HUDSON ECOLOGY PTY LTD
Reg. No. 2014/268110/07

P.O. Box 19287
Noordbrug
2522
South Africa
280 Beyers Naude Ave, Potchefstroom, 2531
Tel +27 (0) 18 2945448
Mobile +27 (0)82 344 2758
http://www.hudsonecology.co.za

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March 2016

REPORT ON

AVUFAUNA BASELINE AND IMPACT ASSSESSMENT REPORT FOR THE 21.5HA EXTENSION AT THE PROPOSED WATERLOO PHOTOVOLTAIC POWER FACILITY NEAR VRYBURG IN THE NORTH WEST PROVINCE

Report Number: 2015/021/01/03

Submitted to:

Environamics BK

PO Box 6484
BAILLIE PARK
2526

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EXECUTIVE SUMMARY

The aim of this avifauna baseline and impact assessment study was to provide a description of the avifauna that may be impacted upon by the proposed project, and identify possible impacts and mitigations with regard to the avifauna of the study area and surrounds.

The objectives in this study can be summarised as follows:

- Location of the proposed development;
- Description of the policy and legislative context applicable to the proposed development;
- Methodologies employed during the avifauna study;
- Description of the receiving avifauna population;
- Potential impact identified during the study; and
- Mitigations to reduce the impacts identified.

The proposed Waterloo project will consist of a PV solar power facility. The facility and its infrastructure are likely to cover an area of approximately 150ha. For the purposes of this study a survey of only the 21.5ha extension area was conducted, the rest of the proposed development area formed part of a previous study. The associated infrastructure to operate the solar development is also taken into account in this avifauna impact assessment as is the cumulative impacts in the region.

The Waterloo facility is to be located in the central part of the North West Province, South Africa, approximately 4 km south-east of the the town of Vryburg. The project will include a Photovoltaic facility and a 7.5km 132KVA transmission line.

In order to investigate possible impacts of the facility on avifauna, vantage point surveys were conducted in order to a section of the entire study area. The use of high quality optics and sound recording equipment made it possible to identify bird species from one vantage point to quite close to the adjacent vantage points. The number of species and individuals recorded during the surveys gives a high degree of confidence in the vantage point surveys conducted. Furthermore, transect surveys were conducted in the drainage lines or washes in order to determine the use of these areas as corridors by avifauna species. These surveys yielded results particularly pertinent to the project and there is high confidence in the understanding of the avifauna in the study area, the project and possible impacts upon each other gained during the study.

The main pertinent observations made during the vantage point surveys can be summarised as follows:

Avifauna diversity - During the study a total of 39 species were recorded and a total of 656 individual birds were recorded. No species of concern were recorded but the occurrence cannot be ruled out.

Avifauna behaviour – One of the main aspects of avifauna behaviour noted was that 78% of bird species, and 98% of individual birds, recorded during the study flew at an average height of 4m (rounded off to the closest meter) and were observed at an average minimum height of 0.5m and an average maximum height of 12m. When applied, to what was learned about the facility, this means that most resident bird species usually fly at the height of the infrastructure. Another noteworthy observation was the lack of activity in the open field areas between 11:00 and 16:00 every day, during this time most species were found to be active in the riparian or wash areas traversing the region.

During the study species of concern appeared absent from the study area, all these species are likely to be resident species and the fact that they were not recorded does strongly suggest that they are in fact not present within the study area.

In order to deter avian species from the facility, the facility needs to be as unsuitable for avian biological requirements as possible, as avifauna tend to avoid areas that are not suitable for their requirements (Hudson & Bouwman, 2008). Biological requirements of avian species can be summarised as follows:

- Food sources;
- Water sources;

- Nesting sites;
- Perching sites; and
- Reduced competition.

TABLE OF CONTENTS

SECTION **PAGE**

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1 INTRODUCTION

Hudson Ecology (Pty) Ltd was commissioned by Environamics BK to conduct an avifauna study for the proposed 21.5ha extension area for the 150ha 75MW Waterloo Photovoltaic (PV) Power Facility.

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The Waterloo facility is to be located in the central part of the North West Province, South Africa, approximately 4 km south-east of the the town of Vryburg. The project will include a Photovoltaic facility and a 7.5km 132KVA transmission line.

2 LEGISLATIVE CONTEXT

This section provides a brief overview of both the national and international requirements that must be met by this report. It includes international conventions and agreements, as well as the IFC Standards and the Equator Principles.

2.1 National Environmental Management Act

This report has been prepared in terms the EIA Regulations 2014 (South Africa, 2014) promulgated under the National Environmental Management Act No. 107 of 1998 (NEMA) and is compliant with Regulation 982. Specialist reports and reports on specialised processes under the Act. Relevant clauses of the above regulation are quoted below and reflect the required information in the —Control sheet for specialist report‖ given above.

Appointment of EAPs and specialists

12. (1) A proponent or applicant must appoint an EAP at own cost to manage the application.

(2) In addition to the appointment of an EAP, a specialist may be appointed, at the cost of the proponent or applicant, if the level of assessment is of a nature requiring the appointment of a specialist.

(3) The proponent or applicant mustThis

(a) take all reasonable steps to verify whether the EAP and specialist complies with regulation 13(1)(a) and (b); and

(b) provide the EAP and specialist with access to all information at the disposal of the proponent or applicant regarding the application, whether or not such information is favourable to the application.

General requirements for EAPs and specialists

13. (1) An EAP and a specialist, appointed in terms of regulation 12(1) or 12(2), must-

(a) be independent;

(b) have expertise in conducting environmental impact assessments or undertaking specialist work as required, including knowledge of the Act, these Regulations and any guidelines that have relevance to the proposed activity;

(c) ensure compliance with these Regulations;

(d) 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;

(e) take into account, to the extent possible, the matters referred to in regulation 18 when preparing the application and any report, plan or document relating to the application; and

(f) disclose to the proponent or applicant, registered interested and affected parties and the competent authority all material information in the possession of the EAP and, where applicable, the specialist, that reasonably has or may have the potential of influencing-

(i) any decision to be taken with respect to the application by the competent authority in terms of these Regulations; or

(ii) the objectivity of any report, plan or document to be prepared by the EAP or specialist, in terms of these Regulations for submission to the competent authority; unless access to that information is protected by law, in which case it must be indicated that such protected information exists and is only provided to the competent authority.

(2) In the event where the EAP or specialist does not comply with subregulation (1)(a), the proponent or applicant must, prior to conducting public participation as contemplated in chapter 5 of these Regulations, appoint another EAP or specialist to externally review all work undertaken by the EAP or specialist, at the applicant's cost.

(3) An EAP or specialist appointed to externally review the work of an EAP or specialist as contemplated in subregulation (2), must comply with subregulation (1).

In terms of Appendix 6 of the Regulations (South Africa, 2014) the specialist report must contain:

(a) details of-

(i) the specialist who prepared the report; and

(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;

(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;

(c) an indication of the scope of, and the purpose for which, the report was prepared;

(d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;

(e) a description of the methodology adopted in preparing the report or carrying out the specialised process;

(f) the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;

(g) an identification of any areas to be avoided, including buffers;

(h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;

(i) a description of any assumptions made and any uncertainties or gaps in knowledge;

(j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment;

(k) any mitigation measures for inclusion in the EMPr;

(l) any conditions for inclusion in the environmental authorisation;

(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;

(n) a reasoned opinion-

(i) as to whether the proposed activity or portions thereof should be authorised; and

(ii) if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;

(o) a description of any consultation process that was undertaken during the course of preparing the specialist report;

(p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto.

2.2 Further South African legislation considered in the compilation of this report

2.2.1 National Environmental Management Act, Act No. 107 of 1998 (NEMA)

NEMA requires, inter alia, that:

- Development must be socially, environmentally, and economically sustainable;
- Disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied; and
- A risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions.

NEMA states that ―the environment is held in public trust for the people, the beneficial use of environmental resources must serve the public interest and the environment must be protected as the people‘s common heritage.‖

2.2.2 Environment Conservation Act No 73 of 1989 Amendment Notice No R1183 of 1997

The ECA states that:

Development must be environmentally, socially, and economically sustainable. Sustainable development requires the consideration of inter alia the following factors:

- That pollution and degradation of the environment is avoided, or, where they cannot be altogether avoided, are minimised and remedied;
- That the use and exploitation of non-renewable natural resources is responsible and equitable, and takes into account the consequences of the depletion of the resource;
- That the development, use and exploitation of renewable resources and the ecosystems of which they are part do not exceed the level beyond which their integrity is jeopardised; and
- That negative impacts on the environment and on peoples'environmental rights be anticipated and prevented, and where they cannot be altogether prevented are minimised and remedied.

The developer is required to undertake Environmental Impact Assessments (EIA) for all projects listed as a Schedule 1 activity in the EIA regulations in order to control activities which might have a detrimental effect on the environment. Such activities will only be permitted with written authorisation from a competent authority.

2.2.3 National Environmental Management: Biodiversity Act (Act No 10 of 2004)

In terms of the Biodiversity Act, the developer has a responsibility for:

- The conservation of endangered ecosystems and restriction of activities according to the categorisation of the area (not just by listed activity as specified in the EIA regulations).
- Promote the application of appropriate environmental management tools in order to ensure integrated environmental management of activities thereby ensuring that all development within the area are in line with ecological sustainable development and protection of biodiversity.
- Limit further loss of biodiversity and conserve endangered ecosystems.

2.3 Key authorities for the EIA application

The DEA will be the decision-making authority for the environmental authorisation process, which is being undertaken in terms of the NEMA.

The Department of Water and Sanitation (DWS) is the authority responsible for issuing WULs, however this EIA will not be integrated with a WUL process as specific detail on the solar development water uses will only be known once the applicant has completed the bidding process with the Department of Energy.

2.4 International Conventions and Agreements

Relevant environmental and social international conventions and agreements to which South Africa is a party are presented in Table 1.

Table 1: Relevant international conventions to which South Africa is a party

Convention	Summary of objectives or relevant conditions	South AfricanStatus
CITES Convention (1 July 1975)	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.	Party to
Convention on Biological Diversity (29 December 1993)	Develop strategies, plans or programs for conservation and sustainable use of biological diversity or adapt for this	Party to.

	purpose existing strategies, plans or programs which shall reflect, inter alia, the measures set out in this Convention.	
Convention on Wetlands of International Importance (Ramsar) (21 December 1975)	To stem the progressive encroachment and loss of wetlands now and in the future.	Party to.

3 AIMS AND OBJECTIVES

The aim of this avifauna baseline and impact assessment study was to provide a description of the avifauna that may be impacted upon by the proposed project, and identify possible impacts and mitigations with regard to the avifauna of the study area and surrounds..

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4 SCOPE OF WORK

4.1 Literature Review

Due to the fact that this type of solar project and its impact on avifauna is relatively new, poorly researched and poorly understood in South Africa, the literature review consisted of the review of existing reports for the current projects, as well as relevant literature for similar projects worldwide in order to obtain a better understanding of the project, as well as the impacts on similar projects in other parts of the world.

4.2 Fieldwork

The fieldwork consisted of a two day field study. During this period one vantage point surveys was conducted and transects were conducted across the study area.

4.3 Analysis of Data

Data, collected during the field surveys, were analysed in order to determine avian behaviour in the area. The data was, analysed in order to determine the risks associated with the development with respect to avifauna species based on the nature of the development and avifauna behaviour in the area. The data collected in this survey is also being investigated in order to determine a suitable collision risk analysis model for this kind of project.

4.4 Reporting and Deliverables

Reporting took the form of a standalone avifauna impact assessment report, which provides the methodology, results, discussion and recommendations arising from the study.

5 STUDY AREA

The proposed development area (study area) covers approximately 21.5ha on the Farm Waterloo. The study area is situated a little way off a minor road about 4km to the south east of the town of Vryburg

in the North West Province (Figure 1). The site falls within the 2724BB quarter degree grid. No alternative site is currently being considered for the proposed solar thermal facility.

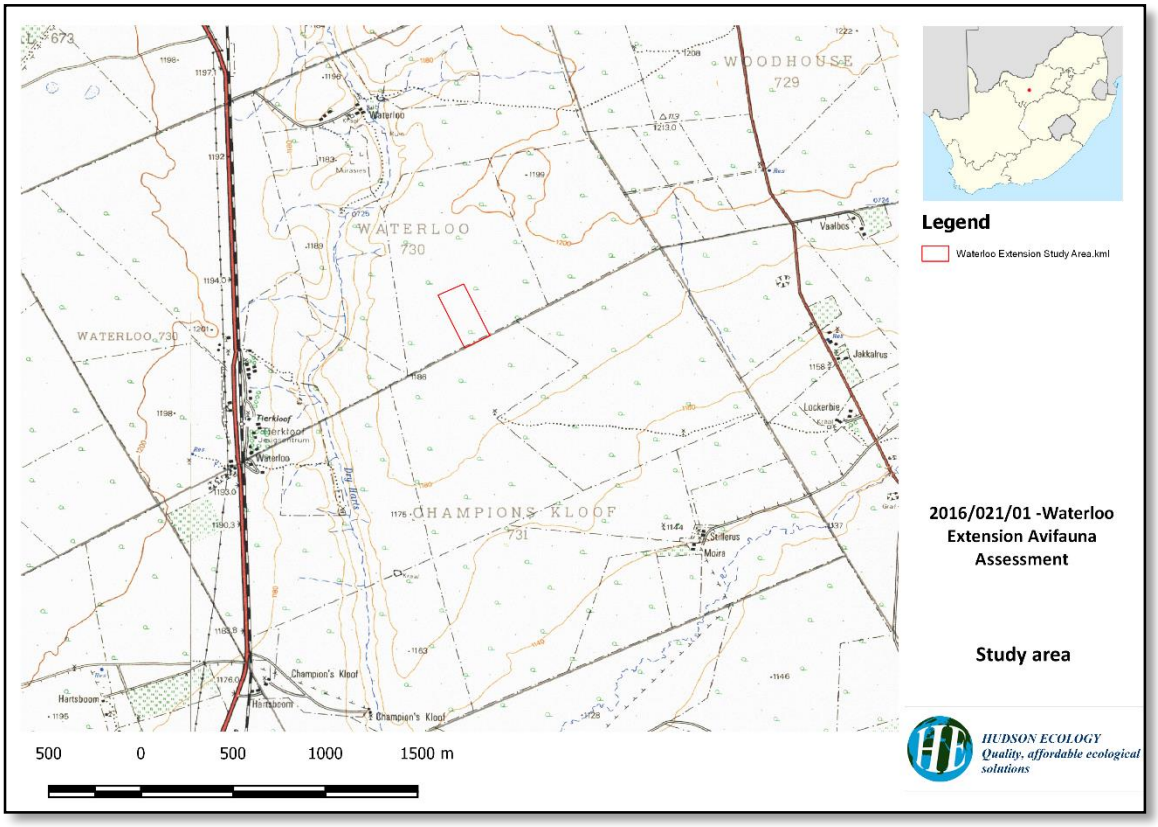

Figure 1: Locality of the study area

6 METHODOLOGY

6.1 Literature Review

The literature review took into account 38 scientific publications on the following subjects:

- Avifauna behaviour in desert and semi-desert regions of southern Africa;
- Avian diversity in the study area;
- Avian endemism in the study area;
- Avian red data species in the study area;
- Ecological consequences of habitat fragmentation;
- The use of corridors by avifauna in arid and semi-arid regions;
- Land transformation effects on avian diversity and population structure;
- Collision effects of various obstacles on avifauna;
- Collision effects of solar power generation on avifauna;
- Avian impacts assessments of solar projects;
- Avifauna collision deterrence;
- Guidelines to minimise impact of solar facilities and infrastructure on avifauna; and
- Monitoring of avian mortalities associated with solar power plants.

