Annex G

Bird Specialist Report

OLYVEN KOLK PV SOLAR POWER PLANT

BIRD IMPACT ASSESSMENT

AVISENSE CONSULTING

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 Olyven Kolk PV Solar Power Plant on the avifauna of the Kenhardt area. The expected impacts are: (i) habitat destruction by the construction of the facility itself and its associated power lines, tracks and roads, (ii) disturbance or displacement by construction, maintenance and decommissioning activities, and possibly by the operation of the facility, and (iii) mortality caused by collision with the associated power line network or with the PV arrays, and electrocution on power line and substation infrastructure. In addition, some birds may interfere with the efficient running of the proposed PV installation.

The broader impact zone of the proposed PV facility is contained within an extensive tract of flat, quite remote, grassy Karoo shrubland . The area is likely to support over 130 bird species, including 11 Red-listed species, 56 endemics, and four Red-listed endemics. The birds of greatest potential relevance and importance in terms of the possible impacts of the PV facility are likely to be breeding pairs of Martial Eagle *Polemaetus bellicosus* and Lanner Falcon *Falco biarmicus*, resident on existing power transmission pylons within the proposed development area. Large terrestrial birds (including Ludwig's Bustard *Neotis ludwigii* and Kori Bustard *Ardeotis kori*), local populations of endemic, and possibly Red-listed passerines (possibly including Red Lark *Calendulauda burra* and/or Sclater's Lark *Spizocorys sclateri*), and passing wetland birds on their way to distant resource areas, may also be affected. Pigeons, crows, weavers, sparrows and some raptor species may perch, roost, forage or even nest on or around the facility and cause pollution or fouling problems.

The proposed solar power plant would occupy a relatively small area of widespread habitat, and it is deemed unlikely to have any significant, long-term impact on the local avifauna, provided that recommended mitigation is applied. A revision of the site layout, and a reduction of the extent of the PV arrays, coincident with the first draft of this report, has already reduced possible impacts. Layout Alternative 2 will still require some limited mitigation, ideally including the relocation of the two Martial Eagle nest sites (one used by a pair of Lanner Falcons) to pylons 1 km further away from the development area than their current position. A comprehensive programme is put forward to fully monitor and research the actual impacts of the solar power plant on the broader avifauna of the area, from pre-construction and into the operational phase of the development.

1. *INTRODUCTION*

AES Solar Energy Ltd (AES) is planning to construct a PV Solar Power Plant (project name 'Olyven Kolk Solar Power Plant), south-west of the town of Kenhardt, in the Northern Cape Province, South Africa. Environmental Resources Management Southern Africa (Pty) Ltd was appointed to do the Environmental Impact Assessment study, and subsequently sub-contracted Dr Andrew Jenkins (*AVISENSE* Consulting cc) to conduct the specialist avifaunal assessment for this proposed development. Jenkins has a PhD in Zoology from the University of Cape Town, and is an experienced ornithologist, with over 20 years experience in avian research and impact assessment work. He has been involved in many power line, wind farm and solar plant EIA and EMP studies in South Africa, and also does research on raptors, bustards and cranes in various parts of the country.

1.1 *DECLARATION OF INDEPENDENCE*

Andrew Jenkins (*AVISENSE* Consulting) is an independent consultant to Environmental Resources Management Southern Africa (Pty) Ltd (ERM) and AES Solar Energy Ltd. He 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.

1.2 *DEVELOPMENT PROPOSAL*

The proposed Olyven Kolk Solar Power Plant will be located on portion 14 (a portion of portion 4) of the farm Olyven Kolk 187. The proposed development will comprise about 500 ha of photovoltaic (PV) solar panels or arrays contained within a development area of about 1000 ha (Fig. 2.1). It should be noted that Development Phase 1 of this solar plant, which comprises 10 MW, is not directly considered in this report as it is covered by a separate EIA process. This study assesses the impact of the remainder of the development, 190 MW of solar panels and associated infrastructure. The development site is situated 44 km south-west of Kenhardt, in the Northern Cape Province, and is bisected by the Sishen-Saldanha railway line, and by Eskom's Aries-Kronos and Aries-Juno 400 kV transmission lines, which run south-east and south respectively from the Aries substation located on the north-west boundary of the development area (Fig. 1). The PV panels will be fitted on mountings, arranged in widely spaced arrays, and will be attended by various infrastructural components (underground and overhead power cabling, site office, a road network). Construction will require the use of lay-down areas for materials and equipment, and the establishment of temporary housing to accommodate 60-80 people.

Once the development is completed, day to day facility operations will involve both regular on site preventive and corrective maintenance tasks in order to keep the PV plant in optimal working order throughout the operational period. Intermittent cleaning of the panels will be carried out as necessary. Faulty components will be replaced as soon as problems are identified.

2.

3. *METHODS*

The required scope of the specialist avifaunal study included:

(i) A baseline description of the study area in terms of avian habitats and avifauna.

(ii) An assessment of potential impacts on birds associated with the development according to the impact assessment methodology specified by ERM.

(iii) A description of relevant and implementable mitigation measures to reduce, avoid, or minimise negative impacts and enhance positive impacts.

(iv) Listed recommendations, including possible monitoring studies.

(v) A comprehensive list of all referenced information sources.

The study included a review of the literature on bird:PV plant interactions, and collation of the data available on the avifauna of the area, including the compilation of a list of species likely to occur in and around the site, a site visit, and an on-site assessment of the avifauna and habitats present, and a resulting assessment of the nature of likely impacts of the development on the most important avifauna, with recommendations on mitigation. The latter stage included a second assessment of impacts and mitigation for a revised project layout, proposed in response to development constraints arising from the EIA process.

