ANNEXURE C2
SPECIALIST ASSESSMENTS

- Avian Impact Assessment

PROPOSED PV2-10 PHOTOVOLTAIC ENERGY PLANTS ON THE FARM HOEKPLAAS NEAR COPPERTON, NORTHERN CAPE

Avian impact assessment

Andrew Jenkins & Johan du Plessis, May 2013

AVISENSE CONSULTING

CONTENTS

1. EXECUTIVE SUMMARY

This study contains a review of the relevant literature on the impacts on avifauna of solar energy facilities and their associated electrical infrastructure, and identifies potential impacts of the proposed PV2-10 Photovoltaic (PV) Energy Plants on the avifauna of the Copperton area, Northern Cape. The proposed plants are located on the same farm as an approved 100 MW facility (PV1) proposed by the same applicant. The expected impacts are: habitat destruction by the construction of the facilities themselves and their associated power lines or substation/s, disturbance by construction and maintenance activities and possibly by the operation of the facilities, and possible displacement or disturbance of sensitive species, and mortality caused by collision with the associated power line network, and electrocution of avifauna on the required power line and substation infrastructure. In addition, some birds may interfere with the efficient running of the proposed PV installations.

The broader impact zone of the proposed PV energy developments are contained within an extensive tract of undulating, remote, arid Bushmanland Karoo, while the immediate vicinity features degraded natural veld with some anthropogenic influences. The area potentially supports over 200 bird species, including up to 18 red-listed species, 68 endemics, and five red-listed endemics. The birds of greatest potential relevance and importance in terms of the possible impacts of the PV facilities are likely to be locally resident or passing raptors, especially red-listed species - Martial Eagle *Polemaetus bellicosus*, Tawny Eagle *Aquila rapax* and Lanner Falcon *Falco biarmicus*, seasonal influxes of Ludwig's Bustard *Neotis ludwigii* and Kori Bustard *Ardeotis kori*, and local populations of endemic, and possibly red-listed passerines (including Sclater's Lark *Spizocorys sclateri* and possibly Red Lark *Calendulauda burra*). The development area encroaches directly into a Martial Eagle breeding territory, which was occupied and possibly active during the site visit made to inform this report. Fairly substantial mitigation efforts may be required to reduce likely negative impacts of these developments on this globally red-listed species. Pigeons, crows, weavers, sparrows and some raptor species may perch, roost, forage or even nest on or around the facilities and cause fouling problems.

When assessed in isolation, and given the relative homogeneity of the habitat within and surrounding the site, this proposed complex of solar energy plants is considered unlikely to have any significant, long-term impacts on the local avifauna (provided that the Martial Eagle territory is adequately protected). However, the considerable spatial extent of these developments suggests that it may be an important contributor to the potentially significant, cumulative impacts imposed by this and a number of other planned renewable energy projects on the natural environment of the Copperton area.

A comprehensive programme is put forward to monitor the actual impacts of these PV projects on the broader avifauna of the area, from pre-construction and into the operational phase of the development, and the first set of data collected as part of this programme is presented.

2. INTRODUCTION

Mulilo Renewable Energy (Pty) Ltd is planning to construct 10 photovoltaic (PV) power generation facilities (project names 'Hoekplaas PV2-11') on portions of the farm Hoekplaas 146, just south-east of the old mining settlement of Copperton, and about 55 km southwest of Prieska, Northern Cape Province, South Africa. Aurecon South Africa (Pty) Ltd were appointed to do the Environmental Impact Assessment (EIA) study, and subsequently appointed *AVISENSE* Consulting cc to conduct the specialist avifaunal assessment. The present report was compiled by Dr Andrew Jenkins and Johan du Plessis. Dr Jenkins is an established ornithologist, with over 20 years of experience in ornithology and impact assessment work. He has been involved in many power line, and wind and solar farm EIA and EMP studies in South Africa, and also does academic research on raptors, bustards and cranes in various parts of the country. Johan du Plessis holds an MSc degree in Zoology from the University of Stellenbosch. He has over six years of experience as a field biologist, and has assisted with field data collection in support of various zoological surveys and EIA studies, including avifaunal monitoring at various wind energy facilities throughout South Africa.

3. DECLARATION OF INDEPENDENCE

Andrew Jenkins and Johan du Plessis (*AVISENSE* Consulting cc) are independent consultants to Aurecon South Africa (Pty) Ltd and Mulilo Renewable Energy (Pty) Ltd. They have no business, financial, personal or other interest in the activity, application or appeal in respect of which they were appointed other than fair remuneration for work performed in connection with the activity. There are no circumstances that compromise the objectivity of these specialists in performing such work.

4. TERMS OF REFERENCE

The terms of reference for the full EIA, as supplied by Aurecon, were to:

- Review the latest literature on bird-solar power interactions as a desk-top exercise.
- Undertake the requisite field work to directly assess the habitats present within the inclusive impact zone, and to determine the *in situ* avifauna.
- Integrate the on-site information with bird atlas (Southern African Bird Atlas Project - SABAP - 1 & 2) and any other relevant data available for the general area, to develop and inclusive, annotated list of the birds likely to occur on the site, highlighting red-listed species, endemic, restricted-range or other species of particular concern that may occur in the study area.
- Identify, describe and assess potential direct and indirect and cumulative impacts resulting from the proposed developments both on the footprint and the immediate surrounding area during construction and operation.
- Recommend mitigation measures to reduce or eliminate potential negative impacts on avifauna, and improve positive impacts.

5. LIMITATIONS AND ASSUMPTIONS

Any inaccuracies or deficiencies in the primary sources of information used in the compilation of this report could limit its value. The SABAP1 data (see below) for the Copperton area are now >15 years old (Harrison *et al.* 1997), and comprise only eight bird atlas cards for the relevant quarter-degree square, while there is presently only two SABAP 2 atlas card for the relevant pentad. No more reliable and/or more recent formal data on bird species presence and abundance in the study area currently exist.

The site visit (conducted on May 09-10 2013), in combination with previous visits to the immediate area for EIA work on neighbouring or associated renewable energy projects (Jenkins 2010, 2011, 2012), goes some way towards remedying this knowledge deficiency. However, with limited time in the field, and no seasonal spread, it is possible, but not likely, that important components of the local avifauna – nest sites, localized areas of key habitat for rare or threatened species – were missed.

Given that there are currently no large scale solar energy facilities operative in South Africa, there are no existing data on the environmental effects of these installations in this country.

6. STUDY METHODOLOGY

6.1 Approach

The study included the following steps:

- A review was done of available published and unpublished literature pertaining to bird interactions with solar energy facilities and associated power infrastructure, summarizing the issues involved and the current level of knowledge in this field. Various information sources (listed below), including data on the birdlife of the area and previous studies of bird interactions with solar energy facilities and electricity infrastructure, were examined.
- A short visit to the development area to determine first-hand the avian habitats present, and to start the process of data collection to quantify aspects of the avifauna as part of a monitoring project spanning the pre-construction to operational phases of the proposed developments (see below).
- Compilation of an inclusive, annotated list of the avifauna likely to occur within the impact zone of the proposed PV facilities was compiled using a combination of the existing distributional data, species seen during the site visit, and previous experience of the avifauna of the general area.
- Compilation of a short-list of priority bird species (defined in terms of conservation status and endemism) which could be impacted by the proposed PV facilities was extracted from the total bird list. These species were subsequently considered as adequate surrogates for the local avifauna in general, and mitigation of impacts on these species was considered likely to accommodate any less important bird populations that may also potentially be affected.

- Construction of a matrix of possible impacts on the local avifauna was drawn up for the proposed PV facilities, and the significance of these impacts was assessed in terms of the available suite of mitigation options.

6.2 Data sources used

The following data sources and reports were used in the compilation of this report:

- Bird distribution data of the SABAP (Harrison *et al.* 1997) were obtained from the Animal Demography Unit website (http://sabap2.adu.org.za/index.php) for the SABAP 1 quarter-degree square covering the proposed PV facilities and its associated infrastructure (3022AB Springbokpoortjie), and for the relevant SABAP 2 pentad (3000_2220). A composite list of species likely to occur in the impact zone of the PV facilities was drawn up as a combination of these data, refined by a more specific assessment of the actual habitats affected, based on general knowledge of the birds of the region (Appendix 1).
- The conservation status and endemism of all species considered likely to occur in the area was determined from the national Red-list for birds (Barnes 2000), and the most recent and comprehensive summary of southern African bird biology (Hockey *et al.* 2005).
- Information on large raptors resident on the nearby Aries-Kronos and Kronos-Hydra 400 kV transmission lines from the Eskom Electric Eagle Project (Jenkins *et al.* 2007, Jenkins *et al.* 2013), and recent information on large bird collision rates on the same lines (Jenkins *et al.* 2011).

7. OVERVIEW OF THE PROPOSAL

The Hoekplaas PV2-10 Energy Facilities are proposed for the farm Hoekplaas 146, near the town of Copperton, Northern Cape, and in addition to an already authorized 100MW PV plant on a different portion of the same property. The new proposal is for nine additional PV energy plants, with a generating capacity of approximately of 75 MW each (Fig. 1). The combined extent of the nine proposed plants is approximately 2267 ha. The proposed alternative to the preferred project (Fig. 2) is also located on the farm Hoekplaas and consists of three PV plants, with generating capacities of 225MW, 290MW, and 500MW, covering an area of approximately 3000ha. Additional electrical infrastructure includes an on-site substation for each of the proposed PV facilities, each of which feeds into one of two on-site multi-bay substations via a network of 132kV overhead transmission lines. A dedicated 132 kV overhead transmission line will connect the two multi-bay substations before a double circuit 132kV feeder overhead transmission line connects the entire proposed Hoekplaas facility to the Eskom Kronos Substation. Sections of the existing road network will be upgraded in addition to the construction of new access routes, laydown areas and construction camps.

