Biodiversity Impact Assessment – Carolus Solar Photo-Voltaic (PV) Solar Energy Facility and associated Grid Connection Infrastructure

Pixley ka Seme District Municipality, Northern Cape Province

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CLIENT

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Executive Summary

Carolus Solar PV1 (Pty) Ltd is proposing the development of a Photovoltaic (PV) Solar Energy Facility and associated infrastructure on Portion 3 of the Farm Carolus Poort No.3, located approximately 10 km east of De Aar within the Emthanjeni Local Municipality in the Northern Cape Province. The facility will have a contracted capacity of up to 120 MW and will be known as Carolus Solar PV1. The project is planned as part of a cluster of renewable energy facilities known as Pixley Park, which includes three (3) additional Solar PV Facilities (Wagt Solar PV1, Rietfontein PV1, and Fontein Solar PV1), and grid connection infrastructure connecting the facilities to the existing Hydra Substation.

The Grid connection infrastructure will include a 132 kV IPP Substation and a powerline with a capacity up to 132 kV which is being assessed within a 300 m wide and between 3.3 km and 9. 3km long corridor connecting to either the new proposed Vetlaagte MTS or the new proposed Wag-'n-Bietjie MTS, which will respectively be located on the farm Vetlaagte (RE/4) or Wagt en Bittje (RE/5). The Vetlaagte MTS will Loop into the Hydra-Perseus 2 or Hydra-Perseus 3 line (400 kV). Substations on either end of the line: Hydra and Perseus. The Wag-'n-Bietjie MTS will loop into the Hydra-Beta 1 line (400 kV). Substations on either end of the line: Hydra and Beta.

The Biodiversity Company (TBC) was appointed to undertake a Biodiversity Impact Assessment for the proposed development. This assessment describes the composition of the floral and faunal (herpetofauna and non-volant mammals) community within the area affected by the proposed development, and the possible impacts on the local biota. In order to achieve this, a review of available desktop information and a field survey for the Project Area of Influence (PAOI) was undertaken. The PAOI comprised of a 300 m buffer around the proposed development footprint, this including both, the PV facility and associated grid connection infrastructure.

The PAOI exhibits diverse habitat characteristics, and although there are negative impacts to biodiversity within the PAOI and surrounding landscape from anthropogenic activities, the area still supports keystone fauna. These keystone fauna, which comprise of ecosystem engineers such as *Orycteropus afer* (Aardvark), and *Messor capensis*, as well as seed dispersers such as *Stigmochelys pardalis* (Leopard Tortoise), are vital in maintaining ecosystem structure and functioning. In addition to supporting keystone fauna, the PAOI predominantly overlaps with an Ecological Support Area and is important in maintaining connectivity between Critical Biodiversity Areas. The PAOI is also traversed by drainage systems that are categorised as Upstream Management Areas as part of the National Freshwater Ecosystem Priority Area.

The Site Ecological Importance (SEI) varied from 'Very Low' to 'Very High' as summarised in the table below.

Conservation Importance	Functional Integrity	Biodiversity Importance	Receptor Resilience	Site Ecological Importance
Medium Confirmed or highly likely occurrence of populations of NT species	High Large (> 20 ha but < 100 ha) intact area for any conservation status of ecosystem type. Good habitat connectivity with potentially functional ecological corridors and a regularly used road network between intact habitat patches.	High	Very Low Habitat that is unable to recover from major impacts, or species that are unlikely to remain at a site even when a disturbance or impact is occurring, or species that are unlikely to return to a site once the disturbance or impact has been removed.	Very High
Medium	Very High	High	Medium	High

Conservation Importance	Functional Integrity	Biodiversity Importance	Receptor Resilience	Site Ecological Importance
Confirmed or highly likely occurrence of populations of NT species	Very large (> 100 ha) intact area for any conservation status of ecosystem type. High habitat connectivity serving as functional ecological corridors, limited road network between intact habitat patches.		Will recover slowly (~ more than 10 years) to restore > 75% of the original species composition and functionality of the receptor functionality, or species that have a moderate likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a moderate likelihood of returning to a site once the disturbance or impact has been removed.	
Very Low No confirmed and highly unlikely populations of SCC. No confirmed and highly unlikely populations of range-restricted species. No natural habitat remaining.	Low Almost no habitat connectivity but migrations still possible across some modified or degraded natural habitat and a very busy used road network surrounds the area.	Very Low	Very High Habitat that can recover rapidly (~ less than 5 years) to restore > 75%28 of the original species composition and functionality of the receptor functionality, or species that have a very high likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a very high likelihood of returning to a site once the disturbance or impact has been removed.	Very Low

The expected impacts of the proposed SEF will include the following:

- habitat loss and fragmentation;
- degradation of surrounding habitat;
- disturbance and displacement of fauna caused during the construction and maintenance phases; and
- direct mortality during the construction phase.

In order to reduce the significance of the impacts several mitigation measures can be implemented during the construction and operational phase of the proposed developed. As indicated in the IUCN guidelines, indigenous vegetation must be maintained under the solar panels to ensure biodiversity maintenance. Solar panels must be mounted on pile driven or screw foundations, such as post support spikes, rather than heavy foundations, such as trench-fill or mass concrete foundations, to reduce the negative effects on natural soil functioning, such as its filtering and buffering characteristics, while maintaining habitats for both fossorial and epigeic biodiversity.

During the construction phase, displacement and disturbance of fauna can be reduced by restricting habitat loss and disturbance to within the footprint of the development area. All personnel should undergo environmental induction with regards to the local fauna and in particular awareness about not harming, collecting or hunting terrestrial species.

Rehabilitation of disturbed areas must occur to mitigate against erosion and the encroachment of invasive plants as this will lead to a negative shift in the wellbeing of the biotic community within the landscape. It is important to ensure that regular monitoring for invasive plant encroachment occurs during the operation phase. This should be undertaken quarterly during the first two years of the operation phase and annually for the life of the project. This is to ensure that the area is not degraded further. Monitoring for signs of erosion must be undertaken in parallel and rectified as soon as possible.

Cumulative impacts of energy developments are a concern and based on the extent of energy developments within the Northern Upper Karoo vegetation type, it was rated as 'Medium'. Based on the outcomes of the SEI determination, there are areas within the PAOI that possess a 'Very High' SEI. This denotes that avoidance mitigation is the only appropriate option for these areas and no destructive development activities should be considered.

There are areas within the PAOI that possess a 'High' SEI. This denotes that avoidance mitigation wherever possible must be implemented. This includes changes to project infrastructure design to limit the amount of habitat impacted.

In order to evaluate the extent of 'avoidance' achieved for the project, the following is noteworthy:

- The total extent of the entire project area is 8 200 ha;
- The footprint of the Carolus Solar PV1 is 285 ha, thus in isolation approximately 3% of the total project area will be developed; and
- The footprint areas for the four proposed solar facilities amounts to 2 103 ha, thus approximately 26% of the total project area will be developed.

Taking into consideration the extent of 'avoidance' achieved for the project, it is the opinion of the specialist that the authorisation of the proposed project may be favourably considered, under condition that all mitigation and impact management actions provided within this report are implemented. It is recommended that should any future developments be proposed for the remaining extent of any 'Very High' or 'High' SEI areas within the associated properties, that offset strategies be required for these authorisations.

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1 Introduction

1.1 Background

Carolus Solar PV1 (Pty) Ltd is proposing the development of a Photovoltaic (PV) Solar Energy Facility and associated infrastructure on Portion 3 of the Farm Carolus Poort No.3, located approximately 10 km east of De Aar within the Emthanjeni Local Municipality in the Northern Cape Province. The facility will have a contracted capacity of up to 120 MW and will be known as Carolus Solar PV1. The project is planned as part of a cluster of renewable energy facilities known as Pixley Park, which includes three (3) additional Solar PV Facilities (Wagt Solar PV1, Rietfontein PV1, and Fontein Solar PV1), and grid connection infrastructure connecting the facilities to the existing Hydra Substation.

The Grid connection infrastructure will include a 132 kV IPP Substation and a powerline with a capacity up to 132 kV which is being assessed within a 300 m wide and between 3.3 km and 9. 3km long corridor connecting to either the new proposed Vetlaagte MTS or the new proposed Wag-'n-Bietjie MTS, which will respectively be located on the farm Vetlaagte (RE/4) or Wagt en Bittje (RE/5). The Vetlaagte MTS will Loop into the Hydra-Perseus 2 or Hydra-Perseus 3 line (400 kV). Substations on either end of the line: Hydra and Perseus. The Wag-'n-Bietjie MTS will loop into the Hydra-Beta 1 line (400 kV). Substations on either end of the line: Hydra and Beta.

It is the developer's intention to bid the proposed project under the Department of Mineral Resources and Energy's (DMRE's) Renewable Energy Independent Power Producer Procurement (REIPPP) Programme (or similar 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 Carolus Solar PV1 Facility set to inject up to 120 MW into the national grid.

The Biodiversity Company (TBC) was appointed to undertake a Biodiversity Impact Assessment for the proposed developments, i.e., the PV Facility and the Grid. The approach was informed by the Environmental Impact Assessment Regulations. 2014 (GNR 326, 7 April 2017) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA). The approach has taken cognisance of the recently published Government Notices 320 (20 March 2020) in terms of NEMA, dated 20 March and 30 October 2020: "*Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998, when applying for Environmental Authorisation*" (Reporting Criteria). See Appendix A for the Protocol Checklist and where the checklist items are located in the report.

The purpose of the specialist assessment is to provide relevant input into the basic assessment process and provide a report for the proposed activities associated with the project. This report, after taking into consideration the findings and recommendations provided by the specialist herein, should inform and guide the Environmental Assessment Practitioner (EAP) and regulatory authorities, enabling informed decision making, as to the ecological viability of the proposed project.

1.2 Project Description

1.2.1 Photovoltaic Facility

Infrastructure associated with the Carolus Solar PV1 Facility will include the following:

- Solar PV array comprising bifacial PV modules and mounting structures, using single axis tracking technology;
- Inverters and transformers;
- Cabling between the panels;

- Battery Energy Storage System (BESS);
- Laydown areas, construction camps, site offices ;
- 12 m wide Access Road and entrance gate to the project site and switching station;
- 6 m wide internal distribution roads;
- Operations and Maintenance Building, Site Offices, Ablutions with conservancy tanks, Storage Warehouse, workshop, Guard House;
- Onsite 132 kV IPP Substation, including the HV Step-up transformer, and MV Interconnection building;
- 132 kV Overhead Power Line (OHPL) – 30 m height from the switching station to the Main Transmission Substation (MTS) located on farms Vetlaagte and Wagt, which is to be handed back to Eskom (a separate EA is being applied for in this regard);
- Extension of the 132 kV Busbar at the MTS;
- 132 kV Feeder Bay at the MTS;
- Extension of the 400 kV Busbar at the MTS; and
- Installation of a new 400/132 kV Transformer and bay at the MTS.

A development footprint of approximately 285 ha has been identified within the broader project site (approximately 8 200 ha in extent), by the developer for the development of the Carolus Solar PV1 Facility, which 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.

1.2.2 Grid Connection Infrastructure

The grid connection corridor will consist of:

- Onsite 132 kV IPP Substation including the HV Stepup transformer, MV Interconnection building (footprint up to 100 m x 100 m located within the 300 m wide corridor);
- Onsite 132 kV Eskom switching station – 100 m x 100 m and 30 m height, metering, relay & control buildings, laydown area, ablutions with conservancy tanks and water storage tanks, and access roads which roads which is handed back to Eskom (Separate EA);
- 132 kV Overhead Power Line (OHPL) – 30 m height from the switching station to the Main Transmission Substation (MTS) located on either Vetlaagte (RE/4) or Wag en Bittje (RE/5) farms which will be handed back to Eskom (within 300 m wide corridor and a 31 m wide servitude); and
- Access roads to substation sites (up to 8 m wide) and service tracks (up to 6 m wide) where no existing roads are available. These may be reduced to 6 m and 4 m respectively as permanent roads.

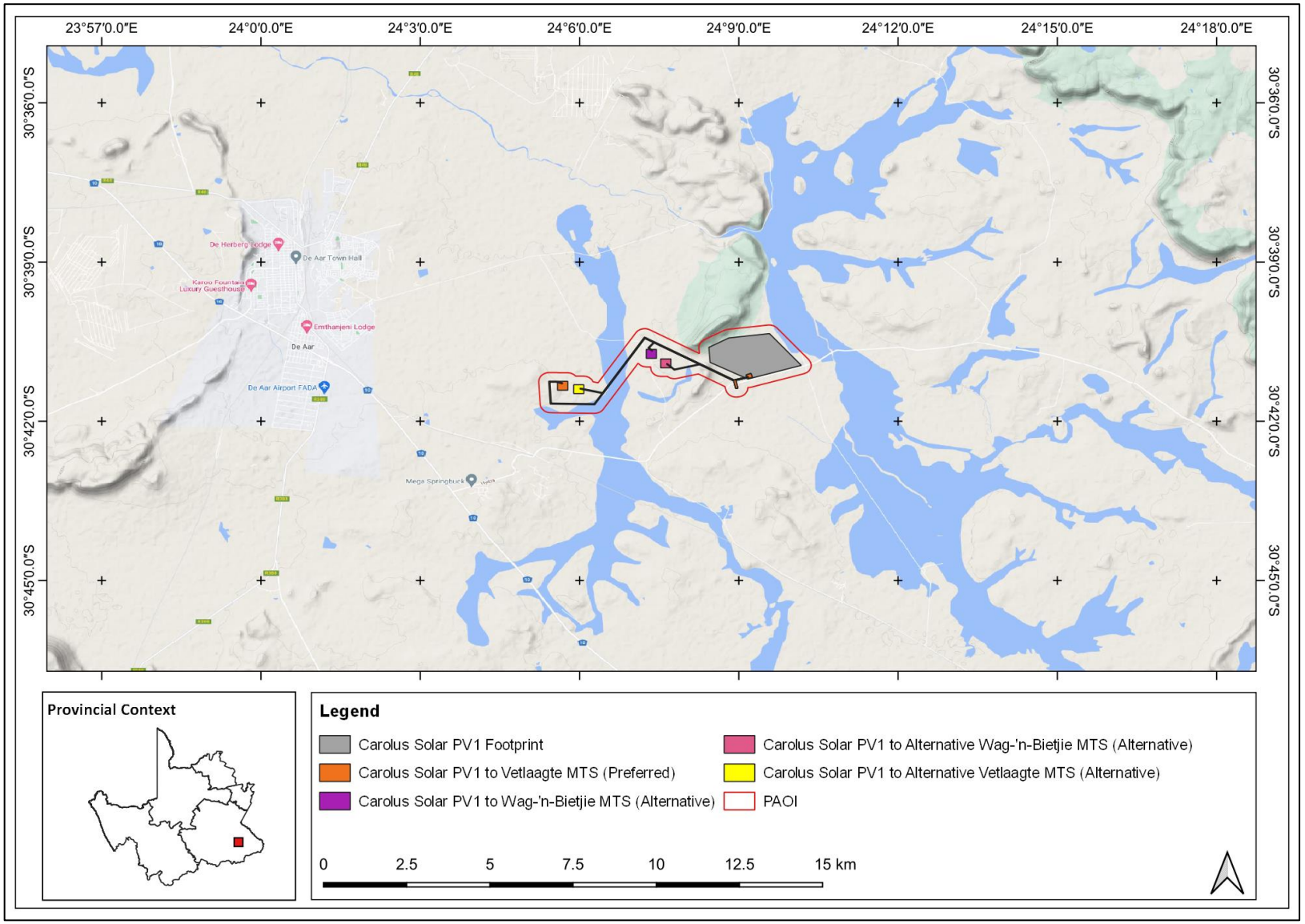


Figure 1-1 Map illustrating the location and layout design of the proposed Carolus Solar PV1 Facility

1.3 Scope of Work

The principal aim of the assessment was to provide information to guide the risk of the proposed development to the flora and fauna communities of the ecosystems associated with the project area. The scope of work for the assessment comprises of the following:

- Desktop assessment to identify the relevant ecologically important geographical features within the Project Area of Influence (PAOI) and surrounding landscape;
- Desktop assessment to compile an expected species list and possible flora and fauna Species of Conservation Concern (SCC) (Figure 1-2) that potentially occur within the proposed PAOI;
- Field survey to ascertain the species composition of the present flora and fauna community within the PAOI;
- Delineate the Site Ecological Importance (SEI) within the PAOI;
- Identify the manner that the proposed development impacts the flora and fauna community and evaluate the level of risk of these potential impacts; and
- The prescription of mitigation measures and recommendations for identified risks.

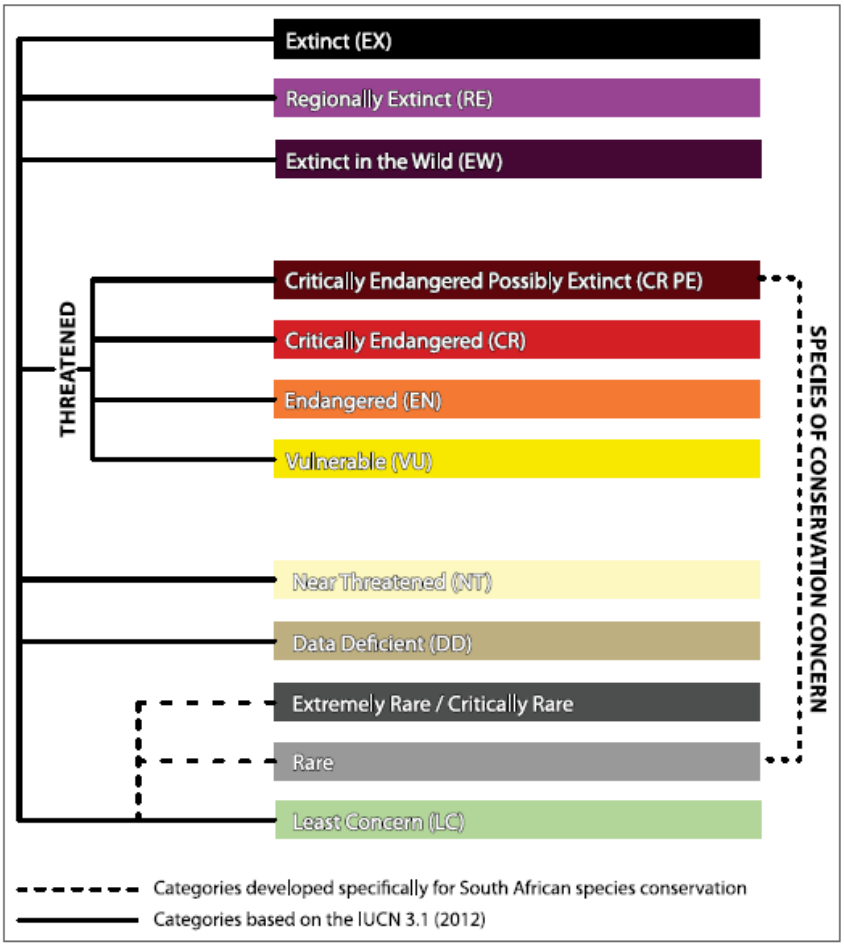


Figure 1-2 The different categories of Species of Conservation Concern modified from the IUCN's extinction risk categories. Source: SANBI (2020)

1.4 Assumptions and Limitations

The following assumptions and limitations are applicable for this assessment:

- The Project Area of Influence (PAOI) was a 300 m buffer around the proposed PV facility footprint and associated grid connection infrastructure. A changed project layout with regards to the grid was provided in April 2022 which was after the field survey. Habitats therefore were delineated based on satellite imagery, terrain and extrapolation from areas visited during the scoping survey;
- For the purposes of this assessment, the results from the desktop evaluation and field survey considered the entire PAOI, i.e., the 300 m buffer around the PV Facility and grid connection infrastructure. The impact assessment considered the PV facility and grid connection infrastructure separately;
- Whilst every effort was made to cover as much of the site as possible, it is possible that some flora and fauna species that are present on site were not recorded during the field survey, especially secretive or rare species;
- With regards to the fauna species assessment, only amphibians, reptiles and non-volant mammal species were considered. The avifauna and volant mammal impact assessment were undertaken by separate specialists;
- No passive sampling techniques for small non-volant mammals were utilised within the PAOI due to time constraints;
- Only a single scoping survey was undertaken in January (mid-Summer) and hence there is a high probability that not all species of flora will be recorded. Due to time constraints no protected flora were geotagged;
- Any alterations and/or missing GIS information pertaining to the development layout subsequent to this assessment may affect the accuracy and/or outcomes of the assessment; and
- The GPS used in the assessment has an accuracy of 5 m and consequently any spatial features may be offset by 5 m.

1.5 Key Legislative Requirements

The legislation, policies and guidelines listed below in Table 1-1 are applicable to the current project. The list below, although extensive, may not be complete and other legislation, policies and guidelines may apply in addition to those listed below.

Table 1-1 A list of key legislative requirements relevant to biodiversity and conservation in the Northern Cape Province

Region	Legislation / Guideline
International	Convention on Biological Diversity (CBD, 1993)
	The Convention on Wetlands (RAMSAR Convention, 1971)
	The United Nations Framework Convention on Climate Change (UNFCC,1994)
	The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 1973)
	The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention, 1979)
National	Constitution of the Republic of South Africa (Act No. 108 of 1996)
	The National Environmental Management Act (NEMA) (Act No. 107 of 1998)
	The National Environmental Management: Protected Areas Act (Act No. 57 of 2003)
	The National Environmental Management: Biodiversity Act (Act No. 10 of 2004), Threatened or Protected Species Regulations
	Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998, GNR 320 of Government Gazette 43310 (March 2020)
	Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998, GNR 1150 of Government Gazette 43855 (October 2020)
	The National Environmental Management: Waste Act, 2008 (Act 59 of 2008);
	The Environment Conservation Act (Act No. 73 of 1989)
	National Protected Areas Expansion Strategy (NPAES)
	Natural Scientific Professions Act (Act No. 27 of 2003)
	National Biodiversity Framework (NBF, 2009)
	National Forest Act (Act No. 84 of 1998)
	National Veld and Forest Fire Act (101 of 1998)
	National Water Act (NWA) (Act No. 36 of 1998)
	National Spatial Biodiversity Impact Assessment (NSBA)
	World Heritage Convention Act (Act No. 49 of 1999)
	Municipal Systems Act (Act No. 32 of 2000)
	Alien and Invasive Species Regulations and, Alien and Invasive Species List 20142020, published under NEMBA
	South Africa's National Biodiversity Strategy and Action Plan (NBSAP)
	Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983) (CARA)
	Sustainable Utilisation of Agricultural Resources (Draft Legislation).
	White Paper on Biodiversity
Provincial	Northern Cape Nature Conservation Act No. 9 of 2009

2 Methods

The desktop assessment was principally undertaken using a Geographic Information System (GIS) to access the latest available spatial datasets to develop digital cartographs and species lists. These datasets and their date of publishing are provided below.