Information gleaned from the review of the available published and unpublished literature pertaining to bird interactions with PV solar plants and associated power infrastructure was integrated into the ultimate assessment of the impacts of the proposed facility. An inclusive, annotated list of the avifauna likely to occur within the impact zone of the proposed PV plant was compiled using a combination of the existing distributional data - listed below - and previous experience of the avian habitats and avifauna of the general area, and a short-list of priority bird species (defined in terms of conservation status and endemism) which could be impacted by the proposed PV plant was derived from this inclusive list. These priority species were subsequently considered as adequate surrogates for the local avifauna generally, and mitigation of impacts on these species was considered likely to accommodate any less important bird populations that may also potentially be affected.

Figure 2.1a The two proposed layouts of roads and PV panels of the Olyven Kolk Solar Power Plant. Layout Alternative 1 comprises 190 MW of solar panels.

Figure 2.1b Layout Alternative 2 also comprises 190 MW of PV panels (brown shapes), but arranged to accommodate previously identified environmentally sensitive areas.

2.2 *SITE VISIT*

The proposed development area was visited on 30-31 May 2011 in order to:

(i) Ground-truth predicted habitats and birds present, mainly by visiting as much of the inclusive area of the proposed development as possible, with an emphasis on sampling the avifauna in all of the primary habitats available.

(ii) Compile Southern African Bird Atlas Project (SABAP) 2 atlas cards (bird lists) for all the pentads (5′ by 5′ squares) visited (http://sabap2.adu.org.za/index.php).

(iii) Search for large terrestrial species, raptors and endemic passerines within the study area to determine the relative importance and on-site distribution of local populations of these key taxa.

2.3 *IMPACT ASSESSMENT*

With the baseline information collected, the final assessment of impacts included:

(i) Identification of impacts and rating of significance in accordance with the impact assessment methodology provided by ERM for the initial proposal, Site Layout Alternative 1.

(ii) Identification of no-go zones and/or the least sensitive/lowest risk areas to locate solar panels within the broader study area. A mitigation workshop was held which resulted in changes of the site layout to accommodate for recommendations by the various specialists to avoid sensitive areas within the site. This resulted in Site Layout Alternative 2, the preferred and final site layout alternative.

(iii) Identification of impacts and rating of significance for Site Layout Alternative 2.

(iv) Recommendations on mitigation and monitoring where necessary.

2.4 *DATA SOURCES USED*

The following published and unpublished data sources were used:

(i) Bird distribution data of the Southern African Bird Atlas Project (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 squares covering the proposed solar energy facility and its associated infrastructure (2920BD Grootriet – 16 cards submitted over the atlas period, and 2920DB Sonderhuis – seven cards submitted, Total = 23 cards for the area, note that the SABAP 1 data are now >15 years old), and for the relevant SABAP 2 pentads (2925_2045 and 2930_2045 – no cards submitted so far for this area combined). A composite list of species likely to occur in the impact zone of the PV plant was drawn up as a combination of these data and the information sources listed below,

refined by a more specific assessment of the actual habitats affected and general knowledge of birds in the region (Appendix 1).

(ii) 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), informed by a more recent revision for raptors (Jenkins 2009), the most recent iteration of the global list of threatened species (http://www.iucnredlist.org), and the most up to date and comprehensive summary of southern African bird biology (Hockey *et al.* 2005).

(iii) Coordinated Avifaunal Roadcount (CAR) data for large terrestrial birds and Black Harrier, and Coordinated Wetland Avifaunal Count (CWAC) data for wetland species (both available from the Animal Demography Unit, UCT - http://adu.org.za/), and relevant published references (Taylor *et al.* 1999, Young *et al.* 2003).

(iv) Information on nesting raptors on the nearby Eskom 400 kV transmission lines from the Eskom Electric Eagle Project (Jenkins *et al.* 2007).

4. THE AFFECTED ENVIRONMENT

3.1 THE NATURAL ENVIRONMENT

The area is situated in the Bushmanland Bioregion of the Nama Karoo Biome. The vegetation is dominated by Bushmanland Basin Shrubland (Mucina & Rutherford 2006), with open, flat topography, sandy soils, and mainly grassy vegetation interspersed with low, drought resistant shrubs. Altitude averages about 930 m above sea level and varies little across the site. The area receives about 70 mm of rain annually, most of which falls in autumn. Temperatures range from a mean minimum in winter of about 3°C overnight, to a mean maximum in summer of about 33°C in the middle of the day.

3.2 THE ALTERED ENVIRONMENT

The site is evidently used for small stock (sheep, goats) farming, and is fenced into camps, with a small number of well-points. Apart from the open Karoo vegetation, the only major avian habitat on site is provided artificially by the Eskom Aries-Kronos and Aries-Helios 400 kV transmission lines.

Figure 4.1a & b *Typical flat, open Karoo vegetation on the proposed development site, with the 400 kV transmission lines in the background.*

Figure 4.1c *Martial Eagle nest on the Aries-Helios 400 kV transmission line.*

3.3 *AVIAN HABITATS*

The habitat on site from an avian perspective is relatively uniform, dominated by open, flat, sandy Karoo veld (Fig. 4.1a & b), with thicker, woody growth along the main drainage lines. The lattice-type steel pylons which support the Eskom transmission power lines provide nesting habitat for birds that would normally nest in trees (e.g. passerines, corvids, raptors), and for birds that normally use nests built by these tree-nesting species (e.g. falcons).

3.4 *THE AVIFAUNA*

More than 130 bird species could possibly occur on the site (Appendix 1), including up to 11 red-listed species, 56 endemics or near-endemics, and four red-listed endemics (Ludwig's Bustard *Neotis ludwigii*, Black Harrier *Circus maurus*, Red Lark *Calendulauda burra* and Sclater's Lark *Spizocorys sclateri*). The site is not located close to any established Important Bird Areas (Barnes 1998). Red-listed species recorded in atlas data (Harrison et al. 1997, (http://sabap2.adu.org.za/index.php) for the area include Kori Bustard *Ardeotis kori*, Ludwig's Bustard *Neotis ludwigii*, Lanner Falcon *Falco biarmicus* and Sclater's Lark *Spizocory's sclateri*, and a number of localised endemics also occur there (e.g. Black-eared Sparrowlark *Eremopterix australis*). The site falls within the documented range of the red-listed endemic Red Lark *Certhilauda burra*, but does not feature the red sand dunes generally favoured by this species. The Rooiberg Dam, which apparently sometimes supports numbers of flamingo, is located about 40 km to the north-east of the proposed development site.

