

Avifaunal Impact Assessment

for the construction of the Doringberg Photovoltaic (PV)
Facility near Prieska: Basic Assessment



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(see Appendices C, D & E, page 210 onwards)

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COVER PAGE:

Ludwig's Bustard *Neotis ludwigii* flushed in the proposed development footprint.

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Glossary of terms, abbreviations & acronyms

AEWA The African-Eurasian Waterbird Agreement (see page 50).

AIA Avifaunal Impact Assessment.

AIA PPR WEF Avifaunal Impact Assessment for the The Prieska Power Reserve Wind Energy Facility conducted by Van Rooyen & Froneman (2023a).

ASA PPR WEF Avifaunal Screening Assessment for the The Prieska Power Reserve Wind Energy Facility conducted by Van Rooyen & Froneman (2023b).

ASSV Avifauna Site Sensitivity Verification.

Broader Study Area: The spatial extent of avifaunal surveys and data collection, encompassing all areas where fieldwork was conducted, up to a maximum radius of 25 km from the Doringberg PV footprint, with the majority of effort and records concentrated within approximately 17 km of the footprint.

CMS Convention on the Conservation of Migratory Species of Wild Animals (see page 49).

Cumulative impact The impact of an activity that in itself may not be significant, but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area (National Environmental Management Act (Act No. 107 of 1998), Environmental Impact Assessment Regulations 2014).

Disturbance Refers to any action by humans which deprives a bird species of its habitat. This includes the physical destruction or alteration of habitat in a way that causes displacement, as well as disturbance which have a negative impact on breeding success. In general this type of disturbance is primarily associated with the construction phase of the project.

Escarpment A long cliff or steep slope separating two comparatively level or more gently sloping surfaces and resulting from erosion or faulting (<https://www.merriam-webster.com/dictionary/escarpment>).

EIA Environmental Impact Assessment.

Gorge A narrow passage through land especially: a narrow steep-walled canyon or part of a canyon (<https://www.merriam-webster.com/dictionary/gorge>).

ha Hectare.

kV Kilovolt = 1 000 volts.

mamsl Metres above mean sea level

NEST National Environmental Screening Tool (<https://screening.environment.gov.za/screeningtool>).

ORSF1 Orange River Solar Facility 1

PAOI Project Area of Influence; see page 35.

Plateau A usually extensive land area having a relatively level surface raised sharply above adjacent land on at least one side (<https://www.merriam-webster.com/dictionary/plateau>).

POPA Pragmatic Operational Project Area. Term adopted in this avifaunal assessment in place of the conventional Project Area of Influence (PAOI); see Section 4.2 on page 35. The POPA is a pragmatic, operational project area drawn to guide fieldwork planning, resource allocation and impact scoping. It does not imply that the development's ecological effects cease at this boundary; actual influences — particularly for wide-ranging avifauna — may extend further into the surrounding landscape.

PPR WEF Prieska Power Reserve Wind Energy Facility.

Pragmatic Operational Project Area See POPA above.

PV Photovoltaic.

PV2 Doringberg PV Solar Facility

Pylon A structure that supports a power line.

Raptor MOU CMS Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia (see page 50).

Resident: Any bird species, including migrant and nomadic taxa, utilising the indicated area at least once a week for an extended period of time (a month or more).

SCC: Species of conservation concern.

Study Area: The spatial extent of avifaunal surveys and data collection, encompassing all areas where fieldwork was conducted, up to a maximum radius of 25 km from the Doringberg PV footprint, with the majority of effort and records concentrated within approximately 17 km of the footprint. It includes the Pragmatic Operational Project Area (POPA) and the the broader study area.

Surface water: Any physical feature on the Earth's surface that involves water, whether natural or man-made, temporary or permanent.

Swale A low-lying or depressed and often wet stretch of land (<https://www.merriam-webster.com/dictionary/swale>).

Toeslope The outermost, lowermost segment of a hillslope profile, typically characterized as a gently inclined (often linear or slightly concave) surface at the base of a slope (Ruhe 1960).

Valley An elongated depression of the earth's surface usually between ranges of hills or mountains (<https://www.merriam-webster.com/dictionary/valley>).

Waterbird All species associated with aquatic habitats as per Harrison *et al.* (1994).

Executive summary

Prieska Power Reserve (Pty) Ltd (PPR) proposes the development of a renewable energy hub at Prieska, Northern Cape, South Africa. The development will consist of a network of solar and wind energy facilities that will provide power for the production of renewable hydrogen and ammonia from water and air. The project will be implemented in phases. The focus of this avifaunal impact assessment is on the proposed Prieska Power Reserve, Doringberg PV facility (PV2), situated on the farm Karabee 3/50 approximately 16 km south of the Prieska CBD. The PV solar field (77.7 ha) will consist of an array of fixed tilt solar panels. The generative capacity may be up to 77.7 MW.

This assessment considers only the PV facility itself, as the associated power line infrastructure has already been addressed in previous studies relating to the project's wind electricity generation turbines and infrastructure (Van Rooyen & Froneman 2023a), as well as the Prieska Power Reserve PV Plant Phase 1 (PV1) and its associated infrastructure (Van Niekerk 2021; Van Rooyen & Froneman 2022).

The impact of utility-scale PV facilities on birds

A review of the literature highlights the following:

- Building a utility-scale PV facility can alter the habitat enough to cause changes in the bird community composition.
- PV facilities are known to cause fatalities among birds via collision trauma. One of the possible mechanisms involve the glare, in combination with other characteristics, of PV panels which is interpreted by birds as coming from water; this hypothesis still needs to be tested experimentally.
- Our knowledge on the impact of utility-scale PV facilities on birds is incomplete and destined to be so for the foreseeable future, given the difficulty of adequately conducting bird mortality rate studies.

Receiving environment

In this avifaunal assessment, the term **Pragmatic Operational Project Area (POPA)** is adopted instead of the conventional PAOI. The POPA is a pragmatic, operational project area to guide fieldwork planning, resource allocation, and impact scoping. It does not imply that the development's ecological effects cease at this line; actual influences — particularly for wide-ranging avifauna — may extend further into the surrounding landscape. The POPA for the PV2 facility encompasses the Doringberg range between the Burchell–Cuprum 132 kV power line in the north-west and Keikamspoort in the south-east, which constitutes the core breeding area of Verreaux's Eagle *Aquila verreauxii* — a Species of Conservation Concern

(SCC) — within the Doringberg range (Fig. 4). Adjacent toeslopes up to 7 km from the footprint are also included in the POPA. The area outside the POPA constitutes the broader study area (up to 25 km from the footprint), and collectively they are referred to as the study area.

The topography of the Doringberg mountain system in the POPA is characterised by a broad summit plateau dissected by several large valleys and gorges. This dissection has fragmented the plateau into multiple plateau remnants—relatively flat, elevated areas that are either fully isolated or connected. These remnants are bounded by steep escarpments, valleys, and gorges, forming distinct topographic compartments within the larger plateau landscape. Where the mountain system opens into expansive lowlands, the toeslopes (the predominantly linear or slightly concave basal zone) typically extends for several kilometres, forming a broad, gently sloping apron. The vegetation in the PV2 footprint is dominated by shrubs and dwarf shrubs. The PV2 footprint is located in a mosaic of ecological support areas and other natural areas.

Study approach & methods

This assessment is based partly on four site visits and a literature survey. More details can be found in the main report.

Avifauna

The distributions of 276 bird species overlap with the PV2 study area:

- **Species of Conservation Concern (SCC; n = 33):** The PV2 footprint forms part of the territory of at least one Karoo Korhaan R235 (Near Threatened) pair. The Ludwig's Bustard R232 (Endangered) is a regular visitor to the plateaus and in particular the footprint. Within the Doringberg range, the PV2 footprint is located in the midst of the core breeding area for the Verreaux's Eagle R131 (Vulnerable), with 29 known nests in the POPA between 0.9 and 5.8 km from the footprint. The Lanner Falcon R172 (Near Threatened) may breed in the POPA. A Cape Vulture R122 (Vulnerable) was once seen in flight over a valley adjacent to the footprint. Tawny Eagle R132, Martial Eagle R140 (both Endangered) and Kori Bustard R230 (Near Threatened) were seen on toeslopes outside the POPA. The Critically Endangered White-backed Vulture R123 and Lappet-faced Vulture R124 are both known to roost on pylons approximately 25 km south-west of the POPA. Of the 23 SCC not recorded in the study area, the most likely ones to visit it is the Black Stork R084 and Secretarybird R118. 21 SCC also appear in CMS lists A1, W, R1 & R2.
- **Endemic Species (n = 25):** Only the Karoo Korhaan R235 and Karoo Scrub Robin R614 are residents in the PV2 footprint. The Jackal Buzzard R152 is a resident in the POPA that occasionally hunt over plateaus. The Grey Tit R551, Fairy Flycatcher R706, and African Rock Pipit R721 occur only in valleys where they are presumed to be resident.

The Black-headed Canary R876 was recorded as a nomadic temporary resident that was only recorded on the plateaus. Single records of Cape Vulture R122 and Southern Double-collared Sunbird R783 suggest that they are irregular visitors in the POPA. All three the endemic CMS species are also SCC, appearing in CMS lists A1, A2, R1, and W. Only the Cape Vulture R122 was recorded during the surveys.

- **Other Species** (n = 276): The PV2 footprint is utilised by a large number of avifaunal species. At least 30 species regularly utilise the footprint, at least for feeding. A further nine species occur as occasional visitors, while 12 aerial insectivores may forage over the plateau. In addition, 27 species are expected to pass over the footprint with little or no feeding activity. Collectively these species include only five CMS species.

Impact assessment and mitigation

A separate section is dedicated to sensitive areas, and each development phase (construction, operational & decommissioning). In each, potential impacts are first investigated and summarise, followed by an overview of the species involved, and an assessment of impact significance for each of the following three categories:

- **Biological Significance:** “An impact is significant if it results in a change that is measurable in a statistically sound sampling program and if it persists, or is expected to persist, more than several years at the population, community, or ecosystem level.”
- **Public Significance:** “... a change or impact in agreement with societal norms. Put another way, an "unacceptable" impact in some way flaunts the public's (or portion thereof) system of values.” The PV2 footprint lies on private land and is not accessible to the public. While limited views of the northern portion may be possible from certain points along the N10 road (located ~6.5 km to the north-east), the distance and intervening topography render any visibility minimal and constrained, such that construction activities and operational bird interactions are expected to be barely noticeable and unlikely to elicit meaningful public concern.
- **Legal Significance:** This refers to the acknowledgement of the importance of environmental resources in government policy, law or plans. It is also called wildlife policy. The impact on SCC and Convention on the Conservation of Migratory Species of Wild Animals (CMS) species were specifically assessed for this category.

After assessing impact significance, including cumulative impact, mitigation and its effect on impact significance was considered.

Sensitive areas

The following sensitive area were identified:

- **Surface Water.** Birds readily exploit accessible water for drinking and bathing. This

heightened activity increases the likelihood of collisions with project-related structures. A natural depression is situated approximately 50 m outside the western boundary of the PV2 footprint, receiving drainage from the central-western portion of the footprint.

- **Mitigation:** It is recommended that a **150 m no-go buffer** be established around the depression and its associated trees and bushes. This will effectively minimise collision risk and disturbance to birds utilising the water source.
- **Nesting Sites:** A 1 km all-infrastructure exclusion buffer is recommended around all nests of Verreaux's Eagle R131 (SCC: Vulnerable), Booted Eagle R136 (CMS:A2,R3), Lanner Falcon R172 (SCC: Near Threatened; CMS:R2), and Rock Kestrel R181 (CMS:R3).

Construction phase

The construction phase will be of relatively short duration. Negative impacts are primarily associated with disturbance and displacement of birds in the affected area.

- **Impact Significance:**
 - **Biological Significance:** None.
 - **Legal Significance:**
 - * **SCC:** Nest destruction is a possibility, but will have minimal impact on the local population.
 - * **CMS Species:** Nest destruction is a possibility, but will have minimal impact on the local population.
- **Mitigation:**
 - The recommended mitigation can reduce the risk significantly.

Operational phase

The operational phase of the PV2 facility will likely be several decades.

- **Positive impacts:** The PV arrays and fencing are likely to be utilised by a variety of bird species for perching, shade, breeding, *etc.*
- **Collisions:** The limited information available suggests that collision-related fatalities involving PV structures is likely to occur, but it is not yet possible to accurately predict which species will be most affected by this.
 - **Impact Significance:**
 - * **Biological Significance:** Indeterminate.

- **Mitigation:** It is recommended that the Bird Monitoring Program detailed in Appendix B be implemented.
- **Entrapment:** Medium- to large-bodied birds can become entrapped in fencing that is not sufficiently spaced to allow them to fully open their wings or manoeuvre out once caught. This can result in injury, stress, predation while trapped, or death from exhaustion, dehydration, or hyperthermia.
 - **Impact Significance:**
 - * **Biological Significance:** None.
 - * **Legal Significance:**
 - **SCC:** Nest destruction is a possibility, but will have minimal impact on the local population.
 - **CMS Species:** Many species of conservation concern and CMS species are potentially exposed to entrapment between two fences. Impact may be very significant.
 - **Mitigation:** To eliminate or substantially reduce this risk, avoid double-fence designs wherever possible.
- **Miscellaneous:** The potential impacts and mitigation options of roads, fences, vegetation management, surface water and ecological light pollution is considered.

Decommissioning phase

The decommissioning phase will be of short duration.

- Decommissioning activities could cause disturbance and possibly displacement of birds in the surrounding area.
- A direct impact during the decommissioning phase will be the destruction of any nests on the infrastructure at the time.
- Removal of PV2 infrastructure implies elimination of collision and other hazards directly associated with it.
- **Impact Significance:**
 - **Biological Significance:** None
 - **Legal Significance:** Unless there is a species of conservation concern or CMS species breeding somewhere in the PV2 facility during the decommissioning phase, legal significance will be very low.
- **Mitigation:** The suggested mitigation can reduce impact significance to minimal levels.

Cumulative Impacts

Cumulative impacts on avifauna were evaluated in the context of the authorised PPR Wind Energy Facility and other regional developments. While the authorised PPR WEF represents the dominant source of potential collision risk for species such as Verreaux's Eagle, the incremental contribution of the proposed Doringberg Solar PV facility is rated as low, primarily through additional habitat transformation and disturbance.

Conclusions

The findings of this avifaunal impact assessment indicate that the proposed Doringberg Solar PV facility is associated with low to moderate negative impacts on avifauna, primarily related to habitat transformation and disturbance. With the effective implementation of the recommended avoidance, mitigation, and monitoring measures, these impacts can be reduced to acceptable levels. In the cumulative context, the incremental contribution of the PV project to regional avifaunal impacts (when considered alongside the authorised PPR Wind WEF) is rated as low.

It is the reasoned opinion of the specialist that the proposed development should be authorised, subject to the inclusion of all recommended mitigation measures and monitoring requirements. No fatal flaws from an avifaunal perspective were identified.

1. Introduction

Prieska Power Reserve (Pty) Ltd (PPR) proposes the development of a renewable energy hub at Prieska, Northern Cape, South Africa. The development will consist of a network of solar and wind energy facilities that will provide power for the production of renewable hydrogen and ammonia from water and air. The project will be implemented in phases. The focus of this avifaunal impact assessment is on the proposed Prieska Power Reserve, Doringberg PV facility (PV2), situated on the farm Karabee 3/50 approximately 16 km south of the Prieska CBD (Figures 1–5, pages 161–165).

This assessment considers only the PV facility itself, as the associated power line infrastructure has already been addressed in previous studies relating to the project's wind electricity generation turbines and infrastructure (Van Rooyen & Froneman 2023a), as well as the Prieska Power Reserve PV Plant Phase 1 (PV1) and its associated infrastructure (Van Niekerk 2021; Van Rooyen & Froneman 2022).

After outlining the project infrastructure and terms of reference, Section 2 examines the impact of PV facilities on birds. Subsequent sections describe the receiving environment (Section 3) and the study approach and methods (Section 4). Section 5 introduces the study's primary subjects: 33 Species of Conservation Concern (SCC), three endemic and 22 near endemic species (including five also listed as SCC), and 224 other bird species recorded in this part of South Africa. Section 6 addresses sensitive areas. The following three sections evaluate impacts, and review and recommend mitigation measures for the construction phase (Section 7), operational phase (Section 8), and decommissioning phase (Section 9). Cumulative impacts are considered in Section 10. The report concludes with the final thoughts in Section 11.

1.1. Planned infrastructure

The proposed development will entail the construction of the following based on information available in November 2025:

- PV solar field (77.7 ha) consisting of an array of fixed tilt solar panels. The generative capacity may be up to 77.7 MW.

1.2. Terms of reference

The terms of reference for the Avifaunal Impact Assessment were as follow:

- Desktop study;
- Site survey;
- Review of literature;
- Identification of high-risk species, particularly SCC and other priority species that might be impacted by the proposed development;

- Description and assessment of the significance of likely impacts on priority avifauna; and
- Recommend mitigation measures to reduce the envisaged impacts.

2. The impact of utility-scale PV facilities on birds

Based on their size and location, solar energy installations can be generally divided into two categories: distributed-scale and utility-scale (Hernandez *et al.* 2014). Distributed-scale PV systems are relatively small in capacity (<1 megawatt (MW)) and are often integrated into the built environment, *e.g.*, on the rooftop of houses. In contrast, utility-scale PV facilities have relatively high capacity (typically >1 MW) and are typically located outside of population centres. The focus of this Section is exclusively on utility-scale PV facilities. Henceforth all references to “PV facility” implies utility-scale installations.

A utility-scale solar energy development can affect bird communities in various ways. Two aspects merit separate consideration: the solar field and associated infrastructure, and the power evacuation system. The latter was assessed by Van Rooyen & Froneman (2023a) and is not addressed here except in the context of cumulative impacts. Instead, this report focuses on the solar field and its associated infrastructure, with this section providing an overview of bird interactions with these types of components specific to the PV2 study area, based on publicly available English documents. Assessments of PV2’s potential impacts on birds, along with proposed mitigation measures, will be presented later (see page 81 onward).

2.1. Habitat alteration

2.1.1. Vegetation management

Vegetation management activities during the construction phase of PV installations could destroy active nesting sites, leading to the displacement of resident species and potential breeding failures. At the same time, these activities may unearth prey items like insect larvae or small invertebrates, drawing opportunistic feeders such as insectivorous birds to the site, temporarily boosting local activity even as habitats are disrupted. Once the PV facility enters its operational phase, ongoing vegetation management beneath the arrays may be necessary to maintain safe clearance space, ensure adequate access for inspection, maintenance, and repair, and reduce flammable plant material that could fuel wildfires—practices critical to both safety and efficiency. These efforts can further alter habitats, potentially reducing cover or food availability for resident species while introducing periodic disturbances that unsettle established populations.

2.1.2. PV panel arrays

The development of a PV facility typically entails the transformation of a relatively large track of habitat into a ‘forest’ of PV arrays (Fig. 6, page 166). Depending on the habitat, the initial vegetation management could entail a radical transformation of the environment. The impact of such habitat changes is likely to vary by species, influenced by the original habitat conditions, degree of modification, and other related factors (see, for example, Anderson 1979; King *et al.* 2009). Towards the one extreme, certain species may vacate the area, while others could colonise the newly created habitat. The outcome could be a new (relative to the original status quo) community (*e.g.* Visser 2016), including altered predator-prey relationships (*e.g.* DeGregorio *et al.* 2014).

Removal of native vegetation or the increase in the amount of impervious surfaces in a watershed significantly changes how the watershed functions (Ross *et al.* 2023). Unlike trees in a natural forest, PV panels are completely impervious to water. Consequently, rainwater falling on the panel does not directly reach the ground beneath it. Instead, it flows off from the panel’s lowest edge. The kinetic energy of water draining from a solar panel is much greater than that of rainfall and can cause erosion at the base of the PV panel (Cook & McCuen 2013). The resulting concentrated flow of water also greatly increases runoff (Baiaamonte *et al.* 2023). Either of these processes can increase the chances of soil erosion.

2.1.3. Roads

Even in situations where the installation and operation of PV panel arrays does not require the direct disturbance of vegetation, installation and maintenance of the arrays is likely to require a road network. Roads are known to have various negative impacts on the environment (for reviews, see Forman & Alexander 1998; Trombulak & Frissell 2000). Its construction may cause disturbance or destruction of active nesting sites. Dust mobilised and spread by road traffic could potentially have a negative impact on nearby plants (Trombulak & Frissell 2000). In addition, dust settling on solar energy collectors or reflectors can impact the efficiency of these systems (Lovich & Ennen 2011). Roads can also change the habitat in ways that could render it unsuitable for resident species. On the other hand, some bird species are attracted to it, which is a double edge sword since this may also place them on a collision course with the vehicles using it. For example, Visser *et al.* (2019) found a dead Crowned Lapwing R255 on the approach road to a PV solar facility.

Once in place, a road can change the routing of shallow groundwater and surface flow in ways that may trigger erosion (Forman & Alexander 1998; Trombulak & Frissell 2000). It can also provide optimal habitat for invasive/exotic plant species (Forman & Alexander 1998; Kuvlesky *et al.* 2007; Trombulak & Frissell 2000). These, in turn, may provide suitable habitat for birds and their prey. Moisture and sediment deposits from road drainage may also benefit patches of local plants (Forman & Alexander 1998), which is likely to foster habitats where insects to flourish, no doubt to be exploited by their many avian nemeses.

2.1.4. Fencing

Security fencing around solar energy facilities could present a collision risk for some bird species (Baines & Andrew 2003; Baines & Summers 1997; Cornwell & Hochbaum 1971; RSPB 2011; D. J. van Niekerk, personal observations). In addition, fence systems could entrap larger birds. For example, Visser *et al.* (2019) found a dead Orange River Francolin R193 that apparently got trapped between the inner electric fence and the outer ribbon mesh, while three Red-crested Korhaans R237 were unable to escape from between the two fences without the help of facility personnel. By monitoring the occurrence of these incidents it may be possible to pinpoint problem areas and devise effective mitigation strategies. On the flip side, some species may find fences suitable for perching or breeding.

2.2. PV-related fatalities

Building on the collision-causal web concept introduced by Van Niekerk (2024), Van Niekerk 2025 generalised this framework into an unnatural-fatality-causal web. The central idea is that behind any fatal incident lies a complex web of contributing factors, the disentanglement of which is often hindered by incomplete knowledge of the factors themselves, their interactions, and the broader web. Effective fatality risk assessment requires a thorough understanding these causal webs. In the sections below, we explore potential components of unnatural-fatality-causal webs relevant to PV installations.

Two primary bird fatality types occur at operational solar facilities: collisions with project structures and deaths from solar flu exposure (Walston *et al.* 2015; Fig. 7, page 167). Since solar-flu-related fatalities are observed only at facilities employing Concentrated Solar Power (CSP) towers, they are irrelevant to the PV2 project and will not be considered further. However, collision-related fatalities have been documented across all solar technology types (Kagan *et al.* 2014; Walston *et al.* 2015).

2.2.1. Who

Data from a PV solar installation in southern California (Kagan *et al.* 2014) showed that avian fatalities span a wide range of bird species—large to small, aerial, terrestrial and aquatic feeders, resident and migrant, nocturnal and diurnal—suggesting that most bird species are, in principle, susceptible to collisions with PV installations.

2.2.2. Where

While the factors driving bird fatalities at PV installations remain poorly understood, valuable lessons can be drawn from the extensive research on power line collisions. Studies of power lines highlight the importance of proximity to bird congregation sites and flight paths—such as those between roosting and feeding areas—as key considerations in routing

decisions, given that these zones are frequent sites of collision incidents (Andriushchenko & Popenko 2012; Avian Power Line Interaction Committee (APLIC) 2012; Brown *et al.* 1987; Crivelli *et al.* 1988; Faanes 1987; Henderson *et al.* 1996; Prinsen *et al.* 2011). For example, in agricultural fields used as feeding areas, collision problems may develop when birds have to make daily, low-altitude flights to and from the fields across power lines (Avian Power Line Interaction Committee (APLIC) 1994; Brown & Drewien 1995). Human disturbance of birds near power lines could also increase collision risk (Avian Power Line Interaction Committee (APLIC) 1994; James & Haak 1979; Murphy *et al.* 2009; Thompson 1978). These type of factors are potentially also applicable to PV installations. For example, Kagan *et al.* (2014) found that waterbirds were well represented among the fatalities at a PV installation where there was also open water within the facility and in adjacent areas (see Figure 1-1 in Kalish 2011). Below, we expand on the potential issues related to surface water, as well as lighting.

2.2.2.1. Surface water

Birds exhibit varying degrees of reliance on water, shaped by their ecological niches and behavioural adaptations. It ranges from species that don't need to drink water at all (*e.g.*, some larks derive their hydration from the food they consume) to those that are totally reliant on water for their entire life-cycle (*e.g.*, grebes). Most bird species do need to drink water daily.

Surface water frequently serves as an attractant for a diverse array of fauna, resulting in elevated concentrations of wildlife, most notably avian species. Consequently, the existence of surface water within a given locale typically correlates with heightened bird activity. Avian populations are known to utilise both ephemeral and perennial water sources, consistently returning to these sites provided they remain viable. This increased avian movement to and from such water bodies may, in turn, elevate the potential for collisions with infrastructure associated with development projects in the vicinity.

2.2.2.2. Lighting

Ecological light pollution (ELP) “includes chronic or periodically increased illumination, unexpected changes in illumination, and direct glare” (Longcore & Rich 2004). The impact of ELP on birds and other animals has been reviewed in recent years (Bruce-White & Shardlow 2011; Longcore & Rich 2004; Navara & Nelson 2007). Among its many impacts on birds and other animals (see Bruce-White & Shardlow 2011; Longcore & Rich 2004; Navara & Nelson 2007; Perry *et al.* 2008) we will here focus on only two aspects. Firstly, security lighting often attracts insects, which can easily serve as food for birds and other predators (Frank 1988). This may become an attractant for birds and may possibly lead to collisions with project infrastructure. Secondly, nocturnal migrating birds can get entrapped by artificial light and may then collide with structures close to the light source, die of exhaustion, or be exposed to an increased risk of predation (Ogden 1996). It is agreed with The Royal Commission on Environmental Pollution (2009) that, while further research is evidently needed, the information

at hand justify concern regarding the potential adverse ecological impact of ELP.

2.2.3. Why: Polarized light?

In natural environments polarized light arises from two main sources, namely the *scattering* of sunlight within the atmosphere and hydrosphere, and the *reflection* of light by water surfaces and other shiny, non-metallic, dielectric surfaces such as soil, rocks and vegetation (Wehner 2001). Experimental evidence for polarised light sensitivity in birds has to date been restricted to cue-calibration experiments with migratory species which points to the use of polarised light from scattered sunlight, particularly around sunrise and sunset, as cues for orientation during migration (Muheim 2011; Muheim *et al.* 2006; Muheim *et al.* 2009). However, these experiments test behavioural consequences of altering the polarisation pattern of the environment rather than directly investigating polarisation vision *per se* (Greenwood *et al.* 2003). Consequently, the behavioural and physiological mechanism for polarised light reception in birds remains one of the big mysteries in sensory biology (Muheim 2011).

Even though it has been speculated that polarisation sensitivity may assist waterbirds in detecting water (*e.g.* Greenwood *et al.* 2003), virtually nothing is actually known about the water detection mechanism in birds (Bernáth *et al.* 2001). What we do know is that birds looking for water can confuse other entities for it. Experimental work involving the use of plastic sheets indicates that the optical cues associated with certain non-water materials can be so strong that a bird looking for water can become visually compelled to linger in the immediate vicinity of the non-water material, even attempting to drink it, in spite of the fact that the bird's other senses signal that it is not water (Bernáth & Horváth 1999; Bernáth *et al.* 2001). This may help explain the occurrence of avifaunal stranding/injury/fatality incidents—often involving waterbirds—at open crude oil surfaces (Bernáth *et al.* 2001; Pilcher & Sexton 1993), asphalt roads and parking lots (Horváth *et al.* 2009; Kriska *et al.* 2008), and PV facilities (Kagan *et al.* 2014; RSPB 2011; Walston *et al.* 2015). In the latter case it is of particular interest to note that the glare from a 25-degree fixed-tilt flat-plate polycrystalline PV system has been determined to be comparable to that of a smooth water surface (Riley & Olson 2011; See also Plante *et al.* 2010). Assuming that this is typical for crystalline PV systems, it is suggested that it may be an important piece in the puzzle of explaining why birds are attracted to these unnatural structures. Specifically, it is hypothesised that under certain circumstance glare in combination with other characteristics of PV panels can present birds with optical cues sufficiently strong to cause the birds to regard the panels as water, similar to the reaction of certain species—ranging in size from swallows and martins to the cisticolas—towards dry plastic sheets as described by Bernáth *et al.* (2001). Although oil, asphalt, and PV surfaces (see below) all reflect polarised light, it is not yet known if the birds attracted to these surfaces are able to detect polarised light directly (Bernáth *et al.* 2001).

In contrast to birds, polarise light sensitivity in insects is much better characterised and understood (for reviews, see Homberg *et al.* 2011; Horváth & Kriska 2008; Krapp 2007; Labhart & Meyer 1999). Of particular interest here is flying insects associated with water bodies;

it has been determined that they use horizontally polarized light reflected from water surfaces to detect water (Schwind 1995; Schwind 1991). Unfortunately, this also renders them vulnerable to polarized light pollution—PLP, referring predominantly to highly and horizontally polarised light reflected from artificial surfaces—which frequently leads to reproductive failure (*e.g.* when the insects lay their eggs on the artificial polarizer) and/or death (*e.g.* as a result of dehydration and exhaustion) (Horváth *et al.* 2009). Sources of PLP include oil surfaces, horizontal black plastic sheets, asphalt roads, red or black car-bodies, and black gravestones (reviewed by Horváth & Kriska 2008). PLP is also produced by vertical black glass surfaces (Kriska *et al.* 2008; Malik *et al.* 2008) and, most importantly, PV solar panels (Blahó *et al.* 2012; Horváth *et al.* 2010); neither the tilt-angle nor height of these panels is likely to change the PLP profile of the PV panels (Horváth *et al.* 2010).

One negative consequences of PLP for polarotactic insects—those lured by horizontally polarized light—is that PLP surfaces concentrate these attracted insects in exposed locations, making them vulnerable to predation (Horváth *et al.* 2009). Examples of bird predation include: Ground-foraging birds, such as Common Greenshank R270, Yellow Wagtail *Motacilla flava* and White Wagtail *Motacilla alba*, have been shown to prey on polarotactic insects drawn to highly polarizing black plastic sheets laid on the ground, while aerial feeders, like swallows, target those above (Bernáth *et al.* 2008; Bernáth *et al.* 2001). Similarly, A White Wagtails and House Sparrows R801 have been observed feeding on caddisflies attracted to vertical glass surfaces (Horváth *et al.* 2009). Additionally, A Hamerkop R081 was seen consuming unidentified (likely polarotactic) insects on an asphalt road in rainy weather (D. J. van Niekerk, personal observations). Consequently, since PV panels also attract polarotactic insects (Horváth *et al.* 2010), they are likely to draw birds to PV facilities, potentially increasing the birds' risk of colliding with related infrastructure.

Although the effect of PLP on insect populations is still unknown, there is some speculation that this could cause rapid and potentially large population declines in these insects, especially when the PV units are located near aquatic habitats (Horváth *et al.* 2010). Therefore, birds may *initially* benefit from the relatively higher polarotactic insect densities around PV installations, but this food source may not be sustainable. It may also have a negative impact on bird species where such insects form an important part of their diet (RSPB 2011). It has been suggested that PLP should become a focus for conservation biologists and resource managers alike as it can trigger maladaptive behaviours in polarotactic taxa (*e.g.* many aquatic insects) and alter ecological interactions (Horváth *et al.* 2009).

In summary, operational PV facilities are known to cause bird fatalities (Walston *et al.* 2015). One possible mechanism involves the glare from PV panels, alongside other traits, which birds may mistake for a wetland—a hypothesis yet to be experimentally tested. Additionally, polarised light is well-known to attract polarotactic insects, potentially drawing birds to PV sites and increasing their collision risk with infrastructure.

2.2.4. Mortality rates

One of the most fundamental requirements for predicting mortality risk, which is a requisite to mitigation, is accurate mortality rates estimation (Thompson 1978). Loss *et al.* (2014) correctly notes that for the mortality rate estimation, the “most useful data will be collected in prospective studies that base sampling on randomization and replication, that sample all groups of birds, and that sample during all months of the year.”

Overhead power lines have been in use since the 1880s (Guarnieri 2013; Nichols 2003). By that time it was already well established that birds collide with overhead telegraph wires (Coues 1876), which has been in use since 1844 (Shaffner 1867). According to Manville (2005), the first recorded instance involving power lines was in 1904 (Emerson 1904). More than a century later, a comprehensive review of the literature for bird collision and electrocution mortality at power lines failed to find any mortality rate estimate study that fulfilled the aforementioned standards (Loss *et al.* 2014). What about utility-scale PV installations?

The 1839 discovery of the photovoltaic (PV) effect by French physicist Alexandre Edmond Becquerel (1820-1891) (Becquerel 1839) predates the use of both overhead telegraph wires (since 1844; Shaffner 1867) and power lines (since 1880s; Guarnieri 2013; Nichols 2003). Even so, the first utility-scale PV systems was only installed in 1982, in the USA (California; Berman 1986) and Europe (Switzerland; Realini *et al.* 2001). South Africa followed decades later.

In a move anticipated in the 1998 White Paper on the energy policy of South Africa (Department of Minerals & Energy 1998), Cabinet in 2003 approved the participation of the private-sector in the electricity industry, with a decision being made that future power generation capacity should be divided between Eskom (70%) and Independent Power Producers, or IPPs (30%) (Department of Energy 2003; see also Department of Energy 2011a). Subsequently the Department of Energy announced the Renewable Energy Independent Power Producer Program (REIPPP) in 2011, involving 3 725 MW (Department of Energy 2011b) to be allotted to IPPs according to a procurement program which is well underway (see www.ipprenewables.co.za). On 10 December 2012, a sod-turning ceremony inaugurating the Solar Capital De Aar PV Project marked the launch of the first official REIPPP project (Peters 2012). Today, 12 years later, there are 45 operational PV facilities in South Africa, 28 (58.3%) of which are located in the Northern Cape while other provinces have less than six each (www.ipp-projects.co.za).

The results from studies at some operational solar facilities in South Africa are starting to trickle in, but accurate determination of mortality rates remains a significant issue (Jeal 2017; Van Heerden 2020; Visser 2016). Consequently, the cumulative impact of renewable energy facilities has yet to be quantified.

2.2.4.1. It's no easy task

Estimating bird mortality rates is fraught with challenges, beyond just the general ignorance of randomisation and replication's importance in research (Bauernfeind 1968; Carver 1993; Johnson 1999, 2002a,b). Numerous factors hinder collecting the “most useful data”, including the daunting sample size, methodological, logistical, manpower, time, and financial demands these types of studies require. For instance, Thompson (1978) highlights the time dimension, noting that the most severe bird kills from collisions with overhead wires are often catastrophic and erratic—unpredictable outcomes of the chance juxtaposition of specific circumstances (see also Brown & Drewien 1995). This unpredictability led Thompson (1978) to argue that ‘specific mortality rates cannot be quantified, except after many decades of exhaustive study.’ The same principle likely holds for PV-related fatalities, complicating efforts to pin down reliable estimates.

Obtaining unbiased estimates of bird mortality through ground searches is no easy task. Given any facility where birds are injured (fatally or otherwise), a ground search will typically not detect all the victims in the searched area. The main reasons for this well-known phenomenon are that at the time of a carcass search, collision victims are either present but overlooked by the observer (detection bias, *e.g.* Bernardino *et al.* 2022; Howe & Atwater 1999; Kerlinger 2000; Kerlinger & Curry 2000; Ponce *et al.* 2010; Smallwood 2007; Strickland *et al.* 2000; Strickland *et al.* 2001; Visser *et al.* 2019), or were injured and moved outside the search zone (crippling bias, *e.g.* Bech *et al.* 2012; Murphy *et al.* 2016), or scavengers consumed them (scavenger bias, *e.g.* Balcomb 1986; Bernardino *et al.* 2022; Borner *et al.* 2017; Costantini *et al.* 2017; Crawford & Engstrom 2001; Hager *et al.* 2012; Higgins *et al.* 1995; Howe & Atwater 1999; Kerns 2005; Ponce *et al.* 2010; Prosser *et al.* 2008; Smallwood 2007; Strickland *et al.* 2000; Strickland *et al.* 2001; Visser *et al.* 2019; Winkelman 1992; Wobeser & Wobeser 1992).

Therefore, in order to obtain an accurate estimate of fatality rates, the result of carcass searches—conducted frequently at each site, possibly as frequent as more than once every seven days (Borner *et al.* 2017; Costantini *et al.* 2017; Erickson *et al.* 2014; Pain 1991; Ponce *et al.* 2010; Smallwood 2007; Van Niekerk 2012; Visser *et al.* 2019)—must be adjusted by correction factors based on observer efficiency and scavenging rate studies (Borner *et al.* 2017; Huso 2011; Korner-Nievergelt *et al.* 2011; Loss *et al.* 2014; Morrison 2002; Murphy *et al.* 2016; Ponce *et al.* 2010; Wobeser & Wobeser 1992), as well as 24-hour monitoring to assess crippling bias (Murphy *et al.* 2016). Site-specific, seasonal and vegetation factors all influence these studies (Anderson *et al.* 2000; Bernardino *et al.* 2022; Higgins *et al.* 1995; Smallwood 2007; Smallwood 2013; Strickland *et al.* 2001; Visser *et al.* 2019). Therefore, separate field trails necessary to determine these correction factors should be conducted concurrently with carcass searches, separately for each site and habitat, and repeated several times each year to account for seasonal factors (Morrison 2002; Smallwood 2007).

