minimum of two surveys over a six month period.



2.1. Information sources

The following data sources were used to compile this report:

Table 2-1: Data sources employed in the scoping report for the proposed Vhuvhili SEF

Data / Information	Source	Date	Type	Description
South African Protected Areas Database (SAPAD)	Department of Forestry, Fisheries and the Environment (DFFE)	2021, Q3	Spatial	Spatial delineation of protected areas in South Africa. Updated quarterly
Atlas of Southern African Birds 1 (SABAP1)	University of Cape Town	1987-1991	Spatial, reference	SABAP1, which took place from 1987-1991.
South African Bird Atlas Project 2 (SABAP2)	University of Cape Town	September 2021	Spatial, database	SABAP2 is the follow-up project to the SABAP1. The second bird atlas project started on 1 July 2007 and is still growing. The project aims to map the distribution and relative abundance of birds in southern Africa.
National Vegetation Map	South African National Biodiversity Institute (SANBI) (BGIS)	2018	Spatial	The National Vegetation Map Project (VEGMAP) is a large collaborative project established to classify, map and sample the vegetation of South Africa, Lesotho and Swaziland.

Data / Information	Source	Date	Type	Description
Red Data Book of Birds of South Africa, Lesotho and Swaziland	BirdLife South Africa	2015	Reference	The 2015 Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland is an updated and peer-reviewed conservation status assessment of the 854 bird species occurring in South Africa undertaken in collaboration between BirdLife South Africa, the Animal Demography Unit of the University of Cape Town, and the SANBI.
IUCN Red List of Threatened Species (2021.2)	IUCN	2021.3	Online reference source	Established in 1964, the International Union for Conservation of Nature's Red List of Threatened Species is the world's most comprehensive information source on the global extinction risk status of animal, fungus and plant species.
Important Bird and Biodiversity Areas of South Africa	BirdLife South Africa	2015	Reference work	Important Bird and Biodiversity Areas (IBAs), as defined by BirdLife International, constitute a global network of over 13 500 sites, of which 112 sites are found in South Africa. IBAs are sites of global significance for bird conservation, identified nationally through multi-stakeholder processes using globally standardised, quantitative and scientifically agreed criteria.
Strategic Environmental Assessment for wind and solar photovoltaic energy in South Africa	Department of Environmental Affairs, 2015. Strategic Environmental Assessment for wind and solar photovoltaic energy in South Africa. CSIR Report Number: CSIR/CAS/EMS/ER/2015/0001/B. Stellenbosch.	2015	SEA	The SEA identifies areas where large scale wind and solar PV energy facilities can be developed in terms of Strategic Infrastructure Project (SIP) and in a manner that limits significant negative impacts on the natural environment, while yielding the highest possible socio-economic benefits to the country. These areas are referred to as Renewable Energy Development Zones (REDZs).
The National Screening Tool	Department of Forestry, Fisheries and Environment	May 2021	Spatial	The National Web based Environmental Screening Tool is a geographically based web-enabled application which allows

Data / Information	Source	Date	Type	Description
				a proponent intending to submit an application for environmental authorisation in terms of the Environmental Impact Assessment (EIA) Regulations 2014, as amended to screen their proposed site for any environmental sensitivity.
National Protected Areas and National Protected Areas Expansion Strategy (NPAES)	DFFE	2016	Spatial	The goal of NPAES is to achieve cost effective protected area expansion for ecological sustainability and adaptation to climate change. The NPAES sets targets for protected area expansion, provides maps of the most important areas for protected area expansion, and makes recommendations on mechanisms for protected area expansion.
Procedures for the Assessment and Minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of NEMA when applying for Environmental Authorisation (Gazetted October 2020)	NEMA	2020	Regulations	Prescribe protocols in respect of specific environmental themes for the assessment of, as well as the minimum report content requirements on, the environmental impacts for activities requiring environmental authorisation.
Guidelines for the Implementation of the Terrestrial Flora & Terrestrial Fauna Species Protocols for EIAs in South Africa produced by the South African National Biodiversity Institute on behalf of the Department of Environment, Forestry and Fisheries (2020).	South African National Biodiversity Institute (SANBI) (BGIS)	2020	Guidelines	The purpose of the Species Environmental Assessment Guideline is to provide background and context to the assessment and minimum reporting criteria contained within the Terrestrial Animal and Plant Species Protocols; as well as to provide guidance on sampling and data collection methodologies for the different taxonomic groups that are represented in the respective protocols. This guideline is intended

Data / Information	Source	Date	Type	Description
				for specialist studies undertaken for activities that have triggered a listed and specified activity in terms of the National Environmental Management Act, 1998 (No. 107 of 1998) (NEMA), as identified by the EIA Regulations, 2014 (as amended) and Listing Notices 1-3.6
The BirdLife South Africa (BLSA) Guidelines for assessing and monitoring the impact of solar power generating facilities on birds in southern Africa. BirdLife South Africa by Jenkins, A.R., Ralston-Patton, Smit- Robinson, A.H. 2017	BirdLife South Africa	2017	Guidelines	These guidelines were developed to ensure that any negative impacts on threatened or potentially threatened bird species are identified and effectively mitigated using structured, methodical and scientific methods. The guidelines prescribe the best practice approach to gathering bird data at proposed utility-scale solar energy plants, primarily for the purposes of accurate and effective impact assessment.

2.2. Assumptions, knowledge gaps and limitations

This study assumed that the sources of information used in this report are reliable. In this respect, the following must be noted:

- The SABAP2 data is regarded as an adequate indicator of the avifauna which could occur at the development area, and it was further supplemented by data collected during the on-site surveys.
- The focus of the study was on the potential impacts of the proposed solar PV facility on priority species.
- Priority species were defined as follows:
  - South African Red Data species;
  - South African endemics and near-endemics;
  - Raptors; and
  - Waterbirds.
- The impact of solar installations on avifauna is a new field of study, with only two published scientific studies on the impact of PV facilities on avifauna in South Africa (Rudman et al., 2017; Visser et al., 2019), as well as a related study on the impacts of concentrated solar power facilities on wildlife in South Africa (Jeal et al., 2019). 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 currently exists at the development area.
- Cumulative impacts include all renewable energy projects (i.e. Wind and Solar PV Facilities) within a 50km radius that have received an authorisation or is in process by end of December 2021.
- Conclusions drawn in this study are based on experience of the specialists on the species found on site 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.
- The **broader area** is defined as the area encompassed by the six pentads where the project is located (see Figure 1 above). The **development area** is defined as the area covered by the land parcels where Vhuvhili SEF will be located. The **PV footprint or PV developable area** is the where the actual development will be located, i.e. the footprint containing the PV solar arrays and associated infrastructure.

3. Description of project aspects relevant to avifaunal specialist scoping report

The Vhuvhili SEF has the following relevant project components from an avifaunal perspective:

Table 3-1: project components of the proposed Vhuvhili SEF relevant to avifaunal concerns

Vhuvhili SEF		
Component	**Description / dimensions**	
Area of PV Array	Proposed area occupied by PV Modules: Total of 652.5 ha (556 solar PV panels). Fencing: Total developable area referred to above includes all associated infrastructure within the fenced off area of the PV facility.	
Area occupied by inverter-transformer stations and on-site substation complex and height	Inverter-Transformer stations: to be determined. On-site substation complex: approximately 10 ha; height to be determined.	
Temporary laydown areas	To be determined	
Internal roads	Length to be determined. Road width will be up to 10 m, including turning circle/bypass areas of up to 20 m. The roads and cables will be positioned within a 20 m wide corridor.	
Upgrading of existing access road/s	The existing access road (R546) will be used as far as practically achievable and widened where required.	
Warehouse/workshop*	Maximum height (m):	To be determined
	Footprint (m²):	To be determined
Site offices*	Maximum height (m):	To be determined
	Footprint (m²):	To be determined
Operational and Maintenance control centre*	Maximum height (m):	To be determined
	Footprint (m²):	To be determined
Guard houses*	Maximum height (m):	To be determined
	Footprint (m²):	To be determined
Ablution facilities*	Maximum height (m):	To be determined
	Footprint (m²):	To be determined
Battery storage*	Battery technology type:	To be determined

Vhuvhili SEF		
Component	**Description / dimensions**	
	Approx. footprint (ha):	To be determined
	Maximum height (m):	To be determined
	Capacity:	To be determined
Underground low voltage cables or cable trays	Maximum depth (m):	To be determined

4. Baseline environmental description

4.1. General description

4.1.1. Biomes and vegetation types

The Vhuvhili site is located within the Soweto Highveld Grassland (Gm8) vegetation ecotype within the Mesic Highveld Grassland Bioregion (SANBI, 2018). This vegetation type covers 14 513 km² of Mpumalanga and Gauteng (and to a very small extent also in the neighbouring Free State and North-West provinces) and occurs at an altitude ranging from 1420 m to 1760 m above sea level (Mucina et al., 2006). The site does not fall within any Centre of Endemism (Van Wyk & Smith, 2001).

Soweto Highveld Grassland is a summer rainfall vegetation (662 mm per annum, mostly September to April), which experiences a cool-temperate climate (mean annual temperature 14.8°C) with thermic continentality. Temperature ranges between 28°C (January) to -0.6°C (July). Frost and frequent grass fires during winter play an important role in limiting the occurrence of trees and shrubs in the region (Mucina et al., 2006). The landscape is gently to moderately undulating on the Highveld plateau, supporting dense tufted grassland dominated by *Themeda triandra*, with a notable herbaceous forb component (see Figure 2). In places which have not been disturbed, scattered wetlands, narrow stream alluvia, pans and occasional ridges interrupt the grassland cover.

Although the conservation status of this vegetation type was listed as “Endangered” by (Mucina & Rutherford (2006) it is listed as “Vulnerable” by the updated NEMA of 2011 (see 7.2.2.). Very few statutorily conserved areas occur in this vegetation type and almost half has been transformed mostly by cultivation, plantations, mining, and urbanisation.

4.1.2. Important bird areas

The development area is not located in an Important Bird Area (IBA). The closest IBAs are the Amersfoort-Bethal-Carolina IBA SA018 – approximately 20.5km east of the Vhuvhili SEF – and the Devon Grasslands IBA SA130 – approximately 34km west of the Vhuvhili SEF(Marnewick et al., 2015). It is not envisaged that the proposed SEF will impact on avifauna in the IBAs due to the distance from the development area.

4.1.3. National Protected Areas Expansion Strategy (NPAES) focus areas

The development area does not fall within a protected area or a NPAES focus area.

4.1.4. The Renewable Energy Development Zones (REDZ)

The development area is not located in a REDZ.

4.1.5. Habitat classes and avifauna in the development area

The following bird habitat features were identified in the development area:

4.1.5.1. Grassland

This habitat feature is described above under 4.1.1. (see Figure 2 & 3)

4.1.5.2. Drainage lines and wetlands

Streams, wetlands, vleis and floodplains are associated mostly with the Klipspruit River and its tributaries (Figure 2 & 4). Surface rocks are present in some places along the streams. The alluvial soils are mostly deep dark brown to black clayey soils

4.1.5.3. Dams and pans

There are several small dams, as well as a few small pans, mostly associated with the Klipspruit River and its tributaries (Figure 2 & 5). There is one moderately large dam near the western central portion of the Vhuvhili SEF (Thompson, 2019).

4.1.5.4. Agriculture

Agricultural activity present within the Vhuvhili SEF comprises cultivated commercial annuals non-pivot cropland (Thompson, 2019), predominately dedicated towards maize production (Figure 6).

4.1.5.5. Alien trees

Alien trees are present on the Vhuvhili SEF site as windbreaks either between agricultural fields or between homesteads (Thompson, 2019) (Figure 7).

4.2. Avifauna

A total of 186 species could potentially occur within the broader area where the project is located (see Appendix E). Of these, 92 are classified as priority species for solar developments. Of the 92 priority species, 47 have a medium to very high probability of occurring in the development site. Of the 47 priority species with a medium to high probability of occurrence, 34 were recorded during site surveys.

Eleven Red Data List species are associated with the broader area. Nine Red Data List species have a low probability of occurrence – African Marsh Harrier, Blue Crane, Caspian Tern, European Roller, Greater Painted Snipe, Lanner Falcon, Maccoa Duck, Pallid Harrier, and Red-footed Falcon – while three Red Data List Species have a medium to high probability of occurrence – Blue Korhaan, Greater Flamingo, and Secretarybird. Three Red Data species were recorded during the site surveys – Blue Korhaan, Greater Flamingo, and Lanner Falcon.

See Appendix E for a list of species potentially occurring in the broader area. The possibility of priority species occurring in the development area and potential long-term impacts are listed in Table 4.1 below.