2.1 Project Area

According to the land type database (Land Type Survey Staff, 1972 - 2006), the project area is characterised by the Ae 137, Ae 138, Ae 139, Ae 140, Ib 47 and Fb 72 land types. The Ae land types are characterized with Hutton, Oakleaf and Mispah soil forms according to the Soil Classification Working Group, (1991) with the possibility of other soils and bare rocky areas. The Ae land type consists of red to yellow apedal soils which are freely drained. The soils tend to have a high base status and are deeper than 300 mm. The Fb land type consists of Glenrosa and/or Mispah soil forms with the possibility of other soils occurring throughout. Lime is generally present within the entire landscape. The Ib land type consists of miscellaneous land classes including rocky areas with miscellaneous soils. The profile of the land terrain units are illustrated in Figure 2-1 to Figure 2-6.

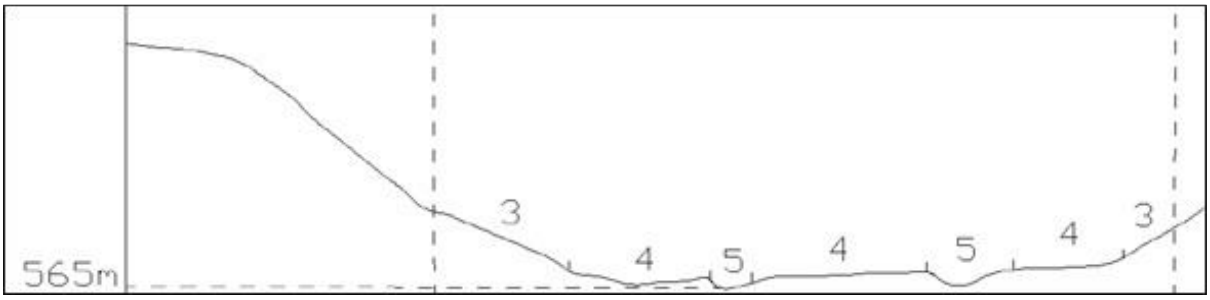


Figure 2-1 Illustration of land type Ae 137 terrain unit (Land Type Survey Staff, 1972 - 2006)

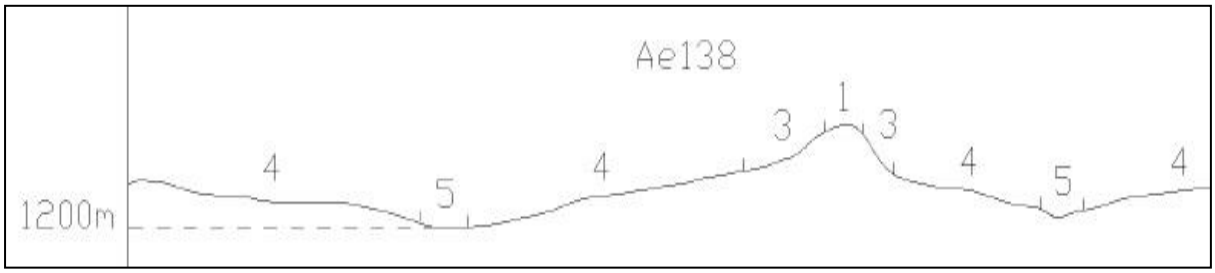


Figure 2-2 Illustration of land type Ae 138 terrain unit (Land Type Survey Staff, 1972 - 2006)

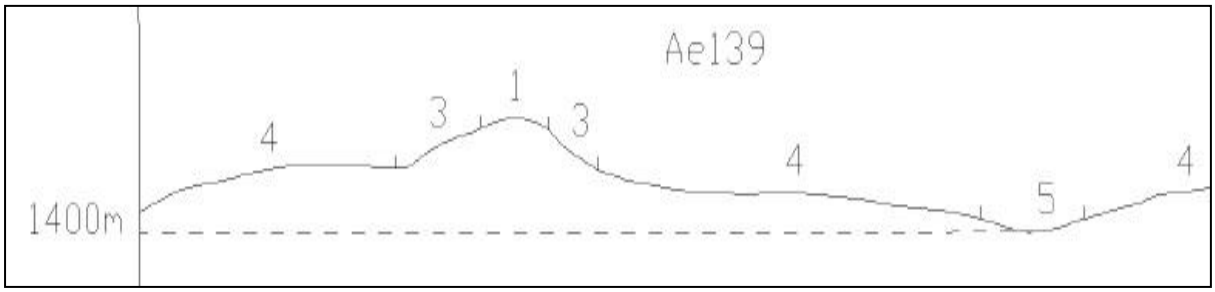


Figure 2-3 Illustration of land type Ae 139 terrain unit (Land Type Survey Staff, 1972 - 2006)

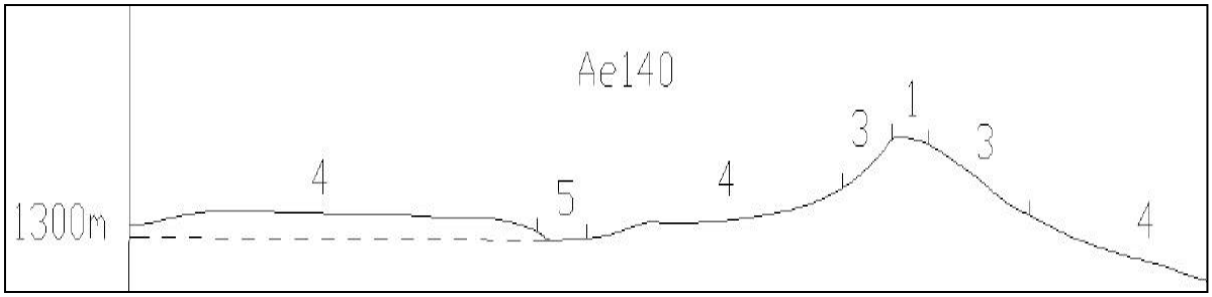


Figure 2-4 Illustration of land type Ae 140 terrain unit (Land Type Survey Staff, 1972 - 2006)

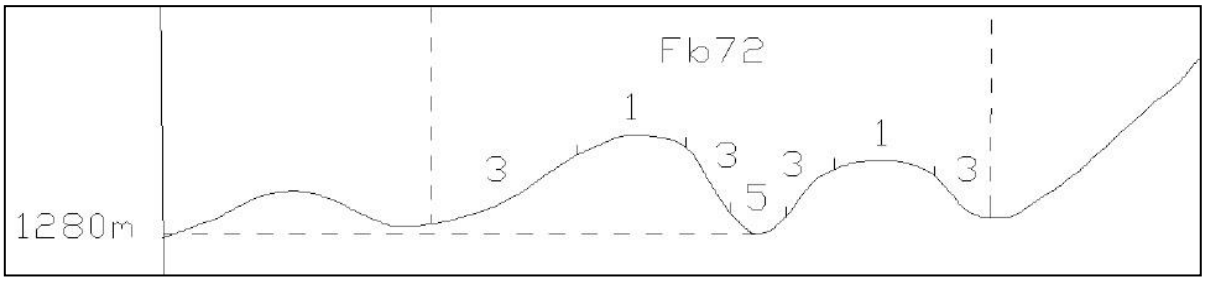


Figure 2-5 Illustration of land type Fb 72 terrain unit (Land Type Survey Staff, 1972 - 2006)

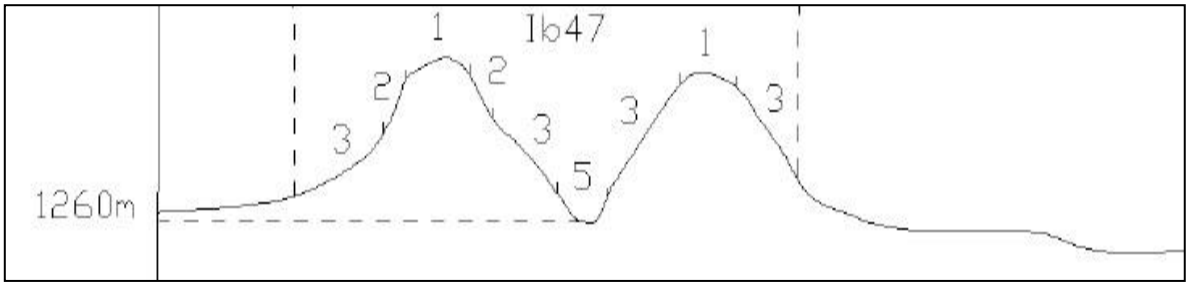


Figure 2-6 Illustration of land type Ib 47 terrain unit (Land Type Survey Staff, 1972 - 2006)

The climate within the project area is considered to be a Cold semi-arid climate (type “BSk”) according to the Köppen-Geiger climate classification (en.climate-data.org). Cold semi-arid climates (BSk) tend to be located in elevated portions of temperate zones, typically bordering a humid continental climate or a Mediterranean climate. They are also typically found in continental interiors distal from large bodies of water. Cold semi-arid climates usually feature warm to hot dry summers, with summers typically not quite as hot as those of hot semi-arid climates. Unlike hot semi-arid climates, areas with cold semi-arid climates tend to have cold and possibly freezing winters. Areas with BSk climates tend to feature major temperature swings between day and night, sometimes by as much as 20°C or more. These large diurnal temperature variations seldom occur in hot semi-arid climates. Cold semi-arid climates at lower latitudes tend to have precipitation patterns more akin to subtropical climates.

The latest landcover dataset indicates that the PAOI is dominated by Nama Karoo low shrubland, interspersed with natural grassland and eroded lands.

2.2 Desktop Assessment

2.2.1 Ecologically Important Landscape Features

Existing ecologically relevant data layers were incorporated into a GIS to establish how the proposed project might interact with any ecologically important entities. Emphasis was placed around the following spatial datasets:

- National Biodiversity Impact Assessment 2018 (Skowno et al, 2019) (NBA) - The purpose of the NBA is to assess the state of South Africa's biodiversity based on best available science, with a view to understanding trends over time and informing policy and decision-making across a range of sectors. The NBA deals with all three components of biodiversity: genes, species and ecosystems; and assesses biodiversity and ecosystems across terrestrial, freshwater, estuarine and marine environments. The two headline indicators assessed in the NBA are:

- Ecosystem Threat Status – indicator of an ecosystem's wellbeing, based on the level of change in structure, function or composition. Ecosystem types are categorised as Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) or Least Concern (LC), based on the proportion of the original extent of each ecosystem type that remains in good ecological condition.

- Ecosystem Protection Level – indicator of the extent to which ecosystems are adequately protected or under-protected. Ecosystem types are categorised as Well Protected (WP), Moderately Protected (MP), Poorly Protected (PP), or Not Protected (NP), based on the proportion of the biodiversity target for each ecosystem type that is included within one or more protected areas. NP, PP or MP ecosystem types are collectively referred to as under-protected ecosystems.

- Protected areas:

- South Africa Conservation Areas Database (SACAD) and South Africa Protected Areas Database (SAPAD) (DFFE, 2021a) – The South African Protected Areas Database (SAPAD) contains spatial data for the conservation of South Africa. It includes spatial and attribute information for both formally protected areas and areas that have less formal protection. SAPAD is updated on a continuous basis and forms the basis for the Register of Protected Areas which is a legislative requirement under the National Environmental Management: Protected Areas Act, Act 57 of 2003.

- National Protected Areas Expansion Strategy (NPAES) (DFEE, 2021b) – The National Protected Area Expansion Strategy (NPAES) provides spatial information on areas that are suitable for terrestrial ecosystem protection. These focus areas are large, intact and unfragmented and are therefore, of high importance for biodiversity, climate resilience and freshwater protection.

- Northern Cape Critical Biodiversity Areas (CBAs) (SANBI, 2016) - The identification of Critical Biodiversity Areas for the Northern Cape was undertaken using a Systematic Conservation Planning approach. Available data on biodiversity features (incorporating both pattern and process, and covering terrestrial and inland aquatic realms), their condition, current Protected Areas and Conservation Areas, and opportunities and constraints for effective conservation were collated. Priorities from existing plans such as the Namakwa District Biodiversity Plan, the Succulent Karoo Ecosystem Plan, National Estuary Priorities, and the National Freshwater Ecosystem Priority Areas were incorporated. Targets for terrestrial ecosystems were based on established national targets, while targets used for other features were aligned with those used in other provincial planning processes. CBA categories are based on their biodiversity characteristics, spatial configuration and requirement for meeting targets for both biodiversity pattern and ecological processes:

- Critical Biodiversity Area (CBA) – An area that must be maintained in a good ecological condition (natural or near-natural state) in order to meet biodiversity targets. CBAs collectively meet biodiversity targets for all ecosystem types as well as for species and ecological

processes that depend on natural or near-natural habitat, that have not already been met in the protected area network (SANBI, 2016).

- Ecological Support Area (ESA) – An area that must be maintained in at least fair ecological condition (semi-natural/moderately modified state) in order to support the ecological functioning of a CBA or protected area, or to generate or deliver ecosystem services, or to meet remaining biodiversity targets for ecosystem types or species when it is not possible or no necessary to meet them in natural or near-natural areas (SANBI, 2016).

- Other Natural Area (ONA) – An area in good or fair ecological condition (natural, near-natural or semi-natural) that is not required to meet biodiversity targets for ecosystem types, species or ecological processes (SANBI, 2016).

- Hydrological Setting:

- South African Inventory of Inland Aquatic Ecosystems (SAIIAE) (Van Deventer *et al,* 2018) – A South African Inventory of Inland Aquatic Ecosystems (SAIIAE) was established during the National Biodiversity Impact Assessment of 2018. It is a collection of data layers that represent the extent of river and inland wetland ecosystem types as well as pressures on these systems.

- Strategic Water Source Areas (SWSAs) (Le Maitre *et al*, 2021) – SWSAs are defined as areas of land that supply a quantity of mean annual surface water runoff in relation to their size and therefore, contribute considerably to the overall water supply of the country. These are key ecological infrastructure assets and the effective protection of surface water SWSAs areas is vital for national security because a lack of water security will compromise national security and human wellbeing.

- National Freshwater Ecosystem Priority Area (NFEPA) (Nel *et al.,* 2011) – The NFEPA database provides strategic spatial priorities for conserving the country's freshwater ecosystems and associated biodiversity as well as supporting sustainable use of water resources.

2.2.2 Desktop Flora Assessment

The Vegetation of South Africa, Lesotho and Swaziland (Mucina & Rutherford, 2006) and SANBI (2019) was used to identify the vegetation type that would have occurred under natural or pre-anthropogenically altered conditions. Furthermore, the Plants of Southern Africa (POSA) database was accessed to compile a list of expected flora species within the project area (Figure 2-7). The Red List of South African Plants (Raimondo *et al.,* 2009; SANBI, 2020) was utilized to provide the most current national conservation status of flora species.

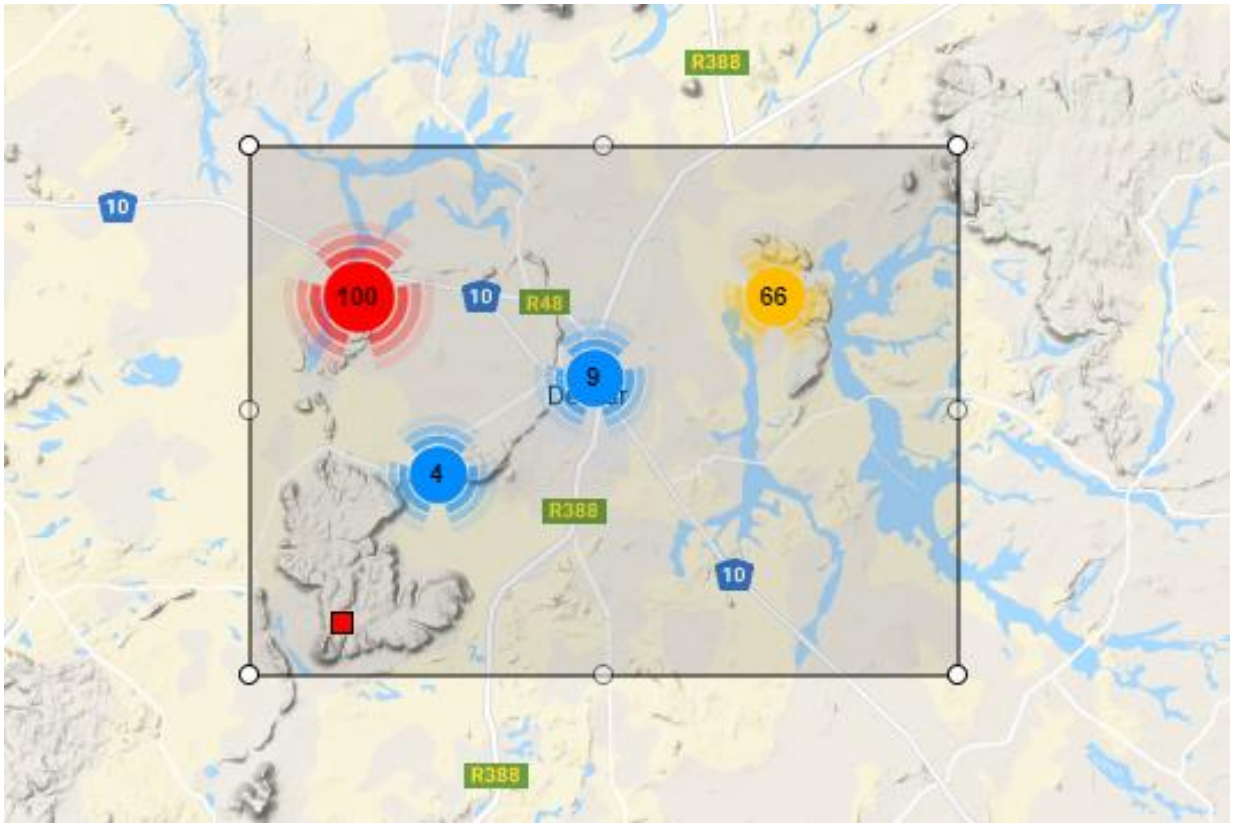


Figure 2-7 Map illustrating extent of area used to obtain the expected flora species list from the Plants of South Africa (POSA) database

2.2.3 Desktop Fauna Assessment

The faunal desktop assessment comprised of the following:

- Compiling an expected Amphibian list, generated from the IUCN spatial dataset (2017) and AmphibianMAP database (Fitzpatrick Institute of African Ornithology, 2022a), using the 3024CA quarter degree square;
- Reptile list, generated from the IUCN spatial dataset (2017) and ReptileMAP database (Fitzpatrick Institute of African Ornithology, 2022b), using the 3024CA quarter degree square; and
- Mammal list from the IUCN spatial dataset (2017) and MammalMAP database (Fitzpatrick Institute of African Ornithology, 2022c), using the 3024CA quarter degree square.

2.2.4 Literature Review

The following assessments were reviewed to confirm species that were observed within the landscape that may have not been observed during the field survey for this assessment:

- Specialist ecological study on the potential impacts of the proposed ACED De Aar Solar Energy Facility, near De Aar, Northern Cape. Prepared by David Hoare Consulting cc; and
- Basic Assessment Report for the De Aar 2 South Wind Energy Facility's On-Site Substation and Battery Energy Storage System, Northern Cape Province. Prepared by Arcus Consultancy Services South Africa (Pty) Limited.

2.3 Field Assessment

A single field survey was undertaken during the 18th – 20th of January 2022 (mid-Summer), which constitutes a wet-season survey, to determine the presence of Species of Conservation Concern (SCC) and to ascertain an overview of the ecological condition of the PAOI. Effort was made to cover the different habitat types within the limits of time and access. The fieldwork was placed within targeted areas perceived as ecologically sensitive based on the preliminary interpretation of satellite imagery (Google Corporation) and GIS analysis (which included the latest applicable biodiversity datasets) available prior to the fieldwork. Fauna species observed adjacent to, but not necessarily within the PAOI were also recorded as species occupying open habitats or arid regions tend to exhibit larger home ranges than those inhabiting wooded or high rainfall areas (Ofstad *et al*, 2016).

2.3.1 Flora Survey

The timed random meander method is a highly efficient method for conducting floristic analysis, specifically in detecting flora SCC and maximising floristic coverage (Goff *et al*, 1982). In addition, the method is time and cost effective and highly suited for compiling flora species lists and therefore gives a rapid indication of flora diversity.

Homogenous vegetation units were subjectively identified using satellite imagery and existing land cover maps. The floristic diversity and search for flora SCC was conducted through meanders within representative habitat units.

During the survey, notes were made regarding current impacts, subjective recording of dominant vegetation species and any sensitive features (e.g., wetlands, outcrops etc.).

Relevant field guides and texts consulted for identification purposes in the field during the survey included the following:

- Identification Guide to Southern African Grasses: An Identification Manual with Keys, Descriptions, and Distributions (Fish *et al,* 2015);
- iNaturalist;
- Flowering Plants of the Southern Kalahari (Van Rooyen and Van Rooyen, 2019);
- Problem Plants and Alien Weeds of South Africa (Bromilow, 2010);
- Field Guide to Succulents in Southern Africa (Smith *et al,* 2017);
- Guide to the Aloes of South Africa (Van Wyk & Smith, 2014);
- Medicinal Plants of South Africa (Van Wyk *et al.,* 2013).

