Bat Environmental Impact Assessment (EIA)

For the proposed Moriri PV Solar Energy Facility, Northern Cape, South Africa

Compiled by

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PREPARED FOR:

Great Karoo Renewable Energy (Pty) Ltd

By

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Appointment of Specialist

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For:	Bat Environmental Impact Assessment Report

Independence

Animalia Consultants (Pty) Ltd has no connection with the developer. Animalia Consultants (Pty) Ltd is not a subsidiary, legally or financially of the developer; remuneration for services by the developer in relation to this Bat Impact Assessment Scoping Report is not linked to approval by decision-making authorities responsible for permitting this proposal and the consultancy has no interest in secondary or downstream developments as a result of the authorisation of this project.

Applicable Legislation

Legislation dealing with biodiversity applies to bats and includes the following:
NATIONAL ENVIRONMENTAL MANAGEMENT: BIODIVERSITY ACT, 2004 (ACT 10 OF 2004; Especially sections 2, 56 & 97).

The Act calls for the management and conservation of all biological diversity within South Africa. Bats constitute an important component of South African biodiversity and therefore all species receive additional attention to those listed as Threatened or Protected.

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Table i. Explanation of abbreviations that may be used in this document.

Abbreviation	Explanation
ACR	**African Chiroptera Report**
BESS	**Battery Energy Storage System**
DFFE	**Department of Forestry, Fisheries & the Environment**
DMRE	**Department of Mineral Resources and Energy**
EAP	**Environmental Assessment Practitioner**
EIA	**Environmental Impact Assessment**
EMPr	**Environmental Management Plan report**
GHAF	**Green Hydrogen & Ammonia Facility**
IRP	**Integrated Resource Plan**
PV	**Photo-voltaic (facility)**
REC	**Renewable Energy Complex**
REIPPPP	**Renewable Energy Independent Power Producer Procurement Programme**
SABAA	**South African Bat Assessment Association**
SEA	**Strategic Environmental Assessment**
WEF	**Wind Energy Facility**
PLP	**Polarized Light Pollution**

NEMA Requirements

The content of a specialist report is specified in the EIA Regulations GN R. 982, as amended (4 Dec 2014) Appendix 6. A specialist report prepared in terms of these Regulations must contain:

NEMA Requirement	Section/page in report
Details of the specialist who prepared the report, and the expertise of that specialist to compile a specialist report including a curriculum vitae.	Separate Curriculum Vitae
A declaration that the specialist is independent in a form as may be specified by the competent authority.	Page 3
An indication of the scope of, and the purpose for which, the report was prepared.	Section 1
An indication of the quality and age of the base data used for the specialist report.	Sections 3; 4
A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change.	Sections 4; 5
The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment.	Section 3
A description of the methodology adopted in preparing the report or carrying out the specialised process, inclusive of equipment and modelling used.	Section 3
Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure.	Section 5
An identification of any areas to be avoided, including buffers.	Section 4.3
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers.	Section 4.3
A description of any assumptions made and any uncertainties or gaps in knowledge.	Section 3.1

A description of the findings and potential implications of such findings on the impact of the proposed activity, or activities.	**Sections 4; 5; 7**
Any mitigation measures for inclusion in the EMPr.	**Sections 5; 6**
Any conditions for inclusion in the environmental authorisation.	**Sections 5; 6; 7**
Any monitoring requirements for inclusion in the EMPr or environmental authorisation.	**Section 5; 7**
A reasoned opinion whether the proposed activity or portions thereof should be authorised, and regarding the acceptability of the proposed activity or activities. And if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr.	**Sections 5; 6; 7**
A description of any consultation process that was undertaken during the course of preparing the specialist report.	**Sections 3**

1 OBJECTIVES AND TERMS OF REFERENCE FOR THE STUDY

- A description of the baseline characteristics and conditions of the receiving environment (e.g., site and/or surrounding land uses including urban and agricultural areas).
- An evaluation of the predicted impacts of the project on the receiving environment.
- An assessment of the probability of each impact occurring, the reversibility of each impact and the level of confidence in each potential impact.
- Consideration and evaluation of the cumulative impacts in terms of the current and proposed activities in the area.
- Recommendations to avoid negative impacts, as well as feasible and practical mitigation, management and/or monitoring options to reduce negative impacts that can be included in the Environmental Management Plan.
- A reasoned opinion as to whether the proposed activity, or portions of the activity should be authorised.
- Details regarding the types of mitigation measures that are possible.

2 INTRODUCTION

This document is the Bat Environmental Impact Assessment Report for the Moriri Photovoltaic (PV) Facility completed by Animalia Consultants (Pty) Ltd.

2.1 Project description

Great Karoo Renewable Energy (Pty) Ltd is proposing the construction and operation of a photovoltaic (PV) solar energy facility and associated infrastructure on Portion 0 of Farm Rondavel 85, located approximately 35km south-west of Richmond and 80km south-east of Victoria West, within the Ubuntu Local Municipality and the Pixley Ka Seme District Municipality in the Northern Cape Province.

A preferred project site with an extent of ~29 909ha and a development area of ~577ha within the project site has been identified by Great Karoo Renewable Energy (Pty) Ltd as a technically suitable area for the development of the Moriri Solar PV Facility with a contracted capacity of up to 100MW.

The Moriri Solar PV Facility project site is proposed to accommodate the following infrastructure, which will enable the facility to supply a contracted capacity of up to 100MW. The Moriri Solar PV Facility project site is proposed to accommodate the following infrastructure, which will enable the facility to supply a contracted capacity of up to 100MW:

- Solar PV array comprising PV modules and mounting structures.
- Inverters and transformers.
- Cabling between the panels.
- 33/132kV onsite facility substation.
- Cabling from the onsite substation to the collector substation (either underground or overhead).
- Electrical and auxiliary equipment required at the collector substation that serves that solar energy facility, including switchyard/bay, control building, fences, etc.
- Battery Energy Storage System (BESS).
- Site offices and maintenance buildings, including workshop areas for maintenance and storage.
- Laydown areas.
- Access roads and internal distribution roads.

The solar PV facility is proposed in response to the identified objectives of the national and provincial government and local and district municipalities to develop renewable energy facilities for power generation purposes. It is the developer's intention to bid the Moriri Solar PV Facility under the Department of Mineral Resources and Energy's (DMRE's) Renewable Energy Independent Power Producer Procurement (REIPPP) Programme, with the aim of evacuating the generated power into the national grid. This will aid in the diversification and stabilisation of the country's electricity supply, in line with the objectives of the Integrated Resource Plan (IRP) with the Moriri Solar PV Facility set to inject up to 100MW into the national grid.