Table 4-1: Priority species with a medium to high potential for regular occurrence in the development area

Global and SA status: CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least concern

Likelihood of regular occurrence: L = Low; M = Medium; H = High

Group	Species name	Scientific name	Full protocol	Global status	SA status	Likelihood of regular occurrence	Recorded during monitoring	Grassland	Drainage lines and wetlands	Agriculture	Alien trees	Dams and pans	Solar - Collisions with solar panels	Solar - Displacement: Disturbance	Solar - Displacement: Habitat transformation	Solar - Entanglement in fences	Electrocution - on site substation
	Hamerkop	*Scopus umbretta*	9.76	-	-	M	x		x		x	x	x				
	Ruff	*Calidris pugnax*	10.98	-	-	M			x			x	x				
	Secretarybird	*Sagittarius serpentarius*	8.54	EN	VU	M		x			x	x		x	x	x	
Avocet	Pied Avocet	*Recurvirostra avosetta*	6.10	-	-	M			x			x	x				
Buzzard	Common Buzzard	*Buteo buteo*	8.54	-	-	M		x		x	x				x		x
Buzzard	Jackal Buzzard	*Buteo rufofuscus*	4.88	-	-	M		x			x				x		x
Coot	Red-knobbed Coot	*Fulica cristata*	74.39	-	-	H	x					x	x				
Cormorant	Reed Cormorant	*Microcarbo africanus*	75.61	-	-	H	x		x			x	x				
Cormorant	White-breasted Cormorant	*Phalacrocorax lucidus*	25.61	-	-	H	x		x		x	x	x				

Group	Species name	Scientific name	Full protocol	Global status	SA status	Likelihood of regular occurrence	Recorded during monitoring	Grassland	Drainage lines and wetlands	Agriculture	Alien trees	Dams and pans	Solar - Collisions with solar panels	Solar - Displacement: Disturbance	Solar - Displacement: Habitat transformation	Solar - Entanglement in fences	Electrocution - on site substation
Darter	African Darter	*Anhinga rufa*	26.83	-	-	H	x		x			x	x				
Duck	African Black Duck	*Anas sparsa*	8.54	-	-	H	x		x				x				
Duck	White-faced Whistling Duck	*Dendrocygna viduata*	14.63	-	-	M			x			x	x				
Duck	Yellow-billed Duck	*Anas undulata*	70.73	-	-	H	x		x			x	x				
Eagle-Owl	Spotted Eagle-Owl	*Bubo africanus*	6.10	-	-	M		x			x		x	x		x	x
Egret	Great Egret	*Ardea alba*	6.10	-	-	M	x		x			x	x				
Egret	Intermediate Egret	*Ardea intermedia*	23.17	-	-	H	x		x			x	x				
Egret	Little Egret	*Egretta garzetta*	23.17	-	-	H	x		x			x	x				
Egret	Western Cattle Egret	*Bubulcus ibis*	70.73	-	-	H	x	x	x		x	x	x				
Falcon	Amur Falcon	*Falco amurensis*	34.15	-	-	H		x		x	x		x		x		
Flamingo	Greater Flamingo	*Phoenicopterus roseus*	4.88	-	NT	M	x					x	x				

Group	Species name	Scientific name	Full protocol	Global status	SA status	Likelihood of regular occurrence	Recorded during monitoring	Grassland	Drainage lines and wetlands	Agriculture	Alien trees	Dams and pans	Solar - Collisions with solar panels	Solar - Displacement: Disturbance	Solar - Displacement: Habitat transformation	Solar - Entanglement in fences	Electrocution - on site substation
Goose	Egyptian Goose	*Alopochen aegyptiaca*	73.17	-	-	H	x		x	x	x	x	x				x
Goose	Spur-winged Goose	*Plectropterus gambensis*	40.24	-	-	H	x	x	x	x		x	x				x
Grebe	Little Grebe	*Tachybaptus ruficollis*	64.63	-	-	H	x		x			x	x				
Greenshank	Common Greenshank	*Tringa nebularia*	18.29	-	-	H	x		x			x	x				
Gull	Grey-headed Gull	*Chroicocephalus cirrocephalus*	37.80	-	-	H	x		x			x	x				x
Heron	Black-headed Heron	*Ardea melanocephala*	81.71	-	-	H	x	x	x		x		x			x	x
Heron	Grey Heron	*Ardea cinerea*	34.15	-	-	H			x		x	x	x				x
Heron	Purple Heron	*Ardea purpurea*	10.98	-	-	M			x			x	x				
Ibis	African Sacred Ibis	*Threskiornis aethiopicus*	63.41	-	-	H	x	x	x		x		x				
Ibis	Glossy Ibis	*Plegadis falcinellus*	36.59	-	-	H	x		x				x				
Kestrel	Greater Kestrel	*Falco rupicoloides*	6.10	-	-	M	x	x	x		x				x		x

Group	Species name	Scientific name	Full protocol	Global status	SA status	Likelihood of regular occurrence	Recorded during monitoring	Grassland	Drainage lines and wetlands	Agriculture	Alien trees	Dams and pans	Solar - Collisions with solar panels	Solar - Displacement: Disturbance	Solar - Displacement: Habitat transformation	Solar - Entanglement in fences	Electrocution - on site substation
Kite	Black-winged Kite	*Elanus caeruleus*	70.73	-	-	H	x	x			x		x		x		x
Korhaan	Blue Korhaan	*Eupodotis caerulescens*	17.07	NT	LC	H	x	x					x	x	x	x	
Lapwing	Blacksmith Lapwing	*Vanellus armatus*	95.12	-	-	H	x	x	x				x				
Moorhen	Common Moorhen	*Gallinula chloropus*	36.59	-	-	H			x			x	x				
Owl	Marsh Owl	*Asio capensis*	24.39	-	-	H	x	x	x				x	x	x	x	x
Plover	Kittlitz's Plover	*Charadrius pecuarius*	17.07	-	-	H	x		x			x	x				
Plover	Three-banded Plover	*Charadrius tricollaris*	50.00	-	-	H	x		x			x	x				
Pochard	Southern Pochard	*Netta erythrophthalma*	12.20	-	-	M	x		x			x	x				
Shelduck	South African Shelduck	*Tadorna cana*	8.54	-	-	M	x		x			x	x				
Shoveler	Cape Shoveler	*Spatula smithii*	29.27	-	-	H	x		x			x	x				
Snipe	African Snipe	*Gallinago nigripennis*	9.76	-	-	M	x		x				x		x		
Spoonbill	African Spoonbill	*Platalea alba*	21.95	-	-	H	x		x			x	x				

Group	Species name	Scientific name	Full protocol	Global status	SA status	Likelihood of regular occurrence	Recorded during monitoring	Grassland	Drainage lines and wetlands	Agriculture	Alien trees	Dams and pans	Solar - Collisions with solar panels	Solar - Displacement: Disturbance	Solar - Displacement: Habitat transformation	Solar - Entanglement in fences	Electrocution - on site substation
Stilt	Black-winged Stilt	*Himantopus himantopus*	19.51	-	-	M			x			x	x				
Stint	Little Stint	*Calidris minuta*	13.41	-	-	M	x		x		x	x	x				
Teal	Red-billed Teal	*Anas erythrorhyncha*	35.37	-	-	H	x		x			x	x				
Tern	Whiskered Tern	*Chlidonias hybrida*	20.73	-	-	M			x			x	x				

4.3. Project specific description

The habitat in the Vhuvhili SEF site comprises largely of natural grassland, agricultural tracts, and herbaceous wetlands, dams and pans associated with the Klipspruit River and its tributaries which intersect the development area. Natural grassland occurs on the plains and gentle footslopes and covers most of the central and northern parts of the Vhuvhili site (Figure 2). Surface rocks and gravel are absent and the deep dark-brown clayey soils are derived from dolerite. This mixture of degraded natural grassland and old abandoned croplands cover most of the southern half of the Vhuvhili site. It is found on the plains, footslopes and midslopes of the undulating countryside (Figures 2). Surface rocks and gravel are absent, and the deep dark-brown clayey soils are derived from dolerite.

4.4. Identification of environmental sensitivities

4.4.1. Sensitivities identified by the national web-based environmental screening tool

The development area and immediate environment is classified largely as **High** sensitivity for terrestrial animals according to the Terrestrial Animal Species Theme.The High classification is linked to the potential occurrence of African Marsh Harrier (Globally Least Concern, Regionally Endangered), Secretarybird (Globally Endangered, Regionally Vulnerable) and Blue Crane (Globally Vulnerable, Regionally Near-threatened). The development area contains confirmed habitat for these species of conservation concern (SCC) as defined in the Protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species (Government Gazette No 43855, 30 October 2020), namely listed on the IUCN Red List of Threatened Species or South Africa's National Red List website as Critically Endangered, Endangered or Vulnerable. The occurrence of SCC was also confirmed during the surveys i.e. Lanner Falcon (Globally Least Concern, Regionally Vulnerable) was recorded in the development area.

Based on the Site Sensitivity Verification field survey conducted, habitat within the development area appears suitable for African Marsh Harrier, Secretarybird, Blue Crane and Lanner Falcon. Therefore, the classification of **High** sensitivity for avifauna in the screening tool is confirmed for the proposed development area.

4.4.2. Specialist sensitivity analyses and verification

4.4.2.1. Very High sensitivity: No Go

All surface water (drainage lines, wetlands, dams, and pans) must be buffered by 200m to ensure unhindered access of priority species to the water. Surface water and wetland habitats are crucially important for priority avifauna, including the African Marsh Harrier (Regionally Endangered) and many non-priority species. No PV panels should be constructed in this zone.

4.4.2.2. High sensitivity zones

Areas of natural and natural rocky grassland (Figure 2) should be demarcated as high sensitivity areas wherein development should be limited where feasible. These natural grassland tracts provide suitable foraging/nesting habitat for Secretarybird (Globally Endangered, Regionally Vulnerable), Blue Korhaan (Globally Near Threatened, Regionally Least Concern) and Blue Crane (Regionally Near-threatened, Globally Vulnerable) within the development area. However, these species do not require specific avoidance measures because there is also habitat available outside the development areas.

Figure 9 below is a sensitivity map, indicating very high and high sensitivity areas identified for PV development.

4.4.3. Sensitivity analysis summary statement

Based on the field surveys to date, the classification of **High sensitivity** for avifauna in the screening tool is confirmed for proposed developable area, given the reliable detection of suitable habitat for African Marsh Harrier, Secretarybird, and other SCCs, namely Blue Korhaan and Blue Crane.

5. Issues, risks, and impacts

5.1. Identification of potential impacts/risks

The potential impacts identified in the course of the study (i.e. Scoping Phase) are listed below.

5.1.1. Construction phase

- Displacement due to disturbance and habitat transformation associated with the construction of the solar PV plants and associated infrastructure.

5.1.2. Operation phase

- Displacement due to habitat transformation associated with the presence of the solar panels.
- Collisions with the solar panels.
- Entrapment in perimeter fences.
- Electrocutions in the onsite substations.

5.1.3. Decommissioning phase

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

5.1.4. Cumulative impacts

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

6. Scoping level – impact assessment

Anthropogenic climate change poses a global conservation concern, and is predicted to drive rapid redistribution of plant and animal species (National Audubon Society, 2015). Such redistribution events include large-scale population displacements alongside species range reductions and fragmentation, alongside population displacements (Ehrlén & Morris, 2015; Pecl et al., 2017), and changes to the timing interactions (Kharouba et al., 2018). Collectively, these anthropogenically-induced changes pose the risk of extinction event occurring at unprecedented rates compared to natural long-term climate (Urban, 2015) – which is itself a fundamental driver behind species distributions. In 2006, WWF Australia produced a report on the envisaged impact of climate change on birds worldwide (Wormworth & Mallon, 2006). The report found that:

- Anthropogenic 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 of 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, range loss is predicted to occur without accompanying range expansion.
- For 188 species, predicted range 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-emitting technologies into the country's complement of power generation will greatly facilitate achieving this important objective (Walwyn & Brent, 2015). Given that South Africa receives among the highest levels of solar radiation on earth (Fluri, 2009; Munzhedzi & Sebitosi, 2009), it is clear that solar power generation should feature prominently in future national efforts to convert to a more sustainable energy suite of energy productions to combat human-induced climate change.

From an avifaunal perspective, solar power generation undoubtedly presents a long-term benefit to species viability, given that solar power generation is anticipated to mitigate the environmental threats posed by anthropogenic climate change (i.e. rapid species redistribution and broad-scale habitat transformation). However, renewable energy facilities – including solar PV facilities – themselves can impede the viability of bird species populations. The environmental risks associated with solar PV facilities need to be recognised and addressed to minimise the negative impacts such facilities may have on bird species populations.

6.1. Potential impacts during the construction phase

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

The noise and movement associated with the construction activities at the proposed developable areas will be a source of disturbance which would lead to the displacement of avifauna from the area. This impact is rated as negative, with a site-specific spatial extent and a short-term duration due to the temporary nature of the construction phase. The impact is rated with a high reversibility (meaning that the potential

impact is highly reversible at end of the project life); and low irreplaceability (meaning there is a low irreplaceability of avifaunal species). The potential impact is allocated a substantial consequence and very likely probability, which will render the impact significance as moderate, without the implementation of mitigation measures. Rudman et al. (2017) found that the construction phase of solar PV facilities presents the most significant impacts to birds and other wildlife in arid environments in South Africa. With the implementation of mitigation measures, the significance of the impact is reduced to low. The recommended mitigation measures are detailed Section 6.1.2. below. Please refer to Appendix D for the Impact Assessment Methodology that was used to assess the significance of potential impacts, as provided by the CSIR.

6.1.2. Impact summary table: construction phase

Table 6-1: Avifaunal impact summary table for the construction phase of the proposed Vhuvhili SEF

Impact 1	*Impact Criteria*		*Significance and Ranking (Pre-Mitigation)*	*Potential mitigation measures*	*Significance and Ranking (Post-Mitigation)*	*Confidence Level*
CONSTRUCTION PHASE						
Impact 1: Displacement due to disturbance associated with the construction of the solar PV plant and associated infrastructure	*Status*	*Negative*	*Moderate (3)*	▪ *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*	*Low (4)*	*High*
	Spatial Extent	*Site-specific*				
	Duration	*Short-term*				
	Consequence	*Substantial*				
	Probability	*Very likely*				
	Reversibility	*High*				
	Irreplaceability	*Low*				

Impact 1	*Impact Criteria*		*Significance and Ranking (Pre-Mitigation)*	*Potential mitigation measures*	*Significance and Ranking (Post-Mitigation)*	*Confidence Level*
				construction footprint is concerned. ▪ *A 200m exclusion zone should be placed around all surface water (drainage lines, wetlands, dams, and pans).*		

6.2. Potential impacts during the operation phase

6.2.1.1. Total or partial displacement of avifauna due to habitat transformation associated with the presence of the solar PV plants and associated infrastructure

This impact relates to the total or partial displacement of avifauna due to habitat transformation associated with the presence of the solar PV plants and associated infrastructure. This impact is rated as negative, with a site-specific spatial extent and a long-term duration due to the extended timeframe of the operational phase (lifetime estimated at 20 years).

Such impacts include ground disturbance, which can disrupt ecological processes (Lovich & Ennen, 2011; Rudman et al., 2017) as follows:

- lessening soil density,
- worsening water infiltration rate
- exacerbating soil erosion
- dust and crytobiotiotic soil crust destabilisation
- promoting secondary plant succession, and encroachment of invasion plant species)

These processes can collectively contribute to local and regional habitat transformation and degradation, often to the detriment of wildlife, including avifauna. Any disturbance and alteration to the landscape, including the construction and decommissioning of utility-scale solar energy facilities, has the potential to increase soil erosion, and exacerbate the magnitude of dust occurrence within the immediate environment of the solar PV facility(Lovich & Ennen, 2011; Rudman et al., 2017). Erosion and dust destabilisation can physically and physiologically lessen plant species productivity, thereby adversely influence primary production and food availability for wildlife (Lovich & Ennen, 2011); dust destabilisation can also present respiratory health risks to both people and wildlife (Rudman et al., 2017).