6.2 Field Methodology

6.2.1 Study area

This section provides a discussion of the study area and context in which the proposed project will take place.

6.2.1.1 Topography

The study area is largely on a flat plateau gently sloping slightly downwards from south to north, with a drop of only 2m from the southern to the northern parts of the study area (a distance of approximately 700m)(Figure 3). The highest point of the study area is at the southernmost point of the study area, which reaches a peak of 1203 m above sea level, while the northernmost section of the study area is approximately 1201m above sea level. (Figure 2).

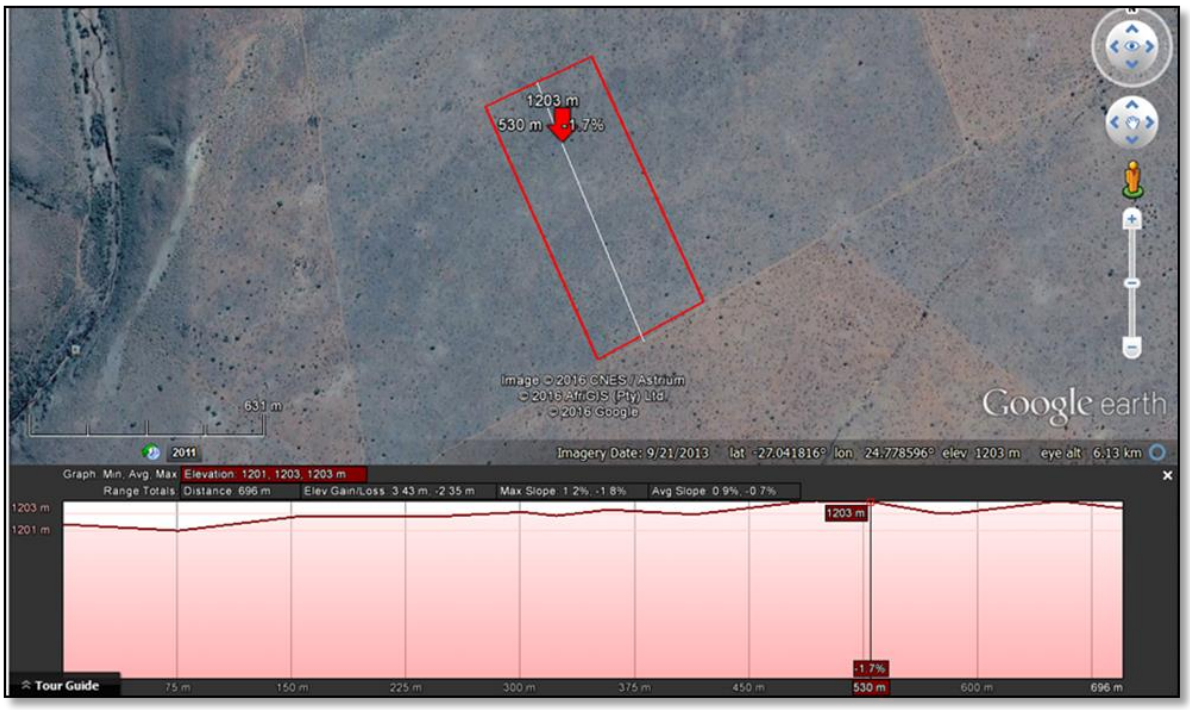

Figure 2: Gradient of the study area (reproduced from Google Earth)

6.2.1.2 Geology & Soils

Most of the area is covered by surface limestone of Tertiary to Recent age, and dolomite and chert of the Campbell Group (Griqualand West Supergroup, Vaalian Erathem) support shallow soils (0.1– 0.25 m) of Mispah and Hutton soil forms. Land types mainly Fc with some Ae and Ag. (Mucina & Rutherford, 2006)

6.2.1.3 Climate

This vegetation type experiences summer and autumn rainfall with very dry winters. Mean Annual Precipitation (MAP) is from approximately 300 mm in the southwest to approximately 500 mm in the northeast. Frost occurs frequently to very frequently in winter. Mean monthly maximum and minimum temperatures for Koopmansfontein are 36.3°C and –7.5°C for January and July, respectively. Corresponding values for Armoedsvlakte (near Vryburg) area 36.6°C and –5.5°C for December and July, respectively. See Figure 3 (Mucina & Rutherford, 2006)

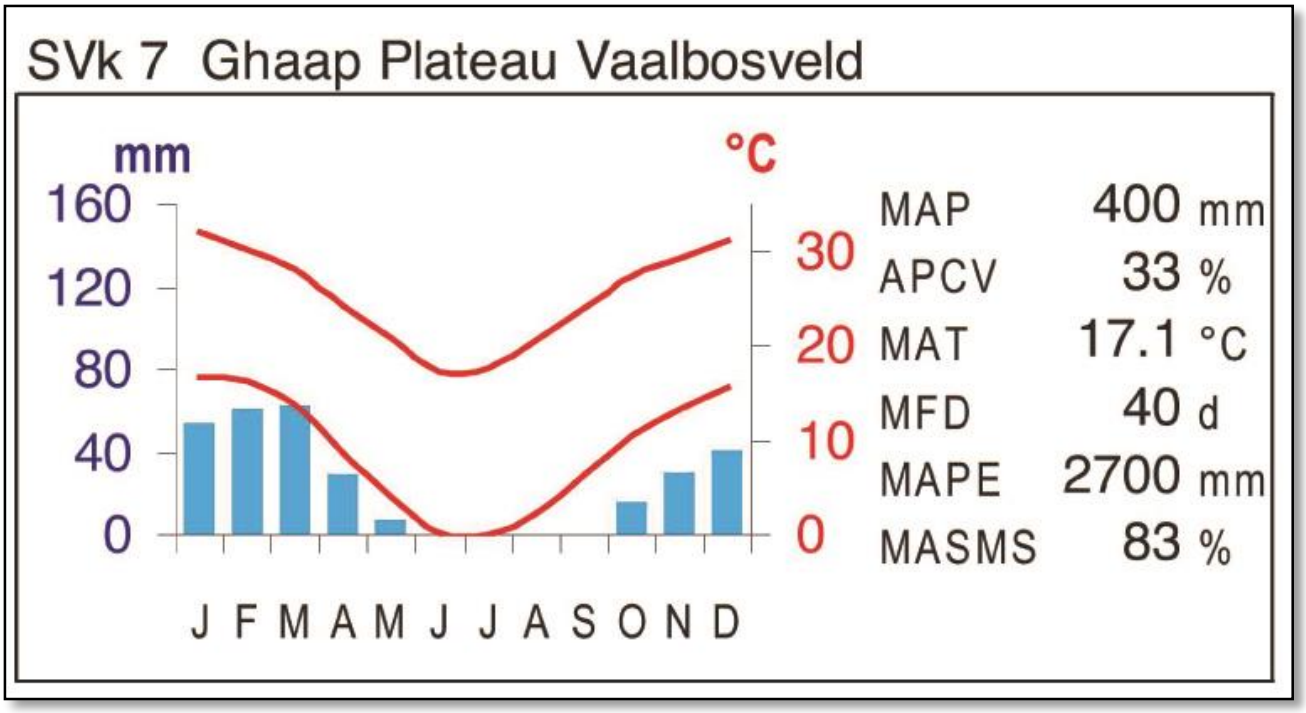

Figure 3: Climate for SVk 7 Ghaap Plateau Vaalbosveld (reproduced form Mucina and Rutherford (2006))

6.2.1.4 Biome and Vegetation Types

The study area falls within savanna vegetation biome of South Africa and Swaziland constitutes the southernmost extension of the most widespread biome in Africa. It represents 32.8% of South Africa (399 600 km2) and 74.2% of Swaziland (12 900 km2). It extends beyond the tropics to meet the Nama-Karoo Biome on the central plateau, the Grassland Biome at higher altitudes towards the east and extends down the eastern seaboard interior and valleys where it grades into Albany Thicket in the Eastern Cape. The most recent and detailed description of the vegetation of this region is part of a national map (Mucina & Rutherford, 2006) (**Error! Reference source not found.**).

- ***Ghaap Plateau Vaalbosveld***

Synonyms: VT 16 Kalahari Thornveld and Shrub Bushveld (74%) (Acocks 1953). LR 33 Kalahari Plateau Bushveld (86%) (Low & Rebelo 1996).

Distribution

Northern Cape and North-West Provinces: Flat plateau from around Campbell in the south, east of Danielskuil through Reivilo to around Vryburg in the north. Altitude 1 100– 1 500 m (Mucina & Rutherford, 2006).

Vegetation & Landscape Features

Flat plateau with well developed shrub layer with *Tarchonanthus camphoratus* and *Acacia karroo*. Open tree layer has *Olea europaea* subsp. *africana*, *A. tortilis, Ziziphus mucronata* and *Rhus lancea*. *Olea* is more important in the southern parts of the unit, while *A. tortilis, A. hebeclada* and *A. mellifera* are more important in the north and part of the west of the unit. Much of the south-central part of this unit has remarkably low cover of *Acacia* species for an arid savanna and is dominated by the non-thorny *T. camphoratus, R. lancea and O. europaea* subsp. *africana*. (Mucina & Rutherford, 2006).

Important Taxa

Graminoids:

Anthephora pubescens (d), *Cenchrus ciliaris (*d*), Digitaria eriantha subsp. Eriantha (*d*), Enneapogon scoparius (*d*), Eragrostis lehmanniana (*d*), Schmidtia pappophoroidesadscensionis, A. congesta, A. diffusa, Cymbopogon pospischilii, Enneapogon cenchroides, E. desvauxii, Eragrostis echinochloidea, E. obtusa, E. rigidior, E. superba, Fingerhuthia africana, Heteropogon contortus, Sporobolus fimbriatus, Stipagrostis uniplumis* and *Tragus racemosus* (Mucina & Rutherford, 2006).

Tall Trees:

Acacia erioloba (Mucina & Rutherford, 2006).

Small Trees: *Acacia mellifera* subsp. *detinens* (d), Searsia *lancea* (d), *Acacia karroo, A. tortilis* subsp. *heteracantha*, *Boscia albitrunca* (Mucina & Rutherford, 2006).

Tall Shrubs:

Olea europaea subsp. *africana* (d), *Rhigozum trichotomum* (d), *Tarchonanthus camphoratus* (d), *Ziziphus mucronata* (d), *Diospyros austro-africana*, *D. pallens*, *Ehretia rigida* subsp. *rigida*, *Euclea crispa* subsp. *ovata*, *Grewia flava*, *Gymnosporia buxifolia*, *Lessertia frutescens* and *Rhus tridactyla* (Mucina & Rutherford, 2006).

Low Shrubs:

Acacia hebeclada subsp. hebeclada (d), *Aptosimum procumbens, Chrysocoma ciliata, Helichrysum zeyheri, Hermannia comosa, Lantana rugosa, Leucas capensis, Melolobium microphyllum, Peliostomum leucorrhizum, Pentzia globosa, P. viridis* and *Zygophyllum pubescens* (Mucina & Rutherford, 2006).

Succulent Shrubs:

Hertia pallens, Lycium cinereum (Mucina & Rutherford, 2006).

Semiparasitic shrub:

Thesium hystrix (Mucina & Rutherford, 2006)

Woody climber:

Asparagus africanus (Mucina & Rutherford, 2006).

Herbs:

Barleria macrostegia, Geigeria filifolia, G. ornativa, Gisekia africana, Helichrysum cerastioides, Heliotropium ciliatum, Hermbstaedtia odorata, Hibiscus marlothianus, H. pusillus, Jamesbrittenia aurantiaca, Limeum fenestratum, Lippia scaberrima, Selago densiflora and *Vahlia capensis subsp. vulgaris* (Mucina & Rutherford, 2006).

Succulent Herbs:

([GW] Griqualand West endemic, [K] Kalahari endemic, [D] Broadly disjunct distribution)

Tall Shrubs*: Lebeckia macrantha[GW], Nuxia gracilis[D]. Low Shrubs: Blepharis marginata[GW], Putterlickia saxatilis[GW], Tarchonanthus obovatus[GW]* (Mucina & Rutherford, 2006).

Succulent Shrubs:

Euphorbia wilmaniae[GW], Prepodesma orpenii[GW] (endemic genus) (Mucina & Rutherford, 2006).

Graminoids:

Digitaria polyphylla[GW], Panicum kalaharense[K] (Mucina & Rutherford, 2006).

Herbs:

Corchorus pinnatipartitus[GW], *Helichrysum arenicola*[K] (Mucina & Rutherford, 2006).

Succulent Herb:

Orbea knobelii[K]. *Aloe grandidentata* (Mucina & Rutherford, 2006).

Endemic Taxon:

Herb*: Rennera stellata*. (Mucina & Rutherford, 2006)

Conservation

Least threatened. Target 16%. None conserved in statutory conservation areas. Only about 1% already transformed. Erosion is very low.(Mucina & Rutherford, 2006).