Furthermore, larger carcasses are more detectable by a human observers than smaller carcasses, and smaller carcasses tend to be removed more readily by scavengers (Smallwood 2007; Visser *et al.* 2019). Therefore, each field trail will require bird carcasses of differ-

ent sizes. In addition, limited studies have shown that using surrogate species for those killed at infrastructure may give misleading results for search detection and scavenger removal trials (Smallwood 2007). Also, scavengers remove fresh carcasses sooner than frozen/thawed carcasses (Kerns 2005). Therefore, carcasses used in trails should be representative of the species actually occurring in the area, and must be fresh in the case of scavenger removal trials (Smallwood 2007).

A further difficulty is determination of the *cause* of death. Visser *et al.* (2019), for example, found it “impossible to infer cause of death” for any of the carcasses found underneath solar panel units.

2.2.4.2. Is it practicable?

There are at least three reasons why accurate determination of fatality rates as outlined above may not be practicable for any given project.

Firstly, obtaining a sufficient number of fresh carcasses for each species group and each field trail is problematic. There is a practical difficulty in acquiring the relevant specimens when needed. In addition, the studies may require more birds than would otherwise be affected by the facility/infrastructure itself, which could be challenging to justify, especially if it involves SCC.

Secondly, because an accurate assessment of collision rates requires a frequent fieldwork schedule, likely involving several fieldworkers over an extended period to account for seasonal and inter-annual variation, the implied time, human resources and financial requirements are likely to be prohibitive. Regarding the assessment of observer efficiency and scavenging rates, there is a limit to the number of carcasses that one can deploy at a time (Smallwood 2007). Consequently, one set of trails is likely to span several weeks. In practice, and regardless of all these requirements, financial constraints will always play an important role when defining the actual research effort (Bernardino *et al.* 2013).

Thirdly, even if one manages to resolve the two points mentioned above, one still must deal with various other methodological issues that may lead to unreliable results. For example, the reliability of observer bias estimates may be questionable if the type and state of carcasses used in the tests reflect different characteristics to those of corpses typically found under normal circumstances. Observers aware of test conditions are also likely to increase their vigilance relative to routine monitoring searches (Visser *et al.* 2019). Another example, a critical (often unstated) assumption, is that the presence of the observer(s) in the area, and the handling of carcasses, does not influence scavenging rates.

2.2.4.3. Something is better than nothing

Without correction for searcher bias, carcass removal bias, *etc.*, one is unlikely to obtain an accurate estimate of fatality rates. However, that does not render carcass searches without these details worthless, as some seem to imply (*e.g.* Jenkins *et al.* 2017). The reality is that

opportunistically collected data, often involving single incidents, is responsible for much of what we know today about, for example, bird fatalities at power lines (Bevanger 1994; Jenkins *et al.* 2010; Lehman *et al.* 2007).

Until studies collecting the “most useful data” becomes more common, the words of Coues (1876) will loom large over any study aiming to quantify bird fatalities: “My observations [of dead birds below telegraph wire] do not enable me to form even an approximate estimate of the annual mortality, and I suppose we shall never possess accurate data”.

3. General description of the receiving environment

From its source in the highlands of Lesotho, the Orange River flows westwards, forming the southern border of the Free State (Fig. 1). Shortly after entering the Northern Cape, the Vaal River joins it from the east, near Douglas. From Douglas the Orange River flows in a south-westerly direction, reaching its most southerly point in the Northern Cape at Prieska, which is located approximately 630 km, as the crow flies, from the Orange River’s ultimate destination, the Atlantic Ocean at Alexander Bay in the west (Fig. 1).

Prieska is located on the southern bank of the Orange River at approximately 920 metres above mean sea level (Fig. 3). Irrigated fields are located along the Orange River from Prieska eastwards (Fig. 3). To the south of Prieska is mountainous terrain dominated by the Doringberg range which runs from the north-west to south-east. The proposed PV2 development will be located on a plateau approximately 16 kilometres south of Prieska (Fig. 3).

3.1. Topography

The Doringberg mountain system in the Pragmatic Operational Project Area (POPA; see Section 4.2 on page 35) south of Prieska is characterised by a broad summit plateau dissected by several large valleys and gorges (Fig. 4). This dissection has fragmented the plateau into multiple plateau remnants—relatively flat, elevated areas that are either fully isolated or connected. These remnants are bounded by steep escarpments, valleys, and gorges, forming distinct topographic compartments within the larger plateau landscape. Where the mountain system opens into expansive lowlands, the toeslope (the predominantly linear or slightly concave basal zone) typically extends for several kilometres, forming a broad, gently sloping apron.

3.1.1. Plateau remnants

The sections below describes the relevant plateau remnants on which more detailed bird observations were conducted (see Section 4, page 34 *ff.*). Henceforth, each plateau remnant will be referred to simply as a plateau.

3.1.1.1. Plateau DPV

The footprint of the PV2 (measuring 1.9 km from north to south and is about 0.7 km at its widest point) is located on one of the plateaus, which will be referred to as **Plateau DPV**, abbreviated **P0** (Fig. 4; Fig. 5; Fig. 8, Page 168).

- The PV footprint part of the plateau will be referred to **Plateau DPVfp (P0fp)**. The altitude of the footprint range from approximately 1 330 mamsl in the south to 1 305 mamsl in the north (Fig. 9, page 169). Water drains radially from this plateau in all directions, with no prominent drainage lines within the development footprint itself (Fig. 5). Subsequent runoff drains into surrounding main drainage systems via geological features of variable morphology, many of which exhibit significant longitudinal variation within individual systems. For example, these may commence as slight depressions or gentle swales in headwater zones (on the plateau margins) before transitioning downslope to steep-sided, narrowly incised channels with prominent side walls, influenced by local geology, slope aspect, and erosion processes (Fig. 10, page 170). There is one notable exception, namely drainage in the central-west of the footprint, which ends up in a natural depression located approximately 50 m outside the footprint (Fig. 5; Fig. 11, page 171).
- Observations were also specifically conducted on the northern part of Plateau DPV, which will be referred to as **Plateau DPVn (P0n)**, on the farms Karabee 4/50 and 8/50. It is gently sloping with water runoff draining into surrounding main drainage systems via geological features of variable morphology, similar to Plateau DPVfp.

3.1.1.2. Plateau North 1

Located north-west from Plateau DPV, **Plateau North 1 (P1)** measures more than 5 km from north to south and is less than 2 km wide (Fig. 4). Although it is more extensive than Plateau DPV, its topography is similar (Fig. 4; Fig. 12, page 172).

3.1.1.3. Plateau North 2

Located north-west from Plateau North 1, **Plateau North 2 (P2)** measures about 3 km from north to south and is less than 2 km wide (Fig. 4). Topography is generally similar to that of Plateau DPV (Fig. 4).

3.1.2. Valleys

Each of the main drainage systems bordering the plateaus consists of a mixture of valley- and gorge-like elements along their courses. For the sake of simplicity, we will refer to each main drainage system as simply a valley in the following descriptions of a selection of valleys.

3.1.2.1. Valley East 1 (VE1; Oskloof):

Originating just east of the southern point of the PV2 footprint, this valley is located to the east of the footprint (Fig. 5; Fig. 13, page 173). It is a relatively open valley approximately 5 km long (Fig. 5), with only minor side branches and several rocky features along its rim (Fig. 13). On its western rim are a few prominent drainage systems that receive water from the PV2 footprint (Fig. 5; Fig. 10).

3.1.2.2. Valley North 1 (VN1; Boskloof):

Flanked by Plateaus North1 and North 2, this valley originates approximately 1 km west of the northern part of the PV2 footprint, from where it runs north-east for approximately 3 km (Fig. 4; Fig. 5). It is a relatively narrow valley with many steep rocky sidewalls (Fig. 14). It has several sizeable side branches, with the ones on its eastern rim receiving water from the footprint (Fig. 5).

3.1.2.3. Valley North 2 (VN2; T'Keikamspoort):

Situated between Plateaus North 1 and North 2, this valley originates approximately 2.6 km north-west of the PV2 footprint, from where it runs north-east for approximately 4 km (Fig. 4; Fig. 5; Fig. 15, page 175). It is a relatively narrow valley with many steep rocky sidewalls, and a few sizeable side branches which receive water from adjacent plateaus (Fig. 4; Fig. 15).

3.1.2.4. Valley South 1 (VS1):

The valley head is located approximately 500 m west of the southern part of the PV2 footprint, from where it runs south-east for approximately 6.8 km. The valley is relatively open with many prominent cliffs and other rocky features along its rim. The top part of this valley receives water from the footprint.

3.1.2.5. Valley South 1b (VS1b):

This major side branch of Valley South 1 originates approximately 400 m south-east of the PV2 footprint from where it runs south for approximately 2.4 km before joining the main valley. The valley is relatively narrow at first and opens up further down. Prominent cliffs and other rocky features dominates the rim.

3.1.2.6. Valley West 1 (VW1):

The valley head is located approximately 2 km west of the northern part of the PV2 footprint, from where it runs south-east initially before turning south just over 1 km from the footprint (Fig. 4; Fig. 8). Its total length is approximately 2.2 km. The upper (northern) part of the valley is relatively steep and narrow with many rocky features, while the lower (southern) part is more open, featuring steep rocky sides on the west and several major side branches

entering from the east (some of which receive water from the footprint) (Fig. 4; Fig. 5; Fig. 8). These side branches also exhibit prominent rocky features.

3.1.3. Toeslopes

Ruhe (1960) defined the five principal hillslope profile elements (as reviewed and illustrated by Wysocki *et al.* 2011; See Figure 19, page 179):

- Summit: the relatively level, uppermost portion of the hillslope profile, typically stable with minimal erosion or deposition.
- Shoulder: the convex transition zone immediately below the summit, where slope gradient increases and erosion often predominates.
- Backslope: the steepest, more linear segment of the hillslope, characterized by active erosion and sediment transport.
- Footslope: the concave lower portion, where deposition begins to dominate as slope gradient decreases.
- Toeslope: the predominantly linear or slightly concave basal zone below the footslope, often subject to alluvial or colluvial accumulation and influenced by adjacent floodplains or valleys.

The area immediately below the Doringberg mountains and downstream from the outlets of the main valleys forms toeslopes (Fig. 16, page 176; Fig. 17, page 177). From the footprint, the nearest adjacent toeslope is located less than 1.5 km to the south-west, starting at about 1 160 mamsl (Fig. 4; Fig. 17). This consists of gently inclined piedmont-like surfaces, with scattered rocky outcrops, colluvial deposits, and diffuse ephemeral drainage lines that spread laterally before converging (Fig. 16; Fig. 17). Man-made impound is constructed in some of these systems (Fig. 17; Fig. 18, page 178).

In the study area, the Doringberg watershed is complex, with initial drainage in the toeslopes dispersing in various directions across individual systems. Most drainage lines eventually converge and reach the Orange River. A notable exception is the system originating at Valley West 1 (Fig. 8, page 8), which drains southwards and terminates in a non-perennial pan 7 km south of the PV2 footprint (Fig. 4).

3.2. Vegetation

This section is based on the vegetation classification of Mucina & Rutherford (2006) (see Figures 1 & 2). The proposed PV2 is located in **Lower Gariep Broken Veld**, embedded within or transitioning to **Bushmanland Arid Grassland**, both within the Bushmanland Bioregion located of the Nama-Karoo Biome.

3.2.1. Lower Gariep Broken Veld

The Lower Gariep Broken Veld, classified as Least Threatened, is a distinctive arid ecosystem occurring mainly along and near the lower reaches of the Orange River, from Onseepkrans in the west to Prieska in the east (Mucina *et al.* 2006). Vegetation and landscape features includes hills and low mountains, slightly irregular plains, and some rugged terrain (e.g. downstream of the Augrabies Falls), with sparse vegetation dominated by shrubs and dwarf shrubs. Annuals are conspicuous, especially in spring, together with perennial grasses and herbs. Groups of widely scattered low trees occur, such as *Aloe dichotoma* var. *dichotoma* on rocky slopes and *Senegalia mellifera* on sandy soils of toeslopes.

In the Prieska area, this vegetation type manifests as hills and low mountains, often with sizeable summit plateaus, such as the one on which the proposed PV2 site is situated (Fig. 3; Fig. 4). The vegetation in the PV2 footprint is dominated by shrubs and dwarf shrubs (Fig. 20, page 180).

3.2.2. Bushmanland Arid Grassland

In the Prieska area, the Lower Gariep Broken Veld is largely enveloped by the Bushmanland Arid Grassland vegetation type (Fig. 2). This unit covers a substantial area (approximately 41 085 km²), extending from around Aggeneys in the west to Prieska in the east, and occurs predominantly south of the Orange River (Mucina *et al.* 2006). A defining characteristic of Bushmanland Arid Grassland is its sparse cover of grassland dominated by white grasses (*Stipagrostis* spp. and related species) (Mucina *et al.* 2006). However, much of the landscape is now a mosaic of vegetation types, ranging from typical arid grassland to areas dominated by *Senegalia mellifera* woodland, *Rhigozum trichotomum* scrubland, or mixtures of both. Both *Senegalia mellifera* and *Rhigozum trichotomum* are recognised as key indicator species of bush encroachment in South Africa (Turpie *et al.* 2019), a widespread phenomenon in this part of the Northern Cape and in other semi-arid regions (e.g. Dougill *et al.* 2016). The mechanisms driving bush encroachment remain poorly understood (Ward 2005). Several factors—including overgrazing, reduced fire frequency, and spatial heterogeneities in water, nutrient, and seed distribution—have been associated with increased woody plant cover, although the relative contribution of each factor is still debated (Kgosikoma & Mogotsi 2013a,b; Ward 2005).

In the POPA, the vegetation of the Bushmanland Arid Grassland biome in the toeslopes is highly varied. It ranges from patches dominated by perennial and annual grasses to areas dominated by *Rhigozum trichotomum* scrubland or *Senegalia mellifera* scrubland/woodland, or mosaics comprising all three vegetation types (Fig. 21, page 181). Drainage lines within these toeslopes are typically dominated by dense stands of *Senegalia mellifera*, often forming closed-canopy thickets or linear woodland corridors along ephemeral watercourses (Fig. 17; Fig. 18).

3.3. Areas of conservation concern

3.3.1. Convention on Wetlands

The Convention on Wetlands of International Importance especially as Waterfowl Habitat is an intergovernmental treaty adopted on 2 February 1971 in the Iranian city of Ramsar and is also known as the Ramsar Convention. The Convention uses a broad definition of wetlands. This includes all lakes and rivers, underground aquifers, swamps and marshes, wet grasslands, peatlands, oases, estuaries, deltas and tidal flats, mangroves and other coastal areas, coral reefs, and all human-made sites such as fish ponds, rice paddies, reservoirs and salt pans. The Convention entered into force in 1975 and currently has 172 Contracting Parties, or member States, in all parts of the world (<https://www.ramsar.org/>). The mission of the Ramsar Convention, as adopted by the Parties in 1999 and refined in 2002, is “the conservation and wise use of all wetlands through local, regional and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world”. South Africa ratified the Ramsar Convention in 1975 and has 32 Ramsar sites. The nearest Ramsar site is Baberspan located approximately 450 km to the north-east (<https://www.ramsar.org/wetland/south-africa>).

3.3.2. South African Critical Biodiversity Areas

The National Environmental Management: Biodiversity Act (2004) allows for the publishing of bioregional plans. The purpose of a bioregional plan is to provide a map of critical biodiversity areas (CBAs) with accompanying land-use planning and decision-making guidelines, to inform land-use planning, environmental assessment and authorisations, and natural resource management by a range of sectors whose policies and decisions impact on biodiversity (Department of Environmental Affairs 2011). A CBA is defined as an area showing terrestrial and aquatic features in the landscape that are critical for conserving biodiversity and maintaining ecological processes; these areas should remain in a natural or near-natural state (Department of Environmental Affairs 2011). In addition to CBAs, a bioregional plan may also identify ecological support areas (ESAs) that support the ecological functioning of critical biodiversity areas and/or deliver ecosystem services and should remain in at least an ecologically functional state (Department of Environmental Affairs 2011).

The PV2 footprint is located in a mosaic of ESAs and Other natural Areas (Fig. 22, page 182; Holness & Oosthuysen 2016; <https://bgis.sanbi.org/Projects/Detail/203>). Various criteria were used by Holness & Oosthuysen (2016) to determine CBA1 and CBA2 classification in the Northern Cape, but none is applicable to the study area, for example:

- Important Bird Areas (Marnewich *et al.* 2015; <https://bgis.sanbi.org/Projects/Detail/10>): The function of the Important Bird Areas program is to identify and protect a network of sites critical for the long-term viability of naturally occurring bird populations, across the range of those bird species for which a site-based approach is appropriate. The IBA

program was initiated in Europe in 1985, Africa in 1993, and southern Africa in 1995 (Barnes 1998). The nearest IBA is Augrabies Falls National Park located more than 150 km west of the study area.

- Distance buffers of up to 10 km around protected areas: The nearest formally protected area is Witsand Provincial nature Reserve located more than 50 km north-east of the study area (see <https://bgis.sanbi.org/Projects/Detail/144>).
- National Protected Areas Expansion Strategy (NPAES) focus areas for protected area expansion (Balfour *et al.* 2018; Government of South Africa 2010; <https://bgis.sanbi.org/Projects/Detail/144>): The current study area does not form part of any such area.
- Freshwater Ecosystem Priority Area (FEPA) (Driver *et al.* 2011; <https://bgis.sanbi.org/Projects/Detail/48>): The study area is not located within a river FEPA. Instead, it is classified as a “Fish Support Area”, which means that it is *not* essential for protecting threatened and near threatened freshwater fish that are indigenous to South Africa (Driver *et al.* 2011). The “Fish Support Area” designation “also include sub-quaternary catchments that are important for migration of threatened or near threatened fish species” (Driver *et al.* 2011).
- Various other criteria also considered are irrelevant to the present study; see Holness & Oosthuysen (2016) for more details.

4. Study approach & Methods

For ease of reference, the so-called Roberts number as per Maclean (1985), is included with the name of bird species whenever they are mentioned, *e.g.* Cape Robin-Chat R601. Thus given, it is easy to locate the species in Table 1 (page 130), where the birds within each group (see below) are sorted by their Roberts number. In cases where changes in taxonomy after Maclean (1985) resulted in a taxon being split into more than one species, a number was improvised, *e.g.* Orange River White-eye R796a. Bird names follows Hardaker (2025). The term ‘resident’ refers to species that are either present in or regularly visit the specified area for an extended period (at least a month per year), including migratory species.

Tables and figures are arranged in order towards the end of this report starting on pages 130 & 161, respectively.

4.1. Assumptions, uncertainties and gaps in knowledge

Assumptions, uncertainties, and gaps in knowledge relevant to this investigation are highlighted in context as underlined text throughout the report. Below is a summary of the key issues:

- Details about the proposed development layout incorporated into this report are based

on information available in November 2025. Subsequent changes could potentially require adjustments to be made.

- In figures where the proposed PV2 footprint is outlined, it is meant for general orientation purposes only, and may not be entirely accurate.
- Knowledge of bird distribution and movement patterns in and around the proposed development area is incomplete, and it is difficult to assess if, when and how these patterns will change over time.
- Our understanding of bird and PV interactions is incomplete (see Section 2.2).
- This report is partially based on four site surveys. Further surveys are expected to refine and enhance the results.
- The present study assesses the potential impact of a PV facility on birds. The occurrence and behaviour of bird species in an area are influenced by internal factors (*e.g.*, circadian and circannual clocks) and external factors (*e.g.*, rainfall timing and amount) (Van Niekerk 2009). While some factors change predictably throughout the year—such as day-length which is the most consistent seasonal variable (Berthold 1996; Brandstätter 2003)—others, like rainfall, are less predictable. For instance, a wetland may be inundated one December but dry the next. Consequently, Environmental Impact Assessments (EIAs) cannot account for all possible environmental conditions within their time-frames. Decisions made during these periods will therefore be based on incomplete data, despite thorough fieldwork efforts. Supplementary information, such as literature and prior experience, can help address some knowledge gaps.
- It is assumed that this report will be distributed and consulted in its entirety. The specialist who compiled this report accepts no responsibility for any amendments made without their explicit written consent. Should there be any uncertainties, please direct your enquiries to Dr Johan van Niekerk at djvnemail@gmail.com.

4.2. Pragmatic Operational Project Area

This avifaunal assessment complies with the Protocol for the Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Terrestrial Animal Species, as published in Government Notice No. 1150 in Government Gazette No. 43855 of 30 October 2020. One of its stipulations is that where the proposed activity is expected to affect Species of Conservation Concern (SCC) beyond the boundaries of the preferred site, the specialist must delineate the Project Area of Influence (PAOI) in accordance with the Species Environmental Assessment Guideline, and the study area must encompass the PAOI so defined.

Defining the PAOI for birds poses a uniquely complex challenge in environmental impact assessments. Unlike most other taxa, whose ecological requirements are comparatively constrained by habitat patches or home ranges, birds — especially migratory, nomadic, and

wide-ranging species — operate across spatial and temporal scales that routinely transcend conventional project boundaries. The PAOI must therefore encompass not only the immediate footprint and its immediate surroundings, but also critical resource areas (e.g., nesting areas, foraging areas, water points), movement corridors, seasonal concentration sites, and potentially even distant breeding or non-breeding grounds linked through flyways or dispersal events. Many of these connections remain unknown or poorly understood. In arid and semi-arid regions such as the Northern Cape, the challenge is further intensified by opportunistic breeding triggered by unpredictable rainfall, irruptive movements in response to resource pulses, and the patchy distribution of critical habitats across vast, largely unsurveyed landscapes. Collectively, these factors hinder the accurate delineation of a biologically meaningful area of influence on a map. In practice, the PAOI is therefore treated as a pragmatic operational area — a working polygon drawn to guide fieldwork planning, resource allocation, and impact scoping — rather than a precise reflection of all possible ecological influences. Actual project effects on birds, particularly displacement, barrier effects, or altered resource use, may extend well beyond this mapped area, especially for mobile species whose movements are shaped by seasonal or episodic drivers. Ultimately, the PAOI for birds is less a fixed geographic polygon than a dynamic conceptual envelope — shaped by species ecology, seasonal phenology, and the best available evidence of utilisation and connectivity — an envelope that demands continual refinement through field verification, long-term monitoring, and iterative assessment, processes which require temporal and financial resources that frequently exceed what is practicable within typical EIA budgets and timeframes.

In this avifaunal assessment, the term **Pragmatic Operational Project Area (POPA)** is adopted instead of the conventional PAOI. The POPA is a pragmatic, operational project area to guide fieldwork planning, resource allocation, and impact scoping. It does not imply that the development's ecological effects cease at this line; actual influences — particularly for wide-ranging avifauna — may extend further into the surrounding landscape.

The POPA for the PV2 facility encompasses the Doringberg range between the Burchell–Cuprum 132 kV power line in the north-west and Keikamspoort in the south-east (Fig. 4), which constitutes the core breeding area of Verreaux's Eagle — a Species of Conservation Concern (SCC) — within the Doringberg range. Adjacent toeslopes up to 7 km from the footprint are also included in the POPA (Fig. 4).

4.3. Broader Study Area

The area outside the POPA constitutes the broader study area. This zone provides essential regional context for interpreting site-specific avifaunal data. The spatial extent of the PV2 broader study area encompasses all areas where fieldwork were conducted, up to a maximum radius of 25 km from the Doringberg PV footprint, with the majority of effort and records concentrated within approximately 17 km of the footprint. This broader study area was primarily covered during the 2021 field surveys (refer to Section 4.5.2 on page 41 for details on survey coverage and effort). Observations recorded in this area, including incidental sightings and

transect data extending beyond the POPA boundaries, were used to:

- Establish a wider baseline of avifaunal diversity and distribution in the surrounding landscape.
- Contextualise the occurrence and relative importance of priority species (including Species of Conservation Concern) recorded within the POPA and development footprint.
- Support the assessment of regional-scale effects, particularly where highly mobile species (e.g., raptors, bustards, or waterbirds) may move between the project site and adjacent habitats.

4.4. Guidelines

The Birds and Renewable Energy Specialist Group (BARESG), established under the auspices of BirdLife South Africa and the Endangered Wildlife Trust, proposed guidelines (see Jenkins *et al.* 2017) that purport to delineate “the best practice approach to gathering bird data at proposed utility-scale solar energy plants, primarily for the purposes of accurate and effective impact assessment” in southern Africa. A particular aspect meriting detailed consideration is their recommendation for measuring the abundance of small terrestrial bird species, which presents numerous challenges.

4.4.1. Distance Sampling

Distance Sampling is the primary method promoted by the guidelines to measure the abundance of small terrestrial bird species. In essence, the method entails estimating population density by measuring distances to detected individuals and accounting for the likelihood of detection based on these distances. The two main methods are line transects and point transects (Thomas *et al.* 2002). However, when Distance Sampling is applied to birds, most of the key assumptions are probably always violated (Hutto & Young 2003). Additionally, a range of confounding factors further undermines the usability of Distance Sampling, along with other counting methods, as a practical approach for estimating the abundance of small terrestrial bird species.

4.4.1.1. Key assumptions

- **Birds on the line or point are certain to be detected** (Buckland *et al.* 2008). This is the only assumption that seems reasonable for birds, because it is probably rare that an investigator would miss these birds (Hutto 2016).
- **Birds are detected at their initial location, prior to any movement in response to the observer** (Buckland *et al.* 2008). If birds move in response to the observer before detection, either towards or away from the line or point, then considerable bias can result (Buckland *et al.* 2008). For dynamic animals such as birds that is frequently

on the go, this assumption, which implies that birds are stationary, is always in violation (Hutto 2016). In a survey setting, birds movements towards or away from the observer (either independently of, and in direct response to, the observers) is likely to occur before they are detected. This causes overestimation/underestimation of abundance (Hutto 2016).

- **Distance measurements are exact** (Buckland *et al.* 2008). Most bird detections are based on sound alone, and distances to bird sounds are notoriously difficult to estimate accurately (Hutto 2016). Consequently, the use of Distance Sampling is not recommended for species whose distances to observers cannot be reliably confirmed through visual estimates (Koper *et al.* 2016).
- **For birds that occur in clusters (groups), cluster sizes are recorded without error** (Buckland *et al.* 2008). A precise count of individuals of any particular species detected from a single point is frequently impossible to determine precisely (Hutto 2016).

4.4.1.2. Confounding factors

- **Sample size.** For any particular species, 60 or more detections are required to estimate density reliably with Distance Sampling (Buckland *et al.* 2001). However, in any multispecies community, there are always only a few very abundant species and many rare species (McGill *et al.* 2007). This universal ecological law militates against the idea that density estimation for all species in a community can be achieved uniformly using Distance Sampling—in any given study the number of detection points are likely to be sufficient for only a few, if any, species (Hutto 2016).
- **Activity pattern variability:** Activity patterns in birds often encompass vocal behaviour, which directly influences detection probability, as increased calling enhances the likelihood of detection, while silence reduces it.
 - **Variability within survey period.** Distance Sampling operates under the assumption that the detection probability for any given distance and species stays constant throughout the survey period. For instance, if a survey takes two hours, it is assumed that the detection probability for a particular species at a specific distance from the observer—say, 20 meters—remains unchanged over the entire two-hour duration. Unfortunately, the activity of bird species, and hence their detectability, varies during the day (Van Niekerk 2009). Consequently, for any given survey many species may be active and more probable of being detected for only a certain fraction of the total survey period. For example, the detection probability of species A may be high (due to vocal displays, for example) for 30 minutes around sunrise, but much lower subsequently (due to unobtrusive behaviour when not displaying, for example). While there are ways to handle time-varying detectability situations such as these (*e.g.*, splitting the survey into time periods), they often demand significant additional effort and resources, which can strain limited time and money budgets, and frequently result in sample sizes too small to produce reliable

estimates, especially when assessing an entire bird community.

- **Weather induced variability.** The activity levels of various bird species, including their vocal behaviour and consequent detection probability, are known to be influenced by meteorological events, as documented by researchers such as Van Niekerk (2009). For instance, following a thunderstorm, numerous bird species may exhibit heightened vocal activity. This response can persist for a duration ranging from minutes to potentially extending across subsequent days, weeks or months during which activity levels may exceed those observed prior to the event. Additionally, precipitation can trigger vegetative growth, such as the sprouting of new leaves, grasses, or flowering plants, which may subsequently alter the activity patterns of avian populations over timescales ranging from days to weeks or even months. This delayed effect might manifest through changes in foraging opportunities, nesting site availability, or predator cover, all of which can influence how active—or vocal—birds are in a given area. The implication of these dynamics is that the timing of a survey could significantly affect density estimates, as a survey conducted shortly after a rain-induced boom in vegetation, for example, might capture heightened bird activity and detectability, whereas one conducted during a drier, less productive period could underestimate populations due to reduced activity and lower detection probabilities. This temporal variability can be difficult to predict, especially in arid areas, where precipitation events are sporadic and their effects on vegetation and bird activity may be particularly pronounced. This complicates the interpretation of before-after comparisons.

4.4.2. Fixed-width transects

As an alternative to Distance Sampling, the guidelines recommend that “transects can be done with a fixed maximum width, and only birds seen or heard within this distance on either side of the transect line should be recorded (e.g. Leddy *et al.* 1999)” (Jenkins *et al.* 2017). However, fixed-width transects present several challenges when used for bird counting. One major limitation is the assumption that detection probability remains constant across the entire width of the transect, which is often unrealistic in field conditions. Birds farther from the observer are generally harder to detect due to factors like vegetation density, terrain, or observer bias, leading to underestimation of populations. Additionally, fixed-width transects fail to account for variation in detectability among species, as some birds are naturally more cryptic or less vocal. These issues collectively reduce the reliability of population estimates derived from fixed-width transects.

4.4.3. Checklist surveys

The guidelines highlight checklist surveys as an additional approach for assessing the occurrence and relative abundance of small terrestrial bird species (Jenkins *et al.* 2017). While the

guidelines advocate for using checklist surveys to monitor species across the broader 'affected area' of the solar energy facility, they recommend complementing this method with transect or fixed-point counts specifically within the solar development area (Jenkins *et al.* 2017). Nevertheless, as previously discussed, these methodologies are inadequate for reliably estimating the abundance of small terrestrial bird species, underscoring the broader limitations of current survey techniques.

4.4.4. Conclusions

Regardless of the rationale behind counting small terrestrial bird species, it is broadly recognised that every enumeration methodology—no matter how advanced—comes with its own set of strengths and weaknesses (Van Niekerk 2009), with no single method achieving absolute precision (Bibby *et al.* 2000). At most, one can aspire to achieve a reasonable approximation of the population sizes for a limited number of species. This constraint highlights the challenges inherent in survey methodologies, where the complexity of ecological systems and species-specific behaviours often impede broader accuracy. As such, these methods are best viewed as tools for gaining insight into key species rather than providing comprehensive community-wide population estimates.

Estimating important species' numbers in EIA is challenging due to resource-intensive methodologies and limited time, expertise, and funding. Moreover, the applicable methods necessarily focus only on a limited number of species, neglecting rare or less visible ones. As a result, these limitations hinder the ability to conduct thorough and inclusive ecological evaluations during the EIA process.

4.5. Field observations

The primary objective of the field observations was not to conduct comprehensive bird counts but to gather data on the behaviour and distribution patterns of bird species within and around the proposed PV2 footprint.

4.5.1. Timing of surveys

Fieldwork for this avifaunal impact assessment was conducted over multiple seasons to capture variation in bird distribution, behaviour, and activity. The survey periods were as follows:

- 26 July 2021 to 21 August 2021 (late winter/early spring): Wide-ranging surveys across the study area, including comprehensive coverage of most of the PV2 footprint (Fig. 23, page 183).
- 6–13 October 2021 (spring): Focused surveys in the toeslope, c. 7 km north of the PV2 footprint, with limited observations in mountainous areas and elsewhere (Fig. 24, page 184; See also Van Niekerk 2021).

- 4–14 November 2025 (late spring/early summer): Targeted surveys of mountainous habitats in the general vicinity of the PV2 footprint (Fig. 25, page 185).
- 12–20 February 2026 (early autumn): Targeted surveys of mountainous habitats in the general vicinity of the PV2 footprint (Fig. 26, page 186).

4.5.2. Areas surveyed

Figures 23–26 demonstrate the collective spatial coverage of the bird surveys, which extended up to ~25 km beyond the PV2 footprint. Spanning different seasons and years, these surveys establish a robust baseline of avifaunal occurrence and distribution in the wider project region. Although various survey approaches were used across the study area, the repeatable 5-minute surveys (detailed in Section 4.5.3) were deliberately designed and implemented in representative habitats to provide a standardised, repeatable dataset suitable for direct comparison with operational-phase monitoring results. These targeted surveys form the core of the local-scale assessment and are discussed in detail below.

4.5.2.1. Repeatable 5-minute bird surveys

The repeatable 5-minute bird surveys described below were developed to provide a baseline dataset against which future monitoring results can be evaluated. All surveys were conducted on foot (see Section 4.5.3 below). Survey details, including locations and effort, are summarised in Table 2 (page 144). Each survey point was assigned a unique code (A–W) for ease of reference in the following descriptions.

- **PV2 footprint** (= Plateau DPVfp): Surveys D–G, and O–Q (Table 2). At the time of first survey on 12 August 2021, the current PV footprint was not yet established. However, an area overlapping extensively with it was covered then in the morning (Fig. 27 (page 187), D). Subsequent coverage included repeated surveys along the footprint perimeter during the morning, midday and late afternoon of 5 November 2025 (Fig. 28 (page 188); E, F & G) and 14 February 2026 (Fig. 29 (189); O, P & Q).
- **Plateau DPVn**: This subunit corresponds to surveys C and W in Table 2. Surveys were carried out on two mornings: 12 August 2021 (Fig. 27; C) and 20 February 2026 (Fig. 29; W). The decision to delineate Plateau DPVn as a distinct survey area was based on clear differences in grazing intensity and resulting habitat structure. Specifically, Portions 4/50 and 8/50 of Farm Karabee exhibited markedly greater grass cover and height than Portion 3/50 (PV2 footprint), potentially influencing bird species composition and abundance.
- **Plateau North 1**: Surveys A, J, and T (Table 2). The initial survey on the morning of 3 August 2021 covered the southern portion of the plateau but not the northern portion on Farm Karabee 5/50 (Fig. 27; A). Following finalisation of the PV2 footprint, survey effort was subsequently focused on the northern portion of the plateau (Farm Karabee 5/50), as no wind turbines are planned in this area (Fig. 28, J; Fig. 29, T).

- **Plateau North 2:** Surveys B, K, and V (Table 2). The initial survey on the morning of 6 August 2021 covered eight $12\text{ s} \times 12\text{ s}$ grid cells (Fig. 27; B). Subsequent surveys expanded coverage to 17–18 grid cells each (Fig. 28, K; Fig. 29, V).
- **Valley East 1:** Surveys H and R (Table 2). Morning surveys were conducted along the valley from the head to the confluence with Valley North 1, following the main drainage line (Fig. 28, H; Fig. 29, R).
- **Valley North 1:** Surveys I and S (Table 2). Morning surveys covered the valley from the confluence with Valley East 1 to the head, following the main drainage line (Fig. 28, I; Fig. 29, S).
- **Valley North 2:** Surveys L and U (Table 2). Morning surveys traversed the valley from the head to its lower end, following the main drainage line. (Fig. 28, L; Fig. 29, U).

4.5.3. Bird records

All birds identified visually or audibly were recorded using a custom Android application, which automatically captured the date, time, and observer’s GPS location for each sighting or call.

For selected species, additional details were recorded, such as the number of individuals, activity (e.g., foraging, flying, perching), and other relevant notes.

The core recording method involved documenting all bird species seen or heard during discrete 5-minute intervals throughout each observation session or transect. For instance, in a transect from 06:00 to 11:00, birds were recorded in the following 5-minute periods: 06:00 (06:00:00–06:04:59), 06:05, 06:10, . . . , 10:50, and 10:55 (10:55:00–10:59:59). Each 5-minute interval was restricted to a single habitat type (plateau, valley, or toeslope) to ensure ecological consistency.

In addition, effort was standardized spatially using a grid system. On foot transects, at least 5 minutes were spent in each 12-second $\times$ 12-second latitude/longitude cell (approximately $369\text{ m} \times 322\text{ m}$ at this latitude), even if the transect only passed through a small corner of the cell. Vehicle-based transects followed a similar approach but used coarser resolution: at least 5 minutes were spent in each 1-minute $\times$ 1-minute latitude/longitude cell (approximately $1\,847\text{ m} \times 1\,611\text{ m}$).