Only eighteen species were seen in the broader impact zone during the site visit (Appendix 1). Significant observations included an adult Martial Eagle *Polemaetus bellicosus* perched near a nest in a transmission pylon on the western boundary of the development area (Fig. 4.1c, 4.2), and a pair of Lanner Falcons at an old Martial Eagle nest on a pylon just to the east of the site (Fig. 4.2). The former species is known to occupy a breeding territory approximately centred on the Aries substation, but has not generally been a productive territory, with breeding recorded only once in the period 2002-2006 (Jenkins *et al.* 2007). The presence of an adult eagle near a well built-up nest structure, and some fresh droppings or whitewash accumulated under the nest pylon (Aries-Helios tower 11) suggests that the site may well be active in 2011. Lanner Falcons do not build their own nests, and when they nest in trees or equivalent man-made structures they usually use stick nests built by other birds as platforms for breeding. The pair seen on site were focused on a second Martial Eagle structure on the Aries-Kronos line, and their behaviour suggested that they may well breed on this nest later in the year. A Kori Bustard power line collision victim was found under the Aries-Helios Power line. Regional endemic species, such as Northern Black Korhaan *Eupodotis afraoides* Karoo Korhaan *Eupodotis vigorsii* , Rufous-eared Warbler *Malcorus pectoralis* probably occur commonly on the site, although only the latter species was seen during the site visit.

The birds most likely to proliferate and become active around the facility, possibly causing fowling problems, could include Speckled Pigeon *Columba guinea*, Greater Kestrel *Falco rupicolus*, 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 variety of other perch-hunting hunting and insectivorous passerines.

On the basis of these observations, in combination with already documented information on the avifauna of the general area, nine priority species are recognized as key in the assessment of avian impacts of the proposed Olyven Kolk Solar Power Plant (Table 4.1). 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 – Martial Eagle, Secretarybird *Sagittarius serpentarius*, Greater Flamingo *Phoenicopterus ruber*, Lesser Flamingo *Phoenicopterus minor*, and Red Lark 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.

Figure 4.2 Distribution of raptor sites on Eskom transmission lines in relation to the broader development area for the proposed Olyven Kolk Solar Power Plant.

Table 3.1 Priority bird species considered central to the avian impact assessment process for the Olyven Kolk Solar Power Plant, 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* = 23 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	56.5	High	Open Karoo	High	-	Moderate
Kori Bustard	*Ardeotis kori*	Vulnerable	-	13.0	Moderate	Open Karoo	High	-	Moderate
Martial Eagle	*Polemaetus bellicosus*	Vulnerable (Near-threatened)	-	0.0	High	Open Karoo, power pylons	High	High	Moderate
Secretarybird	*Sagittarius serpentarius*	Near-threatened (Vulnerable)	-	0.0	Moderate	Open Karoo	High	-	Moderate
Lanner Falcon	*Falco biarmicus*	Near-threatened	-	8.7	Moderate	Open Karoo, power pylons	High	Moderate	-
Greater Flamingo	*Phoenicopterus ruber*	Near-threatened	-	0.0	Low	Wetlands, flying over	High	-	-
Lesser Flamingo	*Phoenicopterus minor*	Near-threatened	-	0.0	Low	Wetlands, flying over	High	-	-
Red Lark	*Calendulauda burra*	Vulnerable	Endemic	0.0	Low	Open Karoo	-	-	Moderate
Sclater's Lark	*Spizocorys sclateri*	Near-threatened	Endemic	4.3	Moderate	Open Karoo	-	-	Moderate

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

5. IMPACT ASSESSMENT

4.1 IMPACT DESCRIPTION

4.1.1 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. 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 the possible cumulative effects of multiple facilities in one area.

To a lesser extent, construction, ongoing maintenance and (if relevant) decommissioning 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.

4.1.2 Other effects

Any vertical, reflective surfaces may confuse approaching birds with the result that numbers are killed in collisions with such surfaces. If either of these sources of unnatural mortality are realistic expectations of a proposed solar power plant, efforts should be made to restrict access by birds into the relevant, hazardous areas of the facility.

Solar power plants generally feature large areas of reflective panelling. It is possible that nearby or overflying birds may be disorientated by any light reflected off the panels, 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, 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 arrays, other animals attracted to the facility). Such scenarios might be associated with fouling of critical components of the solar infrastructure, 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.

4.1.3 *Impacts of associated infrastructure*

Infrastructure commonly associated with wind energy facilities may also have detrimental effects on birds. The construction and maintenance 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).

4.1.4 *Construction and maintenance of power lines*

Some habitat destruction and alteration inevitably takes place during the construction of power lines 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).

4.1.5 *Collision with power lines*

Power lines pose at least an equally significant collision risk to wind turbines, probably affecting the same 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).

4.1.6 *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 energized 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).

4.2 IMPACTS OF THIS PROJECT

This proposal is for a medium-sized PV installation, sited in an area of homogeneous and not particularly bird-rich habitat (although levels of endemism are high), and distant from any established national Important Bird Area. The site is known to include at least two probable nesting sites of Red-listed species, and may (at least seasonally or sporadically) support numbers of other Red-listed species, and of a suite of localised endemics. The proposed solar power plant is likely to have a limited, detrimental effect on these birds, during both the construction and operational phases of the development, and to a lesser extent during decommissioning.