6.3 Field Surveys

The field surveys can be subdivided into three facets, namely:

- A vantage point survey; and
- Line transects.

The methodologies for each of these facets are outlined in sections 6.3.1 to 6.3.2, below.

6.3.1 Vantage point surveys

Due to the small area (21.5ha), only one vantage point suvey was required to cover the entire study area for the project. The approximate radius of the vantage point survey was approximately 800m, allowing visibility far outside of the study area itself.

Equipment used at each of the vantage point surveys comprised of:

- Zeiss Conquest 15x56 binoculars;
- Sightmark SM21031K 6-100x100 Spotting Scope;
- Garmin Montana 600 GPS;
- Tascam DR-100MKII sound recorder with ME66/K6 Microphone;
- Samsung Galaxy 4 Tablet with preloaded field data sheets; and
- Waterproof notebook and pencil.

Each of the vantage points was surveyed for 12 hours, comprising an entire day, from 06:30 to 18:30 each day. The following data were recorded at each site:

- Date of survey;
- Co-ordinates of vantage point;
- Species recorded, number of each species recorded;
- Species behaviour;
- Species flight direction; and
- Species flight height.

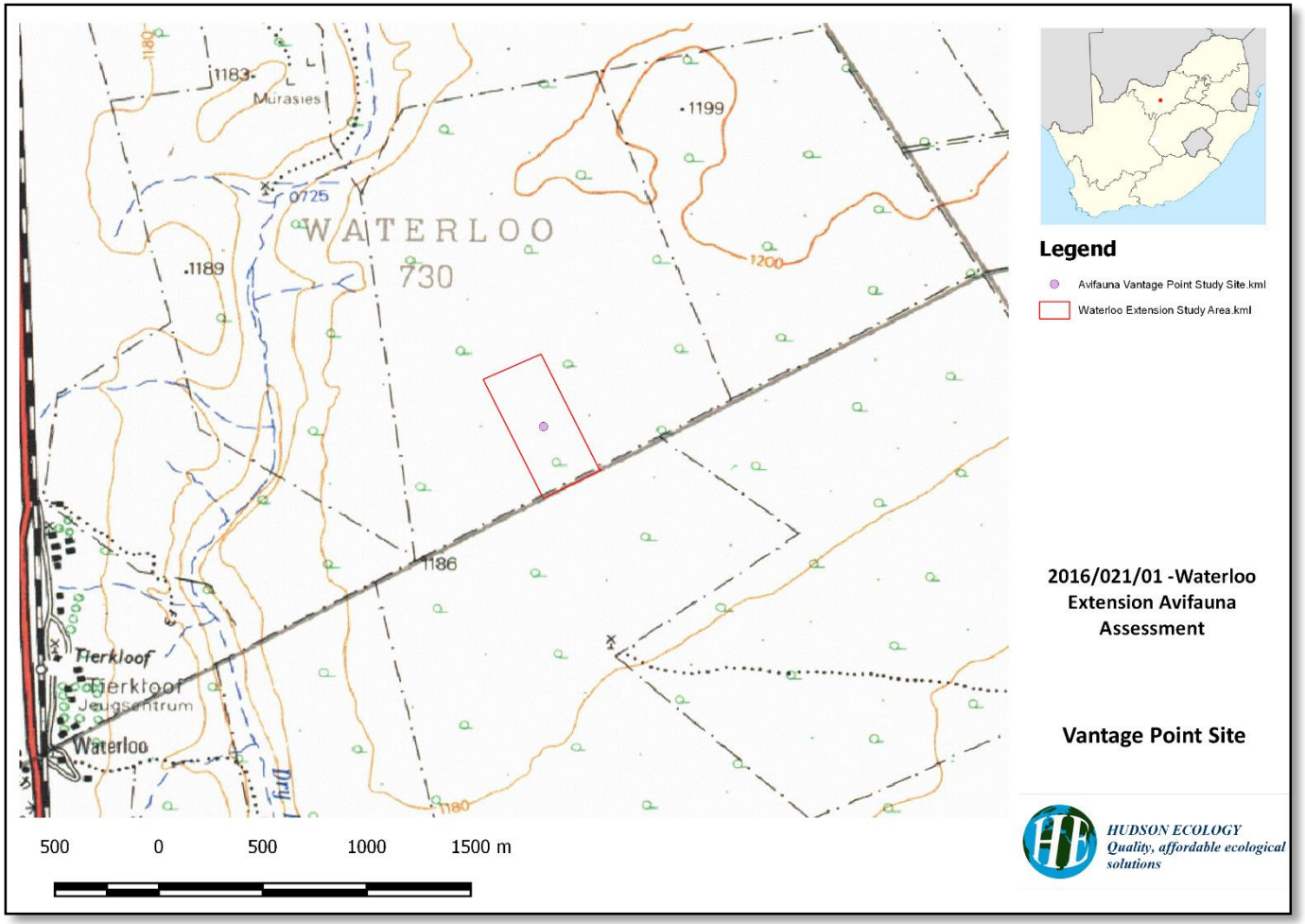

Figure 4: Location of the vantage point survey within the study area

6.3.2 Line transects

Transects were conducted from the north east to south west and south west to north east corners of the study area (Figure 5), in order to investigate these areas for avifauna activity.

- Equipment used at each of the transect surveys comprised of:
- Zeiss Conquest 15x56 binoculars;
- Garmin Montana 600 GPS;
- Samsung Galaxy 4 Tablet with preloaded field data sheets; and
- Waterproof notebook and pencil.

Each transect was surveyed on foot at a steady pace and the following data were recorded along each transect:

- Date of survey;
- Track log of each survey;
- Species recorded, number of each species recorded;
- Species behaviour; and
- Species flight direction

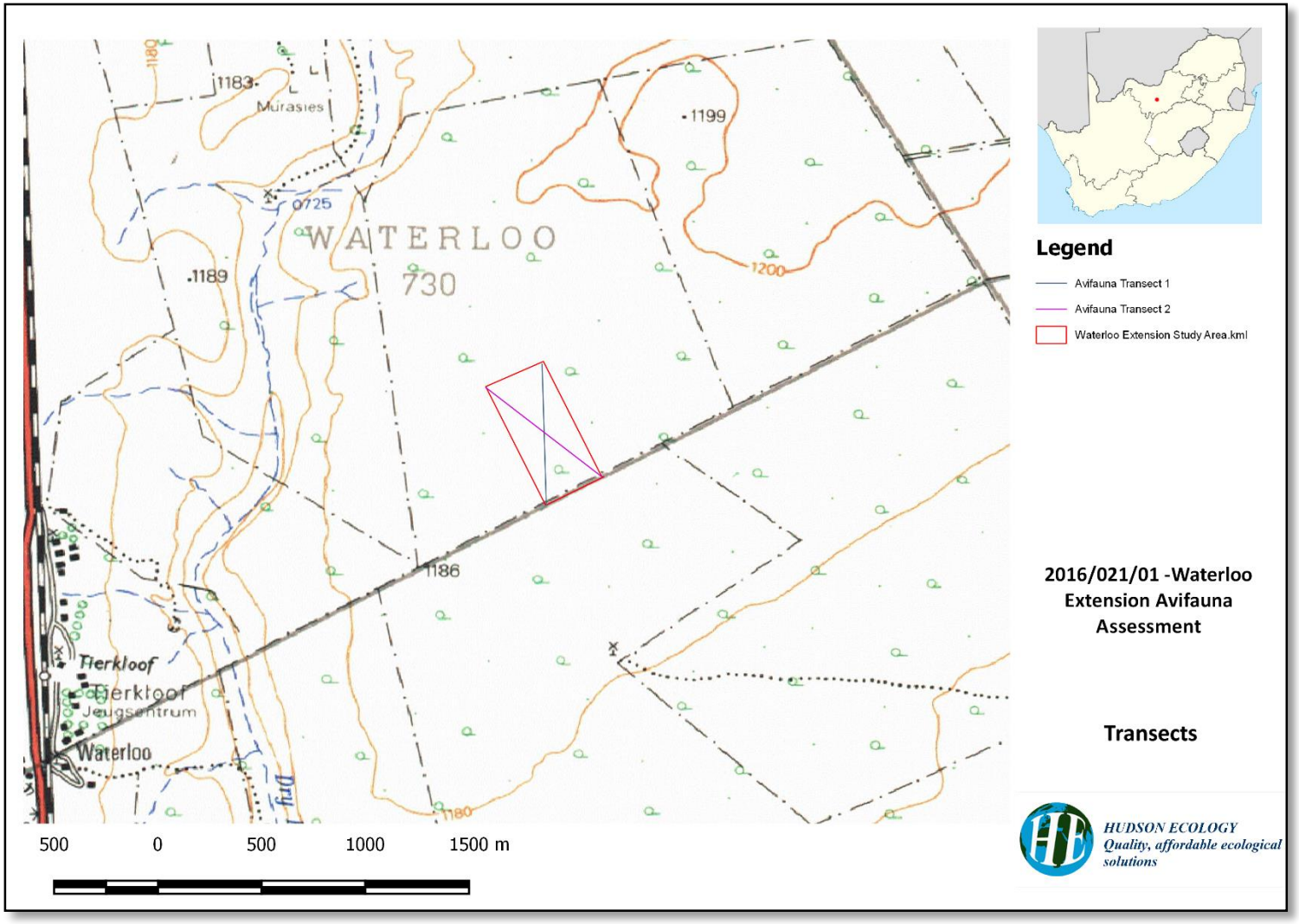

Figure 5: Transects conducted during the 2016 survey

6.4 Data Analysis

Avifauna data was analysed in order to determine:

- Average flight height per species (quantitative);
- Flight speed per species (qualitative); and
- Average flight distance per species (quantitative).

Data was further analysed in order to determine avifauna flight paths and corridors used.

Where possible results were presented graphically or diagrammatically.

These data were then used to determine the possible impacts the proposed infrastructure may have on the species recorded in the area.

6.5 Impact assessment

The Environmental Impact Assessment methodology that has been used in the evaluation of the overall effect of a proposed activity on the environment includes an assessment of the significant direct, indirect, and cumulative impacts. The significance of environmental impacts is to be assessed by means of the criteria of extent (scale), duration, magnitude (severity), probability (certainty) and direction (negative, neutral or positive).

The nature of the impact refers to the causes of the effect, what will be affected and how it will be affected.

Extent (E) of impact

Local (site or surroundings) to Regional (provincial)

Rating = 1 (low) to 5 (high).

Duration (D) rating is awarded as follows:

Whether the life-time of the impact will be:

- Very short term – up to 1 year: Rating = 1
- Short term – >1 – 5 years: Rating = 2
- Moderate term - >5 – 15 years: Rating = 3
- Long term – >15 years: Rating = 4
  - The impact will occur during the operational life of the activity, and recovery may occur with mitigation (restoration and rehabilitation).
- Permanent: Rating = 5
  - The impact will destroy the ecosystem functioning and mitigation (restoration and rehabilitation) will not contribute in such a way or in such a time span that the impact can be considered transient.

Magnitude (M) (severity):

A rating is awarded to each impact as follows:

- Small impact – the ecosystem pattern, process and functioning are not affected
  Rating = 0
- Minor impact - a minor impact on the environment and processes will occur
  Rating = 2
- Low impact - slight impact on ecosystem pattern, process and functioning
  Rating = 4

- Moderate intensity – valued, important, sensitive or vulnerable systems or communities are negatively affected, but ecosystem pattern, process and functions can continue albeit in a slightly modified way
  Rating = 6
- High intensity – environment affected to the extent that the ecosystem pattern, process and functions are altered and may even temporarily cease. Valued, important, sensitive or vulnerable systems or communities are substantially affected
  Rating = 8
- Very high intensity – environment affected to the extent that the ecosystem pattern, process and functions are completely destroyed and may permanently cease
  Rating = 10

Probability (P) (certainty) describes the probability or likelihood of the impact actually occurring, and is rated as follows:

- Very improbable – where the impact will not occur, either because of design or because of historic experience
  Rating = 1
- Improbable – where the impact is unlikely to occur (some possibility), either because of design or historic experience
  Rating = 2
- Probable - there is a distinct probability that the impact will occur (<50% chance of occurring)
  Rating = 3
- Highly probable - most likely that the impact will occur (50 – 90% chance of occurring)
  Rating = 4
- Definite – the impact will occur regardless of any prevention or mitigating measures (>90% chance of occurring).
  Rating = 5

Significance (S) - Rating of low, medium or high. Significance is determined through a synthesis of the characteristics described above where:

$$S = (E + D + M) \times P$$

The significance weighting should influence the development project as follows:

- Low significance (significance weighting: <30 points)
  If the negative impacts have little real effects, it should not have an influence on the decision to proceed with the project. In such circumstances, there is a significant capacity of the environmental resources in the area to respond to change and withstand stress and they will be able to return to their pre-impacted state within the short-term.
- Medium significance (significance weighting: 30 – 60 points)
  If the impact is negative, it implies that the impact is real and sufficiently important to require mitigation and management measures before the proposed project can be approved. In such circumstances, there is a reduction in the capacity of the environmental resources in the area to withstand stress and to return to their pre-impacted state within the medium to long-term.
- High significance (significance weighting: >60 points)
  The environmental resources will be destroyed in the area leading to the collapse of the ecosystem pattern, process and functioning. The impact strongly influences the decision whether or not to proceed with the project. If mitigation cannot be effectively implemented, the proposed activity should be terminated.

7 ASSUMPTIONS AND LIMITATIONS

- Accuracy of the maps, ecosystems, routes and desktop assessments were made using Google earth and converting the .kml files to .shp files and are subject to the accuracy of Google Earth imagery with some loss of accuracy during the conversion process;
- GPS co-ordinates are accurate to within 10m and lines drawn on maps can only be assumed to be accurate to within a distance of 30m;
- Data obtained from published articles, reference books, field guides, official databases or any other official published or electronic sources are assumed to be correct and no review of such data was undertaken by Hudson Ecology Pty Ltd;
- Satellite imagery obtained was limited to imagery on Google Earth, thus the ability to accurately map vegetation communities was limited by the level of accuracy of google earth;
- Time and budget constraints do not allow for an intensive survey of the entire study area, and as with any survey of this kind, rare and cryptic species may be overlooked during the study;
- Every possible precaution was taken to reduce the effect of the above-mentioned limitations on the data collected for this study;
- The fact that a species or Red Data species is not recorded during a survey cannot support the assumption that the species in question does not occur in the area, it can only indicate a decreased probability of the species occurring in the area. This is particularly pertinent if the species has been recently or historically recorded in the area; and
- Ecological studies should be undertaken over at least two seasons in order to obtain significant data. Studies are usually conducted in this way in order to eliminate the effects of unusual climatic conditions or other unusual conditions prevailing at the study area during the time of study. The results of this report are based on a literature review and a single wet season field survey, conducted in early August 2015.