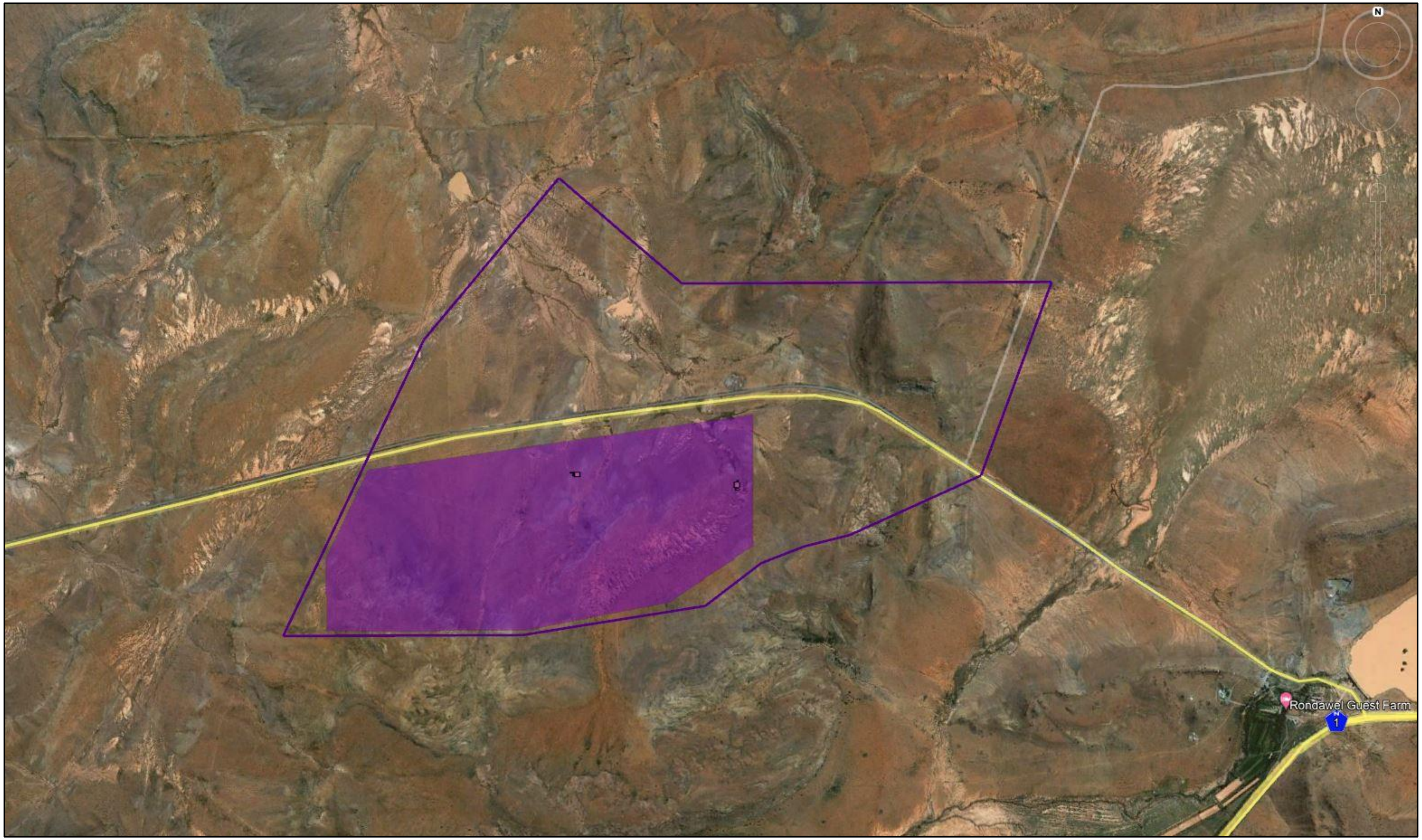


Figure 2.1. Layout of the proposed Moriri PV Facility. Shaded purple area are the PV development area, purple lines are the project boundaries.

2.2 The Bats of South Africa

Bats form part of the Order Chiroptera and are the second largest group of mammals after rodents. They are the only mammals to have developed true powered flight and have undergone various skeletal changes to accommodate this. The forelimbs are elongated, whereas the hind limbs are compact and light, thereby reducing the total body weight. This unique wing profile allows for the manipulation wing camber and shape, exploiting functions such as agility and manoeuvrability. This adaption surpasses the static design of the bird wings in function and enables bats to utilize a wide variety of food sources, including, but not limited to, a large diversity of insects (Neuweiler 2000). Species based facial features may differ considerably as a result of differing lifestyles, particularly in relation to varying feeding and echolocation navigation strategies. Most South African bats are insectivorous and are capable of consuming vast quantities of insects on a nightly basis (Taylor 2000, Tuttle and Hensley 2001) however, they have also been found to feed on amphibians, fruit, nectar and other invertebrates. As a result, insectivorous bats are the predominant predators of nocturnal flying insects in South Africa and contribute greatly to the suppression of these numbers. Their prey also includes agricultural pests such as moths and vectors for diseases such as mosquitoes (Rautenbach 1982, Taylor 2000).

Urban development and agricultural practices have contributed to the deterioration of bat populations on a global scale. Public participation and funding of bat conservation are often hindered by negative public perceptions and unawareness of the ecological importance of bats. Some species choose to roost in domestic residences, causing disturbance and thereby decreasing any esteem that bats may have established. Other species may occur in large communities in buildings, posing as a potential health hazard to residents in addition to their nuisance value. Unfortunately, the negative association with bats obscures their importance as an essential component of ecological systems and their value as natural pest control agents, which actually serves as an advantage to humans.

Many bat species roost in large communities and congregate in small areas. Therefore, any major disturbances within and around the roosting areas may adversely impact individuals of different communities, within the same population, concurrently (Hester and Grenier 2005). Secondly, nativity rates of bats are much lower than those of most other small mammals. This is because, for the most part, only one or two pups are born per female per annum and according to O'Shea *et al*. (2003), bats may live for up to 30 years, thereby limiting the number of pups born due to this increased life expectancy. Under natural circumstances, a population's numbers may accumulate over long periods of time. This is due to the longevity and the relatively low predation of bats when compared to other small mammals. Therefore, bat populations are not able to adequately recover after mass mortalities and major roost disturbances.

2.3 Bats and photovoltaic (PV) energy facilities

Currently there is no evidence of photovoltaic (PV) facilities posing a direct threat of fatality impact on bats during operation (SABAA, 2020). However, roosting and foraging habitats may be significantly impacted during the construction phase. This is primarily due the fact that PV facilities require large areas of land to be cleared, and in some cases, earthworks are required for levelling purposes. This can result in habitat that is suitable for micro roosts, such as rocky outcrops, clumps of trees and certain vegetation being destroyed, which can also be fatal to bats residing in such roosts. Natural vegetation can support higher insect food quantities and diversity than cleared land, therefore foraging habitat can also be displaced by PV facilities.