The taxa which are most likely to be affected are two raptor species (Martial Eagle and Lanner Falcon) which are resident and nesting on existing power transmission pylons within the proposed site. These birds (especially the eagles) will be significantly disturbed by the construction process, possibly to the extent of breeding failure or even territory abandonment. There will be very limited loss of habitat for threatened large terrestrial birds (Ludwig's Bustard, Kori Bustard), and an increased risk of collision for these birds on any new power lines installed. Ludwig's Bustard is prone to erratic influxes to areas of the Karoo, apparently in response to past rainfall, but these factors are not well understood (Allan 1994). Compounding this unpredictability, recent studies of power line collisions by this bird (Jenkins *et al.* 2009, Jenkins *et al.* 2011) have shown no detectable pattern in collisions in relation to landscape features. Hence, while bustards may well occur sporadically on the site in considerable numbers, it is not possible to predict when such influxes are most likely to happen, or where these birds will be most susceptible to collisions, precluding any useful input on where, and where not, to route new power lines.

Table 4.1 Impact characteristics: Olyven Kolk Solar Power Plant – 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, Lanner Falcon, Ludwig's Bustard, Kori Bustard, Karoo endemics. (ii) Martial Eagle, Lanner Falcon, Ludwig's Bustard, Kori Bustard, Karoo endemics.	(iii) All birds on site; key species: Martial Eagle, Lanner Falcon, Ludwig's Bustard, Kori Bustard, Karoo endemics. (i) All birds on site; Martial Eagle, Lanner Falcon, Ludwig's Bustard, Kori Bustard, overflying wetland birds.	(i) All birds on site; key species: Martial Eagle, Lanner Falcon, Ludwig's Bustard, Kori Bustard, Karoo endemics.

Hence, specific impacts of the proposed Olyven Kolk Solar Power Plant are most likely to be manifested in the following ways (summarised in Table 4.1):

(i) Disturbance and displacement of resident/breeding raptors (especially Martial Eagle and Lanner Falcon) from nesting and/or foraging areas by construction and/or operation and/or decommissioning of the facility, 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 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 facility, and /or mortality of these species in collisions with new power lines while commuting between resource areas.

(iii) Disturbance and displacement of resident/breeding Karoo endemics – possibly including Black-eared Sparrowlark, Sclater's Lark and even Red Lark - by construction and/or operation and/or decommissioning of the facility.

(iv) Injury or mortality of wetland birds (especially flamingos) using possible flight lines in and out of resource areas in the broader vicinity, in collisions with the PV infrastructure or associated new power lines.

4.2 IMPACT ASSESSMENT – ALTERNATIVE 1

As already discussed, the initial project (Layout Alternative 1 – 190 MW, Fig. 2.1a) was subject to a provisional impact assessment in terms of the anticipated impacts referred to above. Significance ratings for these impacts are detailed in Boxes 4.1-4.3.

In light of initial suggestions to mitigate these impacts (see below), the client re-designed the project, and a revised proposal (Layout Alternative 2 – 190 MW – Fig. 2.2b) was submitted for further evaluation and assessment.

Box 4.1 ***Construction Impact: Olyven Kolk Solar Power Plant – Birds (Layout Alternative 1)***

(A) Habitat loss

Nature: All construction activities would result in a **negative direct** impact on the avifauna of the Olyven Kolk site: loss of vegetation and habitat affecting Martial Eagle, Lanner Falcon, Ludwig's Bustard, Kori Bustard, Karoo endemics, through site clearance, road upgrade and establishment of the camp, lay-down and assembly areas..

Impact Magnitude – Low-Medium

- **Extent**: The extent of the impact is **local**.
- **Duration**: The duration would be **medium-term** as the ecology of the area would be altered beyond the completion of the project.
- **Intensity**: Loss of irreplaceable habitat for priority species will be minimal, so the magnitude of the change will be **low-medium**.

Likelihood – There is a **high** likelihood that some habitat will be lost.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MINOR-MODERATE

Degree of Confidence: The degree of confidence is **high**.

(B) Disturbance

Nature: All construction activities would result in a **negative direct** impact on the avifauna of the Olyven Kolk site; disturbance associated with noise and movement of construction equipment and personnel, affecting Martial Eagle, Lanner Falcon, Ludwig's Bustard, Kori Bustard, Karoo endemics.

Impact Magnitude – Medium-High

- **Extent**: The extent of the impact is **local**.
- **Duration**: The duration would be **short-term** as this effect will not extend beyond the life of the project.
- **Intensity**: Some threatened species will be severely disturbed, so the magnitude of the change will be **medium-high**.

Likelihood – There is a **high** likelihood that birds will be disturbed.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MODERATE-MAJOR

Degree of Confidence: The degree of confidence is **high**.

Box 4.2 ***Operation Impact: Olyven Kolk Solar Power Plant – Birds (Layout Alternative 1)***

(A) Habitat loss and disturbance

Nature: Operational activities would result in a **negative direct** impact on the avifauna of the Olyven Kolk site; loss of habitat for Martial Eagle, Lanner Falcon, Ludwig's Bustard, Kori Bustard, Karoo endemics, to space occupied by solar panels and associated infrastructure., and disturbance or displacement of these birds by routine maintenance activities.

Impact Magnitude – Medium

- **Extent**: The extent of the impact is **local**.
- **Duration**: The duration would be **long-term** as the ecology of the area would be affected until the project stops operating.
- **Intensity**: Some priority species may be displaced for the duration of the project, and there will be some loss of habitat, so the magnitude of the change will be **medium**.

Likelihood – There is a **high** likelihood that some priority species will be disturbed/displaced.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MODERATE

Degree of Confidence: The degree of confidence is **medium-high**.

(B) Mortality

Nature: Operational activities would result in a **negative direct** impact on the avifauna of the Olyven Kolk site; mortality of Martial Eagle, Lanner Falcon, Ludwig's Bustard, Kori Bustard, overflying wetland birds in collisions with solar panels and/or power lines, or by electrocution on new power infrastructure.