8 RESULTS

8.1 Literature Review

8.1.1 Avian diversity, endemism and red data species in the study area

Using a number of bird atlases and field guides ***(Harrison, et al., 1997; Sinclair, et al., 2002; Hockey, et al., 2005; Maclean, 1993; Hockey, et al., 2005)*** it was determined that avifauna diversity in the area is high with approximately 332 avifauna species (APPENDIX A) occurring in the region. Of these species 8 (6%) area listed as endemic and 26 (7%) are listed as being Red Data species. During the study, avifauna species diversity and abundance was low with only 39 species being during the site visit (Table 2).

Table 2: Avifauna species recorded during the August 2015 survey

Roberts 6 Sort	Full Name	*Scientific Name*	RD (Regional, Global)	S	E
181	Rock Kestrel	*Falco rupicolus*			
183	Lesser Kestrel	*Falco naumanni*			
239.1	Northern Black Korhaan	*Afrotis afraoides*			

354	Cape Turtle Dove	*Streptopelia capicola*			
355	Laughing Dove	*Streptopelia senegalensis*			
356	Namaqua Dove	*Oena capensis*			
411	Common Swift	*Apus apus*			
438	European Bee-eater	*Merops apiaster*			
464	Black-collared Barbet	*Lybius torquatus*			
465	Acacia Pied Barbet	*Tricholaema leucomelas*			
473	Crested Barbet	*Trachyphonus vaillantii*			
494	Rufous-naped Lark	*Mirafra africana*			
495.2	Eastern clapper Lark	*Mirafra fasciolata*			
497	Fawn-coloured Lark	*Calendulauda africanoides*			
498	Sabota Lark	*Calendulauda sabota*			
507	Red-capped Lark	*Calandrella cinerea*			
515	Chestnut-backed Sparrow-lark	*Eremopterix leucotis*			
526	Greater Striped Swallow	*Cecropis cucullata*			
532	Sand Martin	*Riparia riparia*			
567	African Red-eyed Bulbul	*Pycnonotus nigricans*			
589	Familiar Chat	*Cercomela familiaris*			
595	Ant-eating Chat	*Myrmecocichla formicivora*			
615	Kalahari Scrub Robin	*Erythropygia paena*			
664	Zitting Cisticola	*Cisticola juncidis*			
665	Desert Cisticola	*Cisticola aridulus*			
695	Marico flycatcher	*Bradornis mariquensis*			
713	Cape Wagtail	*Motacilla capensis*			
732	Southern (Common) Fiscal	*Lanius collaris*			
739	Crimson-breasted Shrike	*Laniarius atrococcineus*			
743	Brown-crowned Tchagra	*Tchagra australis*			
799	White-browed Sparrow-Weaver	*Plocepasser mahali*			
803	Cape Sparrow	*Passer melanurus*			
804	Southern Grey-headed Sparrow	*Passer diffusus*			
829	White-winged Widowbird	*Euplectes albonotatus*			
845	Violet-eared Waxbill	*Uraeginthus granatinus*			
846	Common Waxbill	*Estrilda astrild*			
860	Pin-tailed Whydah	*Vidua macroura*			

878	Yellow Canary	*Crithagra flaviventris*			
884	Golden-breasted Bunting	*Emberiza flaviventris*			

Red Data (RD); Regional*, Global

CR = Critically Endangered

EN = Endangered

VU = Vulnerable

NT = Near Threatened

LC = Least Concern

EX = Extinct (regionally)

DD= Data Deficient

NR= Not Recognised by BirdLife International

NA = Not Assessed

§ = Refer to footnote

**The 2014 Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland*

Status in South Africa (S)

V = vagrant

I = introduced

Endemism in south Africa (E)

Endemism in South Africa (E) (not southern Africa as in field guides)

* = endemic

SLS = endemic to South Africa, Lesotho and Swaziland

(*) = near endemic (i.e. ~70% or more of population in RSA)

B* = breeding endemic

BSLS = breeding South Africa, Lesotho and Swaziland endemic

W* = winter endemic

The number of species would certainly have been higher if the survey had been conducted in better weather, the inclement weather did much to reduce avifauna activity. No Red Data species were recordedduring the study. Red Data species, which may occur in the study area, are discussed below in section *Error! Reference source not found.*. Only one exotic avifauna species is expected to occur in the study area, namely the House Sparrow (Passer domesticus).

Seven Species of Special Concern have been identified, based on distribution ranges and habitat requirements that are likely to occur within the study area. These species are listed below in the Table below:

Table 3: Avifaunal Species of Special Concern that may occur within the study area

Full Name	***Scientific Name***	**RD (Regional, Global)**
Secretarybird	*Sagittarius serpentarius*	VU, VU
Martial Eagle	*Polemaetus bellicosus*	EN, VU
Lanner Falcon	*Falco biarmicus*	VU, LC
Red-footed Falcon	*Falco vespertinus*	NT, NT
Kori Bustard	*Ardeotis kori*	NT, NT

Secretarybird (*Sagittarius serpentarius*) – Near Threatened

This species is uncommon to locally fairly common, favouring open grasslands with scattered trees and shrubs. Although considered resident, it is not sedentary, with highly nomadic movements across their large home range (up to 230km^2). Local populations are thought to have decreased in South Africa, with the species being highly susceptible to being injured or killed by collisions with overhead power lines and telephone wires. It is sensitive to habitat degradation due to overgrazing, bush encroachment, disturbance, and loss of habitat to afforestation and crop cultivation. Recent data has seen a constriction of its range and lower reporting rates which is cause for concern. This species has the potential to occur within or pass through the study area due to its nomadic movements and wide ranging foraging patterns.

Lanner Falcon (*Falco biarmicus*) – Near Threatened

This species has a fairly high tolerance regarding habitat requirements, being found across southern Africa in most habitat types excluding forest. The Lanner Falcon is generally a cliff nester and its distribution is closely associated with mountainous areas. However, and especially in the Karoo, the increasing number of pylon towers has offered alternative nesting opportunities for this species.

Red-footed Falcon (*Falco vespertinus*) – Near Threatened

This is a diurnal bird of open country with some trees, often near water. They tend to migrate far south for the winter, including in areas of Africa. The red-footed falcon tends not to make their own nests, but tend to use abandoned nests made by other birds such as the hooded crow, rook, and magpie. The nests that are chosen tend to be higher than the majority of the other nests; the nests tend to be 13–20 m above the ground and within 3–4 m of the tree top. Most of these nests tend to be near the edge of woods, avoiding nesting on solitary trees.

Kori Bustard (*Ardeotis kori*) - Vulnerable

This species is considered uncommon to locally common, favouring open savannah woodland, dwarf shrubland and occasionally grassland. Although a sedentary resident, this species is locally nomadic in response to rainfall and the subsequent flush of small invertebrates. The species has declined in South Africa due to habitat loss through transformation, collision with overhead power lines and poisoning. This species has the potential to occur within or pass through the study area due to the availability of suitable foraging habitat and the species nomadic movements.

Martial Eagle (*Polemaetus bellicosus*) - Vulnerable

This species is widespread, although generally uncommon in South Africa, tolerating a wide range of habitat types, including open grassland, scrub and woodland. This species requires exceptionally large home ranges (in excess of 130 km^2), making use of large trees and electricity pylons to provide nest sites – which are often a limiting factor concerning this species. Population declines are largely the result of direct persecution due to the perceived threat posed to livestock, poisoning, electrocutions on electricity pylons and the reduction of its prey base as a result of habitat transformation. SABAP2 data shows records of this species in the vicinity of the study site. One individual was recorded to the north-east of the study area. Although not recorded in the study area, *per se*, this species has the potential to occur within or pass through the study area due to the availability of suitable foraging habitats.

8.1.2 Factors influencing avifauna presence and behaviour

Birds, like all other living organisms, need certain resources and conditions to survive and propagate. The needs of birds, as well as the availability of resources and conditions to fulfil these needs, determine the distribution of these birds. The fact that humans alter the environment for a variety of

needs causes changes in the factors determining birds ability to utilize those areas, and can (and usually does) cause a change in bird species composition in those areas (Hockey, 2003).

Effects of human intervention can have a negative effect on species diversity and numbers, deforestation, land degradation, invasion of exotics and other habitat destruction, caused by human activities, may cause areas to become unsuitable for species. Destruction of forest habitats will cause a decline or total disappearance of forest specialists in the same way draining wetlands to build residential areas will make the area unsuitable for wetland birds (e.g. aquatic birds and waders) and make the area more suitable for generalist species (e.g. starlings) and human commensals such as sparrows (Hockey, 2003).

Human intervention in the environment does not always have a negative impact on bird species. Human movement westwards in southern Africa has caused an increase in man-made structures that form suitable breeding places for birds such as the South African Cliff Swallow (*Hirundo spilodera*) and human commensals such as the Southern Grey-headed Sparrow (*Passer diffuses*). Furthermore, the Southern Grey-headed Sparrow's (*Passer diffuses*) movements appear to be closely tracked by its nest parasite, the Lesser Honeyguide (Hockey, 2003). The construction of dams and mini wetlands by humans, for irrigation and stock watering, has also increased the ranges of water-dependent bird species such as the Burchell's Sandgrouse (*Pterocles burchelli*) and Sclater's Lark (*Spizocorys sclateri*) (Hockey, 2003).

Although factors influencing bird diversity are well documented, there is still an ongoing debate as to which of the factors influencing bird diversity are more important in determining the presence or absence of bird species in a specific area. In a USDAF paper (DeGraaf, et al., 1991) on forest and rangeland birds, food, water and shelter were named as most important factors with nest sites, song posts and perch sites as secondary considerations. The paper does go on to mention that proximate factors such as vegetation structure give indications of ultimate factors such as food availability. Lack (1933) suggested that birds are "programmed" to select habitats by identifying features and patterns that are not immediately required for survival. Lack (1933) also proposed that different species are limited in their ranges by one of three factors more than the other two. The factors taken into consideration during the study were: suitable climatic conditions, sufficient food supply and a safe nesting place. Lack (1933) suggested that birds do not adapt to a specific area, but choose the area because of their ability to recognise potentially satisfactory ultimate factors by means of the visible proximate factors.

8.1.2.1 Food

Studies have been done to examine the possibility that food availability influences the distribution of birds. A study by Johnson & Sherry (Johnson & Sherry, 2001) indicated that food availability does influence the distribution of birds; this study did, however, not take vegetation structure into account during the site selection process. If food availability is not a limiting factor, or if birds are unable to track variations in food availability between habitats, then food availability will not be a determining factor in the distribution of avian species.

Dewalt et al. (2003) did show a correlation between frugivorous birds and the availability of food in tropical forest areas. Insectivore distributions may also be affected by food availability, although the effect may not be as profound, due to the wide distributions of insects. In the same way food availability may not be definitive indicator of distribution of granivorous birds in savanna or grasslands, due to the abundance of seed-bearing grasses in these areas (De Walt, et al., 2003).

Large and small raptor species are, to a much greater extent, restricted in their distribution by food availability (Casey & Hein, 1994) and tend to be greater specialists than birds of other guilds. Raptors also need perches from which to hunt, as well as open areas in which to hunt (Casey & Hein, 1994)

although some owl species, as well as eagle species such as the Crowned Eagle (*Stephanoaetus coronatus*) do hunt in forest areas.

8.1.2.2 Water availability

Birds vary in their needs for water. Granivorous birds, birds such as Sclater's Lark (*Spizocorys sclateri*) and the sandgrouse species are restricted in their distribution by their dependency on a daily supply of water (Hockey, 2003). Many of the birds occurring in the drier area of southern Africa are, however, not dependent on a regular supply of water (Maclean, 1993).

8.1.2.3 Nesting sites

Bird species, particularly specialist species, require specific nesting sites. Some birds, for example Pinkbilled Lark (*Spizocorys conirostris*), Larklike Bunting (*Emberiza impetuans*] and Kori Bustard (*Ardeotis kori*) are ground nesting (Maclean, 1993). Others, for instance Jackal Buzzards (*Buteo rufofuscus*), Peregrine Falcons (Falco peregrinus) and Cliff Swallows (*Hirundo spilodera*), require cliffs, rocky ledges or sometimes man-made structures in areas where cliffs do not occur. Species that only nest in trees also exist, for instance Fork-tailed Drongo (*Dicrurus adsirnilis*), Pied Babblers (*Turdoides bicolor*) and Bateleurs (Terathopius ecaudatus) (Maclean, 1993). Many species like the Pririt Batis (*Batis pririt*), Longbilled Crombec (*Sylvietta rufescens*) and Yellow-bellied Eremomelas (*Eremomela icteropygialis*) nest only in the habitat shrub layer (Maclean, 1993). The last section of birds that can be grouped according to breeding habits are birds such as the Desert Cisticola (*Cisticola aridulus*), White-winged Widowbird (*Euplectes albonotatus*) and Kalahari Robin (*Cercotrichas paena*) that nest in grass just above the ground (Maclean, 1993).

The importance of nesting sites cannot be marginalised; Ricklefs (1969) found that nest predation is the major cause of reproductive failure in birds.

8.1.2.4 Competition

Competition is the process by which species or individuals within species compete for resources. Subsequently, certain species or individuals become deprived of those resources due to the inability to compete with more efficient or aggressive competitors (Begon, et al., 1996).

Competition can be direct, whereby individuals actually interact in order to gain access to a resource (birds jostling for song perches), or indirect, whereby an individual's use of a resource leads to the inability of other individuals to utilize that resource (effective predatory birds hunting out prey so that there is less prey for less effective predatory birds) (Begon, et al., 1996).

Interspecific competition can be defined as competition between different species (Begon et al, 1996). In the case of birds this can be competition for food, nesting sites, song perches and hunting perches. The result of interspecific competition is the reduction in fecundity, survivorship and growth as a result of the interference by individuals of another species (Begon, et al., 1996). Interspecific competition is most pronounced in bird species that belong to the same guild or that in some way or another utilizes the same resources, be it for feeding breeding or nesting. This competition leads to the regulation of the numbers of individuals of species occurring in a system. In areas where resources competed over are in limited supply, competition is more pronounced and can ultimately lead to the complete exclusion of one or more of the weaker competing species.