The 5-minute survey protocol outlined above permits the derivation of a reporting rate for each recorded species, calculated as the proportion of 5-minute intervals during which the species was detected relative to the total number of intervals completed. These reporting rates serve as a standardised index of relative occurrence rather than direct abundance estimates. Interpretation remains species-dependent, being affected by inherent differences in detectability, activity patterns, habitat association, and survey conditions.

For ease of interpretation, reporting rates were categorized into three relative levels (low, moderate, and high). This was achieved by dividing the highest observed reporting rate into

three equal intervals and assigning values accordingly.

Where the 5-minute timed-interval method outlined above was not practicable (typically during vehicle transits between survey areas or in areas of rapid movement), all birds seen or heard were recorded without applying the timed intervals, habitat restrictions, or spatial grid constraints. These incidental records were still logged via the custom Android app with automatic date, time, and GPS details to ensure spatial and temporal accuracy.

This protocol ensured thorough spatial coverage, standardized detection effort across habitats, and reliable data for assessing avian distribution and behaviour patterns.

A concerted effort was also made to locate as many Verreaux's Eagle R131 nests as possible within 6 km from the proposed PV2 footprint.

In the Hx column of Table 1, species confirmed to occur within the POPA are marked an asterisk.

4.6. Species list

A core aspect of any avifaunal impact assessment is a list of bird species likely to be found at the proposed development site and its surroundings. Because PV2 will be in operation for at least a few decades, it would be ideal to consider all species which would occur in the area over that period. However, two factors make this difficult: 1) Current knowledge of the distribution and movement patterns of birds in and around the proposed development area is incomplete; 2) The distribution of species may change over time and for any given species, it is difficult to predict if, when and how this will happen. The analysis presented in this report attempts to draw reasonable inferences from what is presently known.

In the absence of detailed long-term studies over several years, it is often not possible to accurately assess the (potential) utilisation of an area by specific bird species. Instead, the data from the first Southern African Bird Atlas Project (SABAP1: 1987-1991; Harrison *et al.* 1997a,b) and the second Southern African Bird Atlas Project (SABAP2: 2007-present; sabap2.adu.org.za) were combined to produce for each bird species recorded in South Africa a distribution map with a minimum resolution of one quarter degree grid cell (QDGC), *i.e.* 15' latitude by 15' longitude. Each map was then examined, and species with distributions overlapping the study area were selected. Also selected were species where the QDGC of the study area (*i.e.* 2922DD) was just outside the SABAP1/SABAP2 distribution or where it fell within the general area of occurrence in species that were patchily recorded. This was done to compensate for imperfections in the SABAP1 & SABAP2 datasets. While a detailed discussion of all the issues involved is beyond the scope of this report, it is nonetheless instructive to briefly examine the situation in the Prieska area.

SABAP1 (5 years) and SABAP2 (18 years) collectively represent approximately 23 years of bird distribution data collection across southern Africa. In the Northern Cape, coverage dur-

ing both SABAP1 and SABAP2 was generally poor. For example, of the 113 pentads¹ within a 50 km radius of the proposed PV2 development (see Figure 30, page 190), only 3 pentads (2.7%) received 18 or more Full Protocol (FP) submissions, equivalent to an average of at least one submission per year (range: 1.2–1.7 submissions/year). Approximately half of the pentads (51.3%) received only 1 to 4 FP submissions (0.06 to 0.22 submissions/year, or one submission every 4.5 to 18 years), while more than a quarter (27.4%) received no FP submissions at all (Fig. 30).

If SABAP2 coverage over 18 years had been comprehensive, the discovery of new species for any given area would now be exceptional. However, this is not the case. In addition to the poor coverage indicated by the number of FP submissions, this metric itself is less informative than it may appear. For example, pentad 2940_2245 (immediately north of the PV2 footprint) received the second-highest number of FP submissions (24; Fig. 30), with species counts per FP list ranging from 3 to 69 (median 41). In contrast, fieldwork conducted in October 2021 recorded 103 species during a 5-day period (comparable to a FP), demonstrating that the so-called FP lists are often woefully incomplete. Furthermore, a comparison of all species listed for pentad 2940_2245 during SABAP2 with data collected during July 2021, August 2021, and October 2021 revealed 15 species that had not been recorded in SABAP2, including four species of conservation concern.

The pentad containing the PV2 footprint, 2945_2645 (Fig. 4), has received only six SABAP2 Full Protocol (FP) submissions to date, with species counts per 5-day list ranging from 20 to 43. In contrast, fieldwork conducted within this pentad during comparable 5-day periods yielded significantly higher diversity: July 2021 (61 species), August 2021 (59 species), November 2025 (84 species), and February 2026 (81 species). Furthermore, a comparison of all species recorded for pentad 2945_2245 during SABAP2 with data collected during July 2021, August 2021, October 2021, November 2025, and February 2026 revealed 51 species that had not been documented in SABAP2, including three species of conservation concern.

The web-based National Environmental Screening Tool (NEST; <https://screening.environment.gov.za/screeningtool>) is a geographically based web-enabled application which allows a proponent intending to submit an application for environmental authorisation in terms of the Environmental Impact Assessment (EIA) Regulations 2014, as amended, to screen their proposed site for any environmental sensitivity. The usefulness of its assessment of avifauna, which is based on SABAP2 data complimented by species distribution models (see Retief & Colyn 2020), is compromised by the relatively poor state of SABAP2 coverage in this part of the Northern Cape (and elsewhere).

The species list for the current assessment amounts to 276 bird species and is presented in Table 1, where species are arranged in groups and within each group by Roberts's number. Each species is listed only once. The groups are the following:

- A) SCC (arranged by category);
- B) Additional endemic species;

¹A pentad is a 5-minute latitude by 5-minute longitude area, approximately 9.2×8.1 km in size.

- C) Additional species potentially negative impacted by the PV2 facility;
- D) Additional species expected to be recorded in the footprint but unlikely to be impacted;
- E) Additional species listed under CMS;
- F) Additional waterbirds;
- G) Additional species recorded in the POPA;
- H) Additional other species.

4.7. Distribution patterns

The distribution pattern of each species was classified into one of 19 categories based on its directional occurrence pattern in the general vicinity of the study area. Eighteen of these potential patterns are diagrammatically illustrated in Figure 31 (page 191); cases where the study area falls outside the normal distribution of a species (OOR) are not illustrated. This classification is based on incomplete data, partly because this part of South Africa was poorly covered during SABAP1 and SABAP2. Consequently, several species have unclear distribution patterns around the study area. In each of these cases, species was nonetheless placed into one of the categories based on the distribution of suitable habitat and other factors. Despite these shortcomings, it seems reasonable to assume that the patterns revealed are helpful indicators of habitat distribution/utilisation around the study area (see below).

4.8. Habitat preference

Although birds are highly mobile, many species utilise only specific habitats, with habitat diversity playing an important role in determining the avifaunal diversity of any given area (Cody 1985).

The hierarchical habitat classification system of Harrison *et al.* (1994) was used to characterise the habitat preferences of each species. Only their primary habitat levels were used, which include marine (MA), aquatic (AQ), montane/rocky (RC), grassland (GR), scrub (SC), woodland (WO) and forest (FR) habitats. In addition, “habitat-unspecific” species were placed into a ‘habitat generalist’ (HG) category. In the few cases where Harrison *et al.* (1994) did not assess the habitat preferences of a species, where taxonomic changes occurred after the publication of Harrison *et al.* (1994), or where new species were admitted to the Southern African list, appropriate habitat associations were assigned based on information in Hockey *et al.* (2005), and/or personal experience. For this assessment, the term ‘waterbird’ refers to all species associated with aquatic habitats according to the system of Harrison *et al.* (1994). The habitat preferences of all species are indicated in Table 1 (Habitat column) and summarised in Figures 32 (page 192) and 33 (page 193). In addition, the distribution patterns of birds from the respective habitats are summarised in Figure 34 (page 194).

Each species listed in Table 1 was assessed to determine the habitat type within the study area that best matches its ecological preferences. Habitat preferences are indicated in Column H of the table. Species confirmed to occur within the POPA are marked with an asterisk (*).

- **P:** Plateaus.
- **V:** Valleys, including gorges, escarpments, and the shoulder, backslope, and footslope portions of hills (see Figure 19).
- **T:** Toeslopes (see Figure 19).
- **O:** Orange River and associated floodplain, including the irrigation belt at Prieska, irrigated fields, remnant natural vegetation, the town of Prieska, and the Prieska Water Treatment Works.
- **W:** Waterbirds associated with waterbodies outside the Orange River floodplain, for example man-made impoundments.

The Status column in Table 1 describes the observed or expected utilisation of the PV2 development footprint by each species, as follows:

- **A:** Aerial insectivore that may forage over the footprint.
- **BIT:** Bird in transit – species recorded flying over the footprint with little or no feeding activity.
- **U:** Utilises the footprint, at least for feeding.
- **V:** Occasional visitor to the footprint.

A question mark (?) denotes uncertainty in the assigned status.

4.9. Impact significance

According to Rossouw (2003), there are three broad categories of determining impact significance, namely technical, public & legal:

- **Technical:** In the context of avifaunal impact assessment, this is commonly referred to as biological significance, which Buffington (1976) defines as follows: “*An impact is significant if it results in a change that is measurable in a statistically sound sampling program and if it persists, or is expected to persist, more than several years at the population, community, or ecosystem level.*” Subsequent authors had similar definitions (e.g. Avian Power Line Interaction Committee (APLIC) 2012; Willard 1978)
- **Public:** Buffington (1976) defines this category as follows: “*... a change or impact in agreement with societal norms. Put another way, an “unacceptable” impact in some way flaunts the public’s (or portion thereof) system of values.*” In referring to Buffington (1976), Thompson (1978) terms it social acceptability. It is also sometimes called “political significance” (e.g. Amend 1978; Avian Power Line Interaction Committee (APLIC) 1994; Brown 1993; Willard 1978).

- **Legal:** This refers to the acknowledgement of the importance of environmental resources in government policy, law or plans (Rossouw 2003). Avian Power Line Interaction Committee (APLIC) (2012) calls this “wildlife policy”. Those most relevant to the present investigation is considered in Section 3.3 (page 33 onwards).

In the remainder of this section we elaborate on each category.

4.9.1. Biological Significance

Except for the extreme cases—such as the California Condor *Gymnogyps californianus*, of which there were only 22 individuals left in the wild at one point in time (Walters *et al.* 2010)—it is generally considered improbable that any single project, on its own, would have a biologically significant impact on any species (Amend 1978; Drewitt & Langston 2008; Faanes 1987). No restricted-range species (*i.e.* species with global distributions of less than 50 000 km² (Marnewich *et al.* 2015)) occur in the PV2 study area. In other words, the global distribution of each species occurring in the PV2 study area is greater than 50 000 km² (equivalent to a circle with a radius of approximately 126 km). It is therefore improbable that any development at PV2 will, on its own, ever have a biological significant impact on any birds species.

4.9.2. Public Significance: The Eyes and Ears on the Ground

“The public simply does not want to see birds killed by power lines, regardless of the biological significance of such losses.” (Thompson 1978).

Regardless of the type of development, public concerns can drive mitigation requirements—even when biological impacts are limited or absent. In the era of smartphones, a single photo or video can rapidly circulate worldwide, making it essential for developers to anticipate and address potential public scrutiny.

The PV2 footprint is situated on private land and is not accessible to the general public. The nearest public road, the N10 (to Britstown), passes approximately 6.5 km to the north-east of the footprint. The road itself offers no elevated vantage points. However, from certain sections of the N10, limited portions of the northern part of the footprint may be partially visible through a valley opening in the toeslope that aligns with specific lines of sight toward the plateau. Given the substantial distance (>6 km) and intervening topography, any visibility is expected to be minimal, distant, and highly constrained to particular alignments along the road. Construction activities and bird interactions with the facility would therefore appear as very small, distant elements in the landscape and are unlikely to elicit significant public response or concern from road users.

Public significance is therefore considered negligible in this case, **unless** the public becomes aware of potential issues through indirect channels other than direct observation (e.g., media coverage, NGO reports, community networks, or formal stakeholder engagement processes).

4.9.3. Legal Significance

4.9.3.1. National Legislation

The Constitution

The Constitution of the Republic of South Africa (Act 108 of 1996) was approved by the Constitutional Court on 4 December 1996 and took effect on 4 February 1997. The Constitution is the supreme law of the land. No other law or government action can supersede the provisions of the Constitution. In Section 24 Environment (<https://www.gov.za/documents/constitution/chapter-2-bill-rights#24>), the Constitution provides that everyone has the right

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

National Environmental Management Act (NEMA) (Act 107 of 1998)

“To provide for co-operative, environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for co-ordinating environmental functions exercised by organs of state; and to provide for matters connected therewith.”

NEMA is the statutory framework to enforce Section 24 of the Constitution. NEMA Section 2 sets out several principles that apply throughout the Republic to the actions of all organs of state that may significantly affect the environment. For example:

- Principle 3: Development must be socially, environmentally and economically sustainable.
- Principle 4: (a) Sustainable development requires the consideration of all relevant factors including the following:
 - (i) That the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied:
 - (viii) that negative impacts on the environment and on people’s environmental rights be anticipated and prevented, and where they cannot be altogether prevented. are minimised and remedied.

NEMA Section 6 (*i.e.* Sections 25, 26 & 27) makes provision for international environmental instruments, defined as “any international agreement, declaration, resolution, convention or protocol which relates to the management of the environment”.

National Environmental Management: Biodiversity Act (Act 10 of 2004)

“To provide for the management and conservation of South Africa’s biodiversity within the framework of the National Environmental Management Act, 998; the protection of species and ecosystems that warrant national protection; the sustainable use of indigenous biological resources; the fair and equitable sharing of benefits arising from bioprospecting involving indigenous biological resources; the establishment and functions of a South African National Biodiversity Institute; and for matters connected therewith.”

One of the objectives of the act is “to give effect to ratified international agreements relating to biodiversity which are binding to the Republic.” (Section 2(b)).

4.9.3.2. International conventions and agreements

There are presently eight international conventions focusing on biodiversity issues (see <https://www.cbd.int/brc/>). Relevant to the present study are the Convention on the Conservation of Migratory Species of Wild Animals (CMS; Year of entry into force: 1979) and the Convention on Biological Diversity (CBD; 1993).

4.9.3.2.1. Convention on the Conservation of Migratory Species of Wild Animals (CMS)

The CMS (see <https://www.cms.int/>) was concluded in Bonn, Germany, on 23 June 1979, and is thus also known as the Bonn Convention, which is not to be confused with the Bern Convention, which relates to the conservation of European wildlife and natural habitats (<https://www.coe.int/en/web/bern-convention/home>). It is the only global (and UN-based) intergovernmental organization established exclusively for the conservation and management of migratory terrestrial, marine and avian species. CMS parties acknowledge the need to take action to avoid any migratory species becoming endangered. In particular, the parties shall endeavour to:

- provide immediate protection for migratory species included in Appendix I of the convention, which includes migratory species threatened with extinction. Species with distributions overlapping with the study area are indicated as ‘A1’ in the CMS column of Table 1 based on the latest version of Appendix 1 (22 May 2020; <https://www.cms.int/en/species/appendix-i-ii-cms>);
- conclude Agreements covering the conservation and management of migratory species included in Appendix II of the convention (<https://www.cms.int/en/species/appendix-i-ii-cms>), which include migratory species that need or would significantly benefit from

international cooperation. Species with distributions overlapping with the study area are indicated as '**A2**' in the CMS column of Table 1.

For this reason, the Convention encourages the Range States to conclude global or regional Agreements. In this respect, CMS acts as a framework Convention. The Agreements may range from legally binding treaties (called Agreements) to less formal instruments, such as Memoranda of Understanding, and can be adapted to the requirements of particular regions. South Africa ratified the Convention in 1991.

- The *African-Eurasian Waterbird Agreement* (AEWA; www.unep-aewa.org) is pertinent to the present report. It is an international agreement aiming at the conservation of migratory waterbirds. Like other migratory species, AEWA waterbirds cross international boundaries during their migrations, facing a wide range of threats. Without international cooperation, the conservation efforts of one country can be nullified if the species is not protected in another country along the flyway. AEWA is the largest Agreement developed so far under CMS auspices. The Agreement was concluded on 16 June 1995 in The Hague, the Netherlands, and entered into force on 1 November 1999; South Africa ratified the Agreement on 1 January 2000. As a regional agreement, AEWA focuses on 255 waterbird species ecologically dependent on wetlands for at least part of their annual cycle (<https://www.unep-aewa.org/en/species>). AEWA species with distributions overlapping with the study area is indicated with a '**W**' in the CMS column of Table 1.
- The CMS *Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia* (Raptors MOU) aims to promote internationally coordinated actions to achieve and maintain the favourable conservation status of migratory birds of prey throughout their range in the African-Eurasian region, and to reverse their decline when and where appropriate (see <https://www.cms.int/raptors>). It was signed by South Africa on 4 December 2008. It is recognised that birds of prey face various human-induced threats such as habitat loss and degradation, illegal shooting and poisoning, collisions with aerial structures and electrocution by power lines. The species are assigned within the following three categories:
 - Category 1: Globally threatened, and Near Threatened species as defined according to the latest IUCN Red List and listed as such in the BirdLife International World Bird Database. Species with distributions overlapping with the study area are indicated by an '**R1**' in the CMS column of Table 1 A.
 - Category 2: Species considered to have Unfavourable Conservation Status at a regional level within the Range States and territories listed in Annex 2 to the MOU Category. Species with distributions overlapping with the study area are indicated by an '**R2**' in the CMS column of Table 1 A.
 - Category 3: All other migratory species. Species with distributions overlapping with the study area are indicated by an '**R3**' in the CMS column of Table 1 C & E.

4.9.3.2.2. Convention on Biological Diversity (CBD)

Opened for signature at the Earth Summit in Rio de Janeiro in 1992, the CBD (see www.cbd.int) is the international framework for the conservation and sustainable use of biodiversity and the equitable sharing of its benefits. The CBD seeks to address all threats to biodiversity and ecosystem services. In keeping with their commitments under the CBD, South Africa – who ratified the Convention in 1995 – developed a National Biodiversity Strategy and Action Plan (NBSAP) in 2005 (www.cbd.int/doc/world/za/za-nbsap-01-en.pdf). The goal of the NBSAP is to conserve and manage terrestrial and aquatic biodiversity to ensure sustainable and equitable benefits to the people of South Africa, now and in the future. In support of this goal, five key strategic objectives have been identified, each with a number of outcomes and activities. For example, Activity 1.4.7: “Integrate biodiversity considerations in Strategic Environmental Assessment, Integrated Environmental Management and Environmental Impact Assessment”.

Activity 2.5.2 of the NBSAP involves updating South African Red Data lists. Barnes (2000) provides the following perspective on the function of Red Data Books. During the 1970s and 1980s, most efforts to preserve biological diversity focused on species, especially those highlighted by Red Data Books. However, species cannot survive in isolation from their environments. This appreciation shifted emphasis away from species to site and habitat conservation in the 1990s, with efforts also increasingly focused at the ecosystem level. However, continued concern with species, which are the components of these systems, is essential. The Red Data Book concept explicitly attempts to document and highlight potential losses from the global stock of biodiversity at the species level (Barnes 2000). Since their inception in 1976, South African Red Data Books on birds (Barnes 2000; Brooke 1984; Siegfried *et al.* 1976; Taylor *et al.* 2015) all followed the lead of the International Union for Conservation of nature and natural Resources (IUCN).

4.10. Species of special concern

4.10.1. Focus species

Particular emphasis is placed on the following species:

- SCC (both Regional (Lee *et al.* 2025) and Global (IUCN 2022)),
- Species endemic or at least near-endemic to South Africa, Lesotho and Swaziland (all will be referred to as ‘endemic’ in the text; No restricted-range species occur in the study area (Marnewich *et al.* 2015)),
- CMS species (including AWEA & Raptors MOU),
- Species which may potentially interact with, or be affected by, the PV2.

For each species, all this information is indicated in Table 1. Waterbirds are highlighted in Table 1 by printing their risk assessment in blue, except in cases where the risk is high in

which case it appears in red print.

4.10.2. Disturbance and Accidents

A distinction is made between the risk of disturbance and accidents. **Disturbance** refers to any human action depriving a bird species of its habitat. It includes the physical destruction or alteration of habitat in a way that causes displacement, as well as disturbance which have a negative impact on breeding success. In general, this type of disturbance is primarily associated with the project's construction phase. The following *negative* impact levels are distinguished, all referring to direct potential impact before consideration of mitigation measures. The assessment is indicated in Table 1 based on an informed opinion for each species.

- **Unlikely (-):** The species is either unlikely to occur at the proposed PV site, a possible transient visitor there, and/or otherwise unlikely to be disturbed;
- **Low:** The species is a resident or have an unknown status at the proposed PV site, but the risk of disturbance is likely to be minimal (*e.g.* species with large territories and species which utilise the area mainly for activities other than breeding);
- **Moderate (Mod.):** The species is a resident in the proposed PV footprint and environs and the risk of disturbance is likely to be moderate (*e.g.* species which may potentially breed in the affected area);
- **High:** The species is a resident in the proposed PV footprint and environs and the risk of disturbance is likely to be high (*e.g.* species which probably breed in the affected area). It also include species breeding outside the footprint which are deemed sensitive to disturbance.

Accidents refer to any incident involving the project infrastructure which could lead to the injury or death of birds, typically when the facility is completed and operational. It is difficult to predict which species may be subjected to accidents with the PV modules since there only limited research that has been done in this regard (see Section 2.2.4 on page 25). Associated infrastructure such as fences have the potential to cause accidents (primarily through entanglement in mesh/wire, collision with unmarked strands, or entrapment between double fences for large-bodied/terrestrial species). Roads present a lesser risk, mainly incidental vehicle strikes or indirect effects. In addition, other aspects such as the availability of surface water (if present) and ancillary infrastructure such as lighting can also contribute to accidents. These risks could potentially affect a wide range of bird species. In contrast to the species-specific disturbance risks detailed above and indicated per species in Table 1, given the multiplicity of these accident modalities and their general applicability across vulnerable species groups (rather than unique per-species effects), accidents will be mostly considered in general terms in the section on operational phase impacts and not indicated for individual species in that table.

5. Receiving environment from an avifaunal perspective

In its current state, the habitat in the footprint area is utilised, or is at least expected to be utilised, by a range of bird species, including a few species of conservation concern and endemic species. The 276 bird species listed in Table 1 represent cases where distribution overlap with the study site and environs (see Section 4.6 on page 43). Here we will examine each habitat with which these species are associated (see Section 4.8 on page 45); habitat generalists are considered separately at the end. Within each habitat, species of conservation concern (SCC) are introduced first, with a paragraph of relevant information for each species, starting with the main reasons for declines. SCC are followed by a section on endemic species followed by other species. CMS species are also indicated (see Section 4.9.3.2.1 on page 49 for an explanation of codes used, *i.e.* A1, A2, W, R1, R2, R3).

5.1. Overview of species

Half (52.5%) of the 276 bird species have a widespread distribution around the study area. For the rest of the species, the study area is at or near the local limit of their range, with 16.3% limited to the Orange River in this part of their range.

5.1.1. Species of Conservation Concern (SCC)

The 276 species include 33 (12.0%) SCC, with the study area being located at or near the edge of the distribution of 18 (54.5%) of them (Table 1 A). SCC include two Critically Endangered species, six Endangered species, nine Vulnerable species, and 16 Near Threatened species (Table 1 A). Five SCC are also near-endemic to South Africa, Lesotho & Swaziland (Table 1 A).

The PV2 footprint forms part of the territory of at least one Karoo Korhaan R235 (Near Threatened) pair. The Ludwig's Bustard R232 (Endangered) is a regular visitor to the plateaus and in particular the footprint. Within the Doringberg range, the PV2 footprint is located in the midst of the core breeding area for the Verreaux's Eagle R131 (Vulnerable), with 29 known nests in the POPA between 0.9 and 5.8 km from the footprint. The Lanner Falcon R172 (Near Threatened) may breed in the POPA. A Cape Vulture R122 (Vulnerable) was once seen in flight over a valley adjacent to the footprint. Tawny Eagle R132, Martial Eagle R140 (both Endangered) and Kori Bustard R230 (Near Threatened) were seen on toeslopes outside the POPA. The Critically Endangered White-backed Vulture R123 and Lappet-faced Vulture R124 are both known to roost on pylons approximately 25 km south-west of the POPA. Of the 23 SCC not recorded in the study area, the most likely ones to visit it is the Black Stork R084 and Secretarybird R118. 21 SCC also appear in CMS lists A1, W, R1 & R2.

5.1.1.1. National Environmental Screening Tool

The Animal Species Theme Sensitivity of the web-based National Environmental Screening Tool (NEST; <https://screening.environment.gov.za/screeningtool>) indicates high sensitivity associated with the western third of the POPA, and medium sensitivity with the rest which also includes the PV2 footprint (Fig. 35). Only the following two SCC are specifically listed:

- **Ludwig’s Bustard R232:** Species distribution models used by NEST correctly indicate the occurrence of this species across the study area, and observations in the study area confirmed their occurrence in the footprint and environs (see page 65).
- **Verreaux’s Eagle R131:** The sensitivity of this eagle is included in both the high and medium sensitivity categories. The footprint is located in the midst of the core breeding area of this species in the Doringberg range (Van Rooyen & Froneman 2023b).

The confirmed utilisation of the PV2 footprint and environs by Verreaux’s Eagle and Ludwig’s Bustard warrants a high sensitivity classification for the entire POPA. Other SCC, excluding Near Threatened species, recorded in the POPA (Cape Vulture R122) and the broader study area (White-backed Vulture R123 Lappet-faced Vulture R124, Tawny Eagle R132, and Martial Eagle R140), are not expected to make regular or significant use of the POPA and therefore do not materially influence the overall avifaunal sensitivity rating.

5.1.2. Endemic & Restricted-Range species

There is a total of 3 endemic and 22 near endemic species (9.1%) with distributions overlapping with the study area, including five SCC, and no Restricted-Range species (Table 1 A & B). Nine of them (36.0%) have a widespread distribution around the study area (Table 1 A & B).

Only the Karoo Korhaan R235 and Karoo Scrub Robin R614 are residents in the PV2 footprint. The Jackal Buzzard R152 is a resident in the POPA that occasionally hunt over plateaus. The Grey Tit R551, Fairy Flycatcher R706, and African Rock Pipit R721 occur only in valleys where they are presumed to be resident. The Black-headed Canary R876 was recorded as a nomadic temporary resident that was only recorded on the plateaus. Single records of Cape Vulture R122 and Southern Double-collared Sunbird R783 suggest that they are irregular visitors in the POPA.

All three the endemic CMS species are also SCC, appearing in CMS lists A1, A2, R1, and W. Only the Cape Vulture R122 was recorded during the surveys.

5.1.3. Other species

The vast majority of the 276 species with distribution overlapping with the study area are neither threatened nor endemic (76.1%; n = 224 species; Table 1 C–H).

The PV2 footprint is utilised by a large number of avifaunal species (Table 1 C & D). At least

30 species regularly utilise the footprint, at least for feeding (Status = U). A further nine species occur as occasional visitors (Status = V), while 12 aerial insectivores (Status = A) may forage over the plateau. In addition, 27 species are expected to pass over the footprint with little or no feeding activity (Status = BIT). Collectively these species include only five CMS species.

None of the remaining species (Table 1 E–H) are expected to occur within the PV2 footprint, except perhaps as irregular stragglers.

5.2. Woodland

Almost one-third of bird species with distributions overlapping the study area prefer woodland habitats (Fig. 32). Several of these species are also associated with scrub, and some others with grassland and other habitats (Fig. 33). The study area is located at or near the southern local limit of many bird species preferring woodland habitats (Fig. 34), coinciding with the proximity of the limit of the Savanna Biome (Fig. 1). Riparian vegetation along the Orange River also provides suitable habitat for a significant number of woodland species (Fig. 34).

In the study area, woodland elements (bushes and trees) occurs everywhere. On the plateaus they are widely scattered, except in certain sloped areas where their density is higher (e.g., Fig. 14). In the valleys the density of woodland elements is variable, but in general highest along drainage features. Density is similarly variable on toeslope areas, but there more extensive dense stands of *Senegalia mellifera* bushes and trees also occur in places.

5.2.1. Species of Conservation Concern

The four species associated with woodland habitats include a two Critically Endangered species and two Near Threatened species (Table 1 A):

5.2.1.1. Critically Endangered

- **White-backed Vulture R123** (CMS:A1,R1). Poisoning, often motivated by the masking of poaching operations and harvesting for the traditional health industry, and collision and electrocution incidents involving power lines are regarded as the main drivers for apparent declines (Murn & Van den Heever 2025). In the Northern Cape, breeding is mainly confined to the Kgalagadi Transfrontier Park, and private farmland in the Askam, Van Zylsrus, and the greater Kimberly areas (Anderson 2004; Anderson & Maritz 1997; Murn *et al.* 2002; R. Visagie (Platberg Karoo Raptor Project, EWT), personal communication). These areas are all located more than 200 km from the proposed development. The study area is located along the southern edge of their current known distribution. This species typically nest on top of a tree canopy and often in loose colonies with one nest per tree (Steyn 1982). Breeding has also been recorded on power line pylons of the

steel lattice type (Anderson 2013; Anderson & Hohne 2007; Ledger & Hobbs 1985). In the Northern Cape, they typically nest on *Vachellia erioloba* trees (Anderson & Maritz 1997), but also on steel lattice-type power line pylons (Anderson 2013; Anderson & Hohne 2007). This species is known to roost in large numbers (>100) on pylons c. 25 km south-west of the POPA (Van Rooyen & Froneman 2022). Not recorded elsewhere in the study area yet. It is concluded that this species could be rare transitory visitors to the study area, but unlikely to interact with the PV2 infrastructure.

- **Lappet-faced Vulture R124** (CMS:A1,R1). Poisoning, often motivated by the masking of poaching operations and harvesting for the traditional health industry, is considered the primary concern with declining numbers, with electrocution and collisions with power lines and drowning being contributing factors (Shaw 2025b). In 2003, there were less than 50 breeding pairs in the Northern Cape, most of them on farmland, of which many were located in the Van Zylsrus area (Anderson 2004; Anderson & Maritz 1997). Most of the nests found in the Northern Cape was located on top of large *Vachellia erioloba* trees (Anderson & Maritz 1997), a tree not found in the POPA. Even though the species may not be breeding in the study area, they range extensively (Spiegel *et al.* 2013). The study area is located along the southern edge of their current known distribution. It is known to roost on pylons c. 25 km south-west of the POPA (Van Rooyen & Froneman 2022). Not recorded elsewhere in the study area yet. This species could be rare transitory visitors to the study area, but unlikely to interact with the PV2 infrastructure.

5.2.1.2. Near Threatened

- **Kori Bustard R230**. Habitat destruction, collisions with overhead power lines, and hunting count amongst the main threats (Ehlers Smith 2025b). This species has a widespread distribution around the study area. Home ranges vary from one to a few square kilometres for females with chicks to tens, hundreds or more square kilometres otherwise (Osborne & Osborne 1998; Senyatso 2011). While they are sedentary in certain parts of their distribution range, *e.g.* Botswana (Senyatso 2011), local/nomadic movements are evident elsewhere, especially during drought conditions (*e.g.* Osborne 1998). This species have been recorded in the toeslope c. 10–12 km west and north of the PV2, including remains of two birds were found close to Burchell substation along two power lines. This species could be an transient visitor to the PV2 plateau.
- **European Roller R446** CMS:A1,A2). Non-breeding Palaearctic migrant present in South Africa mainly from October to April (Herremans 1997a). The majority of threats faced by this species are within its Palaearctic breeding range, as well as on passage during migration (Wilmott 2025). It forages mainly from a perch from which it would fly down to catch prey (mainly insects) on the ground. The study area is located on the western edge its non-breeding range where they mainly occur from January to March (Herremans 1997a). Any potential use of the footprint or environs is likely to be transitory.

5.2.2. Endemic species

The following five species are all near-endemic to South Africa, Lesotho & Swaziland (Table 1 B):

- **Karoo Thrush R577a:** This widespread species is characteristically associated with relatively humid microhabitats, such as garden and riverine vegetation. Within the study area, it was recorded exclusively along the Orange River and at farmsteads, with no observations in the POPA.
- **Fiscal Flycatcher R698:** This species is widespread in this part of South Africa. In the study area it is characteristically associated with relatively dense woodland along the Orange River and in well-vegetated drainage lines on toeslopes beyond the POPA. It could potentially occur in similar, unsurveyed habitats within the POPA.
- **Fairy Flycatcher R706:** This widespread species exhibits sedentary behaviour in some regions, notably the Karoo, while it is migratory in others (Johnson 1997). In the POPA, it was recorded during all three mountain surveys (February, July, and November), and records were exclusively from valleys.
- **Cape White-eye R796b:** This species reaches the northern limit of its local range in the study area. It was not detected during the surveys, but it is most likely to occur in suitable habitat along the Orange River.
- **Cape Weaver R813:** This species reaches the northern limit of its local range in the study area. It was not detected during the surveys, but it is most likely to occur in suitable habitat along the Orange River.

5.2.3. Other species

Most of the remaining 80 woodland-associated bird species are only associated with woodland (n = 61 species; 76.3%). The following seven species utilise the plateaus, including the PV2 footprint, relatively frequently, at least for feeding.

- **Red-crested Korhaan R237:** Occur at low density on the plateaus (where it may breed) and toeslopes.
- **Rufous-cheeked Nightjar R406:** An breeding intra-African migrant present from August to April (Maclean 1997). This nocturnal aerial insectivore were recorded on toeslopes and plateaus. Low density breeding is possible on the plateaus.
- **Sabota Lark R498:** Occur singly or in pairs. One of the most abundant resident species on the plateaus; they are also common on toeslopes, but scarce valleys (Table 3).
- **Acacia Pied Barbet R465:** Occur singly or in pairs. Common species breeding and roosting in the valleys (in holes excavated in *Aloe dichotoma* trees; also sleep in Sociable Weaver R800 nests). Forage in surrounding areas during the day, including on the

plateaus (PV2 footprint included) (Table 3).

- **African Red-eyed Bulbul R567:** Most common in POPA valleys, but also occur on plateaus (including the PV2) and toeslopes (Table 3).
- **Lesser Grey Shrike R731:** This non-breeding Palaearctic migrant is present in South Africa from November to April (Herremans 1997b). Single birds were recorded on the PV2 plateau and nearby toeslope.
- **Sociable Weaver R800:** This gregarious species build their conspicuous communal nests on elevated structures of all sorts. In the study area, where they are very common, this includes utility poles, trees (mainly *Aloe dichotoma*), buildings and cliffs. In the broader study area a high proportion of utility poles have nests on them. Inside the POPA most nests are constructed in *Aloe dichotoma* trees, which occur mainly in the valleys. The nearest nest to the PV2 is located c. 170 m east of it in a *Aloe dichotoma* tree located on the side of Valley East 1, with several other nests located within 1 km. During the day flocks move out to forage in the valleys, toeslopes and on plateaus (Table 3).

The remaining species that are only associated with woodland exhibit a range of finer habitat preferences that generally exclude plateaus. These range from species closely tied to a single location type (e.g., valleys) to others that utilise two or three (e.g., valleys and toeslopes). The presence of the following species on POPA plateaus indicate that movement across the it does occur:

- **Jacobin Cuckoo R382:** Only recorded once when a bird in flight was heard as it crossed the plateau at the PV2 footprint at dawn on 19 February 2026.
- **Golden-tailed Woodpecker R483:** Based on available records, this species occurs at low density in POPA valleys. It was detected only once on a plateau in the POPA, most likely representing a bird in transit.
- **Ashy Tit R552:** Based on available records, this species occurs at low density in POPA valleys. It was detected only once on a plateau in the POPA, most likely representing a bird in transit.
- **Kalahari Scrub Robin R615:** In the POPA, this common species is restricted to toeslopes (Table 3). One exceptional record was of a bird encountered at the edge of a plateau.
- **Brown-crowned Tchagra R743:** In the POPA, this species is associated with valleys and toeslopes (Table 3). One exceptional record of a bird seen in the PV2 footprint on the plateaus on 12 August 2021 probably involved a bird in transit.
- **Pririt Batis R703:** In the POPA, this species is a resident in valleys and on toeslopes. However, it also visits plateaus on occasion.
- **Black-faced Waxbill R847:** In the study area this species was seen in habitats along the Orange River and on toeslopes, including in the POPA. Once an individual which

was observed to cross the PV2 footprint.

Additional species recorded in the POPA valleys and or on toeslopes include the following (see Table 3): **White-backed Mousebird R425**, **Common Scimitarbill R454**, **Fawn-colored Lark R497**, **Spotted Flycatcher R689**, **Cape Starling R764**, **White-bellied Sunbird R787**, **Orange River White-eye R796a**, **White-browed Sparrow-Weaver R799**, **Scaly-feathered Weaver R806**, **Green-winged Pytilia R834**, **Violet-eared Waxbill R845**, and **Black-throated Canary R870**.