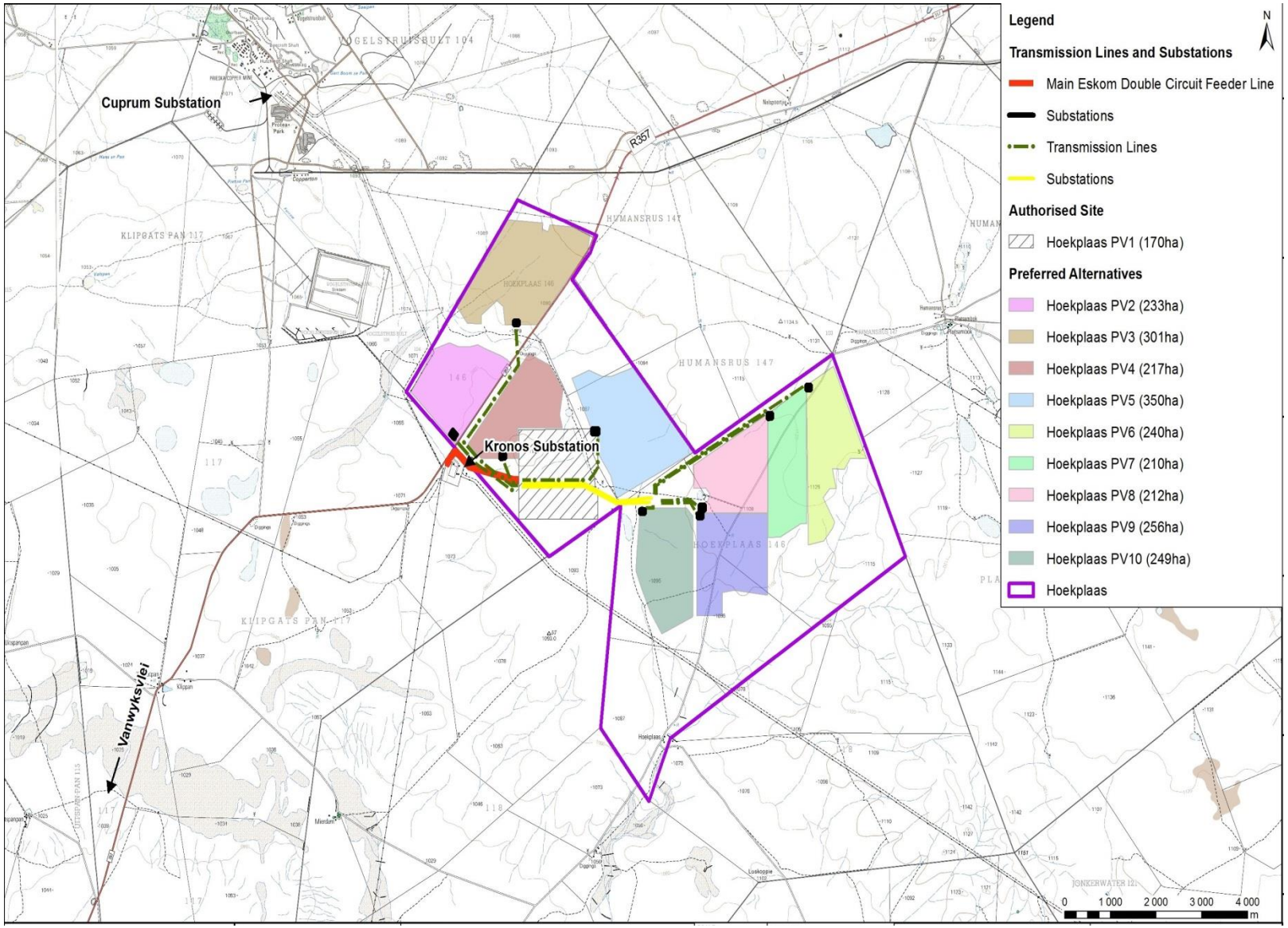

Figure1. The preferred location and layout of the Hoekplaas PV2-10 solar plants, in relation the entire contracted property, PV1 (already authorized), and the Eskom Kronos substation.

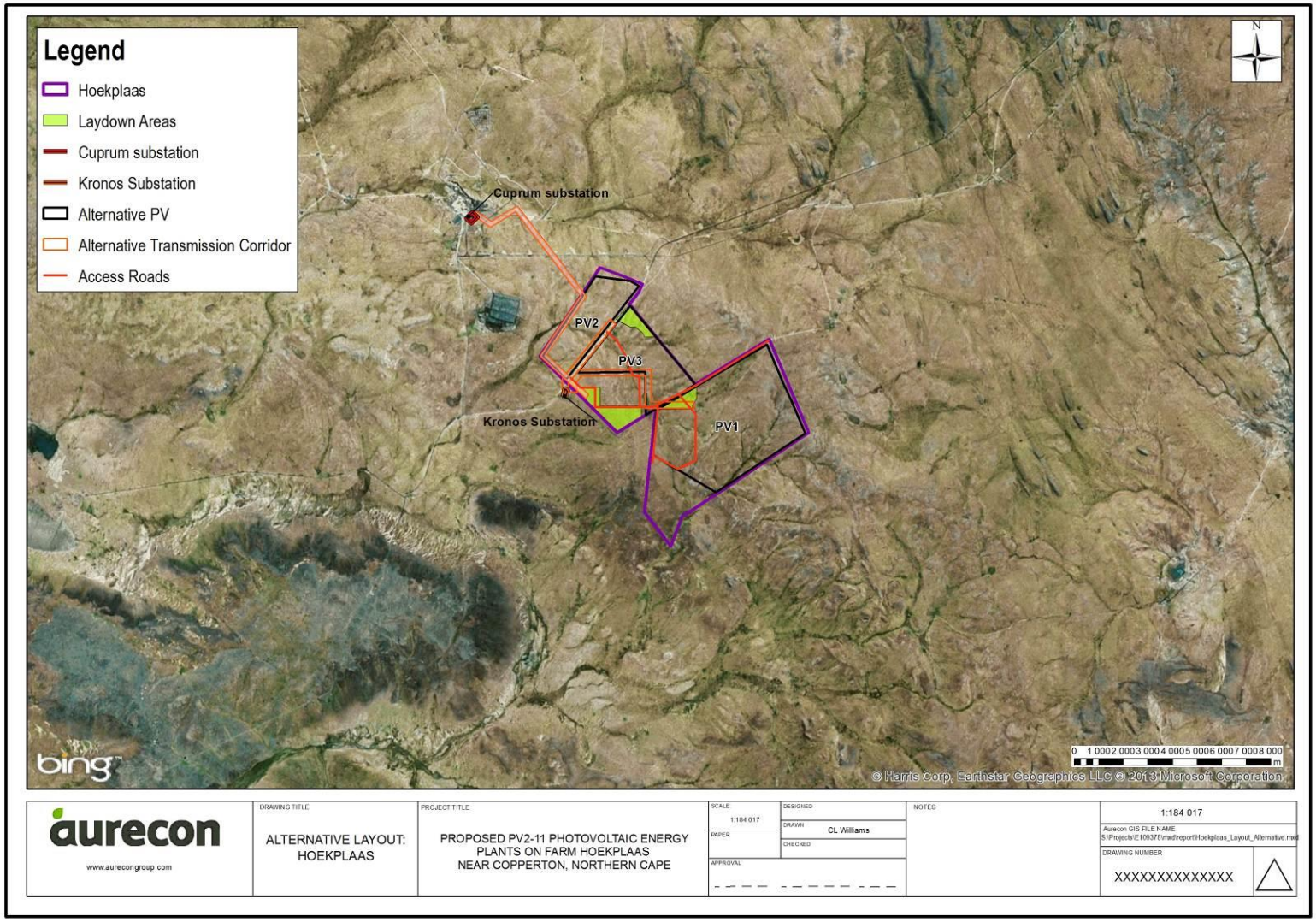

Figure2. The alternative location and layout of the Hoekplaas PV2-10 solar plants, in relation the entire contracted property and the Eskom Kronos substation.

8. DESCRIPTION OF THE AFFECTED ENVIRONMENT

8.1 Vegetation of the study area

The study area is located in the Bushmanland Bioregion of the Nama Karoo Biome (Mucina & Rutherford 2006). The natural vegetation of the study area is dominated by Bushmanland Basin Shrubland – irregular plains with dwarf shrubland, with low, drought resistant shrubs and grassland, and sporadic, rain-driven outbreaks of annuals (Mucina & Rutherford 2006). Altitude on the site varies very little (1050-1150 metres above sea level).The area receives about 80 mm of rain per annum, most of which falls in autumn (February-March). Temperatures range from a mean winter minimum of about 2ºC, to a mean summer maximum of about 32ºC.

8.2 Avian microhabitats

These largely comprise degraded areas of natural Karoo veld, with taller vegetation and trees along drainage lines, areas of exposed rock, road cuttings or borrow-pits, one or two small artificial and/or ephemeral waterbodies, while the existing network of power lines attracts certain species (in particular raptors and corvids which perch and sometimes nest on the support structures for these lines) to the area. The broader area features vast expanses of remote but heavily grazed stock and game ranchland, with the Doringberg range and the Orange River valley system some 40-50 km away to the northeast. The R357 roadway runs through the study area, and the small settlement of Copperton lies about 11 km to the north-west. The Eskom Kronos substation is situated just west of centre of the proposed development area (Figs 1 & 2), which is peripherally traversed by two major transmission lines (Hydra-Kronos and Aries-Kronos 400 kV), and a number of smaller distribution and reticulation lines.

8.3 Avifauna of the impact area

At least 215 bird species are considered likely to occur with some regularity within the anticipated impact zone of the proposed PV development (Appendix 1), including 68 endemic or near-endemic species, 18 red-listed species, and five species – Ludwig's Bustard *Neotis ludwigii*, Blue Crane *Anthropoides paradiseus*, Black Harrier *Circus maurus*, Red Lark *Calendulauda burra* and Sclater's Lark *Spizocorys sclateri* – which are both endemic and red-listed (Barnes 1998, 2000, Table 1). The site is not situated close to any presently recognised national Important Bird Areas (Barnes 1998), or key avian habitats, unique landscape features, or known or likely fly-ways.

The birds of greatest potential relevance and importance in terms of the possible impacts of the PV facilities are likely to be local populations of endemic, and possibly red-listed passerines (Sclater's Lark and possibly Red Lark), seasonal influxes of Ludwig's Bustard and Kori Bustard *Ardeotis kori*, and locally resident or passing raptors, especially red-listed species - Martial Eagle *Polemaetus bellicosus*, Tawny Eagle *Aquila rapax* and Lanner Falcon *Falco biarmicus*, all of which breed on the nearby Eskom transmission lines (Jenkins *et al.* 2007, 2013), and regional endemics such as Jackal Buzzard *Buteo rufofuscus* and Southern Pale Chanting Goshawk *Melierax canorus*.

The birds most likely to proliferate and become active around the facilities, possibly causing fowling problems, could include Speckled Pigeon *Columba guinea*, Greater Kestrel *Falco rupicolus*, Southern Pale Chanting Goshawk, Cape Crow *Corvus capensis*, Pied Crow *Corvus albus*, Cape Sparrow *Passer melanurus*, House Sparrow *Passer domesticus* and Sociable Weaver *Philetairus socius*, and possibly a variety of other perch-hunting and insectivorous passerines. Note: the site is on the southern edge of a recent range expansion by Sociable Weaver. The huge communal grass nests built by this species may require active management if any are attached to critical infrastructure of the development.

Only 34 species were seen during the May site visit (Appendix 1). Most significantly, the Martial Eagle nest site on the Hydra-Kronos 400 kV line (technically, located in the Klipgats PV development area, but equally close to planned PV arrays in this project), that was initially recorded in formalized surveys of large raptors nesting on Eskom's transmission network in the Karoo (Jenkins *et al.* 2007, 2013), and confirmed in the EIA for PV1 (Jenkins 2012), was re-confirmed, with a pair of adults in attendance (copulating, calling, roosting) at a nest on tower 519 (30º 01.579 S, 22º 20.675 E). Only one nest structure was evident, and there was no sign of two other nests that were present on nearby pylons in earlier surveys. We were unable to determine whether or not the pair was actively breeding at the time of our visit, but should be able to clarify this on a subsequent visit, later in the species' breeding season.