Intraspecific competition is defined in Begon et al (1996) as competition between individuals of the same species. Competition between birds of the same species does not lead to the exclusion of the species from an area, but does have a profound effect on the numbers of individuals of the species in a system (Begon, et al., 1996).

In the case of birds, competition has a much more profound effect on specialist species when compared with generalist species. Generalists are more resilient to environmental pressures due to the fact that they are more adaptable than specialists who, as their name would indicate, are much

specialised in their choice of food type, methods of feeding, nesting areas or breeding (Maesetas, et al., 2003).

8.1.2.5 Predation

Predation is defined as the killing and consumption of one organism (prey) by another organism (predator) (Begon, et al., 1996). Besides the obvious effects of predation namely: reduction of prey population size, "weeding out of older and weaker individuals and reducing intraspecific competition within the prey population, predation can have other effects on a prey populations, depending on the conditions under which the predation takes place. In theory, prey populations will not be totally depleted by predators due to reduction in predator numbers when prey populations are decreased in number (Begon, et al., 1996).

However, due to human interference in system processes, prey populations can decrease below the critical level required by that population to regenerate itself; this can lead to local extinctions of those species. Human factors that can increase the intensity or effect of predation are: fragmentation of habitat (Keyser, 2002), introduction of predators, domestic or wild, (Maesetas, et al., 2003) and (in birds) destruction of suitable nesting habitat (Maesetas, et al., 2003).

8.1.2.6 Vegetation structure

De Walt et al. (2003) states that, although the roles of vegetation structure in shaping faunal communities is not clear, vegetation can provide important resources for nesting, foraging and protection for a variety of taxa. MacArthur & MacArthur (1961) showed a definite positive correlation between vertical height diversity of vegetation and number of bird species in North American forest areas.

Furthermore, studies in forest areas (Willson, 1974) and desert scrub (Tomoff, 1974) showed no positive correlation between foliage height diversity and bird species diversity. Dean (2000) also indicated that an increase in taller, woody vegetation shows an increase in avian species richness, when compared to the surrounding shrubland in the Karoo semi-desert areas of South Africa.

Willson (1974) also found no positive correlation between spatial heterogeneity and bird species diversity. These findings appear to indicate that bird species diversity is either more dependent on other factors than spatial heterogeneity or that the findings of these studies were affected by variables that were not taken into account by the researchers.

Flather et al. (1992) found that vertical habitat structure alone could not account for species diversity, and concluded that in order to predict avian species diversity effectively, spatial heterogeneity needed to be taken into account.

Whitford (Whitford, 1997) indicates that bird species diversity actually increased with an increasing degree of desertification (desertification usually indicates less floral species diversity).

A study of avian demography in afforested grasslands in Illinois, USA showed that the planting of trees in grasslands caused a rapid decline in not only grassland species, but in the total number of species in the afforested area (Naddra & Nyberg, 2001). This appears to oppose the school of thought that avian diversity is enhanced by vertical structural diversity.

Hudson and Bouwman (2007) found a distinct correlation between an increase in vegetation structural diversity and avian species diversity in arid savanna regions.

8.1.3 Use of corridors by avifauna in arid and semi-arid regions

Seymore and Simmons (2008) found that birds often exhibit distinct species assemblages associated with habitat and that degradation or removal of riparian habitat, particularly in arid environments, may threaten bird diversity. The importance of riparian zones as corridors for avian species was also noted by Dean et al. (2002).

8.1.4 Effects of solar power generation on avifauna

Very few studies have been conducted on the impacts of solar facilities on avifauna species. In fact the only peer reviewed article on the subject was written by McCrary et al (1986). A number of colloquial articles exist on the subject but these are very much agenda ridden and do not have any place in a scientific report. Between May and June 1982, the avian mortalities at Solar One were studied by McCrary et al. (1986). The study was conducted over a period of 40 weeks and 57 collision fatalities and 13 burning fatalities were recorded (McCrary, et al., 1986). Aerial foragers (swallows and swifts) were found to be more susceptible to being burned due to their foraging behaviour. It must be noted as well that the burned birds were burned while flying through the standby focal point, and not while the heliostats were focused on the tower (McCrary, et al., 1986).

McCrary et al. (1986) found that most of the collision incidences were recorded at the reflective surfaces of the heliostats and not against the heliostat stands or the tower. Considering the avian fatalities during the study the impact of the facility on avifauna was determined to be minimal with a mortality of 1.9 to 2.2 birds per week and with the recorded abundance only 0.6 to 0.7% of the local population (McCrary, et al., 1986).

It must be taken into account that the types of reflective surfaces at CSP sites are considerably more reflective than those at PV sites and therefore pose a far greater danger.

8.2 Field Survey Results

8.2.1 Avifauna Surveys

8.2.1.1 Vantage point surveys

During the surveys a total of 39 species were recorded and a total of 686 individual birds were recorded. The species recorded are given in Table 4. No species of conservation importance were recorded during the study.

Table 4: Species and abundances of avifauna recorded during the study

Species Common Name	Species Biological Name	Number of individuals recorded
Rock Kestrel	*Falco rupicolus*	1
Lesser Kestrel	*Falco naumanni*	1
Northern Black Korhaan	*Afrotis afraoides*	2
Cape Turtle Dove	*Streptopelia capicola*	9
Laughing Dove	*Streptopelia senegalensis*	11
Namaqua Dove	*Oena capensis*	14
Common Swift	*Apus apus*	2
European Bee-eater	*Merops apiaster*	3
Black-collared Barbet	*Lybius torquatus*	5
Acacia Pied Barbet	*Tricholaema leucomelas*	2
Crested Barbet	*Trachyphonus vaillantii*	4
Rufous-naped Lark	*Mirafra africana*	7
Eastern clapper Lark	*Mirafra fasciolata*	8

Fawn-coloured Lark	*Calendulauda africanoides*	15
Sabota Lark	*Calendulauda sabota*	28
Red-capped Lark	*Calandrella cinerea*	14
Chestnut-backed Sparrow-lark	*Eremopterix leucotis*	3
Greater Striped Swallow	*Cecropis cucullata*	11
Sand Martin	*Riparia riparia*	7
African Red-eyed Bulbul	*Pycnonotus nigricans*	29
Familiar Chat	*Cercomela familiaris*	18
Ant-eating Chat	*Myrmecocichla formicivora*	23
Kalahari Scrub Robin	*Erythropygia paena*	12
Zitting Cisticola	*Cisticola juncidis*	26
Desert Cisticola	*Cisticola aridulus*	22
Marico flycatcher	*Bradornis mariquensis*	3
Cape Wagtail	*Motacilla capensis*	15
Southern (Common) Fiscal	*Lanius collaris*	4
Crimson-breasted Shrike	*Laniarius atrococcineus*	2
Brown-crowned Tchagra	*Tchagra australis*	4
White-browed Sparrow-Weaver	*Plocepasser mahali*	78
Cape Sparrow	*Passer melanurus*	76
Southern Grey-headed Sparrow	*Passer diffusus*	56
White-winged Widowbird	*Euplectes albonotatus*	18
Violet-eared Waxbill	*Uraeginthus granatinus*	34
Common Waxbill	*Estrilda astrild*	22
Pin-tailed Whydah	*Vidua macroura*	5
Yellow Canary	*Crithagra flaviventris*	68
Golden-breasted Bunting	*Emberiza flaviventris*	24

8.3 Data Analysis Results

During the avifauna surveys, data was collected on the number of species and abundance at each of the vantage point surveys. Due to the homogeneity of the vegetation throughout the study area there was no significant difference in the species richness or species diversity at any of the vantage points. Information pertinent to the study was also recorded, namely flight height, flight direction and behaviour.

8.3.1 Avifauna flight height

The average flight height data rounded to the nearest one decimal collected during the surveys is represented graphically in Figure 6. It can be noticed that most of the species recorded in the area fly at an average height of 7.4m, while the average minimum height is 2.4m and the average maximum

height is 12.4m. What is noticeable is that the vast majority of species show and average flight height (based on the actual flying height excluding the ground level data) of below 10m. This is likely due to the vegetation being low shrubs and grass with few or no trees, all feeding, nesting and protection against predation thus occurs at very low altitudes.

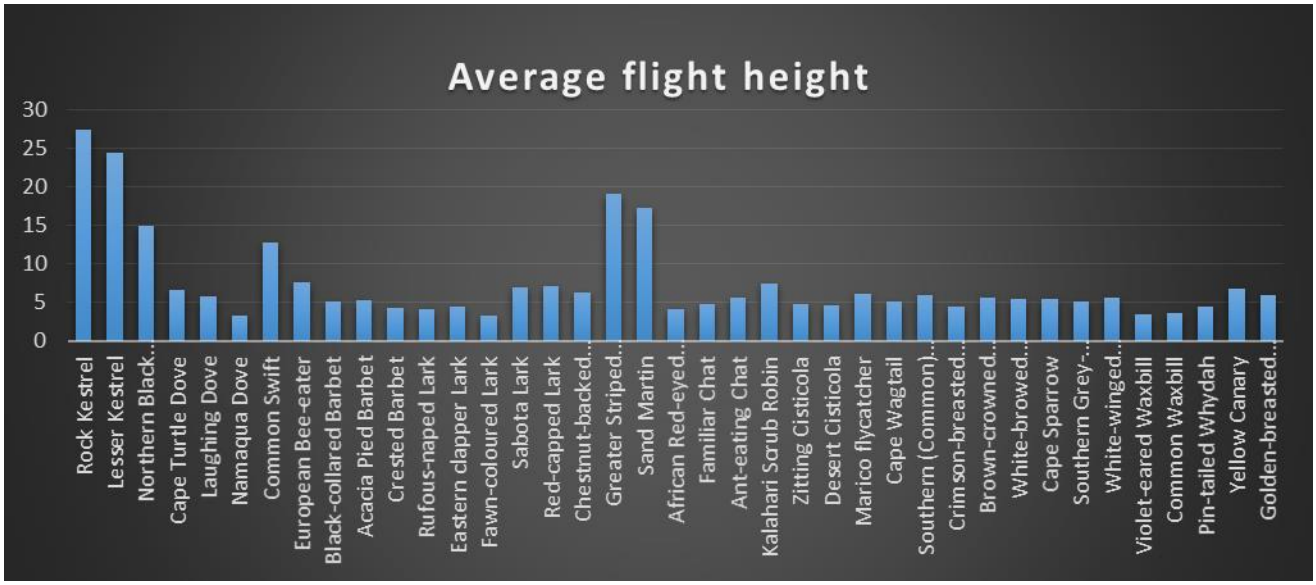

Figure 6: Average flight heights according to data collected during the vantage point surveys

Avifauna flight direction

From the data recorded there does not appear to be any preferred or prevalent direction in which birds tend to fly. This may be due to the fact that there is no significant migration at this time of the year and that all the birds recorded are locally resident.

- ### Avifauna behaviour

Bird activity was restricted to flying, feeding perching and soaring in search of food (for the predatory birds), as expected during a survey at this time of the year.

9 IMPACT ASSESSMENT

Commercial-scale solar technologies are relatively new, with a limited number of significant developments worldwide. Some studies have been conducted on the effects of solar facilities on avifauna, most notably The Solar One plant in the Mojave Desert in the United States (McCrary, et al., 1986).

Although there may be considerable impact due to the clearing of vegetation and the large footprint required for commercial-scale energy production, which would refer to the habitat loss and disturbance created during the construction phase of the facility, birds are the most mobile of vertebrate species and there is considerable amount of the same vegetation in adjacent areas to which avifauna will move. Furthermore, in this case, the vegetation of the area is very low and with revegetation the area of the heliostat field, thereby recovering some of the lost vegetation. Secondary impacts relate to the operation of the facility and include avian mortality due to direct interactions with the facilities and their associated infrastructure.

Based on the information gathered, several impacts have been identified and will be quantified in sections below:

- Impact on local bird community due to habitat loss;
- Impact on local bird community due to disturbance;

- Impact on birds attracted to plant infrastructure;
- Collision of birds with infrastructure associated with the facilities;
- Collision of birds with the associated power line; and
- Electrocution of birds on associated power line tower structures.

These impacts were quantified using the data collected during the site visit and according to criteria set out by Hudson Ecology.

9.1 Impact on local bird community due to habitat loss

Nature: In order for solar energy facilities to be commercially viable, they require large tracts of land, in this case *circa* 150ha. It can therefore be assumed that a habitat will be lost during the establishment of the facility and its associated infrastructure (including clearing for access roads and power lines). Habitat loss reduces the carrying capacity of a habitat, often resulting in localised population declines. Such habitat loss can impact on local as well as, to a lesser degree, migratory species. The general nature of the study area (already relatively disturbed, and extremely uniform throughout wider area) means that this is not likely to impact significantly on the avifauna of the area.

Extent: The entire area will initially be cleared, but reseeded after construction. The impact of habitat loss would therefore be local.

Duration: Due to reseeding and recolonization of the area with shrubs, the loss of habitat will not have a permanent impact for the life of the project. Larger trees and shrubs will not be replaced thus bird species using these physiognomic structures will be displaced as a residual impact. Based on this, the loss of habitat and the subsequent impact on local bird communities will be short term with a long term residual impact.

Magnitude: The magnitude of this type of impact could be low to high, depending on the species concerned, the proportion of the study site affected and the current status of the habitat on site (i.e. degraded or intact). For instance, if Species of Special Concern were adversely affected by the habitat loss on site, then the impact would be high. No Species of Special Concern were however detected on site and the density and diversity of bird species was fairly low. The amount of habitat that would be lost would not be significant. For this reason, the magnitude is minor.

Probability: Habitat will be lost if the construction of the facility takes place and therefore, regardless of any prevention or mitigation measures that are put in place, an impact will occur. The impact will be definite.

Mitigation measures: The following mitigation measures are recommended:

- Minimise vegetation clearing;
- Avoid clearing vegetation in drainage channels or washes or spinneys, where bird density and diversity has the potential to be higher;
- If possible, the servitude of the power line exiting the site should follow existing roads and not cut across habitat; and
- All construction and maintenance activities must be undertaken in accordance with Eskom Transmission's Environmental Best Practise Standards. All construction activities and access roads should be restricted as much as possible.