The remaining 19 species are also associated with habitats other than woodland. Among the 12 species that utilise both scrub and woodland, the following five occur relatively frequently on POPA plateaus (including the PV2 footprint), at least for foraging:

- **Pale Chanting Goshawk R162**: Occur singly or in pairs on the plateaus and toeslopes with breeding likely in the toeslopes.
- **Yellow-bellied Eremomela R653**: Usually occur in pairs or small groups. Occurs mainly on the plateaus and toeslope, but also found in the valleys (Table 3).
- **Black-chested Prinia R685**: Very common resident on plateaus, in valleys, on toeslopes.
- **Red-headed Finch R856**: This highly nomadic species occurs in pairs or small groups during the breeding season but is otherwise gregarious (Maclean 1985). Individuals drink frequently and may gather in large flocks at water points (Maclean 1985). In the POPA, it was encountered on plateaus (including the PV2 footprint) and toeslopes.
- **Lark-like Bunting R887**: This highly nomadic and gregarious species drinks regularly (Maclean 1985). It is very common on POPA plateaus (including the PV2 footprint) and toeslopes. Was particularly common during February 2026 (Table 3). Individuals were observed drinking at the water-filled depression just outside the footprint (Fig. 11).

The 7 remaining woodland/scrub species include those with various finer habitat preferences that excludes plateaus, ranging from those which is closely associated with only one location type (*e.g.*, valleys) to others that prefer two (*e.g.*, valleys & toeslopes). Presence of the following five species on the plateaus indicates that movement onto or across the plateaus does occur:

- **Cape Penduline Tit R557**: Only two records in the study area, both in the POPA. Once heard on the plateaus and during the February 2026 survey a nest was discovered on toeslope less than 3 km from the PV2 footprint.
- **Chestnut-vented Warbler R621**: In the POPA, this species is relatively common in valleys and on toeslopes (Table 3). The limited records on plateaus probably reflect exploratory movements or birds passing through in transit.
- **Long-billed Crombec R651**: In the POPA, this species was primarily recorded in valleys and on toeslopes. Records on plateaus (including the PV2) probably reflect exploratory movements or birds passing through in transit.

- **Chat Flycatcher R697:** This species was recorded on toeslopes in the study area, including within the POPA. Occasional records on POPA plateaus suggest movement across or over these elevated areas.
- **Dusky Sunbird R788:** In the POPA, this sunbird was primarily recorded in valleys (Table 3). Birds seen on the plateaus (including the PV2 footprint) represent birds passing through in transit.

Of the remaining two woodland/scrub species, only the Pygmy Falcon R186 are confirmed to occur in the POPA:

- **Pygmy Falcon R186:** This species roost (and breed) in Sociable Weaver R800 nest chambers throughout the year (Dieter Oschadleus (2022); Maclean (1970)). There are numerous communal Sociable Weaver nests in the study area (see page 58). In the POPA several of them are occupied by these falcons, almost all in the valleys, with the nearest being located 850 m north of the PV2 footprint in Valley North 1. In the POPA these falcons were only recorded in valleys (Table 3), but in the broader study area they also occur in open expanses.

The final woodland/scrub species is the Cape Robin-Chat R601, confined in the study area to the relatively dense woodland and scrub along the Orange River.

Five species are associated with grassland in addition to woodland. Two species occur relatively frequently on POPA plateaus (including the PV2 footprint), at least for foraging:

- **Orange River Francolin R193:** The study area is located on the south-western edge of their distribution. Coveys of up to six birds are resident on the plateaus and toeslopes.
- **Red-headed Finch R856:** Already considered earlier (see page 59).

A further two woodland/grassland species exhibit habitat preferences that generally excludes the plateaus. Nevertheless, it is considered likely that they would at least fly over the POPA plateaus occasionally:

- **Diederik Cuckoo R386:** This breeding intra-African migrant is present in the region from September to April (Vernon & Herremans 1997). It has a widespread local distribution. In the POPA, it was recorded only in the valleys. As a brood parasite, it has diverse host preferences (Dean 2005b), with the following species potentially serving as hosts for breeding in the POPA: Mountain Chat R586, Karoo Scrub Robin R614, Kalahari Scrub Robin R615, Chestnut-vented Warbler R621, Black-chested Prinia R685, Familiar Chat R589, White-browed Sparrow-Weaver R799, Southern Masked Weaver R814, Yellow Canary R878.
- **Red-breasted Swallow R524:** Present in South Africa as an breeding intra-African migrant from August to March (Earlé 1997c), it constructs mud nests in sheltered locations, typically under overhanging structures like roofs or within tunnel-like features. The study area is situated at the south-western limit of its range. In the POPA, records are restricted to the valleys, where breeding is considered possible.

5.3. Aquatic

Surface water, even in temporary habitats shortly after inundation, often draws birds. Consequently, its presence in an area often implies increased bird movements there.

There is no permanent open water in the footprint of the proposed PV development. The most prominent ephemeral feature likely to retain water for at least a few days after rain events is a natural depression located approximately 50 m outside the footprint (Fig. 11). Water troughs for livestock is located c. 2 km and 3 km north-west of the PV2 footprint on on plateaus.

natural drainage feature in the valleys are all ephemeral and unlikely to retain water for long after any particular rain event. However, in the adjacent toeslope areas several man-made impoundments, including earth walls and excavations constructed in natural drainage systems, can retain water for extended periods. There are also water troughs for livestock.

The Orange River, which at its closed approach is 15 km north of the PV2, represents the most prominent, permanent open water feature in the broader study area (Fig. 3). In addition to open water, a host of other avifaunal habitats are also associated with the river, including riverine islands, riparian thickets (including riparian forest), reed beds, vegetated sand banks, and irrigated agricultural fields (Fig. 3). Another prominent surface water feature is the Prieska Water Treatment works located on the southern bank of the Orange River.

Almost a quarter of the bird species with distributions overlapping with the study area are associated with aquatic habitats (24.3%, Fig. 32). Four of these species are also associated with grassland while one with woodland (Fig. 33). 32 (48.5%) of the 66 aquatic species are also associated with the Orange River in this part of their range. All species associated with marine habitats are also associated with freshwater habitats, except the Eurasian Whimbrel R290 which is a non-breeding migrant associated with marine habitats, but with vagrants recorded at inland freshwater habitats (Fig. 33). There is a SABAP1 record of this species near Prieska (Underhill 1997a).

5.3.1. Species of Conservation Concern

The 16 species associated with aquatic habitats include a two Critically Endangered species, four Vulnerable species, and ten Near Threatened species (Table 1 A):

5.3.1.1. Endangered

- **Black Stork R084** (CMS:W,A2). Degradation of wetlands and the damming of small rivers is thought to have had a negative impact on this species in South Africa (Lee 2025a). Collision and electrocution incidents involving power line infrastructure are a known direct cause of death (Demerdzhiev 2014; Ferrer 2012; Kalocsa & Tamás 2021; Prinsen *et al.* 2011; Smallie 2011). This species has a widespread distribution around the study area. They feed primarily in shallow water, including pools in large rivers, and breed in mountainous regions (Maclean 1985). Usually found solitary

or in pairs, less often in small groups (Maclean 1985). Not recorded during field surveys, however individuals may occasionally visit the Orange River and even man-made impoundments in the toeslopes of the POPA.

- **Saddle-billed Stork R088.** Threats are poorly understood (NA Anonymous 2025). In South Africa this species occur mainly in the north-eastern lowveld areas, extending south to Eswatini and north-eastern KwaZulu-Natal (Benn 1997). They are sporadically recorded in the Free State and in the Northern Cape (Benn 1997). It is a huge and conspicuous species associated with relatively large wetlands. Occurrence in the study area and particularly the POPA is considered unlikely.

5.3.1.2. Vulnerable

- **Yellow-billed Stork R090** (CMS:W,A2). The main threat in the region is thought to be the loss of wetland habitat (including pans, marshes and floodplains) on which the species depends for foraging (Evans 2025). Seldom recorded west of the Free State. Mainly associated with inland waters. Possibly a rare visitor to the study area.
- **Lesser Flamingo R097** (CMS:W,A2). Threats are varied, including loss or degradation of its specialised breeding and feeding habitats (open, eutrophic, shallow saline-alkaline wetlands) and collisions with fences and utility lines (Anderson 2025b). The study area is located at the north-western limit of their range. Possibly a sporadic visitor to the study area, but unlikely to occur in the POPA.
- **Chestnut-banded Plover R247** (CMS:W,A2). Its habitats face increasing disturbance and degradation, though commercial salt pans have paradoxically expanded suitable saline areas and boosted populations (Nebel 2025). The study area is located near the western limits of this species range. In inland areas this species is mainly found in natural and man-made salt pans (Tree 1997). There is no suitable habitat for this species in the study area.
- **Curlew Sandpiper R272** (CMS:W,A2). Numerous threats contribute to declining populations of this non-breeding Palaearctic migrant (Shaw & Paul 2025c). Widespread, but scattered, distribution around the study area. Inland habitat includes pans, dams and vleis. Like to visit man-made impoundments in the toeslope.

5.3.1.3. Near Threatened

- **African Darter R060.** Current threats contributing to the projected decline of this piscivorous species is unclear (Radue *et al.* 2025). This diving bird typically occurs in still and slow-moving freshwater bodies with open water. In this part of their range they are closely associated with the Orange River. Not expected to occur in the POPA.
- **Black-crowned Night Heron R076** (CMS:W). While the specific threats to this species in the region is unknown, they are known to be susceptible to certain pesticides, avian influenza, Newcastle disease, and avian botulism (Gibbs *et al.* 2025). During

the day they roost in vegetated margins of water bodies from where they emerge at dusk to forage along shorelines and patches of shallow water. SABAP2 indicates only a few scattered records along the Orange River in the Northern Cape <https://sabap2.birdmap.africa/species/69>. Not expected to occur in the POPA.

- **Hamerkop R081.** No specific threats are currently known for this species (Rose & Paul 2025a). They are associated with all kinds of permanent and ephemeral aquatic habitats. In this part of their range they are closely associated with the Orange River where they are relatively common. Occurrence in the POPA is most likely in the man-made impoundments in the toeslope.
- **Greater Flamingo R096** (CMS:W,A2). One of the primary concern for the continued survival of the species is collisions with fences and utility lines (Anderson 2025a). The species occurs on open, saline wetlands. The study area is located on the north-western limit of their distribution. Rarely recorded along the Orange River in the Northern Cape. A juvenile bird was seen at the Prieska Water Treatment Works on 26 July 2021. Not expected to occur in the POPA.
- **Yellow-billed Duck R104** (CMS:W,A2). Threats for this species include its susceptibility to botulism, hybridization with Mallard (*Anas platyrhynchos*), and hunting (Coetzee & Paul 2025a). Associated with a wide variety of open water habitats. In this part of their range they are closely associated with the Orange River where they are relatively common. This species occurs along the Orange River in the study area, and could potentially visit the man-made impoundments in the POPA.
- **Red-billed Teal R108** (CMS:W,A2). There is currently no known specific threats to this species (Shaw & Paul 2025a). Associated with a wide variety of open water habitats. In this part of their range they have a widespread distribution. In the study area this species was only recorded at the Prieska Water Treatment Works. Unlikely to occur in the POPA.
- **Cape Shoveler R112** (CMS:A2). There is currently no known specific threats to this species (Shaw & Paul 2025b). It prefers shallow, plankton-rich wetlands and dams. In this part of their range they have a widespread distribution. In the study area this species was only recorded at the Prieska Water Treatment Works. Unlikely to occur in the POPA.
- **Southern Pochard R113** (CMS:W). Factors that could contribute to decrease in numbers of this species include botulism and avian influenza, entanglement with fishing nets, and hunting (Coetzee & Paul 2025b). This species prefer fairly deep, clear, freshwater bodies. Rarely encountered along the Orange River in the Northern Cape (<https://sabap2.birdmap.africa/species/102>). In the study area this species was only recorded at the Prieska Water Treatment Works. Unlikely to occur in the POPA.
- **Knob-billed Duck R115** (CMS:W). There is currently no known specific threats to this species (Rose & Paul 2025b). Associated with a wide variety of open water habitats.

Rarely recorded in this part of their range. On 21 August 2021 a single bird was seen at the Prieska Water Treatment Works. Unlikely to occur in the POPA.

- **Kittlitz's Plover R248** (CMS:W,A2). Wetland degradation and susceptibility to avian malaria and avian botulism are the main threats to this species (Nebel & Paul 2025). Habitat preferences range from open shorelines of inland water (less commonly sea-shore) to short grass away from open water. During SABAP2, Northern Cape records of this species are widely scattered, with a notable concentration along the Orange River up to Upington <https://sabap2.birdmap.africa/species/237>. In the study area this species was only recorded at the Prieska Water Treatment Works. Unlikely to occur in the POPA.

5.3.2. Endemic species

The Namaqua Warbler R687 is the only aquatic species that is endemic (Table 1 B). They are common along the Orange River, but not expected to occur in the POPA.

5.3.3. Other species

The distributions of an additional 48 aquatic species overlap with the study area, of which 26 (54.2%) are closely associated with the Orange River in this part of their range. Among these, 17 (35.4%) fall in CMS category A2 and 26 (54.2%) in CMS category W (Table 1 C, D & E). Only five species (listed below) were recorded in the POPA; all are commonly associated with the Orange River and the Prieska Water Treatment works.

- **Little Grebe R008** (CMS:W): Usually in pairs or family groups. One adult was observed at a man-made excavation on the toeslope 3 km south-west of the PV2 footprint.
- **Egyptian Goose R102** (CMS:W): On 12 October 2021, ~500 birds were observed in an irrigation field near the Orange River. Pairs and small flocks fly south daily, routinely crossing POPA plateaus via valleys and utilising the Burchell–Cuprum 132 kV power line valley. They use man-made impoundments north and south of the mountains (up to 12 birds recorded south).
- **South African Shelduck R103** (CMS:W): Pairs and small flocks fly south daily from the Orange River, most frequently using the Burchell–Cuprum 132 kV power line valley to bypass the mountains. They utilise impoundments north and south of the mountains and occasionally cross POPA plateaus via valleys.
- **Cape Wagtail R713**: Typically seen as singles or pairs. Recorded only twice in the POPA: once in the Burchell–Cuprum 132 kV power line valley, and once at a northern impoundment.
- **Southern Red Bishop R824**: In the study area this species is mainly associated with habitats along the Orange River, where it likely breeds. Birds observed elsewhere most

likely derive from these birds. The limited records from the POPA include birds on northern toeslopes and once on a plateau.

5.4. Scrub

18.8% of species with distributions overlapping with the study area are associated with scrub habitats, of which 27.5% are endemics (Fig. 32). For a fair proportion of these species, the study area is located at or near the north-eastern aspect of their range (Fig. 34). Most of the scrub species are also associated with other habitats, particularly grassland and woodland (Fig. 33). The plateaus, including the footprint of the proposed development, is scrubland (Fig. 20). Toeslopes are mosaics of grassland, scrubland and woodland.

5.4.1. Species of Conservation Concern

The six scrub-associated taxa include two Endangered species, one Vulnerable species, and three Near Threatened species (Table 1 A).

5.4.1.1. Endangered species

- **Black Harrier R168** (CMS:R1): Near-endemic. This species's main threats include include habitat loss, pesticides, power lines, wind farms, climate change and low genetic diversity (Simmons & Curtis-Scott 2025). The status of the Black Harrier in the Northern Cape has been described as “irruptive ... in response to food availability, being abundant one year and completely absent the next” (Taylor 2015). Non-breeding individuals from the south-western parts of South Africa (see Garcia-Heras *et al.* 2019-01; Simmons 1997) could potentially visit the study area. However, any potential use of the footprint and environs is likely transitory.
- **Ludwig's Bustard R232**. Mortalities from collisions with power lines and telephone lines are regarded as the main threat to the regional population (Pretorius & Rose 2025). GPS satellite tracking of eight birds in the Northern Cape confirmed Allan's (1994) suggestion that the species is nomadic and partially migratory, with movements primarily along an east–west axis (Shaw 2013). Most travelling flights occurred in the early morning or late afternoon, often in low light and rarely at night (Shaw 2013). The species is polygynous, with dispersed leks where males perform booming calls audible over several kilometres (Allan 2004), and females likely undertake all parental care alone (Tarboton 2001). It has a widespread distribution in this part of South Africa. Surveys in the POPA indicate that it occurs on toeslopes and on plateaus, where it appears to be a regular visitor, with most sightings within the PV2 footprint (February (iNaturalist #348007237), August (iNaturalist #348006334), and November). It was particularly common on the plateaus during the February 2026 survey, with several records of singles and groups of two birds. No booming displays were heard.

5.4.1.2. Vulnerable species

- **Burchell's Courser R299.** The nature, extent and causes of the apparent rapid decline in the range of this species are poorly understood (Ehlers Smith 2025c). This widespread species favours open habitats with bare ground or short or burned grass (Maclean 1985). Any potential use of the footprint and environs is likely to be transitory.

5.4.1.3. Near Threatened

- **Kori Bustard R230.** This species is also associated with woodland and was already considered there (see page 56).
- **Karoo Korhaan R235:** Near-endemic. Collisions with power lines are among the few general threats this species faces (Lee 2025b). It usually lives in pairs that maintain territories throughout the year (Boobyer 1989; Quinton 1948). The species has a widespread distribution in this part of South Africa. Surveys in the POPA indicate that it occurs on toeslopes and on plateaus, with at least one territory overlapping the PV2 footprint.
- **Sclater's Lark R510:** Near-endemic. There is uncertainty regarding the population trend of this species. Its inclusion in the regional Red Data Book is based on its relatively small and fragmented range and evidence of possible range contraction (Theron & Lee 2025). Rapid expansion of renewable energy development across much of its range is a major concern, as the cumulative impact of habitat disturbance, degradation and loss could be substantial (Theron & Lee 2025). This species is highly habitat specific, showing a strong association with veld characterized by calcrete geological intrusions and the presence of the small shrub *Salsola tuberculata* (locally known as 'blomkoolganna') (Lee & Theron 2023). Alongside Stark's Lark R511, it is one of only two bird species known to exploit seeds of the grass *Enneapogon desvauii* (Lloyd 1999). All of these habitat components occur within the POPA (Lamprecht 2022), which lies near the eastern limit of the species' range. Although surveys conducted to date have not detect Sclater's Lark, occasional use of the footprint area remains possible.

5.4.2. Endemic species

There are 15 endemic species, including three SCC considered above. Si species have widespread distributions around the study area while another five is at the northern limit of their respective range.

Only the following five species were recorded in the POPA.

- **Karoo Korhaan R235:** This SCC was already considered above.
- **Grey Tit R551:** It occurs in pairs or small family groups. The study area is situated near the northern limit of its distribution, and the species was recorded only in valleys (Table 3).

- **Karoo Scrub Robin R614:** Usually solitary or in pairs, this widespread species is the most numerous scrub endemic, occurring on plateaus (including the PV2 footprint), in valleys, and on toeslopes (Table 3). The nest is usually on the ground (Tarboton 2001).
- **Fairy Flycatcher R706:** This species is also associated with woodland and was already considered earlier (see page 57)
- **Southern Double-collared Sunbird R783:** Usually solitary, in pairs, or small groups (Maclean 1985), this species occurs at the eastern edge of its local distribution in the study area. Only one record exists: a single individual observed in a valley approximately 3 km south south-east of the PV2 footprint.
- **Black-headed Canary R876:** Breeding populations are largely resident, while non-breeding individuals and post-breeding flocks may undertake irregular movements in response to rainfall events or food shortages, sometimes resulting in temporary interruptions or range expansions (Dean & Harrison 1997). Breeding is seasonal in most areas but probably opportunistic in more arid regions (Skead 1960). In the Nama-Karoo (which includes the study area), breeding occurs from May to October, peaking in July–September (Dean 2005d). The nest is placed 0.3–1.0 m above ground in woody or succulent shrub (Dean 2005d). In the POPA, the species was recorded only during the February 2026 survey, when individuals were encountered exclusively on plateaus. This timing is consistent with seasonal non-breeding use of the area, but breeding cannot be ruled out under favourable conditions (*e.g.*, following good rainfall). Both subspecies were photographed at a water-filled natural depression just to the west of the PV2 footprint (Fig. 11), highlighting the importance of such ephemeral water sources for the species in the arid landscape.

5.4.3. Other species

Eleven (32.4%) of the remaining 34 scrub species are only associated with scrub habitat. The study area lies on the edge of the distribution of three species, including two species (Stark's Lark R511 and Tractrac Chat R590) not recorded during the surveys. The remaining nine are as follows:

- **Namaqua Sandgrouse R344:** A gregarious species with a prominent daily routine, including an early morning flight from roost to a drinking site, followed by movement to a feeding site where birds remain until late afternoon before returning to roost (Knight 1989; Lloyd 1998; Maclean 1968). In one study, up to 1,943 individuals were observed drinking on the Orange River banks near Groblershoop (Lloyd 1998). In the POPA, it occurs on plateaus and toeslopes, where it is encountered both on the ground and in flight.
- **Karoo Long-billed Lark R500d:** Usually solitary or in pairs, this is one of the most abundant species in the POPA, where it is resident on the plateaus (including the PV2 footprint) and toeslopes (Table 3).

- **Karoo Chat R592:** Usually solitary or in pairs, it is relatively common across POPA plateaus (including the PV2 footprint) and was only rarely encountered on toeslopes (Table 3).
- **Layard's Warbler R622:** Usually solitary or in pairs, this common species is primarily associated with POPA valleys, from which it occasionally explores adjacent plateaus, including the PV2 footprint (Table 3).
- **Grey-backed Cisticola R669:** Usually in pairs, this is one of the most abundant species in the POPA, occurring on plateaus (including the PV2 footprint), valleys, and toeslopes (Table 3).
- **Neddicky R681:** The study area is near the western limit of its local range. Usually solitary or in pairs, this species is confined to POPA valleys (Table 3). Notably, it was not recorded in the upper reaches of any of the three valleys assessed.
- **Rufous-eared Warbler R688:** Usually solitary or in pairs, this is one of the most abundant species in the POPA where they occur on the plateaus (including the PV2 footprint) and toeslopes.
- **Bokmakierie R746:** Usually in pairs, this is also a very common species on POPA plateaus (including the PV2 footprint), valleys and toeslopes (Table 3).
- **White-throated Canary R879:** Occurrence range from pairs to flocks, the latter particularly at water points (Dean 2005e). In the POPA, most records were from plateaus (including the PV2 footprint) (Table 3).

Of the remaining 23 species, 12 are also associated with woodland, including two which are additionally associated with a third habitat, grassland and forest respectively. The following five species utilise the POPA plateaus relatively frequently, at least for feeding: Pale Chanting Goshawk R162, Yellow-bellied Eremomela R653, Black-chested Prinia R685, Red-headed Finch R856, Lark-like Bunting R887. All five was already considered earlier (see page 59). Presence of the following six species on the plateaus indicate that movement across the plateaus do occur: Cape Penduline Tit R557, Chestnut-vented Warbler R621, Long-billed Crombec R651, Chat Flycatcher R697, Dusky Sunbird R788. The Pygmy Falcon R186, a resident of POPA valleys, was already considered earlier (see page 60).

Twelve species are associated with grassland in addition to scrub, including two which are additionally associated with a third habitat, woodland and montane/rocky respectively. The following five species utilise the POPA plateaus relatively frequently, at least for feeding:

- **Double-banded Courser R301:** Encountered as pairs or single birds on the plateaus (including the PV2 footprint) and toeslopes. A juvenile encountered on one of the plateaus confirms the breeding status of this species.
- **Spike-heeled Lark R506:** Resident on plateaus (including the PV2 footprint) and on toeslopes where they occur in groups of up to four individuals.
- **Grey-backed Sparrow-Lark R516:** This nomadic and gregarious species

(Maclean 1985) was encountered on plateaus (including the PV2 footprint) and on toeslopes. Drink water frequently (Maclean 1985).

- **Greater Striped Swallow R526:** This breeding intra-African migrant is present in the region from September to May (Earlé 1997d). As an aerial insectivore, it constructs mud nests in sheltered spots, typically beneath overhanging structures such as roofs or inside tunnel-like features. In the POPA, it breeds in valleys, where nests are constructed underneath rock overhangs, and forages over plateaus (including the PV2 footprint), valleys, and toeslopes (Table 3).
- **Cape Bunting R885:** One of the most abundant species and a breeding resident in the POPA, it occurs on plateaus (including within the PV2 footprint), in valleys, and on toeslopes (Table 3).

The seven remaining scrub/grassland species exhibit a range of finer habitat preferences that generally exclude plateaus. These range from species closely associated with only one location type (e.g., valleys) to others that utilise two (e.g., valleys and toeslopes). The presence of the following three species on plateaus indicates that movement across plateaus does occur:

- **Capped Wheatear R587:** Usually seen singly or in pairs, this widespread species exhibits complex and poorly understood movement patterns, with evidence of both resident and breeding migrant populations (Dean 2005c). In the POPA, it probably breeds on toeslopes. A juvenile bird was observed on one of the plateaus on 14 November 2025.
- **Yellow Canary R878:** This widespread species occurs in pairs during the breeding season but otherwise in small flocks, with larger flocks gathering at water points (Maclean 1985). It is scarce in the POPA, where it was encountered only on plateaus and toeslopes.

Finally, the Ant-eating Chat R595 is the only other scrub/grassland species recorded in the POPA. It occurred exclusively on toeslopes more than 3 km from the PV2 footprint.

5.5. Grassland

Only 15.4% of bird species with distributions overlapping with the study area are grassland-associated (Fig. 32). Many of them are also associated with other habitats, mainly scrub (Fig. 33). Slightly more grassland species tend to occur east of the study area than west of it (Fig. 34). In the study area patches of grassland occur on the toeslopes.

5.5.1. Species of Conservation Concern

4 (12.1%) of the 33 SCC are associated with grassland, including one Endangered species, two Vulnerable species and one Near Threatened species (Table 1 A).

5.5.1.1. Endangered:

- **Black Harrier R168** (CMS:R1): Near-endemic. This species is also associated with scrub habitats and is considered there (see page 65).

5.5.1.2. Vulnerable:

- **Blue Crane R208**: Near-endemic. Collision with power lines is the primary threat to this species (Craig 2025). The study area is located near the north-western limit of their distribution. Not recorded in the study area and unlikely to utilise the POPA.
- **Burchell's Courser R299**. This species is also associated with scrub habitats and is considered there (see page 66).

5.5.1.3. Near Threatened:

- **Karoo Korhaan R235**: Near-endemic. This species is also associated with scrub habitats and is considered there (see page 66).

5.5.2. Endemic species

A total of seven of the species associated with grassland are endemics (Fig. 32). The three SCC were already considered above. None of the remaining four endemics were encountered during the surveys in the study area and is not expected in to occur in the POPA.

5.5.3. Other species

In addition to the species considered above, another 35 grassland species have distributions that overlap with the study area, including three CMS species (A2 & W) (Table 1 E). Of the 14 species that are only associated with grassland, the following six are known to occur in the POPA:

- **Common Quail R200**: Little is known about the movements of this species, although migratory, nomadic, and irregular movements (possibly linked to rainfall events) have been inferred from available data (Taylor 2005). When on the move, individuals fly at night, at least in migratory portions of the population (Bertin *et al.* 2007). This widespread species was recorded in the study area and, in particular, within the POPA, where it was encountered on plateaus (including the PV2 footprint) and toeslopes.
- **Common Buttonquail R205**: Movement patterns of this species are complex, with available data indicating a combination of resident, nomadic, and irruptive behaviour (Dean 2005a). Nocturnal movements have been observed (*e.g.* Herholdt 2001), which may increase vulnerability to certain infrastructure types. This widespread species was recorded only on POPA plateaus, including within the PV2 footprint.

- **Northern Black Korhaan R239a:** A solitary yet widespread species, it is common in the study area. Within the POPA, it occurs on plateaus (including the PV2 footprint) as well as toeslopes. In repeated surveys of the footprint, it was only recorded in November 2025 (Table 3). This pattern may indicate that birds observed on the plateaus are individuals moving through from the toeslopes, rather than resident populations.
- **Eastern Clapper Lark R495a:** Common resident on POPA plateaus (including within the PV2 footprint) and toeslopes (Table 3).
- **Desert Cisticola R665:** Common resident on POPA plateaus (including within the PV2 footprint) and toeslopes (Table 3). The only valley in which it was recorded was Valley East 1, reflecting its preference for open habitats. Records in other valleys (Table 3) was at the border of toeslopes.
- **African Pipit R716:** Although this is a widespread species in this part of South Africa, it is uncommon in the study area and POPA, where it was recorded on plateaus and toeslopes.

Twelve species are associated with grassland in addition to scrub, including two which are additionally associated with a third habitat, woodland and montane/rocky respectively. The following six species utilise the POPA plateaus relatively frequently, at least for feeding: Double-banded Courser R301, Spike-heeled Lark R506, Grey-backed Sparrow-Lark R516, Greater Striped Swallow R526, Red-headed Finch R856 and Cape Bunting R885. They were already considered earlier (see page 68).

The seven remaining scrub/grassland species exhibit a range of finer habitat preferences that generally exclude plateaus. The presence of the following species on plateaus indicates that movement across plateaus does occur: **Capped Wheatear R587** and **Yellow Canary R878**. They were already considered earlier (see page 69).

Finally, the **Ant-eating Chat R595** is the only other scrub/grassland species recorded in the POPA. It occurred exclusively on toeslopes more than 3 km from the PV2 footprint.

Five grassland species are additionally associated with woodland (see details on page 60). The Orange River Francolin R193 and Red-headed Finch R856 occur relatively frequently on POPA plateaus (including the PV2 footprint), at least for foraging. Diederik Cuckoo R386 and Red-breasted Swallow R524 exhibit habitat preferences that generally excludes the plateaus, but is considered likely to at least fly over the POPA plateaus occasionally.

5.6. Montane/Rocky

Only 4.0% (n = 11 species) of the 273 bird species are associated with montane and rocky habitats (Fig. 32). One of them, the Cape Bunting (R885), is additionally also associated with scrub and grassland (Fig. 33). The proposed PV2 is located on a plateau in the Doringberg mountains south of Prieska. All 11 species occur in the POPA, and all except two—Cape Eagle-Owl R400 and White-necked Raven R550 are near the northern limit of their respective

ranges—are widespread in this part of their range.

5.6.1. Species of Conservation Concern

The Vulnerable Verreaux's Eagle R131 is the only SCC associated with montane/rocky habitats.

5.6.1.1. Vulnerable

- **Verreaux's Eagle R131:** Within South Africa, this species faces threats including collisions with wind turbines (Ralston-Paton 2025), collisions and electrocution on power line infrastructure, direct persecution, and drowning in reservoirs (Murgatroyd & Rodrigues 2025). It is typically associated with rocky or mountainous terrain, where its presence almost invariably coincides with that of its principal prey, the Rock Hyrax (*Procapra capensis*) (Steyn 1982).

The PV2 footprint is located in the midst of the core breeding area for this species in the Doringberg range (Van Rooyen & Froneman 2023b). To date, no fewer than 29 nests have been discovered in the POPA between 0.9 and 5.8 km from the footprint (Fig. 36, page 196; Table 4, page 159). These are distributed across 12 nesting localities (labelled C–H and J–O), with 1–6 nests per locality (nests spaced 1–461 m apart within localities). Each locality is separated from the next by more than 1 km, and nearest-neighbour localities are separated by 1.1–2.5 km (median = 1.2 km; Fig. 36). The distance from the PV2 footprint to the nearest nest in each of the 12 localities ranges from 0.9 km (M) to 5.7 km (F) (median = 3.0 km) (Fig. 36).

The exact number of breeding pairs currently utilising these nests is not precisely known, but at least six pairs were confirmed to breed within the POPA during the 2021 breeding season, prior to the discovery of nesting localities K, L, M, N, and O. The distance between nearest-neighbour active nests ranged from 2.06 km to 4.16 km, with an exceptionally low mean of only 2.91 km. For comparison, Ralston-Paton & Murgatroyd (2021) tabulated the mean distance between nests of different pairs at 15 localities in South Africa. If the Doringberg site is added to that list, it would rank second, between the 2.72 km mean reported by Davies (1994) and the 3.84 km mean from an unspecified wind farm location, all within the Nama Karoo.

5.6.2. Endemic species

- **African Rock Pipit R721:** The only endemic species that occur near the study area. When not calling this species is very difficult to detect. Fortunately, this species is very vocal during the breeding season. Common in POPA valleys (Table 3). Records from toeslopes in Table 3 represent birds calling from adjacent mountain slopes.

5.6.3. Other species

All nine species was recorded in the study area.

- **Cape Eagle-Owl R400:** This nocturnal species is resident in the POPA, where it is recorded in valleys and presumed to breed. It may occasionally visit adjacent plateau areas.
- **Large Rock Martin R529:** A breeding resident in the POPA, where it is largely confined to valleys but occasionally visits adjacent plateaus, including the PV2 footprint (Table 3). It builds half-cup-shaped mud nests lined with grass and feathers, usually attached to a vertical such as a building or rock face (Maclean 1985). As an aerial insectivore, it forages almost exclusively on flying insects captured in sustained, low-level flight.
- **White-necked Raven R550:** A breeding resident in the POPA, it was most commonly recorded in two discrete areas: valleys 0.8–2.0 km south-east of the PV2 footprint, and the escarpment 3–4 km north-west of the footprint. Nests assumed to belong to this species were also found in these locations. Occasional flights across the plateaus were documented.
- **Short-toed Rock Thrush R583:** Breeding resident in the POPA, where it is largely confined to valleys but also occasionally visits the edges of adjacent plateaus, including the PV2 footprint (Table 3).
- **Mountain Chat R586:** Breeding resident in the POPA, where it is largely confined to valleys but also occasionally visits the edges of adjacent plateaus, including the PV2 footprint (Table 3).
- **Nicholson's Pipit R717:** Breeding resident in the POPA, where it is confined to valleys.
- **Pale-winged Starling R770:** Breeding resident in POPA valleys. Regularly fly across plateaus to other valleys and to toeslopes (Table 3).
- **Cape Bunting R885:** One of the most abundant species and a breeding resident in the POPA, it occurs on plateaus (including within the PV2 footprint), in valleys, and on toeslopes.
- **Cinnamon-breasted Bunting R886:** This species is nomadic when not breeding (Maclean 1985). In the POPA it occurs at low density and was mostly recorded on the rims of valleys

5.7. Forest

Only 4 (1.5%) of the 273 species are associated with forest habitats (Fig. 32). They are also associated with scrub and/or woodland (Fig. 33). For three of the four species the study area is located on the edge of their respective distributions. narrow strips of closed canopy forest

habitats occur along the banks of the Orange River.

5.7.1. Species of Conservation Concern

None.

5.7.2. Endemic species

Only two endemic species are associated with forest habitats:

- **Southern Double-collared Sunbird R783:** This species is associated with scrub in addition to forest and was already considered earlier (see page 67).
- **Cape White-eye R796b:** This species is associated with scrub and woodland in addition to forest and was considered earlier (see page 57).

5.7.3. Other species

The remaining two forest-associated species are as follows:

- **Fork-tailed Drongo R541:** The study area lies at the southern limit of this species' local range. It is additionally also associated with woodland. It was not recorded during the surveys, but it could potentially occur in woodland along the Orange River.
- **Cape Robin-Chat R601:** This widespread species is also associated with woodland and scrub. In the study area it is confined to relatively dense woodland and scrub along the Orange River.

5.8. Habitat generalists

One-fifth (20.2%) of all bird species with distributions that overlap the study area are considered habitat generalists (Fig. 32). No dominant distribution pattern is evident (Fig. 34).

5.8.1. Species of Conservation Concern

The six SCC include two Endangered species, two Vulnerable species, and two Near Threatened species.

5.8.1.1. Endangered

- **Tawny Eagle R132 (CMS:R1).** Woody plant encroachment, poisoning, persecution and drowning are considered to be the primary reasons for the apparent decline of this

species (Tate 2025a). Collision and electrocution incidents involving power line infrastructure have also been recorded (Anderson 2000a; Environmental Information Service Namibia 2022; Prinsen *et al.* 2011; Shaw 2013; Shaw *et al.* 2021; Smallie 2011; Van Rooyen & Ledger 1999; Vosloo & Van Rooyen 2009a). The study area is located along the south-western limit of their range. They hunt either from a perch or on the wing, with their diet including carrion, mammals, birds, reptiles and insects (Steyn 1982). In the study area the only record of this species was an individual seen by Van Rooyen & Froneman (2023a) about 7.1 km west of the PV2 footprint.

- **Martial Eagle R140.** Fatal interactions with power line infrastructure via collisions and electrocution count among several major threats to this species (Tate 2025b). This widespread species does most of its hunting on the wing and feed mainly on mammals, birds and reptiles (Steyn 1982). They are well known to breed on lattice type pylons (Anderson 2000a, 2013; Anderson & Hohne 2007; Dean 1975; Jenkins *et al.* 2013; Ledger & Hobbs 1985; Ledger & Hobbs 1999; Machange 2003; Tarboton & Allan 1984; Vosloo & Van Rooyen 2009b). The only record of this species in the study area was a juvenile seen 14 km north-east of the PV2 footprint on 21 August 2021.