Habitat transformation can disrupt the breeding, foraging, and roosting behaviour of bird populations within the development area. 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.

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 factors influencing species' occurrence and their relative density within the development footprint. Their 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).

The impact is rated with a high reversibility (meaning that the potential impact is highly reversible at the end of the project life); and low irreplaceability (meaning there is a low irreplaceability of avifaunal species). The potential impact is allocated a severe consequence and very likely probability, which will render the impact significance as high, without the implementation of mitigation measures. With the implementation of mitigation measures, the significance of the impact is reduced to moderate. The recommended mitigation measures are detailed Section 6.2.2. below.

6.2.1.2. Bird mortality and injury as a result of collisions with the solar panels

This impact relates to the bird mortalities because of potential collisions with the solar panels. This impact is rated as negative, with a site-specific spatial extent and a long-term duration due to the extended timeframe of the operational phase (lifetime estimated at 20 years).

Impact trauma fatality has been occasionally documented at solar projects of all technology types (Hernandez et al., 2014; Kagan et al., 2014; McCrary et al., 1986). Impact trauma fatality can result indirectly through wounded birds more readily succumbing to predation. Sheet glass used in buildings are a well-known hazard for birds, as birds can be misguided by reflections of the sky from sheet glass, oftentimes resulting in high-speed collisions with the glass (Loss, Will, Loss, et al., 2014). Reflective surfaces of solar panels may pose an avifaunal risk like sheet glass, although this concern remains unsubstantiated.

A related, rarer problem is 'lake effect' whereby the reflective surfaces – particularly of large sheets of dark blue photovoltaic panels – attract flying birds which mistake these surfaces for water (Kagan et al., 2014). This concern is supported by a high proportion of waterbird mortalities (44%) at the Desert Sunlight PV Facility, USA, (Western EcoSystems Technology Inc., 2014), although nearby evaporation ponds are a confounding factor. A meta-analysis by Kosciuch et al. (2020) found no significant evidence for mass mortality related to the lake effect at 10 PV solar facilities in the USA across 13 site years, despite the occurrence of water-obligate birds at 9/10 of these sites. In South Africa, no avian fatalities at solar power facilities have been formally ascribed to the lake effect hypothesis (Jeal et al., 2019; Rudman et al., 2017; Visser et al., 2019). However, there remains insufficient scientific evidence to confidently reject the 'lake effect' hypothesis, and so its potential impacts should still be considered.

Weekly mortality searches at 20% coverage were conducted at the California Valley Solar Ranch PV site (Harvey, 2015b, 2015a). These reports found 152 and 54 avian mortalities between November 2013 – 15 February 2014, and February 2014 – May 2014, respectively, for which ~90% had unknown cause of death. These figures give an estimated unadjusted 1,030 mortalities per year, ignoring adjustments for carcasses removed by scavengers, and those missed by searchers. A report by the National Fish and Wildlife Forensic Laboratory (Kagan et al., 2014) determined that impact trauma emerged as the highest identifiable cause of avian mortality, although for most mortalities the cause was unidentifiable. Walston et al. (2015) reviewed avian fatality data from large scale solar facilities in the USA, finding collisions to be the second highest cause of death, after unknown causes; predation following impact trauma is speculated for some of the unknown mortalities

The only study assessing the avifaunal impacts of a South African PV facility was completed in 2016 at the 96MW Jasper PV solar facility (28°17′53″S, 23°21′56″E), 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. Mortality surveys were conducted from the 14th of September 2015 - 6th of December 2015, reporting seven total avian mortalities inferred from feather spots (0.003 birds/ha/yr). The 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 sample size. The mortality estimate is likely conservative because detection probabilities were based on intact birds, which 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 in South Africa. Despite these limitations, the few bird fatalities observed suggest non- significant collision-related mortality at the study site (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 apparent 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.

The impact is rated with a high reversibility (meaning that the potential impact is highly reversible at the end of the project life); and low irreplaceability (meaning there is a low irreplaceability of avifaunal species). The potential impact is allocated a slight consequence and unlikely probability, which will render the impact significance as very low. As detailed in Section 6.2.2. below, no mitigation is required due to the very low impact significance.

6.2.1.3. Entrapment of birds by the perimeter fences, leading to mortality

This impact pertains to the entrapment of medium and large terrestrial birds between the perimeter fences, and potential snaring of owls, leading to mortality. This impact is rated as negative, with a site-specific spatial extent and a long-term duration due to the long timeframe of the operational phase (lifetime estimated at 20 years).

Visser et al. (2019) recorded a fence-line fatality of an Orange River Francolin *Scleroptila gutturalis* resulting entrapment between the inner and outer perimeter fence of the facility; additionally, three Red-crested Korhaans were claimed to be unable to escape between these two fences without intervention from facility personnel. 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. Potentially, too-close a parallel configuration of double-fenced perimeters can cause fatalities, particularly of larger terrestrial birds, by way of entrapment, and especially if disturbed by people. This risk remains low, however, with Visser et al. (2019) tentatively presenting a fatality rate of 0.002 birds per km per month from this risk factor, although qualifying that the single documented fatality was inadequate for robust extrapolations.

The impact is rated with a high reversibility (meaning that the potential impact is highly reversible at the end of the project life); and low irreplaceability (meaning there is a low irreplaceability of avifaunal species). The potential impact is rated with a moderate consequence and likely probability, which will result in a low impact significance, without the implementation of mitigation measures. With the implementation of mitigation measures, the significance of the impact is reduced to very low. The recommended mitigation measure includes using a single perimeter fence around the PV Facility. Increasing the spacing between at least the top two wires (to a minimum of 30 cm) and ensuring they are correctly tensioned will reduce the snaring risk for owls.

6.2.1.4. Electrocution of priority species in the onsite substations

This impact deals with the potential electrocution of priority species in the onsite substation. This impact is rated as negative, with a local spatial extent and a long-term duration due to the extended timeframe of the operational phase (lifetime estimated at 20 years).

Electrocution refers to instances where birds perch, or attempt to perch, upon electrical structure in a manner that physically bridges the air gap between live components and/or live and earthed components, causing a fatal electrical short circuit through the birds (Bevanger, 1994; van Rooyen, 2000). The electrocution risk is largely determined by the design of the electrical hardware, with medium voltage electricity poles posing a potential electrocution risk to raptors (Cole & Dahl, 2013; Haas et al., 2006; Loss, Will, & Marra, 2014).

The impact is rated with a high reversibility (meaning that the potential impact is highly reversible at the end of the project life); and low irreplaceability (meaning there is a low irreplaceability of avifaunal species). The potential impact is allocated a severe consequence but unlikely probability, which will result in an impact significance of moderate, without the implementation of mitigation measures. With the implementation of mitigation measures (i.e. reactive insulation of electrical hardware), the significance of the impact is reduced to very low.

6.2.2. Impact summary tables: operation phase

The rating of the impacts identified for the operational phase is discussed in this section.

Table 6-2: Avifaunal impacts identified for the operational phase of the proposed Vhuvhili SEF

Impact 1	*Impact Criteria*		*Significance and Ranking (Pre-Mitigation)*	*Potential mitigation measures*	*Significance and Ranking (Post-Mitigation)*	*Confidence Level*
OPERATIONAL PHASE						
Total or partial displacement of avifauna due to habitat transformation associated with the presence of the solar PV plants and associated infrastructure.	*Status*	*Negative*	*High (2)*	▪ *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.* ▪ *All surface water (pans and water troughs) must be buffered by 200m to ensure unhindered access of priority species to the water. No PV panels should be constructed in this zone. (see sensitivity map Figure 9).*	*Moderate (3)*	*Medium*
	Spatial Extent	*Site specific*				
	Duration	*Long term*				
	Consequence	*Severe*				
	Probability	*Very likely*				
	Reversibility	*High*				
	Irreplaceability	*Low*				

Impact 2	*Impact Criteria*		*Significance and Ranking (Pre-Mitigation)*	*Potential mitigation measures*	*Significance and Ranking (Post-Mitigation)*	*Confidence Level*
OPERATIONAL PHASE						
Bird mortality and injury as a result of collisions with the solar panels.	*Status*	*Negative*	*Very low (5)*	*No mitigation is required due to the very low significance*	*Very low (5)*	*Medium*
	Spatial Extent	*Site specific*				
	Duration	*Long term*				
	Consequence	*Slight*				
	Probability	*Unlikely*				
	Reversibility	*High*				
	Irreplaceability	*Low*				

Impact 3	*Impact Criteria*		*Significance and Ranking (Pre-Mitigation)*	*Potential mitigation measures*	*Significance and Ranking (Post-Mitigation)*	*Confidence Level*
OPERATIONAL PHASE						
Entrapment of priority species in the the perimeter fences, leading to mortality.	*Status*	*Negative*	*Low (4)*	• *If possible, s single perimeter fence should be used.* • *Increasing the spacing between at least the top two wires (to a minimum of 30cm) and ensuring they are correctly tensioned will reduce the snaring risk for owls.*	*Very low (5)*	*High*
	Spatial Extent	*Site specific*				
	Duration	*Long term*				
	Consequence	*Moderate*				
	Probability	*Likely*				
	Reversibility	*High*				
	Irreplaceability	*Low*				

Impact 4	*Impact Criteria*		*Significance and Ranking (Pre-Mitigation)*	*Potential mitigation measures*	*Significance and Ranking (Post-Mitigation)*	*Confidence Level*
OPERATIONAL PHASE						
Electrocution of priority species in the onsite substations.	*Status*	*Negative*	*Moderate (3)*	*The hardware within the proposed substation yards is too complex to warrant any mitigation for electrocution at this stage. It is recommended that if on-going impacts are recorded once operational, site specific mitigation (insulation) be applied reactively. This is an acceptable approach because Red List priority species are unlikely to frequent the substation and be electrocuted.*	*Very Low (5)*	*High*
	Spatial Extent	*Local*				
	Duration	*Long term*				
	Consequence	*Severe*				
	Probability	*Unlikely*				
	Reversibility	*High*				
	Irreplaceability	*Low*				

6.3. Potential impacts during decommissioning phase

6.3.1.1. Displacement due to disturbance associated with the decommissioning of the solar PV plants and associated infrastructure

The noise and movement associated with the potential decommissioning activities will be a source of disturbance which would lead to the displacement of avifauna from the area. This impact is rated as negative, with a site-specific spatial extent and a short-term duration. The impact is rated with a high reversibility (meaning that the potential impact is highly reversible at end of the project life); and low irreplaceability (meaning there is a low irreplaceability of avifaunal species). The potential impact is allocated a substantial consequence and very likely probability, which will render the impact significance as moderate, without the implementation of mitigation measures. With the implementation of mitigation measures, the significance of the impact is reduced to low. The recommended mitigation measures are detailed in Section 6.3.1.1 below.

6.3.2. Impact summary tables: decommissioning phase

The rating of the impacts identified for the decommissioning phase is discussed in this section.

Table 6-3: Avifaunal impacts for the decommissioning phase of the proposed Vhuvhili SEF

Impact	*Impact Criteria*		*Significance and Ranking (Pre-Mitigation)*	*Potential mitigation measures*	*Significance and Ranking (Post-Mitigation)*	*Confidence Level*
DECOMMISSIONING PHASE						
The noise and movement associated with the activities at the development area will be a source of disturbance which would lead to the displacement of avifauna from the area.	*Status*	*Negative*	*Moderate (3)*	▪ *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 best practice in the industry at the time.* ▪ *Maximum use should be made of existing access roads during the decommissioning phase and the construction of new roads should be kept to a minimum as far as practical.* ▪ *The recommendations of the ecological*	*Low (4)*	*High*
	Spatial Extent	*Site specific*				
	Duration	*Short term*				
	Consequence	*Substantial*				
	Probability	*Very likely*				
	Reversibility	*High*				

				and botanical specialist studies must be strictly implemented, especially as far as limitation of the activity footprint is concerned		

6.4. Cumulative impacts

See Figure 10 for list and map of the proposed and authorised Solar PV projects within a 50 km of the Vhuvhili SEF project.

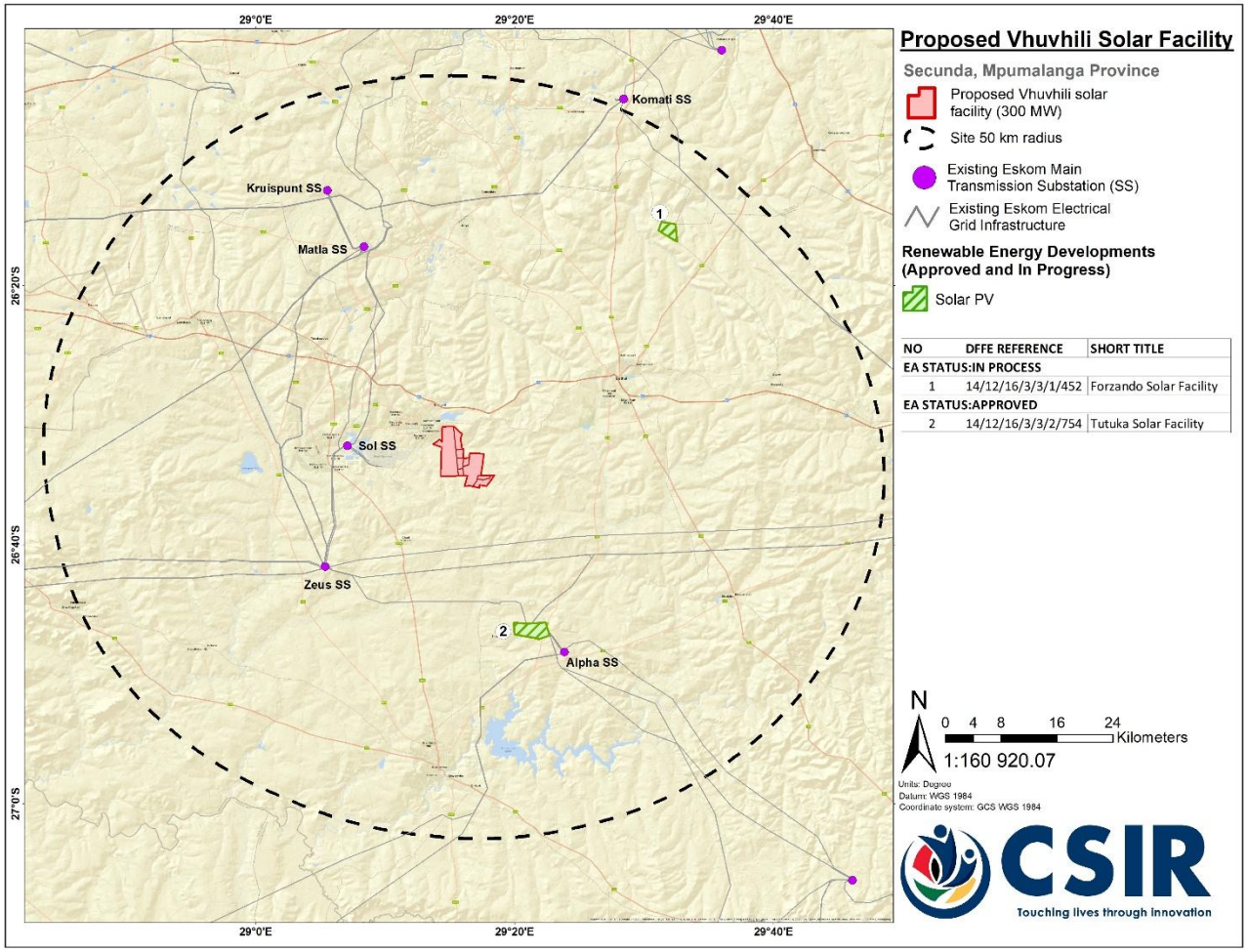


Figure 10: Proposed and authorised Solar PV projects within a 50 km of the Vhuvhili SEF project.