Impact Magnitude – Medium

- **Extent**: The extent of the impact is **local**.
- **Duration**: The duration would be **long-term** as the ecology of the area would be affected at least until the project stops operating.
- **Intensity**: Some of individuals of threatened species may be killed in collision/electrocution incidents, so the intensity of change will be **medium-high**.

Likelihood – There is a **medium** likelihood that some individuals of priority species will be killed.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MODERATE

Degree of Confidence: The degree of confidence is **medium**.

Box 4.3 ***Decommissioning Impact: Olyven Kolk Solar Power Plant – Birds (Layout Alternative 1)***

(A) Disturbance

Nature: All decommissioning activities would result in a **negative direct** impact on the avifauna of the Olyven Kolk site; disturbance associated with noise and movement of decommissioning equipment and personnel, affecting Martial Eagle, Lanner Falcon, Ludwig's Bustard, Kori Bustard, Karoo endemics.

Impact Magnitude – Medium-High

- **Extent**: The extent of the impact is **local**.
- **Duration**: The duration would be **short-term** as this effect will not extend beyond the life of the project.
- **Intensity**: Some threatened species will be severely disturbed, so the magnitude of the change will be **medium-high**.

Likelihood – There is a **high** likelihood that birds will be disturbed.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MODERATE-MAJOR

Degree of Confidence: The degree of confidence is **high**.

4.3 PROPOSED MITIGATION

Mitigation of impacts identified above will be best achieved in the following ways:

(i) Timing construction and decommissioning to avoid sensitive times (e.g. Martial Eagle pre-breeding, incubation and small nestling seasons from March/April to June/July).

(ii) Minimizing the disturbance impacts associated with the operation of the facility by scheduling maintenance activities to avoid disturbances at sensitive times (see above) or in sensitive areas (see below).

(iii) Excluding development from:

(a) Within a 1 km radius of the Martial Eagle nest site.

(b) Within a 500 m radius of the Lanner Falcon nest site.

Ideally, these areas should remain undisturbed and undeveloped. The radii referred to are working estimates, arrived at purely in terms of the author's experience of disturbance susceptibility of the two species concerned, and not in terms of any supporting empirical evidence.

(iv) Relocate both the eagle nest structures to more distant pylons (e.g. Jenkins *et al.* 2007) in order to put greater distance between those birds likely to use them and the disturbance sources of the development. This would have to be done outside of the eagle and falcon breeding seasons (i.e. between December/January and February/March, and would involve deconstructing both nests, re-building both in specially designed galvanized steel baskets, and positioning these in the 'waist' area of towers at least three spans (+/- 1 km) further away from the development area. Such an exercise would require the cooperation of Eskom, and the practical assistance of their live-line maintenance team and would require active supervision by an experienced avian specialist at all times. However, if successful it would greatly reduce the potential impact of the proposed solar development, and would have the added benefit of removing the two large eagle nest structures from locations above the conductors on VVV transmission towers (where they could cause streamer-related outages) to safe positions below the conductors. This would effectively improve Eskom's quality of supply to customers, and reduce associated maintenance costs (Jenkins *et al.* 2007). There is a good chance that both eagles and falcons will relocate to the new nest structures in the following breeding season, although this cannot be guaranteed.

(v) Minimizing the length of any new power lines installed, and ensuring that all new lines are marked with bird flight diverters – either static or dynamic markers, generally fitted to the upper, earth wire in most power line configurations (Jenkins *et al.* 2010), and that all new power 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.

(vi) Carefully monitoring the local avifauna pre- and post-construction (see Section 6 below), and implementing appropriate additional mitigation as and when significant changes are recorded in the number, distribution or breeding behaviour of any of the priority species listed in this report, or when collision or electrocution mortalities are recorded.

(vii) Ensuring that the results of pre-construction monitoring are applied to project-specific impact mitigation in a way that allows for the potential cumulative effects on the local/regional avifauna of any other solar energy projects proposed for this area. Viewed in isolation, each of these projects may pose

only a limited threat to the avifauna of the area. However, in combination they may result in significant losses of habitat for regionally important bird populations, and/or significant levels of mortality in these populations in collisions with new infrastructure.

4.4 FINAL IMPACT ASSESSMENT – LAYOUT ALTERNATIVE 2

Buffer or development exclusion zones for birds were partly accommodated in this new layout (with the nearest PV panels to either of the two nest sites extended to about 600-700 m - Fig. 4.1), which is effectively a partially mitigated version of Layout Alternative 1. While this allowance does not entirely rule out disturbance impacts on the birds at these nest sites, it is a meaningful step towards this end, substantially reducing the amount of construction and subsequent maintenance activity likely to occur close to either site.