2.3.2 Fauna Survey

The faunal field survey comprised of the following active and passive techniques:

- Active hand-searches - are used for species that shelter in or under particular micro-habitats (typically in dense shrubs, under rocks and coarse woody debris). Diagnostic features of the individuals that were captured were photographed at site and released (Figure 2-8A);
- Visual and auditory searches - This typically comprised of traversing the PAOI and using a camera to view species from a distance without them being disturbed as well as listening to species calls. Due to the secretive behaviour as well as climatic and habitat characteristics of the project area, the use of signs and tracks was vital in recording species (Figure 2-8B); and

- Camera Traps (Figure 2-8C-E) – Three camera traps were deployed within the landscape for 48 hours, accounting for a total of 144 trapping hours. The camera traps were baited with tinned sardines to improve sampling efficacy.

Relevant field guides and texts consulted for identification purposes included the following:

- Field Guide to Snakes and other Reptiles of Southern Africa (Branch, 1998);
- A Complete Guide to the Snakes of Southern Africa (Marais, 2004);
- Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland (Bates *et al,* 2014);
- A Complete Guide to the Frogs of Southern Africa (du Preez and Carruthers, 2009);
- Stuarts' Field Guide to Mammals of Southern Africa including Angola, Zambia & Malawi (Stuart and Stuart, 2015); and
- Mammals of Southern Africa and their Tracks & Signs (Gutteridge & Liebenberg, 2021).

Figure 2-8 ***Photographs illustrating sampling methods utilised in the biodiversity impact assessment for the proposed Carolus Solar PV1 Facility. A) Photographing diagnostic features of specimens captured, B) Recording signs of fauna such tracks, bones and scat, C-E) Camera traps placed within strategic fine-scale habitat features which are imperative for recording fauna in arid or semi-arid regions***

2.4 Site Ecological Importance

The different habitat types within the assessment area were delineated and identified based on observations during the field assessment as well as available satellite imagery. These habitat types were assigned Site Ecological Importance (SEI) categories based on their ecological integrity, conservation value, the presence of species of conservation concern and their ecosystem processes. The determination of the SEI was in accordance with the method described in the Species Environmental Assessment Guideline (SANBI, 2020).

Site Ecological Importance (SEI) is a function of the Biodiversity Importance (BI) of the receptor (e.g., SCC, the vegetation/fauna community or habitat type present on the site) and Receptor Resilience (RR) (its resilience to impacts).

BI is a function of Conservation Importance (CI) and the Functional Integrity (FI) of the receptor as follows. The criteria for the CI and FI ratings are provided in Table 2-1 and Table 2-2, respectively.

Table 2-1 Summary of Conservation Importance (CI) criteria

Conservation Importance	Fulfilling Criteria
Very High	Confirmed or highly likely occurrence of CR, EN, VU or Extremely Rare or Critically Rare species that have a global extent of occurrence (EOO) of < 10 km^2. Any area of natural habitat of a CR ecosystem type or large area (> 0.1% of the total ecosystem type extent) of natural habitat of an EN ecosystem type. Globally significant populations of congregatory species (> 10% of global population).
High	Confirmed or highly likely occurrence of CR, EN, VU species that have a global EOO of > 10 km^2. IUCN threatened species (CR, EN, VU) must be listed under any criterion other than A. If listed as threatened only under Criterion A, include if there are less than 10 locations or < 10 000 mature individuals remaining. Small area (> 0.01% but < 0.1% of the total ecosystem type extent) of natural habitat of EN ecosystem type or large area (> 0.1%) of natural habitat of VU ecosystem type. Presence of Rare species. Globally significant populations of congregatory species (> 1% but < 10% of global population).
Medium	Confirmed or highly likely occurrence of populations of NT species, threatened species (CR, EN, VU) listed under Criterion A only and which have more than 10 locations or more than 10 000 mature individuals. Any area of natural habitat of threatened ecosystem type with status of VU. Presence of range-restricted species. > 50% of receptor contains natural habitat with potential to support SCC.
Low	No confirmed or highly likely populations of SCC. No confirmed or highly likely populations of range-restricted species. < 50% of receptor contains natural habitat with limited potential to support SCC.
Very Low	No confirmed and highly unlikely populations of SCC. No confirmed and highly unlikely populations of range-restricted species. No natural habitat remaining.

Table 2-2 Summary of Functional Integrity (FI) criteria

Functional Integrity	Fulfilling Criteria
Very High	Very large (> 100 ha) intact area for any conservation status of ecosystem type or > 5 ha for CR ecosystem types. High habitat connectivity serving as functional ecological corridors, limited road network between intact habitat patches. No or minimal current negative ecological impacts with no signs of major past disturbance.
High	Large (> 20 ha but < 100 ha) intact area for any conservation status of ecosystem type or > 10 ha for EN ecosystem types. Good habitat connectivity with potentially functional ecological corridors and a regularly used road network between intact habitat patches. Only minor current negative ecological impacts with no signs of major past disturbance and good rehabilitation potential.
Medium	Medium (> 5 ha but < 20 ha) semi-intact area for any conservation status of ecosystem type or > 20 ha for VU ecosystem types. Only narrow corridors of good habitat connectivity or larger areas of poor habitat connectivity and a busy used road network between intact habitat patches.

Functional Integrity	Fulfilling Criteria
	Mostly minor current negative ecological impacts with some major impacts and a few signs of minor past disturbance. Moderate rehabilitation potential.
Low	Small (> 1 ha but < 5 ha) area. Almost no habitat connectivity but migrations still possible across some modified or degraded natural habitat and a very busy used road network surrounds the area. Low rehabilitation potential. Several minor and major current negative ecological impacts.
Very Low	Very small (< 1 ha) area. No habitat connectivity except for flying species or flora with wind-dispersed seeds. Several major current negative ecological impacts.

BI can be derived from a simple matrix of CI and FI as provided in Table 2-3

Table 2-3 Matrix used to derive Biodiversity Importance (BI) from Functional Integrity (FI) and Conservation Importance (CI)

Biodiversity Importance (BI)		Conservation Importance (CI)				
		Very high	**High**	**Medium**	**Low**	**Very low**
Functional Integrity (FI)	**Very high**	Very High	Very High	High	Medium	Low
	High	Very High	High	Medium	Medium	Low
	Medium	High	Medium	Medium	Low	Very Low
	Low	Medium	Medium	Low	Low	Very Low
	Very low	Medium	Low	Very Low	Very Low	Very Low

The fulfilling criteria to evaluate RR are based on the estimated recovery time required to restore an appreciable portion of functionality to the receptor as summarised in Table 2-4.

Table 2-4 Summary of Resource Resilience (RR) criteria

Resilience	Fulfilling Criteria
Very High	Habitat that can recover rapidly (~ less than 5 years) to restore > 75% of the original species composition and functionality of the receptor functionality, or species that have a very high likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a very high likelihood of returning to a site once the disturbance or impact has been removed.
High	Habitat that can recover relatively quickly (~ 5–10 years) to restore > 75% of the original species composition and functionality of the receptor functionality, or species that have a high likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a high likelihood of returning to a site once the disturbance or impact has been removed.
Medium	Will recover slowly (~ more than 10 years) to restore > 75% of the original species composition and functionality of the receptor functionality, or species that have a moderate likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a moderate likelihood of returning to a site once the disturbance or impact has been removed.
Low	Habitat that is unlikely to be able to recover fully after a relatively long period: > 15 years required to restore ~ less than 50% of the original species composition and functionality of the receptor functionality, or species that have a low likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a low likelihood of returning to a site once the disturbance or impact has been removed.
Very Low	Habitat that is unable to recover from major impacts, or species that are unlikely to remain at a site even when a disturbance or impact is occurring, or species that are unlikely to return to a site once the disturbance or impact has been removed.

Subsequent to the determination of the BI and RR, the SEI can be ascertained using the matrix as provided in Table 2-5.

Table 2-5 Matrix used to derive Site Ecological Importance from Receptor Resilience (RR) and Biodiversity Importance (BI)

Site Ecological Importance		Biodiversity Importance (BI)				
		Very High	High	Medium	Low	Very Low
Receptor Resilience (RR)	Very Low	Very High	Very High	High	Medium	Low
	Low	Very High	Very High	High	Medium	Very Low
	Medium	Very High	High	Medium	Low	Very Low
	High	High	Medium	Low	Very Low	Very Low
	Very High	Medium	Low	Very Low	Very Low	Very Low

Interpretation of the SEI in the context of the proposed development activities is provided in Table 2-6.

Table 2-6 Guidelines for interpreting Site Ecological Importance in the context of the proposed development activities (SANBI, 2020)

Site Ecological Importance	Interpretation in relation to proposed development activities
Very High	Avoidance mitigation – no destructive development activities should be considered. Offset mitigation not acceptable/not possible (i.e., last remaining populations of species, last remaining good condition patches of ecosystems/unique species assemblages). Destructive impacts for species/ecosystems where persistence target remains.
High	Avoidance mitigation wherever possible. Minimisation mitigation – changes to project infrastructure design to limit the amount of habitat impacted, limited development activities of low impact acceptable. Offset mitigation may be required for high impact activities.
Medium	Minimisation and restoration mitigation – development activities of medium impact acceptable followed by appropriate restoration activities.
Low	Minimisation and restoration mitigation – development activities of medium to high impact acceptable followed by appropriate restoration activities.
Very Low	Minimisation mitigation – development activities of medium to high impact acceptable and restoration activities may not be required.

The SEI evaluated for each taxon can be combined into a single multi-taxon evaluation of SEI for the assessment area. Either a combination of the maximum SEI for each receptor should be applied, or the SEI may be evaluated only once per receptor but for all necessary taxa simultaneously. For the latter, justification of the SEI for each receptor is based on the criteria that conforms to the highest CI and FI, and the lowest RR across all taxa.

3 Results & Discussion

3.1 Desktop Assessment

3.1.1 Ecologically Important Landscape Features

The GIS analysis pertaining to the relevance of the proposed project to ecologically important landscape features are summarised in Table 3-1.

Table 3-1 Summary of relevance of the proposed project to ecologically important landscape features

Ecological Feature	Relevance	Section
Ecosystem Threat Status	Irrelevant – Overlaps with Least Concern ecosystems	3.1.1.1
Ecosystem Protection Level	Relevant – Overlaps with Not Protected and Poorly Protected ecosystems	3.1.1.2
Protected Areas	Irrelevant – Located approximately 11 km east from the De Aar Nature Reserve	3.1.1.3
National Protected Areas Expansion Strategy (NPAES)	Irrelevant – Does not overlap a NPAES focus area	3.1.1.3
Northern Cape Critical Biodiversity Areas	Relevant – Overlaps Ecological Support Areas	3.1.1.4
Hydrological Context	Relevant – Drainage lines traverse the PAOI that drain into an Endangered reach of the Brak River. Upstream Management Area	3.1.1.5

3.1.1.1 Ecosystem Threat Status

The Ecosystem Threat Status is an indicator of an ecosystem's wellbeing, based on the level of change in structure, function or composition. Ecosystem types are categorised as Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) or Least Concern (LC), based on the proportion of the original extent of each ecosystem type that remains in good ecological condition. According to the spatial dataset the proposed project overlaps with LC ecosystems (Figure 3-1).

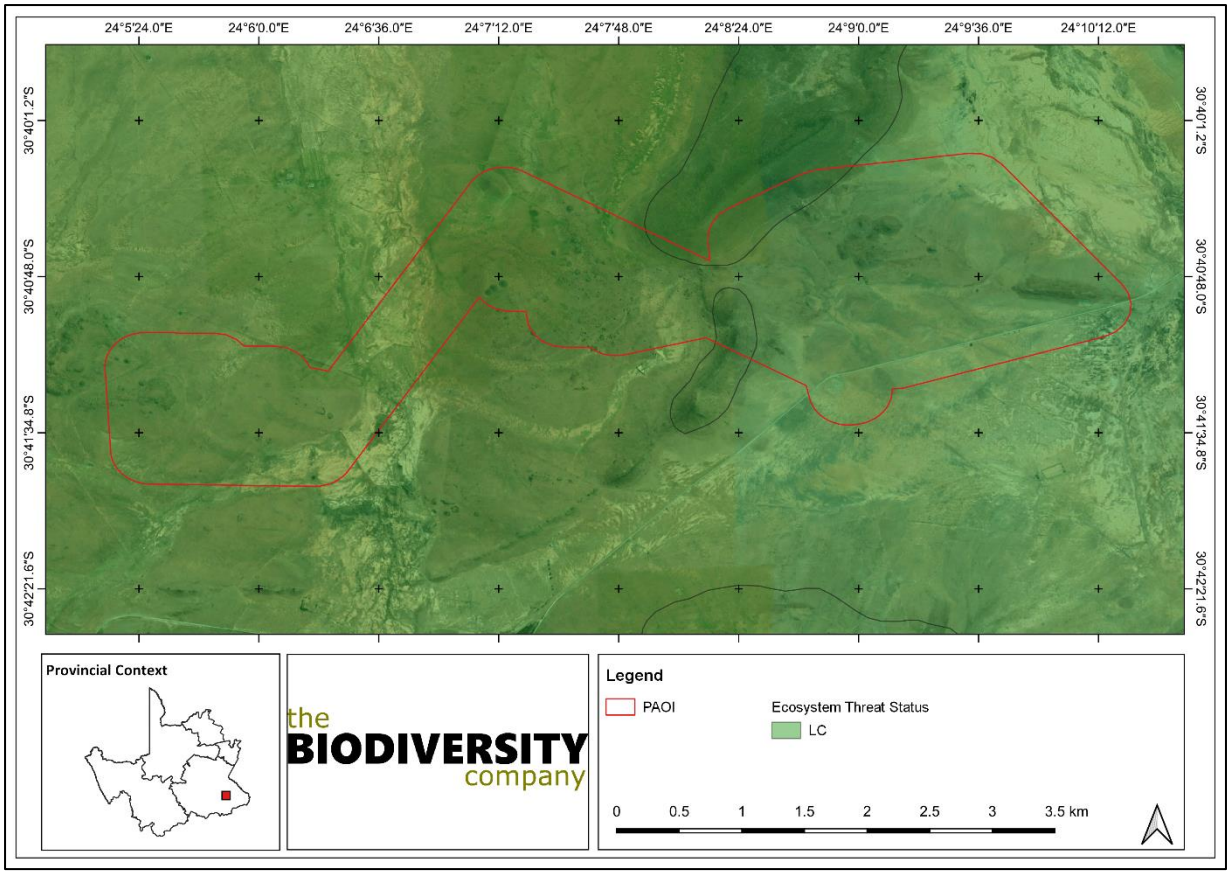


Figure 3-1 Map illustrating the ecosystem threat status associated with the proposed Carolus Solar PV1 Facility PAOI

3.1.1.2 Ecosystem Protection Level

This is an indicator of the extent to which ecosystems are adequately protected or under-protected. Ecosystem types are categorised as Well Protected (WP), Moderately Protected (MP), Poorly Protected (PP), or Not Protected (NP), based on the proportion of the biodiversity target for each ecosystem type that is included within one or more protected areas. NP, PP or MP ecosystem types are collectively referred to as under-protected ecosystems. The PAOI overlaps with NP and PP ecosystems (Figure 3-2).

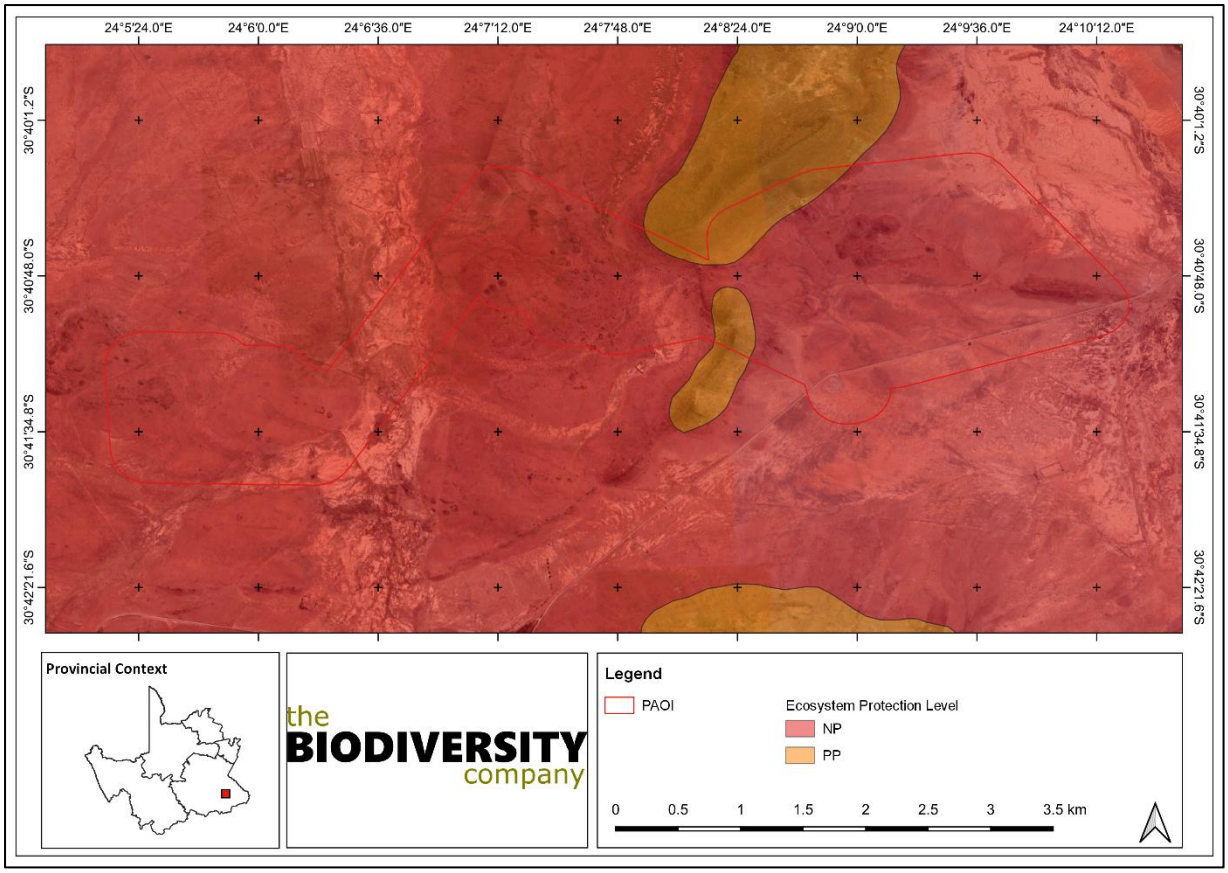


Figure 3-2 Map illustrating the ecosystem protection level associated with the proposed Carolus Solar PV1 Facility PAOI

3.1.1.3 Protected Areas

The proposed Carolus Solar PV1 Facility is not located within a protected area, nor does it overlap with any NPAES Focus Areas (Figure 3-3). The De Aar Nature Reserve is located approximately 11 km to the west, thereby located outside the 5 km buffer zone. The Senqu Caledon NPAES Focus Area is located approximately 10 km to the north-east. The proposed development is therefore unlikely to negatively impact the ecological condition of these landscape features.

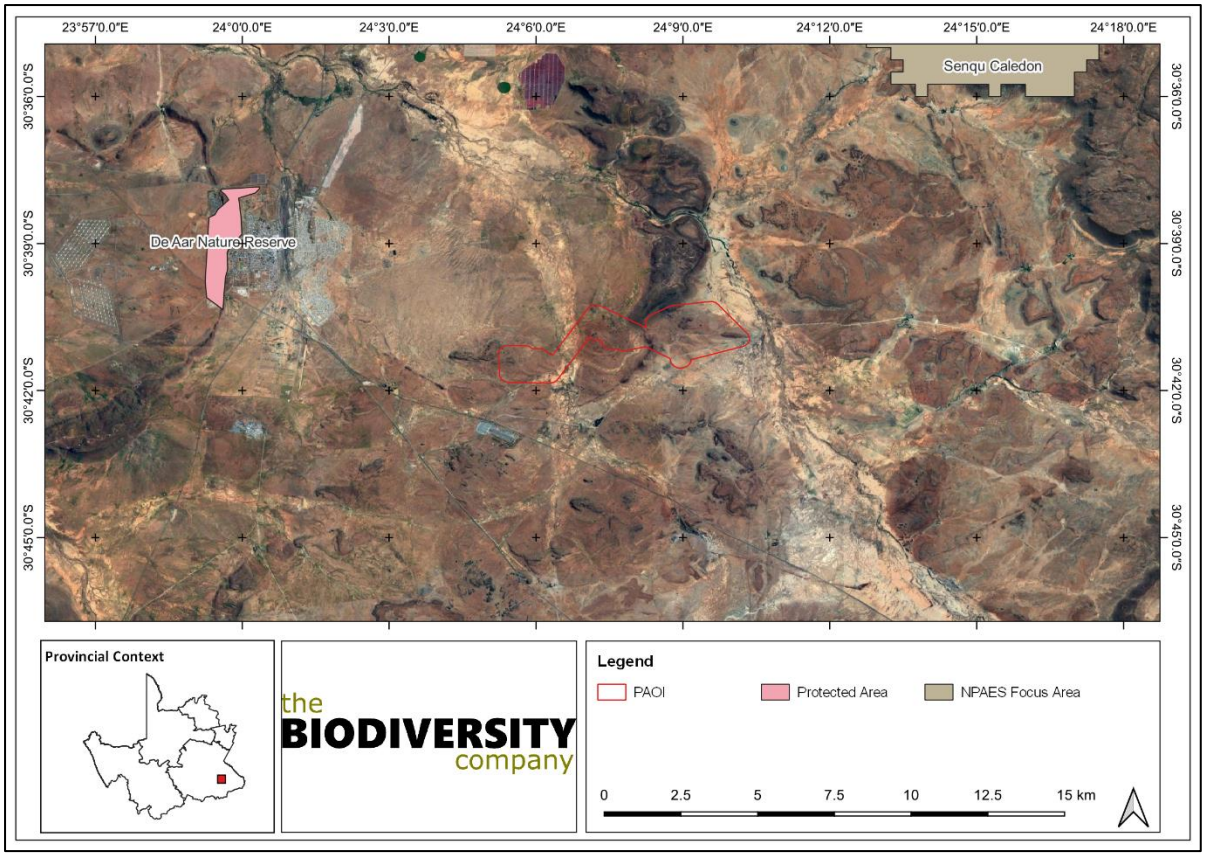


Figure 3-3 Map illustrating the proposed Carolus Solar PV1 Facility PAOI in relation to the Protected Areas and National Protected Area Expansion Strategy Focus Areas

3.1.1.4 Northern Cape Critical Biodiversity Areas

Figure 3-4 illustrates that the PAOI predominantly overlaps with an Ecological Support Area. ESAs area that must be maintained in at least fair ecological condition (semi-natural/moderately modified state) in order to support the ecological functioning of a CBA or protected area, or to generate or deliver ecosystem services, or to meet remaining biodiversity targets for ecosystem types or species when it is not possible or no necessary to meet them in natural or near-natural areas (SANBI, 2016).