6.4.1.1. Construction Phase - Displacement due to disturbance associated with the construction of the solar PV plant and associated infrastructure

The noise and movement associated with the construction activities of similar projects within the 50 km radius will be a source of disturbance which would lead to the displacement of avifauna from the area. This impact is rated as negative, with a site-specific spatial extent and a short-term duration due to the

temporary nature of the construction phase. The impact is rated with a high reversibility (meaning that the potential impact is highly reversible at end of the project life); and low irreplaceability (meaning there is a low irreplaceability of avifaunal species). The potential impact is allocated a substantial consequence and very likely probability, which will render the impact significance as moderate, without the implementation of mitigation measures. With the implementation of mitigation measures, the significance of the impact is reduced to low. The recommended mitigation measures are detailed Section 6.4.2. below.

6.4.1.2. Operational Phase - Habitat transformation, collisions with the solar panels, entrapment in fences, and electrocution in onsite substations

This impact deals with the following during the operational phase with regards to other similar projects in the 50 km radius:

- Total or partial displacement of avifauna due to habitat transformation associated with the presence of the solar PV plant and associated infrastructure
- Bird mortality and injury because of collisions with the solar panels
- Entrapment of priority species in the perimeter fences, leading to mortality
- Electrocution of priority species in the onsite substations

This impact is rated as negative, with a regional spatial extent and a long-term duration. The impact is rated with a high reversibility (meaning that the potential impact is highly reversible at the end of the project life); and low irreplaceability (meaning there is a low irreplaceability of avifaunal species). The potential impact is allocated a severe consequence and with a high probability, which will render the impact significance as high, without the implementation of mitigation measures. With the implementation of mitigation measures, the significance of the impact is reduced to moderate. The recommended mitigation measures are detailed Section 6.4.2. below.

6.4.1.3. Decommissioning Phase - Displacement due to disturbance associated with the decommissioning of the solar PV plants and associated infrastructure

The noise and movement associated with the potential decommissioning activities (in terms of other similar projects in the 50 km radius) will be a source of disturbance which would lead to the displacement of avifauna from the area. This impact is rated as negative, with a site-specific spatial extent and a short-term duration. The impact is rated with a high reversibility (meaning that the potential impact is highly reversible at end of the project life); and low irreplaceability (meaning there is a low irreplaceability of avifaunal species). The potential impact is allocated a substantial consequence and very likely probability, which will render the impact significance as moderate, without the implementation of mitigation measures. With the implementation of mitigation measures, the significance of the impact is reduced to low. The recommended mitigation measures are detailed Section 6.4.2 below.

6.4.2. Impact summary tables: cumulative impacts

Table 6-4: Cumulative avifaunal impacts identified for the proposed Vhuvhili SEF.

Impact	*Impact Criteria*		*Significance and Ranking (Pre-Mitigation)*	*Potential mitigation measures*	*Significance and Ranking (Post-Mitigation)*	*Confidence Level*
CONSTRUCTION PHASE						
Displacement due to disturbance associated with the construction of the solar PV plant and associated infrastructure	*Status*	*Negative*	*Moderate (3)*	▪ *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 best practice in the industry at the time.* ▪ *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.*	*Low (4)*	*High*
	Spatial Extent	*Site specific*				
	Duration	*Short term*				
	Consequence	*Substantial*				
	Probability	*Very likely*				
	Reversibility	*High*				
	Irreplaceability	*Low*				
OPERATIONAL PHASE						
Habitat transformation, collisions with the solar panels, entrapment in	*Status*	*Negative*	*High (2)*	▪ *The recommendations of the botanical specialist must be strictly*	*Moderate (3)*	
	Spatial Extent	*Regional*				
	Duration	*Long term*				
	Consequence	*Severe*				
	Probability	*Likely*				

Impact	*Impact Criteria*		*Significance and Ranking (Pre-Mitigation)*	*Potential mitigation measures*	*Significance and Ranking (Post-Mitigation)*	*Confidence Level*
fences, and electrocution in onsite substations	*Reversibility*	*High*		*implemented, especially as far as limiting the vegetation clearance to what is absolutely necessary, and rehabilitation of transformed areas are concerned.* ▪ *Solar panel-free buffers must be maintained around the water reservoirs and other waterbodies* ▪ *A single perimeter fence should be used where possible and strands must be correctly tensioned.* ▪ *The hardware within the proposed substation yards is too complex to warrant any mitigation for electrocution at this stage. It is recommended that if on-going impacts are recorded once operational, site-specific mitigation (insulation) be applied reactively. This is an acceptable approach because Red List priority species are unlikely to frequent the*		
	Spatial Extent	*Local*				
	Duration	*Long term*				
	Consequence	*Severe*				
	Probability	*Likely*				
	Reversibility	*High*				
	Irreplaceability	*Low*				

Impact	*Impact Criteria*		*Significance and Ranking (Pre-Mitigation)*	*Potential mitigation measures*	*Significance and Ranking (Post-Mitigation)*	*Confidence Level*
				substation and be electrocuted.		
DECOMMISSIONING PHASE						
The noise and movement associated with the activities at the development area will be a source of disturbance which would lead to the displacement of avifauna from the area	*Status*	*Negative*	*Moderate (3)*	▪ *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 during the decommissioning phase 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*	*Low (4)*	
	Spatial Extent	*Site specific*				
	Duration	*Short term*				
	Consequence	*Substantial*				
	Probability	*Very likely*				
	Reversibility	*High*				
	Irreplaceability	*Low*				

6.5. Scoping level assessment summary

The overall impact significance is provided in this section, in terms of pre- and post-mitigation.

Table 6-5: Summary of avifaunal impact significances anticipated for the proposed Vhuvhili SEF

Phase	Overall Impact Significance (Pre-Mitigation)		Overall Impact Significance (Post Mitigation)	
Construction	Moderate (3)		Low (4)	
Operational	Low (4) to	Moderate (3)	Very Low (5) to	Low (4)
Decommissioning	Moderate (3)		Low (4)	
Nature of Impact	**Overall Impact Significance**		**Overall Impact Significance**	
Cumulative - Construction	Moderate (3)		Low (4)	
Cumulative - Operational	Moderate (3) to	High (2)	Low (4) to	Moderate (3)
Cumulative - Decommissioning	Moderate (3)		Low (4)	

7. Legislative and Permit Requirements

There is no legislation pertaining specifically to the impact of solar facilities and associated electrical infrastructure on avifauna.

7.1. Agreements and conventions

Below is a list of agreements and conventions which South Africa is party to, and which are relevant to the conservation of avifauna.

Table 6-6: Agreements and conventions which South Africa are party to, and which is relevant to the conservation of avifauna[1].

Convention name	Description	Geographic scope
African-Eurasian Waterbird Agreement (AEWA)	The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (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 The fair and equitable sharing of the benefits arising out of the utilization of genetic resources.	Global
Convention on the Conservation of Migratory	As an environmental treaty under the aegis of the United Nations Environment Programme, CMS provides a global platform for the	Global

[1] (BirdLife International (2021) Country profile: South Africa. Available from: http://www.birdlife.org/datazone/country/south_africa.

Convention name	Description	Geographic scope
Species of Wild Animals, (CMS), Bonn, 1979	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.	
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

7.2. National legislation

7.2.1. 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.

7.2.2. The National Environmental Management Act 107 of 1998, as amended (NEMA)

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, which may significantly affect the environment, may be performed only after an environmental impact assessment or basic assessment

has been done and authorization 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.

NEMA makes provision for the prescription of procedures for the assessment and minimum criteria for reporting on identified environmental themes (Sections 24(5)(a) and (h) and 44) when applying for environmental authorisation. The Protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species (Government Gazette No 43855, 30 October 2020) is applicable in the case of solar PV developments.

7.2.3. The National Environmental Management: Biodiversity Act 10 of 2004 (NEMBA) and the Threatened or Protected Species Regulations, February 2007 (TOPS Regulations)

The most prominent statute containing provisions directly aimed at the conservation of birds is the National Environmental Management: Biodiversity Act 10 of 2004 (as amended) (NEMBA) 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. The State is endowed with the trusteeship of biodiversity and has the responsibility to manage, conserve and sustain the biodiversity of South Africa.

7.2.4. Provincial legislation

The current legislation applicable to the conservation of fauna and flora in the Northern Cape is the Northern Cape Nature Conservation Act No 9 of 2009. It provides for the sustainable utilisation of wild animals, aquatic biota, and plants; the implementation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora; describes offences and penalties for contravention of the Act; provides for the appointment of nature conservators to implement the provisions of the Act; provides for the issuing of permits and other authorisations; and provides for matters connected therewith.

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Appendix A – Specialist expertise

Curriculum vitae: Chris van Rooyen

Profession/Specialisation	:	Avifaunal Specialist
Highest Qualification	:	BA 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.

Key project experience

Bird Impact Assessment Studies and avifaunal monitoring for wind-powered generation facilities:

1. Eskom Klipheuwel Experimental Wind Power Facility, Western Cape
2. Mainstream Wind Facility Jeffreys Bay, Eastern Cape (EIA and monitoring)
3. Biotherm, Swellendam, (Excelsior), Western Cape (EIA and monitoring)
4. Biotherm, Napier, (Matjieskloof), Western Cape (pre-feasibility)
5. Windcurrent SA, Jeffreys Bay, Eastern Cape (2 sites) (EIA and monitoring)
6. Caledon Wind, Caledon, Western Cape (EIA)
7. Innowind (4 sites), Western Cape (EIA)
8. Renewable Energy Systems (RES) Oyster Bay, Eastern Cape (EIA and monitoring)
9. Oelsner Group (Kerriefontein), Western Cape (EIA)
10. Oelsner Group (Langefontein), Western Cape (EIA)
11. InCa Energy, Vredendal Wind Energy Facility Western Cape (EIA)
12. Mainstream Loeriesfontein Wind Energy Facility (EIA and monitoring)
13. Mainstream Noupoort Wind Energy Facility (EIA and monitoring)
14. Biotherm Port Nolloth Wind Energy Facility (Monitoring)
15. Biotherm Laingsburg Wind Energy Facility (EIA and monitoring)

16. Langhoogte Wind Energy Facility (EIA)
17. Vleesbaai Wind Energy Facility (EIA and monitoring)
18. St. Helena Bay Wind Energy Facility (EIA and monitoring)
19. Electrawind, St Helena Bay Wind Energy Facility (EIA and monitoring)
20. Electrawind, Vredendal Wind Energy Facility (EIA)
21. SAGIT, Langhoogte and Wolseley Wind Energy facilities
22. Renosterberg Wind Energy Project – 12-month preconstruction avifaunal monitoring project
23. De Aar – North (Mulilo) Wind Energy Project – 12-month preconstruction avifaunal monitoring project
24. De Aar – South (Mulilo) Wind Energy Project – 12-month bird monitoring
25. Namies – Aggenys Wind Energy Project – 12-month bird monitoring
26. Pofadder - Wind Energy Project – 12-month bird monitoring
27. Dwarsrug Loeriesfontein - Wind Energy Project – 12-month bird monitoring
28. Waaihoek – Utrecht Wind Energy Project – 12-month bird monitoring
29. Amathole – Butterworth Utrecht Wind Energy Project – 12-month bird monitoring & EIA specialist
30. Phezukomoya and San Kraal Wind Energy Projects 12-month bird monitoring & EIA specialist study (Innowind)
31. Beaufort West Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mainstream)
32. Leeuwdraai Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mainstream)
33. Sutherland Wind Energy Facility 12-month bird monitoring (Mainstream)
34. Maralla Wind Energy Facility 12-month bird monitoring & EIA specialist study (Biotherm)
35. Esizayo Wind Energy Facility 12-month bird monitoring & EIA specialist study (Biotherm)
36. Humansdorp Wind Energy Facility 12-month bird monitoring & EIA specialist study (Cennergi)
37. Aletta Wind Energy Facility 12-month bird monitoring & EIA specialist study (Biotherm)
38. Eureka Wind Energy Facility 12-month bird monitoring & EIA specialist study (Biotherm)
39. Makambako Wind Energy Faclity (Tanzania) 12-month bird monitoring & EIA specialist study (Windlab)
40. R355 Wind Energy Facility 12-month bird monitoring (Mainstream)
41. Groenekloof Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mulilo)
42. Tsitsikamma Wind Energy Facility 24-months post-construction monitoring (Cennergi)
43. Noupoort Wind Energy Facility 24-months post-construction monitoring (Mainstream)
44. Kokerboom Wind Energy Facility 12-month bird monitoring & EIA specialist study (Business Venture Investments)
45. Kuruman Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mulilo)
46. Dassieklip Wind Energy Facility 3 years post-construction monitoring (Biotherm)
47. Loeriesfontein 2 Wind Energy Facility 2 years post-construction monitoring (Mainstream)
48. Khobab Wind Energy Facility 2 years post-construction monitoring (Mainstream)
49. Excelsior Wind Energy Facility 18 months construction phase monitoring (Biotherm)
50. Boesmansberg Wind Energy Facility 12-months pre-construction bird monitoring (juwi)
51. Mañhica Wind Energy Facility, Mozambique, 12-months pre-construction monitoring (Windlab)
52. Kwagga Wind Energy Facility, Beaufort West, 12-months pre-construction monitoring (ABO)
53. Pienaarspoort Wind Energy Facility, Touws River, Western Cape, 12-months pre-construction monitoring (ABO).
54. Koup 1 and 2 Wind Energy Facilities, Beaufort West, Western Cape, 12 months pre-construction monitoring (Genesis Eco-energy)
55. Duiker Wind Energy Facility, Vredendal, Western Cape 12 months pre-construction monitoring (ABO)