The presence of security lights on and around PV facilities can create significant light pollution that will impact bat feeding habits and species compositions negatively, by discouraging photophobic (light averse) species and encouraging species that readily forage around lights attracting insects.

Evidence exists of bats using polarised light at dusk to calibrate their internal magnetic compasses (Grief *et al.,* 2014), and PV solar panels are strong reflectors of horizontally polarised light (Polarised Light Pollution or PLP) which can possibly interfere with this method of navigation, additionally horizontal polarised light can mimic light reflected from water bodies **(**Szaz *et al.,* 2016). Although, the degree of impact on bats needs to be determined for bats foraging near and around their roost, since the study referenced experimented on the homing capabilities of bats released away from their roost.

3 METHODOLOGY

Three factors need to be present for most South African bats to be prevalent in an area: availability of roosting space, food (insects/arthropods or fruit), and accessible open water sources. However, the dependency of a bat on each of these factors is subject to the species, its behaviour and ecology. Nevertheless, bat activity, abundance and diversity are likely to be higher in areas supporting all three above-mentioned factors.

The site is evaluated by comparing the amount of surface rock (possible roosting space), topography (influencing surface rock in most cases), vegetation (possible roosting spaces and foraging sites), climate (can influence insect numbers and availability of fruit), and presence of surface water (influences insects and acts as a source of drinking water) to identify bat species that may be impacted by the PV facility. These comparisons are done chiefly by briefly studying the geographic literature of each site, available satellite imagery and by ground-truthing with site visits. Species probability of occurrence based on the above-mentioned factors are estimated for the site and the surrounding larger area, but also considers species already confirmed on site as well as from the surrounding areas. Five site visits were carried out over a period of 12 months (Table 3.1). The passive bat activity data gathered during the proposed adjacent Merino WEF preconstruction study, informed the occurrence of bat species on the Moriri site.

Table 3.1: Site visit information.

Site visit dates	**First visit**	14 – 17 December 2020
	Second visit	12 – 14 April 2021
	Third visit	23 – 25 July 2021
	Fourth visit	20 – 24 Sept 2021
	Fifith visit	16 – 19 December 2021

3.1 Assumptions and Limitations

Distribution maps of South African bat species still require further refinement, thus the bat species proposed to occur on the site (and not detected in the area yet) should be considered precautionary. If a species has a distribution marginal to the site, it was assumed to occur in the area.

The sensitivity map is based partially on satellite imagery and from a site visit, given the large extent of the site there is always the possibility that what has been mapped may differ slightly to what is on the ground.

Since it's not possible to discover all bat roosts or individual roosting bats, it remains possible that bat roosts can be present in terrain not identified or anticipated as roosting habitat in the sensitivity map, subsequently the roosts may be damaged and bat fatalities may occur. This is due to the large size of renewable energy development sites as well as the elusive nature of many roosting bat species in micro roosts, as well as their capability to roost in very small inconspicuous spaces.

4 RESULTS AND DISCUSSION

4.1 Land Use, Vegetation, Climate and Topography

The proposed Moriri PV Facility is situated entirely in the **Eastern Upper Karoo** vegetation unit of the Nama Karoo Biome, with small sections of **Upper Karoo Hardeveld** situated approximately 1 – 1.5km south and south east of the site (**Figure 4.1**, Mucina & Rutherford 2012), but outside the development area. The general characteristics of the vegetation units are applicable from a bat habitat point of view.

Figure 4.1: Vegetation units present on the proposed Moriri PV Facility (Mucina & Rutherford 2012).

4.1.1 Upper Karoo Hardeveld

Upper Karoo Hardeveld is typified by steep-sloped koppies, buttes and mesas as part of the Great Escarpment. Large boulders and stones mark the landscape and it supports sparse vegetation such as dwarf Karoo scrub and drought-tolerant grasses (*Aristida*, *Eragrostis* and *Stipagrostis*).

Geologically, this vegetation unit comprises primitive and skeletal soils in a rocky landscape. These soils cover sedimentary rock such as those mudstones and arenites of the Adelaide Subgroup (Karoo Supergroup). Dolerite boulders cover slopes of the mesas and buttes found here.

The Mean Annual Precipitation of this unit ranges from 150 – 350mm per year from north west to east, and frost days are relatively high, although variable (30 – 80 days, depending on altitude).

4.1.2 Eastern Upper Karoo

Flats and gently sloping plains are found within the Eastern Upper Karoo vegetation unit and intersperse with fingers of Karoo Hardeveld on site.

Dwarf microphyllous shrubs dominate this landscape and 'white' grasses (*Aristida* and *Eragrostis* species) are prominant after good summer rains. Karoo scrub species of *Pentzia*, *Eriocephalus*, *Rosenia* and *Lycium* are important taxa (Mucina & Rutherford 2012).

Beaufort Group sandstones and mudstones are common in this vegetation unit, and some Jurassic dolerites are also to be found.

Mean annual precipitation ranges from 180 – 430mm per year (west to east), peaking in March, and as for Karoo Upper Hardeveld, frost incidence is high (30 – 80 days per year). Nearby, Victoria West has recorded mean maximum and minimum monthly temperatures of 37°C and -8°C respectively.

Vegetation units and geology are of great importance as these may serve as suitable sites for the roosting of bats and support of their foraging habits (Monadjem *et al.* 2020). Houses and buildings may also serve as suitable roosting spaces (Taylor 2000; Monadjem *et al.* 2020).

4.2 Currently Confirmed, Previously Recorded as well as Literature Based Species Probability of Occurrence

Table 4.1: Table of species that are currently confirmed on site, and/or have been previously recorded in the area and may be occurring based on literature. Roosting or foraging in the study area, the possible site-specific roosts, and their occurrence based on literature as well as recordings and observations in the surrounding area, is also briefly described (Monadjem *et al.* 2020).

Species	Common name	Occurrence in area*	Conservation status (SANBI & EWT, 2016)	Possible roosting habitat on site	Possible foraging habitat utilised on site
Tadarida aegyptiaca	Egyptian free-tailed bat	Confirmed on site	Least Concern (2016 Regional Listing)	Roosts in rock crevices, hollows in trees, and behind the bark of dead trees. The species has also taken to roosting in roofs of buildings.	It forages over a wide range of habitats; its preferences of foraging habitat seem independent of vegetation. It seems to forage in all types habitats.
Neoromicia capensis	Cape serotine	Confirmed on site	Least Concern (2016 Regional Listing)	Roosts in the roofs of houses and buildings, and also under the bark of trees.	It appears to tolerate a wide range of environmental conditions from arid semi-desert areas to montane grasslands, forests, and savannahs. But is predominantly a medium height clutter edge forager on site.
Miniopterus natalensis	Natal long-fingered bat	Confirmed on site	Least Concern (2016 Regional Listing)	No known caves in the vicinity of the site. Small groups or individuals may roost in culverts or other hollows.	Clutter-edge forager. May forage in more open terrain during suitable weather.
Eptesicus hottentotus	Long-tailed serotine	Confirmed on site	Least Concern (2016 Regional Listing)	It is a crevice dweller roosting in rock crevices, as well as other crevices in buildings. Rock crevices in valleys on site.	It generally seems to prefer woodland habitats, and forages on the clutter edge. But may still forage over open terrain occasionally.