The nature of the development, i.e., a SEF and associated infrastructure, will lead to the destruction of a portion of the ESA and consequently, the footprint area will be no longer congruent with an ESA.

There is partial overlap with areas classified as a CBA1 and CBA2 in the north-eastern corner (Figure 3-4). CBAs are areas that must be maintained in a good ecological condition (natural or near-natural state) in order to meet biodiversity targets. CBAs collectively meet biodiversity targets for all ecosystem types as well as for species and ecological processes that depend on natural or near-natural habitat, that have not already been met in the protected area network (SANBI, 2016).

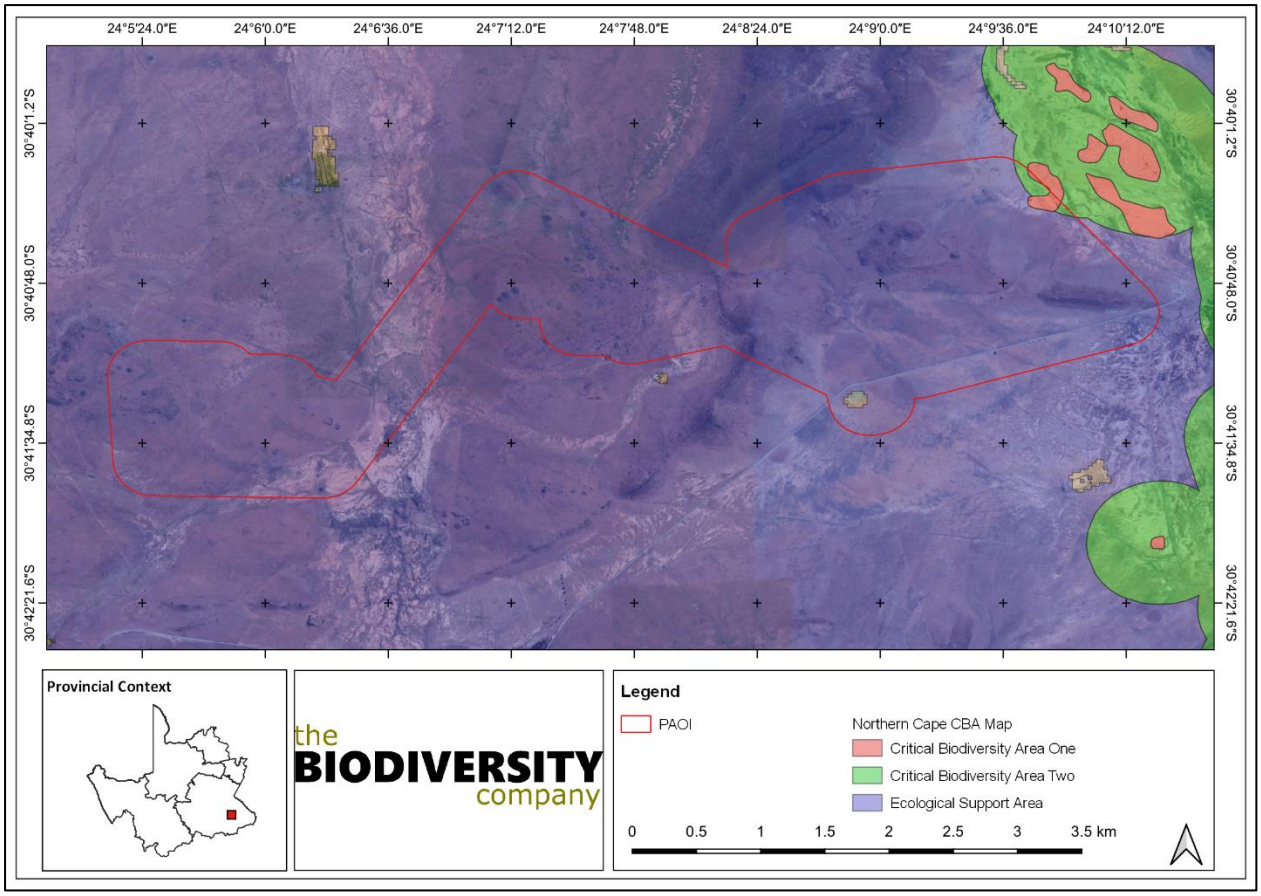


Figure 3-4 Map illustrating the proposed Carolus Solar PV1 Facility PAOI in relation to the Northern Cape Critical Biodiversity Areas

3.1.1.5 Hydrological Context

The proposed Carolus Solar PV1 Facility PAOI is located within the Brak River Catchment (Secondary Catchment D6).

The South African Inventory of Inland Aquatic Ecosystems (SAIIAE) was released with the NBA 2018. Ecosystem threat status (ETS) of river and wetland ecosystem types are based on the extent to which each river ecosystem type had been altered from its natural condition. Ecosystem types are categorised as CR, EN, VU or LT, with CR, EN and VU ecosystem types collectively referred to as 'threatened' (Van Deventer *et al.,* 2019; Skowno *et al.,* 2019). The project area does not overlap with any wetland or river systems that were assessed as part of the SAIIAE (Figure 3-5). However, there are minor drainage lines traversing the PAOI that drain into the Brak River. The Brak River is located in close proximity to the project area, and the associated reach classified as EN. Wetlands within the surrounding landscape are classified as CR.

The Brak River is considered as an Upstream Management Area according to the NFEPA database. Upstream management areas are regions in which anthropogenic activities need to be managed to prevent further degradation of downstream river FEPAs. Any negative impacts to the Brak River and its associated tributaries will lead to downstream impacts. The NFEPA database indicates that the wetlands within the surrounding landscape are not important for maintaining threatened biodiversity or support large numbers of waterbirds.

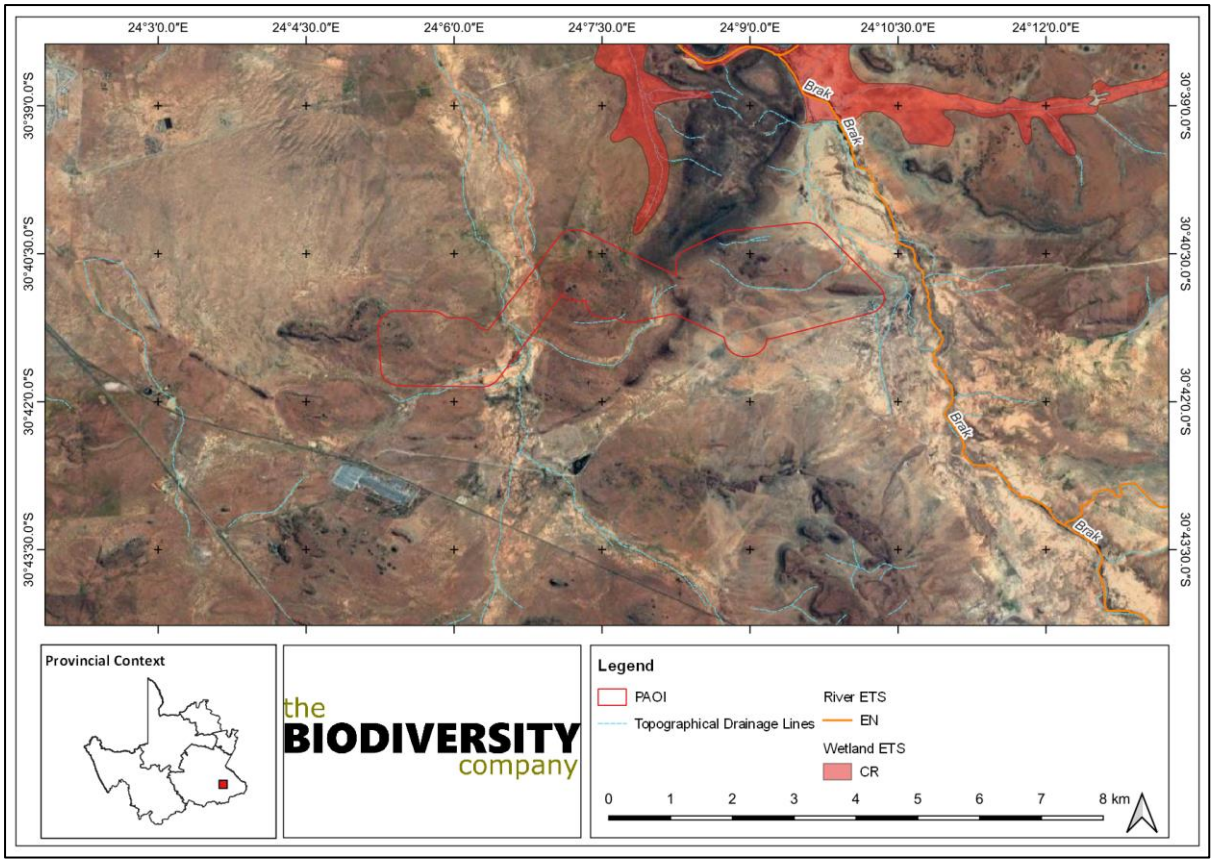


Figure 3-5 Map illustrating the hydrological context of the proposed Carolus Solar PV1 Facility PAOI

3.1.2 Flora Assessment

This section is divided into a description of the vegetation type expected under natural conditions and the expected flora species.

3.1.2.1 Vegetation Type

The proposed Carolus Solar PV1 Facility PAOI is situated within two biomes, the Grassland and Nama Karoo biomes.

The Nama Karoo Biome, which is a large, landlocked region on the central plateau of the western half of South Africa and extends into south-eastern Namibia. This is an arid biome with majority of the river systems being non-perennial. Apart from the Orange River and the few permanent streams in the southwest that originate in higher-rainfall neighbouring areas, the limited number of perennial streams that originate in the Nama-Karoo are restricted to the more mesic east. The low precipitation is unreliable (coefficient of variation of annual rainfall up to 40%) and droughts are unpredictable and prolonged. The unpredictable rainfall impedes the dominance of leaf succulents and is too dry in summer for dominance by perennial grasses alone, and the soils are generally too shallow, and the rainfall is too low for trees. Unlike other biomes of southern Africa, local endemism is very low and consequently, the Nama-Karoo Biome does not contain any centre of endemism. Despite relatively low floristic diversity, the Nama-Karoo vegetation has a high diversity of plant life forms. These include co-occurring ephemerals, annuals, geophytes, C3 and C4 grasses, succulents, deciduous and evergreen chamaephytes and trees. This is probably a consequence of an ecotonal and climatically unstable nature of the region.

Scattered rocky hills, mesas and inselbergs are distinctive features of an otherwise relatively homogeneous landscape. These features are either capped by or wholly comprised of dolerite, which

is a fine- to medium-grained dark, intrusive igneous rock. The surrounding plains and lowland habitats are dominated by shale and sandstone, which is a fine- to medium-grained sedimentary rock. Due to their structure, these features provide greater heterogeneity in habitat and microclimate than the surrounding plains and therefore, support higher species richness and diversity (Petersen *et al*, 2020). Species richness and relative cover of the varying plant growth forms are driven by gradients of a combination soil, environmental and climatic parameters. Unlike other biomes of southern Africa, local endemism is very low and consequently, the Nama-Karoo Biome does not contain any centre of endemism.

The Grassland biome is centrally located in southern Africa, and adjoins all except the desert, fynbos and succulent Karoo biomes (Mucina & Rutherford, 2006). Major macroclimatic traits that characterise the grassland biome include:

- Seasonal precipitation; and
- The minimum temperatures in winter (Mucina & Rutherford, 2006).

The grassland biome is found chiefly on the high central plateau of South Africa, and the inland areas of KwaZulu-Natal and the Eastern Cape. The topography is mainly flat and rolling but includes the escarpment itself. Altitude varies from near sea level to 2 850 m above sea level.

Grasslands are dominated by a single layer of grasses. The amount of cover depends on rainfall and the degree of grazing. The grassland biome experiences summer rainfall and dry winters with frost (and fire), which are unfavourable for tree growth. Thus, trees are typically absent, except in a few localized habitats. Geophytes (bulbs) are often abundant. Frosts, fire and grazing maintain the grass dominance and prevent the establishment of trees.

On a fine-scale vegetation type, the project area overlaps with Besemkaree Koppies Shrubland and Northern Upper Karoo (Figure 3-6).

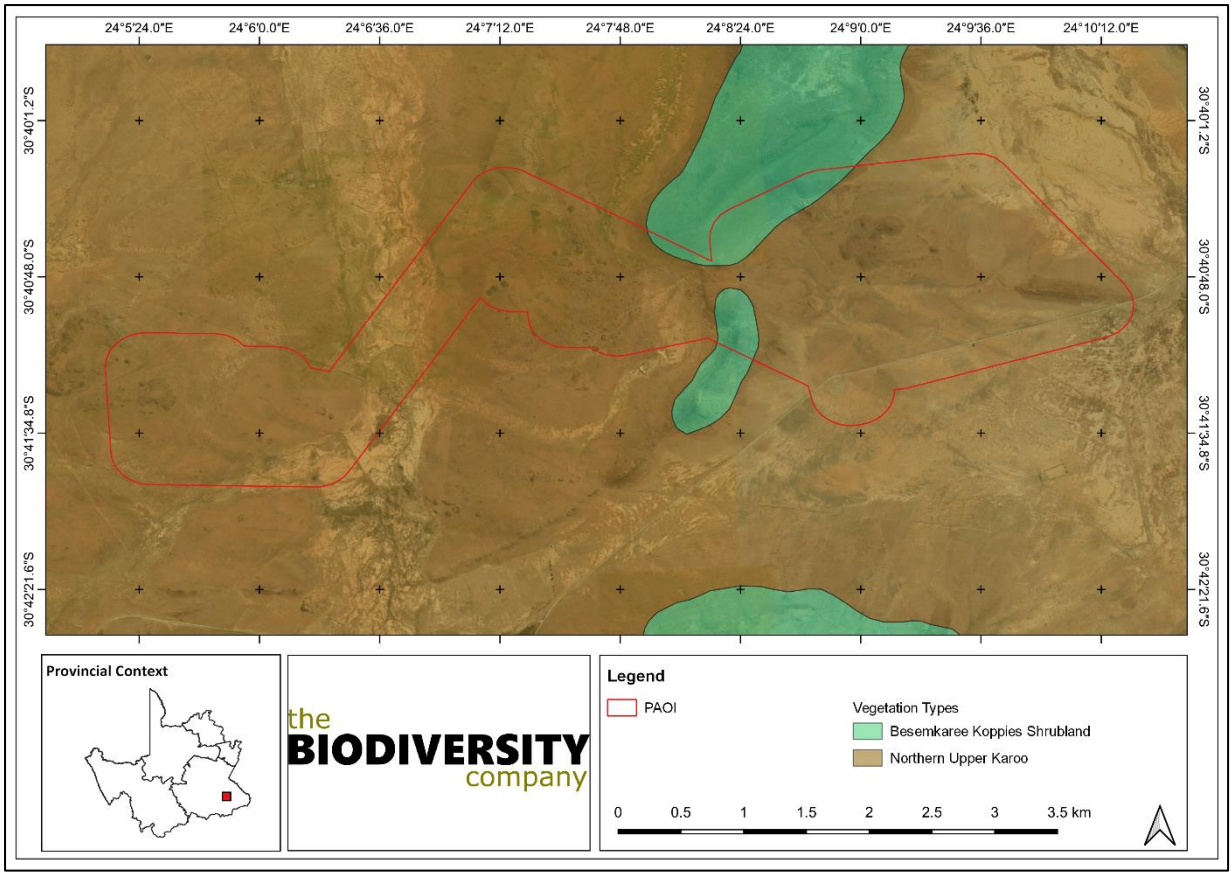


Figure 3-6 Map illustrating the vegetation types associated with the proposed Carolus Solar PV1 Facility PAOI

3.1.2.1.1 Northern Upper Karoo

The Northern Upper Karoo is restricted to the Northern Cape and Free State Provinces, specifically in the northern regions of the Upper Karoo plateau from Prieska, Vosburg and Carnarvon in the west to Philipstown, Petrusville and Petrusburg in the east. In the north, it is bordered by the towns of Niekerkshoop, Douglas and Petrusburg and in the south by Carnarvon, Pampoenpoort and De Aar. Additionally, there are a few patches in Griqualand West. Altitude varies mostly from 1000 to 1500 m (Mucina & Rutherford, 2006).

Its main vegetation feature is a shrubland dominated by dwarf karoo shrubs, grasses and *Senegalia mellifera* subsp. *detinens* and some other low trees (especially on sandy soils in the northern parts and vicinity of the Orange River). In terms of landscape features, it is flat to gently sloping, with isolated hills of Upper Karoo Hardeveld in the south and Vaalbos Rocky Shrubland in the northeast and with many interspersed pans (Mucina & Rutherford, 2006).

Important Plant Taxa in Northern Upper Karoo

Based on Mucina and Rutherford's (2006) vegetation classification, important plant taxa are those species that have a high abundance, a frequent occurrence (not being particularly abundant) or are prominent in the landscape within a particular vegetation type. They note that the following species are important taxa in the Northern Upper Karoo vegetation type:

Small Trees: *Senegalia mellifera* subsp. *detinens*, *Boscia albitrunca*.

Tall Shrubs: *Lycium cinereum*, *L. horridum*, *L. oxycarpum*, *L. schizocalyx*, *Rhigozum trichotomum*.

Low Shrubs: *Chrysocoma ciliata*, *Gnidia polycephala*, *Pentzia calcarea*, *P. globosa*, *P. incana*, *P. spinescens*, *Rosenia humilis*, *Amphiglossa triflora*, *Aptosimum marlothii*, *A. spinescens*, *Asparagus glaucus*, *Barleria rigida*, *Berkheya annectens*, *Eriocephalus ericoides* subsp. *ericoides*, *E. glandulosus*, *E. spinescens*, *Euryops asparagoides*, *Felicia muricata*, *Helichrysum lucilioides*, *Hermannia spinosa*, *Leucas capensis*, *Limeum aethiopicum*, *Melolobium candicans*, *Microloma armatum*, *Osteospermum leptolobum*, *O. spinescens*, *Pegolettia retrofracta*, *Pentzia lanata*, *Phyllanthus maderaspatensis*, *Plinthus karooicus*, *Pteronia glauca*, *P. sordida*, *Selago geniculata*, *S. saxatilis*, *Tetragonia arbuscula*, *Zygophyllum lichtensteinianum*.

Succulent Shrubs: *Hertia pallens*, *Salsola calluna*, *S. glabrescens*, *S. rabieana*, *S. tuberculata*, *Zygophyllum flexuosum*.

Semiparasitic Shrub: *Thesium hystrix*.

Herbs: *Chamaesyce inaequilatera*, *Convolvulus sagittatus*, *Dicoma capensis*, *Gazania krebsiana*, *Hermannia comosa*, *Indigofera alternans*, *Lessertia pauciflora*, *Radyera urens*, *Sesamum capense*, *Sutera pinnatifida*, *Tribulus terrestris*, *Vahlia capensis*.

Succulent Herb: *Psilocaulon coriarium*.

Geophytic Herb: *Moraea pallida*.

Graminoids: *Aristida adscensionis*, *A. congesta*, *A. diffusa*, *Enneapogon desvauxii*, *Eragrostis lehmanniana*, *E. obtusa*, *E. truncata*, *Sporobolus fimbriatus*, *Stipagrostis obtusa, Eragrostis bicolor*, *E. porosa*, *Fingerhuthia africana*, *Heteropogon contortus*, *Stipagrostis ciliata*, *Themeda triandra*, *Tragus berteronianus*, *T. koelerioides*, *T. racemosus*.

Conservation Status

The conservation target is 21%, with none being conserved in statutory conservation areas and about 4% has already been cleared for cultivation (the highest proportion of any type in the Nama-Karoo) or irreversibly transformed by building of dams (Houwater, Kalkfontein and Smart Syndicate Dams). *Prosopis glandulosa*, one of the 12 agriculturally most important invasive alien plants in South Africa, is widely distributed in this vegetation type. Erosion ranges from very low to moderate.

3.1.2.1.2 Besemkaree Koppies Shrubland

The Besemkaree Koppies Shrubland is restricted to the Northern Cape, Free State and Eastern Cape Provinces. Within these provinces, it can be found on plains of Eastern Upper Karoo (between Richmond and Middelburg in the south and the Orange River) and within dry grasslands of the southern and central Free State. Additionally, there are also extensive dolerite-dominated landscapes along the upper Orange River that belong to this unit as well. It extends northwards to around Fauresmith in the northwest and to the Wepener District in the northeast. Altitude varies from 1 120 to 1 680 m (Mucina & Rutherford, 2006).