5.8.1.2. Vulnerable

- **Secretarybird R118.** Habitat loss is considered the primary threat to this species (Carstens & Rose 2025). This species appears on may lists recording collision incidents involving power line infrastructure (Brown & Lawson 1989; Diamond 2008; Diamond *et al.* 2010; Environmental Information Service Namibia 2022; Pallett *et al.* 2022; Prinsen *et al.* 2011; Shaw 2013; Shaw *et al.* 2021; Smallie 2011; Van Niekerk 2013; Van Rooyen & Ledger 1999; Vosloo & Van Rooyen 2009a). This widespread raptor roosts in trees and forages while walking tens of kilometres a day through the veld in search of prey (Steyn 1982). Not recorded in the study area, but is potentially an infrequent visitor to plateaus and toeslopes.
- **Cape Vulture R122 (CMS:A1,R1).** The species faces numerous threats, including electrocution on, and collision with, electricity infrastructure (Shaw 2025a). The study area is located on the south-western limit of the species's range. Only recorded once when a bird was seen in flight on 31 July 2021 over the valley just east of the PV2.

5.8.1.3. Near Threatened

- **Black-winged Kite R127:** Threats to this species are not well defined (Ehlers Smith 2025a). It occurs in various open habitats, where it preys mainly on rodents (Steyn 1982). In the study area, situated at the south-western edge of its local range, the species is restricted to agricultural fields along the Orange River, with no records in the POPA.
- **Lanner Falcon R172 (CMS:R2).** Threats include loss or transformation of habitat, direct persecution, collisions with power lines and Avian Influenza (Jenkins & Van

Zyl 2025). Electrocution incidents involving power line infrastructure have also been recorded (Anderson 2000a; Prinsen *et al.* 2011; Smallie 2011). The diet of this widespread raptor consists mainly of birds, supplemented by small mammals, reptiles, and insects (Jenkins 2005b; Steyn 1982). It breeds preferentially on cliffs but also utilises stick nests of other birds in trees or on power pylons (Steyn 1982). In the POPA, evidence suggestive of breeding includes aggressive interactions observed in July (consistent with the egg-laying period of late May to early September (Jenkins 2005b)) as well as the presence of two apparently separate groups of three juveniles each interacting in February (Fig. 37, page 197).

5.8.2. Endemic species

Among the habitat generalists, there are only two endemic species.

- **Jackal Buzzard R152:** This species occurs in hilly or mountainous terrain, but they also hunt in habitats some distance from mountains (Steyn 1982). The study area is located near the northern limit of their local range. It is a resident in the POPA. One suspected nest was located about 1 km south-west of the PV2 footprint (Van Rooyen & Froneman 2023a). They do hunt over the plateaus including the PV2 footprint.
- **Pied Starling R759:** The study area is located along the north-western limit of the species range, and they have not been recorded in the study area during the surveys.

5.8.3. Other species

Eleven of the remaining 48 habitat generalists are CMS species in three categories (A2, W & R3) (Table 1 E). Species recorded only along the Orange River and its environs include the following species: **Black-headed Heron R063**, **White Stork R083**, **Abdim's Stork R085**, **African Sacred Ibis R091**, and **Common Buzzard R149**. The **Western Cattle Egret R071** was recorded along the Orange river as well as on the toeslope just outside the POPA, where a individual was observed associating with goats. In addition, the following CMS species were recorded within the POPA:

- **Black Kite R126y** (CMS:A2,R3). Van Rooyen & Froneman (2023a) recorded the Yellow-billed Kite *Milvus migrans parasitus* in their PAOI, which overlaps extensively with the current POPA, but provided no additional details. This subspecies is an intra-African migrant to southern Africa, present from September to February, with evidence of at least some breeding in the region (Mendelsohn 1997).
- **Booted Eagle R136** (CMS:A2,R3). The status of this species in South Africa has long been complicated by the existence of two morphologically indistinguishable populations (Brooke 1974; Steyn 1982). One is a breeding intra-African migrant that is present mainly from August to March (with some individuals overwintering), with egg-laying peaking from September to November (Boshoff & Allan 1997). The second population

is a trans-Saharan Palaearctic migrant which breeds in the Palaearctic (egg laying April–May; Orta *et al.* 2020) where present from February to August (Snow & Perrins 1998).

According to the literature (e.g. (Boshoff & Allan 1997; Maclean 1985)), the study area falls outside the currently mapped South African breeding range of the intra-African population. The nests of this species are difficult to locate, being built on small ledges and usually at the base of a tree or bush (Steyn 1982). However, breeding was confirmed in the POPA when a nest containing a nestling was discovered on 13 November 2025 in a gorge known as Lelikekloof (Fig. 38, page 198). This nest is located 1.3 km west of the PV2 footprint. Breeding is also suspected at the following locations in the POPA (see Figure 36 for the location of wind turbines and Verreaux's Eagle nesting locations):

- One of the gorges associated with the isolated plateau just north of Plateau 2, possibly the one with Verreaux's Eagle nest location F.
- The gorge at Verreaux's Eagle nesting location E.
- The small gorge c. 750 m north of Verreaux's Eagle nesting location E.
- Valley North 2, specifically in the vicinity of a gorge c. 750 m west of Verreaux's Eagle nesting location E.
- The lower half of Valley North 1.
- In, or near, the gorge north-west of Verreaux's Eagle nesting location D.

In the POPA, the Booted Eagle hunts on plateaus, in valleys, and on toeslopes. Its diet consists mainly of bird up to the size of Namaqua Sandgrouse R344, and also lizards and rodents and insects (Steyn & Grobler 1981a,b, 1985a,b).

- **Rock Kestrel R181** (CMS:R3): In South Africa, this widespread species is a partial migrant, with both sedentary and migratory populations present (Van Zyl *et al.* 1994). Its diet varies regionally and includes small mammals, birds, reptiles, and arthropods (Jenkins 2005a). Eggs are laid from September to January, with a peak occurring from October to December. It most commonly nests on ledges or in hollows on cliffs, where a simple scrape on the substrate serves as the nest without any nesting material (Steyn 1982). It was recorded during all surveys in the study area, indicating the presence of a resident population. In the POPA, it is primarily associated with valleys, although it was also observed hunting over plateaus, including within the PV2 footprint. Evidence of breeding in the POPA includes:
 - a nest containing an egg discovered in a hollow on a cliff approximately 950 m east of the PV2 footprint (14 November 2025; Fig. 39, page 199),
 - a pair observed feeding a fledgling (10 October 2021), and
 - aggressive interactions with other species (Verreaux's Eagle R131, Booted Eagle R136 & Pied Crow R548) during the November 2025 survey.
- **European Bee-eater R438** (CMS:A2): Two populations occur in South Africa: breed-

ing intra-African migrants and non-breeding visitors from the Palaearctic (Underhill 1997b). In this part of its range, the species is mainly present from October to March (Underhill 1997b). Birds of the two populations are morphologically indistinguishable; however, differences in the timing of moult have helped to confirm the intra-African migrant status of birds breeding in South Africa (Brooke & Herroelen 1988). As an aerial insectivore, this species was recorded in the study area along the Orange River and, within the POPA, was observed over plateaus, valleys, and toeslopes.

Of the remaining 37 species, the following ten are aerial insectivores:

- **Common Swift R411:** This widespread species is a non-breeding Palaearctic migrant, present in this part of its range mainly from November to March (Brooke 1997a). It is gregarious and forages aerially over open country (Brooke 1997a). In the POPA, it was recorded on plateaus, in valleys, and on toeslopes.
- **African Black Swift R412:** This species is a partial breeding intra-African migrant (Brooke 1997b). The study area lies near the north-western edge of its distribution. It breeds (usually colonially) in horizontal crevices in overhanging cliffs, while foraging occurs over open country (Maclean 1985). In the POPA, it was recorded only in valleys. Although suitable breeding cliffs are available, breeding could not be confirmed during the surveys.
- **Bradfield's Swift R413:** The study area is located near the southern limit of this resident species' range. It mainly breeds colonially in fissures and cracks of caves and overhanging cliffs, but forage over any habitat (Maclean 1985). In the POPA, breeding was suspected at two locations in VALn2, and the species was also recorded on toeslopes.
- **White-rumped Swift R415:** This breeding intra-African migrant present in this part of its range primarily from September to April (Brooke 1997c). Habitat include cliffs and it forages over adjacent open ground (Maclean 1985). Breeding typically occurs in existing swallow or swift nests, or in self-constructed nests in rock crevices or holes in rock faces or under eaves of buildings (Maclean 1985). In the POPA, it was recorded on plateaus (including the PV2 footprint) and in valleys.
- **Little Swift R417:** The habitat of this partial migrant includes cliffs, gorges and rocky hills and forages over adjacent open country (Maclean 1985). Breed colonially under eaves or overhang of building, bridge or natural rock face (Maclean 1985). In the POPA, it was recorded in on plateaus (including the PV2 footprint), valleys and toeslopes.
- **Alpine Swift R418:** This species is a resident and intra-African migrant, strongly associated with mountainous terrain and gorges, although it forages over a wide range of habitat types (Maclean 1985). It breeds colonially, sometimes in same cliff as **African Black Swift R412**, constructing nests in vertical cracks in rock faces (Maclean 1985). In the POPA, where it was recorded on plateaus (including the PV2 footprint) and in valleys, at least one breeding colony has been confirmed.
- **African Palm Swift R421:** This widespread species, which is resident in South Africa,

is closely associate with palm trees in which it roosts and breeds (Maclean 1985). Recorded in several places in the study area. In the POPA it was only recorded on toeslopes.

- **Barn Swallow R518:** This non-breeding Palaearctic migrant is present in this part of its range mainly from October to April (Earlé 1997a). In the POPA, it forages over plateaus (including the PV2 footprint) and toeslopes. It was also observed perched and preening on bushes within the footprint, and drinking at the water-filled depression just outside the footprint (Fig. 11).
- **Pearl-breasted Swallow R523:** This species comprises both resident and intra-African migratory populations, though the details remain poorly understood (Earlé 1997b). In the study area, it was recorded exclusively along the Orange River.
- **Western House Martin R530:** A non-breeding Palaearctic migrant present from October to May (Earlé 1997e), this species is rarely recorded west of the Free State and then primarily along the Orange River (<https://sabap2.birdmap.africa/species/507>). In the study area, it was observed only once, with a single individual seen in a valley.

Of the remaining 27 the following two are resident on the POPA plateaus:

- **Familiar Chat R589:** Common resident in the POPA where it occurs on plateaus (including the PV2 footprint) and valleys (Table 3).
- **Southern Fiscal R732:** Resident in the POPA where it occurs on the plateaus (including the PV2 footprint), in valleys and on toeslopes (Table 3).

Two additional species utilise POPA plateaus:

- **Pied Crow R548:** Common resident in the study area. In the POPA it occurs on plateaus (including the PV2), in valleys and on toeslopes (Table 3). Several nests were found on cliffs and on utility structures in the north-west.
- **Red-billed Quelea R821:** In the POPA this nomadic species was encountered on the plateaus (including the PV2 footprint) and toeslopes.

Additional species which only fly over the POPA plateaus include the following:

- **Hadada Ibis R094:** In the study area, this widespread species is resident along the Orange River, from where it may venture to feeding areas further afield. Records in the POPA always involved birds in flight along a north-south axis through valleys and across the plateaus.
- **African Harrier-Hawk R169:** Only recorded once when an adult bird was seen flying over a POPA plateau.
- **Rock Dove R348:** Recorded in the town of Prieska and as birds in flight across the plateaus in the POPA.

Additional species occurring in POPA valleys include the following:

- **Speckled Pigeon R349:** Breeding resident in the study area where it occurs in the town Prieska and in POPA valleys. Also observed to fly over plateaus (Table 3).
- **Laughing Dove R355:** Very common in the study area in general. In the POPA it is largely limited to the valleys (but largely absent from Valley East 1) and in woodland areas of toeslopes.
- **Western Barn Owl R392:** This nocturnal species was recorded only once in the POPA, when a bird was heard calling near the top of one of the valleys at dusk.
- **Spotted Eagle-Owl R401:** There are several records of this nocturnal species in the study area. In the POPA, it is probably resident in the valleys where it was seen and heard.
- **Southern Masked Weaver R814:** In the POPA this species breeds in valleys and also occurs on toeslopes (Table 3).

Additional species occurring on POPA toeslopes include the following:

- **Helmeted Guineafowl R203:** In the study area this species was seldom seen during the day, however in the early evening they conspicuously roost on utility structures. In the POPA they occur at very low density on toeslopes.
- **Spotted Thick-knee R297:** Only a few records in the study area. In the POPA it occurs on toeslopes and was once heard on the plateaus.
- **Ring-necked Dove R354:** In the POPA, this species is most common in woodland areas of toeslopes, but was only rarely encountered in valleys.
- **Namaqua Dove R356:** In the POPA, this species is most common in woodland areas on toeslopes, is absent from valleys, and was only rarely observed on plateaus.
- **Wattled Starling R760:** In the POPA this nomadic species was only recorded on toeslopes more than 4 km from the PV2 footprint.
- **House Sparrow R801:** This species is closely associated with human dwellings, often building nests under eaves or in thatched roofs (Maclean 1985). Within the POPA, it was recorded only at farmsteads located on toeslopes. It is a Category 3 introduced invasive species (National Environmental Management: Biodiversity Act (10 of 2004): Alien and Invasive Species List 2014).
- **Cape Sparrow R803:** In the POPA this species was only recorded on toeslopes.

Additional species only encountered along the Orange River valley include the following:

- **Common Myna R758:** Only recorded in the town Prieska.
- **Pin-tailed Whydah R860:** Only recorded in habitats along the Orange River.

6. Impact assessment and mitigation: Sensitive areas

6.1. Surface water

Natural depressions and water sources in the region are important for birds, which readily exploit accessible water for drinking and bathing (see Section 2.2.2.1 on page 22). This heightened activity increases the likelihood of collisions with project-related structures (e.g., PV panels, fencing, or overhead lines). In addition, construction and operational activities within the PV2 footprint have the potential to increase erosion and sediment runoff, which could enter nearby surface water features and degrade water quality, alter hydrology, or affect bird utilisation of the site.

A natural depression is situated approximately 50 m outside the western boundary of the PV2 footprint, receiving drainage from the central-western portion of the footprint (Fig. 11). Several sizeable trees and bushes occur along its outer edges (Fig. 11). Water may persist in the depression for several days following rainfall, during which time it is expected to attract significant bird activity.

6.1.1. Species

During a targeted observation at the site on 20 February 2026 (12:55–14:00), numerous individuals of several species were observed drinking (Fig. 11). The site is likely to be utilised by a wide range of species, including species of conservation concern such as Verreaux's Eagle R131 and Ludwig's Bustard R232, or other water-dependent species recorded or expected.

6.1.2. Mitigation

It is recommended that a **150 m no-go buffer** be established around the depression and its associated trees and bushes. No structures higher than 1 m above ground level (e.g. PV panels, fencing, or other infrastructure) should be placed within this buffer zone to minimise collision risk and disturbance to birds utilising the water source.

6.1.2.1. Demarcation

The buffer zone must be clearly demarcated on-site prior to any construction activities. Demarcation should be maintained throughout the construction phase and inspected regularly to ensure no unauthorised access or placement of materials occurs within the buffer. Signage should be erected at regular intervals around the buffer stating: "No-Go Buffer Zone – natural Depression / Wetland Area – No Construction or Disturbance Allowed".

6.1.2.2. Erosion and sediment control

The primary objective is to maintain natural hydrological connectivity to the depression (allowing clean rainwater runoff to continue entering as under pre-development conditions) while preventing sediment, pollutants, hydrocarbons, construction debris, or other contaminants from reaching the water body. The following measures must be implemented upslope of the depression:

- Minimise bare soil exposure by limiting vegetation clearance to the absolute minimum required for construction.
- Immediately stabilise or re-vegetate any disturbed areas using indigenous grass or erosion-control blankets.
- Apply dust suppression (water spraying or approved chemical suppressants) during dry conditions to reduce airborne dust deposition into the depression.
- Use temporary diversion berms (low earth berms lined with grass or geotextile) to redirect clean runoff around active construction zones and release it downslope away from disturbed areas.
- Ensure all diversion features are designed to maintain natural flow paths and do not permanently intercept or reduce recharge to the depression.
- No refuelling, chemical storage, concrete batching, or waste disposal is permitted upslope of the depression.
- All hazardous substances must be stored in bunded areas with spill containment at least 110% of the largest container volume.
- Implement strict storm-water management during concrete works, vehicle maintenance, and other potential polluting activities.
- Inspect all erosion and sediment control measures after every significant rainfall event (≥ 10 mm) and repair or replace as necessary.
- Conduct visual monitoring of the depression water quality (turbidity, visible sediment plumes, oil sheen) during and immediately after construction.
- Photographic records and a basic water quality checklist must be included in monthly EMPr compliance reporting.

6.2. Nesting sites

6.2.1. Verreaux's Eagle R131 (SCC: Vulnerable)

Background on this species is provided on page 72. In line with the relevant recommendation in the Avifaunal Impact Assessment for the wind farm associated with PV2 (Van Rooyen & Froneman 2023a), a 1 km all-infrastructure exclusion buffer is recommended around all nests.

6.2.2. Booted Eagle R136 (CMS:A2,R3)

Background on this species is provided on page 76. A 1 km all-infrastructure exclusion buffer is recommended around all nests. At present, only one confirmed nest site is known, but more nests are expected elsewhere. A dedicated survey is therefore required to verify that no additional nests occur within 1 km of the PV2 footprint.

6.2.3. Lanner Falcon R172 (SCC: Near Threatened; CMS:R2)

Background on this species is provided on page 75. A 1 km all-infrastructure exclusion buffer is recommended around all nests. At present, there is no confirmed nest site is known, but breeding is suspected in the general area. A dedicated survey is therefore required to verify that no nests occur within 1 km of the PV2 footprint.

6.2.4. Rock Kestrel R181 (CMS:R3)

Background on this species is provided on page 77. A 1 km all-infrastructure exclusion buffer is recommended around all nests. At present, only one confirmed nest site is known, but more nests are expected elsewhere. A dedicated survey is therefore required to verify that no additional nests occur within 1 km of the PV2 footprint.

7. Impact assessment and mitigation: Construction phase

The construction phase will be of relatively short duration, presumably not longer than a few months. The potential impacts during the construction phase of PV2 include the following:

- Positive:
 - *Feeding opportunities*: During the initial clearing of vegetation, some species could exploit prey items (e.g. insect larvae) that become available through these activities. However, this is likely to be of short duration.
 - *Nesting material*: Birds may use loose pieces of wire and string picked up from the construction site to incorporate into their nests, which may be on nearby power line infrastructure.
- Negative:
 - *Displacement*: Construction activities and its effect on habitat may force birds present at the time to relocate (temporarily?). Because avifaunal habitats equivalent to that in the impacted area are common in the general area, it is possible that at least some of these birds would resettle successfully there. The displacement of individuals of territorial species may have a ripple effect, causing temporary upheaval in the surrounding area (or places further afield) as the displaced

males/pairs/family groups compete with established individuals elsewhere for territories.

- *Breeding* interference: Construction activities could negatively affect breeding success in several ways. On one hand, the presence of construction workers and equipment might cause nest abandonment. On the other hand, a nest could be destroyed.

7.1. Overview of species

Many bird species could potentially be negatively impacted during the construction phase of PV2. The sections below detail the situation separately for species of conservation concern, endemic, CMS, and other species. The term 'disturbance' is used to imply simple displacement and or breeding interference.

- **Species of Conservation Concern:** Applying the precautionary principle, all four of the following species are evaluated to be facing a high probability of disturbance. The PV2 footprint forms part of the territory of a Karoo Korhaan R235 pair (see page 66). The footprint is also utilised by Ludwig's Bustard R232 for feeding and possibly breeding (see page 65). Both of these species breeds on the ground. For Verreaux's Eagle R131, a cliff-nesting species, there are four nesting localities (each >1 km apart) located 934 m to 1 221 m from the footprint, in addition to eight others located 2.5–5.7 km away (see page 72). The Lanner Falcon R172, also a cliff-nesting species, potentially breeds in nearby valleys (see page 75).
- **Endemic Species:** Karoo Korhaan R235 is an SCC and was already considered above. Karoo Scrub Robin R614 occurs within the PV2 footprint, where it could potentially also breed. Black-headed Canary R876 could potentially breed on POPA plateaus (see page 67). For the latter two species, while construction activities could lead to nest destruction (both breed on or near ground level), they may also benefit from temporary feeding opportunities created by disturbed ground (e.g., exposed seeds or insects). Jackal Buzzard R152 is resident in the POPA, and one suspected cliff nest was located approximately 1 km south-west of the PV2 footprint. It sometimes hunts over the plateaus, including the footprint. Grey Tit R551, Fairy Flycatcher R706 and African Rock Pipit R721 are all confined to nearby valleys and are unlikely to experience significant disturbance from the proposed development.
- **CMS Species:** The Common Quail R200, a ground-nesting species, is the only CMS species that is likely to breed in the footprint itself and which is at risk of direct disturbance during the construction phase. The following three CMS raptors breed, or is expected to breed, on nearby cliffs and could also experience disturbance: Booted Eagle R136 (page 76), Lanner Falcon R172 (page 75) & Rock Kestrel R181 (page 77).
- **Other Species:** There are 54 additional species which could potentially experience disturbance during construction (Table 1 C). Those assigned a high risk of disturbance (n = 30 species) include mainly species that utilise the footprint extensively, but also a few

other that may breed in nearby valleys (Booted Eagle R136, Rock Kestrel R181, Cape Eagle-Owl R400 & White-necked Raven R550). Moderate risk is associated with ten species that occur in the adjacent valleys.

7.2. Impact significance

- **Biological Significance:** On its own, the construction phase of PV will not have a biologically significant impact on any species.
- **Public Significance:** Refer to Section 4.9.2 on page 47.
- **Legal Significance:** As highlighted in the overview section above, there are four SCC and four CMS species (Lanner Falcon R172 is also CMS) that are potentially exposed to disturbance during construction. They fall into two categories, namely species that breed on the ground and species that breed on cliffs.
 - The ground-nesting species include the following: Common Quail R200, Ludwig's Bustard R232 & Karoo Korhaan R235. A worst-case scenario for each of these species would be the destruction of one, or possibly two, nests. None of them is bound to a fixed nesting site, and the loss of a nest is unlikely to have long-term population consequences given their opportunistic breeding strategies. Nevertheless, such disturbance could still result in immediate reproductive failure for the affected individuals, and repeated nest losses across seasons may cumulatively reduce local recruitment, particularly in the sedentary Karoo Korhaan. The risk is therefore best described as low in terms of overall population viability, but non-negligible at the site level, warranting mitigation measures to minimize direct impacts.
 - The cliff-nesting species include Verreaux's Eagle R131, Booted Eagle R136, Lanner Falcon R172 & Rock Kestrel R181. Because construction activities are restricted to the plateau and do not involve cliffs, the likelihood of direct nest destruction is negligible. However, suitable cliff-nesting sites are not unlimited, and if disturbance from noise, vibration, or increased human presence were to cause nest abandonment, the affected pairs may struggle to relocate successfully. This could have negative consequences for the local population. Thus, while the probability of direct impact is minimal, the potential for indirect disturbance remains a concern and should be acknowledged in site-level risk assessments.

Taken together, the ground-nesting species face a higher likelihood of direct nest loss due to construction activities on the plateau, while the cliff-nesting species are less exposed to direct impacts but remain vulnerable to disturbance and nest abandonment. This contrast underscores the need for tailored mitigation measures that address both immediate and indirect risks.

7.3. Mitigation

The following mitigation actions are recommended for the construction phase:

- No development in the sensitive areas considered in Section 6 (page 81).
- Conduct pre-construction nest surveys on the plateau: Surveys should be undertaken by a qualified ornithologist no more than 10 days before construction begins, covering the full footprint plus a buffer zone of 1 km. The aim is to identify active nests of SCC and CMS ground-nesting species. Bustards in particular are known to be intolerant of disturbance, and if active nests are detected, construction activities in the vicinity may need to be postponed until breeding is complete. All nests located must be mapped, flagged, and reported, with exclusion zones established to prevent accidental destruction. This approach ensures that construction does not inadvertently cause nest abandonment or reproductive failure, while demonstrating compliance with conservation obligations.
- As far as is reasonably possible, restrict all activities to the footprint area of the infrastructure.
- Retain natural vegetation as much as possible.
- Existing roads/tracks should be utilised whenever possible. Minimise the creation of additional roads as far as possible.
- Crows and other birds often incorporate foreign objects into their nests; if so used on electrical infrastructure this could lead to flashovers and even fire (see Van Niekerk 2024). Therefore, throughout the construction phase, all wires and string must be disposed of in an approved manner as soon as it is no longer needed. This will help to reduce the chances of flashovers caused by nesting material on pylons.
- Schedule disruptive activities. Disruptive construction activities, such as blasting and earth-moving works, should be scheduled outside the peak breeding seasons of priority SCC wherever possible. However, because the collective breeding seasons of all SCC in the region span almost the entire year, it is recommended that priority be given to the most sensitive species and those with the greatest vulnerability to disturbance. In this case, particular attention must be given to the cliff-nesting Verreaux's Eagle, whose breeding cycle (from egg-laying to fledging) typically extends from April to October (Ralston-Paton & Murgatroyd 2021). It is therefore strongly recommended that no blasting or other significant earth-moving activities be permitted within 1 km of any Verreaux's Eagle nest sites during the period April to October inclusive.
- Train construction crews to recognize and avoid nests.

7.3.1. Effect on impact significance

In the case of wires and strings, the recommended mitigation will effectively reduce the availability of these items and reduce the impact significantly.

Legal significance before mitigation is high for individuals of the species in the affected area, but inconsequential for the populations involved. The mitigation recommended can reduce impact significantly.

8. Impact assessment and mitigation: Operational phase

The operational phase of the PV2 will likely last several decades. After that, the existing components will likely be replaced with more modern technology, or it will be decommissioned, and the area returned to its natural state. Each of the sections below assesses the potential impacts of the operational phase of PV2 on birds.

8.1. Positive impacts

The proposed PV development will result in the transformation of the existing open habitat into a ‘forest’ of PV panels. While this activity will inevitably displace at least some of the resident species, the newly created ‘forest’ habitat may also be beneficial to current residents and other species.

- **Perching:** In order to maximise their efficiency, PV panels are typically installed so that they are higher than other objects in their surroundings. This will no doubt be exploited by birds in the area.
- **Shading:** PV panels are designed to absorb sunlight. As a consequence they cast a good shadow. Birds are opportunistic and will use this shade to get out of the blistering sun.
- **Feeding:** The shady environment underneath the arrays in combination with water run-off from the arrays during rain events may lead to micro-climates conducive to relatively higher prey densities there than would otherwise be the case. This may also attract birds to the facility. Polarotactic insects attracted to the PV panels may likewise attract birds (see Section 2.2.3 on page 23 onwards).
- **Breeding:** The many different structures at a PV facility can potentially provide niches for birds to breed.

8.1.1. Overview of species

Birds are opportunistic and individual can sometimes turn up at unexpected places. It is expected that several bird species could potentially benefit from the PV2. The aim here is to give an broad overview of some of the potential scenarios in each category.

- **Species of Conservation Concern:** The Lanner Falcon R172 is likely the only species that could potentially benefit from the development by using elevated infrastructure as perches.

- **Endemic Species:** Both Karoo Scrub Robin R614 and Black-headed Canary R876 could likely visit the PV arrays for food, perch and shade.
- **CMS Species:** The Common Quail R200(A2) could benefit from micro-climates below PV arrays. Raptors including Booted Eagle R136, Lanner Falcon R172 and Rock Kestrel R181 could utilise elevated infrastructure as perches.
- **Other species:** There are many other species that could potentially benefit from the PV2 facility. The following species occurring in the area are known to build their nests on man-made structures and they may attempt to do so underneath/in the PV arrays and associated infrastructure (fences, buildings, *etc.*). This may interfere with the normal functioning of these structures or even create a fire hazard. The Red-breasted Swallow R524 and Greater Striped Swallow R526 construct their nests from mud underneath horizontal surfaces and the Large Rock Martin R529 on vertical surfaces. Other species, including the Speckled Pigeon R349, Laughing Dove R355, Little Swift R417, Pied Crow R548, African Red-eyed Bulbul R567, Mountain Chat R586, Familiar Chat R589, Sociable Weaver R800, House Sparrow R801 and Cape Sparrow R803 use plant material to construct their nest.

8.1.2. Impact significance

- **Biological Significance:** Not applicable.
- **Public Significance:** Refer to Section 4.9.2 on page 47.
- **Legal Significance:** Not applicable.

8.1.3. Mitigation

In cases where mitigation would be required, the following strategies are suggested:

- Avoid the use of lattice-type structures in order to minimise perching and nesting opportunities;
- Minimise standing water. This will make it more difficult for mud-nest builders to obtain mud for their nests. In addition, it will help to minimise the risk of large congregations of birds near the PV facility.
- Observations at substations suggest that the only effective counter measure against small birds nesting in equipment is to remove the nesting material when it appears (Van Rooyen & Ledger 1999). The same strategy is recommended for the PV facility, but only if the nest would interfere with the operation of the PV module and/or if it creates a fire risk. Inspect each PV section at least once a month throughout the year for any nest-building activity. This can be accomplished by the staff working at the facility during other routine maintenance activities. However, they will first need basic

training in order to ensure that they know what to look for and how to fill in the Bird Incident Forms (see Appendix B on page 207).

8.2. Collisions

The limited information available indicates that collision-related fatalities involving PV infrastructure do occur, but it is not yet possible to accurately predict which species will be most affected by this. However, a necessary precondition for such collisions is that birds move across or over the area where the panels are located. In the case of the PV2 footprint, several species exhibit such movement patterns. These include:

- species resident on the plateau,
- occasional visitors to the plateau,
- aerial insectivores that forage over open elevated terrain, and
- individuals or flocks in transit across the plateau landscape.

This variety of movement types means that collision risk cannot be dismissed.

8.2.1. Impact significance

- **Biological Significance:** Indeterminate.
- **Public Significance:** Refer to Section 4.9.2 on page 47.
- **Legal Significance:** Indeterminate.

8.2.2. Mitigation

Where does one start to mitigate the unknown? Make the unknown, known! It is recommended that the Bird Monitoring Program detailed in Appendix B be implemented.

8.3. Entrapment

Medium- to large-bodied birds can become entrapped in fencing that is not sufficiently spaced to allow them to fully open their wings or manoeuvre out once caught (Visser 2016). This can result in injury, stress, predation while trapped, or death from exhaustion, dehydration, or hyperthermia.

8.3.1. Overview of species

Only medium- to large-bodied birds need to be considered in the context of fencing entrapment. This risk could potentially affect any bird present in the area, not only resident species.

- **Species of Conservation Concern:** Most SCC are sufficiently large-bodied to become entrapped in double fencing. POPA residents include the Verreaux's Eagle R131, Lanner Falcon R172, Ludwig's Bustard R232, and Karoo Korhaan R235.
- **Endemic Species:** Only a few endemic species are large enough to be at risk of entrapment in double fencing. Residents in the POPA include the Jackal Buzzard R152 and Booted Eagle R136.
- **CMS Species:** Many CMS species fall within the size range vulnerable to entrapment. Residents in the POPA include the Booted Eagle R136, Lanner Falcon R172, and Rock Kestrel R181.
- **Other Species:** Several other species are large enough to become entrapped in double fencing. POPA residents include the Pale Chanting Goshawk R162, Orange River Francolin R193, Red-crested Korhaan R237, Northern Black Korhaan R239a, Namaqua Sandgrouse R344, Cape Eagle-Owl R400, Spotted Eagle-Owl R401, Pied Crow R548, and White-necked Raven R550.

8.3.2. Impact significance

- **Biological Significance:** On its own, entrapment will not have a biologically significant impact on any species.
- **Public Significance:** Refer to Section 4.9.2 on page 47.
- **Legal Significance:** Many species of conservation concern and CMS species are potentially exposed to entrapment between two fences. Impact may be very significant.

8.3.3. Mitigation

To eliminate or substantially reduce this risk, avoid double-fence designs wherever possible. Replace with a single-fence alternative (e.g., a single strand or mesh fence of appropriate height and spacing) that meets security requirements while allowing birds to pass through or over without entrapment.

8.3.4. Effect on impact significance

- **Biological Significance:** Mitigation irrelevant.
- **Public Significance:** Refer to Section 4.9.2 on page 47.

- **Legal Significance:** Impact significance much reduced.

8.4. Miscellaneous

8.4.1. Roads

The construction of the road network in the proposed PV development area could also have a negative impact on birds. Dust suppressants other than pure water should be used only as a last resort, and then only after very careful research were conducted as it could potentially have adverse environmental impacts (Lovich & Ennen 2011; Piechota *et al.* 2002). The road network should also be carefully designed in order to avoid erosion over the long term and minimise the occurrence of areas where water could collect to create pools.

8.4.2. Fences

Fences may pose a collision risk to birds. The incidence of this should be monitored during the Bird Monitoring Program and the appropriate steps taken to minimise the threat.

8.4.3. Vegetation management

Wherever possible, grazing or mechanical methods should be used instead of chemical alternatives to keep the vegetation in check where necessary. In this way the possible poisoning of birds and other animals will be avoided.

8.4.4. Surface Water

Water sources, including ephemeral pools formed during rain events, could attract birds to the proposed PV development area, potentially increasing flight activity over the facility and collision risks. These pools should be filled in, and the road network designed to minimise open water accumulation after rain.

8.4.5. Ecological light pollution (ELP)

As indicate earlier in Section 2.2.2.2 on page 22, insects attracted by security lighting, which is a source of ELP, could attract birds, and this could lead to collisions with project infrastructure. Gaston *et al.* (2012) investigated options for reducing the ecological consequences of ELP. They concluded that the most effective option would probably be to maintain and increase natural unlit areas. Relevant mitigation options in this regard include the following (see Gaston *et al.* 2012 for more information):

- Maintain and increase natural unlit areas;

- Security lighting should be installed only where it is absolutely essential;
- Avoid direct illumination of PV infrastructure;
- Reduce the trespass of lighting by using luminaires that prevents light from shining beyond the intended area and eliminates light directed upwards or at the horizontal;
- Decreasing light intensity will reduce energy consumption and limit both sky glow and the area impacted by high-intensity direct light;
- Lighting technologies emitting a narrow spectrum of light are likely to have less ecological impact compared to broader spectrum light sources.

9. Impact assessment and mitigation: Decommissioning phase

The potential impacts during the decommissioning phase of the PV2 include the following:

- **Negative:**
 - Decommissioning activities could cause disturbance and possibly displacement of birds in the surrounding area.
 - A direct impact during the decommissioning phase will be the destruction of any nests present on the infrastructure at the time. This is a distinct possibility given that the utilisation of PV2 by birds for nesting is considered one of its potential positive impacts (see Section 8.1.1 on page 88)
- **Positive:**
 - Removal of PV2 implies eliminating any collision and other hazards directly associated with it.

9.1. Impact significance

In general, displacement is not expected to be a major factor. The destruction of nests could be an issue, especially if it involves a species of conservation concern. Overall, removal of the PV2 will have positive impact.

- **Biological Significance:** With the possible theoretical exception of a nest of an exceptionally rare, range-restricted species, the decommissioning phase of the PV2 will not have a biologically significant impact.
- **Public Significance:** Refer to Section 4.9.2 on page 47.
- **Legal Significance:** Unless there is a species of conservation concern or CMS species breeding somewhere in PV2 facility during the decommissioning phase, legal significance will be very low.

9.2. Mitigation

From the forgoing it is clear that the decommissioning phase could have impacts on birds. The following mitigation measures are recommended:

1. Restrict activities to the footprint area of the infrastructure.
2. Vehicles should not depart from existing roads unless it is required for safety, technical or other valid reasons.
3. If birds are actively breeding on infrastructure, delay decommissioning until after the breeding is completed.
4. All parts of the infrastructure, including all wires, must be removed and disposed of in an approved manner, as these could be used by birds, especially crows, to construct their nests on power line infrastructure and potentially cause flashovers as a result.

9.2.1. Effect on impact significance:

- **Biological Significance:** None.
- **Public Significance:** Refer to Section 4.9.2 on page 47.
- **Legal Significance:** Implementation of mitigation point 3 above can greatly reduce legal significance.

10. Cumulative impacts

In terms of the National Environmental Management Act (NEMA, Act 107 of 1998) and the 2014 EIA Regulations (as amended), cumulative impact is defined as the combined effect of past, existing, approved, and reasonably foreseeable future activities on the receiving environment. In South Africa, where renewable energy development (particularly solar PV and wind farms) is rapidly expanding in semi-arid and biodiversity-sensitive regions such as the Northern Cape, cumulative impacts on avifauna, water resources, vegetation, and visual/aesthetic values are increasingly scrutinised. These impacts may result from the spatial clustering of projects, shared infrastructure corridors, habitat fragmentation, or increased disturbance pressure. Assessing cumulative impact requires consideration of baseline conditions, existing developments, approved projects not yet constructed, and likely future projects within a reasonable radius (typically 30–50 km), as guided by the Screening Tool, DEA protocols, and specialist input.

10.1. Renewable Energy Projects

Within the 30 km radius of the proposed PV2 project, several currently approved renewable energy developments are clustered in two discrete areas. One cluster is located more than 5 km to the north, in the vicinity of Prieska, while the second is situated more than 24 km to the south-west, towards Copperton (Fig. 40, page 200). With the exception a wind farm near Copperton, all other projects in the 30 km study area are solar PV facilities (Figure 40). The solar PV projects around Prieska overlaps partially with the Doringberg mountain range.