56. Perdekraal East Wind Energy Facility, Touws River, Western Cape, 18 months construction phase monitoring (Mainstream).
57. Swellendam Wind Energy Facility, Western Cape, 12-month pre-construction monitoring (Veld Renewables)
58. Lombardskraal Wind Energy Facility, Western Cape, 12-month pre-construction monitoring (Enertrag SA)
59. Mainstream Kolkies & Heuweltjies Wind Energy Facilities, Western Cape, 12-month pre-construction monitoring (Mainstream)
60. Great Karoo Wind Energy Facility, Northern Cape, 12-month pre-construction monitoring (African Green Ventures).
61. Mpumalanga & Gauteng Wind and Hybrid Energy Facilities (6x), pre-construction monitoring (Enertrag SA)
62. Dordrecht Wind Energy Facilities, Eastern Cape, Screening Report (Enertrag SA)
63. Dordrecht Wind Energy Facilities, Eastern Cape, Screening Report (ACED)
64. Nanibees North & South Wind Energy Facilities, Northern Cape, Screening Report (juwi)
65. Sutherland Wind Energy Facilities, Northern Cape, Screening Report (WKN Windcurrent)
66. Pofadder Wind Energy Facility, Northren Cape, Screening Report (Atlantic Energy)
67. Haga Haga Wind Energy Facility, Eastern Cape, Amendment Report (WKN Windcurrent)
68. Banken Wind Energy Facility, Northern Cape, Screening Report (Atlantic Energy)
69. Hartebeest Wind Energy Facility, Western Cape, 12-month pre-construction monitoring (juwi).

Bird impact assessment studies for solar energy plants:

1. Concentrated Solar Power Plant, Upington, Northern Cape.
2. Globeleq De Aar and Droogfontein Solar PV Pre- and Post-construction avifaunal monitoring
3. JUWI Kronos PV project, Copperton, Northern Cape
4. Sand Draai CSP project, Groblershoop, Northern Cape
5. Biotherm Helena PV Project, Copperton, Northern Cape
6. Biotherm Letsiao CSP Project, Aggeneys, Northern Cape
7. Biotherm Enamandla PV Project, Aggeneys, Northern Cape
8. Biotherm Sendawo PV Project, Vryburg, North-West
9. Biotherm Tlisitseng PV Project, Lichtenburg, North-West
10. JUWI Hotazel Solar Park Project, Hotazel, Northern Cape
11. Namakwa Solar Project, Aggeneys, Northern Cape
12. Brypaal Solar Power Project, Kakamas, Northern Cape
13. ABO Vryburg 1,2,3 Solar PV Project, Vryburg, North-West
14. NamPower CSP Facility near Arandis, Namibia
15. Dayson Klip PV Facility near Upington, Northern Cape
16. Geelkop PV Facility near Upington, Northern Cape
17. Oya PV Facility, Ceres, Western Cape
18. Vrede and Rondawel PV Facilities, Free State
19. Kolkies & Sadawa PV Facilities, Western Cape
20. Leeuwbosch PV1 and 2 and Wildebeeskuil PV1 and 2 Facilities, North-West
21. Kenhardt PV 3,4 and 5, Northern Cape
22. Wittewal PV, Grootfontein PV and Hoekdoornen PV Facilities, Touws River, Western Cape

Bird impact assessment studies for the following overhead line projects:

1. Chobe 33kV Distribution line
2. Athene - Umfolozi 400kV
3. Beta-Delphi 400kV
4. Cape Strengthening Scheme 765kV
5. Flurian-Louis-Trichardt 132kV
6. Ghanzi 132kV (Botswana)
7. Ikaros 400kV
8. Matimba-Witkop 400kV
9. Naboomspruit 132kV
10. Tabor-Flurian 132kV
11. Windhoek - Walvisbaai 220 kV (Namibia)
12. Witkop-Overyssel 132kV
13. Breyten 88kV
14. Adis-Phoebus 400kV
15. Dhuva-Janus 400kV
16. Perseus-Mercury 400kV
17. Gravelotte 132kV
18. Ikaros 400 kV
19. Khanye 132kV (Botswana)
20. Moropule – Thamaga 220 kV (Botswana)
21. Parys 132kV
22. Simplon –Everest 132kV
23. Tutuka-Alpha 400kV
24. Simplon-Der Brochen 132kV
25. Big Tree 132kV
26. Mercury-Ferrum-Garona 400kV
27. Zeus-Perseus 765kV
28. Matimba B Integration Project
29. Caprivi 350kV DC (Namibia)
30. Gerus-Mururani Gate 350kV DC (Namibia)
31. Mmamabula 220kV (Botswana)
32. Steenberg-Der Brochen 132kV
33. Venetia-Paradise T 132kV
34. Burgersfort 132kV
35. Majuba-Umfolozi 765kV
36. Delta 765kV Substation
37. Braamhoek 22kV
38. Steelpoort Merensky 400kV
39. Mmamabula Delta 400kV
40. Delta Epsilon 765kV
41. Gerus-Zambezi 350kV DC Interconnector: Review of proposed avian mitigation measures for the Okavango and Kwando River crossings
42. Giyani 22kV Distribution line
43. Liqhobong-Kao 132/11kV distribution power line, Lesotho
44. 132kV Leslie – Wildebeest distribution line

45. A proposed new 50 kV Spoornet feeder line between Sishen and Saldanha
46. Cairns 132kv substation extension and associated power lines
47. Pimlico 132kv substation extension and associated power lines
48. Gyani 22kV
49. Matafin 132kV
50. Nkomazi_Fig Tree 132kV
51. Pebble Rock 132kV
52. Reddersburg 132kV
53. Thaba Combine 132kV
54. Nkomati 132kV
55. Louis Trichardt – Musina 132kV
56. Endicot 44kV
57. Apollo Lepini 400kV
58. Tarlton-Spring Farms 132kV
59. Kuschke 132kV substation
60. Bendstore 66kV Substation and associated lines
61. Kuiseb 400kV (Namibia)
62. Gyani-Malamulele 132kV
63. Watershed 132kV
64. Bakone 132kV substation
65. Eerstegoud 132kV LILO lines
66. Kumba Iron Ore: SWEP - Relocation of Infrastructure
67. Kudu Gas Power Station: Associated power lines
68. Steenberg Booysendal 132kV
69. Toulon Pumps 33kV
70. Thabatshipi 132kV
71. Witkop-Silica 132kV
72. Bakubung 132kV
73. Nelsriver 132kV
74. Rethabiseng 132kV
75. Tilburg 132kV
76. GaKgapane 66kV
77. Knobel Gilead 132kV
78. Bochum Knobel 132kV
79. Madibeng 132kV
80. Witbank Railway Line and associated infrastructure
81. Spencer NDP phase 2 (5 lines)
82. Akanani 132kV
83. Hermes-Dominion Reefs 132kV
84. Cape Pensinsula Strengthening Project 400kV
85. Magalakwena 132kV
86. Benficosa 132kV
87. Dithabaneng 132kV
88. Taunus Diepkloof 132kV
89. Taunus Doornkop 132kV
90. Tweedracht 132kV
91. Jane Furse 132kV

92. Majeje Sub 132kV
93. Tabor Louis Trichardt 132kV
94. Riversong 88kV
95. Mamatsekele 132kV
96. Kabokweni 132kV
97. MDPP 400kV Botswana
98. Marble Hall NDP 132kV
99. Bokmakiere 132kV Substation and LILO lines
100. Styldrift 132kV
101. Taunus – Diepkloof 132kV
102. Bighorn NDP 132kV
103. Waterkloof 88kV
104. Camden – Theta 765kV
105. Dhuva – Minerva 400kV Diversion
106. Lesedi –Grootpan 132kV
107. Waterberg NDP
108. Bulgerivier – Dorset 132kV
109. Bulgerivier – Toulon 132kV
110. Nokeng-Fluorspar 132kV
111. Mantsole 132kV
112. Tshilamba 132kV
113. Thabamoopo - Tshebela – Nhlovuko 132kV
114. Arthurseat 132kV
115. Borutho 132kV MTS
116. Volspruit - Potgietersrus 132kV
117. Neotel Optic Fibre Cable Installation Project: Western Cape
118. Matla-Glockner 400kV
119. Delmas North 44kV
120. Houwhoek 11kV Refurbishment
121. Clau-Clau 132kV
122. Ngwedi-Silwerkrans 134kV
123. Nieuwehoop 400kV walk-through
124. Booysendal 132kV Switching Station
125. Tarlton 132kV
126. Medupi - Witkop 400kV walk-through
127. Germiston Industries Substation
128. Sekgame 132kV
129. Botswana – South Africa 400kV Transfrontier Interconnector
130. Syferkuil – Rampheri 132kV
131. Queens Substation and associated 132kV powerlines
132. Oranjemond 400kV Transmission line
133. Aries – Helios – Juno walk-down
134. Kuruman Phase 1 and 2 Wind Energy facilities 132kV Grid connection
135. Transnet Thaba 132kV

Bird impact assessment studies for the following residential and industrial developments:

1. Lizard Point Golf Estate
2. Lever Creek Estates
3. Leloko Lifestyle Estates
4. Vaaloewers Residential Development
5. Clearwater Estates Grass Owl Impact Study
6. Somerset Ext. Grass Owl Study
7. Proposed Three Diamonds Trading Mining Project (Portion 9 and 15 of the Farm Blesbokfontein)
8. N17 Section: Springs To Leandra –"Borrow Pit 12 And Access Road On (Section 9, 6 And 28 Of The Farm Winterhoek 314 Ir)
9. South African Police Services Gauteng Radio Communication System: Portion 136 Of The Farm 528 Jq, Lindley.
10. Report for the proposed upgrade and extension of the Zeekoegat Wastewater Treatment Works, Gauteng.
11. Bird Impact Assessment for Portion 265 (a portion of Portion 163) of the farm Rietfontein 189-JR, Gauteng.
12. Bird Impact Assessment Study for Portions 54 and 55 of the Farm Zwartkop 525 JQ, Gauteng.
13. Bird Impact Assessment Study Portions 8 and 36 of the Farm Nooitgedacht 534 JQ, Gauteng.
14. Shumba's Rest Bird Impact Assessment Study
15. Randfontein Golf Estate Bird Impact Assessment Study
16. Zilkaatsnek Wildlife Estate
17. Regenstein Communications Tower (Namibia)
18. Avifaunal Input into Richards Bay Comparative Risk Assessment Study
19. Maquasa West Open Cast Coal Mine
20. Glen Erasmia Residential Development, Kempton Park, Gauteng
21. Bird Impact Assessment Study, Weltevreden Mine, Mpumalanga
22. Bird Impact Assessment Study, Olifantsvlei Cemetery, Johannesburg
23. Camden Ash Disposal Facility, Mpumalanga
24. Lindley Estate, Lanseria, Gauteng
25. Proposed open cast iron ore mine on the farm Lylyveld 545, Northern Cape
26. Avifaunal monitoring for the Sishen Mine in the Northern Cape as part of the EMPr requirements
27. Steelpoort CNC Bird Impact Assessment Study

Professional affiliation

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 18 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 (reg. nr 400177/09) with The South African Council for Natural Scientific Professions, specialising in Zoological Science.