In terms of vegetation and landscape features, this vegetation type is characterised by slopes of koppies, butts and tafelbergs covered with two-layered karroid shrublands. The lower closed-canopy layer is dominated by dwarf small-leaved shrubs and, especially in precipitation-rich years, also by abundant grasses, while the upper loose canopy layer is dominated by tall shrubs, including several *Rhus* species, *Euclea crispa* subsp. *ovata*, *Diospyros austro-africana* and *Olea europaea* subsp. *africana* (Mucina & Rutherford, 2006).

Important Plant Taxa in Besemkaree Koppies Shrubland

Mucina and Rutherford (2006) note that the following species are important taxa in the Besemkaree Koppies Shrubland:

Small Trees: *Cussonia paniculata*, *Ziziphus mucronata*.

Tall Shrubs: *Diospyros austro-africana*, *Euclea crispa* subsp. *ovata*, *Olea europaea* subsp. *africana*, *Rhus burchellii*, *R. ciliata*, *R. erosa*, *Buddleja saligna*, *Diospyros lycioides* subsp. *lycioides*, *Ehretia rigida*, *Grewia occidentalis*, *Gymnosporia polyacantha*, *Tarchonanthus minor*.

Low Shrubs: *Asparagus suaveolens*, *Chrysocoma ciliata*, *Amphiglossa triflora*, *Aptosimum elongatum*, *Asparagus striatus*, *Diospyros pallens*, *Eriocephalus ericoides*, *E. spinescens*, *Euryops empetrifolius*, *Felicia filifolia* subsp. *filifolia*, *F. muricata*, *Helichrysum dregeanum*, *H. lucilioides*, *Hermannia multiflora*, *H. vestita*, *Lantana rugosa*, *Limeum aethiopicum*, *Lycium cinereum*, *Melolobium candicans*, *M. microphyllum*, *Nenax microphylla*, *Pegolettia retrofracta*, *Pentzia globosa*, *Rhigozum obovatum*, *Selago saxatilis*, *Stachys linearis*, *S. rugosa*, *Sutera halimifolia*, *Wahlenbergia albens*.

Succulent Shrubs: *Aloe broomii*, *Chasmatophyllum musculinum*, *C. verdoorniae*, *Cotyledon orbiculata* var. *dactylopsis*, *Pachypodium succulentum*.

Graminoids: *Aristida adscensionis*, *A. congesta*, *A. diffusa*, *Cenchrus ciliaris*, *Cymbopogon caesius*, *Cynodon incompletus*, *Digitaria eriantha*, *Eragrostis curvula*, *E. lehmanniana*, *Heteropogon contortus*, *Setaria lindenbergiana*, *Themeda triandra*, *Tragus koelerioides*, *Cymbopogon pospischilii*, *Enneapogon scoparius*, *Eragrostis chloromelas*, *E. obtusa*, *Eustachys paspaloides*, *Fingerhuthia africana*, *Hyparrhenia hirta*, *Sporobolus fimbriatus*.

Herbs: *Convolvulus sagittatus*, *Dianthus caespitosus* subsp. *caespitosus*, *Gazania krebsiana* subsp. *krebsiana*, *Hibiscus pusillus*, *Indigofera alternans*, *I. rhytidocarpa*, *Lepidium africanum* subsp. *africanum*, *Pollichia campestris*.

Herbaceous Climber: *Argyrolobium lanceolatum*.

Geophytic Herbs: *Albuca setosa*, *Asplenium cordatum*, *Cheilanthes bergiana*, *C. eckloniana*, *Freesia andersoniae*, *Haemanthus humilis* subsp. *humilis*, *Oxalis depressa*, *Pellaea calomelanos*.

Succulent Herbs: *Aloe grandidentata*, *Crassula nudicaulis*, *Duvalia caespitosa*, *Euphorbia pulvinata*, *Huernia piersii*, *Stapelia grandiflora*, *S. olivacea*, *Tridentea gemmiflora*.

Conservation Status

The conservation target is 28% and about 5% statutorily conserved in the Rolfontein, Tussen Die Riviere, Oviston, Gariep Dam, Caledon and Kalkfontein Dam Nature Reserves. Additionally, there is a small patch that is protected in the private Vulture Conservation Area. About 3% of the area has been transformed due to dams. Erosion varies from low to high (Mucina & Rutherford, 2006).

3.1.2.2 Expected Flora Species of Conservation Concern

The POSA database indicates that 116 species of indigenous plants are expected to occur within the project area and surrounding landscape. Appendix B provides the list of species and their respective conservation status and endemism. None of the species expected are SCC.

3.1.3 Fauna Assessment

3.1.3.1 Expected Amphibian Species of Conservation Concern

Based on the IUCN Red List Spatial Data and AmphibianMap database, 10 amphibian species are expected to occur within the project area (Appendix C). One of the species is regarded as a SCC (Table 3-2).

Table 3-2 Amphibian Species of Conservation Concern (SCC) that are expected to occur within the proposed Carolus Solar PV1 Facility PAOI

Family	Scientific Name	Common Name	Conservation Status		Likelihood of Occurrence
			Regional	Global	
Pyxicephalidae	*Pyxicephalus adspersus*	Giant Bullfrog	NT	LC	High

The Giant Bull Frog (*Pyxicephalus adspersus*) is listed as LC on a global scale (IUCN SSC Amphibian Specialist Group, 2013), but NT on a regional scale (Minter *et al*, 2004). The species is widely distributed in arid sub-saharan Africa, mainly at higher elevations. Within South Africa, it occurs in the north-eastern part of the Western Cape, central and southern Eastern Cape, northern, central and eastern parts of Northern Cape, northern KwaZulu-Natal (except the low-lying parts), Free State, North West, Gauteng and Limpopo provinces, and at only a few localities in Mpumalanga Province. It typically breeds in seasonal, shallow, grassy pans in flat, open areas but also utilises non-permanent vleis and shallow water on the margins of waterholes and dams. Although they sometimes inhabit clay soils, they prefer sandy substrates. Habitat loss due to crop agriculture and urbanisation is a major threat to this species. Adults migrating to, and juveniles dispersing from, breeding sites are often killed on roads. The use of insecticides and herbicides may also have a negative impact on breeding success but requires further investigation. Although there are no records of the species within the PAOI, there are several reports within the proximal surrounding landscape.

3.1.3.2 Expected Reptile Species of Conservation Concern

Based on the IUCN Red List Spatial Data and the ReptileMAP database, 18 reptile species are expected to occur within the area (Appendix D). One (1) is regarded as a SCC (Table 3-3).

Table 3-3 Reptile Species of Conservation Concern (SCC) that are expected to occur within the proposed Carolus Solar PV1 Facility PAOI

Family	Scientific Name	Common Name	Conservation Status		Likelihood of Occurrence
			Regional	Global	
Testudinidae	*Psammobates tentorius verroxii*	Verrox's Tent Tortoise	NT	NT	High

Psammobates tentorius verroxii (Verrox's Tent Tortoise) is widely distributed throughout the Nama Karoo in the Northern Cape and penetrates the Western Cape and possibly the Eastern Cape peripherally. The species has been exhibiting declines and is therefore regarded as NT (Hofmeyer *et al*, 2018). There is no estimate on the total global population. Threats include road mortality, veld fires, electrocution by livestock/game fences, overgrazing from domestic livestock, uncontrolled harvesting of natural products and irresponsible tourism activities in sensitive areas. Available information indicates that Pied Crow (*Corvus albus*) predation on this is increasingly severe, with anthropogenic facilitation of Pied Crow range expansion having led to increased predation rates (Hofmeyr *et al*, 2018). Although there are no records of the species within the PAOI, there are several reports within the proximal surrounding landscape.

3.1.3.3 Expected Mammal Species of Conservation Concern

The IUCN Red List Spatial Data lists 46 non-volant mammal species that could be expected to occur within the area (Appendix E). This list excludes large mammal species that are limited to protected areas. Three (3) of these expected species are regarded as SCC (Table 3-4).

Table 3-4 Mammal Species of Conservation Concern (SCC) that are expected to occur within the proposed Carolus Solar PV1 Facility PAOI

Family	Scientific Name	Common Name	Conservation Status		Likelihood of Occurrence
			Regional	Global	
Felidae	*Felis nigripes*	Black-footed Cat	VU	VU	Low
Felidae	*Panthera pardus*	Leopard	VU	VU	Low
Hyaenidae	*Parahyaena brunnea*	Brown Hyaena	NT	NT	Low

Felis nigripes (Black-footed cat) is endemic to the arid regions of southern Africa. This species is naturally rare, has cryptic colouring is small in size and is nocturnal. These factors have contributed to a lack of information on this species. The estimated number of mature individuals is 9 707, with the population exhibiting a continuing decline (Sliwa *et al*, 2016). The principle long-term threat for the species is the loss of key resources, such as den sites and prey, from anthropogenic disturbance or habitat degradation (Sliwa *et al*, 2016). An additional threat is indirect persecution, such as accidental poisonings (for example locust spraying, predator control lures/baits) and general predator persecution throughout most of their range. The long-term effects of climate change should not be overlooked and may lead to changes in range, changes in timing of breeding events, increases in severe weather such as flooding and droughts, as well as increased disease patterns or risks of the spread of pathogens from parasites.

Panthera pardus (Leopard) has a wide distributional range across Africa and Asia, but populations have become reduced and isolated, and they are now extirpated from large portions of their historic range (Stein *et al*, 2020). There are few reliable data on changes in the status (distribution or abundance) throughout Africa over the last three generations, although there is compelling evidence that subpopulations have likely declined considerably. Impacts that have contributed to the decline in populations of this species include continued persecution by farmers, habitat fragmentation, increased illegal wildlife trade, excessive harvesting for ceremonial use of skins, prey base declines and poorly managed trophy hunting (Stein *et al*, 2020).

Parahyaena brunnea (Brown Hyaena) is endemic to southern Africa. This species occurs in dry areas, generally with annual rainfall less than 100 mm, particularly along the coast, semi-desert, open scrub and open woodland savanna. The total population size has been estimated between 5 000-8 000 individuals with a continuing decline in mature individuals (Wiesel, 2015). Outside protected areas, the Brown Hyaena may come into conflict with humans, and they are often shot, poisoned, trapped, and hunted with dogs in predator eradication or control programmes, or inadvertently killed in non-selective control programs (Wiesel, 2015). The species is regarded as a threat to livestock in some areas, despite the finding that they very seldom prey on livestock. Their body parts are also used in traditional medicine.

3.2 Field Assessment

The following sections provides the results from the field survey for the proposed development that was undertaken during January 2022.

3.2.1 Flora Assessment

3.2.1.1 Indigenous Flora

A total of 53 species, representing 24 families were recorded within the PAOI during the survey period (Table 3-5, Figure 3-7). Six of these species are endemic to South Africa, accounting for 11% of the total number of recorded species. None of the species recorded are regarded as SCC. Nevertheless, nine of the species recorded are protected by provincial legislation and if granted authorisation, it is imperative that a Plant Search and Rescue be undertaken prior to clearing and development. A permit from the relevant authority must be obtained to remove and relocate individuals of these species to

proximal surrounding natural areas. N.B. due to time constraints individuals of these flora were not geotagged.

Table 3-5 Summary of indigenous flora recorded within the Carolus Solar PV1 Facility PAOI during the survey period. Protected species are highlighted in bold. LC = Least Concern and NE = Not Evaluated

Family	Species Name	Growth Form	Conservation Status	Endemism
Acanthaceae	*Barleria rigida*	Herb	LC	
Aizoaceae	***Mestoklema tuberosum***	**Succulent herb**	**LC**	
Aizoaceae	***Ruschia intricata***	**Succulent herb**	**LC**	**Endemic**
Amaryllidaceae	***Ammocharis coranica***	**Geophytic herb**	**LC**	
Anacardiaceae	*Searsia erosa*	Small tree	LC	
Asparagaceae	*Asparagus striatus*	Herb	LC	Endemic
Asparagaceae	*Asparagus suaveolens*	Herb	LC	
Asphodelaceae	***Aloe broomii***	**Succulent megaherb**	**LC**	
Asteraceae	*Felicia filifolia* subsp. *filifolia*	Herb	LC	
Asteraceae	*Felicia muricata* subsp. *muricata*	Herb	LC	
Asteraceae	*Gazania jurineifolia* subsp. *jurineifolia*	Herb	LC	
Asteraceae	*Gazania krebsiana* subsp. *arctotoides*	Herb	LC	
Asteraceae	*Geigeria burkei*	Herb	LC	
Asteraceae	*Helichrysum dregeanum*	Herb	LC	
Asteraceae	*Helichrysum* sp.	Herb		
Asteraceae	*Helichrysum zeyheri*	Herb	LC	
Asteraceae	*Osteospermum sinuatum var. sinuatum*	Herb	LC	
Asteraceae	*Pegolettia retrofracta*	Herb	LC	
Asteraceae	*Pentzia incana*	Herb	LC	
Asteraceae	*Phymaspermum parvifolium*	Herb	LC	
Boraginaceae	*Heliotropium ciliatum*	Herb	LC	
Brassicaceae	*Heliophila minima*	Herb	LC	
Cucurbitaceae	*Cucumis hirsutus*	Herbaceous scrambler	LC	
Cyperaceae	*Afroscirpoides dioeca*	Graminoid	LC	
Cyperaceae	*Cyperus usitatus*	Graminoid	LC	
Fabaceae	*Indigofera alternans* var. *alternans*	Herb	LC	
Fabaceae	*Lessertia annularis*	Herb	LC	
Geraniaceae	*Monsonia angustifolia*	Herb	LC	
Hyacinthaceae	***Dipcadi crispum***	**Geophytic herb**	**LC**	
Hyacinthaceae	***Dipcadi viride***	**Geophytic herb**	**LC**	
Hyacinthaceae	***Ledebouria apertiflora***	**Geophytic herb**	**LC**	
Malvaceae	*Hermannia coccocarpa*	Herb	LC	
Malvaceae	*Hermannia comosa*	Herb	LC	
Melianthaceae	*Melianthus comosus*	Herbaceous shrub	LC	
Oxalidaceae	***Oxalis obliquifolia***	**Geophytic herb**	**LC**	
Pedaliaceae	*Sesamum triphyllum*	Herb	LC	
Poaceae	*Cenchrus ciliaris*	Graminoid	LC	
Poaceae	*Enneapogon scaber*	Graminoid	LC	
Poaceae	*Eragrostis lehmanniana*	Graminoid	LC	
Poaceae	*Eragrostis obtusa*	Graminoid	LC	

Family	Species Name	Growth Form	Conservation Status	Endemism
Poaceae	*Melinis nerviglumis*	Graminoid	LC	
Poaceae	*Panicum impeditum*	Graminoid	LC	
Poaceae	*Puccinellia acroxantha*	Graminoid	LC	
Poaceae	*Sporobolus ioclados*	Graminoid	LC	
Poaceae	*Stipagrostis ciliata* var. *capensis*	Graminoid	LC	
Poaceae	*Tragus berteronianus*	Graminoid	LC	
Poaceae	*Tragus racemosus*	Graminoid	LC	
Pteridaceae	*Cheilanthes eckloniana*	Fern	LC	
Scrophulariaceae	***Jamesbrittenia tysonii***	**Herb**	**LC**	**Endemic**
Scrophulariaceae	*Selago albida*	Herb	LC	
Scrophulariaceae	*Aptosimum indivisum*	Herb	LC	Endemic
Scrophulariaceae	*Selago geniculata*	Herbaceous shrub	LC	Endemic
Solanaceae	*Withania somnifera*	Herb	LC	
Zygophyllaceae	*Roepera lichtensteiniana*	Woody shrub	NE	Endemic

Figure 3-7 ***Photographs illustrating a portion of the indigenous flora recorded within the Carolus Solar PV1 Facility PAOI during the survey period. A) Mestoklema tuberosum, B) Dipcadi viride, C) Ruschia intricata, D) Dipcadi crispum, E) Ledebouria apertiflora, F) Ammocharis coranica, G) Jamesbrittenia tysonii, H) Oxalis obliquifolia, I) Melianthus comosus, J) Hermannia coccocarpa and K) Aloe broomii***

The ecological state of grasses (Poaceae) refers to the grouping of grasses according to their reaction to different levels of grazing (van Oudsthoorn, 2020). The dominant graminoid species, in terms of cover, are classified as increaser II species. These grasses are abundant in overgrazed veld and are generally common in semi-arid to arid regions. These grasses increase due to the disturbing effect of overgrazing and include mostly pioneer and sub-climax species. In contrast, the 'decreaser' category are assigned to grass species that are abundant in well-managed habitats but decrease in numbers when the veld is over- or under-grazed. These grasses are palatable climax grasses preferred by grazers. The decreaser grass species, *Cenchrus ciliaris* and *Stipagrostis ciliata* var. *capensis*, tended to be restricted to dolerite extrusions where grazing was limited.

3.2.1.2 Invasive Alien Plants

Invasive Alien Plants (IAPs) tend to dominate or replace indigenous flora, thereby transforming the structure, composition and functioning of ecosystems. Therefore, it is important that these plants are controlled by means of an eradication and monitoring programme. Some invader plants may also degrade ecosystems through superior competitive capabilities to exclude native plant species.

NEMBA is the most recent legislation pertaining to alien invasive plant species. In August 2014, the list of Alien Invasive Species was published in terms of the NEMBA. The Alien and Invasive Species Regulations were published in the Government Gazette No. 44182, 24th of February 2021. The legislation calls for the removal and / or control of IAP species. In addition, unless authorised thereto in terms of the NWA, no land user shall allow Category 2 plants to occur within 30 meters of the 1:50 year flood line of a river, stream, spring, natural channel in which water flows regularly or intermittently, lake, dam or wetland. Category 3 plants are also prohibited from occurring within proximity to a watercourse. Below is a brief explanation of the three categories in terms of the NEMBA:

- Category 1a: Invasive species requiring compulsory control. Remove and destroy. Any specimens of Category 1a listed species need, by law, to be eradicated from the environment. No permits will be issued.
- Category 1b: Invasive species requiring compulsory control as part of an invasive species control programme. Remove and destroy. These plants are deemed to have such a high invasive potential that infestations can qualify to be placed under a government sponsored invasive species management programme. No permits will be issued.
- Category 2: Invasive species regulated by area. A demarcation permit is required to import, possess, grow, breed, move, sell, buy or accept as a gift any plants listed as Category 2 plants. No permits will be issued for Category 2 plants to exist in riparian zones.
- Category 3: Invasive species regulated by activity. An individual plant permit is required to undertake any of the following restricted activities (import, possess, grow, breed, move, sell, buy or accept as a gift) involving a Category 3 species. No permits will be issued for Category 3 plants to exist in riparian zones.

Note that according to the regulations, a person who has under his or her control a category 1b listed invasive species must immediately:

- Notify the competent authority in writing
- Take steps to manage the listed invasive species in compliance with:
    - Section 75 of the Act;
    - The relevant invasive species management programme developed in terms of regulation 4; and
    - Any directive issued in terms of section 73(3) of the Act.

No species of invasive plants were observed within the PAOI although they were observed in the surrounding areas. Disturbance of areas due to the activities of the proposed development may enable encroachment of the invasive species into these areas. Accordingly, invasive species must be controlled by developing and implementing an Invasive Alien Plant Control Programme, should the proposed development be granted authorisation.

3.2.2 Fauna Assessment

3.2.2.1 Amphibians

Two amphibian species were recorded within the PAOI as indicated by the species calls (Table 3-6). Based on the presence of ephemeral ecosystems within the PAOI additional species are expected, but the species assemblage is not expected to be very diverse.

Table 3-6 Summary of amphibian species recorded within the proposed Carolus Solar PV1 Facility PAOI during the survey period. LC = Least Concern

Family	Scientific Name	Common Name	Conservation Status	
			Regional	Global
Bufonidae	*Poyntonophrynus vertebralis*	Pygmy Toad	LC	LC
Bufonidae	*Vandijkophrynus gariepensis*	Karoo Toad	LC	LC

3.2.2.2 Reptiles

Six species of reptile were recorded within the PAOI during the survey period, accounting for 33% of the expected species (Table 3-7, Figure 3-8). None of the species recorded are regarded as SCC. The lack of species diversity recorded within the PAOI is due to the secretive behaviour of many reptile species and therefore, extensive survey periods are required to obtain an accurate representative sample. Considering the heterogenous structure of the PAOI in terms of habitat structure, it is likely to support a highly diverse species assemblage. Notably, *Stigmochelys pardalis* (Leopard Tortoise), is regarded as a keystone species within the Nama Karoo biome. The species possesses a relatively large home range between 40.53 and 258.52 ha and therefore, are vital seed dispersers.

Table 3-7 Summary of reptile species recorded within the proposed Carolus Solar PV1 Facility PAOI during the survey period. LC = Least Concern

Family	Scientific Name	Common Name	Conservation Status	
			Regional	Global
Agamidae	*Agama aculeata aculeata*	Common Ground Agama	LC	LC
Agamidae	*Agama atra*	Southern Rock Agama	LC	LC
Cordylidae	*Karusasaurus polyzonus*	Karoo Girdled Lizard	LC	LC
Elapidae	*Naja nivea*	Cape Cobra	LC	LC
Scincidae	*Trachylepis sulcata sulcata*	Western Rock Skink	LC	LC
Testudinidae	*Stigmochelys pardalis*	Leopard Tortoise	LC	LC

Figure 3-8 ***Photographs illustrating individuals of a portion of the reptile species recorded within the proposed Carolus Solar PV1 Facility PAOI during the survey period. A) Stigmochelys pardalis (Leopard Tortoise) and B) Trachylepis sulcata sulcata (Western Rock Skink)***

3.2.2.3 Mammals

Ten (10) mammal species were recorded during the survey based on either direct observation, capture of specimens by passive sampling techniques or the presence of visual tracks and signs (Table 3-8). This accounts for approximately 22% of the expected species. Due to the presence of anthropogenic activities, especially fragmentation caused by fences, a high diversity of large mammal species is not expected. Nevertheless, due to the diversity of habitats on a broad and fine scale, there is a high likelihood of occurrence of other small mammal species occurring within the PAOI.