Otherwise, we saw a single Kori Bustard in the south-eastern sector of the development area, small numbers of Sclater's Lark (as well as Pink-billed Lark *Spizocorys conirostris*, Stark's Lark *Spizocorys starki*) in the north-western sector, and recorded quite high densities of other regionally endemic passerines - such as Sabota Lark *Calendulauda sabota*, Eastern Clapper Lark *Mirafra fasciolata*, Spike-heeled Lark *Chersomanes albofasciata* and Rufous-eared Warbler *Malcorus pectoralis* – across much of the development area (see monitoring data in Table 3 and Appendix 2, below). We also possibly saw Red Lark in the south-eastern sector (around PV10) but this is subject to confirmation in a future site visit.

On the basis of these observations, and in combination with already documented information on the avifauna of the general area, eight priority species are recognized as key in the assessment of avian impacts of the proposed Hoekplaas PV Energy Facilities (Table 1). These are mostly nationally and/or globally threatened species which are known to occur, or could occur, in relatively high numbers in the development area and which are likely to be, or could be, negatively affected by the PV solar power plant project. Five species were included despite the fact that they were not recorded in either SABAP 1 or SABAP 2 data for the area, either because (a) they were seen on site, (b) the site is located within their respective distributions and the available habitat is possibly suitable, or (c) they may occasionally fly over the site *en route* between distant resource areas, and in so doing be exposed possible impacts.

Overall, with the notable exception of the Martial Eagle site on the Hydra-Kronos transmission line, and the possibility that significant numbers of Red and Sclater's Larks may occur in some areas at certain times (to be clarified by the monitoring project) the avifauna of the development site itself is largely replaceable, at best replicating that which occurs across huge areas of Bushmanland. However, the considerable spatial extent of this development suggests that it may be an important contributor to the potentially significant, cumulative impacts imposed by this and a number of other planned renewable energy projects on the natural environment of the Copperton area.

Table 1. Priority bird species considered central to the avian impact assessment process for the proposed Hoekplaas PV Energy Facilities, selected mainly on the basis of South African (Barnes 2000) or global conservation status (www.iucnredlist.org or http://www.birdlife.org/datazone/species/), level of endemism, relative abundance on site (SABAP reporting rates, direct observation), and estimated conservation or ecological significance of the local population. Red-listed endemic species are shaded in grey.

Common name	Scientific name	SA conservation status/ (Global conservation status)	Regional endemism	Average reporting rate[1] (*n* = 10 cards)	Estimated importance of local population	Preferred habitat	Risk posed by		
							Collision	Electro-cution	Disturbance / habitat loss
Ludwig's Bustard	*Neotis ludwigii*	Vulnerable (Endangered)	Near-endemic	20.0	Moderate-High	Open Karoo	High	-	Moderate
Kori Bustard	*Ardeotis kori*	Vulnerable	-	0.0	Moderate	Open Karoo	High	-	Moderate
Tawny Eagle	*Aquila rapax*	Vulnerable	-	0.0	Low				
Martial Eagle	*Polemaetus bellicosus*	Vulnerable (Near-threatened)	-	0.0	High	Open Karoo, power pylons	High	High	Moderate
Secretarybird	*Sagittarius serpentarius*	Near-threatened (Vulnerable)	-	10.0	Moderate	Open Karoo	High	-	Moderate
Lanner Falcon	*Falco biarmicus*	Near-threatened	-	0.0	Moderate	Open Karoo, power pylons	High	Moderate	-
Red Lark	*Calendulauda burra*	Vulnerable (Vulnerable)	Endemic	0.0	Low	Open Karoo	-	-	Moderate
Sclater's Lark	*Spizocorys sclateri*	Near-threatened	Endemic	20.0	Moderate	Open Karoo	-	-	Moderate

[1] Reporting rate calculated as the % of bird lists submitted for a given area which include each species.

9. ASSESSMENT OF IMPACTS

9.1 General assessment of impacts & mitigation

9.1.1 Impacts of solar energy facilities

Habitat loss – destruction, disturbance and displacement

Perhaps the most significant potential impact on birds of any solar energy generation facility is the displacement or exclusion of threatened, rare, endemic or range-restricted species from critical areas of habitat (RSPB 2011, Turney & Fthenakis 2011, Smit 2012). Given the considerable space requirements of commercially viable facilities (>50-100 ha), this effect could be significant in some instances, particularly given the possibility that the initial footprint of successful facilities may be expanded over time, and allowing for the possible cumulative effects of multiple facilities in one area.

To a lesser extent, construction and ongoing maintenance activities are likely to cause some disturbance of birds in the general surrounds of a solar facility, and especially of shy and/or ground-nesting species resident in the area. Mitigation of such effects requires that generic best-practice principles be rigorously applied - sites are selected to avoid the destruction of key habitats, and construction and final footprints, as well as sources of disturbance of key species, must be kept to an absolute minimum.

Other effects

Any vertical, reflective surfaces may confuse approaching birds with the result that numbers are killed in collisions with such surfaces. If this source of unnatural mortality is a realistic expectation of a proposed solar installation, efforts should be made to restrict access by birds into the relevant, hazardous areas of the facility. Solar installations generally feature large areas of reflective paneling. It is possible that nearby or overflying birds may be disorientated by the reflected light, and consequently be displaced from an area more extensive than just the developed footprint of the facility.

Conversely, certain bird species may be attracted to the solar arrays. The possibility also exists that waterbirds will mistake the reflective surface for an expanse of water, and attempt to land on the panels, incurring injury and/or being disorientated in the process. Other species may seek to benefit from the installations, using the erected structures as prominent perches, sheltered roost sites or even nesting sites, and possibly foraging around the infrastructure in response to changes in the distribution of preferred foods (plants growing under the paneling, other animals attracted to the facility). Such scenarios might be associated with fouling of critical components in the solar array, bringing local bird populations into conflict with the facility operators. Under these circumstances, specialist advice should be sought in devising effective avian deterrents to minimize associated damage.

9.1.2 Impacts of associated infrastructure

Infrastructure commonly associated with solar energy facilities may also have detrimental effects on birds. The construction and maintenance of substations, power lines, servitudes and roadways causes both temporary and permanent habitat destruction and disturbance, and overhead power lines pose a collision and

possibly an electrocution threat to certain species (Van Rooyen 2004a, Lehman *et al.* 2007, Jenkins *et al.* 2010).

Construction and maintenance of power lines and substations

Some habitat destruction and alteration inevitably takes place during the construction of power lines, substations and associated roadways. Also, power line service roads or servitudes have to be cleared of excess vegetation at regular intervals in order to allow access to the line for maintenance, and to prevent vegetation from intruding into the legally prescribed clearance gaps between the ground and the conductors. These activities have an impact on birds breeding, foraging and roosting in or in close proximity to the servitude, and retention of cleared servitudes can have the effect of altering bird community structure along the length of any given power line (e.g. King & Byers 2002).

Collision with power lines

Power lines pose a significant collision risk to birds, affecting a particular suite of collision prone species (Bevanger 1994, 1995, 1998, Janss 2000b, Anderson 2001, van Rooyen 2004a, Drewitt & Langston 2008, Jenkins *et al.* 2010). Mitigation of this risk involves the informed selection of low impact alignments for new power lines relative to movements and concentrations of high risk species, and the use of either static or dynamic marking devices to make the lines, and in particular the earthwires, more conspicuous. While various marking devices have been used globally, many remain largely untested in terms of their efficacy in reducing collision incidence, and those that have been fully assessed have all been found to be only partially effective (Drewitt & Langston 2008, Jenkins *et al.* 2010).

Electrocution on power infrastructure

Avian electrocutions occur when a bird perches or attempts to perch on an electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2004b, Lehman *et al.* 2007). Electrocution risk is strongly influenced by the voltage and design of the power lines erected (generally occurring on lower voltage infrastructure where air gaps are relatively small), and mainly affects larger, perching species, such as vultures, eagles and storks, easily capable of spanning the spaces between energised components. Mitigation of electrocution risk involves the use of bird-safe structures (ideally with critical air gaps >2 m), the physical exclusion of birds from high risk areas of live infrastructure, and comprehensive insulation of such areas (van Rooyen 2004b, Lehman *et al.* 2007).

Table 2. Impact characteristics: Hoekplaas PV2-10 Energy Plants – Birds.

Summary	**Construction**	**Operation**	**Decommissioning**
Project Aspect/ activity	(i) Disturbance/displacement associated with noise and movement of construction equipment and personnel. (ii) Loss of vegetation and avian habitat through site clearance, road upgrade and establishment of the camp, lay-down and assembly areas.	(i) Loss of habitat to space occupied by solar panels and associated infrastructure, and disturbance / displacement associated with routine maintenance work. (ii) Mortality in collisions with solar panels and/or power lines, or by electrocution on new power infrastructure.	(i) Disturbance/displacement associated with noise and movement of decommissioning equipment and personnel.
Impact Type	Direct	Direct	Direct
Receptors Affected	(i) All birds on site; key species: Martial Eagle, Tawny Eagle, Lanner Falcon, Ludwig's Bustard, Kori Bustard, Karoo endemics, especially Sclater's Lark. (ii) Martial Eagle, Tawny Eagle, Lanner Falcon, Ludwig's Bustard, Kori Bustard, Karoo endemics, especially Sclater's Lark.	(iii) All birds on site; key species: Martial Eagle, Tawny Eagle, Lanner Falcon, Ludwig's Bustard, Kori Bustard, Karoo endemics, especially Sclater's Lark. (i) All birds on site; Martial Eagle, Tawny Eagle, Lanner Falcon, Ludwig's Bustard, Kori Bustard.	(i) All birds on site; key species: Martial Eagle, Tawny Eagle, Lanner Falcon, Ludwig's Bustard, Kori Bustard, Karoo endemics, especially Sclater's Lark.

Box 1.1. **Pre-mitigation Construction Impact: Hoekplaas PV2-10 Energy Facilities – Birds**, with ratings for the alternative proposal (where these differ) in square brackets. Significance ratings ascribed as per the criteria provided by Aurecon South Africa. The following ratings can be applied to PV 2-10 in isolation or as a unit.

(A) Habitat loss

Nature: All construction activities would result in a **negative direct** impact on the avifauna of the Hoekplaas site: loss of vegetation and habitat affecting Karoo endemics, raptors and large terrestrial species, through site clearance, road upgrade and establishment of the camp and assembly areas.

Impact Magnitude – **Medium [Medium-High]**

- **Extent**: The extent of the impact is **local**.
- **Duration**: The duration would be **short-term** as the ecology of the area may be altered beyond the completion of the project.
- **Probability:** Habitat will **definitely** be lost.

IMPACT SIGNIFICANCE – LOW-MEDIUM [MEDIUM]

Confidence: Certain

Reversibility: Reversible

Cumulative impacts: Could be substantially amplified by multiple renewable energy projects in the area, which seems highly likely.