Sauromys petrophilus	Robert's flat-headed bat	Confirmed on site	Least Concern (2016 Regional Listing)	Roosts mainly in rock crevices.	It forages over a wide range of habitats and may utilise higher air spaces.
Epomophorus wahlbergi	Wahlberg's epauletted fruit bat	Literature	Least Concern (2016 Regional Listing)	Roosts in dense foliage of large, leafy trees and may travel several kilometres each night to reach fruiting trees.	Feeds on fruit, nectar, pollen and flowers. If and where available on site.
Nycteris thebaica	Egyptian slit-faced bat	Museum record from greater area	Least Concern (2016 Regional Listing)	Roosts in hollows, aardvark burrows, culverts under roads and the trunks of dead trees.	It appears to occur throughout the savannah and karoo biomes but avoids open grasslands. May possibly occur in the thickets of man-made gardens, and in aardvark burrows.
Cistugo lesueuri	Lesueur's wing-gland bat	Museum record from greater area	Least Concern (2016 Regional Listing)	It is a crevice dweller roosting in rock crevices. Exposed rocky cliffs and rocky koppies.	Areas with available drinking water. Clutter edge forager. May forage in more open terrain during suitable weather.
Rhinolophus darlingi	Darling's horseshoe bat	ACR 2018 record	Least Concern (2016 Regional Listing)	May utilise man made hollows, Aardvark burrows or hollows formed by rocky boulder koppies.	It is associated with a variety of habitats including thickets that may be found in the vegetated drainage areas.
Eidolon helvum	African straw-coloured fruit bat	Literature	Least Concern (2016 Regional Listing) (Globally Near-threatened)	It's a non-breeding migrant with sparse scattered records in the karoo.	Feeds on fruit, nectar, pollen and flowers. If and where available on site.

*Occurrence of species records based on site data collected off passive monitoring systems to date (from the adjacent proposed Merino WEF), ACR 2020 and Monadjem *et al*. 2020

4.3 Sensitivity Map

Figure 4.2 depicts the sensitive areas of the site, based on features identified to be important for foraging and roosting of the species that are most probable to occur on site. Thus, the sensitivity map is based on species ecology and habitat preferences.

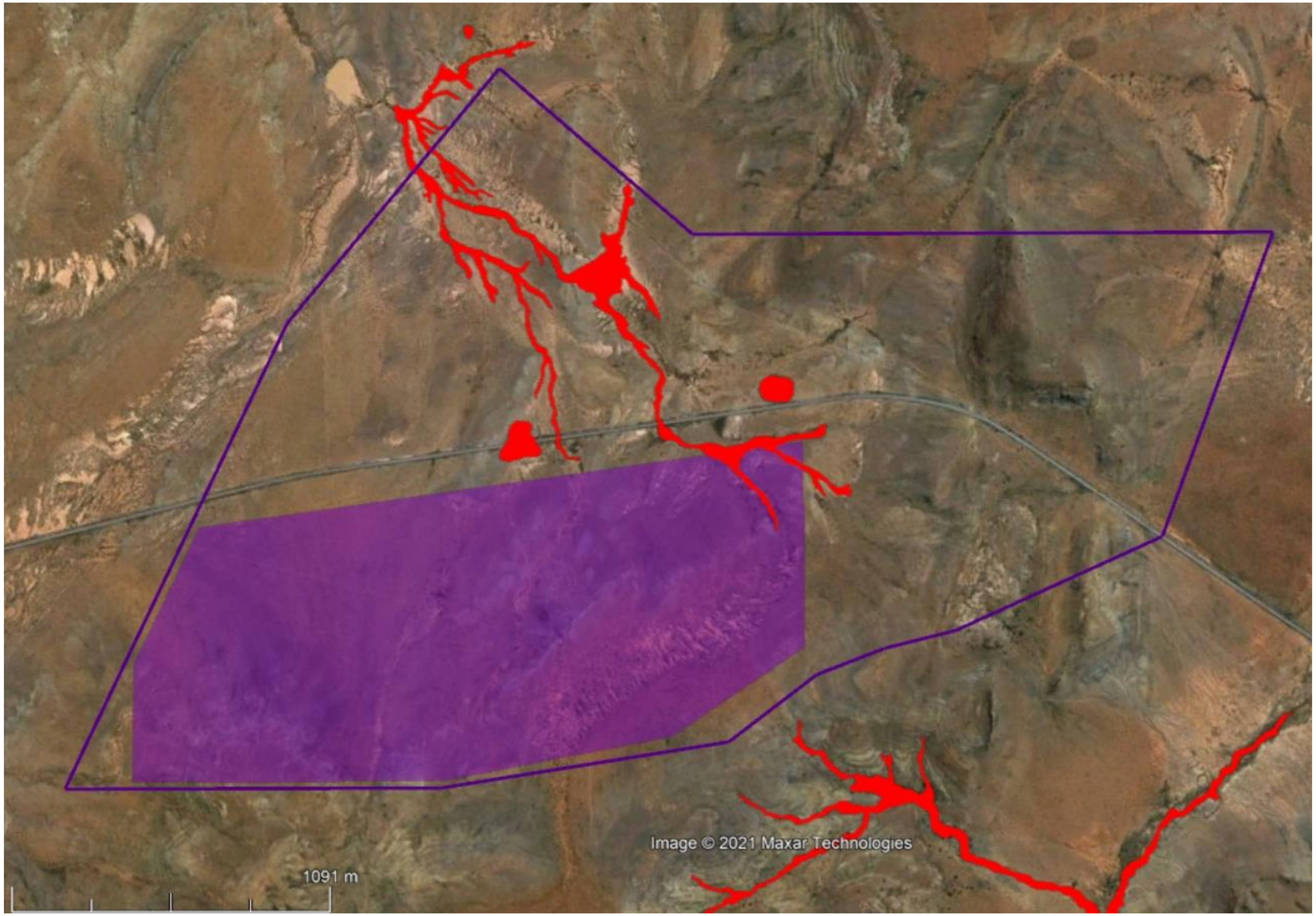
The sensitivities have been classified as high or medium, where high sensitivities no-go zones for PV panels, construction camps, substation, O&M building, the BESS and any other activity that requires earthworks or complete vegetation clearing. With the exception of access roads and underground/overhead cables (**Table 4.3**). Medium sensitivities indicate areas of probable increased risk, but PV panels are allowed to be constructed in medium sensitivity areas.