Key Project Experience

Renewable Energy Facilities –avifaunal monitoring projects in association with Chris van Rooyen Consulting

1. Jeffrey's Bay Wind Farm – 12-months preconstruction avifaunal monitoring project
2. Oysterbay Wind Energy Project – 12-months preconstruction avifaunal monitoring project
3. Ubuntu Wind Energy Project near Jeffrey's Bay – 12-months preconstruction avifaunal monitoring project
4. Bana-ba-Pifu Wind Energy Project near Humansdorp – 12-months preconstruction avifaunal monitoring project
5. Excelsior Wind Energy Project near Caledon – 12-months preconstruction avifaunal monitoring project
6. Laingsburg Spitskopvlakte Wind Energy Project – 12-months preconstruction avifaunal monitoring project
7. Loeriesfontein Wind Energy Project Phase 1, 2 & 3 – 12-months preconstruction avifaunal monitoring project
8. Noupoort Wind Energy Project – 12-months preconstruction avifaunal monitoring project
9. Vleesbaai Wind Energy Project – 12-months preconstruction avifaunal monitoring project
10. Port Nolloth Wind Energy Project – 12-months preconstruction avifaunal monitoring project
11. Langhoogte Caledon Wind Energy Project – 12-months preconstruction avifaunal monitoring project
12. Lunsklip – Stilbaai Wind Energy Project – 12-months preconstruction avifaunal monitoring project
13. Indwe Wind Energy Project – 12-months preconstruction avifaunal monitoring project

14. Zeeland St Helena bay Wind Energy Project – 12-months preconstruction avifaunal monitoring project
15. Wolseley Wind Energy Project – 12-months preconstruction avifaunal monitoring project
16. Renosterberg Wind Energy Project – 12-months preconstruction avifaunal monitoring project
17. De Aar – North (Mulilo) Wind Energy Project – 12-months preconstruction avifaunal monitoring project (2014)
18. De Aar – South (Mulilo) Wind Energy Project – 12-months bird monitoring
19. Namies – Aggenys Wind Energy Project – 12-months bird monitoring
20. Pofadder - Wind Energy Project – 12-months bird monitoring
21. Dwarsrug Loeriesfontein - Wind Energy Project – 12-months bird monitoring
22. Waaihoek – Utrecht Wind Energy Project – 12-months bird monitoring
23. Amathole – Butterworth Utrecht Wind Energy Project – 12-months bird monitoring & EIA specialist study
24. De Aar and Droogfontein Solar PV Pre- and Post-construction avifaunal monitoring
25. Makambako Wind Energy Faclity (Tanzania) 12-month bird monitoring & EIA specialist study (Windlab)
26. R355 Wind Energy Facility 12-month bird monitoring (Mainstream)
27. Groenekloof Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mulilo)
28. Tsitsikamma Wind Energy Facility 24-months post-construction monitoring (Cennergi)
29. Noupoort Wind Energy Facility 24-months post-construction monitoring (Mainstream)
30. Kokerboom Wind Energy Facility 12-month bird monitoring & EIA specialist study (Business Venture Investments)
31. Kuruman Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mulilo)
32. Mañhica Wind Energy Facility 12-month bird monitoring & EIA specialist study (Windlab)
33. Kwagga Wind Energy Facility, Beaufort West, 12-months pre-construction monitoring (ABO)
34. Pienaarspoort Wind Energy Facility, Touws River, Western Cape, 12-months pre- construction monitoring (ABO). Koup 1 and 2 Wind Energy Facilities, Beaufort West, Western Cape, 12 months pre-construction monitoring (Genesis Eco-energy)
35. Duiker Wind Energy Facility, Vredendal, Western Cape 12 months pre-construction monitoring (ABO)
36. Perdekraal East Wind Energy Facility, Touws River, Western Cape, 18 months construction phase monitoring (Mainstream).
37. Swellendam Wind Energy Facility, Western Cape, 12-month pre-construction monitoring (Veld Renewables)
38. Lombardskraal Wind Energy Facility, Western Cape, 12-month pre-construction monitoring (Enertrag SA)
39. Mainstream Kolkies & Heuweltjies Wind Energy Facilities, Western Cape, 12-month pre-construction monitoring (Mainstream)
40. Great Karoo Wind Energy Facility, Northern Cape, 12-month pre-construction monitoring (African Green Ventures).
41. Mpumalanga & Gauteng Wind and Hybrid Energy Facilities (6x), pre-construction monitoring (Enertrag SA)
42. Dordrecht Wind Energy Facilities, Eastern Cape, Screening Report (Enertrag SA)
43. Dordrecht Wind Energy Facilities, Eastern Cape, Screening Report (ACED)
44. Nanibees North & South Wind Energy Facilities, Northern Cape, Screening Report (juwi)
45. Sutherland Wind Energy Facilities, Northern Cape, Screening Report (WKN Windcurrent)
46. Pofadder Wind Energy Facility, Northren Cape, Screening Report (Atlantic Energy)
47. Haga Haga Wind Energy Facility, Eastern Cape, Amendment Report (WKN Windcurrent)
48. Banken Wind Energy Facility, Northern Cape, Screening Report (Atlantic Energy)
49. Hartebeest Wind Energy Facility, Western Cape, 12-month pre-construction monitoring (juwi).

Bird Impact Assessment studies and / or GIS analysis:

1. Aviation Bird Hazard Assessment Study for the proposed Madiba Bay Leisure Park adjacent to Port Elizabeth Airport.
2. Extension of Runway and Provision of Parallel Taxiway at Sir Seretse Khama Airport, Botswana Bird / Wildlife Hazard Management Specialist Study
3. Maun Airport Improvements Bird / Wildlife Hazard Management Specialist Study
4. Bird Impact Assesment Study - Bird Helicopter Interaction – The Bitou River, Western Cape Province South Africa
5. Proposed La Mercy Airport – Bird Aircraft interaction specialists study using bird detection radar to assess swallow flocking behaviour.
6. KwaZulu Natal Power Line Vulture Mitigation Project – GIS analysis
7. Perseus-Zeus Powerline EIA – GIS Analysis
8. Southern Region Pro-active GIS Blue Crane Collision Project.
9. Specialist advisor ~ Implementation of a bird detection radar system and development of an airport wildlife hazard management and operational environmental management plan for the King Shaka International Airport
10. Matsapha International Airport – bird hazard assessment study with management recommendations
11. Evaluation of aviation bird strike risk at candidate solid waste disposal sites in the Ekurhuleni Metropolitan Municipality
12. Gateway Airport Authority Limited – Gateway International Airport, Polokwane: Bird hazard assessment; Compile a bird hazard management plan for the airport
13. Bird Specialist Study - Evaluation of aviation bird strike risk at the Mwakirunge Landfill site near Mombasa Kenya
14. Bird Impact Assessment Study - Proposed Weltevreden Open Cast Coal Mine Belfast, Mpumalanga
15. Avian biodiversity assessment for the Mafube Colliery Coal mine near Middelburg Mpumalanga
16. Avifaunal Specialist Study - SRVM Volspruit Mining project – Mokopane Limpopo Province
17. Avifaunal Impact Assessment Study (with specific reference to African Grass Owls and other Red List species) Stone Rivers Arch
18. Airport bird and wildlife hazard management plan and training to Swaziland Civil Aviation Authority (SWACAA) for Matsapha and Sikhupe International Airports
19. Avifaunal Impact Scoping & EIA Study - Renosterberg Wind Farm and Solar PV site
20. Bird Impact Assessment Study - Proposed 60 year Ash Disposal Facility near to the Kusile Power Station
21. Avifaunal pre-feasibility assessment for the proposed Montrose dam, Mpumalanga
22. Bird Impact Assessment Study – Proposed ESKOM Phantom Substation near Knysna, Western Cape
23. Habitat sensitivity map for Denham's Bustard, Blue Crane and White-bellied Korhaan in the Kouga Municipal area of the Eastern Cape Province
24. Swaziland Civil Aviation Authority – Sikhuphe International Airport – Bird hazard management assessment
25. Avifaunal monitoring – extension of Specialist Study - SRVM Volspruit Mining project – Mokopane Limpopo Province
26. Avifaunal Specialist Study – Rooikat Hydro Electric Dam – Hope Town, Northern Cape
27. The Stewards Pan Reclamation Project – Bird Impact Assessment study
28. Airports Company South Africa – Avifaunal Specialist Consultant – Airport Bird and Wildlife Hazard Mitigation

Geographic Information System analysis & maps

1. ESKOM Power line Makgalakwena EIA – GIS specialist & map production
2. ESKOM Power line Benficosa EIA – GIS specialist & map production
3. ESKOM Power line Riversong EIA – GIS specialist & map production
4. ESKOM Power line Waterberg NDP EIA – GIS specialist & map production
5. ESKOM Power line Bulge Toulon EIA – GIS specialist & map production
6. ESKOM Power line Bulge DORSET EIA – GIS specialist & map production
7. ESKOM Power lines Marblehall EIA – GIS specialist & map production
8. ESKOM Power line Grootpan Lesedi EIA – GIS specialist & map production
9. ESKOM Power line Tanga EIA – GIS specialist & map production
10. ESKOM Power line Bokmakierie EIA – GIS specialist & map production
11. ESKOM Power line Rietfontein EIA – GIS specialist & map production
12. Power line Anglo Coal EIA – GIS specialist & map production
13. ESKOM Power line Camcoll Jericho EIA – GIS specialist & map production
14. Hartbeespoort Residential Development – GIS specialist & map production
15. ESKOM Power line Mantsole EIA – GIS specialist & map production
16. ESKOM Power line Nokeng Flourspar EIA – GIS specialist & map production
17. ESKOM Power line Greenview EIA – GIS specialist & map production
18. Derdepoort Residential Development – GIS specialist & map production
19. ESKOM Power line Boynton EIA – GIS specialist & map production
20. ESKOM Power line United EIA – GIS specialist & map production
21. ESKOM Power line Gutshwa & Malelane EIA – GIS specialist & map production
22. ESKOM Power line Origstad EIA – GIS specialist & map production
23. Zilkaatsnek Development Public Participation –map production
24. Belfast – Paarde Power line - GIS specialist & map production
25. Solar Park Solar Park Integration Project Bird Impact Assessment Study – avifaunal GIS analysis.
26. Kappa-Omega-Aurora 765kV Bird Impact Assessment Report – Avifaunal GIS analysis.
27. Gamma – Kappa 2nd 765kV – Bird Impact Assessment Report – Avifaunal GIS analysis.
28. ESKOM Power line Kudu-Dorstfontein Amendment EIA – GIS specialist & map production.
29. Proposed Heilbron filling station EIA – GIS specialist & map production
30. ESKOM Lebatlhane EIA – GIS specialist & map production
31. ESKOM Pienaars River CNC EIA – GIS specialist & map production
32. ESKOM Lemara Phiring Ohrigstad EIA – GIS specialist & map production
33. ESKOM Pelly-Warmbad EIA – GIS specialist & map production
34. ESKOM Rosco-Bracken EIA – GIS specialist & map production
35. ESKOM Ermelo-Uitkoms EIA – GIS specialist & map production
36. ESKOM Wisani bridge EIA – GIS specialist & map production
37. City of Tswane – New bulkfeeder pipeline projects x3 Map production
38. ESKOM Lebohang Substation and 132kV Distribution Power Line Project Amendment GIS specialist & map production
39. ESKOM Geluk Rural Powerline GIS & Mapping
40. Eskom Kimberley Strengthening Phase 4 Project GIS & Mapping
41. ESKOM Kwaggafontein - Amandla Amendment Project GIS & Mapping
42. ESKOM Lephalale CNC – GIS Specialist & Mapping
43. ESKOM Marken CNC – GIS Specialist & Mapping
44. ESKOM Lethabong substation and powerlines – GIS Specialist & Mapping

45. ESKOM Magopela- Pitsong 132kV line and new substation – GIS Specialist & Mapping

Professional affiliations

South African Council for Natural Scientific Professions (SACNASP) registered Professional Natural Scientist (reg. nr 400177/09) – specialist field: Zoological Science. Registered since 2009.

Curriculum vitae: Jake Mulvaney

Profession/Specialisation	:	Postdoctoral researcher/Avifaunal Specialist
Highest Qualification	:	PhD in Zoology
Nationality	:	South African
Years of experience	:	0.5 years

Key experience

Jake Mulvaney is a postdoctoral researcher in ornithology at Stellenbosch University. He is author and/or co-author of four academic papers involving bird population assessments and GIS modelling and is a licensed South African bird ringer. From 2021, he assists Chris van Rooyen Consulting with environmental impact assessments of wind and solar energy facility developments.

Key project experience

Bird Impact Assessment Studies and avifaunal monitoring for wind-powered generation facilities:

1. Highlands Wind Energy Facility, Dordrecht, Eastern Cape
2. Duiker Wind Energy Facility, Vredendal, Western Cape
3. Taaibosch Wind Energy Complex, Postmasburg, Northern Cape

Bird impact assessment studies for solar energy plants:

1. Taaibosch Solar Energy Complex, Postmasburg, Northern Cape

Professional affiliation

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.

Appendix B – Specialist statement of independence

10.4 The Specialist

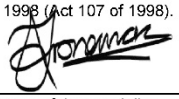
Note: Duplicate this section where there is more than one specialist.

I Albert Froneman, as the appointed specialist hereby declare/affirm the correctness of the information provided as part of the application, and that I:

- in terms of the general requirement to be independent (tick which is applicable):

✓	other than fair remuneration for work performed/to be performed in terms of this application, have no business, financial, personal or other interest in the activity or application and that there are no circumstances that may compromise my objectivity; or
	am not independent, but another EAP that is independent and meets the general requirements set out in Regulation 13 has been appointed to review my work (Note: a declaration by the review specialist must be submitted);

- have expertise in conducting specialist work as required, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- will ensure compliance with the EIA Regulations 2014;
- will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the application;
- will take into account, to the extent possible, the matters listed in regulation **18** of the regulations when preparing the application and any report, plan or document relating to the application;
- will disclose to the proponent or applicant, registered interested and affected parties 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 or the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority (unless access to that information is protected by law, in which case I will indicate that such protected information exists and is only provided to the competent authority);
- declare that all the particulars furnished by me in this form are true and correct;
- am aware that it is an offence in terms of Regulation 48 to provide incorrect or misleading information and that a person convicted of such an offence is liable to the penalties as contemplated in section 49B(2) of the National Environmental Management Act, 1998 (Act 107 of 1998).



Signature of the specialist

Afrimage Photography (Pty) Ltd t/a Chris van Rooyen Consulting

Name of company

05 June 2022

Date

10.4 The Specialist

Note: Duplicate this section where there is more than one specialist.

I Chris van Rooyen, as the appointed specialist hereby declare/affirm the correctness of the information provided as part of the application, and that I:

- in terms of the general requirement to be independent (tick which is applicable):

✓	other than fair remuneration for work performed/to be performed in terms of this application, have no business, financial, personal or other interest in the activity or application and that there are no circumstances that may compromise my objectivity; or
	am not independent, but another EAP that is independent and meets the general requirements set out in Regulation 13 has been appointed to review my work (Note: a declaration by the review specialist must be submitted);

- have expertise in conducting specialist work as required, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- will ensure compliance with the EIA Regulations 2014;
- will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the application;
- will take into account, to the extent possible, the matters listed in regulation **18** of the regulations when preparing the application and any report, plan or document relating to the application;
- will disclose to the proponent or applicant, registered interested and affected parties 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 or the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority (unless access to that information is protected by law, in which case I will indicate that such protected information exists and is only provided to the competent authority);
- declare that all the particulars furnished by me in this form are true and correct;
- am aware that it is an offence in terms of Regulation 48 to provide incorrect or misleading information and that a person convicted of such an offence is liable to the penalties as contemplated in section 49B(2) of the National Environmental Management Act, 1998 (Act 107 of 1998).