The cumulative impact of renewable energy facilities on birds remains unquantified, partly due to the difficulty of obtaining accurate mortality rates at individual sites—let alone across many scattered over a wide area—and partly because such facilities are a relatively recent development (see Section 2.2.4 on page 25). Measuring demographic parameters like survival and productivity directly, and linking them to external factors is inherently challenging (Alves 2013).

As noted in Section 2.2.4, our understanding of fatal bird interactions with power lines far exceeds that of utility-scale PV installations, prompting this analysis to focus on power line interactions to illustrate the complications of determining demographic parameters, such as mortality rates and population impacts. For instance, while researchers suggest that cumulative effect of mortality from power lines—an integral part of PV developments—across multiple sites may significantly affect rare or endangered species, particularly when combined with other factors (Amend 1978; Drewitt & Langston 2008; Faanes 1987; Van Niekerk 2024), proving this remains elusive. The Endangered Ludwig’s Bustard *Neotis ludwigii* is an excellent case study: Anderson (2000b) claimed its population was declining due to power line collisions and hunting, estimating a 20% lost over three generations. Subsequently, Shaw (2013), replicating Allan’s (1994) study, found “no evidence for a population decline over the past two decades,” despite high collision estimates (Jenkins & Smallie 2009; Jenkins *et al.* 2011; Shaw 2013; Shaw *et al.* 2021). Shaw concluded that “These results . . . suggest that the South African population is not decreasing rapidly, despite the large numbers estimated to be killed by power line collisions,” while noting “considerable uncertainty in the two estimates” and that “the population estimates are probably not accurate enough to detect a change between the two census counts”—a sentiment echoing Thompson’s (1978) view that “we may not be able to perceive or measure changes in carrying capacity attributable to wire strikes, even if they are sizable and long-term.” .

Advances in demographic modelling over recent decades have bolstered scientists’ ability to analyse complex ecological trends Alves 2013. Large, long-term spatial datasets—such as SABAP1 & SABAP2 (see Section 4.6 on page 43)—are deemed essential for investigating how risk factors influence shifts in species ranges, *etc.* (Wijewardhana *et al.* 2020). However, these datasets must be used cautiously, as they might not be as comprehensive as is often assumed (see, for example, Section 4.6, page 43).

One aspect which all renewable energy facilities have in common is that each require connection to the Eskom grid via power lines. In addition, Eskom may also need to expand its

network to accommodate these and future developments. It is reasonable to expect that the total length of power lines in the Northern Cape and elsewhere will steadily increase in the coming years and beyond. This could, in the long run, have negative consequences for non-resident species such as the Endangered Ludwig’s Bustard R232 (Van Niekerk 2024).

10.2. PPR WEF

The proposed PV2 footprint forms part of the Prieska Power Reserve renewable energy hub proposed by PPR at Prieska. The hub envisages integrated solar PV, wind, and green hydrogen/ammonia production. The PV2 footprint is located in the midst of the authorised Prieska Power Reserve Wind Energy Facility (henceforth PPR WEF), with the PV2 footprint overlapping the wind turbine layout and several turbines situated less than 100 m from the PV infrastructure (Fig. 36). The wind turbine component was granted environmental authorisation on 13 November 2023 by the Northern Cape Department of Agriculture, Environmental Affairs, Rural Development and Land Reform (NC/EIA/11/PI/SIY/PRI4/2022 (AMENDMENT1)). While the wind project is authorised, the full hub—including the solar PV phases—remains subject to further approvals and implementation. Given the close spatial proximity and direct overlap of the PV2 footprint with the authorised PPR WEF, the remainder of this cumulative impact assessment will focus primarily on this wind component as the most relevant and proximate approved development. The Environmental Authorisation is based in part on an Avifaunal Impact Assessment (AIA PPR WEF) conducted by Van Rooyen & Froneman (2023a), and an accompanying Avifaunal Screening Assessment (ASA PPR WEF) aimed at determining the population size of the Verreaux’s Eagle R131 population within a 50 km radius of the PPR WEF (Van Rooyen & Froneman 2023b), all based on fieldwork conducted in 2022.

According to the project proponent, the PPR WEF is subject to ongoing assessment through proposed authorisation amendments. We trust that the information presented in this report — particularly the cumulative impact analysis — will assist with that process.

10.2.1. Errors in the Environmental Authorisation

The locations of the following two wind turbines are incorrectly indicated in the Environmental Authorisation (NC/EIA/11/PI/SIY/PRI4/2022 (AMENDMENT1)). The corrected coordinates have been used for the cumulative impact assessment presented herein.

Turbine no.	EA		Corrected	
	Longitude	Latitude	Longitude	Latitude
B03	22°45’53.26”	29°46’26.67”	22°44’53.26"E	29°46’26.67"S
B04	22°44’22.14"	29°47’44.14"	22°45’22.14"	29°47’44.14"S

10.2.2. Updates to the AIA PPR WEF Bird Data

The POPA of the proposed PV2 facility overlaps extensively with the PAOI defined in the AIA PPR WEF as an aggregate area comprising a 1 km buffer around the turbine layout and a 2 km buffer around the proposed 132 kV overhead power line (Van Rooyen & Froneman 2023a). Examination of the figures in that assessment indicates that the PAOI also includes a 2 km buffer around the 33 kV MV overhead lines connecting the wind turbines. Several observations and findings from the PV2 investigation are relevant to the PPR WEF and are presented in the sections below.

10.2.2.1. Species of Conservation Concern (SCC)

10.2.2.1.1. Verreaux's Eagle R131

A Vulnerable SCC (Murgatroyd & Rodrigues 2025), this species is highly susceptible to collisions with wind turbines (Ralston-Paton 2025). The Avifaunal Impact Assessment for the PPR WEF (Van Rooyen & Froneman 2023a) recommended a 1 km all-infrastructure exclusion zone around nests, and specifically listed eight nest locations, including three localities (E, F, and G) where each contains two nests spaced 1–118 m apart, and one locality (D) with two nests 337 m apart located outside their defined PAOI (Fig. 36). The eight nest locations reported in the AIA are offset by 3–23 m from those verified by drone surveys in the current investigation. Only nest O1 has implications for turbine placement, with turbine B19 now <1 km away (Fig. 36).

In total, the AIA list only nine nests within their PAOI ($8 + 3 - 2$). Recent surveys have identified 24 nests in the same PAOI, meaning that 15 nests were not accounted for. This discrepancy arises partly from nests that were known during the previous assessment but were not afforded any buffer, as well as from nests identified in subsequent surveys. Collectively, these 15 nests are located less than 1 km from the following eight proposed wind turbine locations: B01, B02, C02, D04, D05, D06, F01, and F02 (Fig. 36). These aspects are detailed below. The missing 15 nests include the following (see Figure 36 for nest and wind turbine locations, and Table 4 for nest codes):

- Locality E: Previously reported as containing only two nests, this locality has been confirmed to contain six nests, with the two furthest nests spaced 461 m apart. All wind turbines are more than 1 km from this site.
- Locality F: Previously reported as containing only two nests, this locality has been confirmed to contain three nests, with the two furthest nests spaced 118 m apart. All wind turbines are more than 1 km from this site.
- Locality G: Previously reported as containing only two nests, this locality has been confirmed to contain five nests, with the two furthest nests spaced 38 m apart. All wind turbines are more than 1 km from this site.
- Locality J: One nest, more than 1 km from the nearest wind turbine.

- Locality K: Two nests, 97 m apart. Wind turbine C01 is less than 1 km from this site.
- Locality L: One nest, less than 1 km from wind turbines D04, D05, and D06.
- Locality M: One nest, less than 1 km from wind turbines D06, F01 & F02.
- Locality N: Van Rooyen & Froneman (2023a) were clearly aware of the two nests at this locality, as both are visible on their Figure 11 map, yet neither is mentioned in the text of the AIA. Three wind turbines (B01, B02, and C01) are proposed less than 1 km from these two nests. In the accompanying ASA, both nests are described as “abandoned” and as two “old nests that belonged to the same pair” (Van Rooyen & Froneman 2023b). However, because nests unoccupied for years can subsequently become re-occupied (Ralston-Paton 2025), buffers are applicable to all nests (Ralston-Paton & Murgatroyd 2021). Therefore, the two nests at N should also be afforded a 1 km buffer. Recorded flight intensity was also determined to be medium to very high in that area during the AIA (Van Rooyen & Froneman 2023a, their figure 9).

10.2.2.1.2. Lanner Falcon R172

The AIA PPR WEF correctly lists this Near Threatened species as exposed to displacement during construction, collisions with overhead power lines and wind turbines, and electrocution during the operational phase of the wind farm. The AIA PPR WEF rated the likelihood of occurrence in the PAOI as “M” (medium), which suggests that the species could occur on the plateaus but was only observed elsewhere during their surveys. However, the species may actually breed in the mountains (see page 75). Wind turbine locations at places where notable flying activity was observed include B01, B02, and C01 (Fig. 37; Fig. 36).

10.2.2.1.3. Ludwig’s Bustard R232

For this Endangered species (Pretorius & Rose 2025), the AIA PPR WEF correctly list it as a “local migrant” exposed to displacement during construction, and collisions with overhead power lines and wind turbines during the operational phase of the wind farm. It also acknowledges that this species could occur with some regularity in the PAOI depending on the season of the year, and especially in response to rainfall. The AIA PPR WEF rated the likelihood of occurrence in the PAOI as “M” (medium) (Van Rooyen & Froneman 2023a). Unfortunately, the AIA report does not explicitly define what “M” means. Comparison with other species assigned “M” suggests it may indicate that the species could occur on the plateaus but was only observed elsewhere during their surveys. Regardless, the surveys for the PV2 indicate that Ludwig’s Bustard is a regular visitor to the PAOI plateaus, and in particular the PV2 footprint (see page 65). This species is particularly vulnerable to fatal collisions with overhead power lines, and it is highly likely to collide with overhead power lines associated with the PPR WEF, particularly on the plateaus. Unfortunately, line markers, as recommended in the AIA PPR WEF (Van Rooyen & Froneman 2023a) are ineffective for bustards (Shaw *et al.* 2021). These findings align with studies by Martin & Shaw (2010), who demonstrated that visual markers may have limited success in birds with narrow visual fields, such as bustards,

as they can render the birds blind in the direction of travel when they pitch their heads downward in flight. The only effective mitigation for this risk is the use of underground cables, as also recommended in the AIA PPR WEF (Van Rooyen & Froneman 2023a).

10.2.2.2. Endemic species

10.2.2.2.1. Jackal Buzzard R152

A recent summary of bird monitoring reports from operational wind energy facilities in South Africa found that the Jackal Buzzard was the most commonly found victim of collisions with wind turbines (Ralston-Paton 2025). Although this species is not currently not listed as a SCC, Ralston-Paton (2025) recommend that steps should be taken to mitigate impacts in planning and operation of wind energy facilities, pending an accurate assessment of population size and its ability to withstand additional losses.

The AIA PPR WEF correctly lists the Jackal Buzzard as exposed to displacement during construction, collisions with overhead power lines and wind turbines, and electrocution during the operational phase of the wind farm (Van Rooyen & Froneman 2023a). The AIA PPR WEF rated the likelihood of occurrence in the PAOI as “M” (medium), which suggests that the species could occur on the plateaus but was only observed elsewhere during their surveys. However, the surveys for the PV2 indicates that they do occur in the mountains and hunt over the plateaus.

10.2.2.2.2. African Rock Pipit R721

The AIA PPR WEF correctly lists the African Rock Pipit as exposed to displacement and disturbance due to the PPR WEF (Van Rooyen & Froneman 2023a). However, they list its likelihood of occurrence in the PAOI as “L” (low), and also indicated that it was not recorded in the PAOI (Van Rooyen & Froneman 2023a). However, the surveys for the PV2 indicate that it is relatively common the valleys (Table 3).

10.2.2.2.3. Grey-winged Francolin *Scleroptila afra*

The AIA PPR WEF lists the species as being at risk of displacement during construction, as well as collision with overhead power lines and wind turbines, and electrocution during the operational phase (Van Rooyen & Froneman 2023a). The assessment rated the likelihood of occurrence within the Project Area of Influence (PAOI) as “M”, which suggests that the species could occur on the plateaus but was only observed elsewhere during their surveys.

The two sightings plotted on their Figure 4 are both located on toeslopes. This is considered highly unlikely to represent the target species, which is strongly associated with mountainous and rugged terrain. Furthermore, the Prieska area lies well outside the species’ known distribution according to SABAP2 data (<https://sabap2.birdmap.africa/species/176>). It is therefore probable that these records represent misidentified individuals of the resident

Orange River Francolin R193, a species that occurs on both plateaus and toeslopes in the region.

10.2.2.3. CMS Species

10.2.2.3.1. Booted Eagle R136

This species features in CMS lists A2 and R3, and is vulnerable to wind turbine collisions (Ralston-Paton 2025). Data collected during the PV2 fieldwork reveals that this species is more widespread in the PPR WEF PAOI than is shown in the AIA report (Van Rooyen & Froneman 2023a), specifically in Figure 8 which shows its recorded flight intensity during that study. Additional areas of flying activity includes the following (see Figure 36 for the location of wind turbines and Verreaux's Eagle nesting locations):

- The isolated plateau north of Plateau 2 in the north on which wind turbines B01, B02, and C01 is to be located.
- The gorge at Verreaux's Eagle nesting location E.
- The minor gorge c. 750 m north of Verreaux's Eagle nesting location E.
- Most of Valley North 2.
- Valley West 1.
- Lelikekloof, which is in the mountain system along the east of Valley East 1. The November 2025 discovery of a nest in Lelikekloof is significant. This nest is located only 11 m south-west of Verreaux's Eagle nest L1, both less than 1 km from wind turbines D04, D05, and D06 (Fig. 36). Breeding is also expected at several other localities in the PAOI (see page 76).

Wind turbine locations posing the highest collision risk include B01, B02, B04, C01, C10, D01, D02, D05, D06, and F01.

10.2.2.3.2. Rock Kestrel R181

Even though the AIA PPR WEF acknowledges the high mortality rate of Rock Kestrels at WEFs (see also Ralston-Paton 2025), and indicated that they recorded them during monitoring, they omitted them from any further consideration. This species is a breeding resident in the WEF PAOI (see page 5.8.3).

10.2.2.3.3. Common Quail R200

This species is known to collide with wind turbines (Ralston-Paton 2025). Apart from the fact that this species was recorded during monitoring, the AIA PPR WEF does not mention it anywhere else. The surveys for PV2 indicates that the species occur on plateaus and toeslopes.

10.2.2.3.4. European Bee-eater R438

This species is not known to collide with wind turbines (Ralston-Paton 2025). Apart from the fact that this species was recorded during monitoring, the AIA PPR WEF does not mention it anywhere else. The surveys for PV2 indicates that the species occur on plateaus, in valleys and on toeslopes.

10.2.2.4. Other Species

Although not listed as “Wind priority” species in the AIA PPR WEF Van Rooyen & Froneman (2023a), several additional species prone to collision with wind turbines were recorded during the current surveys. The previous assessment did not restrict this designation to SCC, as it also encompassed common species such as Pale Chanting Goshawk R162 and Northern Black Korhaan R239a.

Collectively, swifts, swallows and martins accounted for 16% of carcasses found beneath wind turbines in South Africa (Ralston-Paton 2025). Many of these aerial insectivore species occur in the PPR WEF PAOI (see pages 5.6.3 and 78).

Several additional species that have experienced ten or more fatal collisions with wind turbines according to Ralston-Paton (2025) are considered likely to regularly cross paths with turbines in the WEF PAOI. These species are:

- **Egyptian Goose R102:** Pairs and small flocks routinely cross the WEF PAOI plateaus via valleys. Specific wind turbines locations observed to be directly in their flight path include B04, B20, B21, and B23 (Fig. 36).
- **Speckled Pigeon R349:** Breeding resident in WEF PAOI valleys that fly across plateaus.
- **Spotted Eagle-Owl R401:** Resident in the WEF PAOI.
- **Pied Crow R548:** Common breeding resident in the WEF PAOI.
- **Bokmakierie R746:** A very common resident species in the WEF PAOI.

10.2.3. Surface Water

The AIA PPR WEF recommended that no wind turbines, including their rotor-swept area, should be placed within 200 m of any water point or within 150 m of the centre line of any drainage line. This buffer was proposed to reduce collision risk to priority species that are attracted to surface water (Van Rooyen & Froneman 2023a).

However, a review of the current layout indicates that a natural depression located approximately 140 m north-west of proposed turbine B21 falls within the recommended 200 m buffer around water points (Figure 11). This feature was apparently not considered in the original buffer application.

10.2.4. Mitigation Considerations for the PPR WEF

Given the significant spatial overlap between the proposed Doringberg Solar PV project and the authorised PPR Wind Energy Facility on the Doringberg plateaus, the effective implementation of appropriate mitigation measures at the WEF is important for managing cumulative avifaunal impacts in the broader landscape. The discussion below provides contextual information on mitigation measures proposed or under consideration for the PPR WEF and highlights potential residual cumulative risks. This information is presented to support the overall cumulative impact evaluation for the Doringberg Solar PV application. All site-specific mitigation recommendations for the Doringberg Solar PV project are provided separately in Sections 6–9.

10.2.4.1. Wind Turbine Curtailment

A precautionary buffer of 5.2 km around Verreaux’s Eagle nests (including alternate nests) was recommended in the wind energy guidelines to reduce collision risk (Ralston-Paton & Murgatroyd 2021). Even with the minimum recommended buffer of 3.7 km, a large portion of the PPR WEF PAOI would be effectively excluded from development. To address this constraint, the Avifaunal Impact Assessment for the PPR WEF proposed blanket curtailment of all turbines from one hour before sunrise to one hour after sunset for the operational life of the facility (Van Rooyen & Froneman 2023a). This measure is expected to reduce the majority of collision incidents, although some residual risk may remain.

The applicant for the PPR WEF is reportedly investigating the feasibility of implementing Shutdown-on-Demand (SDoD) technologies to allow daytime turbine operation. A detailed technical review of SDoD systems falls beyond the scope of this assessment. For a comprehensive overview, refer to Smallie *et al.* (2025).

Given the local topography, with proposed turbines located close to valleys and plateau edges and inter-valley distances of less than 2 km (Fig. 36), detection times for soaring birds rising from the valleys are expected to be limited. This topography could result in residual collision risk for Verreaux’s Eagle even with the mitigation measures proposed for the WEF.

In summary, several mitigation measures have been proposed or are under consideration for the authorised PPR Wind Energy Facility, including nest buffers, blanket curtailment, and investigation of Shutdown-on-Demand technologies. In the cumulative context, even with these measures, some residual collision risk for Verreaux’s Eagle and other priority species may remain due to the challenging local topography and the species’ use of plateau margins and adjacent valleys. The addition of the proposed Doringberg Solar PV facility will contribute to the overall development footprint and disturbance pressures in the broader landscape, with the incremental contribution rated as low. All site-specific mitigation recommendations for the Doringberg Solar PV project are provided in Sections 6–9 of this report.

11. Conclusions

No restricted-range species occur in the study area, and all recorded bird species have extensive global distributions well exceeding 50 000 km². In accordance with the definition of biological significance applied in this assessment — whereby an impact is considered significant only if it results in a measurable, persistent change at the population, community, or ecosystem level — it is highly improbable that the PV2 project on its own would result in a biologically significant impact on any bird species.

The PV2 footprint is situated on private land and is not accessible to the general public. Given the substantial distance (>6 km) and intervening topography, any visibility is expected to be minimal, distant, and highly constrained to particular alignments along the road. Construction activities and bird interactions with the facility would therefore appear as very small, distant elements in the landscape and are unlikely to elicit significant public response or concern from road users. Public significance is therefore considered negligible in this case, **unless** the public becomes aware of potential issues through indirect channels other than direct observation (e.g., media coverage, NGO reports, community networks, or formal stakeholder engagement processes).

There are a number of impacts related to legal significance, referring to the acknowledgement of the importance of environmental resources in government policy, law or plans: The species include those listed as SCC and CMS species

- **Construction Phase:** Potential impacts range from direct impacts such as nest destruction and displacement in the footprint, to the disturbance of birds outside the footprint. The mitigation recommended, including the avoidance of sensitive areas, can reduce impact significantly.
- **Operational Phase:** Although collision-related fatalities involving PV infrastructure is known to occur, it is not yet possible to accurately predict which species will be most affected by this. However, a necessary precondition for such collisions is that birds move across or over the area where the panels are located. In the case of the PV2 footprint, several species exhibit such movement patterns. Direct assessment of the impact of PV2 on birds is recommended via a Bird Monitoring Program. In addition to the PV arrays, consideration are also given to other potential sources of impact such as fences and roads. The suggested mitigation can reduce impact significantly.
- **Decommissioning Phase:** Unless there is a species of conservation concern or CMS species breeding somewhere in PV2 facility during the decommissioning phase, legal significance will be very low. The suggested mitigation can reduce impact significantly.

Cumulative impacts on avifauna were evaluated in the context of the authorised PPR Wind Energy Facility and other regional developments. While the authorised PPR WEF represents the dominant source of potential collision risk for species such as Verreaux's Eagle, the incremental contribution of the proposed Doringberg Solar PV facility is rated as low, primarily through additional habitat transformation and disturbance.

The findings of this avifaunal impact assessment indicate that the proposed Doringberg Solar PV facility is associated with low to moderate negative impacts on avifauna, primarily related to habitat transformation and disturbance. With the effective implementation of the recommended avoidance, mitigation, and monitoring measures, these impacts can be reduced to acceptable levels. In the cumulative context, the incremental contribution of the PV project to regional avifaunal impacts (when considered alongside the authorised PPR Wind WEF) is rated as low.

It is the reasoned opinion of the specialist that the proposed development should be authorised, subject to the inclusion of all recommended mitigation measures and monitoring requirements. No fatal flaws from an avifaunal perspective were identified.

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Table 1: Bird species with distributions overlapping with the study area (see Section 4.6 on page 43). Each species is included in only one of seven groups (A–F) with the groups arranged in descending order of priority. Name: Roberts’ number (Maclean 1985) followed by English and scientific name based on Hardaker (2025) (E, endemic; n-E, near-endemic); The NESW column signifies the directional local limits of a species’ range relative to the study area (see Section 4.7 on page 45); Habitat: Habitat preferences according to Harrison *et al.* (1994): AQ, Aquatic; FR, Forest; GR, Grassland; HG, Generalist; MR, Marine; RC, Montane\Rocky; SC, Scrub; WO, Woodland; SCC: Species of Conservation Concern status regionally (Lee *et al.* 2025), globally (IUCN): CE: Critically Endangered; EN: Endangered; VU: Vulnerable; NT: Near Threatened; LC: Least Concern; CMS, CMS species: A1: CMS Appendix 1 species; A2: CMS Appendix 2 species; W: AEWA; R1, R2 & R3: Raptors MOU (see Section 4.9.3.2.1 on page 49); Hsa: Habitat preferences in the study area (see page 45); REFrisk: Risk associated with the primary renewable energy structures (see Section 4.10.2 on page 52); Status: Footprint habitat utilisation (see page 46).

Name	NESW	Habitat	SCC	CMS	Hsa	REFrisk Disturb.	Status
A. 33 SPECIES OF CONSERVATION CONCERN:							
R123 White-backed Vulture (<i>Gyps africanus</i>)	S	WO	CE,CE	A1,R1	-	--	--
R124 Lappet-faced Vulture (<i>Torgos tracheliotos</i>)	S	WO	CE,EN	A1,R1	-	--	--
R084 Black Stork (<i>Ciconia nigra</i>)	X	AQ	EN,LC	W,A2	OW	--	--
R088 Saddle-billed Stork (<i>Ephippiorhynchus senegalensis</i>)	OOR	AQ	EN,LC	-	-	--	--
R132 Tawny Eagle (<i>Aquila rapax</i>)	SW	HG	EN,VU	R1	-	--	--
R140 Martial Eagle (<i>Polemaetus bellicosus</i>)	X	HG	EN,EN	-	*T	--	--
R168 Black Harrier (<i>Circus maurus</i>) n-E	X	GR, SC	EN,EN	R1	-	--	--
R232 Ludwig’s Bustard (<i>Neotis ludwigii</i>)	X	SC	EN,EN	-	*PT	HIGH	U
R090 Yellow-billed Stork (<i>Mycteria ibis</i>)	OR	AQ	VU,LC	W,A2	-	--	--
R097 Lesser Flamingo (<i>Phoeniconaias minor</i>)	NW	AQ	VU,NT	W,A2	-	--	--
R118 Secretarybird (<i>Sagittarius serpentarius</i>)	X	HG	VU,EN	-	-	--	--
R122 Cape Vulture (<i>Gyps coprotheres</i>) n-E	SW	HG	VU,VU	A1,R1	*V	--	--

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Name	NESW	Habitat	SCC	CMS	Hsa	REFrisk Disturb.	Status
R131 Verreaux's Eagle (<i>Aquila verreauxii</i>)	X	RC	VU,LC	-	*PV	HIGH	BIT?
R208 Blue Crane (<i>Grus paradisea</i>) n-E	NW	GR	VU,VU	W,A2	-	--	--
R247 Chestnut-banded Plover (<i>Anarhynchus pallidus</i>)	W	AQ, MR	VU,LC	W,A2	-	--	--
R272 Curlew Sandpiper (<i>Calidris ferruginea</i>)	X	AQ, MR	VU,VU	W,A2	OW	--	--
R299 Burchell's Courser (<i>Cursorius rufus</i>)	X	GR, SC	VU,LC	-	-	--	--
R060 African Darter (<i>Anhinga rufa</i>)	OR	AQ	NT,LC	-	-	--	--
R076 Black-crowned Night Heron (<i>Nycticorax nycticorax</i>)	OR	AQ, MR	NT,LC	W	-	--	--
R081 Hamerkop (<i>Scopus umbretta</i>)	OR	AQ	NT,LC	-	OW	--	--
R096 Greater Flamingo (<i>Phoenicopterus roseus</i>)	NW	AQ	NT,LC	W,A2	*O	--	--
R104 Yellow-billed Duck (<i>Anas undulata</i>)	OR	AQ	NT,LC	W,A2	*OW	--	--
R108 Red-billed Teal (<i>Anas erythrorhyncha</i>)	X	AQ	NT,LC	W,A2	*O	--	--
R112 Cape Shoveler (<i>Spatula smithii</i>)	X	AQ	NT,LC	A2	*O	--	--
R113 Southern Pochard (<i>Netta erythrophthalma</i>)	OR	AQ	NT,LC	W	O	--	--
R115 Knob-billed Duck (<i>Sarkidiornis melanotos</i>)	OOR	AQ	NT,LC	W	*O	--	--
R127 Black-winged Kite (<i>Elanus caeruleus</i>)	SW	HG	NT,LC	-	O	--	--
R172 Lanner Falcon (<i>Falco biarmicus</i>)	X	HG	NT,LC	R2	*V	HIGH	BIT?
R230 Kori Bustard (<i>Ardeotis kori</i>)	X	SC, WO	NT,NT	-	*T	--	--
R235 Karoo Korhaan (<i>Heterotetrax vigorsii</i>) n-E	X	GR, SC	NT,LC	-	*PT	HIGH	U
R248 Kittlitz's Plover (<i>Anarhynchus pecuarius</i>)	X	AQ	NT,LC	W,A2	*O	--	--
R446 European Roller (<i>Coracias garrulus</i>)	X	WO	NT,LC	A1,A2	-	--	--
R510 Sclater's Lark (<i>Spizocorys sclateri</i>) n-E	E	SC	NT,NT	-	-	--	--

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Name	NESW	Habitat	SCC	CMS	Hsa	REFrisk Disturb.	Status
B. 20 ADDITIONAL ENDEMIC AND/OR RANGE RESTRICTED SPECIES:							
R152 Jackal Buzzard (<i>Buteo rufofuscus</i>) n-E	N	HG	LC,LC	-	*V	HIGH	V
R195 Cape Spurflower (<i>Pternistis capensis</i>) n-E	OR	SC	LC,LC	-	-	--	--
R512 Large-billed Lark (<i>Galerida magnirostris</i>) E	N	GR, SC	LC,LC	-	-	--	--
R517 Black-eared Sparrow-Lark (<i>Eremopterix australis</i>) n-E	X	SC	LC,LC	-	-	--	--
R528 South African Cliff Swallow (<i>Petrochelidon spilodera</i>) b-E	NW	GR	LC,LC	-	-	--	--
R551 Grey Tit (<i>Melaniparus afer</i>) n-E	N	SC	LC,LC	-	*V	--	--
R577a Karoo Thrush (<i>Turdus smithi</i>) n-E	X	WO	LC,LC	-	*O	--	--
R591 Sickie-winged Chat (<i>Emarginata sinuata</i>) n-E	X	GR, SC	LC,LC	-	-	--	--
R614 Karoo Scrub Robin (<i>Tychaemon coryphoeus</i>) n-E	X	SC	LC,LC	-	*PVT	HIGH	U
R654 Karoo Eremomela (<i>Eremomela gregalis</i>) n-E	N	SC	LC,LC	-	-	--	--
R686a Karoo Prinia (<i>Prinia maculosa</i>) n-E	N	SC	LC,LC	-	-	--	--
R687 Namaqua Warbler (<i>Phragmacia substriata</i>) n-E	OR	AQ	LC,LC	-	*O	--	--
R698 Fiscal Flycatcher (<i>Sigelus silens</i>) n-E	X	WO	LC,LC	-	*TO	--	--
R706 Fairy Flycatcher (<i>Stenostira scita</i>) n-E	X	SC, WO	LC,LC	-	*V	--	--
R721 African Rock Pipit (<i>Anthus crenatus</i>) E	X	RC	LC,NT	-	*V	low	BIT?
R759 Pied Starling (<i>Lamprotornis bicolor</i>) E	NW	HG	LC,LC	-	-	--	--
R783 Southern Double-collared Sunbird (<i>Cinnyris chalybeus</i>) n-E	E	FR, SC	LC,LC	-	*T	--	--
R796b Cape White-eye (<i>Zosterops virens</i>) n-E	N	FR, SC, WO	LC,LC	-	-	--	--
R813 Cape Weaver (<i>Ploceus capensis</i>) n-E	N	GR, WO	LC,LC	-	-	--	--
R876 Black-headed Canary (<i>Serinus alario</i>) n-E	-NE	SC	LC,LC	-	*P	HIGH	U

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Name	NESW	Habitat	SCC	CMS	Hsa	REFrisk Disturb.	Status
C. 51 ADDITIONAL SPECIES POTENTIALLY NEGATIVE AFFECTED BY RENEWABLE ENERGY FACILITY							
R136 Booted Eagle (<i>Hieraaetus pennatus</i>)	X	HG	LC,LC	A2,R3	*PVT	HIGH	V
R181 Rock Kestrel (<i>Falco rupicolus</i>)	X	HG	LC,LC	R3	*V	HIGH	V
R186 Pygmy Falcon (<i>Polihierax semitorquatus</i>)	S	SC, WO	LC,LC	-	*V	Moderate	BIT?
R193 Orange River Francolin (<i>Scleroptila gutturalis</i>)	S	GR, WO	LC,LC	-	*PT	HIGH	U
R200 Common Quail (<i>Coturnix coturnix</i>)	X	GR	LC,LC	A2	*PT	HIGH	U
R205 Common Buttonquail (<i>Turnix sylvaticus</i>)	X	GR	LC,LC	-	*P	HIGH	U
R237 Red-crested Korhaan (<i>Lophotis ruficrista</i>)	S	WO	LC,LC	-	*PT	low	U
R239a Northern Black Korhaan (<i>Afrotis afraoides</i>)	X	GR	LC,LC	-	*PT	HIGH	U
R297 Spotted Thick-knee (<i>Burhinus capensis</i>)	X	HG	LC,LC	-	*PTO	low	BIT
R301 Double-banded Courser (<i>Smutornis africanus</i>)	X	GR, SC	LC,LC	-	*PT	HIGH	U
R344 Namaqua Sandgrouse (<i>Pterocles namaqua</i>)	X	SC	LC,LC	-	*PT	low	U,BIT
R349 Speckled Pigeon (<i>Columba guinea</i>)	X	HG	LC,LC	-	*VO	Moderate	BIT
R400 Cape Eagle-Owl (<i>Bubo capensis</i>)	N	RC	LC,LC	-	*V	HIGH	V?
R406 Rufous-cheeked Nightjar (<i>Caprimulgus rufigena</i>)	X	WO	LC,LC	-	*PT	Moderate	U
R413 Bradfield's Swift (<i>Apus bradfieldi</i>)	S	HG	LC,LC	-	*PVT	low	A
R418 Alpine Swift (<i>Tachymarptis melba</i>)	X	HG	LC,LC	-	*PV	low	A
R465 Acacia Pied Barbet (<i>Tricholaema leucomelas</i>)	X	WO	LC,LC	-	*PVTO	Moderate	U
R495a Eastern Clapper Lark (<i>Corypha fasciolata</i>)	X	GR	LC,LC	-	*PT	HIGH	U
R498 Sabota Lark (<i>Calendulauda sabota</i>)	X	WO	LC,LC	-	*PT	HIGH	U
R500d Karoo Long-billed Lark (<i>Certhilauda subcoronata</i>)	X	SC	LC,LC	-	*PT	HIGH	U
R506 Spike-heeled Lark (<i>Chersomanes albofasciata</i>)	X	GR, SC	LC,LC	-	*PT	HIGH	U
R516 Grey-backed Sparrow-Lark (<i>Eremopterix verticalis</i>)	X	GR, SC	LC,LC	-	*PT	HIGH	U

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Name	NESW	Habitat	SCC	CMS	Hsa	REFrisk Disturb.	Status
R526 Greater Striped Swallow (<i>Cecropis cucullata</i>)	X	GR, SC	LC,LC	-	*PVTO	Moderate	A
R529 Large Rock Martin (<i>Ptyonoprogne fuligula</i>)	X	RC	LC,LC	-	*V	Moderate	A
R548 Pied Crow (<i>Corvus albus</i>)	X	HG	LC,LC	-	*PVTO	Moderate	V
R550 White-necked Raven (<i>Corvus albicollis</i>)	N	RC	LC,LC	-	*V	HIGH	BIT
R552 Ashy Tit (<i>Melaniparus cinerascens</i>)	S	WO	LC,LC	-	*V	low	BIT
R567 African Red-eyed Bulbul (<i>Pycnonotus nigricans</i>)	X	WO	LC,LC	-	*PVTO	HIGH	U
R583 Short-toed Rock Thrush (<i>Monticola brevipes</i>)	X	RC	LC,LC	-	*V	HIGH	V
R586 Mountain Chat (<i>Myrmecocichla monticola</i>)	X	RC	LC,LC	-	*V	HIGH	V
R589 Familiar Chat (<i>Oenanthe familiaris</i>)	X	HG	LC,LC	-	*PVTO	HIGH	U
R592 Karoo Chat (<i>Emarginata schlegelii</i>)	X	SC	LC,LC	-	*P	HIGH	U
R621 Chestnut-vented Warbler (<i>Curruca subcoerulea</i>)	X	SC, WO	LC,LC	-	*VT	Moderate	BIT
R622 Layard's Warbler (<i>Curruca layardi</i>)	X	SC	LC,LC	-	*V	Moderate	V
R651 Long-billed Crombec (<i>Sylvietta rufescens</i>)	X	SC, WO	LC,LC	-	*VT	Moderate	BIT
R653 Yellow-bellied Eremomela (<i>Eremomela icteropygialis</i>)	X	SC, WO	LC,LC	-	*PT	HIGH	U
R665 Desert Cisticola (<i>Cisticola aridulus</i>)	X	GR	LC,LC	-	*PT	HIGH	U
R669 Grey-backed Cisticola (<i>Cisticola subruficapilla</i>)	X	SC	LC,LC	-	*PVT	HIGH	U
R685 Black-chested Prinia (<i>Prinia flavicans</i>)	X	SC, WO	LC,LC	-	*PVTO	HIGH	U
R688 Rufous-eared Warbler (<i>Malcorus pectoralis</i>)	X	SC	LC,LC	-	*PT	HIGH	U
R697 Chat Flycatcher (<i>Agricola infuscatus</i>)	X	SC, WO	LC,LC	-	*T	low	BIT
R703 Pririt Batis (<i>Batis pririt</i>)	X	WO	LC,LC	-	*VTO	low	V
R716 African Pipit (<i>Anthus cinnamomeus</i>)	X	GR	LC,LC	-	*PT	low	BIT?
R732 Southern Fiscal (<i>Lanius collaris</i>)	X	HG	LC,LC	-	*PVT	HIGH	U
R746 Bokmakierie (<i>Telophorus zeylonus</i>)	X	SC	LC,LC	-	*PVT	HIGH	U
R770 Pale-winged Starling (<i>Onychognathus nabouroup</i>)	X	RC	LC,LC	-	*PVT	low	BIT

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Name	NESW	Habitat	SCC	CMS	Hsa	REFrisk Disturb.	Status
R788 Dusky Sunbird (<i>Cinnyris fuscus</i>)	X	SC, WO	LC,LC	-	*V	Moderate	BIT
R800 Sociable Weaver (<i>Philetairus socius</i>)	S	WO	LC,LC	-	*PVT	HIGH	U
R879 White-throated Canary (<i>Crithagra albogularis</i>)	X	SC	LC,LC	-	*PT	HIGH	U
R885 Cape Bunting (<i>Emberiza capensis</i>)	X	GR, RC, SC	LC,LC	-	*PVT	HIGH	U
R887 Lark-like Bunting (<i>Emberiza impetuani</i>)	X	SC, WO	LC,LC	-	*PT	HIGH	U

D 26 ADDITIONAL SPECIES EXPECTED TO BE RECORDED IN THE FOOTPRINT BUT UNLIKELY TO EXPERIENCE REFRIK DISTURBANCE IMPACT:

R094 Hadada Ibis (<i>Bostrychia hagedash</i>)	X	HG	LC,LC	-	*PTO	--	BIT
R162 Pale Chanting Goshawk (<i>Melierax canorus</i>)	X	SC, WO	LC,LC	-	*PT	--	V
R169 African Harrier-Hawk (<i>Polyboroides typus</i>)	X	HG	LC,LC	-	*V	--	BIT
R348 Rock Dove (<i>Columba livia</i>)	X	HG	LC,LC	-	*O	--	BIT
R356 Namaqua Dove (<i>Oena capensis</i>)	X	HG	LC,LC	-	*T	--	BIT
R382 Jacobin Cuckoo (<i>Clamator jacobinus</i>)	S	WO	LC,LC	-	*T	--	BIT
R386 Diederik Cuckoo (<i>Chrysococcyx caprius</i>)	X	GR, WO	LC,LC	-	*VT	--	BIT
R411 Common Swift (<i>Apus apus</i>)	X	HG	LC,LC	-	*PVT	--	A
R412 African Black Swift (<i>Apus barbatus</i>)	NW	HG	LC,LC	-	*PVT	--	A
R415 White-rumped Swift (<i>Apus caffer</i>)	X	HG	LC,LC	-	*PV	--	A
R417 Little Swift (<i>Apus affinis</i>)	X	HG	LC,LC	-	*PVT	--	A
R438 European Bee-eater (<i>Merops apiaster</i>)	X	HG	LC,LC	A2	*PVTO	--	A
R483 Golden-tailed Woodpecker (<i>Campethera abingoni</i>)	S	WO	LC,LC	-	*V	--	BIT
R518 Barn Swallow (<i>Hirundo rustica</i>)	X	HG	LC,LC	-	*PT	--	A
R524 Red-breasted Swallow (<i>Cecropis semirufa</i>)	SW	GR, WO	LC,LC	-	*NA	--	A
R530 Western House Martin (<i>Delichon urbicum</i>)	S	HG	LC,LC	-	*V	--	A

CONTINUED ON NEXT PAGE...