Table 5: Summary of impact significance table for habitat loss

1. Activity: Vegetation clearing for the CSP facility, access roads and powerlines		
Avifaunal Aspect: Impact on local bird community due to habitat loss from the construction and associated infrastructure including power lines.		
	Without Mitigation	**With Mitigation**

Extent (E)	**2**	Local	2	Local
Duration (D)	4	>15 years	3	>5 to 15 years
Magnitude (M)	4	Low Intensity	2	Minor
Probability (P)	4	Highly Probable	4	Highly Probable
Significance (S = [E+D+M]xP)	40	Moderate	20	Low
Status (Positive, negative or neutral)	Negative		Negative	
Reversibility	Possible		Possible	
Irreplaceable loss of resources	None		None	
Mitigability	Yes		Yes	
Mitigation measures: Where possible, avoid clearing vegetation in drainage channels or washes, where bird density and diversity has the potential to be higher (although this higher diversity was not recorded during the site visit). If possible, the servitude of the power line exiting the site should follow existing roads and not cut across habitat. All construction and maintenance activities must be undertaken in accordance with Eskom's Environmental Best Practise Standards. The construction footprint and access roads should be restricted to within the development footprint. All social weavers nests that may be affected by the development must be moved by a qualified contractor or with the assistance of the relevant qualified persons; other bird nests in trees/higher shrubs need to be monitored and only removed if not used for breeding.				
Cumulative impacts: The loss of habitat on-site has the potential to add to the cumulative impacts that habitat loss in the region is having on avifauna. However, in the context of the amount of similar habitat in the region the impact is a negligible amount.				
Residual impacts: Localised displacement of certain avifauna species.				

9.2 Impact on local bird communities due to disturbance

Nature: Disturbance from human activity, during the construction and operational phase, has the potential to modify bird behaviour on site. For shy and sensitive species, this may result in displacement or exclusion.

Construction and maintenance activities associated with the power facility as well as the power line impact on birds through disturbance, particularly during the breeding season.

Certain bird species could also choose to nest on the towers of the proposed power line. In this arid and largely treeless landscape any form of available nesting substrate will probably be utilised by medium sized raptors, crows and the Sociable Weaver. The proposed power line is likely to be built on a monopole structure, which does not present the most conducive structure for nesting.

Extent: It is assumed that all new construction, and subsequent operational activities, will be limited mainly to the area demarcated for development. Based on this, the impact will be local.

Duration: Disturbance will mainly occur during the construction phase of the development, and to a lesser extent, during operation. Over time, bird species are able to adapt to and co-exist with certain disturbances. The duration of the impact will be of a short duration.

Magnitude: The magnitude of the impact is measured by the potential outcome should certain individuals in the bird community present on site be unduly disturbed and affected by the construction and operation of the facility. No Species of Special Concern were detected during the site visit. In addition, none of the species detected on site are unduly shy or secretive species and particularly sensitive to disturbance. The magnitude of the impact will therefore be minor.

Probability: There is a distinct possibility of this impact occurring.

Mitigation: The additional disturbance will be minimal and it not expected to have a particularly significant impact on the local bird community. However:

- Contractors need to minimise the amount of disturbance during the construction phase of the facility, by staying within the demarcated construction area
- If the nest of a large species is detected within the vicinity of the area to be disturbed, then the Department needs to be notified and all attempts made to minimise the amount of disturbance near it.

Table 6: Summary of impact significance table for disturbance

2. Activity: Disturbance				
Avifaunal Aspect: Nature: Impact on local bird community due to disturbance on site and in surrounding area. Sensitive and threatened species are of most concern and particularly while breeding				
	Without Mitigation		**With Mitigation**	
Extent (E)	**1**	Low	1	Low
Duration (D)	2	1-5 years	2	1-5 years
Magnitude (M)	2	Negligible Intensity	2	Negligible Intensity
Probability (P)	3	Probable	3	Probable
Significance (S = [E+D+M]xP)	15	Low	15	Low
Status (Positive, negative or neutral)	Negative		Negative	
Reversibility	Possible		Possible	
Irreplaceable loss of resources	None		None	
Mitigability	Yes		Yes	
Mitigation measures: Contractors need to minimise the amount of disturbance during the construction phase of the facility, by staying within the demarcated construction area. If the nest of a large species is detected within the vicinity of the area to be disturbed, then the North West Department needs to be notified and all attempts made to minimise the amount of disturbance near it.				
Cumulative impacts: Development of multiple solar energy facilities in this region near Vryburg may have cumulative impacts on birds, however limited due to the species which occur in the area. Each plant will have to individually assess if mitigation measures are required to protect avifauna. An avifauna monitoring program is advised.				
Residual impacts: Localised loss or displacement of avifauna species.				

9.3 Impact on birds attracted to the solar thermal infrastructure

Nature: The facility will include a series of raised panels as well as other potential nesting, roosting and feeding sites.

Extent: This would be limited to the immediate area of the facility. The extent of the impact would therefore be local.

Duration: The impact would exist for the life of the facility and would therefore be long term.

Magnitude: In order to measure the magnitude of this impact, one has to measure what impact the facility may have on birds attracted to the facility. It is uncertain as to whether birds will be attracted to the facility and if so, to what extent they would interact with the facility. While this phenomenon

cannot be ruled out, evidence to date from other installed facilities have shown that the magnitude is low due to the type of birds resident in the area.

Probability: The probability of this occurring is relatively probable before mitigation.

Mitigation: Put deterents in place and make less visible structures powerlines, fences etc more visible through the use of deterrent devices, barrier tape etc.

Table 7: Impacts and mitigations of the operation of the CSP

Activity: Operation of the CSP				
Avifaunal Aspect: The facility will include a series of raised panels as well as other potential nesting, roosting and feeding sites				
Impact on Avifauna: Possible mortality for a number of reasons				
	Without Mitigation		**With Mitigation**	
Extent (E)	1	Low	1	Low
Duration (D)	5	Permanent	5	Permanent
Magnitude (M)	2	Negligible Intensity	1	Negligible Intensity
Probability (P)	2	Improbable	1	Very Improbable
Significance (S = [E+D+M]xP)	16	Low	7	Low
Status (Positive, negative or neutral)	Negative		Negative	
Reversibility	Possible		Possible	
Irreplaceable loss of resources	None		None	
Mitigability	Yes		Yes	
Mitigation: Put deterents in place and make less visible structures powerlines, fences etc more visible through the use of deterrent devices, barrier tape etc.				
Cumulative Impacts: A number of facilities in the area with an increased amount of infrastructure and reduced natural habitat will increase the potential for interaction between bird species and the infrastructure. The consolidation of impacts is preferred, localising the impact to an area where the risk to birds is considered low. In addition, the spacing between facilities should be sufficient to provide a corridor for avifauna movement.				
Residual impacts: Localised loss or displacement of avifauna species.				

9.4 Collision of birds with infrastructure associated with the development

Nature: Collisions are one of the biggest single threat posed by overhead power lines to birds in southern Africa. In South Africa, bird collisions with power lines are a major form of unnatural mortality, affecting several threatened species as well as other species. The majority of species that are susceptible to collisions tend to be long-lived, slow reproducing species such as bustards, cranes, korhaans and various water bird species who are not the most agile flyers. Due to the slow reproductive nature of many of the susceptible species, long-term mortalities caused by collisions may result in future population's abilities to sustain themselves. Birds usually avoid the highly visible bundled conductors, but often fail to see the thin ground wires, with typical injuries resulting from collisions including broken necks and legs. Threatened species that have the potential to occur in the study area and that may be involved in collision events include:

- Secretarybirds *Sagittarius serpentarius* – Near Threatened
- Kori Bustard *Ardeotis kori* – Vulnerable

While the aforementioned species only included endangered species, all korhaan and bustard populations are currently under pressure. Birdlife SA lists the collision of large terrestrial birds with power lines as one of the highest mortality factors for these particular birds in South Africa – with this single mortality factor leading to the decline of Ludwig's Bustard *Neotis ludwigii*. For species such as Northern Black Korhaan *Afrotis afraoides* and Karoo Korhaan *Eupodoptis vigorsii* which occur on site, collision mortalities would probably not have a hugely significant impact on their regional populations. Ongoing mortalities on a large-scale may however result in long term effects on these species and as such, an effort should be made to minimise the impacts upon these populations.

Susceptible species to collisions with power lines utilise waterways as flyways and the proximity of the Dry Harts River accentuates the likelihood of interactions with power lines.

Duration: The impact would cover the lifespan of the facility and will be long-term.

Extent: The extent will be confined to the study area (i.e. the demarcated site for the facility as well as the extent of the power line). The extent is therefore local.

Magnitude: The magnitude of this impact will be moderate to high due to the conservation status of the species which have the potential to be involved in collision events. Bustards are of particular concern based on its biology and known incidences of collision events. This species may therefore be susceptible to collisions with the proposed power line, the consequences of which would be significant.

Probability: Bird species susceptible to collisions with power lines occur in the area and some, in large numbers. Northern Black Korhaan were recorded on site. This, heavy bodied, low flying species is susceptible to collisions. There is therefore a high possibility of collision events and subsequent impacts on local bird populations. The probability of events can be minimised through the implementation of mitigation measures.

Significance: The significance of this impact will be moderate to high (due to the conservation status of the species involved in possible collision events). The significance of this impact can however be reduced through mitigation measures.

Mitigation: The incidences of birds interacting with the solar facility itself and subsequent mortalities are minimal. It is however recommended that appropriate bird deterrents are placed at power line locations around the facility to reduce this impact. Mitigation measures regarding the power line include:

- Install anti bird collision line marking devices on high risk sections of power line;
- Conduct avifaunal walk through to identify these high risk area;s
- The line should be kept as low as possible taking into account engineering and legal requirements;
- The span lengths should be kept as short as possible;
- Placement of bird flappers as markers on the earth wire, which will increase the visibility of the power line;
- Markers should be placed with sufficient regularity (at least every 5-10m). Eagle eye devices may be used, if feasible to deter birds from the CSP plant area/ solar field; and
- Regular monitoring and assessment and improvement of mitigation factors.

Table 8: Summary of impacts of collision of birds with infrastructure

Nature: Impact on local bird communities due to the power line due to collision by the overhead power lines				
Impact on Avifauna:				
	Without Mitigation		**With Mitigation**	
Extent (E)	1	Low	1	Low

Duration (D)	4	>15 years	4	>15 years
Magnitude (M)	8	Negligible Intensity	4	Negligible Intensity
Probability (P)	4	Highly Probable	2	Improbable
Significance (S = [E+D+M]xP)	52	Moderate	18	Low
Status (Positive, negative or neutral)	Negative		Negative	
Reversibility	No		No	
Irreplaceable loss of resources	Yes - Avifauna fatalities		Yes - Avifauna fatalities	
Mitigability	Yes		Yes	
Mitigation measures: The line should be kept as low as possible taking into account engineering and legal requirements. The span lengths should be kept as short as is reasonable. Placement of bird flappers or deterrents as markers on the earth wire, which will increase the visibility of the power line. Markers should be placed with sufficient regularity (at least every 5-10m). Eagle eye devices may be used, if feasible to deter birds from the CSP plant area/ solar field.				
Cumulative impacts: There are a number of power lines in the vicinity as well as throughout the North West Province. Power lines that cross remote areas should be fitted with bird diverters (diurnal and nocturnal) to reduce the high incidence of collisions. As the number of power lines increase so the number of deaths of bustards and other birds will increase. With mitigation, it is considered unlikely that the addition of the proposed length of power line will significantly add to the cumulative impact of collision events in the region.				
Residual impacts: Localised loss or displacement of avifauna species.				

9.5 Electrocution of birds on associated power line tower structures

Nature: The design has allowed for an overhead power line, feeding into the Eskom network (a distance of approximately 7.5km). Power lines have a range of bird related impacts, one of which is electrocution events, which occur when a bird perches on an electrical structure and causes an electrical short circuit by bridging the gap between live components and/or live and earthed components. The larger transmission lines (220kV to 765kV) are not a threat to large raptors and other birds which are vulnerable to electrocutions – often proving to be beneficial by providing roosting and nesting sites. The smaller distribution lines, such as the 132kV proposed for the development, can however be dangerous to birds. Birds that are typically at risk are those with large wingspans which can bridge the gaps between lines, such as raptors, bustards and storks. Threatened species that have the potential to occur in the study area and that may be involved in electrocution events include:

- Secretarybird *Sagittarius serpentarius* – Near Threatened
- Kori Bustard *Ardeotis kori* – Vulnerable
- Martial Eagle *Polemaetus bellicosus* - Vulnerable

In flat landscapes, typical of the study area, large raptors will instinctively look for the highest vantage point on which to perch. Given that the towers will be the highest structures in the area, there is a high probability that raptors will be landing on the structures and using them to survey the surrounding habitat or to nest on.

Electrocution is possible on lines such as those proposed, depending on the exact pole structure used. Since the developer have not yet committed to a tower structure, this impact cannot be fully assessed. The minimum phase – phase and phase – earth clearance of 2000mm should be adhered to for whichever structure is used, in order to mitigate for electrocution.

Extent: The impact will be confined to the length of the power line. It will however, potentially, have a regional impact on bird populations.

Duration: The impact will cover the lifespan of the facility and will be long term.

Magnitude: The magnitude of this impact will be moderate to high due to the conservation status of the species which may be involved in electrocution events.

Probability: There is a distinct possibility of electrocution events and subsequent impacts on local bird communities, including endangered species. The probability of such events can be minimised through mitigation measures.

Mitigation: It has been indicated that mono pole bird friendly tower structures will be utilised in the development. This will significantly minimise the number of electrocutions.

Table 9: Summary of the electrocution impacts associated with the development

Nature: Impact on local bird communities due to electrocution events				
Impact on Avifauna:				
	Without Mitigation		**With Mitigation**	
Extent (E)	1	Low	1	Low
Duration (D)	4	>15 years	4	>15 years
Magnitude (M)	6	Moderate Intensity	2	Minor Intensity
Probability (P)	4	Highly Probable	2	Improbable
Significance (S = [E+D+M]xP)	44	Moderate	14	Low
Status (Positive, negative or neutral)	Negative		Negative	
Reversibility	Yes		Yes	
Irreplaceable loss of resources	Yes - Avifauna fatalities		Yes - Avifauna fatalities	
Mitigability	Yes		Yes	
Mitigation measures: Mono pole bird friendly tower structures will be utilised in the development. This will significantly minimise the number of electrocutions				
Cumulative impacts: There are a number of power lines in the vicinity as well as throughout the North West Province. Power lines that cross remote areas should be fitted with bird guards to reduce the incidence of perching on towers. With mitigation, it is considered unlikely that the addition of the proposed length of power line will significantly add to the cumulative impact of electrocution events in the region.				
Residual impacts: Localised loss or displacement of avifauna species.				