The species *Orycteropus afer afer* (Southern Aardvark) is regarded as a keystone species within the Nama Karoo biome. The burrows they create are also utilised as shelter by an array of faunal species, which is pertinent in the thermally variable and semi-arid environment of the PAOI and surrounding landscape. In addition, they are ecosystem engineers as their foraging behaviour plays a role in vegetation dynamics. *Orycteropus afer afer* feed on the Formicidae species, *Messor capensis*, which is a major seed predator within the Karoo bioregion. During foraging by *O.afer afer*, the nests are damaged but usually not destroyed, and the seed stores are frequently distributed with the mound soils over a larger area. The seeds are usually buried within the mound soil and germinate during favourable conditions. A portion of the seeds may also be ingested by *O. afer afer* while feeding on the ants and these are distributed with the faeces. Consequently, the species inadvertently also plays a role in seed dispersal and germination.

Notably, the PAOI appears to not support a species rich assemblage of mesocarnivores. This is attributed to carnivore-proof fencing and possible persecution. However, there are certain species that are present. Mesocarnivores have strong effects on their prey species, and this especially so in simple ecological communities or in regions where apex predators are lacking (Roemer *et al*, 2009). Consequently, shifts in the population or diversity of the mesocarnivore community may lead to trophic cascade effects. This may result in the population explosion of lower trophic organisms, including groups that reach pest proportions such as rodents.

Table 3-8 Summary of mammal species recorded within the proposed Carolus Solar PV1 Facility PAOI during the survey period. LC = Least Concern

Family	Scientific Name	Common Name	Conservation Status	
			Regional	Global
Bathyergidae	*Cryptomys hottentotus*	Common Molerat	LC	LC
Bovidae	*Raphicerus campestris campestris*	Southern Steenbok	LC	LC
Bovidae	*Damaliscus pygargus phillipsi*	Blesbok	LC	LC
Canidae	*Lupulella mesomelas mesomelas*	Southern Black-backed Jackal	LC	LC
Felidae	*Caracal caracal caracal*	Southern and Eastern Caracal	LC	LC
Herpestidae	*Cynictis penicillata penicillata*	Southern Yellow Mongoose	LC	LC
Herpestidae	*Herpestes pulverulentus*	Cape Grey Mongoose	LC	LC
Hyaenidae	*Proteles cristatus cristatus*	Southern Aardwolf	LC	LC
Hystricidae	*Hystrix africaeaustralis africaeaustralis*	Southern Porcupine	LC	LC
Leporidae	*Lepus capensis*	Cape Hare	LC	LC

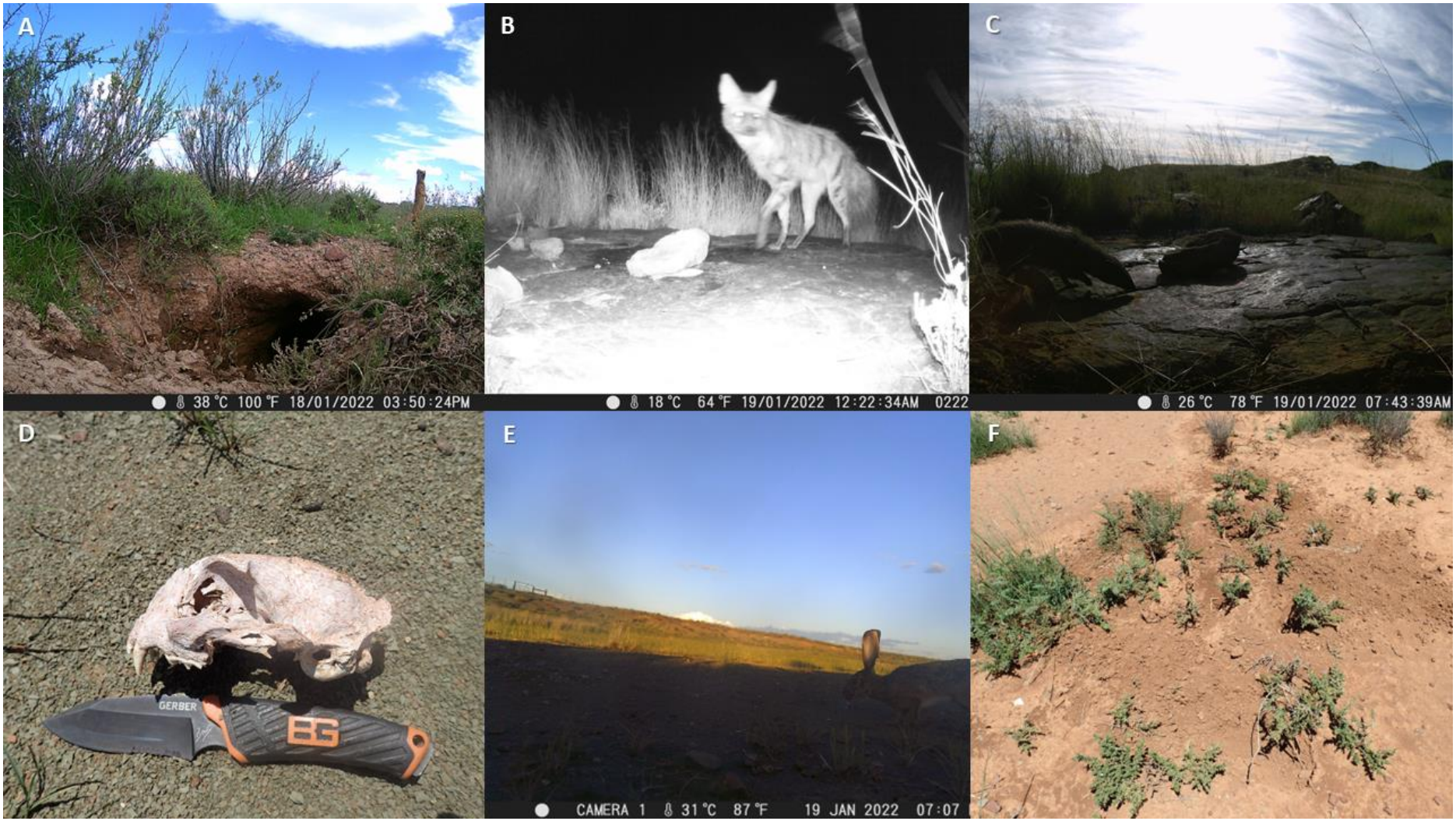


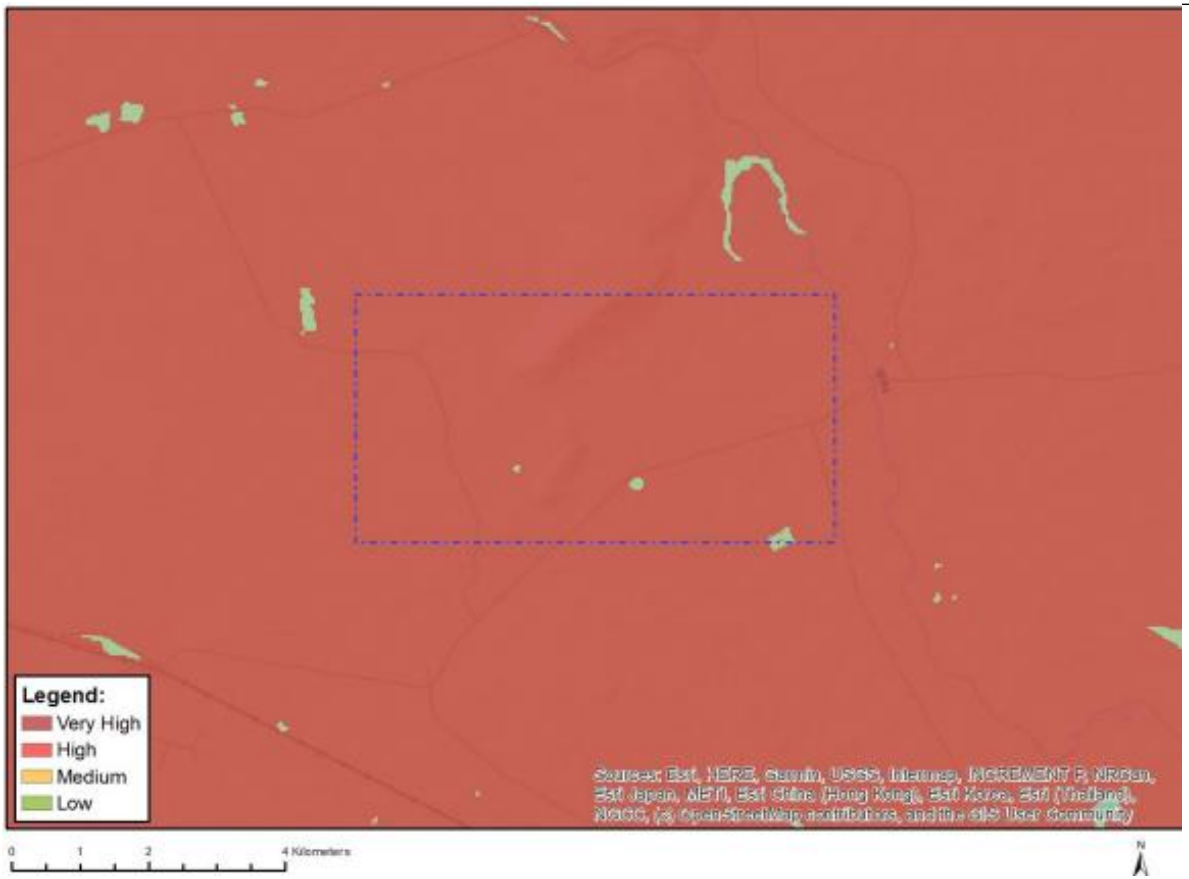
Figure 3-9 ***Photographs illustrating a portion of the mammal species recorded within the proposed Carolus Solar PV1 Facility PAOI during the survey period. A) Cynictis penicillata penicillata (Southern Yellow Mongoose), B) Proteles cristata cristata (Southern Aardwolf), C) Herpestes pulverulentus (Cape Grey Mongoose), D) Caracal caracal caracal (Southern and Eastern African Caracal), E) Lepus capensis (Cape Hare) and F) Hystrix africaeaustralis africaeaustralis (Southern Porcupine) feeding signs***

4 Site Ecological Importance and Ecosystem Processes

4.1 Environmental Screening Tool

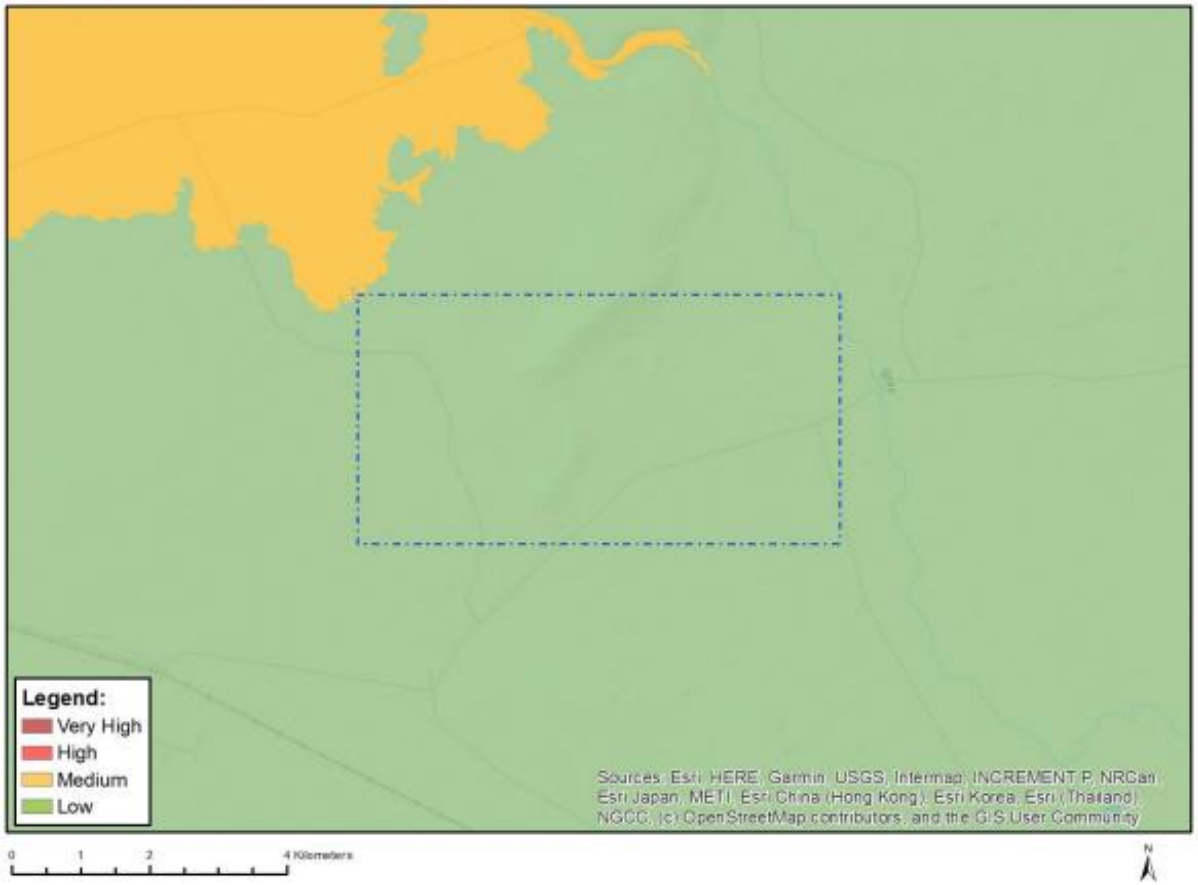
According to the Screening Tool Report generated (Regulation 16(1)(v) of the Environmental Impact Assessment Regulations 2014, as amended), the following sensitivity classifications were extracted from the National Web-based Environmental Screening Tool (Figure 4-1 to Figure 4-3):

- Combined Terrestrial Biodiversity Theme is Very High, due to overlap with CBA1, CBA2, ESA features;
- Plant Species Theme is Low; and
- Animal Species Theme is predominantly Medium.



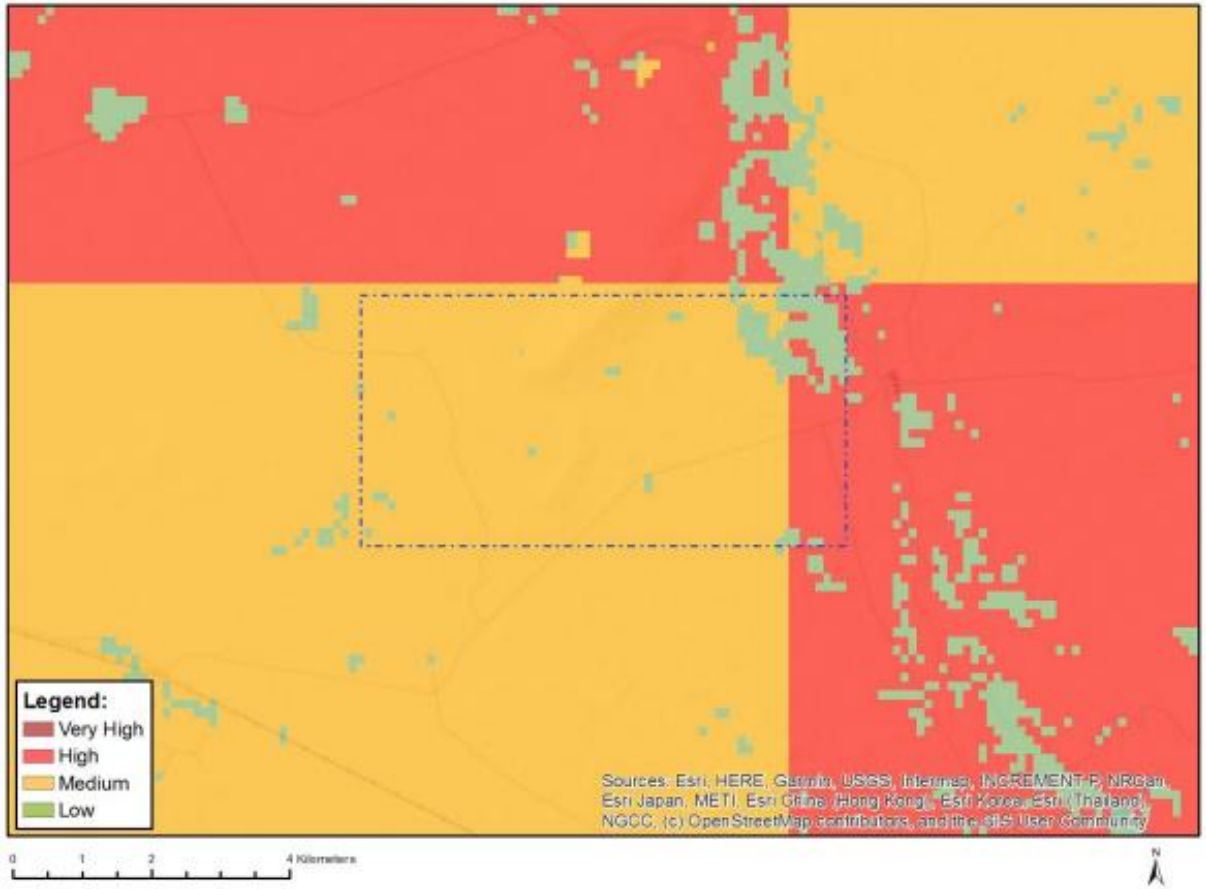
Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
X			

Figure 4-1 Relative Terrestrial Biodiversity Theme Sensitivity for the proposed Carolus Solar PV1 Facility PAOI



Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
			X

Figure 4-2 Relative Plant Species Theme Sensitivity for the proposed Carolus Solar PV1 Facility PAOI



Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
		X	

Figure 4-3 Relative Animal Species Theme Sensitivity for the proposed Carolus Solar PV1 Facility PAOI

4.2 Site Ecological Importance

Based on the criteria provided in section 2.4 of this report, all habitats within the PAOI were assigned a sensitivity category, i.e., a SEI category. The PAOI was categorised as possessing habitats possessing areas of 'Very Low', 'High' and 'Very High' SEI. (Table 4-1). This indicates that the findings of this assessment are congruent with the Screening Tool with respect to the Combined Terrestrial and Animal Species Theme sensitivity.

The SEI of the PAOI as well as lotic system buffers are illustrated in Figure 4-4. Based on the buffer recommendations as provided in Macfarlane *et al* (2009) a 50 m buffer was applied to the lotic systems traversing the PAOI. This is because these lotic systems play a critical role in maintaining connectivity within the landscape.