Signature of the specialist

Afrimage Photography (Pty) Ltd t/a Chris va Rooyen Consulting

Name of company

05 June 2022

Date

Appendix C – Site sensitivity verification

Prior to commencing with the specialist assessment in accordance with Appendix 6 of the National Environmental Management Act (Act 107 of 1998, as amended) (NEMA) Environmental Impact Assessment (EIA) Regulations of 2014, a site sensitivity verification was undertaken in order to confirm the current land use and environmental sensitivity of the proposed project area as identified by the National Web-Based Environmental Screening Tool (Screening Tool). NEMA makes provision for the prescription of procedures for the assessment and minimum criteria for reporting on identified environmental themes (Sections 24(5)(a) and (h) and 44) when applying for environmental authorisation. The Protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species (Government Gazette No 43855, 30 October 2020) is applicable in the case of solar PV developments.

The details of the site sensitivity verification (SSV) are noted below:

Date of Site Visits	22 – 26 July, 04 December 2021, 05 – 08 January 2022.
Supervising Specialist Name	Albert Froneman
Professional Registration Number	MSc Conservation Biology (SACNASP Zoological Science Registration number 400177/09)
Specialist Affiliation / Company	Chris van Rooyen Consulting

C1. Methodology

The following methods were used to compile this report:

- Bird distribution data of the South African Bird Atlas 2 (SABAP 2) was obtained from the Animal Demography Unit (ADU) of the University of Cape Town (ADU 2020), as a means to ascertain which species occurs within the broader area i.e. within a block consisting of 15 pentad grid cells each within which the proposed projects are situated. A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km. From 2011 to date, a total of 82 full protocol lists (i.e. surveys lasting a minimum of two hours each) have been completed for this area. In addition, 34 *ad hoc* protocol lists (i.e. surveys lasting less than two hours but still yielding valuable data) have been completed, and 0 incidental records collected.
- 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 (Taylor et al., 2015), and the latest authoritative summary of southern African bird biology (Hockey et al., 2005).
- The global threatened status of all priority species was determined by consulting the (2021.2) International Union for Conservation of Nature (IUCN) Red List of Threatened Species (http://www.iucnredlist.org/).
- A classification of the habitat in the development area was obtained from the Atlas of Southern African Birds 1 (SABAP 1) (Harrison et al., 1997a, 1997b) and the National Vegetation Map (2012 beta2) from the South African National Biodiversity Institute (SANBI) website (Mucina & Rutherford, 2006; SANBI, 2018). Development area is the area covered by the land parcels where PV development will be located.
- The Important Bird Areas of Southern Africa (Marnewick et al., 2015) was consulted for information on potentially relevant Important Bird Areas (IBAs).
- Satellite imagery (Google Earth ©2021) was used in order to view the broader development area on a landscape level and to help identify sensitive bird habitat.

- Priority solar species were defined as follows: South African Red Data species, South African endemics and near-endemics, raptors and waterbirds.
- The SANBI BGIS map viewer (http://bgisviewer.sanbi.org) was used to determine the locality of the proposed site relative to National Protected Areas and National Protected Areas Expansion Strategy (NPAES) focus areas.
- The Department of Forestry, Fisheries and the Environment (DFFE) National Screening Tool was used to determine the assigned avian sensitivity of the proposed development areas.
- Data collected during previous site visits to the broader area was also considered as far as habitat classes and the occurrence of priority species are concerned.
- The following sources were used to determine the investigation protocol that is required for the site:
    - Procedures for the Assessment and Minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of NEMA when applying for Environmental Authorisation (Gazetted October 2020);
    - Guidelines for the Implementation of the Terrestrial Flora & Terrestrial Fauna Species Protocols for EIAs in South Africa produced by the SANBI on behalf of the Department of Environment, Forestry and Fisheries (2020); and
    - The BirdLife South Africa (BLSA) Guidelines for assessing and monitoring the impact of solar power generating facilities on birds in southern Africa. BirdLife South Africa by (Jenkins et al., 2017) – hereafter referred to as the 'Solar Guidelines' – were consulted to determine the level of survey effort that is required.

The main source of information on the avifaunal diversity and abundance at the development area was an integrated pre-construction monitoring programme which was implemented in 2021 - 2022.The pre-construction avifaunal monitoring programme followed an adapted Regime 2 protocol as defined in the Solar Guidelines which require a minimum of two surveys over a six month period.

C2. Results of site assessment

The development area and immediate environment is classified largely as **High** sensitivity for terrestrial animals according to the Terrestrial Animal Species Theme[2]. The High classification is linked to the potential occurrence of African Marsh Harrier (Globally Least Concern, Regionally Endangered), Secretarybird (Globally Endangered, Regionally Vulnerable) and Blue Crane (Globally Vulnerable, Regionally Near-threatened). The development area contains confirmed habitat for these species of conservation concern (SCC) as defined in the Protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species (Government Gazette No 43855, 30 October 2020), namely listed on the IUCN Red List of Threatened Species or South Africa's National Red List website as Critically Endangered, Endangered or Vulnerable. The occurrence of SCC was also confirmed during the surveys i.e. Lanner Falcon (Globally Least Concern, Regionally Vulnerable) was recorded in the development area.

[2] Note that the Avian theme for PV in the Screening Tool is incorrect, as it displays the sensitivities for bats, and not birds.

C2.1. Avifauna

A total of 186 species could potentially occur within the broader area where the project is located (see Appendix E). Of these, 92 are classified as priority species for solar developments. Of the 92 priority species, 47 have a medium to very high probability of occurring in the development site. Of the 47 priority species with a medium to high probability of occurrence, 34 were recorded during site surveys.

Eleven Red Data List species are associated with the broader area. Nine Red Data List species have a low probability of occurrence – African Marsh Harrier, Blue Crane, Caspian Tern, European Roller, Greater Painted Snipe, Lanner Falcon, Maccoa Duck, Pallid Harrier, and Red-footed Falcon – while to Red Data List Species have a medium to high probability of occurrence – Blue Korhaan, Greater Flamingo, and Secretarybird. Three Red Data species were recorded during the site surveys – Blue Korhaan, Greater Flamingo, and Lanner Falcon.

C2.2. Bird habitat

The following bird habitat features were recorded at and near the development area:

C2.2.1. Biomes and vegetation types

The Vhuvhili site is located within the Soweto Highveld Grassland (Gm8) vegetation ecotype within the Mesic Highveld Grassland Bioregion (SANBI, 2018). This vegetation type covers 14 513 km2 of Mpumalanga and Gauteng (and to a very small extent also in the neighbouring Free State and North-West provinces) and occurs at an altitude ranging from 1420 m to 1760 m above sea level (Mucina et al., 2006). The site does not fall within any Centre of Endemism (Van Wyk & Smith, 2001).

Soweto Highveld Grassland is a summer rainfall vegetation (662 mm per annum, mostly September to April), which experiences a cool-temperate climate (mean annual temperature 14.8°C) with thermic continentality. Temperature ranges between 28°C (January) to -0.6°C (July). Frost and frequent grass fires during winter play an important role in limiting the occurrence of trees and shrubs in the region (Mucina et al., 2006).

The landscape is gently to moderately undulating on the Highveld plateau (Figure C2), supporting dense tufted grassland dominated by *Themeda triandra*, with a notable herbaceous forb component. In places which have not been disturbed, scattered wetlands, narrow stream alluvia, pans and occasional ridges interrupt the grassland cover.

Although the conservation status of this vegetation type was listed as “Endangered” by (Mucina & Rutherford (2006) it is listed as “Vulnerable” by the updated NEMA of 2011 (see 7.2.2.). Very few statutorily conserved areas occur in this vegetation type and almost half has been transformed mostly by cultivation, plantations, mining, and urbanisation.

C2.2.2. Drainage lines and wetlands

These streams, wetlands, vleis and floodplains are associated mostly with the Klipspruit River and its tributaries and cover most of the Vhuvhili SEF (Figure C3). Surface rocks are present in some places along the streams. The alluvial soils are mostly deep dark brown to black clayey soils

C2.2.3. Dams and pans

There are several small dams, as well as a few small pans, mostly associated with the Klipspruit River and its tributaries (Figure C4). There is one moderately large near the western central portion of the Vhuvhili SEF (Thompson, 2019).

C2.2.4. Agricultural land

Agricultural activity present within the Vhuvhili SEF comprises cultivated commercial annuals non-pivot cropland (Thompson, 2019), predominately dedicated towards maize production (Figure C5).

C2.2.5 Alien trees

Alien trees are present on the Vhuvhili SEF as windbreaks either between agricultural fields or between homesteads (Thompson, 2019) (Figure C6)

C3. Conclusions

Based on the Site Sensitivity Verification field survey conducted, habitat within the development area appears suitable for African Marsh Harrier, Secretarybird, Blue Crane and Lanner Falcon. Therefore, the classification of High sensitivity for avifauna in the screening tool is confirmed for the proposed development area.

Appendix D – Impact assessment methodology

The impact assessment includes:

- *the nature, significance and consequences of the impact and risk;*
- *the extent and duration of the impact and risk;*
- *the probability of the impact and risk occurring.*
- *the degree to which impacts and risks can be mitigated;*
- *the degree to which the impacts and risks can be reversed; and*
- *the degree to which the impacts and risks can cause loss of irreplaceable resources.*

As per the DFFET Guideline 5: Assessment of Alternatives and Impacts, the following methodology is applied to the prediction and assessment of impacts and risks. Potential impacts and risks have been 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.*

The impact assessment methodology includes the following aspects:

- *Nature of impact/risk - The type of effect that a proposed activity will have on the environment.*
- *Status - Whether the impact/risk on the overall environment will be:*
    - *Positive - environment overall will benefit from the impact/risk;*
    - *Negative - environment overall will be adversely affected by the impact/risk; or*
    - *Neutral - environment overall not be affected.*
- *Spatial extent – The size of the area that will be affected by the impact/risk:*
    - *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 impact/risk 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)).*
- *Consequence – The anticipated consequence of the risk/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).*

- *Reversibility of the Impacts - the extent to which the impacts/risks are reversible assuming that the project has reached the end of its life cycle (decommissioning phase):*
  - *High reversibility of impacts (impact is highly reversible at end of project life i.e. this is the most favourable assessment for the environment);*
  - *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).*
- *Irreplaceability of Receiving Environment/Resource Loss caused by impacts/risks – 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):*
  - *High irreplaceability of resources (project will destroy unique resources that cannot be replaced, i.e. this is the least favourable assessment for the environment);*
  - *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 have been further assessed in terms of the following:

- *Probability – The probability of the impact/risk 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).*

To determine the significance of the identified impact/risk, the consequence is multiplied by probability (qualitatively as shown in Figure D1).

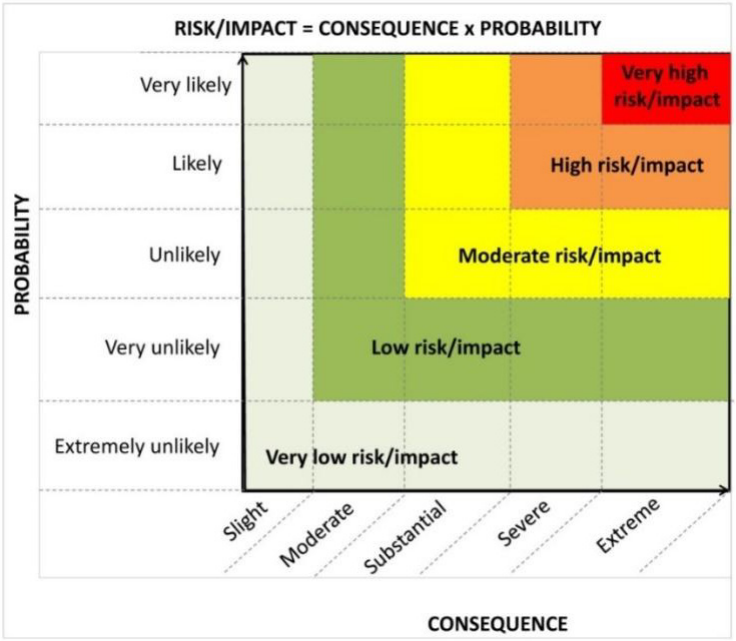


Figure D1 Guide to assessing risk/impact significance as a result of consequence and probability.