(B) Disturbance

Nature: All construction activities would result in a **negative direct** impact on the avifauna of the Hoekplaas PV site; disturbance associated with noise and movement of construction equipment and personnel, affecting Karoo endemics, raptors and large terrestrial species.

Impact Magnitude – **Medium-High**

- **Extent**: The extent of the impact is **local [regional]**.
- **Duration**: The duration will not extend beyond the **construction period**.
- **Probability:** There will **definitely** be disturbance.

IMPACT SIGNIFICANCE – MEDIUM-HIGH

Confidence: Certain

Reversibility: Possible reversible (?)

Cumulative impacts: Could be substantially amplified by multiple renewable energy projects in the area, which seems highly likely.

Box 1.2. **Pre-mitigation Operation Impact: Hoekplaas PV2-11 Energy Facilities – Birds,** with ratings for the alternative proposal (where these differ) in square brackets. Significance ratings ascribed as per the criteria provided by Aurecon South Africa. The following ratings can be applied to PV 2-10 in isolation or as a unit.

(A) Habitat loss and disturbance

Nature: Operational activities would result in a **negative direct** impact on the avifauna of the Hoekplaas PV site; loss of habitat for Karoo endemics, raptors and large terrestrial species, to space occupied by solar panels and associated infrastructure, and disturbance or displacement of these birds by routine maintenance activities.

Impact Magnitude – Medium [Medium-High]

- **Extent**: The extent of the impact is potentially **local**.
- **Duration**: The duration would be **long-term** as the ecology of the area would be affected until the project stops operating and is fully decommissioned.
- **Probability:** Habitat will **definitely** be lost and some priority species will be disturbed/displaced.

IMPACT SIGNIFICANCE – MEDIUM [MEDIUM-HIGH]

Confidence: Certain

Reversibility: Possibly reversible (?)

Cumulative impacts: Could be substantially amplified by multiple renewable energy projects in the area, which seems highly likely.

(B) Mortality

Nature: Operational activities would result in a **negative direct** impact on the avifauna of the Hoekplaas PV site; mortality of raptors, large terrestrials in collisions with solar panels and/or power lines, or by electrocution on new power infrastructure.

Impact Magnitude – Medium-High

- **Extent**: The extent of the impact is potentially **regional**.
- **Duration**: The duration would be **long-term** as the ecology of the area would be affected at least until the project stops operating and is fully decommissioned.
- **Probability:** It is **probable** that some individuals of priority species will be killed.

IMPACT SIGNIFICANCE – MEDIUM-HIGH

Confidence: Unsure

Reversibility: Irreversible

Cumulative impacts: Could be substantially amplified by multiple renewable energy projects in the area, which seems highly likely.

Box 1.3. **Pre-mitigation Decommissioning Impact: Hoekplaas PV2-11 Energy Facilities – Birds**, with ratings for the alternative proposal (where these differ) in square brackets. Significance ratings ascribed as per the criteria provided by Aurecon South Africa. The following ratings can be applied to PV 2-10 in isolation or as a unit

(A) Disturbance

Nature: All decommissioning activities would result in a **negative direct** impact on the avifauna of the Hoekplaas PV site; disturbance associated with noise and movement of decommissioning equipment and personnel, affecting Karoo endemics, raptors and large terrestrial species.

Impact Magnitude – **Medium [Medium-High]**

- **Extent**: The extent of the impact is **local [regional]**.
- **Duration**: The duration will not extend beyond the **decommissioning period**.
- **Probability:** There will **definitely** be disturbance.

IMPACT SIGNIFICANCE – MEDIUM [MEDIUM-HIGH]

Confidence: Certain

Reversibility: Reversible

Cumulative impacts: Could be substantially amplified by multiple renewable energy projects in the area, which seems highly likely.

Table 3. Pre- and Post- Mitigation Significance: Hoekplaas PV2-11 Energy Facilities - Birds; preferred *vs* alternative options. Significance ratings ascribed as per the criteria provided by Aurecon South Africa. The following rating can be applied to PV 2-10 in isolation or as a unit.

Impact	Alternative Pre-mitigation	Alternative Residual (post-mitigation)	Preferred Pre-mitigation	Preferred Residual (post-mitigation)
Construction Phase				
Habitat loss	MEDIUM	LOW-MEDIUM	LOW-MEDIUM	LOW
Disturbance	MEDIUM-HIGH	MEDIUM	MEDIUM-HIGH	LOW-MEDIUM
Operation Phase				
Habitat loss & disturbance	MEDIUM-HIGH	MEDIUM-HIGH	MEDIUM	MEDIUM
Mortality	MEDIUM-HIGH	LOW-MEDIUM	MEDIUM-HIGH	LOW-MEDIUM
Decommissioning Phase				
Disturbance	MEDIUM-HIGH	MEDIUM	MEDIUM	LOW-MEDIUM

9.2 Project specific impacts

Specific impacts of the proposed Hoekplaas PV Energy projects are most likely to be manifested in the following ways (summarised in Table 2): The following applies to all the PV facilities (PV2-10) as separate smaller developments or as larger development that combines all the PV units.

(i) Disturbance and displacement of resident/breeding raptors - especially Martial Eagle, but also including Tawny Eagle and Lanner Falcon - from nesting and/or foraging areas by construction and/or operation and/or decommissioning of the facilities, and /or mortality of these species in collisions with new power lines or by electrocution when perched on power infrastructure.

(ii) Disturbance and displacement of resident/breeding Karoo endemics – especially including Sclater's Lark and possibly even Red Lark - by construction and/or operation and/or decommissioning of the facilities.

(iii) Disturbance and displacement of seasonal influxes of large terrestrial birds - especially Ludwig's Bustard and Kori Bustard - from nesting and/or foraging areas by construction and/or operation and/or decommissioning of the facilities, and /or mortality of these species in collisions with new power lines while commuting between resource areas.

Generally, however, the anticipated impacts on birds of the proposed developments are not considered to be of any great significance (Boxes 1.1 – 1.3, Table 3). There may be significant levels of disturbance of resident and breeding Martial Eagles which must be managed appropriately. There will also be some habitat loss for Karoo endemic species, and some species (Karoo endemics, large terrestrial species, raptors) may be displaced from a broader area either temporarily by construction and maintenance activities, or more permanently by the disruptive, reflective properties of the solar panels, and some species (large terrestrial species and raptors may be killed in interactions (collisions, electrocutions) with the new power infrastructure, but again, numbers affected are likely to be low.

10. MITIGATION

Should the proposed PV facilities be approved, mitigation of impacts on birds should focus on:

(i) Selecting the preferred development option (PV2-10). Simply by virtue of its larger development footprint, and the fact that its proposed layout includes a substantial area of ecologically sensitive ground delineated by the EIA for PV1, the alternative project is likely to have a greater impact on the local avifauna in all aspects of construction, operation and decommissioning (Table 3).

(ii)

(iii) Given that the authorized PV1 layout already impinges on the buffer area recommended in the EIA for that project (Jenkins 2012) to protect the Martial Eagle nest site located on the south-western edge of the development area it will be necessary to try to relocate this eagle nest site to a more distant, less disturbed area (e.g. Jenkins *et al.* 2007, 2013). The extent and

distribution of other renewable energy developments planned for the immediate vicinity (Fig. 3) probably precludes a short-range relocation, and a dedicated structure, strategically situated off the power line network aggregated around the Kronos substation, may be the best option. The requirements of such an undertaking will be further investigated during future visits to the site as part of the pre-construction monitoring project.

(iv) Excluding development from areas/microhabitats identified during the bird monitoring project (see below) as being of particular value to threatened/priority species (e.g. Red Lark, Sclater's Lark).

(v) Minimizing the inclusive construction footprint of the development and abbreviating construction time.

(vi) Minimizing noise and disturbance associated with maintenance activities at the plant once it becomes operational.

(vii) Minimising the length of any new power lines installed and burying lines wherever possible. If lines cannot be buried, ensure that all new lines are marked with bird flight diverters (Jenkins *et al.* 2010) along their entire length, and that all new power line infrastructure is adequately insulated and bird friendly in configuration (Lehman *et al.* 2007). Note that current understanding of power line collision risk in birds precludes any guarantee of successfully distinguishing high risk from medium or low risk sections of a new line (Jenkins *et al.* 2010). The relatively low cost of marking the entire length of a new line during construction, especially quite a short length of line in an area frequented by collision prone birds, more than offsets the risk of not marking the correct sections, causing unnecessary mortality of birds, and then incurring the much greater cost of retro-fitting the line post-construction. In situations where new lines run in parallel with existing, unmarked power lines, this approach has the added benefit of reducing the collision risk posed by the older line.

(viii) Minimising the amount of fencing used to enclose the development areas, given that these may present a collision risk for collision-prone birds.

(ix) Instituting a comprehensive impact monitoring scheme, and using the results of this scheme to inform and refine a dynamic approach to mitigation.