Photographs illustrating the habitat structure of the PAOI is provided in Figure 4-5. The guidelines for interpreting the SEI category within the context of the proposed development are provided in

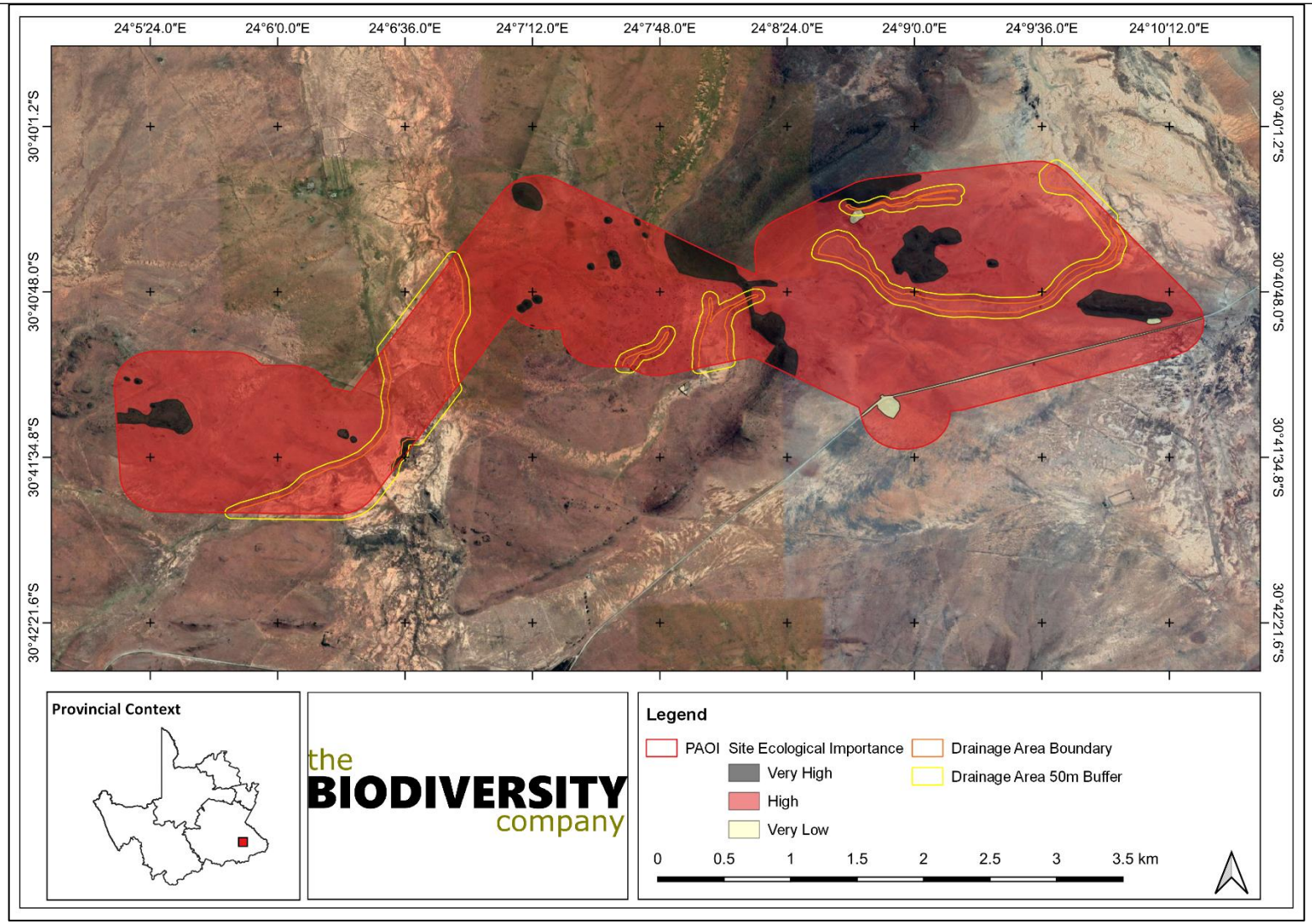


Figure 4-4 Map illustrating the Site Ecological Importance of the proposed Carolus Solar PV1 Facility PAOI

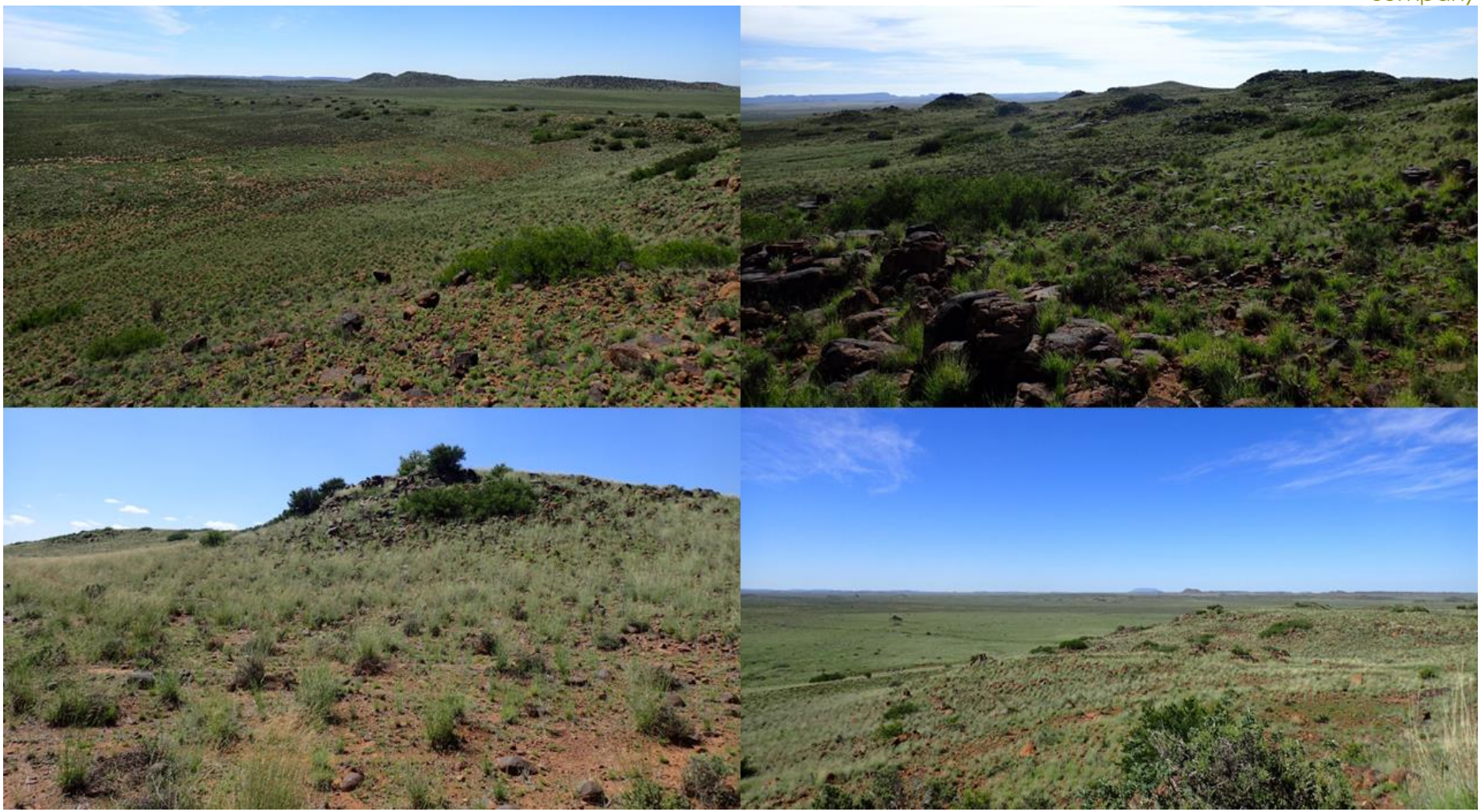


Figure 4-5 Photographs illustrating an overview of the physiognomy of the habitats present within the proposed Carolus Solar PV1 Facility PAOI which comprised of shrub-grass plains interspersed with Dolerite extrusions

Table 4-2 below.

Table 4-1 Summary of the proposed Carolus Solar PV1 Facility PAOI Site Ecological Importance

Conservation Importance	Functional Integrity	Biodiversity Importance	Receptor Resilience	Site Ecological Importance	Area (ha)
Medium Confirmed or highly likely occurrence of populations of NT species	High Large (> 20 ha but < 100 ha) intact area for any conservation status of ecosystem type. Good habitat connectivity with potentially functional ecological corridors and a regularly used road network between intact habitat patches.	High	Very Low Habitat that is unable to recover from major impacts, or species that are unlikely to remain at a site even when a disturbance or impact is occurring, or species that are unlikely to return to a site once the disturbance or impact has been removed.	Very High	82
Medium Confirmed or highly likely occurrence of populations of NT species	Very High Very large (> 100 ha) intact area for any conservation status of ecosystem type. High habitat connectivity serving as functional ecological corridors, limited road network between intact habitat patches.	High	Medium Will recover slowly (~ more than 10 years) to restore > 75% of the original species composition and functionality of the receptor functionality, or species that have a moderate likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a moderate likelihood of returning to a site once the disturbance or impact has been removed.	High	1 068
Very Low No confirmed and highly unlikely populations of SCC. No confirmed and highly unlikely populations of range-restricted species. No natural habitat remaining.	Low Almost no habitat connectivity but migrations still possible across some modified or degraded natural habitat and a very busy used road network surrounds the area.	Very Low	Very High Habitat that can recover rapidly (~ less than 5 years) to restore > 75%28 of the original species composition and functionality of the receptor functionality, or species that have a very high likelihood of remaining at a site even when a disturbance or impact is occurring, or species that have a very high likelihood of returning to a site once the disturbance or impact has been removed.	Very Low	8

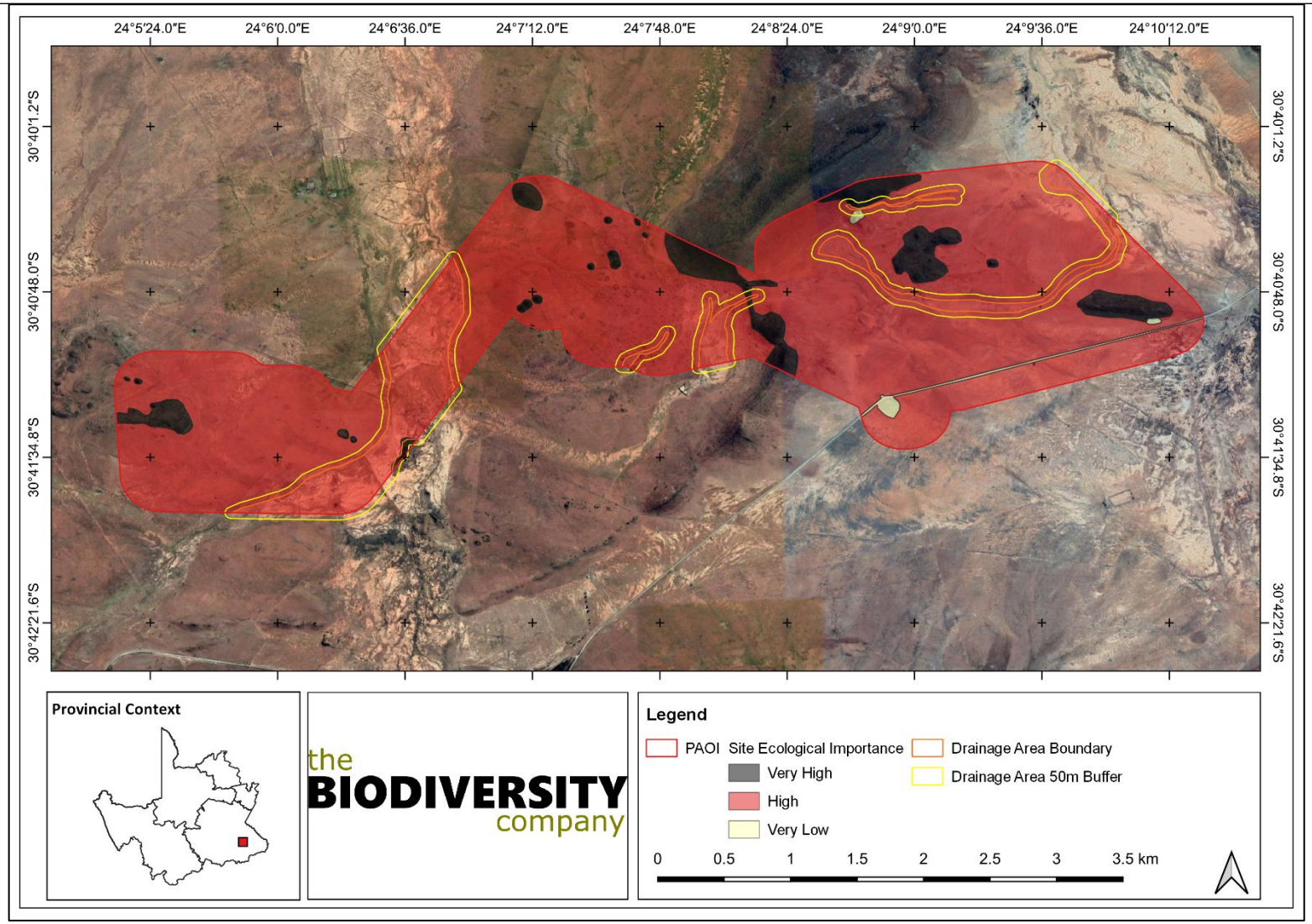


Figure 4-4 Map illustrating the Site Ecological Importance of the proposed Carolus Solar PV1 Facility PAOI

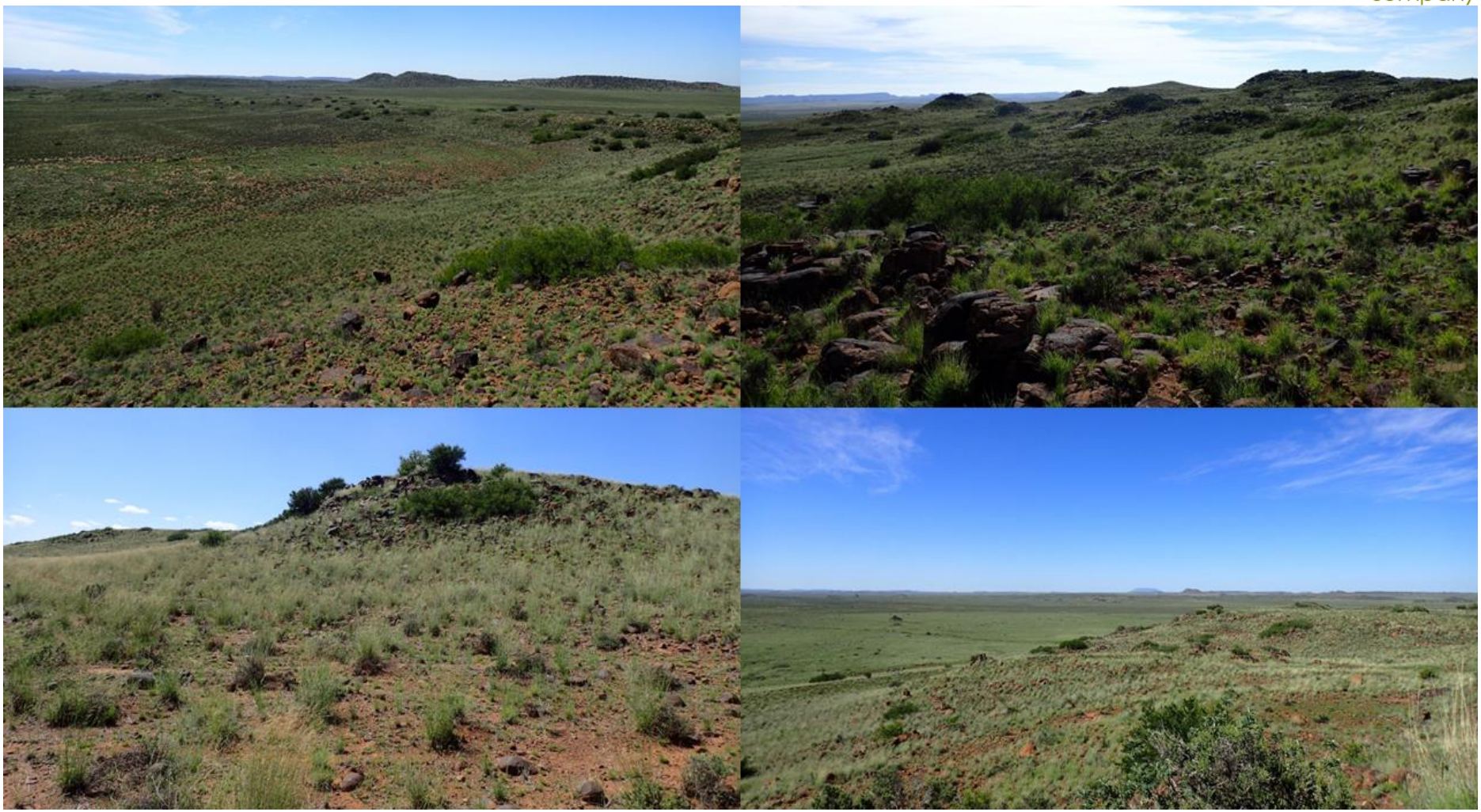


Figure 4-5 Photographs illustrating an overview of the physiognomy of the habitats present within the proposed Carolus Solar PV1 Facility PAOI which comprised of shrub-grass plains interspersed with Dolerite extrusions

Table 4-2 Guidelines for interpreting Site Ecological Importance in the context of the proposed development activities

Site Ecological Importance	Interpretation in relation to proposed development activities
Very High	Avoidance mitigation – no destructive development activities should be considered. Offset mitigation not acceptable/not possible (i.e., last remaining populations of species, last remaining good condition patches of ecosystems/unique species assemblages). Destructive impacts for species/ecosystems where persistence target remains.
High	Avoidance mitigation wherever possible. Minimisation mitigation – changes to project infrastructure design to limit the amount of habitat impacted, limited development activities of low impact acceptable. Offset mitigation may be required for high impact activities.
Very Low	Minimisation mitigation – development activities of medium to high impact acceptable and restoration activities may not be required.

4.3 Ecosystem Processes

The area provides an array of ecosystem services due to its inherent processes from its biotic components as well as its high level of functional integrity. Apart from the aforementioned hydrological provisioning services (as mentioned in section 3.1.1.5 the area is an NFEPA Upstream Management Area), additional ecosystem processes and concomitant services observed during the field survey are described below.

The Formicidae species *Messor capensis* (Figure 4-6) influences soil characteristics and plant growth via its tunnelling activity. The major physical change to the soils is the drier mound than inter-mound spaces, as although they permit greater water infiltration, they dry out faster due to less compaction and higher organic content. The chemical properties between mounds and inter-mound spaces also differ significantly, with mounds containing approximately 50% more phosphorous, potassium and nitrogen. This spatial discrepancy in soil physico-chemical properties therefore influences vegetation heterogeneity.

Mounds are also not static, with new mounds being developed around replacement entrances after disturbance by rainfall or feeding *O. afer afer*, thereby affecting wide areas. As aforementioned, the foraging activity of *O. afer afer* inadvertently distributes the nest seed stores with mound soil and considering that the mound soil possesses elevated nutrient content, it is likely to provide an improved germination material.

Figure 4-6 Photograph illustrating individuals of Messor capensis within the Carolus Solar PV1 Facility PAOI

Pollination is a critical ecosystem process that is required for the necessary recruitment levels of flora in order to maintain diversity and its concomitant ecosystem functioning. Pollination by several taxonomic groups was observed within the PAOI, with numerous interactions observed (Figure 4-7). Consequently, the PAOI provides important pollination services within the landscape. Therefore, any negative impacts to the pollinator community within the PAOI will have cascading ecosystem affects.

Figure 4-7 ***Photographs illustrating examples of the pollinators recorded within the Carolus Solar PV1 Facility PAOI. A) Belenois aurota aurota (Pieridae), B) Helicoverpa armigera (Noctuidae), C) Sarcophagidae (Diptera), D) Tylopaedia sardonyx ssp. sardonyx (Lycaenidae), E) Lepidochrysops patricia (Lycaenidae) and F) Dischista cincta (Cetoniini)***

During favourable weather conditions within the Nama Karoo biome, accelerated and elevated plant growth leads to the substantial increases in the abundance of 'outbreak' herbivorous insects. This population explosion of herbivorous insects, particularly Orthopterans and *Loxostele frustalis* (Lepidoptera: Crambidae), can lead to extensive areas of vegetation being defoliated. Studies of Orthopteran outbreaks revealed that they are cyclical, with peak outbreaks occurring at 17.3 years increments. Peak swarm irruptions are correlated with warm El Niño/Southern Oscillation (ENSO) climate events, which drives wet and dry cycles within southern Africa. Swarm outbreaks was linked to the amount of precipitation over the 12 months prior to the outbreak. Personal communication with property owners and residents of De Aar had indicated that higher than average rainfall was experienced prior to the survey period with flooding of the plains occurring. Some thunderstorms were also experienced during the survey period. However, this higher-than-average rainfall was vital as it had occurred subsequent to a prolonged drought period. Consequently, there was a substantial increase in plant growth with a concomitant population explosion of herbivorous insects encompassing several taxonomic groups (Figure 4-8).

Figure 4-8 Photographs illustrating a portion of the abundant herbivorous insects recorded within the Carolus Solar PV1 Facility PAOI

This abundance of insects provides a vital resource for higher trophic organisms, both invertebrate and vertebrate, in this arid landscape. The larvae of the diverse family Meloidae (Coleoptera) are important predators of Acrididae locust egg pods, including plague locusts, and during an outbreak their abundance increases considerably. The adults are plant-associated and feed on nectar, flowers or foliage. Meloidae usually lay their eggs close to where the first instar larvae are able to rapidly find a host by smell. Meloidae were ubiquitous within the PAOI. This group therefore provides an important ecosystem service by impeding the population of plague insects, and a negative shift in the population wellbeing of this group may lead to enhanced outbreaks of plague insects. In addition, although not considered within this assessment, insect outbreaks are important in providing nutritional resources for avifauna, which owing to their mobility, can respond to temporally and/or spatially variable outbreaks of invertebrates.

Figure 4-9 ***Photographs illustrating individuals of Meloidae (Coleoptera) recorded within the Carolus Solar PV1 Facility PAOI***

5 Impact Risk Assessment

The section below and associated tables serve to indicate and summarise the significance of perceived impacts on the terrestrial ecology of the project area.

5.1 Biodiversity Risk Assessment

Potential impacts were evaluated against the data captured during the desktop assessment to identify relevance to the project area. The relevant impacts associated with the proposed development were then subjected to a prescribed impact assessment methodology which were provided by Savannah Environmental and is available on request.

Anthropogenic activities drive habitat destruction causing displacement of fauna and flora and possibly direct mortality. Land clearing destroys local wildlife habitat and can lead to the loss of local breeding grounds, nesting sites and wildlife movement corridors such as rivers, streams and drainage lines, or other locally important features. The removal of natural vegetation may reduce the habitat available for fauna species and may reduce animal populations and species compositions within the area.

5.2 Present Impacts to Biodiversity

Considering the anthropogenic activities and influences within the landscape, several negative impacts to biodiversity were observed within the PAOI and the surrounding landscape. These include:

- Livestock grazing land-use;
- Persecution and trapping;
- Roads and associated vehicle traffic and road kills;
- Railway line;
- Existing Renewable Energy Facilities in the surrounding landscape; and
- Fence lines and predator-proof fences.

While all of these impacts were not necessarily within the PAOI, they would still affect species occupancy within the landscape.