Name	NESW	Habitat	SCC	CMS	Hsa	REFrisk Disturb.	Status
R557 Cape Penduline Tit (<i>Anthoscopus minutus</i>)	X	SC, WO	LC,LC	-	*T	--	BIT
R587 Capped Wheatear (<i>Oenanthe pileata</i>)	X	GR, SC	LC,LC	-	*T	--	BIT
R689 Spotted Flycatcher (<i>Muscicapa striata</i>)	X	WO	LC,LC	A2	*V	--	BIT?
R731 Lesser Grey Shrike (<i>Lanius minor</i>)	S	WO	LC,LC	-	*PT	--	BIT
R733 Red-backed Shrike (<i>Lanius collurio</i>)	S	WO	LC,LC	-	*T	--	BIT?
R743 Brown-crowned Tchagra (<i>Tchagra australis</i>)	S	WO	LC,LC	-	*VT	--	BIT
R821 Red-billed Quelea (<i>Quelea quelea</i>)	X	HG	LC,LC	-	*VTO	--	U
R847 Black-faced Waxbill (<i>Brunhilda erythronotos</i>)	S	WO	LC,LC	-	*TO	--	BIT
R856 Red-headed Finch (<i>Amadina erythrocephala</i>)	X	GR, SC, WO	LC,LC	-	*PT	--	U
R878 Yellow Canary (<i>Crithagra flaviventris</i>)	X	GR, SC	LC,LC	-	*TO	--	BIT

E 45 ADDITIONAL SPECIES LISTED UNDER CMS AND UNLIKELY TO EXPERIENCE IMPACT RISK:

R008 Little Grebe (<i>Tachybaptus ruficollis</i>)	OR	AQ	LC,LC	W	*OW	--	--
R055 Great Cormorant (<i>Phalacrocorax carbo</i>)	OR	AQ, MR	LC,LC	W	*O	--	--
R062 Grey Heron (<i>Ardea cinerea</i>)	OR	AQ, MR	LC,LC	W	*O	--	--
R063 Black-headed Heron (<i>Ardea melanocephala</i>)	X	HG	LC,LC	W	O	--	--
R067 Little Egret (<i>Egretta garzetta</i>)	OR	AQ, MR	LC,LC	W	-	--	--
R071 Western Cattle Egret (<i>Ardea ibis</i>)	X	HG	LC,LC	W	*TO	--	--
R072 Squacco Heron (<i>Ardeola ralloides</i>)	OR	AQ	LC,LC	W	*O	--	--
R078 Little Bittern (<i>Botaurus minutus</i>)	OR	AQ	LC,LC	W	-	--	--
R083 White Stork (<i>Ciconia ciconia</i>)	OR	HG	LC,LC	W,A2	O	--	--
R085 Abdim's Stork (<i>Ciconia abdimii</i>)	OR	HG	LC,LC	W	O	--	--
R091 African Sacred Ibis (<i>Threskiornis aethiopicus</i>)	OR	HG	LC,LC	W,A2	*O	--	--

CONTINUED ON NEXT PAGE...

Name	NESW	Habitat	SCC	CMS	Hsa	REFrisk	Status
						Disturb.	
R093 Glossy Ibis (<i>Plegadis falcinellus</i>)	OR	AQ	LC,LC	W,A2	*O	--	--
R095 African Spoonbill (<i>Platalea alba</i>)	OR	AQ	LC,LC	W,A2	*O	--	--
R099 White-faced Whistling Duck (<i>Dendrocygna viduata</i>)	OR	AQ	LC,LC	W	*O	--	--
R102 Egyptian Goose (<i>Alopochen aegyptiaca</i>)	X	AQ	LC,LC	W	*OW	--	--
R103 South African Shelduck (<i>Tadorna cana</i>)	X	AQ	LC,LC	W	*OW	--	--
R105 African Black Duck (<i>Anas sparsa</i>)	OR	AQ	LC,LC	A2	O	--	--
R106 Cape Teal (<i>Anas capensis</i>)	X	AQ	LC,LC	W,A2	*O	--	--
R116 Spur-winged Goose (<i>Plectropterus gambensis</i>)	X	AQ	LC,LC	W	*O	--	--
R126y Black Kite (<i>Milvus migrans</i>)	X	HG	LC,LC	A2,R3	-	--	--
R130 European Honey Buzzard (<i>Pernis apivorus</i>)	S	WO	LC,LC	A2,R3	-	--	--
R143 Black-chested Snake Eagle (<i>Circaetus pectoralis</i>)	X	HG	LC,LC	R3	-	--	--
R149 Common Buzzard (<i>Buteo buteo</i>)	X	HG	LC,LC	A2,R3	O	--	--
R213 Black Crake (<i>Zapornia flavirostra</i>)	OR	AQ	LC,LC	W	*O	--	--
R226 Common Moorhen (<i>Gallinula chloropus</i>)	OR	AQ	LC,LC	W	*O	--	--
R228 Red-knobbed Coot (<i>Fulica cristata</i>)	X	AQ	LC,LC	W	*O	--	--
R249 Three-banded Plover (<i>Thinornis tricollaris</i>)	X	AQ	LC,LC	W,A2	*O	--	--
R255 Crowned Lapwing (<i>Vanellus coronatus</i>)	X	GR	LC,LC	W	*O	--	--
R264 Common Sandpiper (<i>Actitis hypoleucos</i>)	OR	AQ, MR	LC,LC	W,A2	*O	--	--
R266 Wood Sandpiper (<i>Tringa glareola</i>)	X	AQ	LC,LC	W,A2	*O	--	--
R269 Marsh Sandpiper (<i>Tringa stagnatilis</i>)	X	AQ	LC,LC	W,A2	-	--	--
R270 Common Greenshank (<i>Tringa nebularia</i>)	X	AQ, MR	LC,LC	W,A2	-	--	--
R274 Little Stint (<i>Calidris minuta</i>)	X	AQ, MR	LC,LC	W,A2	*O	--	--
R284 Ruff (<i>Calidris pugnax</i>)	X	AQ	LC,LC	W,A2	-	--	--
R290 Eurasian Whimbrel (<i>Numenius phaeopus</i>)	OOR	MR	LC,LC	W,A2	-	--	--

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Name	NESW	Habitat	SCC	CMS	Hsa	REFrisk Disturb.	Status
R294 Pied Avocet (<i>Recurvirostra avosetta</i>)	X	AQ	LC,LC	W,A2	-	--	--
R295 Black-winged Stilt (<i>Himantopus himantopus</i>)	X	AQ	LC,LC	W,A2	*O	--	--
R315 Grey-headed Gull (<i>Chroicocephalus cirrocephalus</i>)	X	AQ, MR	LC,LC	W	-	--	--
R339 White-winged Tern (<i>Chlidonias leucopterus</i>)	OR	AQ, GR	LC,LC	W,A2	-	--	--
R543 Eurasian Golden Oriole (<i>Oriolus oriolus</i>)	S	WO	LC,LC	A2	-	--	--
R619 Garden Warbler (<i>Sylvia borin</i>)	W	WO	LC,LC	A2	-	--	--
R631 Common Reed Warbler (<i>Acrocephalus scirpaceus</i>)	OR	AQ	LC,LC	A2	-	--	--
R633 Marsh Warbler (<i>Acrocephalus palustris</i>)	W	AQ, WO	LC,LC	A2	-	--	--
R634 Sedge Warbler (<i>Acrocephalus schoenobaenus</i>)	W	AQ	LC,LC	A2	-	--	--
R643 Willow Warbler (<i>Phylloscopus trochilus</i>)	X	WO	LC,LC	A2	-	--	--

F. 19 ADDITIONAL WATERBIRDS:

R058 Reed Cormorant (<i>Microcarbo africanus</i>)	OR	AQ	LC,LC	-	*O	--	--
R064 Goliath Heron (<i>Ardea goliath</i>)	OR	AQ	LC,LC	-	-	--	--
R074 Little Heron (<i>Butorides atricapilla</i>)	OR	AQ	LC,LC	-	-	--	--
R148 African Fish Eagle (<i>Ichthyophaga vocifer</i>)	OR	AQ	LC,LC	-	O	--	--
R242 Greater Painted-snipe (<i>Rostratula benghalensis</i>)	OR	AQ	LC,LC	-	-	--	--
R258 Blacksmith Lapwing (<i>Vanellus armatus</i>)	X	AQ	LC,LC	-	*O	--	--
R428 Pied Kingfisher (<i>Ceryle rudis</i>)	OR	AQ	LC,LC	-	O	--	--
R429 Giant Kingfisher (<i>Megaceryle maxima</i>)	OR	AQ	LC,LC	-	*O	--	--
R431 Malachite Kingfisher (<i>Corythornis cristatus</i>)	OR	AQ	LC,LC	-	*O	--	--
R520 White-throated Swallow (<i>Hirundo albigularis</i>)	X	AQ	LC,LC	-	*O	--	--
R532 Sand Martin (<i>Riparia riparia</i>)	W	AQ, GR	LC,LC	-	-	--	--

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Name	NESW	Habitat	SCC	CMS	Hsa	REFrisk Disturb.	Status
R533 Brown-throated Martin (<i>Riparia paludicola</i>)	OR	AQ	LC,LC	-	*O	--	--
R635 Lesser Swamp Warbler (<i>Acrocephalus gracilirostris</i>)	OR	AQ	LC,LC	-	*O	--	--
R677 Levillant's Cisticola (<i>Cisticola tinniens</i>)	X	AQ, GR	LC,LC	-	*O	--	--
R711 African Pied Wagtail (<i>Motacilla aguimp</i>)	OR	AQ	LC,LC	-	*O	--	--
R713 Cape Wagtail (<i>Motacilla capensis</i>)	X	AQ	LC,LC	-	*OW	--	--
R824 Southern Red Bishop (<i>Euplectes orix</i>)	X	AQ	LC,LC	-	*ptO	--	--
R826 Yellow-crowned Bishop (<i>Euplectes afer</i>)	W	AQ, GR	LC,LC	-	-	--	--
R846 Common Waxbill (<i>Estrilda astrild</i>)	X	AQ	LC,LC	-	*O	--	--

G. 47 ADDITIONAL SPECIES RECORDED IN STUDY AREA:

R203 Helmeted Guineafowl (<i>Numida meleagris</i>)	X	HG	LC,LC	-	*T	--	--
R352 Red-eyed Dove (<i>Streptopelia semitorquata</i>)	X	WO	LC,LC	-	*O	--	--
R354 Ring-necked Dove (<i>Streptopelia capicola</i>)	X	HG	LC,LC	-	*VT	--	--
R355 Laughing Dove (<i>Spilopelia senegalensis</i>)	X	HG	LC,LC	-	*VTO	--	--
R392 Western Barn Owl (<i>Tyto alba</i>)	X	HG	LC,LC	-	*V	--	--
R398 Pearl-spotted Owlet (<i>Glaucidium perlatus</i>)	S	WO	LC,LC	-	*V	--	--
R401 Spotted Eagle-Owl (<i>Bubo africanus</i>)	X	HG	LC,LC	-	*V	--	--
R421 African Palm Swift (<i>Cypsiurus parvus</i>)	X	HG	LC,LC	-	*T	--	--
R425 White-backed Mousebird (<i>Colius colius</i>)	X	WO	LC,LC	-	*TO	--	--
R426 Red-faced Mousebird (<i>Urocolius indicus</i>)	X	WO	LC,LC	-	*TO	--	--
R435 Brown-hooded Kingfisher (<i>Halcyon albiventris</i>)	OR	WO	LC,LC	-	*O	--	--
R443 White-fronted Bee-eater (<i>Merops bullockoides</i>)	OR	WO	LC,LC	-	*O	--	--
R445 Swallow-tailed Bee-eater (<i>Merops hirundineus</i>)	S	WO	LC,LC	-	*O	--	--

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Name	NESW	Habitat	SCC	CMS	Hsa	REFrisk	Status
						Disturb.	
R451 Common Hoopoe (<i>Upupa epops</i>)	S	WO	LC,LC	-	*O	--	--
R454 Common Scimitarbill (<i>Rhinopomastus cyanomelas</i>)	S	WO	LC,LC	-	*VTO	--	--
R473 Crested Barbet (<i>Trachyphonus vaillantii</i>)	S	WO	LC,LC	-	*O	--	--
R486 Cardinal Woodpecker (<i>Dendropicos fuscescens</i>)	S	WO	LC,LC	-	*O	--	--
R497 Fawn-colored Lark (<i>Calendulauda africanoides</i>)	X	WO	LC,LC	-	*T	--	--
R523 Pearl-breasted Swallow (<i>Hirundo dimidiata</i>)	X	HG	LC,LC	-	*O	--	--
R595 Ant-eating Chat (<i>Myrmecocichla formicivora</i>)	X	GR, SC	LC,LC	-	*T	--	--
R596 African Stonechat (<i>Saxicola torquatus</i>)	X	GR, SC	LC,LC	-	*TO	--	--
R601 Cape Robin-Chat (<i>Dessonornis cafffer</i>)	X	FR, SC, WO	LC,LC	-	*O	--	--
R615 Kalahari Scrub Robin (<i>Cercotrichas paena</i>)	X	WO	LC,LC	-	*T	--	--
R664 Zitting Cisticola (<i>Cisticola juncidis</i>)	X	GR	LC,LC	-	*O	--	--
R681 Neddicky (<i>Cisticola fulvicapilla</i>)	W	SC	LC,LC	-	*V	--	--
R717 Nicholson's Pipit (<i>Anthus nicholsoni</i>)	X	RC	LC,LC	-	*V	--	--
R739 Crimson-breasted Shrike (<i>Laniarius atrococcineus</i>)	S	WO	LC,LC	-	*T	--	--
R741 Brubru (<i>Nilaus afer</i>)	S	WO	LC,LC	-	*TO	--	--
R758 Common Myna (<i>Acridotheres tristis</i>)	SW	HG	LC,LC	-	*O	--	--
R760 Wattled Starling (<i>Creatophora cinerea</i>)	X	HG	LC,LC	-	*TO	--	--
R764 Cape Starling (<i>Lamprotornis nitens</i>)	SW	WO	LC,LC	-	*TO	--	--
R787 White-bellied Sunbird (<i>Cinnyris talatala</i>)	SW	WO	LC,LC	-	*T	--	--
R796a Orange River White-eye (<i>Zosterops pallidus</i>)	X	WO	LC,LC	-	*VO	--	--
R799 White-browed Sparrow-Weaver (<i>Plocepasser mahali</i>)	X	WO	LC,LC	-	*VT	--	--
R801 House Sparrow (<i>Passer domesticus</i>)	X	HG	LC,LC	-	*TO	--	--
R803 Cape Sparrow (<i>Passer melanurus</i>)	X	HG	LC,LC	-	*TO	--	--
R804a Southern Grey-headed Sparrow (<i>Passer diffusus</i>)	X	WO	LC,LC	-	*O	--	--

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Name	NESW	Habitat	SCC	CMS	Hsa	REFrisk Disturb.	Status
R806 Scaly-feathered Weaver (<i>Sporopipes squamifrons</i>)	X	WO	LC,LC	-	*T	--	--
R814 Southern Masked Weaver (<i>Ploceus velatus</i>)	X	HG	LC,LC	-	*VTO	--	--
R834 Green-winged Pytilia (<i>Pytilia melba</i>)	S	WO	LC,LC	-	*VT	--	--
R842 Red-billed Firefinch (<i>Lagonosticta senegala</i>)	OR	WO	LC,LC	-	*O	--	--
R845 Violet-eared Waxbill (<i>Granatina granatina</i>)	S	WO	LC,LC	-	*VT	--	--
R852 Quailfinch (<i>Ortygospiza atricollis</i>)	W	GR	LC,LC	-	*T	--	--
R860 Pin-tailed Whydah (<i>Vidua macroura</i>)	OR	HG	LC,LC	-	*O	--	--
R870 Black-throated Canary (<i>Crithagra atrogularis</i>)	X	WO	LC,LC	-	*VTO	--	--
R884 Golden-breasted Bunting (<i>Emberiza flaviventris</i>)	SW	WO	LC,LC	-	*T	--	--
R886 Cinnamon-breasted Bunting (<i>Emberiza tahapisi</i>)	X	RC	LC,LC	-	*V	--	--

H. 35 ADDITIONAL SPECIES:

R001 Common Ostrich (<i>Struthio camelus</i>)	X	HG	LC,LC	-	-	--	--
R161 Gabar Goshawk (<i>Micronisus gabar</i>)	OOR	WO	LC,LC	-	-	--	--
R178 Red-necked Falcon (<i>Falco chicquera</i>)	S	WO	LC,LC	-	-	--	--
R182 Greater Kestrel (<i>Falco rupicoloides</i>)	X	GR, SC	LC,LC	-	-	--	--
R199 Swainson's Spurfowl (<i>Pternistis swainsonii</i>)	SW	GR, WO	LC,LC	-	-	--	--
R202x Indian Peafowl (<i>Pavo cristatus</i>)	ESC	HG	LC,LC	-	-	--	--
R300 Temminck's Courser (<i>Cursorius temminckii</i>)	X	GR	LC,LC	-	-	--	--
R391a Burchell's Coucal (<i>Centropus burchellii</i>)	OR	WO	LC,LC	-	-	--	--
R397 Southern White-faced Owl (<i>Ptilopsis granti</i>)	S	WO	LC,LC	-	-	--	--
R404 European Nightjar (<i>Caprimulgus europaeus</i>)	W	HG	LC,LC	-	-	--	--
R405 Fiery-necked Nightjar (<i>Caprimulgus pectoralis</i>)	X	WO	LC,LC	-	-	--	--

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Name	NESW	Habitat	SCC	CMS	Hsa	REFrisk Disturb.	Status
R416 Horus Swift (<i>Apus horus</i>)	NW	HG	LC,LC	-	-	--	--
R447 Lilac-breasted Roller (<i>Coracias caudatus</i>)	S	WO	LC,LC	-	-	--	--
R457 African Grey Hornbill (<i>Lophoceros nasutus</i>)	S	WO	LC,LC	-	-	--	--
R459 Southern Yellow-billed Hornbill (<i>Tockus leucomelas</i>)	S	WO	LC,LC	-	-	--	--
R464 Black-collared Barbet (<i>Lybius torquatus</i>)	W	WO	LC,LC	-	-	--	--
R474 Greater Honeyguide (<i>Indicator indicator</i>)	OR	WO	LC,LC	-	-	--	--
R476 Lesser Honeyguide (<i>Indicator minor</i>)	OR	WO	LC,LC	-	-	--	--
R481 Bennett's Woodpecker (<i>Campethera bennettii</i>)	S	WO	LC,LC	-	-	--	--
R489 Red-throated Wryneck (<i>Jynx ruficollis</i>)	OOR	WO	LC,LC	-	-	--	--
R507 Red-capped Lark (<i>Calandrella cinerea</i>)	X	GR, SC	LC,LC	-	-	--	--
R508 Pink-billed Lark (<i>Spizocorys conirostris</i>)	X	GR	LC,LC	-	-	--	--
R511 Stark's Lark (<i>Spizocorys starki</i>)	E	SC	LC,LC	-	-	--	--
R534 Banded Martin (<i>Neophedina cincta</i>)	OR	GR	LC,LC	-	-	--	--
R541 Fork-tailed Drongo (<i>Dicrurus adsimilis</i>)	S	FR, WO	LC,LC	-	-	--	--
R547 Cape Crow (<i>Corvus capensis</i>)	X	HG	LC,LC	-	-	--	--
R590 Tractrac Chat (<i>Emarginata tractrac</i>)	NE	SC	LC,LC	-	-	--	--
R695 Marico Flycatcher (<i>Bradornis mariquensis</i>)	S	WO	LC,LC	-	-	--	--
R718 Plain-backed Pipit (<i>Anthus leucophrys</i>)	W	GR	LC,LC	-	-	--	--
R719 Buffy Pipit (<i>Anthus vaalensis</i>)	X	GR	LC,LC	-	-	--	--
R757 Common Starling (<i>Sturnus vulgaris</i>)	X	HG	LC,LC	-	-	--	--
R779 Marico Sunbird (<i>Cinnyris mariquensis</i>)	S	WO	LC,LC	-	-	--	--
R802 Great Sparrow (<i>Passer motitensis</i>)	S	WO	LC,LC	-	-	--	--
R861 Shaft-tailed Whydah (<i>Vidua regia</i>)	S	WO	LC,LC	-	-	--	--

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Name	NESW	Habitat	SCC	CMS	Hsa	REFrisk	Status
						Disturb.	
R867 Village Indigobird (<i>Vidua chalybeata</i>)	S	WO	LC,LC	-	-	--	--

Table 2: Summary of repeatable 5-minute checklist transects on foot conducted in the POPA.

Code	Place	Date	Start	End	n (5 mins.)	Distance (km)
A	Plateau North 1	20210803	733	1138	48	11
B	Plateau North 2	20210806	730	1030	34	6.3
C	Plateau DPVn	20210812	708	810	11	2
D	Plateau DPVfp	20210812	810	1224	34	7.1
E	Plateau DPVfp	20251105	638	943	37	5.7
F	Plateau DPVfp	20251105	1125	1410	32	5.4
G	Plateau DPVfp	20251105	1619	1834	26	5.1
H	Valley East 1	20251106	631	941	37	4.9
I	Valley North 1	20251106	941	1301	40	4
J	Plateau North 1	20251108	610	1052	40	6.1
K	Plateau North 2	20251110	636	958	36	6.1
L	Valley North 2	20251111	609	1308	69	7.3
M	Toeslope	20251112	625	1020	47	7.2
N	Toeslope	20260213	623	1053	48	8.6
O	Plateau DPVfp	20260214	641	956	39	6.2
P	Plateau DPVfp	20260214	1108	1353	33	5.9
Q	Plateau DPVfp	20260214	1605	1850	33	5.9
R	Valley East 1	20260215	619	947	35	6.2
S	Valley North 1	20260215	1122	1416	31	4.5
T	Plateau North 1	20260216	635	1145	45	9.4
U	Valley North 2	20260217	658	1105	36	5.1
V	Plateau North 2	20260218	643	930	33	6.9
W	Plateau DPVn	20260220	709	844	19	3.5

Table 3: Reporting rates of species recorded during selected 5minute checklist surveys on foot (see Table 2). Categories: L = low reporting rate; M = moderate reporting rate; H = high reporting rate. The letter above each value indicates the relative reporting rate for the species, while the letter below indicates the relative reporting rate for the survey.

	Plateau												Valley										
	DPVfp							DPVn		North 1			North 2			E1		N1		N2		Toeslope	
Species	D: 20210812_810	E: 20251105_638	F: 20251105_1125	G: 20251105_1619	O: 20260214_641	P: 20260214_1108	Q: 20260214_1605	C: 20210812_708	W: 20260220_709	A: 20210803_733	J: 20251108_610	T: 20260216_635	B: 20210806_730	K: 20251110_636	V: 20260218_643	H: 20251106_631	R: 20260215_619	I: 20251106_941	S: 20260215_1122	L: 20251111_609	U: 20260217_658	M: 20251112_625	N: 20260213_623
No birds recorded	H 24 M	-	L 3 L	L 4 L	L 3 L	L 3 L	L 3 L	H 27 M	-	M 15 L	-	-	M 15 L	-	-	-	-	-	-	-	-	-	-
R094 Hadada Ibis	-	-	-	-	-	-	-	-	-	-	-	-	H 3 L	-	-	-	-	-	-	-	-	-	-
R102 Egyptian Goose	-	-	-	-	-	-	-	-	H 5 L	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R103 South African Shelduck	-	-	-	-	-	-	-	-	-	H 2 L	-	-	-	-	-	-	-	-	-	-	-	-	-
R131 Verreaux’s Eagle	-	L 3 L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H 7 L	-	-	-	-
R136 Booted Eagle	-	-	-	-	-	-	-	-	-	-	L 2 L	L 2 L	-	-	-	-	-	L 2 L	H 19 L	H 16 L	H 17 L	-	-

	Plateau												Valley										
	DPVfp							DPVn	North 1		North 2			E1		N1		N2	Toeslope				
Species	D: 20210812_810	E: 20251105_638	F: 20251105_1125	G: 20251105_1619	O: 20260214_641	P: 20260214_1108	Q: 20260214_1605	C: 20210812_708	W: 20260220_709	A: 20210803_733	J: 20251108_610	T: 20260216_635	B: 20210806_730	K: 20251110_636	V: 20260218_643	H: 20251106_631	R: 20260215_619	I: 20251106_941	S: 20260215_1122	L: 20251111_609	U: 20260217_658	M: 20251112_625	N: 20260213_623
R232 Ludwig's Bustard	-	-	-	-	H 5 L	-	-	-	-	-	-	L 2 L	-	-	-	-	-	-	-	-	-	-	-
R235 Karoo Korhaan	-	-	-	-	-	-	-	-	H 5 L	L 2 L	-	-	-	-	-	-	-	-	-	-	-	H 4 L	L 2 L
R237 Red-crested Korhaan	-	-	-	-	-	-	-	-	-	-	L 10 L	-	-	L 3 L	-	-	-	-	-	-	-	H 55 H	H 52 H
R239a Northern Black Korhaan	-	L 8 L	L 12 L	L 12 L	-	-	-	-	-	-	L 2 L	-	-	-	-	L 3 L	-	-	-	-	-	H 43 M	H 50 H
R301 Double-banded Courser	H 3 L	-	-	-	-	-	-	-	-	L 2 L	-	-	-	-	-	-	-	-	-	-	-	-	-
R344 Namaqua Sandgrouse	-	-	-	-	-	-	-	-	-	L 2 L	-	-	L 3 L	-	-	-	-	-	-	-	-	H 19 L	H 17 L
R349 Speckled Pigeon	-	-	-	-	-	-	-	-	L 5 L	L 2 L	L 5 L	L 2 L	M 9 L	L 6 L	L 3 L	-	-	M 10 L	-	H 16 L	M 11 L	-	-

	Plateau												Valley										
	DPVfp							DPVn	North 1			North 2		E1		N1		N2		Toeslope			
Species	D: 20210812_810	E: 20251105_638	F: 20251105_1125	G: 20251105_1619	O: 20260214_641	P: 20260214_1108	Q: 20260214_1605	C: 20210812_708	W: 20260220_709	A: 20210803_733	J: 20251108_610	T: 20260216_635	B: 20210806_730	K: 20251110_636	V: 20260218_643	H: 20251106_631	R: 20260215_619	I: 20251106_941	S: 20260215_1122	L: 20251111_609	U: 20260217_658	M: 20251112_625	N: 20260213_623
R354 Ring-necked Dove	-	-	H 3 L	-	-	-	-	-	-	-	M 2 L	-	-	-	-	-	-	-	-	-	-	-	L 2 L
R355 Laughing Dove	-	-	-	-	-	-	-	-	-	L 6 L	L 2 L	-	L 12 L	L 6 L	-	-	L 3 L	L 12 L	-	H 38 M	M 17 L	L 2 L	-
R356 Namaqua Dove	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H 3 L	-	-	-	-	-	-	L 2 L	-
R398 Pearl-spotted Owlet	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H 4 L	-	-	-	-
R412 African Black Swift	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L 2 L	-	H 4 L	-	-	-
R413 Bradfield’s Swift	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L 3 L	H 8 L	-	L 2 L
R415 White-rumped Swift	-	-	-	-	L 3 L	-	-	-	-	-	-	-	-	-	-	-	-	H 5 L	-	-	-	-	-

	Plateau														Valley								
	DPVfp							DPVn	North 1			North 2			E1		N1		N2	Toeslope			
Species	D: 20210812_810	E: 20251105_638	F: 20251105_1125	G: 20251105_1619	O: 20260214_641	P: 20260214_1108	Q: 20260214_1605	C: 20210812_708	W: 20260220_709	A: 20210803_733	J: 20251108_610	T: 20260216_635	B: 20210806_730	K: 20251110_636	V: 20260218_643	H: 20251106_631	R: 20260215_619	I: 20251106_941	S: 20260215_1122	L: 20251111_609	U: 20260217_658	M: 20251112_625	N: 20260213_623
R417 Little Swift	-	-	-	-	-	M 3 L	-	-	-	-	-	-	-	-	-	-	-	-	-	L 1 L	-	-	H 4 L
R418 Alpine Swift	-	-	-	-	-	-	-	-	-	-	L 2 L	L 7 L	-	-	-	-	-	-	-	H 19 L	L 6 L	-	-
R438 European Bee-eater	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H 1 L	-	-	-
R465 Acacia Pied Barbet	-	L 3 L	-	-	L 3 L	L 3 L	L	-	M 37 M	L 6 L	L 5 L	L 13 L	L 6 L	L 17 L	L	M 24 M	M 26 L	M 32 M	H 61 H	M 42 H	H 64 H	L 11 L	L 4 L
R483 Golden-tailed Woodpecker	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H 3 L	-	-	-	-	-	-	-	-
R495a Eastern Clapper Lark	-	M 24 L	L 3 L	L 4 L	L 3 L	-	-	-	-	-	M 35 M	L 2 L	-	H 53 H	M 21 L	-	-	-	-	L 9 L	-	H 45 M	L 15 L
R497 Fawn-colored Lark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L 6 L	H 17 L

	Plateau														Valley								
	DPVfp							DPVn		North 1			North 2			E1		N1		N2		Toeslope	
Species	D: 20210812_810	E: 20251105_638	F: 20251105_1125	G: 20251105_1619	O: 20260214_641	P: 20260214_1108	Q: 20260214_1605	C: 20210812_708	W: 20260220_709	A: 20210803_733	J: 20251108_610	T: 20260216_635	B: 20210806_730	K: 20251110_636	V: 20260218_643	H: 20251106_631	R: 20260215_619	I: 20251106_941	S: 20260215_1122	L: 20251111_609	U: 20260217_658	M: 20251112_625	N: 20260213_623
R498 Sabota Lark	-	L	L	L	M	L	L	-	H	L	H	M	L	M	M	L	L	L	-	L	-	H	H
		24	12	12	28	15	9		53	6	60	40	12	44	42	3	3	8		7		68	71
		L	L	L	M	M	L		M	L	H	M	L	M	M	L	L	L		L		H	H
R500d Karoo Long-billed Lark	M	H	M	H	H	M	M	H	M	M	H	M	M	H	H	L	-	-	-	L	-	M	M
	47	68	50	62	72	36	36	64	42	46	65	42	41	75	52	3				9		38	35
	H	H	H	H	H	H	H	H	M	H	H	M	H	H	M	L				L		M	M
R506 Spike-heeled Lark	H	-	-	M	-	-	L	-	-	H	-	-	-	-	-	-	-	-	-	-	-	L	M
	6			4			3			6												2	4
	L			L			L			L												L	L
R516 Grey-backed Sparrow-Lark	-	L	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		3	3																				
		L	L																				
R518 Barn Swallow	-	-	-	-	M	H	L	-	M	-	-	M	-	-	L	-	L	-	-	-	L	-	L
					15	24	9		11			13			9		6				3		8
					L	M	L		L			L			L		L			L			L
R524 Red-breasted Swallow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H	-	-	-	-	-	-
																	3						
																	L						
R526 Greater Striped Swallow	-	L	-	-	L	-	L	-	-	-	-	L	-	L	M	-	L	M	H	L	M	L	-
		3			3		3					2		3	12		3	15	23	6	11	4	
		L			L		L					L		L	L		L	L	M	L	L	L	

	Plateau														Valley								
	DPVfp							DPVn		North 1		North 2			E1		N1		N2		Toeslope		
Species	D: 20210812_810	E: 20251105_638	F: 20251105_1125	G: 20251105_1619	O: 20260214_641	P: 20260214_1108	Q: 20260214_1605	C: 20210812_708	W: 20260220_709	A: 20210803_733	J: 20251108_610	T: 20260216_635	B: 20210806_730	K: 20251110_636	V: 20260218_643	H: 20251106_631	R: 20260215_619	I: 20251106_941	S: 20260215_1122	L: 20251111_609	U: 20260217_658	M: 20251112_625	N: 20260213_623
R529 Large Rock Martin	-	-	L 3 L	L 4 L	L 8 L	L 3 L	-	-	-	-	L 4 L	L 6 L	L 6 L	L 12 L	L 3 L	L 6 L	M 25 M	H 48 H	M 30 M	M 31 M	-	-	
R548 Pied Crow	L 3 L	L 5 L	-	-	-	-	-	-	-	L 2 L	-	L 2 L	-	-	-	L 3 L	-	H 18 M	L 6 L	H 14 L	L 3 L	-	M 8 L
R551 Grey Tit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H 6 L	-	-	
R552 Ashy Tit	-	-	-	-	-	-	-	-	-	-	H 2 L	-	-	-	-	-	-	-	-	L 1 L	-	-	
R557 Cape Penduline Tit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H 2 L
R567 African Red-eyed Bulbul	-	L 11 L	L 3 L	-	-	-	-	-	-	-	L 2 L	L 4 L	L 15 L	-	-	L 5 L	L 3 M	M 30 M	M 26 M	H 32 M	H 44 M	L 2 L	L 2 L
R583 Short-toed Rock Thrush	-	-	-	-	L 3 L	-	-	-	-	-	-	L 2 L	L 3 L	L 3 L	-	-	-	-	-	H 13 L	-	L 2 L	-

	Plateau														Valley								
	DPVfp							DPVn		North 1			North 2			E1		N1		N2		Toeslope	
Species	D: 20210812_810	E: 20251105_638	F: 20251105_1125	G: 20251105_1619	O: 20260214_641	P: 20260214_1108	Q: 20260214_1605	C: 20210812_708	W: 20260220_709	A: 20210803_733	J: 20251108_610	T: 20260216_635	B: 20210806_730	K: 20251110_636	V: 20260218_643	H: 20251106_631	R: 20260215_619	I: 20251106_941	S: 20260215_1122	L: 20251111_609	U: 20260217_658	M: 20251112_625	N: 20260213_623
R586 Mountain Chat	-	L	-	-	-	-	L	-	-	-	-	L	-	L	-	L	H	L	L	L	-	-	L
		3					3					2		3		3	26	2	3	3			4
		L					L					L		L		L	L	L	L	L			L
R587 Capped Wheatear	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H
																						2	
																						L	
R589 Familiar Chat	-	-	-	-	-	M	-	-	-	M	-	-	-	-	H	H	M	L	-	-	H	-	-
						6				6					9	11	6	2			8		
						L				L					L	L	L	L		L			
R592 Karoo Chat	M	H	M	L	-	L	M	-	-	M	-	L	H	L	-	-	-	-	-	-	-	-	-
	12	24	12	4		9	12			12		2	26	6									
	L	L	L	L		L	L			L		L	M	L									
R614 Karoo Scrub Robin	-	-	L	-	L	M	L	M	H	-	M	L	-	M	M	H	H	L	L	L	L	L	L
			3		3	6	3	9	11		8	4		8	6	11	14	2	3	1	6	2	4
			L		L	L	L	L	L		L	L		L	L	L	L	L	L	L	L	L	L
R615 Kalahari Scrub Robin	-	-	-	-	-	-	-	-	-	-	-	-	-	L	-	-	-	-	-	-	-	L	H
														3								4	25
														L								L	M
R621 Chestnut-vented Warbler	-	-	-	-	-	-	-	-	-	L	-	-	-	-	-	L	H	H	H	L	H	L	-
										4						5	11	12	16	1	14	2	
										L						L	L	L	L	L	L	L	