Table 4.2: Description of parameters used in the development of the sensitivity map.

Last revision	October 2021
High sensitivities	Valley bottom wetlands.
	Pans and depressions.
	Dams.
	Rocky boulder koppies (tors).
	Exposed rocky cliff edges.
	Drainage lines capable of supporting riparian vegetation.
	Other water bodies and other sensitivities such as manmade structures, buildings, houses, barns and sheds.
Moderate sensitivities	Alluvial plains and washes.
	Seasonal drainage lines.

Table 4.1. The significance of sensitivity map categories for each infrastructure component for PV technology.

Sensitivity	PV panels and buildings	Roads and cables	Internal overhead transmission lines	Substation and construction camp/yards)
High Sensitivity	**These areas are 'no-go' zones for infrastructure where earthworks and vegetation clearing are required.**	**Preferably keep to a minimum within these areas where practically feasible.**	**Allowed inside these areas.**	**Avoid these areas.**
Medium Sensitivity	**Not favourable for infrastructure where earthworks and vegetation clearing are required, excluding the other infrastructure mentioned in this table.**	**Allowed inside these areas.**	**Allowed inside these areas.**	**Allowed inside these areas.**



High bat sensitivity area

Moderate bat sensitivity area

Figure 4.11: Bat sensitivity map of the site, site area indicated in a blue boundary. Sensitivity polygons are provided in .KML format with this report. Shaded purple area are the PV development area, purple lines are the project boundaries.

5 IMPACT ASSESSMENT & EMP

Tables 5.1 – 5.4 below indicates the assessed impacts associated with the proposed Moriri Solar PV facility during the construction and operational phases. No significant impacts are identified for the decommissioning phase.

5.1 Construction phase

Table 5.1: Description of impact: foraging habitat destruction.

Nature: **Loss of bat foraging habitat.**			
Impact description: **The construction of PV panels requires continuous areas to be cleared of vegetation, and in some cases earthworks and levelling**			
	Rating	Motivation	Significance
Prior to Mitigation			
Duration	**Short-term (1)**	**The construction period will last for less than one year.**	Medium Negative (40)
Extent	**Local (1)**	**Only limited to the construction areas.**	
Magnitude	**Moderate (6)**	**A relatively small area will be disturbed by construction, but the area is continuous and not fragmented.**	
Probability	**Definite (5)**	**If the PV facility is approved the construction will destroy vegetation.**	
Mitigation/Enhancement Measures			
Mitigation: • Adhere to the bat sensitivity map. • Rehabilitate areas disturbed during construction, such as temporary construction camps and laydown yards.			
Post Mitigation/Enhancement Measures			
Duration	**Short-term (1)**	**The construction period will last for less than one year.**	Medium Negative (30)
Extent	**Local (1)**	**Only limited to the construction areas.**	

Magnitude	**Low (4)**	**A relatively small area will be disturbed by construction, and less critical vegetation if the mitigation measures are adhered to.**	
Probability	**Definite (5)**	**If the PV facility is approved the construction will destroy vegetation, but less critical vegetation if the mitigation measures are adhered to.**	
Cumulative impacts: **The cumulative effect of this impact is low since the relative footprint of the construction disturbance is low, and PV facilities are spaced relatively far apart.**			
Residual Risks: **The residual risk is very low since the site will still offer sufficient foraging areas for bats.**			

Table 5.2: Description of impact: Bat roost disturbance/destruction.

Nature: **Bat roost destruction/disturbance.**			
Impact description: **Bat roosts may be destroyed or disturbed by earthworks during construction.**			
	Rating	Motivation	Significance
Prior to Mitigation			
Duration	**Short-term (1)**	**The construction period will last for less than one year.**	Medium Negative (30)
Extent	**Local (1)**	**Only limited to the construction areas.**	
Magnitude	**High (8)**	**A relatively small area will be disturbed by construction.**	
Probability	**Probable (3)**	**If the PV facility is approved the construction will destroy vegetation.**	
Mitigation/Enhancement Measures			
Mitigation: • Adhere to the bat sensitivity map.			

Post Mitigation/Enhancement Measures			
Duration	**Short-term (1)**	**The construction period will last for less than one year.**	Low Negative (20)
Extent	**Local (1)**	**Only limited to the construction areas.**	
Magnitude	**High (8)**	**A relatively small area will be disturbed by construction, and less critical vegetation if the mitigation measures are adhered to.**	
Probability	**Improbable (2)**	**If the PV facility is approved the construction will destroy vegetation, but less critical vegetation if the mitigation measures are adhered to.**	
Cumulative impacts: **The cumulative effect of this impact is low since the relative footprint of the construction disturbance is low, and PV facilities are spaced relatively far apart.**			
Residual Risks: **The residual risk is very low if the sensitivity map is adhered to.**			

5.2 Operational phase

Table 5.3: Description of impact: Increased bat mortality due to light pollution.

Nature: **Increased bat mortality due to light pollution.**			
Impact description: **The probability of bat mortalities caused by moving turbine blades of nearby wind farms (e.g. the proposed adjacent Merino WEF) may be significantly increased by artificial lighting at the PV facility attracting insects and thereby eating bats. Particularly if such lights are placed in close proximity of wind turbines. This applies to insect eating bats that readily forage around lights, cave dwelling species tend to avoid lights.**			
	Rating	Motivation	Significance
Prior to Mitigation			

<table>
<tr><td>Duration</td><td>Long term (4)</td><td>The impact is applicable for the lifetime of the facility.</td><td rowspan="4">Medium Negative (56)</td></tr>
<tr><td>Extent</td><td>Site and adjacent areas (2)</td><td>Light pollution can affect adjacent areas.</td></tr>
<tr><td>Magnitude</td><td>High (8)</td><td>Increased bat activity near turbines, due to lights, can significantly increase the probability of bat mortalities.</td></tr>
<tr><td>Probability</td><td>Highly probable (4)</td><td>If not mitigated, the possibility of this impact is high.</td></tr>
<tr><td colspan="4">Mitigation/Enhancement Measures</td></tr>
<tr><td colspan="4">Mitigation:
• Adhere to the bat sensitivity map.
• Use lights with passive motion sensors that only switch on when a person/vehicle is nearby, if possible for safety and security reasons.
• All floodlights must be down-hooded to minimise light pollution.
• If possible, do not place outside lights near turbines of adjacent WEF’s.</td></tr>
<tr><td colspan="4">Post Mitigation/Enhancement Measures</td></tr>
<tr><td>Duration</td><td>Long term (4)</td><td>The impact is applicable for the lifetime of the facility.</td><td rowspan="4">Low Negative (28)</td></tr>
<tr><td>Extent</td><td>Site and adjacent areas (2)</td><td>Light pollution can affect adjacent areas.</td></tr>
<tr><td>Magnitude</td><td>High (8)</td><td>Increased bat activity near turbines, due to lights, can significantly increase the probability of bat mortalities.</td></tr>
<tr><td>Probability</td><td>Improbable (2)</td><td>If not mitigated, the possibility of this impact is high.</td></tr>
<tr><td colspan="4">Cumulative impacts:

The proposed PV facilities in the area are near enough for light pollution to cumulatively be significant.</td></tr>
<tr><td colspan="4">Residual Risks:

Some outside lighting will always be present and poses a low to medium risk for the lifetime of the facility.</td></tr>
</table>

Table 5.4: Description of impact: Interference with bat navigation by polarised light pollution (PLP).