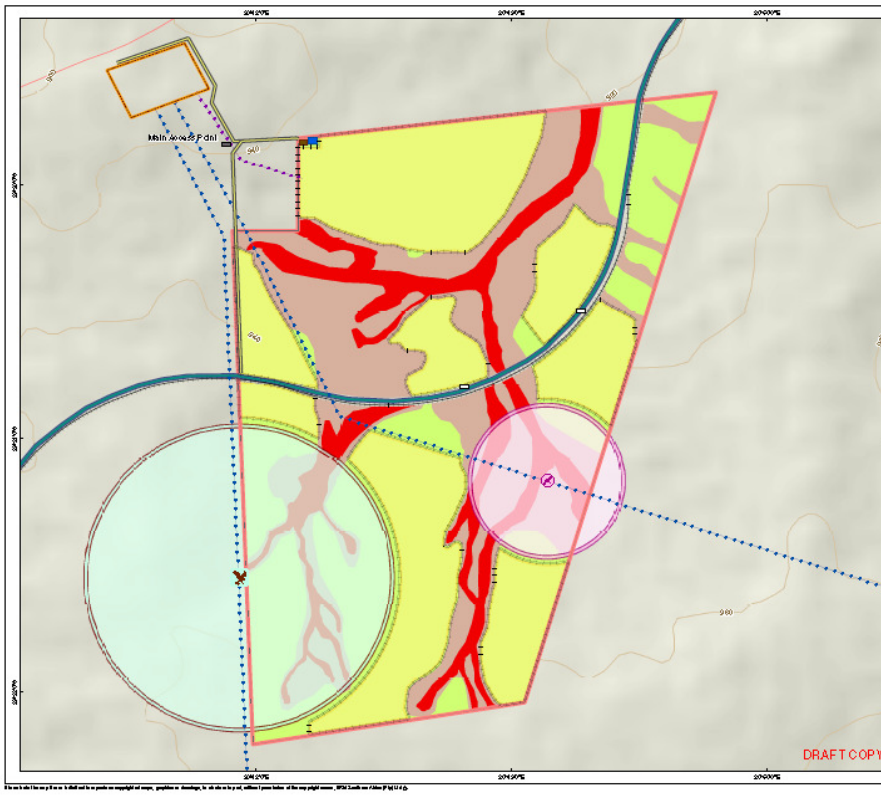

Figure 4.1 Constraints Map showing layout Alternative 2 for the Olyven Kolk Solar Power Plant, showing the four construction phases (including Phase 1 in pale blue, which is the subject of a separate EIA) and the allowances made for avian sensitivity buffers (above, red circles) and for all specialist inputs (below) delineated in an earlier draft of this report.

Figure 4.1 Constraints Map showing layout Alternative 2 for the Olyven Kolk Solar Power Plant, showing the allowances made for avian sensitivity buffers (circles) and for other specialist inputs delineated in an earlier draft of this report.

Table 4.1 Pre- and Post- Mitigation Significance: Olyven Kolk Solar Power Plant - Birds, (Layout Alternatives 1 and 2 - also refer to Boxes 4.1-4.3).

Impact	Layout 1	Layout 2	
	Pre-mitigation	Pre-mitigation	Residual (post-mitigation)
Construction Phase			
Habitat loss	**MINOR-MODERATE**	**MINOR**	**MINOR**
Disturbance	**MODERATE-MAJOR**	**MINOR-MODERATE**	**MINOR**
Operation Phase			
Displacement & disturbance	**MODERATE**	**MINOR-MODERATE**	**MINOR**
Mortality	**MODERATE**	**MODERATE**	**MINOR**
Decommissioning Phase			
Disturbance	**MODERATE-MAJOR**	**MINOR-MODERATE**	**MINOR**

The redesign of Layout Alternative 1 lowered initial, pre-mitigation impacts from up to Moderate-Major to a maximum of Moderate. If the remaining mitigation recommendations are applied, including an attempt to relocate these two nest sites to nest platforms situated well away from the proposed development area, the residual impacts of Layout Alternative 2 will be reduced to Minor across all phases of the development (Table 5.2).

6. MONITORING

Given that solar energy development is new to South Africa, and its potential impacts on birds are generally not well understood, it is recommended that attention be given to improving this understanding by initiating quantitative studies of the avifauna at proposed sites both pre- and post-construction. The primary aims of this 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) Document patterns of bird activity and movements in the vicinity of the proposed solar power plant before construction, and afterwards, once the plant is operational.

(iii) Register and as far as possible document the circumstances surrounding all avian mortalities associated with the solar power plant and its ancillary infrastructure for at least a full calendar year after the plant becomes operational.

(iv) 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 a full calendar year 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 (see Table 4.1). 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. It will also establish a precedent and a template for research and monitoring of avian impacts at possible, future solar power plant sites in the region.

Failing the institution of a structured and formalised general monitoring effort (as outlined above and detailed below), at the very least a specialist ornithologist should periodically monitor activities at both of the key raptor nests, immediately preceding, during and after construction.

Monitoring protocols: Avian densities before and after

A set of at least 10 walk-transect routes, each of at least 250 m in length, should be established in areas representative of all the avian habitats present within a 2 km radius of centre of the Olyven Kolk 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, 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: Bird activity monitoring

Monitoring of bird activity in the vicinity of the solar power plant should be done over a single day at least every two months for the six months preceding construction, and at least once per quarter for a full calendar year starting at least six months after the solar power plant is commissioned. Each monitoring period should involve full-day counts of all species flying over or past the PV plant impact area (see passage rates below).

Monitoring protocols: Bird flight behavior and activities around solar arrays

Counts of bird traffic over and around the proposed/operational solar power plant should be conducted from suitable vantage points (selected and used to provide coverage of avian flights in relation to all areas of the PV plant). Once in position at the selected count station, the observer should record (preferably on a specially designed data sheet) the date, count number, start-time and conditions at start - extent of cloud cover, temperature, wind velocity and visibility – and proceed with the count. The counts should detail all individuals or flocks of the stipulated priority bird species, all raptors, and any additional species of particular interest or conservation concern, seen flying within 200 m of the envisaged or actual periphery of the solar power plant. Each record should include the following data: time, updated weather assessment, species, number, mode of flight (flapping, gliding, soaring), flight activity (commuting, hunting other), direction of flight and, for post construction monitoring, notes on any obvious evasive behaviour or flight path changes observed in response to the solar power plant. The time and weather conditions should again be noted at the end of each count. These observations should also detail (time, species, nature, location, duration) all direct interactions between birds and the solar panels (e.g. perching, hunting, displaying, nest-building).

Monitoring of avian collisions

Collision monitoring should have two components: (i) experimental assessment of search efficiency and scavenging rates of bird carcasses on the site, and (ii) regular searches of the vicinity of the solar power plant for collision casualties.