	Plateau														Valley								
	DPVfp							DPVn	North 1			North 2			E1		N1		N2		Toeslope		
Species	D: 20210812_810	E: 20251105_638	F: 20251105_1125	G: 20251105_1619	O: 20260214_641	P: 20260214_1108	Q: 20260214_1605	C: 20210812_708	W: 20260220_709	A: 20210803_733	J: 20251108_610	T: 20260216_635	B: 20210806_730	K: 20251110_636	V: 20260218_643	H: 20251106_631	R: 20260215_619	I: 20251106_941	S: 20260215_1122	L: 20251111_609	U: 20260217_658	M: 20251112_625	N: 20260213_623
R622 Layard's Warbler	- L - - L L -	3			3	3		- L L	5 8				L - -			L L 14	L 3	M 22	L 10	H 39	L 8	-	-
	L				L	L		L	L				L			L	L	M	L	M	L		
R651 Long-billed Crombec	-	-	-	-	-	-	-	-	-	-	-	L 2	-	-	-	-	L 3	-	-	H 9	-	L 2	-
												L					L			L		L	
R653 Yellow-bellied Eremomela	- M M L - M L	11 9	4			12 6		- M L M L	11 4	10 7			- H M			L L 8	L 3	L 2	L 3	- -		H 17	M 10
	L L L					L L		L L L L	L	L L			L L			L L	L L	L L	L L			L L	L L
R665 Desert Cisticola	- L - - L - L	8			5	3		- L L L L	11 8	18 13		L 9	H 44	M 27		- L 20	-	L 3	L 3	-		M 36	H 60
	L				L	L		L L L L	L	L L		L M	L			L		L L	L L			M L	H
R669 Grey-backed Cisticola	L L L L L L L	3 27	9 8		15 12	18		- L - M M	16	40 44		L 3	H 72	H 76		H 57	H 60	M 48	H 52	H 62	M 47	M 28	L 19
	L M L L L L M				L L	M		L M H L H	L	M H		L H	H			H H	H H	H H	H H	M M		M M	L
R681 Neddicky	- - - - - - -							- - - L -				- - -				M 14	H 26	M 12	M 13	H 20	M 11	-	-
																L	L	L	L	L L			
R685 Black-chested Prinia	L M L L M M L	12 22	3 19		36 24	15		- M L L H	26 15	8 38		L 6	L 8	M 30		M 22	H 54	M 30	H 42	M 26	H 39	H 40	H 54
	L L L L M M M				M M	M		L L L M	L	L M		L L	M			L M	M M	M H	M M	M M		M M	H

[illegible]

	Plateau														Valley								
	DPVfp							DPVn		North 1			North 2			E1		N1		N2		Toeslope	
Species	D: 20210812_810	E: 20251105_638	F: 20251105_1125	G: 20251105_1619	O: 20260214_641	P: 20260214_1108	Q: 20260214_1605	C: 20210812_708	W: 20260220_709	A: 20210803_733	J: 20251108_610	T: 20260216_635	B: 20210806_730	K: 20251110_636	V: 20260218_643	H: 20251106_631	R: 20260215_619	I: 20251106_941	S: 20260215_1122	L: 20251111_609	U: 20260217_658	M: 20251112_625	N: 20260213_623
R732 Southern Fiscal	L 3 L	L 5 L	L 3 L	-	L 5 L	M 12 L	H 15 M	- 11 L	M L	L 2 L	- L	L 2 L	L 3 L	- L	H 21 L	L 5 L	M 9 L	- L	L 3 L	L 3 L	M 11 L	L 2 L	H 21 L
R733 Red-backed Shrike	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H 6 L
R743 Brown-crowned Tchagra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- 3 L	L 12 L	H 12 L	- L	L 1 L	M 8 L	L 4 L	L 2 L
R746 Bokmakierie	L 12 L	M 38 M	L 28 M	L 8 L	M 46 M	M 45 H	L 30 H	L 18 L	H 89 H	L 17 M	M 50 H	H 67 H	M 38 H	H 69 H	H 88 H	H 65 H	H 86 H	M 50 H	M 52 H	M 58 H	H 81 H	H 74 H	H 75 H
R770 Pale-winged Starling	-	-	-	-	-	-	-	-	-	L 8 L	L 10 L	L 7 L	H 47 H	L 6 L	L 6 L	- L	L 3 M	M 32 M	M 32 M	M 29 M	H 50 M	L 2 L	L 2 L
R788 Dusky Sunbird	-	-	-	-	L 3 L	L 3 L	L 6 L	-	-	-	-	-	-	L 3 L	-	- 26 L	H L	- L	M 19 L	- L	H 28 M	-	-
R799 White-browed Sparrow-Weaver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H 54 H	M 34 M	L 2 L	L 6 L	-	-	M 21 L	L 19 L

[illegible]

	Plateau														Valley								
	DPVfp							DPVn	North 1			North 2			E1		N1		N2		Toeslope		
Species	D: 20210812_810	E: 20251105_638	F: 20251105_1125	G: 20251105_1619	O: 20260214_641	P: 20260214_1108	Q: 20260214_1605	C: 20210812_708	W: 20260220_709	A: 20210803_733	J: 20251108_610	T: 20260216_635	B: 20210806_730	K: 20251110_636	V: 20260218_643	H: 20251106_631	R: 20260215_619	I: 20251106_941	S: 20260215_1122	L: 20251111_609	U: 20260217_658	M: 20251112_625	N: 20260213_623
R870 Black-throated Canary	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H 1 L	-	-	
R876 Black-headed Canary	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H 3 L	-	-	-	-	-	-	-	-
R878 Yellow Canary	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H 2 L
R879 White-throated Canary	-	-	-	-	M 5 L	M 6 L	M 6 L	-	-	H 8 L	-	M 4 L	H 9 L	M 6 L	H 9 L	-	L 3 L	-	-	L 1 L	-	L 2 L	-
R885 Cape Bunting	L 3 L	M 27 M	L 3 L	L 4 L	M 38 M	M 30 H	L 21 M	-	L 16 L	L 2 L	L 15 L	M 27 M	L 21 M	M 31 M	H 64 H	M 38 M	H 51 M	M 30 M	L 19 L	H 54 H	H 58 H	L 17 L	M 25 M
R886 Cinnamon-breasted Bunting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H 2 L
R887 Lark-like Bunting	-	L 5 L	L 6 L	L 4 L	H 51 H	H 45 H	H 45 H	-	L 16 L	-	L 2 L	L 13 L	L 3 L	L 11 L	H 55 M	-	L 6 L	-	-	-	-	-	L 8 L

Table 4: Summary of Verreaux’s Eagle R131 nests identified in the study area. Nest codes consist of a letter indicating the nesting locality (A–P) followed by a number identifying the individual nest. Old codes refer to those used in previous reports and correspondence. Distances are given in metres (m) from the PV2 footprint, together with direction and approximate location coordinates for each nest.

Nest code	Old codes		Distance	Direction	Latitude	Longitude
	JvN	CvR				
			m		South	East
A1	01	33	22 630	W	-29.883204 ^o	22.555364 ^o
B1	02	–	12 392	NW	-29.746030 ^o	22.672060 ^o
C1	03a	–	4 647	SE	-29.853970 ^o	22.821720 ^o
C2	03b	–	4 682	SE	-29.854726 ^o	22.821358 ^o
C3	03d	–	4 875	SE	-29.854269 ^o	22.824656 ^o
C4	03e	–	4 875	SE	-29.854269 ^o	22.824656 ^o
D1	04	31	3 126	SE	-29.835814 ^o	22.817205 ^o
D2	04b	30	3 242	SE	-29.838835 ^o	22.816810 ^o
E1	05a	7	2 950	N	-29.782789 ^o	22.777122 ^o
E2	05b	8	2 951	N	-29.782772 ^o	22.777594 ^o
E3	05c	–	2 911	N	-29.783458 ^o	22.772892 ^o
E4	05d	–	2 785	N	-29.784492 ^o	22.773853 ^o
E5	05e	–	2 7	N	-29.784564 ^o	22.773575 ^o
E6	05f	–	2 781	N	-29.784569 ^o	22.773511 ^o
F1	06a	–	5 689	N	-29.759853 ^o	22.762289 ^o
F2	06b	–	5 725	N	-29.759520 ^o	22.762266 ^o
F3	06c	19	5 5	N	-29.758877 ^o	22.7614 ^o
G1	07	–	1 071	SW	-29.830422 ^o	22.774586 ^o
G2	07b	–	1 079	SW	-29.830431 ^o	22.774489 ^o
G3	07c	12	1 088	SW	-29.830544 ^o	22.774483 ^o
G4	07d	13	1 088	SW	-29.830536 ^o	22.774475 ^o
G5	07e	–	1 059	SW	-29.830200 ^o	22.774519 ^o
H1	08	6	4 335	NW	-29.785192 ^o	22.742425 ^o
I1	09	2	7 437	NW	-29.760920 ^o	22.724470 ^o
J1	10	–	2 473	broader study area	-29.840328 ^o	22.805545 ^o
K1	20a	–	4 462		-29.769253 ^o	22.774153 ^o
K2	20b	–	4 530	N	-29.768603 ^o	22.774831 ^o
L1	21	–	1 221	E	-29.812669 ^o	22.796525 ^o
M1	22	–	934	E	-29.823033 ^o	22.797167 ^o
N1	23a	9	4 560	N	-29.770714 ^o	22.761581 ^o
N2	23b	11	4 585	N	-29.770408 ^o	22.761800 ^o
O1	24	5	1 007	W	-29.821597 ^o	22.767792 ^o
P1	30	3	10 962	NW	-29.755010 ^o	22.682960 ^o

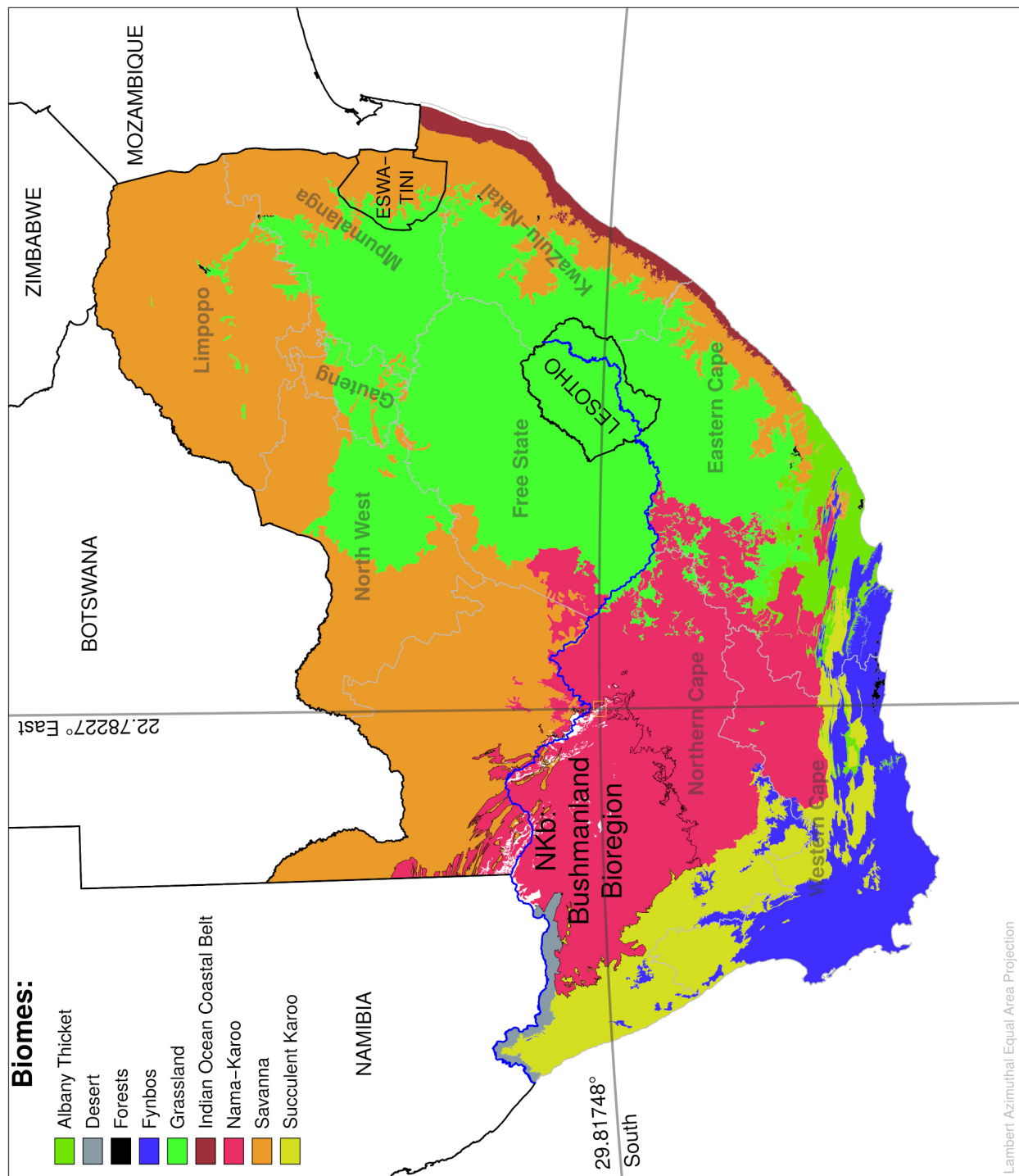
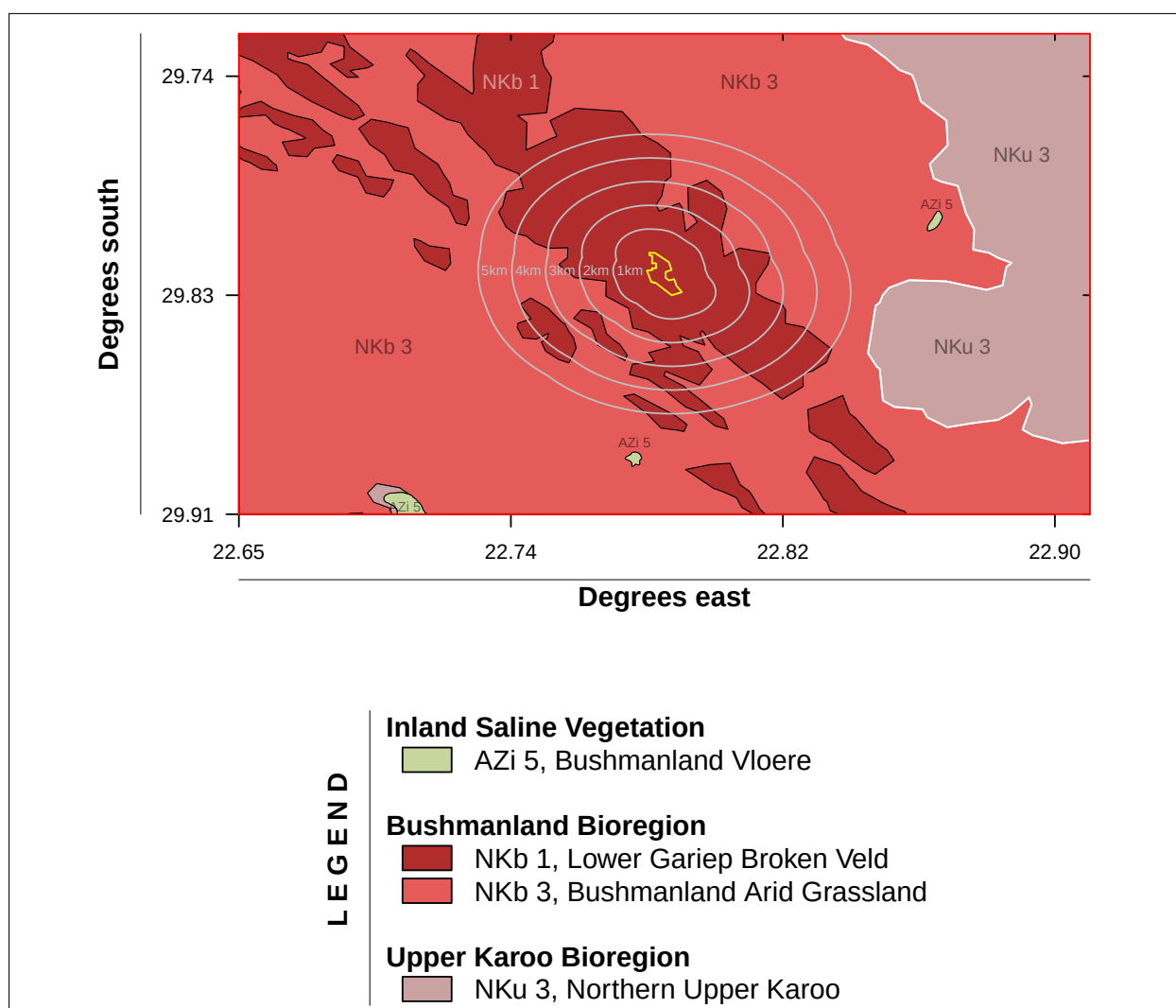


Figure 1: Location of the proposed PV2 near Prieska, Northern Cape Province, in relation to South African biomes as classified by Mucina & Rutherford (2006). White: Lower Gariep Broken Veld (NKb 1). The intersection of the latitudinal and longitudinal lines, forming a crosshair, denotes the approximate central location of the project, with the surrounding yellow block indicating the area enlarged in Figure 2.



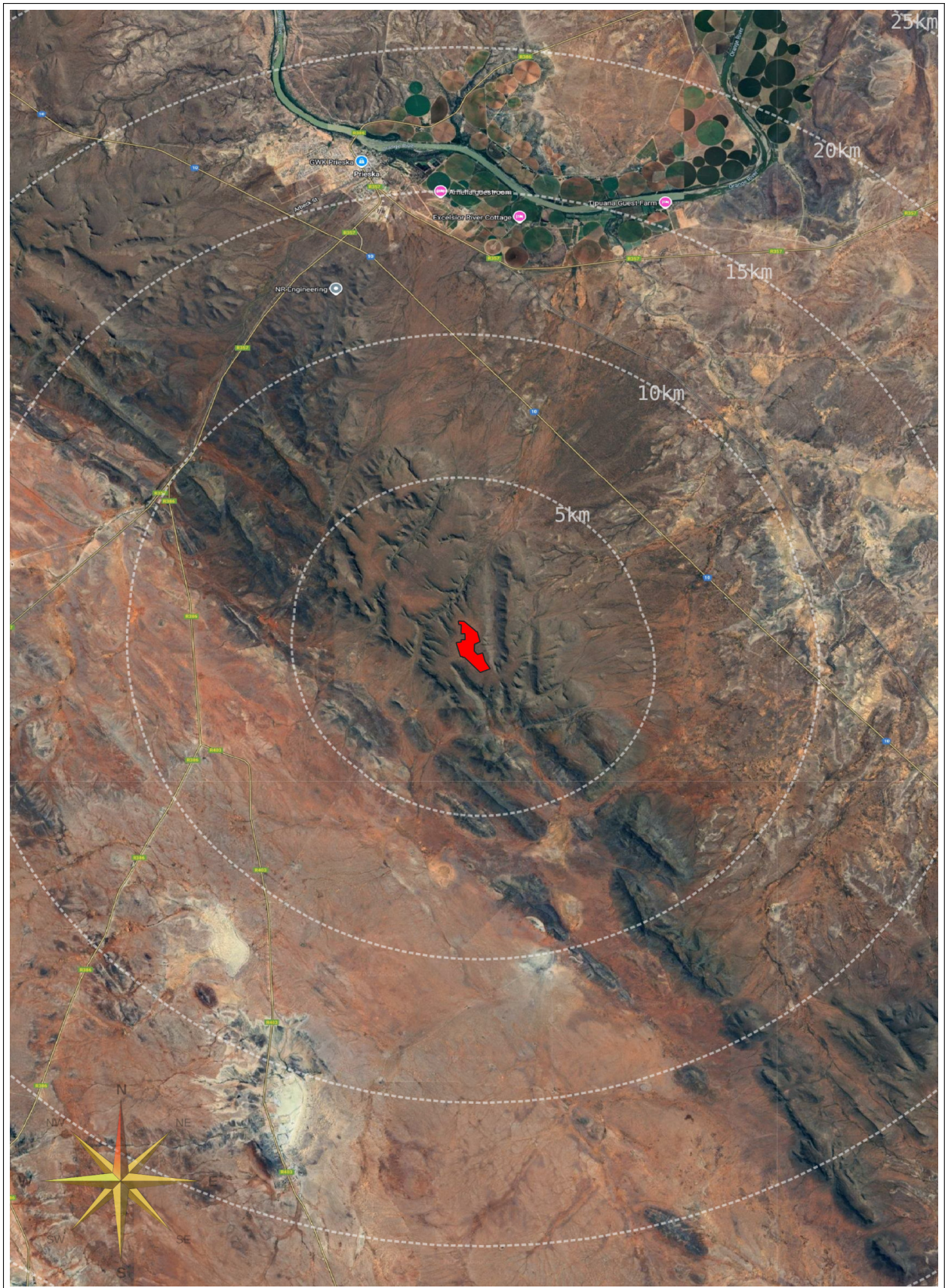


Figure 3: Environs of the proposed PV2 site (red polygon in the centre) to be situated south of Prieska, Northern Cape (see Figures 1 & 2). The white stippled lines are drawn at 5 km intervals. At the top the Orange River with irrigated fields east (right) of Prieska is clearly visible.

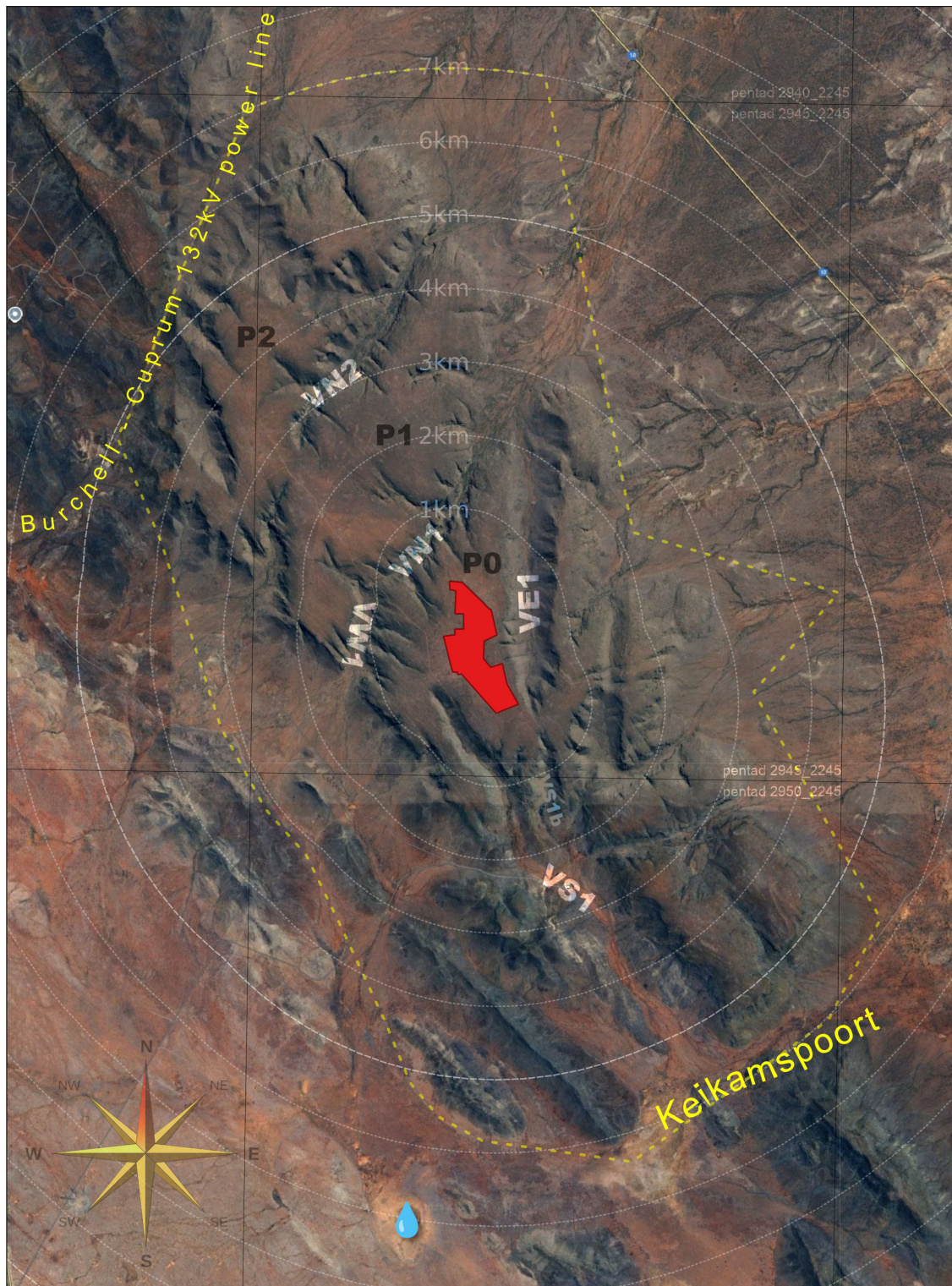


Figure 4: Google Earth view of the Pragmatic Operational Project Area (POPA; yellow stippled line). Red polygon: PV2 footprint; VE1: Valley East 1; VN1: Valley North 1; VN2: Valley North 2; VW1: Valley West 1; VS1: Valley South 1. Blue drop (bottom): non-perennial pan. SABAP2 pentads are also indicated.

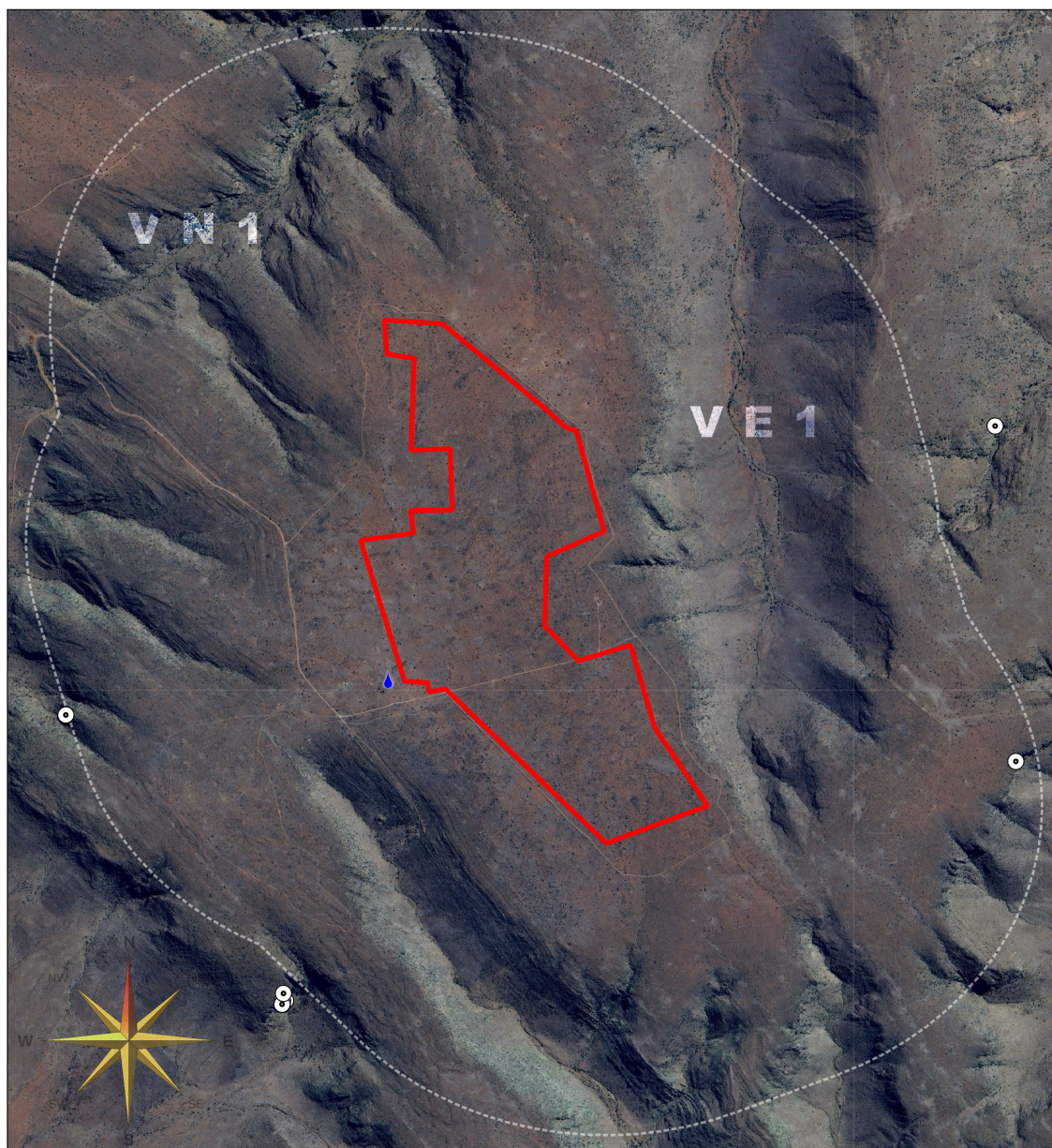


Figure 5: Google Earth view of the 1 km environs of the PV2 site (red outline in the centre). VE1: Valley East 1; VN1: Valley North 1; White marker: Verreaux's Eagle R131 nest. Blue drop just outside central-western (left): depression (see also Figure 11).



Figure 6: Aerial view of Greefspan Solar PV located between Prieska and Douglas.

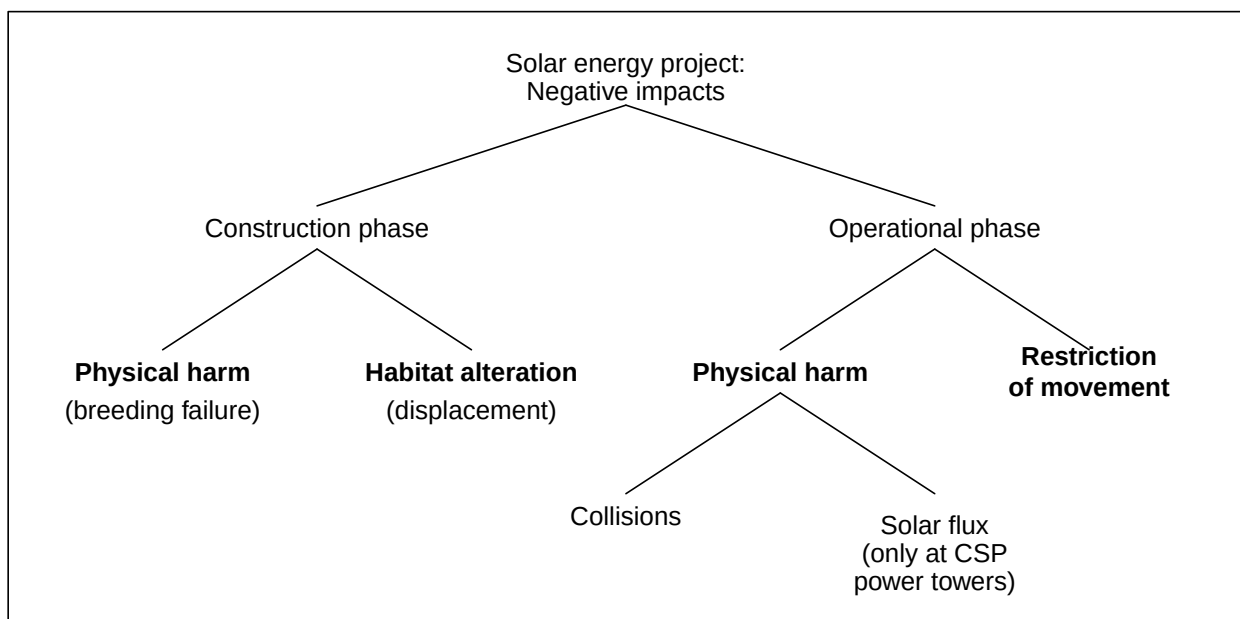


Figure 7: Summary of impact categories associated with solar energy projects. All these impacts are relevant to all utility-scale solar technology types, except solar-flu-related incidents which have only been observed at Concentrated Solar Power (CSP) power towers (Walston *et al.* 2015).



Figure 8: Aerial drone view looking north-east over Valley West 1 (left) and Plateau DPV.

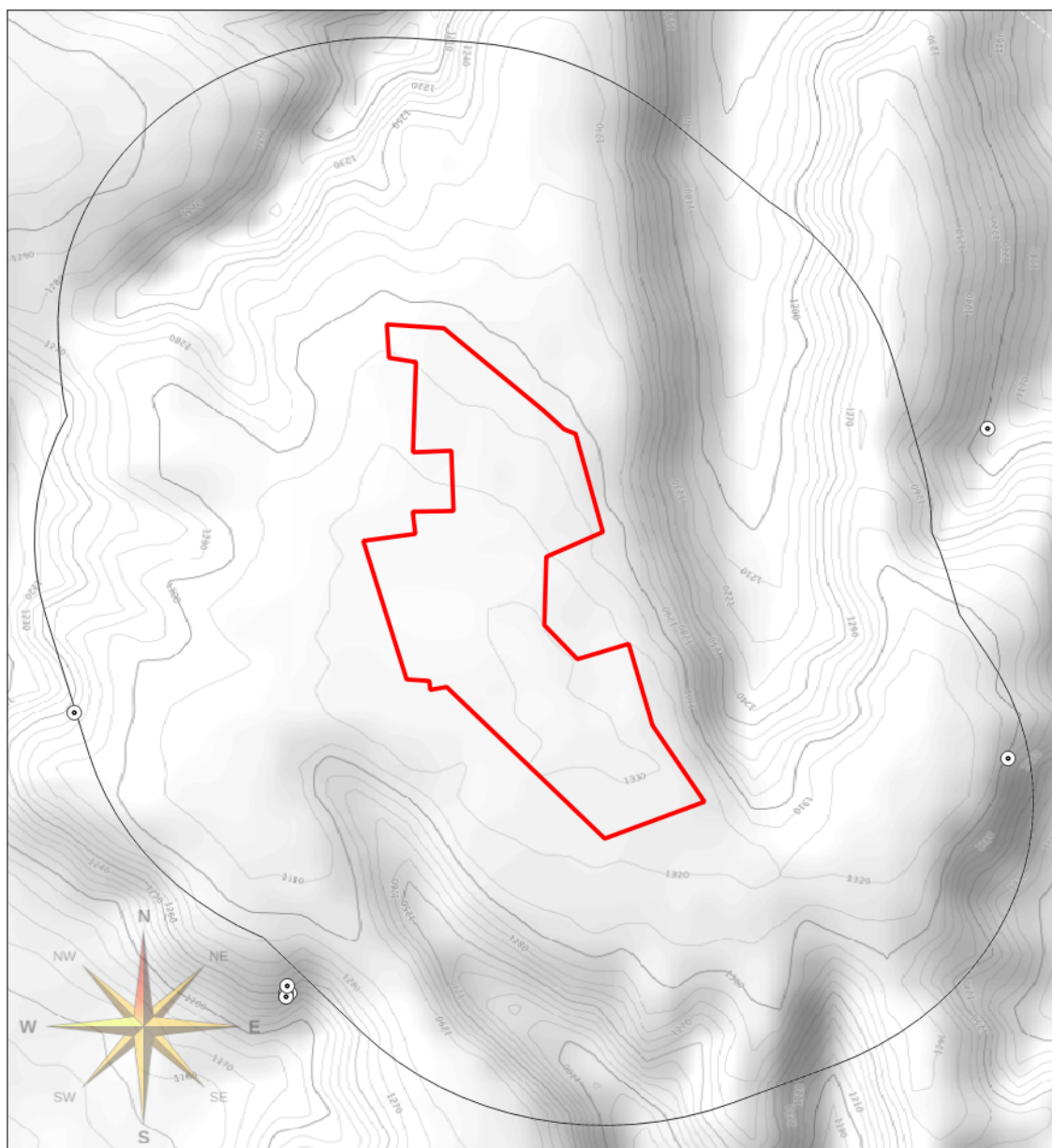


Figure 9: OpenTopoMap (<https://opentopomap.org>) view of the 1km environs of the PV2 site (red polygon in the centre). White marker: Verreaux's Eagle R131 nesting site.



Figure 10: Aerial drone view looking west across the proposed PV2 footprint showing drainage systems on the western rim of Valley East
1.



Figure 11: Drone photograph (looking east) of a rain-filled natural depression located approximately 50 m west of the proposed PV2 development footprint, captured on 20 February 2026 following recent precipitation. The drone was positioned at approximately the same height as the highest background point, with metadata indicating that the depression surface is about 11 m below that reference elevation. Birds visible at the top of the image were observed drinking from the pooled water.



Figure 12: Aerial drone view (looking north-east) over the northern part of Plateau North 1.