Nature: **Interference with bat navigation by polarised light pollution (PLP).**			
Impact description: **Evidence exists of bats using polarised light at dusk to calibrate their internal magnetic compasses, and PV solar panels are strong reflectors of horizontally polarised light which can possibly interfere with this method of navigation. Although, the degree of impact on bats needs to be determined for bats foraging near and around their roost, since the study referenced experimented on the homing capabilities of bats released away from their roost.**			
	Rating	Motivation	Significance
Prior to Mitigation			
Duration	**Long term (4)**	**The impact is applicable for the lifetime of the facility.**	Medium Negative (30)
Extent	**Site and adjacent areas (2)**	**PLP can affect adjacent areas.**	
Magnitude	**Low (4)**	**It is possible that bats may habituate and adjust to the interference.**	
Probability	**Probable (3)**	**Evidence of the impact exists. Yet the effect on foraging bats, as opposed to homing bats, have not been established.**	
Mitigation/Enhancement Measures			
Mitigation: • It is recommended that the PV solar panels be tilted away from the direction of sunset directly after sunset, to have them facing as far as possible in the opposite direction of sunset during dusk. In this way any remaining light from sunset will fall on the back of the solar panels and not at a reflective angle in relation to the low-lying sunset. • Using matte solar panels with anti-reflective coatings can also reduce the range of reflective light angles and therefore reduce PLP.			
Post Mitigation/Enhancement Measures			
Duration	**Long term (4)**	**The impact is applicable for the lifetime of the facility.**	Low negative (20)
Extent	**Site and adjacent areas (2)**	**PLP can affect adjacent areas.**	
Magnitude	**Low (4)**	**It is possible that bats may habituate and adjust to the interference.**	

Probability	**Improbable (2)**	**If mitigated the effect of the impact is improbable.**	
Cumulative impacts: **The proposed PV facilities in the area are near enough for polarized light pollution to cumulatively be significant.**			
Residual Risks: **Some reflections of solar panels will always remain even after mitigation, although these are expected to be very low in effect.**			

5.3 Cumulative impact

There are seven Solar PV Facilities within a 30km radius of Moriri Solar PV, their project status and other details are depicted in Table 5.5 and shown in Figure 5.1 below. Table 5.6 below assesses only the impacts of Polarized and ordinary light pollution, since the facilities indicated in Figure 5.1 below are too far from the Moriri site to have a cumulative effect on the other identified impacts.

Table 5.5. Approved Wind Energy Facility developments within 30km of the Moriri Solar PV.

Wind Farm	DEA Reference	Status
Mainstream Wind and Solar Energy Facility at Victoria West, Northern Cape Province	12/12/20/1788/AM1	Approved
Victoria West PV	12/12/20/2462/AM2	Approved
Brakpoort PV	14/12/16/3/3/2/331/AM2	Approved
Aurora Power Solutions PV	14/12/16/3/3/2/380	Approved
Wildebeest Karoo PV	14/12/16/3/3/1/481	In process
Kwana PV		Proposed
Nku PV		Proposed

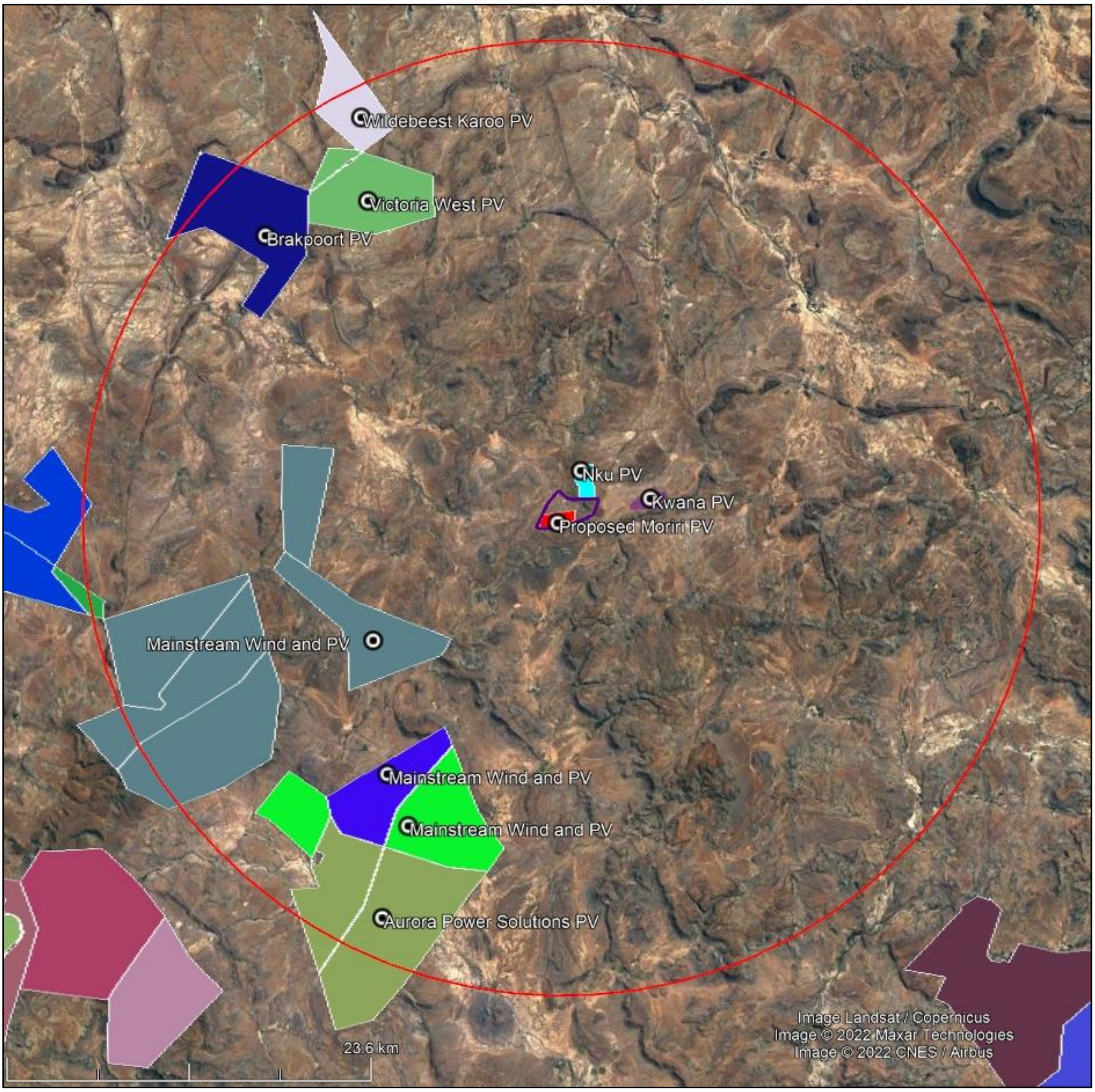


Figure 5.1: PV Facilities within a radius of approximately 30km (red line) around the proposed Moriri Solar PV site (DEA, 2021).