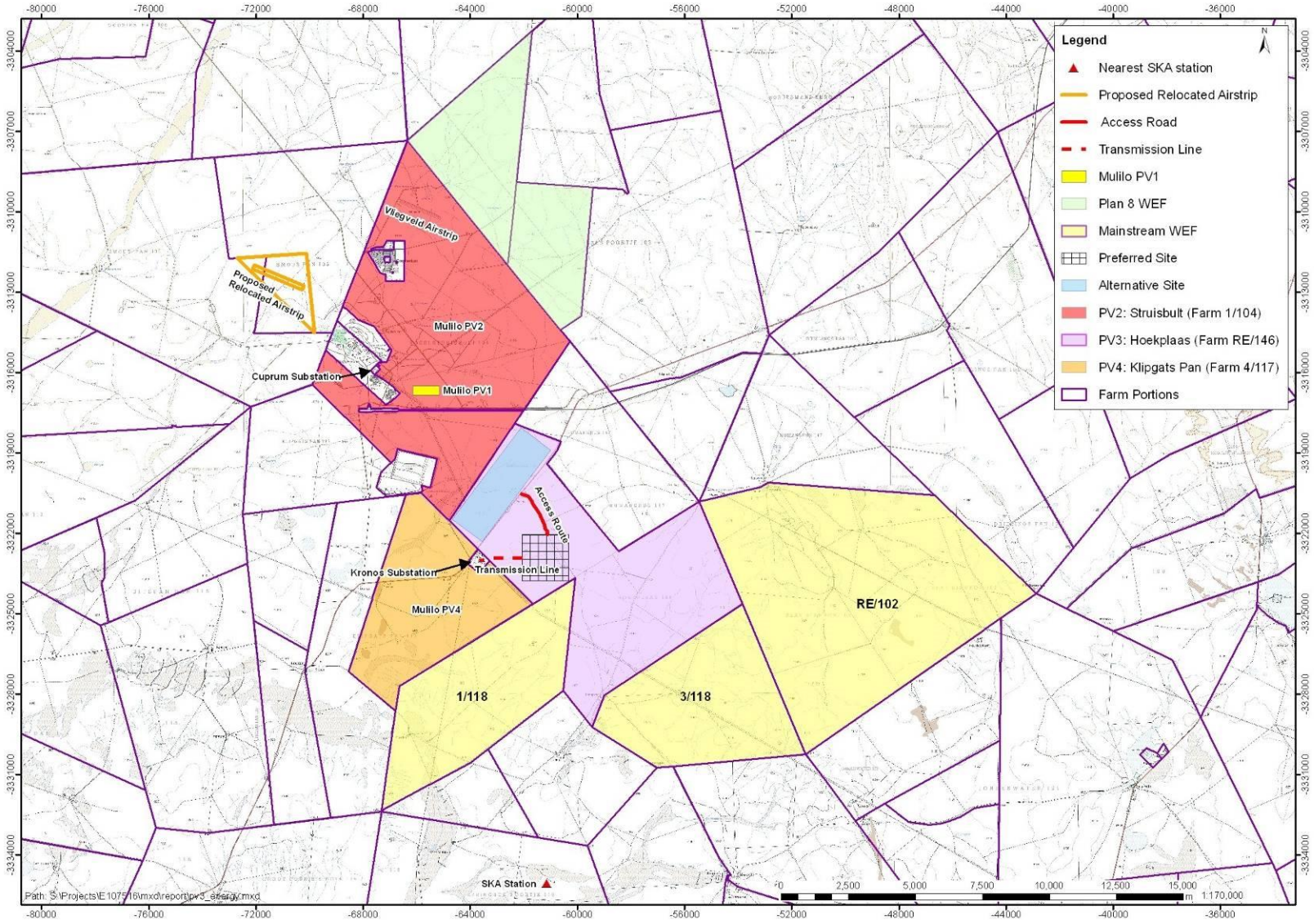

Figure 3. The location of the proposed Hoekplaas PV Energy Facilities in relation to other renewable energy projects proposed for the Copperton area.

11. CONCLUSION

The proposed PV development is likely to have relatively little significant, long-term impact on the avifauna of the area, after mitigation. Careful and responsible implementation of the required mitigation measures, particularly including steps required to reduce impacts on the Martial Eagle nest located in proximity to the development area, should reduce construction and operational phase impacts to tolerable and sustainable levels. This would apply especially if every effort is made to monitor impacts throughout, to learn as much as possible about the effects of solar energy developments on South African avifauna, and to implement mitigation measures suggested as a result of ongoing monitoring.

Note that the anticipated net impacts of these proposed developments should ideally be considered in the context of accumulated impacts imposed by at least four other renewable energy projects within a 20 km radius of Copperton (Fig. 3). Furthermore, the project itself comprises a number of potentially independent PV installations, each of which has its own inherent impact profile, contributing to the net aggregate impact of the whole proposed development. While the impact potential of each separate PV array must, by definition, be less than the sum of all the components together, we have assumed here that each component has the same impact as the sum, partly in the interests of conservatism and pragmatism, and partly because the assessment criteria imposed on the study do not allow for a finer scale evaluation of relative impacts.

The negative impacts resulting from all phases of this proposed development (i.e. development to the extent of individual farms) would certainly be substantially amplified by the construction and operation of multiple renewable energy projects in the area (development to the extent of broader localities or even regions). Relatively minor levels of disturbance at the individual project level (i.e. farm) would escalate to combined levels likely to cause complete and possibly long-term evacuation of the locality or region by more sensitive species. These disturbance effects would be exacerbated by the loss or degradation of markedly more habitat to a much larger aggregate construction and operational footprint, possibly resulting in the permanent loss from the affected area of key elements of the avifauna.

Bearing the above in mind, it is essential that the suitability of this single proposal, and the mitigation strategies applied should the project be approved, be considered in the context of broader renewable energy development plans for Copperton and surrounding areas. For example (and in particular), the future welfare of the Martial Eagle nest site located in the centre of the total area presently earmarked for solar and wind energy projects (Fig, 3) depends entirely on the development of an integrated mitigation approach that safeguards these birds from impacts stemming from ALL the projects collectively, and not those arising from each project separately.

12. LONG-TERM MONITORING

12.1 Rationale for monitoring

Given that solar energy development is new to South Africa, and its potential impacts on birds are generally not well understood, it is strongly recommended that attention be given to improving this understanding by initiating quantitative studies of the avifauna at proposed sites both pre- and post-construction (Smit 2012). The primary aims of such monitoring work would be to:

(i) Determine the densities of birds resident within the impact area of the solar power plant before construction of the plant, and afterwards, once the plant, or phases of the plant, become operational.

(ii) Register and as far as possible document the circumstances surrounding all avian mortalities associated with the ancillary infrastructure of the solar plant for at least six months after the plant becomes operational.

(iii) Register and as far as possible document the circumstances surrounding all other avian interactions with the solar arrays of the solar power plant for at least six months after the plant becomes operational.

Bird density and activity monitoring should focus on rare and/or endemic, potentially disturbance or collision prone species, which occur with some regularity in the area. Ultimately, the study should provide much needed quantitative information on the effects of the solar power plant on the distribution and abundance of birds, and the actual risk it poses to the local avifauna, and serve to inform and improve mitigation measures to reduce this risk.

Monitoring protocols: Avian densities before and after

A set of at least 10 walk transect routes, each of at least 20 minutes in duration or 750 m in length, should be established in areas representative of all the avian habitats present within and around the periphery of the Hoekplaas PV site. Each of these should be walked at least once every two months over the six months preceding construction, and at least once every two months over the same calendar period, at least six months after the PV plant is commissioned. The transects should be walked after 06h00 and before 09h00 in summer, and after 07h00 and before 12h00 in winter, and the species, number and perpendicular distance from the transect line of all birds seen should be recorded for subsequent analysis and comparison.

Monitoring protocols: collisions and fouling

The area within 5 m on either side of any new lengths of power line, should be checked regularly for bird casualties (Anderson *et al.* 1999, Morrison 2002). The frequency of these surveys should be informed by assessments of scavenge and decomposition rates. All suspected mortality incidents should be comprehensively documented, detailing the apparent cause of death, precise location (preferably a GPS reading), date and time at which the evidence was found, and the site of the find should be photographed with all the evidence *in situ*. All physical evidence should then be collected, bagged and carefully labeled, and refrigerated or frozen to await further examination. If any injured birds are recovered, each should be contained in a suitably-sized cardboard box, and the local conservation authority should be notified and requested to transport casualties to the nearest reputable veterinary clinic or wild animal/bird rehabilitation centre.

These post-construction surveys should also include detailing (location, extent, size, number) of all bird products (e.g. faeces, pellets, nest structures etc) found on and around the solar panels.

12.2 Results of first monitoring iteration

Seventeen walk transects were established within (n = 10) and outside (n = 7) of the proposed development area (Fig. 4), and surveys of small terrestrial bird densities were measured along each of these transect lines as per the stipulated protocols (Table 4, Appendix 2). In combination with the data obtained in two further site visits, these initial density estimates will establish a baseline against which to estimate the numbers of Karoo endemic passerines displaced by the developments, and to monitor the effect of the built and operational PV plants on the density and community structure of surrounding passerine populations.

Other results of the first monitoring iteration are integrated into this EIA report.

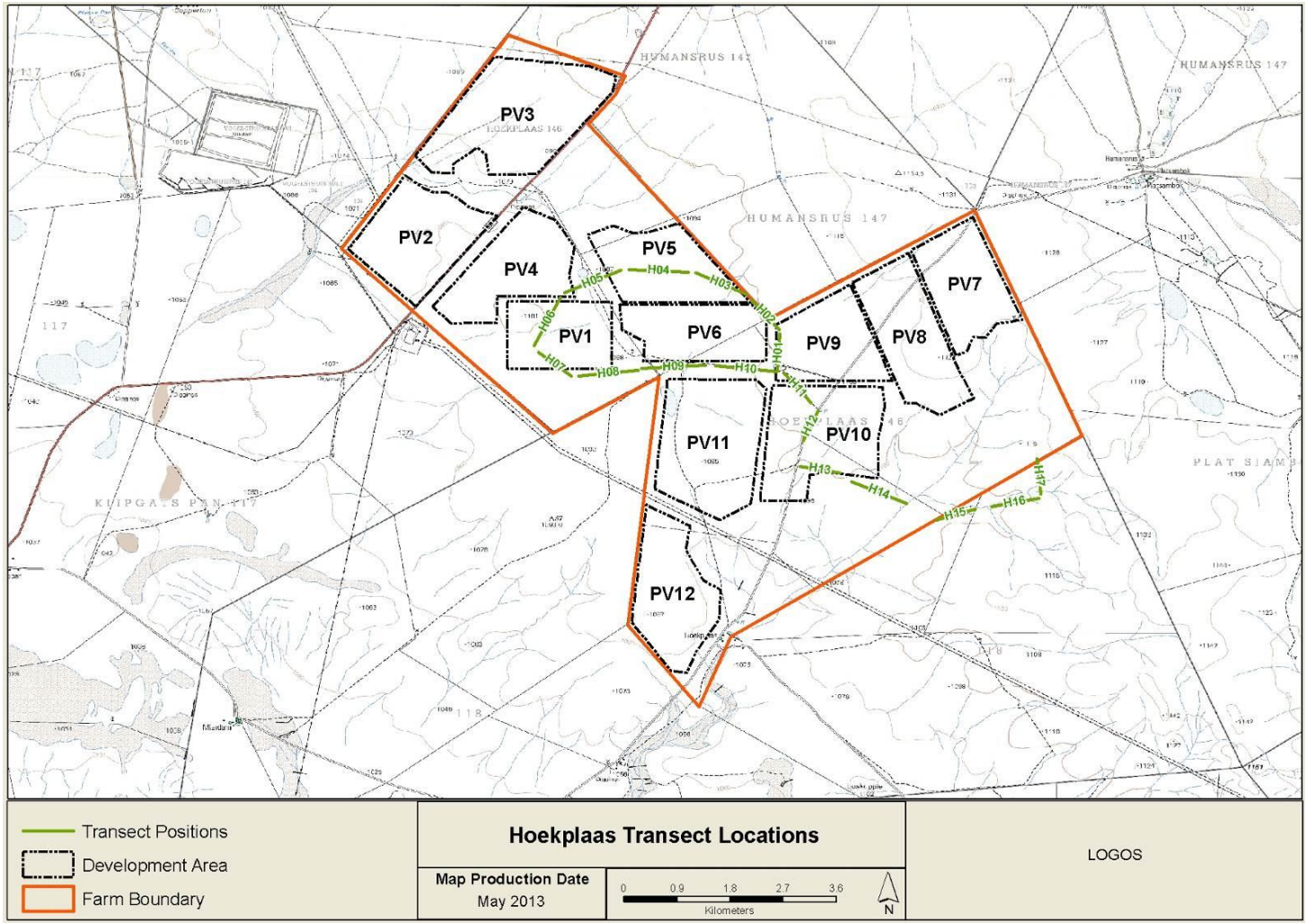

Figure 4. Layout and location of the small terrestrial bird transects walked in and around the Hoekplaas PV development area. Note that PV5 and PV6 on this map have subsequently been integrated into a single plant, PV5. Please note that this map has been amended and that the PV plant labeled as PV12 is no longer included as part of the proposed development.