- *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/impact will result in major alteration to the environment even with the implementation on the appropriate mitigation measures and will have an influence on decision-making); and*
- *Very high (the risk/impact 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)).*

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

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

Confidence – The degree of confidence in predictions based on available information and specialist knowledge:

- *Low;*
- *Medium; or*
- *High.*

Appendix E – Species lies for the broader area

Group	Species name	Scientific name	Full protocol	Ad hoc protocol
	Hamerkop	*Scopus umbretta*	9.8	0.0
	Mallard	*Anas platyrhynchos*	8.5	2.9
	Quailfinch	*Ortygospiza atricollis*	32.9	8.8
	Ruff	*Calidris pugnax*	11.0	0.0
	Secretarybird	*Sagittarius serpentarius*	8.5	0.0
Avocet	Pied Avocet	*Recurvirostra avosetta*	6.1	2.9
Barbet	Black-collared Barbet	*Lybius torquatus*	12.2	0.0
Barbet	Crested Barbet	*Trachyphonus vaillantii*	18.3	5.9
Bishop	Southern Red Bishop	*Euplectes orix*	85.4	29.4
Bishop	Yellow-crowned Bishop	*Euplectes afer*	37.8	2.9
Bittern	Little Bittern	*Ixobrychus minutus*	2.4	0.0
Bulbul	Dark-capped Bulbul	*Pycnonotus tricolor*	8.5	0.0
Buzzard	Common Buzzard	*Buteo buteo*	8.5	0.0
Buzzard	Jackal Buzzard	*Buteo rufofuscus*	4.9	0.0
Canary	Black-throated Canary	*Crithagra atrogularis*	36.6	0.0
Canary	Cape Canary	*Serinus canicollis*	1.2	0.0
Canary	Yellow Canary	*Crithagra flaviventris*	11.0	0.0
Canary	Yellow-fronted Canary	*Crithagra mozambica*	2.4	0.0
Chat	Ant-eating Chat	*Myrmecocichla formicivora*	13.4	2.9
Cisticola	Cloud Cisticola	*Cisticola textrix*	19.5	0.0
Cisticola	Desert Cisticola	*Cisticola aridulus*	8.5	0.0
Cisticola	Levaillant's Cisticola	*Cisticola tinniens*	68.3	17.6
Cisticola	Pale-crowned Cisticola	*Cisticola cinnamomeus*	4.9	0.0
Cisticola	Wing-snapping Cisticola	*Cisticola ayresii*	11.0	0.0
Cisticola	Zitting Cisticola	*Cisticola juncidis*	40.2	0.0
Coot	Red-knobbed Coot	*Fulica cristata*	74.4	29.4
Cormorant	Reed Cormorant	*Microcarbo africanus*	75.6	20.6
Cormorant	White-breasted Cormorant	*Phalacrocorax lucidus*	25.6	11.8
Crane	Blue Crane	*Grus paradisea*	1.2	2.9
Crow	Cape Crow	*Corvus capensis*	13.4	5.9
Crow	Pied Crow	*Corvus albus*	31.7	2.9
Cuckoo	Diederik Cuckoo	*Chrysococcyx caprius*	18.3	5.9
Cuckoo	Red-chested Cuckoo	*Cuculus solitarius*	4.9	0.0
Darter	African Darter	*Anhinga rufa*	26.8	11.8
Dove	Cape Turtle Dove	*Streptopelia capicola*	95.1	35.3
Dove	Laughing Dove	*Spilopelia senegalensis*	86.6	11.8
Dove	Namaqua Dove	*Oena capensis*	1.2	0.0
Dove	Red-eyed Dove	*Streptopelia semitorquata*	74.4	17.6
Dove	Rock Dove	*Columba livia*	34.1	14.7

Group	Species name	Scientific name	Full protocol	Ad hoc protocol
Duck	African Black Duck	*Anas sparsa*	8.5	0.0
Duck	Fulvous Whistling Duck	*Dendrocygna bicolor*	2.4	0.0
Duck	Knob-billed Duck	*Sarkidiornis melanotos*	1.2	0.0
Duck	Maccoa Duck	*Oxyura maccoa*	3.7	0.0
Duck	White-backed Duck	*Thalassornis leuconotus*	3.7	0.0
Duck	White-faced Whistling Duck	*Dendrocygna viduata*	14.6	0.0
Duck	Yellow-billed Duck	*Anas undulata*	70.7	26.5
Eagle	African Fish Eagle	*Haliaeetus vocifer*	1.2	0.0
Eagle	Long-crested Eagle	*Lophaetus occipitalis*	3.7	0.0
Eagle-Owl	Spotted Eagle-Owl	*Bubo africanus*	6.1	0.0
Egret	Great Egret	*Ardea alba*	6.1	2.9
Egret	Intermediate Egret	*Ardea intermedia*	23.2	2.9
Egret	Little Egret	*Egretta garzetta*	23.2	14.7
Egret	Western Cattle Egret	*Bubulcus ibis*	70.7	23.5
Falcon	Amur Falcon	*Falco amurensis*	34.1	2.9
Falcon	Lanner Falcon	*Falco biarmicus*	4.9	0.0
Falcon	Red-footed Falcon	*Falco vespertinus*	1.2	0.0
Finch	Cuckoo Finch	*Anomalospiza imberbis*	1.2	0.0
Finch	Red-headed Finch	*Amadina erythrocephala*	7.3	0.0
Fiscal	Southern Fiscal	*Lanius collaris*	87.8	20.6
Flamingo	Greater Flamingo	*Phoenicopterus roseus*	4.9	5.9
Flycatcher	Fiscal Flycatcher	*Melaenornis silens*	1.2	0.0
Flycatcher	Spotted Flycatcher	*Muscicapa striata*	3.7	0.0
Francolin	Grey-winged Francolin	*Scleroptila afra*	1.2	0.0
Francolin	Orange River Francolin	*Scleroptila gutturalis*	19.5	5.9
Francolin	Red-winged Francolin	*Scleroptila levaillantii*	1.2	0.0
Goose	Domestic Goose	*Anser anser domesticus*	2.4	0.0
Goose	Egyptian Goose	*Alopochen aegyptiaca*	73.2	38.2
Goose	Spur-winged Goose	*Plectropterus gambensis*	40.2	8.8
Grebe	Great Crested Grebe	*Podiceps cristatus*	2.4	0.0
Grebe	Little Grebe	*Tachybaptus ruficollis*	64.6	17.6
Greenshank	Common Greenshank	*Tringa nebularia*	18.3	0.0
Guineafowl	Helmeted Guineafowl	*Numida meleagris*	69.5	20.6
Gull	Grey-headed Gull	*Chroicocephalus cirrocephalus*	37.8	17.6
Harrier	African Marsh Harrier	*Circus ranivorus*	1.2	0.0
Harrier	Pallid Harrier	*Circus macrourus*	1.2	0.0
Heron	Black Heron	*Egretta ardesiaca*	3.7	2.9
Heron	Black-crowned Night Heron	*Nycticorax nycticorax*	1.2	0.0
Heron	Black-headed Heron	*Ardea melanocephala*	81.7	23.5
Heron	Goliath Heron	*Ardea goliath*	6.1	2.9

Group	Species name	Scientific name	Full protocol	Ad hoc protocol
Heron	Grey Heron	*Ardea cinerea*	34.1	14.7
Heron	Purple Heron	*Ardea purpurea*	11.0	0.0
Heron	Squacco Heron	*Ardeola ralloides*	7.3	0.0
Hoopoe	African Hoopoe	*Upupa africana*	4.9	2.9
Ibis	African Sacred Ibis	*Threskiornis aethiopicus*	63.4	23.5
Ibis	Glossy Ibis	*Plegadis falcinellus*	36.6	5.9
Ibis	Hadada Ibis	*Bostrychia hagedash*	79.3	35.3
Kestrel	Greater Kestrel	*Falco rupicoloides*	6.1	2.9
Kestrel	Rock Kestrel	*Falco rupicolus*	2.4	2.9
Kingfisher	Giant Kingfisher	*Megaceryle maxima*	2.4	0.0
Kingfisher	Malachite Kingfisher	*Corythornis cristatus*	9.8	0.0
Kingfisher	Pied Kingfisher	*Ceryle rudis*	8.5	5.9
Kite	Black-winged Kite	*Elanus caeruleus*	70.7	23.5
Korhaan	Blue Korhaan	*Eupodotis caerulescens*	17.1	2.9
Lapwing	African Wattled Lapwing	*Vanellus senegallus*	13.4	0.0
Lapwing	Blacksmith Lapwing	*Vanellus armatus*	95.1	35.3
Lapwing	Crowned Lapwing	*Vanellus coronatus*	63.4	20.6
Lark	Pink-billed Lark	*Spizocorys conirostris*	17.1	2.9
Lark	Red-capped Lark	*Calandrella cinerea*	43.9	11.8
Lark	Spike-heeled Lark	*Chersomanes albofasciata*	22.0	0.0
Longclaw	Cape Longclaw	*Macronyx capensis*	70.7	17.6
Martin	Banded Martin	*Riparia cincta*	1.2	2.9
Martin	Brown-throated Martin	*Riparia paludicola*	36.6	11.8
Martin	Rock Martin	*Ptyonoprogne fuligula*	7.3	0.0
Moorhen	Common Moorhen	*Gallinula chloropus*	36.6	11.8
Mousebird	Red-faced Mousebird	*Urocolius indicus*	8.5	0.0
Mousebird	Speckled Mousebird	*Colius striatus*	23.2	5.9
Myna	Common Myna	*Acridotheres tristis*	61.0	23.5
Openbill	African Openbill	*Anastomus lamelligerus*	1.2	0.0
Ostrich	Common Ostrich	*Struthio camelus*	37.8	14.7
Owl	Marsh Owl	*Asio capensis*	24.4	2.9
Owl	Western Barn Owl	*Tyto alba*	0.0	2.9
Painted-snipe	Greater Painted-snipe	*Rostratula benghalensis*	1.2	0.0
Pigeon	Speckled Pigeon	*Columba guinea*	78.0	35.3
Pipit	African Pipit	*Anthus cinnamomeus*	65.9	20.6
Pipit	Plain-backed Pipit	*Anthus leucophrys*	1.2	0.0
Plover	Kittlitz's Plover	*Charadrius pecuarius*	17.1	0.0
Plover	Three-banded Plover	*Charadrius tricollaris*	50.0	11.8
Pochard	Southern Pochard	*Netta erythrophthalma*	12.2	0.0
Prinia	Black-chested Prinia	*Prinia flavicans*	7.3	2.9

Group	Species name	Scientific name	Full protocol	Ad hoc protocol
Prinia	Tawny-flanked Prinia	*Prinia subflava*	3.7	0.0
Quail	Common Quail	*Coturnix coturnix*	15.9	0.0
Quelea	Red-billed Quelea	*Quelea quelea*	39.0	8.8
Robin-Chat	Cape Robin-Chat	*Cossypha caffra*	7.3	0.0
Roller	European Roller	*Coracias garrulus*	2.4	0.0
Sandpiper	Common Sandpiper	*Actitis hypoleucos*	8.5	0.0
Sandpiper	Curlew Sandpiper	*Calidris ferruginea*	3.7	0.0
Sandpiper	Marsh Sandpiper	*Tringa stagnatilis*	4.9	0.0
Sandpiper	Wood Sandpiper	*Tringa glareola*	13.4	2.9
Shelduck	South African Shelduck	*Tadorna cana*	8.5	2.9
Shoveler	Cape Shoveler	*Spatula smithii*	29.3	11.8
Shrike	Lesser Grey Shrike	*Lanius minor*	1.2	0.0
Shrike	Red-backed Shrike	*Lanius collurio*	3.7	0.0
Snipe	African Snipe	*Gallinago nigripennis*	9.8	2.9
Sparrow	Cape Sparrow	*Passer melanurus*	91.5	26.5
Sparrow	House Sparrow	*Passer domesticus*	39.0	5.9
Sparrow	Southern Grey-headed Sparrow	*Passer diffusus*	23.2	0.0
Sparrow-Weaver	White-browed Sparrow-Weaver	*Plocepasser mahali*	2.4	0.0
Spoonbill	African Spoonbill	*Platalea alba*	22.0	5.9
Spurfowl	Swainson's Spurfowl	*Pternistis swainsonii*	64.6	8.8
Starling	Cape Starling	*Lamprotornis nitens*	11.0	2.9
Starling	Pied Starling	*Lamprotornis bicolor*	2.4	2.9
Starling	Wattled Starling	*Creatophora cinerea*	1.2	5.9
Stilt	Black-winged Stilt	*Himantopus himantopus*	19.5	5.9
Stint	Little Stint	*Calidris minuta*	13.4	0.0
Stonechat	African Stonechat	*Saxicola torquatus*	84.1	26.5
Stork	White Stork	*Ciconia ciconia*	3.7	0.0
Swallow	Barn Swallow	*Hirundo rustica*	46.3	2.9
Swallow	Greater Striped Swallow	*Cecropis cucullata*	47.6	5.9
Swallow	South African Cliff Swallow	*Petrochelidon spilodera*	29.3	2.9
Swallow	White-throated Swallow	*Hirundo albigularis*	45.1	14.7
Swamphen	African Swamphen	*Porphyrio madagascariensis*	6.1	0.0
Swift	African Palm Swift	*Cypsiurus parvus*	24.4	14.7
Swift	Little Swift	*Apus affinis*	36.6	2.9
Swift	White-rumped Swift	*Apus caffer*	41.5	0.0
Teal	Blue-billed Teal	*Spatula hottentota*	1.2	0.0
Teal	Cape Teal	*Anas capensis*	2.4	0.0
Teal	Red-billed Teal	*Anas erythrorhyncha*	35.4	2.9
Tern	Caspian Tern	*Hydroprogne caspia*	1.2	5.9

Group	Species name	Scientific name	Full protocol	Ad hoc protocol
Tern	Whiskered Tern	*Chlidonias hybrida*	20.7	2.9
Tern	White-winged Tern	*Chlidonias leucopterus*	2.4	2.9
Thick-knee	Spotted Thick-knee	*Burhinus capensis*	39.0	2.9
Thrush	Groundscraper Thrush	*Turdus litsitsirupa*	0.0	2.9
Thrush	Karoo Thrush	*Turdus smithi*	19.5	8.8
Thrush	Sentinel Rock Thrush	*Monticola explorator*	1.2	0.0
Wagtail	Cape Wagtail	*Motacilla capensis*	64.6	20.6
Warbler	African Reed Warbler	*Acrocephalus baeticatus*	8.5	0.0
Warbler	Great Reed Warbler	*Acrocephalus arundinaceus*	1.2	0.0
Warbler	Lesser Swamp Warbler	*Acrocephalus gracilirostris*	23.2	2.9
Warbler	Little Rush Warbler	*Bradypterus baboecala*	1.2	0.0
Warbler	Marsh Warbler	*Acrocephalus palustris*	1.2	0.0
Warbler	Sedge Warbler	*Acrocephalus schoenobaenus*	1.2	0.0
Warbler	Willow Warbler	*Phylloscopus trochilus*	4.9	0.0
Waxbill	Common Waxbill	*Estrilda astrild*	36.6	11.8
Waxbill	Orange-breasted Waxbill	*Amandava subflava*	3.7	0.0
Weaver	Cape Weaver	*Ploceus capensis*	2.4	0.0
Weaver	Southern Masked Weaver	*Ploceus velatus*	92.7	17.6
Weaver	Village Weaver	*Ploceus cucullatus*	1.2	2.9
Wheatear	Capped Wheatear	*Oenanthe pileata*	28.0	11.8
Wheatear	Mountain Wheatear	*Myrmecocichla monticola*	6.1	0.0
White-eye	Cape White-eye	*Zosterops virens*	9.8	2.9
Whydah	Pin-tailed Whydah	*Vidua macroura*	57.3	8.8
Widowbird	Fan-tailed Widowbird	*Euplectes axillaris*	41.5	2.9
Widowbird	Long-tailed Widowbird	*Euplectes progne*	84.1	26.5
Widowbird	White-winged Widowbird	*Euplectes albonotatus*	19.5	0.0
Wood Hoopoe	Green Wood Hoopoe	*Phoeniculus purpureus*	7.3	0.0
Wryneck	Red-throated Wryneck	*Jynx ruficollis*	2.4	0.0