Table 5.6: Assessment of cumulative impact: Increased bat mortality due to light pollution.

<table>
<tr><td colspan="3">Nature:

The probability of bat mortalities caused by moving turbine blades of nearby wind farms (e.g. the proposed adjacent Merino WEF) may be significantly increased by artificial lighting at the PV facility attracting insects and thereby eating bats. Particularly if such lights are placed in close proximity of wind turbines. This applies to insect eating bats that readily forage around lights, cave dwelling species tend to avoid lights.</td></tr>
<tr><td></td><td>Overall impact of the proposed project considered in isolation</td><td>Cumulative impact of the project and other projects in the area</td></tr>
<tr><td>Extent</td><td>Site and adjacent areas (2)</td><td>Larger area (3)</td></tr>
<tr><td>Duration</td><td>Long term (4)</td><td>Long term (4)</td></tr>
<tr><td>Magnitude</td><td>High (8)</td><td>High (8)</td></tr>
<tr><td>Probability</td><td>Highly probable (4)</td><td>Highly probable (4)</td></tr>
<tr><td>Significance</td><td>Medium Negative (56)</td><td>High negative (60)</td></tr>
<tr><td>Status (positive or negative)</td><td>Negative</td><td>Negative</td></tr>
<tr><td>Reversibility</td><td>Medium</td><td>Medium</td></tr>
<tr><td>Irreplaceable loss of resources?</td><td>Yes (bat mortalities)</td><td>Yes (bat mortalities)</td></tr>
<tr><td>Can impacts be mitigated?</td><td>Yes</td><td>Yes</td></tr>
<tr><td colspan="3">Confidence in findings: High.</td></tr>
<tr><td colspan="3">Mitigation:
Each facility should adhere to it’s bat sensitivity map.
Each facility should use lights with passive motion sensors that only switch on when a person/vehicle is nearby, if possible for safety and security reasons.
All floodlights must be down-hooded to minimise light pollution.
If possible, do not place outside lights near turbines of adjacent WEF’s.</td></tr>
</table>

Table 5.7: Assessment of cumulative impact: Interference with bat navigation by polarised light pollution (PLP).

<table>
<tr><td colspan="3">Nature:

Evidence exists of bats using polarised light at dusk to calibrate their internal magnetic compasses, and PV solar panels are strong reflectors of horizontally polarised light which can possibly interfere with this method of navigation. Although, the degree of impact on bats needs to be determined for bats foraging near and around their roost, since the study referenced experimented on the homing capabilities of bats released away from their roost.</td></tr>
<tr><td></td><td>Overall impact of the proposed project considered in isolation</td><td>Cumulative impact of the project and other projects in the area</td></tr>
<tr><td>Extent</td><td>Site and adjacent areas (2)</td><td>Larger area (3)</td></tr>
<tr><td>Duration</td><td>Long term (4)</td><td>Long term (4)</td></tr>
<tr><td>Magnitude</td><td>Low (4)</td><td>Low (4)</td></tr>
<tr><td>Probability</td><td>Probable (3)</td><td>Probable (3)</td></tr>
<tr><td>Significance</td><td>Medium Negative (30)</td><td>Medium negative (33)</td></tr>
<tr><td>Status (positive or negative)</td><td>Negative</td><td>Negative</td></tr>
<tr><td>Reversibility</td><td>High</td><td>High</td></tr>
<tr><td>Irreplaceable loss of resources?</td><td>No</td><td>No</td></tr>
<tr><td>Can impacts be mitigated?</td><td>Yes</td><td>Yes</td></tr>
<tr><td colspan="3">Confidence in findings: High.</td></tr>
<tr><td colspan="3">Mitigation:
It is recommended for each facility that the PV solar panels be tilted away from the direction of sunset directly after sunset, to have them facing as far as possible in the opposite direction of sunset during dusk. In this way any remaining light from sunset will fall on the back of the solar panels and not at a reflective angle in relation to the low-lying sunset.
Each facility should be using matte solar panels with anti-reflective coatings can also reduce the range of reflective light angles and therefore reduce PLP.</td></tr>
</table>

5.4 Environmental Management Plan (EMP)

Table 5.8: Measurements for inclusion into the Environmental Management Plan for the impacts of foraging habitat and roost disturbance/destruction.

Project component/s	**Earthworks and vegetation clearing during construction.**	
Potential Impact	**Bat roosts may be destroyed and bat foraging habitat will be destroyed**	
Activity/risk source	**Earthworks and vegetation clearing during construction.**	
Mitigation: Target/Objective	**During construction.**	
Mitigation: Action/control	Responsibility	Timeframe
Bat sensitivity map need to be adhered to.	**Site planning team and ECO on site during construction.**	**From planning to end of construction.**
Performance Indicator	**Refer to sensitivity map during planning and construction.**	
Monitoring	**Refer to sensitivity map during planning and construction.**	

Table 5.9: Measurements for inclusion into the Environmental Management Plan for the impact of increased bat mortality due to light pollution.

Project component/s	**Lighting on the PV facility.**	
Potential Impact	**The probability of bat mortalities caused by moving turbine blades of nearby wind farms (e.g. the proposed adjacent Merino WEF) may be significantly increased by artificial lighting at the PV facility attracting insects and thereby eating bats. Particularly if such lights are placed in close proximity of wind turbines. This applies to insect eating bats that readily forage around lights, cave dwelling species tend to avoid lights.**	
Activity/risk source	**Artificial lights that are placed near operational turbines.**	
Mitigation: Target/Objective	**Minimal lighting on the site, and necessary lights not to be placed near turbines.**	
Mitigation: Action/control	Responsibility	Timeframe
• Adhere to the bat sensitivity map.	**Site planning team, and wind farm operations manager.**	**From planning, throughout the lifetime of the facility**

• Use lights with passive motion sensors that only switch on when a person/vehicle is nearby, if possible for safety and security reasons. • All floodlights must be down-hooded to minimise light pollution. • If possible, do not place outside lights near turbines.		