Table 4. Parameters describing the 20 min walked transects plotted (see Fig. 4) and sampled in and around the Hoekplaas PV development area. Cloud cover: 0-8 eighths; Temp(erature): 1 = cool, 2 = mild, 3 = warm, Wind: 0 = calm, 2 = breeze, 3 = wind, 4 = strong wind.

Transect number	Start time	Cloud cover	Temp	Wind	Inside PV footprint?	Habitat	Gradient	Length (km)	Mean transect width (m)	*n* sightings	*n* birds	Density (birds.ha^{-1})
H01	07:30	0	2	0	Yes	Karoo	Flat	0.62	29	10	25	14.05
H02	07:58	1	2	1	Yes	Karoo	Flat	0.65	28	7	10	5.54
H03	08:41	1	2	1	Yes	Karoo	Flat	0.84	22	12	19	10.13
H04	09:05	1	2	1	Yes	Karoo	Flat	0.88	43	8	14	3.75
H05	09:28	1	2	1	No	Karoo	Flat	0.91	19	6	7	3.99
H06	09:52	1	2	1	Yes	Grassy/Karoo	Undulating	0.89	47	9	34	8.19
H07	10:15	1	2	1	Yes	Karoo	Undulating	0.62	25	10	35	22.24
H08	10:38	1	2	1	No	Karoo	Undulating	0.88	24	7	26	12.06
H09	11:05	1	3	1	No	Karoo	Flat	0.94	8	5	6	7.60
H10	11:28	1	3	1	No	Grassy/Karoo	Undulating	0.91	20	6	6	3.22
H11	07:40	1	2	0	Yes	Grassy/Karoo	Flat	0.65	32	16	28	13.61
H12	08:10	1	2	1	Yes	Karoo	Flat	0.55	23	25	59	46.47
H13	08:40	1	2	1	Yes	Karoo	Flat	0.59	29	10	17	9.93
H14	09:10	1	2	1	Yes	Karoo	Flat	0.89	28	16	57	23.20
H15	09:45	1	2	1	No	Dense Karoo Thicket	Flat	0.59	21	9	18	14.38
H16	10:20	1	2	1	No	Dense Karoo Thicket	Flat	0.70	48	11	19	5.61
H17	10:45	1	2	1	No	Karoo	Flat	0.59	30	12	37	20.78
Overall								**0.75**	**28.1**	**10.5**	**24.5**	**13.22**

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Appendix 1. Inclusive, annotated list of the bird species considered likely to occur within the broader impact zone of the proposed locations for the Hoekplaas PV Energy Facilities. Species seen on site during the May site visit appear in **bold**.

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines & alien trees	Screes and cuttings	Dams & ephemeral waterbodies	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Common Ostrich	*Struthio camelus*	-	-	X					-	-	High
Orange River Francolin	*Scleroptila levaillantoides*	-	Near-endemic	X	X				Moderate	-	High
Cape Spurfowl	*Pternistis capensis*	-	Endemic		X				Moderate	-	High
Common Quail	*Coturnix coturnix*	-	-	X					-	-	High
Helmeted Guineafowl	*Numida meleagris*	-	-		X				Moderate	-	High
Egyptian Goose	*Alopochen aegyptiaca*	-	-				X		High	High	-
South African Shelduck	*Tadorna cana*	-	Endemic				X		High	-	-
Yellow-billed Duck	*Anas undulata*	-	-				X		Moderate	-	-
Cape Shoveler	*Anas smithii*	-	Endemic				X		Moderate	-	-
Red-billed Teal	*Anas erythrorhyncha*	-	-				X		Moderate	-	-

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines & alien trees	Screes and cuttings	Dams & ephemeral waterbodies	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Kurrichane Buttonquail	*Turnix sylvaticus*	-	-	X					-	-	High
Lesser Honeyguide	*Indicator minor*	-	-		X				-	-	Moderate
Golden-tailed Woodpecker	*Campethera abingoni*	-	-		X				-	-	Moderate
Cardinal Woodpecker	*Dendropicos fuscescens*	-	-		X				-	-	Moderate
Acacia Pied Barbet	*Tricholaema leucomelas*	-	Near-endemic		X				-	-	Moderate
African Grey Hornbill	*Tockus nasutus*	-	-		X				-	-	Moderate
African Hoopoe	*Upupa africana*	-	-		X				-	-	Moderate
Common Scimitarbill	*Rhinopomastus cyanomelas*	-	-		X				-	-	Moderate
European Roller	*Coracias garrulus*	-	-	X	X				-	-	-
Lilac-breasted Roller	*Coracias caudatus*	-	-		X				-	-	Moderate
Malachite Kingfisher	*Alcedo cristata*	-	-				X		-	-	-
Pied Kingfisher	*Ceryle rudis*	-	-				X		-	-	-

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines & alien trees	Screes and cuttings	Dams & ephemeral waterbodies	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Swallow-tailed Bee-eater	*Merops hirundineus*	-	-	X	X	X	X		-	-	Moderate
European Bee-eater	*Merops apiaster*	-	-						-	-	-
White-backed Mousebird	*Colius colius*	-	Endemic		X				-	-	Moderate
Red-faced Mousebird	*Urocolius indicus*	-	-		X				-	-	Moderate
Jacobin Cuckoo	*Clamator jacobinus*	-	-		X				-	-	Moderate
Diderick Cuckoo	*Chrysococcyx caprius*	-	-		X				-	-	Moderate
Rosy-faced Lovebird	*Agapornis roseicollis*	-	Near-endemic		X				-	-	Moderate
African Palm-Swift	*Cypsiurus parvus*	-	-		X				-	-	-
Alpine Swift	*Tachymarptis melba*	-	-					X	-	-	-
Common Swift	*Apus apus*	-	-					X	-	-	-
Bradfield's Swift	*Apus bradfieldi*	-	Near-endemic			X		X	-	-	-
Little Swift	*Apus affinis*	-	-			X			-	-	-

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines & alien trees	Screes and cuttings	Dams & ephemeral waterbodies	Fly over	Collision	Electro-cution	Disturbance / habitat loss
White-rumped Swift	*Apus caffer*	-	-					X	-	-	-
Barn Owl	*Tyto alba*	-	-	X	X	X			-	Moderate	Moderate
Southern White-faced Scops-Owl	*Ptilopsis granti*	-	-		X				-	-	Moderate
Cape Eagle-Owl	*Bubo capensis*	-	-			X			-	High	Moderate
Spotted Eagle-Owl	*Bubo africanus*	-	-	X	X	X			-	High	Moderate
Verreaux's Eagle-Owl	*Bubo lacteus*	-	-		X				-	High	Moderate
Pearl-spotted Owlet	*Glaucidium perlatum*	-	-		X				-	-	Moderate
Rufous-cheeked Nightjar	*Caprimulgus rufigena*	-	-	X					-	-	Moderate
Rock Dove	*Columba livia*	-	-			X		X	-	-	Moderate
Speckled Pigeon	*Columba guinea*	-	-			X		X	-	-	Moderate
Laughing Dove	*Streptopelia senegalensis*	-	-		X				-	-	Moderate
Cape Turtle-Dove	*Streptopelia capicola*	-	-		X				-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines & alien trees	Screes and cuttings	Dams & ephemeral waterbodies	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Red-eyed Dove	*Streptopelia semitorquata*	-	-		X				-	-	Moderate
Namaqua Dove	*Oena capensis*	-	-	X	X				-	-	Moderate
Ludwig's Bustard	*Neotis ludwigii*	Vulnerable	Near-endemic	X					High	-	Moderate
Kori Bustard	***Ardeotis kori***	**Vulnerable**	-	**X**					**High**	-	**Moderate**
Red-crested Korhaan	*Eupodotis ruficrista*	-	Near-endemic	X					Moderate	-	Moderate
Northern Black Korhaan	***Afrotis afraoides***	-	**Endemic**	**X**					**Moderate**	-	**Moderate**
Karoo Korhaan	***Eupodotis vigorsii***	-	**Endemic**	**X**					**Moderate**	-	**Moderate**
Blue Crane	*Anthropoides paradiseus*	Vulnerable	Endemic	X			X		High	-	Moderate
Common Moorhen	*Gallinula chloropus*	-	-				X		-	-	-
Red-knobbed Coot	*Fulica cristata*	-	-				X		-	-	-
Namaqua Sandgrouse	***Pterocles namaqua***	-	**Near-endemic**	**X**			**X**		-	-	-

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines & alien trees	Screes and cuttings	Dams & ephemeral waterbodies	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Double-banded Sandgrouse	*Pterocles bicinctus*	-	-	X			X		-	-	-
Burchell's Sandgrouse	*Pterocles burchelli*	-	Near-endemic	X			X		-	-	-
Marsh Sandpiper	*Tringa stagnatilis*	-	-				X		-	-	-
Common Greenshank	*Tringa nebularia*	-	-				X		-	-	-
Wood Sandpiper	*Tringa glareola*	-	-				X		-	-	-
Common Sandpiper	*Actitis hypoleucos*	-	-				X		-	-	-
Little Stint	*Calidris minuta*	-	-				X		-	-	-
Curlew Sandpiper	*Calidris ferruginea*	-	-				X		-	-	-
Ruff	*Philomachus pugnax*	-	-				X		-	-	-
Spotted Thick-knee	*Burhinus capensis*	-	-	X	X				-	-	-
Black-winged Stilt	*Himantopus himantopus*	-	-				X		-	-	-
Pied Avocet	*Recurvirostra avosetta*	-	-				X		-	-	-

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines & alien trees	Screes and cuttings	Dams & ephemeral waterbodies	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Kittlitz's Plover	*Charadrius pecuarius*	-	-				X		-	-	-
Three-banded Plover	*Charadrius tricollaris*	-	-				X		-	-	-
Chestnut-banded Plover	*Charadrius pallidus*	Near-threatened	-				X		-	-	-
Blacksmith Lapwing	*Vanellus armatus*	-	-				X		-	-	-
Crowned Lapwing	*Vanellus coronatus*	-	-	X					-	-	-
Double-banded Courser	*Rhinoptilus africanus*	-	-	X					-	-	-
Burchell's Courser	*Cursorius rufus*	-	Near-endemic	X					-	-	-
White-winged Tern	*Chlidonias leucopterus*	-	-				X		-	-	-
Black-shouldered Kite	*Elanus caeruleus*	-	-	X	X				-	-	Moderate
Black Kite	*Milvus migrans*	-	-	X				X	-	-	-
African Fish-Eagle	*Haliaeetus vocifer*	-	-					X	-	High	-