10 DISCUSSION

10.1 Study confidence

In order to investigate possible impacts of the facility on avifauna, vantage point surveys were conducted in order to a section of the entire study area. The use of high quality optics and sound recording equipment made it possible to identify bird species from one vantage point to quite close to the adjacent vantage points. The number of species and individuals recorded during the surveys gives a high degree of confidence in the vantage point surveys conducted. Furthermore, transect surveys were conducted in the drainage lines or washes in order to determine the use of these areas as corridors by avifauna species. These surveys yielded results particularly pertinent to the project and

there is high confidence in the understanding of the avifauna in the study area, the project and possible impacts upon each other gained during the study.

10.2 Main pertinent observations

The main pertinent observations made during the vantage point surveys can be summarised as follows:

Avifauna diversity - During the study a total of 39 species were recorded and a total of 656 individual birds were recorded. No species of concern were recorded but the occurrence cannot be ruled out.

Avifauna behaviour – One of the main aspects of avifauna behaviour noted was that 78% of bird species, and 98% of individual birds, recorded during the study flew at an average height of 4m (rounded off to the closest meter) and were observed at an average minimum height of 0.5m and an average maximum height of 12m. When applied, to what was learned about the facility, this means that most resident bird species usually fly at the height of the infrastructure. Another noteworthy observation was the lack of activity in the open field areas between 11:00 and 16:00 every day, during this time most species were found to be active in the riparian or wash areas traversing the region.

During the study species of concern appeared absent from the study area, all these species are likely to be resident species and the fact that they were not recorded does strongly suggest that they are in fact not present within the study area.

In order to deter avian species from the facility, the facility needs to be as unsuitable for avian biological requirements as possible, as avifauna tend to avoid areas that are not suitable for their requirements (Hudson & Bouwman, 2008). Biological requirements of avian species can be summarised as follows:

- Food sources;
- Water sources;
- Nesting sites;
- Perching sites; and
- Reduced competition.

Adrian Hudson (Senior Ecologist)

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APPENDIX A

Avifauna species occurring in the region of the study area

Roberts 6 Sort	Full Name	*Scientific Name*	RD (Regional, Global)	S	E
1	Common Ostrich	*Struthio camelus*			
55	White-breasted Cormorant	*Phalacrocorax lucidus*			
58	Reed Cormorant	*Phalacrocorax africanus*			
60	African Darter	*Anhinga rufa*			
62	Grey Heron	*Ardea cinerea*			
64	Goliath Heron	*Ardea goliath*			
65	Purple Heron	*Ardea purpurea*			
66	Great Egret	*Egretta alba*			
67	Little Egret	*Egretta garzetta*			
68	Yellow-billed Egret	*Egretta intermedia*			
69	Black Heron	*Egretta ardesiaca*			
71	Western Cattle Egret	*Bubulcus ibis*			
72	Squacco Heron	*Ardeola ralloides*			
74	Green-backed Heron	*Butorides striata*			
76	Black-crowned Night Heron	*Nycticorax nycticorax*			
78	Little Bittern	*Ixobrychus minutus*			
81	Hamerkop	*Scopus umbretta*			
83	White Stork	*Ciconia ciconia*			
84	Black Stork	*Ciconia nigra*	VU, LC		
85	Abdim's Stork	*Ciconia abdimii*	NT, LC		
89	Marabou Stork	*Leptoptilos crumeniferus*	NT, LC		
90	Yellow-billed Stork	*Mycteria ibis*	EN, LC		
91	African Sacred Ibis	*Threskiornis aethiopicus*			
93	Glossy Ibis	*Plegadis falcinellus*			
94	Hadeda Ibis	*Bostrychia hagedash*			
95	African Spoonbill	*Platalea alba*			
96	Greater Flamingo	*Phoenicopterus roseus*	NT, LC		
97	Lesser Flamingo	*Phoeniconaias minor*	NT, NT		
99	White-faced Whistling Duck	*Dendrocygna viduata*			
100	Fulvous Whistling Duck	*Dendrocygna bicolor*			
101	White-backed Duck	*Thalassornis leuconotus*			
102	Egyptian Goose	*Alopochen aegyptiaca*			
103	South African Shelduck	*Tadorna cana*			
104	Yellow-billed Duck	*Anas undulata*			
105	African Black Duck	*Anas sparsa*			

106	Cape Teal	*Anas capensis*			
107	Hottentot Teal	*Anas hottentota*			
108	Red-billed Teal	*Anas erythrorhyncha*			
112	Cape Shoveler	*Anas smithii*			
113	Southern Pochard	*Netta erythrophthalma*			
115	Knob-billed Duck	*Sarkidiornis melanotos*			
116	Spur-winged Goose	*Plectropterus gambensis*			
117	Maccoa Duck	*Oxyura maccoa*	NT, NT		
118	Secretarybird	*Sagittarius serpentarius*	VU, VU		
122	Cape Vulture	*Gyps coprotheres*	EN, VU		
123	White-backed Vulture	*Gyps africanus*	EN, EN		
124	Lappet-faced Vulture	*Torgos tracheliotos*	EN, VU		
126	Black Kite	*Milvus migrans*			
127	Black-shouldered Kite	*Elanus caeruleus*			
132	Tawny Eagle	*Aquila rapax*	EN, LC		
135	Wahlberg's Eagle	*Hieraaetus wahlbergi*			
136	Booted Eagle	*Hieraaetus pennatus*			
140	Martial Eagle	*Polemaetus bellicosus*	EN, VU		
142	Brown Snake Eagle	*Circaetus cinereus*			
143	Black-chested Snake Eagle	*Circaetus pectoralis*			
148	African Fish Eagle	*Haliaeetus vocifer*			
149	Common (Steppe) Buzzard	*Buteo buteo*			
152	Jackal Buzzard	*Buteo rufofuscus*			(*)
156	Ovambo Sparrowhawk	*Accipiter ovampensis*			
157	Little Sparrowhawk	*Accipiter minullus*			
159	Shikra	*Accipiter badius*			
161	Gabar Goshawk	*Melierax gabar*			
162	Pale Chanting Goshawk	*Melierax canorus*			
165	African Marsh Harrier	*Circus ranivorus*	EN, LC		
166	Montagu's Harrier	*Circus pygargus*			
167	Pallid Harrier	*Circus macrourus*	NT, NT		
169	African Harrier-Hawk	*Polyboroides typus*			
170	Western Osprey	*Pandion haliaetus*			
171	Peregrine Falcon	*Falco peregrinus*			
172	Lanner Falcon	*Falco biarmicus*	VU, LC		
178	Red-necked Falcon	*Falco chicquera*			
179	Red-footed Falcon	*Falco vespertinus*	NT, NT		
180	Amur Falcon	*Falco amurensis*			
181	Rock Kestrel	*Falco rupicolus*			
182	Greater Kestrel	*Falco rupicoloides*			

183	Lesser Kestrel	*Falco naumanni*			
188	Coqui Francolin	*Peliperdix coqui*			
189	Crested Francolin	*Dendroperdix sephaena*			
193	Orange River Francolin	*Scleroptila gutturalis*			
199	Swainson's Spurfowl	*Pternistis swainsonii*			
200	Common Quail	*Coturnix coturnix*			
201	Harlequin Quail	*Coturnix delegorguei*			
203	Helmeted Guineafowl	*Numida meleagris*			
205	Common (Kurrichane) Buttonquail	*Turnix sylvaticus*			
208	Blue Crane	*Anthropoides paradiseus*	NT, VU		
210	African Rail	*Rallus caerulescens*			
212	African Crake	*Crecopsis egregia*			
213	Black Crake	*Amaurornis flavirostra*			
215	Baillon's Crake	*Porzana pusilla*			
223	African (Purple) Swamphen	*Porphyrio madagascariensis*			
226	Common Moorhen	*Gallinula chloropus*			
228	Red-knobbed coot	*Fulica cristata*			
230	Kori Bustard	*Ardeotis kori*	NT, NT		
237	Red-crested Korhaan	*Lophotis ruficrista*			
239.1	Northern Black Korhaan	*Afrotis afraoides*			
240	African Jacana	*Actophilornis africanus*			
242	Greater Painted-snipe	*Rostratula benghalensis*	VU, LC		
245	Common Ringed Plover	*Charadrius hiaticula*			
246	White-fronted Plover	*Charadrius marginatus*			
248	Kittlitz's Plover	*Charadrius pecuarius*			
249	Three-banded Plover	*Charadrius tricollaris*			
252	Caspian Plover	*Charadrius asiaticus*			
255	Crowned Lapwing	*Vanellus coronatus*			
258	Blacksmith Lapwing	*Vanellus armatus*			
262	Ruddy Turnstone	*Arenaria interpres*			
264	Common Sandpiper	*Actitis hypoleucos*			
266	Wood Sandpiper	*Tringa glareola*			
269	Marsh Sandpiper	*Tringa stagnatilis*			
270	Common Greenshank	*Tringa nebularia*			
272	Curlew Sandpiper	*Calidris ferruginea*			
274	Little Stint	*Calidris minuta*			
284	Ruff	*Philomachus pugnax*			
287	Black-tailed Godwit	*Limosa limosa*	NA, NT	V	
294	Pied Avocet	*Recurvirostra avosetta*			

295	Black-winged Stilt	*Himantopus himantopus*			
297	Spotted Thick-knee	*Burhinus capensis*			
299	Burchell's Courser	*Cursorius rufus*	VU, LC		
300	Temminck's Courser	*Cursorius temminckii*			
301	Double-banded Courser	*Rhinoptilus africanus*			
303	Bronze-winged Courser	*Rhinoptilus chalcopterus*			
305	Black-winged Pratincole	*Glareola nordmanni*	NT, NT		
315	Grey-headed Gull	*Chroicocephalus cirrocephalus*			
322	Caspian Tern	*Sterna caspia*	VU, LC		
338	Whiskered Tern	*Chlidonias hybrida*			
339	White-winged Tern	*Chlidonias leucopterus*			
344	Namaqua Sandgrouse	*Pterocles namaqua*			
347	Double-banded Sandgrouse	*Pterocles bicinctus*			
348	Rock Dove	*Columba livia*			
349	Speckled Pigeon	*Columba guinea*			
350	African Olive Pigeon	*Columba arquatrix*			
352	Red-eyed Dove	*Streptopelia semitorquata*			
354	Cape Turtle Dove	*Streptopelia capicola*			
355	Laughing Dove	*Streptopelia senegalensis*			
356	Namaqua Dove	*Oena capensis*			
373	Grey Go-away-bird	*Corythaixoides concolor*			
374	Common Cuckoo	*Cuculus canorus*			
375	African Cuckoo	*Cuculus gularis*			
377	Red-chested Cuckoo	*Cuculus solitarius*			
378	Black Cuckoo	*Cuculus clamosus*			
380	Great Spotted Cuckoo	*Clamator glandarius*			
381	Levaillant's Cuckoo	*Clamator levaillantii*			
382	Jacobin Cuckoo	*Clamator jacobinus*			
385	Klaas's Cuckoo	*Chrysococcyx klaas*			
386	Diederik Cuckoo	*Chrysococcyx caprius*			
391	Burchell's Coucal	*Centropus burchellii*			
392	Western Barn Owl	*Tyto alba*			
395	Marsh Owl	*Asio capensis*			
396	African Scops Owl	*Otus senegalensis*			
398	Pearl-spotted Owlet	*Glaucidium perlatum*			
401	Spotted Eagle-Owl	*Bubo africanus*			
402	Verreaux's Eagle-Owl	*Bubo lacteus*			
404	European Nightjar	*Caprimulgus europaeus*			
406	Rufous-cheeked Nightjar	*Caprimulgus rufigena*			

408	Freckled Nightjar	*Caprimulgus tristigma*			
411	Common Swift	*Apus apus*			
412	African Black Swift	*Apus barbatus*			
415	White-rumped Swift	*Apus caffer*			
416	Horus Swift	*Apus horus*			
417	Little Swift	*Apus affinis*			
418	Alpine Swift	*Tachymarptis melba*			
421	African Palm Swift	*Cypsiurus parvus*			
425	White-backed Mousebird	*Colius colius*			
426	Red-faced Mousebird	*Urocolius indicus*			
428	Pied Kingfisher	*Ceryle rudis*			
429	Giant Kingfisher	*Megaceryle maxima*			
431	Malachite Kingfisher	*Alcedo cristata*			
432	African Pygmy Kingfisher	*Ispidina picta*			
435	Brown-hooded Kingfisher	*Halcyon albiventris*			
437	Striped Kingfisher	*Halcyon chelicuti*			
438	European Bee-eater	*Merops apiaster*			
440	Blue-cheeked Bee-eater	*Merops persicus*			
443	White-fronted Bee-eater	*Merops bullockoides*			
444	Little Bee-eater	*Merops pusillus*			
445	Swallow-tailed Bee-eater	*Merops hirundineus*			
446	European Roller	*Coracias garrulus*	NT, NT		
447	Lilac-breasted Roller	*Coracias caudatus*			
449	Purple Roller	*Coracias naevius*			
451	African Hoopoe	*Upupa africana*			
452	Green Wood-hoopoe	*Phoeniculus purpureus*			
454	Common Scimitarbill	*Rhinopomastus cyanomelas*			
457	African Grey Hornbill	*Tockus nasutus*			
459	Southern Yellow-billed Hornbill	*Tockus leucomelas*			
464	Black-collared Barbet	*Lybius torquatus*			
465	Acacia Pied Barbet	*Tricholaema leucomelas*			
470	Yellow-fronted Tinkerbird	*Pogoniulus chrysoconus*			
473	Crested Barbet	*Trachyphonus vaillantii*			
474	Greater Honeyguide	*Indicator indicator*			
476	Lesser Honeyguide	*Indicator minor*			
481	Bennett's Woodpecker	*Campethera bennettii*			
483	Golden-tailed Woodpecker	*Campethera abingoni*			
486	Cardinal Woodpecker	*Dendropicos fuscescens*			
487	Bearded Woodpecker	*Dendropicos namaquus*			
493	Monotonous Lark	*Mirafra passerina*			