Monitoring of avian collisions: Assessing search efficiency and scavenging rates

The value of surveying the area for collision victims only holds if some measure of the accuracy of the survey method is developed (Morrison 2002). To do this, a sample of suitable bird carcasses (of similar size and colour to the priority species – e.g. Egyptian Goose *Alopochen aegyptiacus*, domestic waterfowl and pigeons) should be obtained and distributed randomly around the site without the knowledge of the surveyor, some time before the site is surveyed. This process should be repeated opportunistically (as and when suitable bird carcasses become available) for the first two months of the monitoring period, with the total number of carcasses not less than 10. The proportion of the carcasses located in surveys will indicate the relative efficiency of the survey method.

Simultaneous to this process, the condition and presence of all the carcasses positioned on the site should be monitored throughout the initial two-month period, to determine the rates at which carcassess are scavenged from the area, or decay to the point that they are no longer obvious to the surveyor. This should provide an indication of scavenge rate that should inform subsequent survey work for collision

victims, particularly in terms of the frequency of surveys required to maximize survey efficiency and/or the extent to which estimates of collision frequency should be adjusted to account for scavenge rate (Osborn *et al.* 2000, Morrison 2002). Scavenger numbers and activity in the area may vary seasonally so, ideally, scavenge and decomposition rates should be measured twice during the monitoring year, once in winter and once in summer.

Monitoring of collisions: Collision victim surveys

The area within a radius of at least 20 m of each solar panel, the area on and under the panel itself, and 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 conducted in the initial stages of the monitoring period (see above), but they should be done at least weekly for the first two months of the study. 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 surveys should also include detailing (location, extent, size, number) of all bird products (e.g. faeces, pellets, nest structures etc) found on the solar panels.

7. CONCLUSIONS

Provided that there is good compliance with the mitigation stipulations listed above, and particularly if the suggested monitoring protocols are instituted, and any further mitigation requirements identified by that monitoring work are applied wherever possible post-construction, this development should be sustainable in terms of all anticipated impacts on avifauna.

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Appendix 1. Annotated list of the bird species considered likely to occur within the impact zone of the proposed Olyven Kolk PV plant (species in bold were seen during the April site visit).

Common name	Scientific name	Conservation status	Regional endemism	Habitat			Risk of		
				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Collision	Electro-cution	Disturbance / habitat loss
Egyptian Goose	*Alopochen aegyptiaca*	-	-			X	High	High	-
South African Shelduck	*Tadorna cana*	-	Endemic			X	High	-	-
Yellow-billed Duck	*Anas undulata*	-	-			X	Moderate	-	-
Acacia Pied Barbet	*Tricholaema leucomelas*	-	Near-endemic		X		-	-	Moderate
African Hoopoe	*Upupa africana*	-	-	X			-	-	Moderate
Common Scimitarbill	*Rhinopomastus cyanomelas*	-	-	X			-	-	Moderate
Swallow-tailed Bee-eater	*Merops hirundineus*	-	-	X	X	X	-	-	Moderate
European Bee-eater	*Merops apiaster*	-	-				-	-	-
White-backed Mousebird	*Colius colius*	-	Endemic		X		-	-	Moderate
Red-faced Mousebird	*Urocolius indicus*	-	-		X		-	-	Moderate
Alpine Swift	*Tachymarptis melba*	-	-				-	-	-
Common Swift	*Apus apus*	-	-				-	-	-

Common name	Scientific name	Conservation status	Regional endemism	Habitat			Risk of		
				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Collision	Electro-cution	Disturbance / habitat loss
Little Swift	*Apus affinis*	-	-				-	-	-
Bradfield's Swift	*Apus bradfieldi*	-	Near-endemic	X			-	-	-
White-rumped Swift	*Apus caffer*	-	-				-	-	-
Barn Owl	*Tyto alba*	-	-	X	X		-	Moderate	Moderate
Spotted Eagle-Owl	*Bubo africanus*	-	-	X	X		-	High	Moderate
Rufous-cheeked Nightjar	*Caprimulgus rufigena*	-	-	X			-	-	Moderate
Rock Dove	*Columba livia*	-	-				-	-	Moderate
Speckled Pigeon	*Columba guinea*	-	-				-	-	Moderate
Laughing Dove	*Streptopelia senegalensis*	-	-		X		-	-	Moderate
Cape Turtle-Dove	*Streptopelia capicola*	-	-		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
Northern Black Korhaan	*Afrotis afraoides*	-	Endemic	X			Moderate	-	Moderate
Karoo Korhaan	*Eupodotis vigorsii*	-	Endemic	X			Moderate	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat			Risk of		
				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Collision	Electro-cution	Disturbance / habitat loss
Red-knobbed Coot	*Fulica cristata*	-	-			X	-	-	-
Namaqua Sandgrouse	*Pterocles namaqua*	-	Near-endemic	X		X	-	-	-
Spotted Thick-knee	*Burhinus capensis*	-	-	X	X		-	-	-
Black-winged Stilt	*Himantopus himantopus*	-	-			X	-	-	-
Pied Avocet	*Recurvirostra avosetta*	-	-			X	-	-	-
Kittlitz's Plover	*Charadrius pecuarius*	-	-			X	-	-	-
Three-banded Plover	*Charadrius tricollaris*	-	-			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			-	-	-
Black-shouldered Kite	*Elanus caeruleus*	-	-	X	X		-	-	Moderate
Black-chested Snake-Eagle	*Circaetus pectoralis*	-	-				-	Moderate	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat			Risk of		
				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Collision	Electro-cution	Disturbance / habitat loss
Black Harrier	*Circus maurus*	Near-threatened	Endemic	X		X	-	-	Moderate
Southern Pale Chanting Goshawk	*Melierax canorus*	-	Near-endemic	X	X		-	Moderate	Moderate
Steppe Buzzard	*Buteo vulpinus*	-	-	X			-	Moderate	Moderate
Jackal Buzzard	*Buteo rufofuscus*	-	Endemic	X			-	Moderate	Moderate
Verreaux's Eagle	*Aquila verreauxii*	-	-				Moderate	High	Moderate
Booted Eagle	*Aquila pennatus*	-	-				-	-	Moderate
Martial Eagle	***Polemaetus bellicosus***	**Vulnerable**	**-**				**Moderate**	**High**	**Moderate**
Secretarybird	*Sagittarius serpentarius*	Near-threatened	-	X			High	-	Moderate
Pygmy Falcon	*Polihierax semitorquatus*	-	-	X	X		-	-	Moderate
Lesser Kestrel	*Falco naumanni*	Vulnerable	-	X	X		Moderate	-	Moderate
Rock Kestrel	*Falco rupicolus*	-	-	X			-	-	Moderate
Greater Kestrel	***Falco rupicoloides***	**-**	**-**	**X**			**-**	**-**	**Moderate**
Lanner Falcon	***Falco biarmicus***	**Near-threatened**	**-**	**X**			**High**	**Moderate**	**-**
Little Grebe	*Tachybaptus ruficollis*	-	-			X	-	-	-
Reed Cormorant	*Phalacrocorax africanus*	-	-			X	-	-	-