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines & alien trees	Screes and cuttings	Dams & ephemeral waterbodies	Fly over	Collision	Electro-cution	Disturbance / habitat loss
White-backed Vulture	*Gyps africanus*	Vulnerable	-					X	Moderate	High	Moderate
Lappet-faced Vulture	*Aegypius tracheliotus*	Vulnerable	-					X	Moderate	High	Moderate
Black-chested Snake-Eagle	*Circaetus pectoralis*	-	-					X	-	Moderate	Moderate
Bateleur	*Terathopius ecaudatus*	Vulnerable	-					X	-	Moderate	Moderate
Black Harrier	*Circus maurus*	Near-threatened	Endemic	X			X		-	-	Moderate
African Harrier-Hawk	*Polyboroides typus*	-	-		X			X	-	-	Moderate
Southern Pale Chanting Goshawk	***Melierax canorus***	-	**Near-endemic**	**X**	**X**				-	**Moderate**	**Moderate**
Gabar Goshawk	*Melierax gabar*	-	-		X				-	-	Moderate
Steppe Buzzard	*Buteo vulpinus*	-	-	X				X	-	Moderate	Moderate
Jackal Buzzard	*Buteo rufofuscus*	-	Endemic	X				X	-	Moderate	Moderate
Tawny Eagle	*Aquila rapax*	Vulnerable	-		X			X	-	High	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines & alien trees	Screes and cuttings	Dams & ephemeral waterbodies	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Verreauxs' Eagle	*Aquila verreauxii*	-	-					X	Moderate	High	Moderate
Booted Eagle	*Aquila pennatus*	-	-					X	-	-	Moderate
Martial Eagle	***Polemaetus bellicosus***	**Vulnerable**	**-**					**X**	**Moderate**	**High**	**Moderate**
Secretarybird	*Sagittarius serpentarius*	Near-threatened	-	X				X	High	-	Moderate
Pygmy Falcon	*Polihierax semitorquatus*	-	-	X	X				-	-	Moderate
Rock Kestrel	*Falco rupicolus*	-	-	X		X			-	-	Moderate
Greater Kestrel	*Falco rupicoloides*	-	-	X					-	-	Moderate
Red-necked Falcon	*Falco chicquera*	-	-		X			X		-	Moderate
Red-footed Falcon	*Falco vespertinus*	-	-	X				X	-	-	-
Lanner Falcon	*Falco biarmicus*	Near-threatened	-	X				X	High	Moderate	-
Peregrine Falcon	*Falco peregrinus*	Near-threatened	-	X				X	High	Moderate	-
Little Grebe	*Tachybaptus ruficollis*	-	-				X		-	-	-
Black-necked Grebe	*Podiceps nigricollis*	-	-				X		-	-	-

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines & alien trees	Screes and cuttings	Dams & ephemeral waterbodies	Fly over	Collision	Electro-cution	Disturbance / habitat loss
African Darter	*Anhinga rufa*	-	-				X		-	-	-
Reed Cormorant	*Phalacrocorax africanus*	-	-				X		-	-	-
Little Egret	*Egretta garzetta*	-	-				X		-	-	-
Grey Heron	*Ardea cinerea*	-	-				X		Moderate	Moderate	-
Black-headed Heron	*Ardea melanocephala*	-	-	X			X		Moderate	Moderate	-
Cattle Egret	*Bubulcus ibis*	-	-				X		-	-	-
Greater Flamingo	*Phoenicopterus ruber*	Near-threatened	-					X	High	-	-
Lesser Flamingo	*Phoenicopterus minor*	Near-threatened	-					X	High	-	-
Hadeda Ibis	*Bostrychia hagedash*	-	-		X			X	Moderate	-	-
African Sacred Ibis	*Threskiornis aethiopicus*	-	-				X	X	Moderate	-	-
African Spoonbill	*Platalea alba*	-	-				X	X	Moderate	-	-
Black Stork	*Ciconia nigra*	Near-threatened	-				X	X	High	Moderate	-
Abdim's Stork	*Ciconia abdimii*	-	-				X	X	Moderate	Moderate	-

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines & alien trees	Screes and cuttings	Dams & ephemeral waterbodies	Fly over	Collision	Electro-cution	Disturbance / habitat loss
White Stork	*Ciconia ciconia*	-	-				X	X	High	High	-
Fork-tailed Drongo	*Dicrurus adsimilis*	-	-		X				-	-	Moderate
Brubru	*Nilaus afer*	-	-		X				-	-	Moderate
Crimson-breasted Shrike	*Laniarius atrococcineus*	-	Near-endemic		X				-	-	Moderate
Bokmakierie	***Telophorus zeylonus***	**-**	**Near-endemic**		**X**				**-**	**-**	**Moderate**
Pririt Batis	*Batis pririt*	-	Near-endemic		X				-	-	Moderate
Cape Crow	*Corvus capensis*	-	-	X	X				-	-	Moderate
Pied Crow	***Corvus albus***	**-**	**-**	**X**	**X**	**X**			**-**	**-**	**Moderate**
White-necked Raven	*Corvus albicollis*	-	-	X		X			-	-	Moderate
Red-backed Shrike	*Lanius collurio*	-	-	X					-	-	Moderate
Lesser Grey Shrike	*Lanius minor*	-	-	X					-	-	Moderate
Common Fiscal	***Lanius collaris***	**-**	**-**	**X**	**X**				**-**	**-**	**Moderate**
Cape Penduline-Tit	*Anthoscopus minutus*	-	Near-endemic	X					-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines & alien trees	Screes and cuttings	Dams & ephemeral waterbodies	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Ashy Tit	*Parus cinerascens*	-	Near-endemic	X					-	-	Moderate
Brown-throated Martin	*Riparia paludicola*	-	-				X	X	-	-	Moderate
Barn Swallow	*Hirundo rustica*	-	-				X	X	-	-	Moderate
White-throated Swallow	*Hirundo albigularis*	-	-				X		-	-	Moderate
Greater Striped Swallow	*Hirundo cucullata*	-	-				X	X	-	-	Moderate
Rock Martin	*Hirundo fuligula*	-	-			X	X	X	-	-	Moderate
African Red-eyed Bulbul	*Pycnonotus nigricans*	-	Near-endemic		X				-	-	Moderate
Fairy Flycatcher	*Stenostira scita*	-	Endemic		X				-	-	Moderate
Long-billed Crombec	*Sylvietta rufescens*	-	-	X	X				-	-	Moderate
Yellow-bellied Eremomela	***Eremomela icteropygialis***	-	-	**X**	**X**				-	-	**Moderate**

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines & alien trees	Screes and cuttings	Dams & ephemeral waterbodies	Fly over	Collision	Electro-cution	Disturbance / habitat loss
African Reed-Warbler	*Acrocephalus baeticatus*	-	-				X		-	-	Moderate
Lesser Swamp-Warbler	*Acrocephalus gracilirostris*	-	-				X		-	-	Moderate
Willow Warbler	*Phylloscopus trochilus*	-	-		X				-	-	Moderate
Layard's Tit-Babbler	*Parisoma layardi*	-	Endemic	X	X				-	-	Moderate
Chestnut-vented Tit-Babbler	***Parisoma subcaeruleum***	-	**Near-endemic**		**X**				-	-	**Moderate**
Orange River White-eye	*Zosterops pallidus*	-	Endemic		X				-	-	Moderate
Grey-backed Cisticola	***Cisticola subruficapilla***	-	**Near-endemic**	**X**	**X**				-	-	**Moderate**
Levaillant's Cisticola	*Cisticola tinniens*	-	-				X		-	-	Moderate
Zitting Cisticola	*Cisticola juncidis*	-	-				X		-	-	Moderate
Desert Cisticola	***Cisticola aridulus***	-	-				**X**		-	-	**Moderate**

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines & alien trees	Screes and cuttings	Dams & ephemeral waterbodies	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Black-chested Prinia	***Prinia flavicans***	-	-		**X**				-	-	**Moderate**
Karoo Prinia	*Prinia maculosa*	-	Endemic	X	X				-	-	Moderate
Namaqua Warbler	*Phragmacia substriata*	-	Endemic		X				-	-	Moderate
Rufous-eared Warbler	***Malcorus pectoralis***	-	**Endemic**	**X**					-	-	**Moderate**
Eastern Clapper Lark	***Mirafra fasciolata***	-	**Near-endemic**	**X**					-	-	**Moderate**
Sabota Lark	***Calendulauda sabota***	-	-	**X**					-	-	**Moderate**
Fawn-coloured Lark	*Calendulauda africanoides*	-	Near-endemic	X					-	-	Moderate
Red Lark	*Calendulauda burra*	Vulnerable	Endemic	X					-	-	Moderate
Spike-heeled Lark	***Chersomanes albofasciata***	-	-	**X**					-	-	**Moderate**
Karoo Long-billed Lark	***Certhilauda subcoronata***	-	**Endemic**	**X**					-	-	**Moderate**

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines & alien trees	Screes and cuttings	Dams & ephemeral waterbodies	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Black-eared Sparrowlark	*Eremopterix australis*	-	Endemic	X					-	-	Moderate
Grey-backed Sparrowlark	*Eremopterix verticalis*	-	Near-endemic	X					-	-	Moderate
Red-capped Lark	*Calandrella cinerea*	-	-	X					-	-	Moderate
Stark's Lark	***Spizocorys starki***	-	**Endemic**	**X**					-	-	**Moderate**
Pink-billed Lark	***Spizocorys conirostris***	-	**Near-endemic**	**X**					-	-	**Moderate**
Sclater's Lark	***Spizocorys sclateri***	**Near-threatened**	**Endemic**	**X**					-	-	**Moderate**
Large-billed Lark	*Galerida magnirostris*	-	Endemic	X					-	-	Moderate
Short-toed Rock-Thrush	*Monticola brevipes*	-	Near-endemic			X			-	-	Moderate
Karoo Thrush	*Turdus smithi*	-	Endemic		X				-	-	Moderate
Chat Flycatcher	***Bradornis infuscatus***	-	**Near-endemic**	**X**					-	-	**Moderate**
Marico Flycatcher	*Bradornis mariquensis*	-	Near-endemic	X	X				-	-	Moderate
Fiscal Flycatcher	*Sigelus silens*	-	Endemic		X				-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines & alien trees	Screes and cuttings	Dams & ephemeral waterbodies	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Cape Robin-Chat	*Cossypha caffra*	-	-		X				-	-	Moderate
Kalahari Scrub-Robin	*Cercotrichas paena*	-	Near-endemic	X	X				-	-	Moderate
Karoo Scrub-Robin	***Cercotrichas coryphoeus***	-	**Endemic**	**X**	**X**				-	-	**Moderate**
Mountain Wheatear	*Oenanthe monticola*	-	Near-endemic	X		X			-	-	Moderate
Capped Wheatear	***Oenanthe pileata***	-	-	**X**					-	-	**Moderate**
Sickle-winged Chat	***Cercomela sinuata***	-	**Endemic**	**X**					-	-	**Moderate**
Karoo Chat	*Cercomela schlegelii*	-	Near-endemic	X					-	-	Moderate
Tractrac Chat	*Cercomela tractrac*	-	Near-endemic	X					-	-	Moderate
Familiar Chat	*Cercomela familiaris*	-	-	X					-	-	Moderate
Ant-eating Chat	***Myrmecocichla formicivora***	-	**Endemic**	**X**					-	-	**Moderate**
Pale-winged Starling	*Onychognathus nabouroup*	-	Near-endemic			X		X	-	-	Moderate
Cape Glossy Starling	*Lamprotornis nitens*	-	-		X				-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines & alien trees	Screes and cuttings	Dams & ephemeral waterbodies	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Pied Starling	*Spreo bicolor*	-	Endemic			X		X	-	-	Moderate
Wattled Starling	*Creatophora cinerea*	-	-	X	X			X	-	-	Moderate
Common Starling	*Sturnus vulgaris*	-	-		X	X			-	-	Moderate
Malachite Sunbird	*Nectarinia famosa*	-	-		X				-	-	Moderate
Dusky Sunbird	*Cinnyris fuscus*	-	Near-endemic	X	X				-	-	Moderate
Scaly-feathered Finch	***Sporopipes squamifrons***	-	**Near-endemic**	**X**					-	-	**Moderate**
White-browed Sparrow-Weaver	*Plocepasser mahali*	-	-	X	X				-	-	Moderate
Sociable Weaver	***Philetairus socius***	-	**Endemic**	**X**	**X**				-	-	**Moderate**
Southern Masked-Weaver	*Ploceus velatus*	-	-		X		X		-	-	Moderate
Red-billed Quelea	***Quelea quelea***	-	-	**X**	**X**		**X**	**X**	-	-	**Moderate**
Southern Red Bishop	***Euplectes orix***	-	-				**X**		-	-	**Moderate**