494	Rufous-naped Lark	*Mirafra africana*			
495.2	Eastern clapper Lark	*Mirafra fasciolata*			
497	Fawn-coloured Lark	*Calendulauda africanoides*			
498	Sabota Lark	*Calendulauda sabota*			
501	Short-clawed Lark	*Certhilauda chuana*	NT, LC		
506	Spike-heeled Lark	*Chersomanes albofasciata*			
507	Red-capped Lark	*Calandrella cinerea*			
508	Pink-billed Lark	*Spizocorys conirostris*			
515	Chestnut-backed Sparrow-lark	*Eremopterix leucotis*			
516	Grey-backed Sparrow-lark	*Eremopterix verticalis*			
518	Barn Swallow	*Hirundo rustica*			
520	White-throated Swallow	*Hirundo albigularis*			
523	Pearl-breasted Swallow	*Hirundo dimidiata*			
524	Red-breasted Swallow	*Cecropis semirufa*			
526	Greater Striped Swallow	*Cecropis cucullata*			
528	South African Cliff Swallow	*Petrochelidon spilodera*			BSLS
529	Rock Martin	*Hirundo fuligula*			
530	Common House Martin	*Delichon urbicum*			
532	Sand Martin	*Riparia riparia*			
533	Brown-throated Martin	*Riparia paludicola*			
534	Banded Martin	*Riparia cincta*			
541	Fork-tailed Drongo	*Dicrurus adsimilis*			
543	Eurasian Golden Oriole	*Oriolus oriolus*			
547	Cape Crow	*Corvus capensis*			
548	Pied crow	*Corvus albus*			
552	Ashy Tit	*Parus cinerascens*			
558	Grey Penduline-Tit	*Anthoscopus minutus*			
560	Arrow-marked Babbler	*Turdoides jardineii*			
563	Southern Pied Babbler	*Turdoides bicolor*			
567	African Red-eyed Bulbul	*Pycnonotus nigricans*			
577.1	Karoo Thrush	*Turdus smithi*			(*)
580	Groundscraper Thrush	*Turdus litsitsirupa*			
583	Short-toed Rock Thrush	*Monticola brevipes*			
586	Mountain Wheatear	*Oenanthe monticola*			
587	Capped Wheatear	*Oenanthe pileata*			
589	Familiar Chat	*Cercomela familiaris*			
591	Sickle-winged Chat	*Cercomela sinuata*			(*)
593	Mocking Cliff Chat	*Thamnolaea cinnamomeiventris*			
595	Ant-eating Chat	*Myrmecocichla formicivora*			

596	African StoneChat	*Saxicola torquatus*			
601	Cape Robin-Chat	*Cossypha caffra*			
602	White-throated Robin-Chat	*Cossypha humeralis*			
615	Kalahari Scrub Robin	*Erythropygia paena*			
619	Garden Warbler	*Sylvia borin*			
620	Common Whitethroat	*Sylvia communis*			
621	Chestnut-vented Tit-Babbler	*Sylvia subcaerulea*			
625	Icterine Warbler	*Hippolais icterina*			
628	Great Reed Warbler	*Acrocephalus arundinaceus*			
633	Marsh Warbler	*Acrocephalus palustris*			
634	Sedge Warbler	*Acrocephalus schoenobaenus*			
635	Lesser Swamp Warbler	*Acrocephalus gracilirostris*			
638	Little Rush Warbler	*Bradypterus baboecala*			
643	Willow Warbler	*Phylloscopus trochilus*			
651	Long-billed crombec	*Sylvietta rufescens*			
653	Yellow-bellied Eremomela	*Eremomela icteropygialis*			
657.1	Grey-backed Camaroptera	*Camaroptera brevicaudata*			
658	Barred Wren-Warbler	*Calamonastes fasciolatus*			
664	Zitting Cisticola	*Cisticola juncidis*			
665	Desert Cisticola	*Cisticola aridulus*			
666	Cloud Cisticola	*Cisticola textrix*			(*)
667	Wing-snapping Cisticola	*Cisticola ayresii*			
672	Rattling Cisticola	*Cisticola chiniana*			
677	Levaillant's Cisticola	*Cisticola tinniens*			
679	Lazy Cisticola	*Cisticola aberrans*			
681	Neddicky	*Cisticola fulvicapilla*			
683	Tawny-flanked Prinia	*Prinia subflava*			
685	Black-chested Prinia	*Prinia flavicans*			
688	Rufous-eared Warbler	*Malcorus pectoralis*			
689	Spotted flycatcher	*Muscicapa striata*			
695	Marico flycatcher	*Bradornis mariquensis*			
697	Chat Flycatcher	*Bradornis infuscatus*			
698	Fiscal Flycatcher	*Sigelus silens*			(*)
701	Chinspot Batis	*Batis molitor*			
703	Pririt Batis	*Batis pririt*			
706	Fairy Flycatcher	*Stenostira scita*			(*)
710	African Paradise Flycatcher	*Terpsiphone viridis*			
711	African Pied Wagtail	*Motacilla aguimp*			
713	Cape Wagtail	*Motacilla capensis*			

714	Western Yellow Wagtail	*Motacilla flava*			
716	African Pipit	*Anthus cinnamomeus*			
717	Long-billed Pipit	*Anthus similis*			
718	Plain-backed Pipit	*Anthus leucophrys*			
719	Buffy Pipit	*Anthus vaalensis*			
720	Striped Pipit	*Anthus lineiventris*			
727	Cape Longclaw	*Macronyx capensis*			
731	Lesser Grey Shrike	*Lanius minor*			
732	Southern (Common) Fiscal	*Lanius collaris*			
733	Red-backed Shrike	*Lanius collurio*			
736	Southern Boubou	*Laniarius ferrugineus*			
739	Crimson-breasted Shrike	*Laniarius atrococcineus*			
741	Brubru	*Nilaus afer*			
743	Brown-crowned Tchagra	*Tchagra australis*			
746	Bokmakierie	*Telophorus zeylonus*			
758	Common Myna	*Acridotheres tristis*		I	
760	Wattled Starling	*Creatophora cinerea*			
765	Greater Blue-eared Starling	*Lamprotornis chalybaeus*			
772	Red-billed Oxpecker	*Buphagus erythrorhynchus*			
779	Marico Sunbird	*Cinnyris mariquensis*			
787	White-bellied Sunbird	*Cinnyris talatala*			
788	Dusky Sunbird	*Cinnyris fuscus*			
792	Amethyst Sunbird	*Chalcomitra amethystina*			
796	Cape White-eye	*Zosterops virens*			(*)
798	Red-billed Buffalo Weaver	*Bubalornis niger*			
799	White-browed Sparrow-Weaver	*Plocepasser mahali*			
800	Sociable Weaver	*Philetairus socius*			
801	House Sparrow	*Passer domesticus*		I	
802	Great Sparrow	*Passer motitensis*			
803	Cape Sparrow	*Passer melanurus*			
804	Southern Grey-headed Sparrow	*Passer diffusus*			
806	Scaly-feathered Finch	*Sporopipes squamifrons*			
813	Cape Weaver	*Ploceus capensis*			(*)
814	Southern Masked Weaver	*Ploceus velatus*			
821	Red-billed Quelea	*Quelea quelea*			
824	Southern Red Bishop	*Euplectes orix*			
826	Yellow-crowned Bishop	*Euplectes afer*			
829	White-winged Widowbird	*Euplectes albonotatus*			
831	Red-collared Widowbird	*Euplectes ardens*			

832	Long-tailed Widowbird	*Euplectes progne*			
834	Green-winged Pytilia	*Pytilia melba*			
841	Jameson's Firefinch	*Lagonosticta rhodopareia*			
842	Red-billed Firefinch	*Lagonosticta senegala*			
844	Blue Waxbill	*Uraeginthus angolensis*			
845	Violet-eared Waxbill	*Uraeginthus granatinus*			
846	Common Waxbill	*Estrilda astrild*			
847	Black-faced Waxbill	*Estrilda erythronotos*			
852	African Quail-finch	*Ortygospiza fuscocrissa*			
854	Orange-breasted Waxbill	*Amandava subflava*			
856	Red-headed Finch	*Amadina erythrocephala*			
860	Pin-tailed Whydah	*Vidua macroura*			
861	Shaft-tailed Whydah	*Vidua regia*			
862	Long-tailed Paradise Whydah	*Vidua paradisaea*			
867	Village Indigobird	*Vidua chalybeata*			
869	Yellow-fronted Canary	*Crithagra mozambica*			
878	Yellow Canary	*Crithagra flaviventris*			
884	Golden-breasted Bunting	*Emberiza flaviventris*			
885	Cape Bunting	*Emberiza capensis*			
886	Cinnamon-breasted Bunting	*Emberiza tahapisi*			
887	Lark-like Bunting	*Emberiza impetuani*			
126.1	Yellow-billed Kite	*Milvus aegyptius*			

Red Data (RD); Regional*, Global	**Status in South Africa (S)**	**Endemism in south Africa (E)**
CR = Critically Endangered	V = vagrant	Endemism in South Africa (E) (not southern Africa as in field guides)
EN = Endangered	I = introduced	
VU = Vulnerable		* = endemic
NT = Near Threatened		
LC = Least Concern		SLS = endemic to South Africa, Lesotho and Swaziland
EX = Extinct (regionally)		(*) = near endemic (i.e. ~70% or more of population in RSA)
DD= Data Deficient		B* = breeding endemic

APPENDIX B

Details of Specialist

Appointment of specialist

Hudson Ecology Pty Ltd was commissioned by Environamics BK to provide specialist consulting services for the Environmental Impact Assessment for the extension of the Waterloo PV plant near Vryburg in the North West Province. The consulting services comprise an assessment of potential impacts on the avifauna in the study area by the proposed project.

Details of specialist

Adrian Hudson
Hudson Ecology Pty Ltd
P.O. Box 19287
Noordbrug
Potchefstroom
2522
Telephone: 018 294 5448
Cell: 082 344 2758
Email: adrian@hudsonecology.co.za

Summary of expertise

Adrian Hudson is the owner, director and senior ecologist Hudson Ecology Pty Ltd. In this role, he provides assessments which encompass all aspects of terrestrial and wetland ecological studies including (but not limited to) baseline ecological assessments, ecological impact assessments and biodiversity management plans. He also has considerable experience in conservation, and conducted studies in veld management, stocking rates (wildlife and domestic) for a number of companies and organisations. Projects, unless otherwise requested by the client, are conducted according to the IFC Performance standard 6 criteria and Adrian Hudson is, therefore, au fait with the requirements and criteria of the Standard. Adrian has reviewed a number of projects throughout Africa for IFC Performance Standard 6 compliance, including Hassai Gold Mine in Sudan and Konkola North Copper mine in Zambia.

Adrian Hudson is a qualified ecologist and ornithologist who holds a Master's of Science degree in Ecology from the North West University and is currently completing his PhD in Ecology at the same institution. Adrian is currently still closely associated with the university as a supervisor for Honours and Masters degree students, lecturing of short courses at the university and co-authoring of scientific articles with faculty members of the university. Adrian is a member of the Zoological Society of Southern Africa and the International Society of Conservation Biology. Adrian is also a member of the Department of Environmental Affairs and Tourism (South African Government Department) roster of experts on ecology and desertification and a reviewer for a number of internationally accredited scientific journals. He is also accredited with authorship of a number of articles published in scientific journals.

Before founding Hudson Ecology Pty Ltd. in September 2014, Adrian worked for 18 years for a diverse range of organizations, including Natal Parks Board, North West University, United Nations Environmental Program /Global Environment Facility, ECOSUN cc and Golder Associates Africa Pty Ltd. In these roles, Adrian was responsible for anti- poaching, lecturing, research and consulting respectively. Thus far Adrian has worked as a consulting ecologist on more than 90 projects in 20 countries, including projects in Angola, South Africa, Lesotho, Swaziland, Namibia, Botswana, Mozambique, Zambia, Tanzania, Central African Republic, Democratic Republic of Congo, Sudan, Guinea, Guinea-Bissau, Uzbekistan and Liberia.

Independence

Hudson Ecology Pty Ltd and its Directors have no connection with SunEdison Pty Ltd. Hudson Ecology Pty Ltd is not a subsidiary, legally or financially, of the proponent. Remuneration for services by the proponent in relation to this project is not linked to approval by decision-making authorities responsible for authorising this proposed project and the consultancy has no interest in secondary or downstream developments as a result of the authorisation of this project. Adrian Hudson is an independent consultant to Environamics BK and has no business, financial, personal or other interest in the activity, application or appeal in respect of which he was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of this specialist performing such work. The percentage work received directly or indirectly from the proponent in the last twelve months is approximately 0% of turnover.

Scope and purpose of report

The scope and purpose of the report are reflected in the Terms of reference section of this report

Conditions relating to this report

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APPENDIX C

CONTROL SHEET FOR SPECIALIST REPORT

The table below lists the specific requirements for specialist studies, according to the 2014 EIA Regulations (South Africa, 2014)

Activity	Yes	No	Comment
Details of: i the peson who prepared the report; and	√		
ii the expertise of that person to carry out the specialist study or specialised process	√		
	√		
ii. the expertise of that person to carry out the specialist study or specialised process	√		
A declaration that the person is independent in a form as may be specified by the competent authority	√		
An indication of the scope of, and the purpose for which, the report was prepared	√		
A description of the methodology adopted in preparing the report or carrying out the specialised process	√		
A description of any assumptions made and any uncertainties or gaps in knowledge	√		
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	√		
Recommendations in respect of any mitigation measures that should be considered by the applicant and the competent authority	√		
A description of any consultation process that was undertaken during the course of carrying out the study		√	
A summary and copies of any comments that were received during any consultation process		√	
Any other information requested by the competent authority	√		

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HUDSON ECOLOGY PTY LTD
Reg. No. 2014/268110/07

P.O. Box 19287
Noordbrug
2522
South Africa

280 Beyers Naude Ave
Potchefstroom
2531

Tel +27 (0) 18 2945448

Mobile +27 (0)82 344 2758

http://www.hudsonecology.co.za