Common name	Scientific name	Conservation status	Regional endemism	Habitat			Risk of		
				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Collision	Electro-cution	Disturbance / habitat loss
White-breasted Cormorant	*Phalacrocorax lucidus*	-	-			X	Moderate	-	-
Black-headed Heron	*Ardea melanocephala*	-	-	X		X	Moderate	Moderate	-
Greater Flamingo	*Phoenicopterus ruber*	Near-threatened	-				High	-	-
Lesser Flamingo	*Phoenicopterus minor*	Near-threatened	-				High	-	-
African Spoonbill	*Platalea alba*	-	-			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**		**-**	**-**	**Moderate**
Common Fiscal	***Lanius collaris***	**-**	**-**	**X**	**X**		**-**	**-**	**Moderate**
Cape Penduline-Tit	*Anthoscopus minutus*	-	Near-endemic	X			-	-	Moderate
Ashy Tit	*Parus cinerascens*	-	Near-endemic	X			-	-	Moderate
Brown-throated Martin	*Riparia paludicola*	-	-			X	-	-	Moderate
Barn Swallow	*Hirundo rustica*	-	-			X	-	-	Moderate
Greater Striped Swallow	*Hirundo cucullata*	-	-			X	-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat			Risk of		
				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Collision	Electro-cution	Disturbance / habitat loss
South African Cliff Swallow	*Hirundo spilodera*	-	Breeding endemic	X			-	-	Moderate
Rock Martin	***Hirundo fuligula***	**-**	**-**			**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
Karoo Eremomela	*Eremomela gregalis*	-	Endemic	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
Desert Cisticola	*Cisticola aridulus*	-	-			X	-	-	Moderate
Black-chested Prinia	***Prinia flavicans***	**-**	**-**		**X**		**-**	**-**	**Moderate**

Common name	Scientific name	Conservation status	Regional endemism	Habitat			Risk of		
				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Collision	Electro-cution	Disturbance / habitat loss
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**
Red Lark	*Calendulauda burra*	Vulnerable	Endemic	X			-	-	Moderate
Spike-heeled Lark	*Chersomanes albofasciata*	-	-	X			-	-	Moderate
Karoo Long-billed Lark	*Certhilauda subcoronata*	-	Endemic	X			-	-	Moderate
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*	-	Near-endemic	X			-	-	Moderate
Sclater's Lark	*Spizocorys sclateri*	Near-threatened	Endemic	X			-	-	Moderate
Large-billed Lark	***Galerida magnirostris***	**-**	**Endemic**	**X**			**-**	**-**	**Moderate**

Common name	Scientific name	Conservation status	Regional endemism	Habitat			Risk of		
				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Collision	Electro-cution	Disturbance / habitat loss
Chat Flycatcher	***Bradornis infuscatus***	**-**	**Near-endemic**	**X**			**-**	**-**	**Moderate**
Fiscal Flycatcher	*Sigelus silens*	-	Endemic		X		-	-	Moderate
Karoo Scrub-Robin	***Cercotrichas coryphoeus***	**-**	**Endemic**	**X**	**X**		**-**	**-**	**Moderate**
Mountain Wheatear	*Oenanthe monticola*	-	Near-endemic	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				-	-	Moderate
Pied Starling	*Spreo bicolor*	-	Endemic				-	-	Moderate
Wattled Starling	*Creatophora cinerea*	-	-	X	X		-	-	Moderate
Southern Double-collared Sunbird	*Cinnyris chalybeus*	-	Endemic		X		-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Habitat			Risk of		
				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Collision	Electro-cution	Disturbance / habitat loss
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			-	-	Moderate
Southern Masked-Weaver	*Ploceus velatus*	-	-		X	X	-	-	Moderate
Red-billed Quelea	*Quelea quelea*	-	-	X	X	X	-	-	Moderate
Southern Red Bishop	*Euplectes orix*	-	-			X	-	-	Moderate
African Quailfinch	*Ortygospiza atricollis*	-	-	X			-	-	Moderate
Red-headed Finch	*Amadina erythrocephala*	-	Near-endemic	X	X		-	-	Moderate
Common Waxbill	*Estrilda astrild*	-	-			X	-	-	Moderate
Pin-tailed Whydah	*Vidua macroura*	-	-		X		-	-	Moderate
House Sparrow	*Passer domesticus*	-	-	X	X		-	-	Moderate
Cape Sparrow	***Passer melanurus***	**-**	**Near-endemic**	**X**	**X**		**-**	**-**	**Moderate**

Common name	Scientific name	Conservation status	Regional endemism	Habitat			Risk of		
				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Collision	Electro-cution	Disturbance / habitat loss
Cape Wagtail	*Motacilla capensis*	-	-			X	-	-	Moderate
African Pipit	*Anthus cinnamomeus*	-	-				-	-	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