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines & alien trees	Screes and cuttings	Dams & ephemeral waterbodies	Fly over	Collision	Electro-cution	Disturbance / habitat loss
African Quailfinch	*Ortygospiza atricollis*	-	-	X					-	-	Moderate
Red-headed Finch	*Amadina erythrocephala*	-	Near-endemic	X	X				-	-	Moderate
Black-faced Waxbill	*Estrilda erythronotos*	-	-		X				-	-	Moderate
Common Waxbill	*Estrilda astrild*	-	-				X		-	-	Moderate
Violet-eared Waxbill	*Granatina granatina*	-	-	X	X				-	-	Moderate
Pin-tailed Whydah	*Vidua macroura*	-	-		X				-	-	Moderate
House Sparrow	*Passer domesticus*	-	-		X				-	-	Moderate
Cape Sparrow	***Passer melanurus***	-	**Near-endemic**	**X**	**X**				-	-	**Moderate**
Southern Grey-headed Sparrow	*Passer diffusus*	-	-	X	X				-	-	Moderate
Cape Wagtail	***Motacilla capensis***	-	-				**X**		-	-	**Moderate**
African Pipit	*Anthus cinnamomeus*	-	-			X			-	-	Moderate
Long-billed Pipit	*Anthus similis*	-	-	X					-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat					Susceptibility to		
				Karoo veld	Drainage lines & alien trees	Screes and cuttings	Dams & ephemeral waterbodies	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Kimberley Pipit	*Anthus pseudosimilis*	-	Endemic	X					-	-	Moderate
Black-headed Canary	*Serinus alario*	-	Endemic	X					-	-	Moderate
Black-throated Canary	*Crithagra atrogularis*	-	-	X					-	-	Moderate
Yellow Canary	*Crithagra flaviventris*	-	Near-endemic	X					-	-	Moderate
White-throated Canary	***Crithagra albogularis***	-	**Near-endemic**	**X**					-	-	**Moderate**
Lark-like Bunting	***Emberiza impetuani***	-	**Near-endemic**	**X**					-	-	**Moderate**
Cape Bunting	*Emberiza capensis*	-	Near-endemic	X					-	-	Moderate

Appendix 2. Species, numbers and densities of birds observed during 20 min walked transects in and around the Hoekplaas Dam PV development area in May 2013.

Transect number	Length (km)	Species	*n* sightings	*n* birds	Mean transect width (m)	Density (Birds.ha^{-1})
H01	0.62	Chestnut-vented Tit-babbler	1	1	40.0	0.40
		Desert Cisticola	1	1	60.0	0.27
		Rufous-eared Warbler	1	1	4.0	4.05
		Sabota Lark	2	3	23.3	2.08
		Spike-heeled Lark	1	3	10.0	4.85
		Chat Flycatcher	1	3	20.0	2.43
		Capped Wheatear	1	1	4.0	4.05
		Lark-like Bunting	2	12	1.7	116.52
H02	0.65	Rufous-eared Warbler	2	2	31.0	1.00
		Sabota Lark	2	4	17.5	3.54
		Capped Wheatear	1	1	40.0	0.39
		Sickle-winged Chat	1	2	10.0	3.10
		Lark-like Bunting	1	1	4.0	3.88
H03	0.84	Black-chested Prinia	1	1	20.0	0.60
		Sabota Lark	4	7	14.6	5.72
		Karoo Scrub-Robin	2	2	2.0	5.95
		Capped Wheatear	1	1	60.0	0.20
		Sickle-winged Chat	1	1	10.0	1.19
		White-throated Canary	1	2	15.0	1.59
		Lark-like Bunting	1	5	1.2	49.61
H04	0.88	Rufous-eared Warbler	3	4	50.0	0.91
		Sabota Lark	3	3	13.3	2.56
		Pink-billed Lark	2	6	10.0	6.83
		White-throated Canary	1	1	40.0	0.28
H05	0.91	Rufous-eared Warbler	1	1	4.0	2.75
		Sabota Lark	1	1	30.0	0.37
		Spike-heeled Lark	1	1	2.0	5.50
		Stark's Lark	1	1	20.0	0.55
		Pink-billed Lark	1	2	10.0	2.20
		Karoo Scrub-Robin	1	1	40.0	0.28
H06	0.89	Rufous-eared Warbler	1	1	60.0	0.19
		Sabota Lark	4	5	24.0	2.34
		Spike-heeled Lark	2	5	20.0	2.81
		Stark's Lark	2	23	6.1	42.50
H07	0.62	Common Fiscal	1	1	20.0	0.81

Transect number	Length (km)	Species	*n* sightings	*n* birds	Mean transect width (m)	Density (Birds.ha^{-1})
		Yellow-bellied Eremomela	1	1	10.0	1.61
		Rufous-eared Warbler	1	2	20.0	1.61
		Sabota Lark	4	7	10.6	10.69
		Spike-heeled Lark	1	2	40.0	0.81
		Lark-like Bunting	2	22	1.4	260.41
H08	0.88	Rufous-eared Warbler	1	2	5.0	4.53
		Sabota Lark	2	2	13.0	1.74
		Spike-heeled Lark	1	3	3.3	10.18
		Sclater's Lark	2	17	7.1	27.25
		Sickle-winged Chat	1	2	2.0	11.32
H09	0.94	Rufous-eared Warbler	2	3	8.0	3.99
		Sabota Lark	1	1	10.0	1.06
		Lark-like Bunting	2	2	4.0	5.32
H10	0.91	Common Fiscal	1	1	20.0	0.55
		Rufous-eared Warbler	1	1	20.0	0.55
		Sabota Lark	2	2	15.0	1.46
		Scaly-feathered Finch	6	1	2.0	5.48
H11	0.65	Bokmakierie	1	2	50.0	0.62
		Rufous-eared Warbler	4	5	18.0	4.27
		Spike-heeled lark	2	6	5.0	18.45
		Karoo-scrub Robin	1	2	5.0	6.15
		Capped Wheatear	1	1	20.0	0.77
		Sickle-winged Chat	1	1	10.0	1.54
		Karoo Chat	1	1	2.0	7.69
		Lark-like Bunting	3	8	4.3	28.95
		Unidentified lark sp.	1	1	10.0	1.54
H12	0.55	Bokmakierie	1	2	50.0	0.73
		Common Fiscal	2	1	5.0	3.65
		Rufous-eared Warbler	3	3	10.0	5.48
		Sobota Lark	1	2	20.0	1.83
		Spike-heeled lark	1	2	5.0	7.31
		Karoo Scrub Robin	3	5	14.0	6.53
		Capped Wheatear	2	2	15.0	2.44
		Sickle-winged Chat	2	2	25.0	1.46
		Familiar Char	1	1	20.0	0.91
		Sociable Weaver	3	29	2.1	256.10
		White-throated Canary	2	3	10.0	5.48
		Lark-like Bunting	2	4	5.0	14.62

Transect number	Length (km)	Species	*n* sightings	*n* birds	Mean transect width (m)	Density (Birds.ha^{-1})
		Unidentified lark sp.	2	2	25.0	1.46
H13	0.59	Rufous-eared Warbler	3	4	12.5	5.42
		Spike-heeled lark	1	2	50.0	0.68
		Karoo Scrub Robin	1	2	10.0	3.39
		Sickle-winged Chat	1	1	40.0	0.42
		Lark-like Bunting	3	6	10.0	10.16
		Unidentified lark sp.	1	2	10.0	3.39
H14	0.89	Bokmakierie	1	1	60.0	0.19
		Rufous-eared Warbler	2	2	20.0	1.13
		Sobota Lark	1	1	10.0	1.13
		Spike-heeled lark	2	4	15.0	3.01
		Grey-backed Sparrowlark	2	2	15.0	1.51
		Karoo Scrub Robin	1	3	3.3	10.17
		Sickle-winged Chat	1	1	20.0	0.56
		Red-billed Quelea	1	16	6.3	28.92
		southern Red Bishop	1	1	10.0	1.13
		White-throated Canary	1	2	30.0	0.75
		Lark-like Bunting	3	24	1.8	147.88
H15	0.59	Grey-backed Cisticola	1	1	10.0	1.69
		Black-chested Prinia	1	3	3.3	15.18
		Rufous-eared Warbler	3	3	3.3	15.18
		Karoo Scrub Robin	1	2	20.0	1.69
		Red-billed Quelea	1	4	2.5	26.98
		Lark-like Bunting	1	3	3.3	15.18
		Unidentified lark sp.	1	2	10.0	3.37
H16	0.70	Bokmakierie	1	2	100.0	0.28
		Grey-backed Cisticola	1	1	20.0	0.71
		Black-chested Prinia	1	2	10.0	2.85
		Rufous-eared Warbler	3	4	40.0	1.42
		Sobota Lark	1	1	20.0	0.71
		Spike-heeled lark	1	2	30.0	0.95
		Black-eared Sparrowlark	1	5	4.0	17.79
		Lark-like Bunting	1	1	10.0	1.42
		Unidentified lark sp.	1	1	20.0	0.71
H17	0.59	Common Fiscal	1	1	40.0	0.42
		Rufous-eared Warbler	2	2	15.0	2.25
		Spike-heeled lark	2	5	12.0	7.02
		Karoo Long-billed lark	1	2	10.0	3.37

Transect number	Length (km)	Species	*n* sightings	*n* birds	Mean transect width (m)	Density (Birds.ha^{-1})
		Black-eared Sparrowlark	1	15	1.3	189.55
		Karoo Scrub Robin	1	2	50.0	0.67
		Capped Wheatear	1	1	30.0	0.56
		Lark-like Bunting	2	8	5.0	26.96
		Unidentified lark sp.	1	1	20.0	0.84