Performance Indicator	**Observations at night. The operational bat monitoring study at the proposed Merino WEF must determine if this impact is present on site or not.**
Monitoring	**Observations should be made at night at the PV facility on an annual basis to determine if the outside lights are fitted with passive motion sensors that functions correctly, and if all floodlights are down-hooded. After any maintenance/replacements done on outside lights, this observation must be done.**

Table 5.10: Measurements for inclusion into the Environmental Management Plan for the impact of interference with bat navigation by polarised light pollution (PLP).

Project component/s	**PV panels**
Potential Impact	**Evidence exists of bats using polarised light at dusk to calibrate their internal magnetic compasses, and PV solar panels are strong reflectors of horizontally polarised light which can possibly interfere with this method of navigation. Although, the degree of impact on bats needs to be determined for bats foraging near and around their roost, since the study referenced experimented on the homing capabilities of bats released away from their roost.**
Activity/risk source	**Reflection of PV panels**
Mitigation: Target/Objective	**Minimised reflection of PV panels at dusk.**

Mitigation: Action/control	Responsibility	Timeframe
• It is recommended that the PV solar panels be tilted away from the direction of sunset directly after sunset, to have them facing as far as possible in the opposite direction of sunset during dusk. In this way any remaining light from sunset will fall on the back of the solar panels and not at a reflective angle in relation to the low-lying sunset. • Using matte solar panels with anti-reflective coatings can also reduce the range of reflective light angles and therefore reduce PLP.	**Site planning team, and wind farm operations manager.**	**From planning, throughout the lifetime of the facility**

Performance Indicator	**Visual observations of panel orientation at dusk.**
Monitoring	**Visual observations of panel orientation at dusk.**

6 POSSIBLE MITIGATION MEASURES

The primary impacts predicted for the PV facility are destruction of bat roosting and foraging habitats during construction (and to a lesser degree during decommissioning), which can lead to accidental direct bat fatalities if a roost is destroyed. Light pollution during operation due to the need for security lighting at PV facilities is also a significant predicted impact, this also includes lights used at associated infrastructure such as the substation, O&M building and BESS. Polarised light pollution has also been identified as a potential impact on bats, as well as normal light pollution which can increase bat numbers in the area.

Destruction of bat roosts, roosting habitat and foraging habitat:

Adhere to the sensitivity map during all phases of the facility, thus avoiding all bat sensitive areas (roosting and foraging) as well as their buffers. This also applies to temporary activities such as storage yards and construction offices. Vegetation should be allowed to recover where it was cleared after the construction and decommissioning of the facility, and where significant topsoil was removed a vegetation rehabilitation specialist must be consulted.

Since it's not possible to discover all bat roosts or individual roosting bats, it remains possible that bat roosts can be present in terrain not identified or anticipated as roosting habitat in the sensitivity map, subsequently the roosts may be damaged and bat fatalities may occur. This is due to the large size of renewable energy development sites as well as the elusive nature of many roosting bat species in micro roosts, as well as their capability to roost in very small inconspicuous spaces.

In the case of an active bat roost being discovered during construction, alternatives should be considered depending on the size and significance of the bat roost. Such alternatives in the case of a small roost may include eviction of the bats by a qualified bat specialist during the correct season when pups are not present, and under a relevant permit issued by the relevant authorities. For larger roosts, decisions on the appropriate alternatives will need to be made on a case-by-case basis in consultation with the bat fraternity, since no specific protocols on this matter currently exist in South Africa.

Increased probability of bat mortality due to ordinary light pollution:

An essential mitigation to implement in the design of the facility is to keep artificial lighting to a minimum at infrastructure buildings, while still adhering to safety and security requirements. For example, this can be achieved by having floodlights down-hooded, installing passive motion sensors onto lights around buildings, and possibly utilising lights with lighting colours that attract fewer insects. The probability of bat mortalities caused by moving turbine blades of nearby WEF's (e.g. the proposed adjacent Merino WEF) may be significantly increased by artificial lighting attracting insects and thereby insect eating bats. Particularly if such lights are placed in close proximity of wind turbines. This applies to insect eating bats that readily forage around lights, cave dwelling species tend to avoid lights.

Interference with bat navigation due to polarised light pollution (PLP) :

It is recommended that the PV solar panels be tilted away from the direction of sunset directly after sunset, in order to have them facing as far as possible in the opposite direction of sunset during dusk. In this way any remaining light from sunset will fall on the back of the solar panels and not at a reflective angle in relation to the low-lying sunset. Using matte solar panels with anti-reflective coatings can also reduce the range of reflective light angles and therefore reduce PLP.

7 CONCLUSION

This Bat Environmental Impact Assessment Report considered information gathered from five site visits, literature, and satellite imagery.

The sensitivities have been classified as high or medium, where high sensitivities no-go zones for PV panels, construction camps, substation, O&M building, the BESS and any other activity that requires earthworks or complete vegetation clearing. With the exception of access roads and underground/overhead cables. Medium sensitivities indicate areas of probable increased risk, but PV panels are allowed to be constructed in medium sensitivity areas.

The main possible impacts identified includes foraging and roosting habitat destruction due to earthworks and vegetation clearing, increased probability of bat mortalities at nearby WEF's due to normal light pollution, and bat navigation interference due to polarised light pollution (PP).

The destruction of foraging and roosting habitat can be mitigated by adhering to the sensitivity map.

The presence of security lights on and around PV facilities (including associated infrastructures) can create significant light pollution that can increase the probability of bats being killed by nearby wind turbines. This can be mitigated by having floodlights down-hooded, installing passive motion sensors onto lights around buildings, and possibly utilising lights with lighting colours that attract fewer insects. The probability of bat mortalities caused by moving turbine blades of nearby WEF's (e.g. the proposed adjacent Merino WEF) may be significantly increased by artificial lighting attracting insects and thereby insect eating bats. Particularly if such lights are placed in close proximity of wind turbines. This applies to insect eating bats that readily forage around lights, cave dwelling species tend to avoid lights.

Evidence exists of bats using polarised light at dusk to calibrate their internal magnetic compasses, and PV solar panels are strong reflectors of horizontally polarised light which can possibly interfere with this method of navigation. Although, the degree of impact on bats needs to be determined for bats foraging near and around their roost, since the study referenced experimented on the homing capabilities of bats released away from their roost. The impact may be medium if not mitigated. This can be mitigated by tilting PV solar panels be away from the direction of sunset directly after sunset, in order to have them facing as far as possible in the opposite direction of sunset during dusk. In this way any remaining light from sunset will fall on the back of the solar panels and not at a reflective angle in relation to the low-lying sunset. Using matte solar panels with anti-reflective coatings can also reduce the range of reflective light angles and therefore reduce PLP.

Thus far, from a bat impact perspective, no reasons have been identified for the Moriri PV facility not to proceed to the approval phase.

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