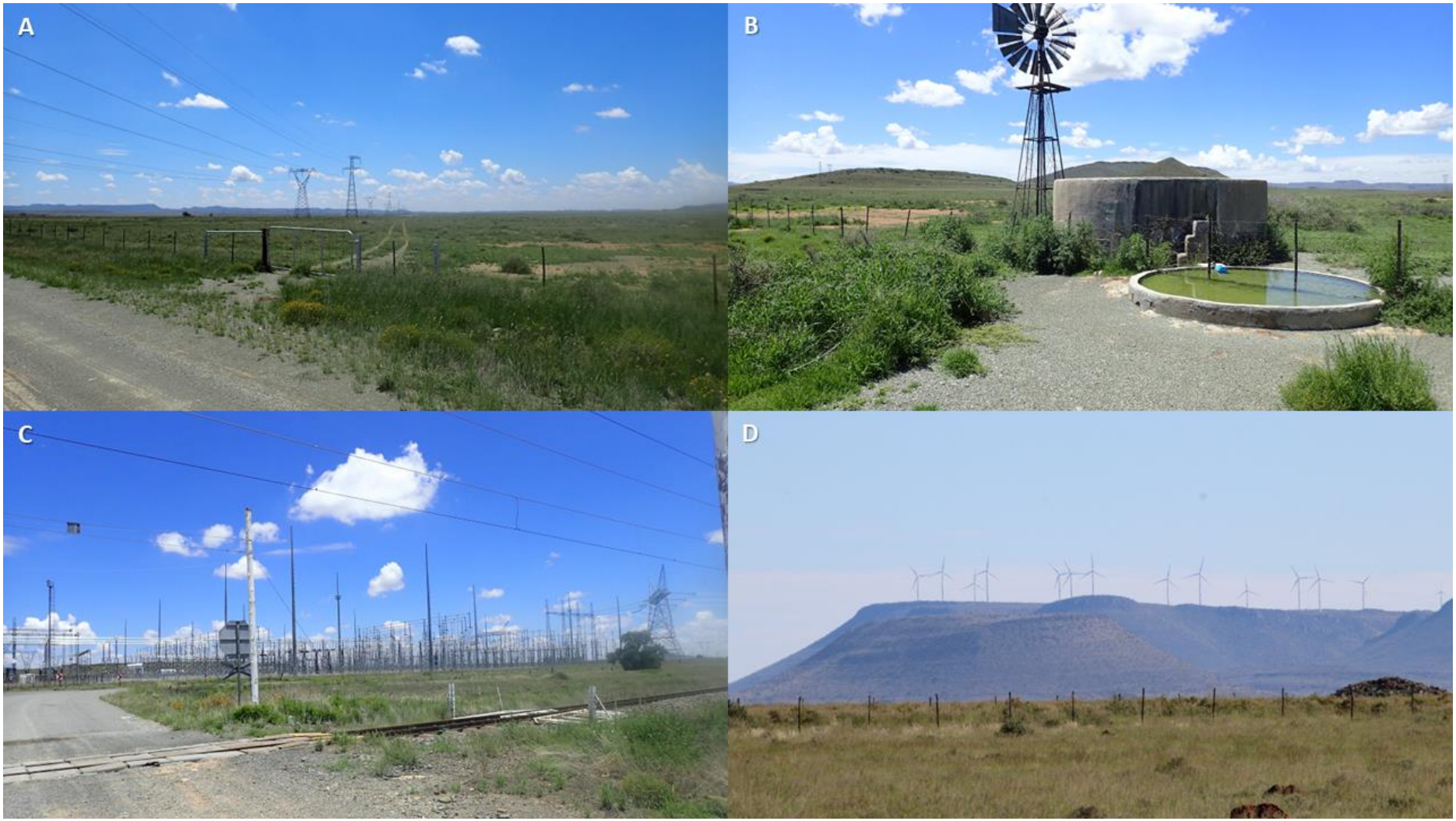


Figure 5-1 ***Photographs illustrating impacts to biodiversity within the proposed Carolus Solar PV Facility PAOI and surrounding landscape. A) Road and associated vehicle traffic, fence lines and pylons, B) Livestock agriculture, C) Railway line and energy distribution infrastructure and D) Renewable energy facilities***

5.3 Alternatives considered

No alternatives were provided for the development.

5.4 Loss of Irreplaceable Resources

- An ESA; and
- Potentially occurring SCC will also be lost.

5.5 Identification of Additional Potential Impacts

Bennun *et al* (2021) describes three broad types of impacts associated with solar energy development:

- Direct impacts – Impacts that result from project activities or operational decisions that can be predicted based on planned activities and knowledge of local biodiversity, such as habitat loss under the project footprint, habitat frag- mentation as a result of project infrastructure and species disturbance or mortality as a result of project operations;
- Indirect impacts – Impacts induced by, or 'by-products' of, project activities within a project's area of influence; and
- Cumulative impacts – Impacts that result from the successive, incremental and/or combined effects of existing, planned and/or reasonably anticipated future human activities in combination with project development impacts.

The ecosystem processes and biotic components influencing vegetation heterogeneity and wellbeing have been described in sections 3.2.2.3 and 4.3 of this report. The proposed development will lead to a loss in habitat for these biotic components and therefore, cause a negative shift in the wellbeing of the vegetation within the development footprint and proximal surrounding landscape.

Within southern Africa, a proportion of biomes, and the associated vegetation types, are dependent on the dynamics of fire to maintain ecosystem functioning and wellbeing. In contrast, fire in the western arid region of the Nama Karoo is extremely rare. Occasional fires may occur after successive years of good rainfall in combination with light grazing, resulting in an increased fuel load. Fire is potentially more common in the east along the southwestern edge of the Grassland Biome including the interface with this biome on the eastern mountains. The grasslands bordering the Nama Karoo biome are regarded as Dry Highveld Grassland. Inappropriate burning regimes are likely to have detrimental consequences to ecosystem structure and functioning. An appropriate fire management plant must therefore be developed and implemented. As rainfall and productivity are unpredictable, it is difficult to set out burning frequency rules for Dry Highveld Grassland; in general, and in the absence of more specific information, the following guidelines can be applied (SANBI, 2013):

- A burning interval of approximately 10 years should be applied; and
- Burning should take place in late winter, and only in seasons that have been wet enough to ensure enough biomass to support an intense fire.

Accidental fires from the proposed development that are not in accordance with these guidelines will lead to a negative shift in the wellbeing of the vegetation.

Information on the influence of habitat fragmentation on the pollinator community within the Nama Karoo Biome is lacking. However, it is known that fragmentation of other shrub- or graminoid-dominated vegetation communities leads to a loss in pollinator diversity and change in behaviour (Donaldson *et al*,

2002; Rusterholz & Baur, 2010; Zschokke *et al*, 2000). This leads to negative alterations in the reproductive success in terms of fruit set of particular plant species, or a group of plant species, thereby causing a negative shift in the flora species composition and diversity. Therefore, it is postulated that if the proposed development drives habitat fragmentation, it will lead to a negative shift in the diversity of the pollinator community. In addition, the use of pesticides will lead to substantial declines in the diversity of the pollinator community, leading to a considerable negative shift in the levels of flora recruitment and overall ecosystem functioning.

The potential impacts during the construction and operation phases of the proposed development are summarised in Table 5-1.

Table 5-1 Potential impacts to biodiversity associated with the proposed Carolus Solar PV1 Facility and Grid Connection Infrastructure

Main Impact	**Project activities that can cause loss of habitat**	**Secondary impacts anticipated**
Habitat Destruction	Physical removal of vegetation and surface grading for construction of the Solar Park.	• Displacement/loss of flora & fauna (including SCC) • Increased potential for soil erosion • Habitat fragmentation • Increased potential for establishment of alien & invasive vegetation
Main Impact	**Project activities that can cause the spread and/or establishment of alien and/or invasive species**	**Secondary impacts anticipated**
Spread and/or establishment of alien and/or invasive species into disturbed areas	Vegetation removal	• Habitat loss for indigenous flora & fauna (including potential SCC) • Spreading of potentially dangerous diseases due to invasive and pest species • Increased potential for soil erosion • Alteration of fauna assemblages due to habitat modification
	Vehicles potentially spreading seed	
	Unsanitary conditions surrounding infrastructure promoting the establishment of pest rodents	
Main Impact	**Project activities that can cause the direct mortality of fauna**	**Secondary impacts anticipated**
	Roadkill due to vehicle collision	• Loss of ecosystem services
	Intentional killing of fauna for food (hunting and persecution)	
Main Impact	**Project activities that can cause reduced dispersal/migration of fauna**	**Secondary impacts anticipated**
Reduced dispersal/migration of fauna	Loss of landscape used as corridor	• Loss of ecosystem services • Reduced plant seed dispersal • Reduced gene flow
	Removal of vegetation	
Main Impact	**Project activities that can cause emigration of fauna**	**Secondary impacts anticipated**
Emigration of fauna	Operation of machinery (Large earth moving machinery, generators)	• Loss of ecosystem services
	Reflection of solar panel arrays	
	Heavy vehicle use	
	Outside lighting	

5.6 Assessment of Impact Significance – Photovoltaic Facility

The assessment of impact significance was undertaken in consideration of the following:

- Extent of impact;
- Duration of impact;
- Magnitude of impact;

- Probability of impact; and
- Reversibility.

The assessment of impact significance considers pre-mitigation as well as implemented post-mitigation scenarios. Three phases were considered for the impact assessment:

- Construction Phase;
- Operational Phase; and
- Closure/Rehabilitation Phase.

5.6.1 Construction Phase

Impact Nature: Loss of habitat within development footprint		
There will be a loss of natural vegetation and habitat due to construction of the solar energy facility. This impact was considered for both the construction and operational phases.		
	Without mitigation	**With mitigation**
Extent	Low (2)	Low (2)
Duration	Long term (4)	Long term (4)
Magnitude	Very high (10)	Moderate (6)
Probability	Definite (5)	Definite (5)
Significance	High	Medium
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes, albeit to a limited extent.	
Mitigation:		
• Solar panels must be mounted on pile driven or screw foundations, such as post support spikes, rather than heavy foundations, such as trench-fill or mass concrete foundations, to reduce the negative effects on natural soil functioning, such as its filtering and buffering characteristics, while maintaining habitats for both fossorial and epigeic biodiversity (Bennun et al, 2021). If concrete foundations are used that would increase the impact of the project as there would be direct impacts to soil permeability and characteristics, thereby influencing inhabitant fauna. In addition, stormwater runoff and runoff from cleaning the panels would be increased, increasing erosion in the surrounding areas. • Indigenous vegetation to be maintained under the solar panels to ensure biodiversity is maintained and to prevent soil erosion (Beatty et al, 2017; Sinha et al, 2018). The photographs below are sourced from these documents.   • Vegetation clearing to commence only after the necessary permits have been obtained. • Environmental Officer (EO) to provide supervision and oversight of vegetation clearing activities.		
Residual Impacts:		
The loss of indigenous vegetation is an unavoidable consequence of the development and cannot be entirely mitigated. The residual impact would be moderate.		

Impact Nature: Degradation and loss of surrounding natural habitat		
Degradation and loss of surrounding natural vegetation arising from construction activities if these are allowed to penetrate into the surrounding area.		
	Without mitigation	**With mitigation**
Extent	Moderate (3)	Low (2)
Duration	Long term (4)	Very short term (1)
Magnitude	Moderate (6)	None (0)
Probability	Highly probable (4)	Improbable (2)
Significance	Medium	Low
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	
Mitigation:		
• All 'Very High' SEI habitats and buffer zones are to be avoided. • Pre-construction environmental induction for all construction staff on site to ensure that basic environmental principles are adhered to. This includes awareness of no littering, appropriate handling of pollution and chemical spills, avoiding fire hazards, remaining within demarcated construction areas etc. • All construction activity and roads to be within the clearly defined and demarcated areas. • Temporary laydown areas should be clearly demarcated and rehabilitated subsequent to end of use. • Appropriate dust control measures to be implemented. • Suitable sanitary facilities to be provided for construction staff as per the guidelines in Health and Safety Act. • All hazardous materials, if any, should be stored in the appropriate manner to prevent contamination of the site. Any accidental chemical, fuel and oil spills that occur at the site should be cleaned up in the appropriate manner.		
Residual Impacts:		
It is unlikely that residual impacts are expected if the appropriate mitigation measures are implemented. However, there may still be minimal degradation due to dust precipitation.		

Impact Nature: Direct mortality of fauna		
Construction activity will likely lead to direct mortality of fauna due to earthworks, vehicle collisions, accidental hazardous chemical spills and persecution.		
	Without mitigation	**With mitigation**
Extent	Moderate (3)	Low (2)
Duration	Short term (2)	Short term (2)
Magnitude	Moderate (6)	Minor (2)
Probability	Highly probable (4)	Improbable (2)
Significance	Medium	Low
Status (positive or negative)	Negative	Negative
Reversibility	Moderate	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes, vehicle collisions, poaching, and persecution can be mitigated.	
Mitigation:		
• All personnel and contractors must undergo Environmental Awareness Training and must include awareness about not harming or collecting species. • Prior to commencing work each day, two individuals should traverse the working area in order to disturb any fauna and so they have a chance to vacate.		

Impact Nature: Direct mortality of fauna
• Any fauna threatened by the construction activities should be removed safely by an appropriately qualified environmental officer or removal specialist. • All construction vehicles should adhere to a speed limit of maximum 40 km/h to avoid collisions. Appropriate speed control measures and signs must be erected. • All hazardous materials, if any, should be stored in the appropriate manner to prevent contamination of the site. Any accidental chemical, fuel and oil spills that occur at the site should be cleaned up in the appropriate manner. • Any excavations should not be left open for extended periods of time as fauna may fall in and become trapped in them. Excavations should only be dug when they are required and should be used and filled shortly thereafter.
Residual Impacts:
It is probable that some individuals of susceptible species will be lost to construction-related activities despite mitigation. However, this is not likely to impact the viability of the local population of any fauna species.

Impact Nature: Emigration of fauna due to noise pollution		
Construction activity will likely lead to the emigration of fauna due to noise pollution.		
	Without mitigation	**With mitigation**
Extent	Moderate (3)	Moderate (3)
Duration	Short term (2)	Short term (2)
Magnitude	Moderate (6)	Low (4)
Probability	Highly probable (4)	Highly probable (4)
Significance	Medium	Medium
Status (positive or negative)	Negative	Negative
Reversibility	Moderate	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes, but only to a limited extent. The mitigation of noise pollution during construction is difficult to mitigate against	
Mitigation:		
• Considering that many of the mammal fauna recorded within the project area are nocturnal, no construction activity is to occur at night.		
Residual Impacts:		
It is probable that some individuals of susceptible species will emigrate due to the noise generated from the construction activity. However, this is not likely to impact the viability of the local population of any fauna species.		

5.6.2 Operational Phase

Impact Nature: Loss of habitat within development footprint		
There will be a loss of natural vegetation and habitat due to construction of the solar energy facility. This impact was considered for both the construction and operational phases.		
	Without mitigation	**With mitigation**
Extent	Low (2)	Low (2)
Duration	Long term (4)	Long term (4)
Magnitude	Very high (10)	Moderate (6)
Probability	Definite (5)	Definite (5)
Significance	High	Medium
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No

Impact Nature: Loss of habitat within development footprint	
Can impacts be mitigated?	Yes, albeit to a limited extent.
Mitigation:	
• All 'Very High' SEI habitats and buffer zones are to be avoided. • Solar panels must be mounted on pile driven or screw foundations, such as post support spikes, rather than heavy foundations, such as trench-fill or mass concrete foundations, to reduce the negative effects on natural soil functioning, such as its filtering and buffering characteristics, while maintaining habitats for both below and above-ground biodiversity (Bennun et al, 2021). If concrete foundations are used that would increase the impact of the project as there would be direct impacts to soil permeability and characteristics, thereby influencing inhabitant fauna. In addition, stormwater runoff and runoff from cleaning the panels would be increased, increasing erosion in the surrounding areas. • Indigenous vegetation to be maintained under the solar panels to ensure biodiversity is maintained and to prevent soil erosion (Beatty et al, 2017; Sinha et al, 2018). The photographs below are sourced from these documents.   • Vegetation clearing to commence only after the necessary permits have been obtained. • Environmental Officer (EO) to provide supervision and oversight of vegetation clearing activities.	
Residual Impacts:	
The loss of indigenous vegetation is an unavoidable consequence of the development and cannot be entirely mitigated. The residual impact would be moderate.	

Impact Nature: Encroachment of Invasive Alien Plants into disturbed areas		
Invasive Alien Plants (IAPs) tend to encroach into disturbed areas and can outcompete/displace indigenous vegetation.		
	Without mitigation	**With mitigation**
Extent	Moderate (3)	Moderate (3)
Duration	Permanent (5)	Very short term (1)
Magnitude	High (8)	Minor (2)
Probability	Highly probable (4)	Improbable (2)
Significance	High	Low
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	
Mitigation:		
• An IAP Management Plan must be written and implemented for the development. The developer must contract a specialist to develop the plan and the developer is responsible for its implementation. • Regular monitoring for IAP encroachment during the operation phase to ensure that no alien invasion problems have developed as result of the disturbance. This should be every 3 months during the first two years of the operation phase and every six months for the life of the project. • All IAP species must be removed/controlled using the appropriate techniques as indicated in the IAP management plan.		
Residual Impacts:		
Based on the lack of IAPs within the development area and the implementation of an IAP Management Plan there are unlikely to be residual impacts		

Impact Nature: Continued habitat degradation and erosion due to improper stormwater and solid waste management		
Disturbance created during the construction phase will leave the development area vulnerable to erosion.		
	Without mitigation	**With mitigation**
Extent	Moderate (3)	Moderate (3)
Duration	Permanent (5)	Very short term (1)
Magnitude	High (8)	Minor (2)
Probability	Highly probable (4)	Improbable (2)
Significance	High	Low
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	
Mitigation:		
• Compile and implement a Solid Waste Management Plan. Waste management must be a priority and all waste must be collected, stored and disposed of adequately. It is recommended that all waste be removed from site on a weekly basis as a minimum. • A Rehabilitation Plan must be written for the development area and ensured that it be adhered to. • Access roads should have run-off control features which redirect water flow and dissipate any energy in the water which may pose an erosion risk. • All erosion observed should be rectified as soon as possible, using the appropriate erosion control structures and revegetation techniques. • There should be follow-up rehabilitation and re-vegetation of any remaining denuded areas with local indigenous perennial shrubs and succulents from the area.		
Residual Impacts:		
There is still the potential for erosion but would have a low impact.		

Impact Nature: Impacts to fauna movement patterns due to reflection effects		
The reflection caused by solar panels may affect the movement patterns of fauna within the landscape		
	Without Mitigation	**With Mitigation**
Extent	High (4)	High (4)
Duration	Long term (4)	Long term (4)
Magnitude	High (8)	Minor (2)
Probability	Probable (3)	Probable (3)
Significance	Medium	Low
Status	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes	
Mitigation:		
• Non-polarising white tape can be used around and/or across panels to minimise reflection (Bennun *et al*, 2021). The reflection caused by the panels attracts numerous insects as the panels are perceived as water bodies. This will negatively impact surrounding ecosystems due to the loss of biota and will result in an influx of fauna attempting to feed on the insects.		

Impact Nature: Impacts to fauna movement patterns due to reflection effects	
Residual Impacts	There is still the potential for reflection impacts but would have a low impact.

Impact Nature: Disturbance or persecution of fauna		
The operation and maintenance of the Solar Energy Facility may lead to disturbance or persecution of fauna in the vicinity of the development.		
	Without Mitigation	**With Mitigation**
Extent	Low (2)	Low (2)
Duration	Long term (4)	Very short term (1)
Magnitude	High (8)	Minor (2)
Probability	Probable (3)	Very improbable (1)
Significance	**Medium**	**Low**
Status	Negative	Negative
Reversibility	Moderate	High
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes	
Mitigation:		
• All personnel and contractors must undergo Environmental Awareness Training and must include awareness about not harming or collecting species. • Any fauna threatened by the maintenance and operational activities should be removed to a safe location by an appropriate individual. • All vehicles accessing the site should adhere to a max 40 km/h max to avoid collisions. Appropriate signs must be erected. • If any excavations are to be dug these must not be left open for more than a few hours without ramps for trapped fauna to leave and must be filled at night.		
Residual Impacts:		
Disturbance from maintenance activities will occur albeit at a low and infrequent level.		

5.6.3 Decommissioning/Rehabilitation Phase

Impact Nature: Direct mortality of fauna		
Decommissioning activity will likely lead to direct mortality of fauna due to earthworks, vehicle collisions and persecution.		
	Without mitigation	**With mitigation**
Extent	Moderate (3)	Low (2)
Duration	Short term (2)	Short term (2)
Magnitude	Moderate (6)	Mlinor (2)
Probability	Highly probable (4)	Improbable (2)
Significance	Medium	Low
Status (positive or negative)	Negative	Negative
Reversibility	Moderate	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes, vehicle collisions, poaching, and persecution can be mitigated.	
Mitigation:		

Impact Nature: Direct mortality of fauna
• All personnel should undergo environmental induction with regards to fauna and awareness about not harming or collecting species. • Prior to commencing work each day, two individuals should traverse the working area in order to disturb any fauna and so they have a chance to vacate. • Any fauna threatened by the construction activities should be removed safely by an appropriately qualified environmental officer or removal specialist. • All construction vehicles should adhere to a speed limit of maximum 40 km/h to avoid collisions. Appropriate speed control measures and signs must be erected. • All hazardous materials, if any, should be stored in the appropriate manner to prevent contamination of the site. Any accidental chemical, fuel and oil spills that occur at the site should be cleaned up in the appropriate manner. • Any excavations should not be left open for extended periods of time as fauna may fall in and become trapped in them. Excavations should only be dug when they are required and should be used and filled shortly thereafter.
Residual Impacts:
It is probable that some individuals of susceptible species will be lost to construction-related activities despite mitigation. However, this is not likely to impact the viability of the local population of any fauna species.

Impact Nature: Continued habitat degradation		
Disturbance created during decommissioning will leave the development area vulnerable to erosion and alien plant invasion for several years.		
	Without Mitigation	**With Mitigation**
Extent	Moderate (3)	Local (1)
Duration	Permanent (5)	Long-term (3)
Magnitude	Very High (5)	Minor (2)
Probability	Highly Probable (4)	Improbable (2)
Significance	High	Low
Status	Negative	Negative
Reversibility	Low	High
Irreplaceable loss of resources	Yes	No
Can impacts be mitigated?	Yes, with proper management and avoidance, this impact can be mitigated to a low level.	
Mitigation:		
• Rehabilitation in accordance with the Rehabilitation Plan for the development must be undertaken in areas disturbed during the decommissioning phase. • Monitoring of the rehabilitated area must be undertaken at quarterly intervals for 3 years after the decommissioning phase. • All erosion problems observed should be rectified as soon as possible, using the appropriate erosion control structures and revegetation techniques. • There should be follow-up rehabilitation and revegetation of any remaining bare areas with indigenous flora.		
Residual Impacts:		
No significant residual risks are expected, although IAP encroachment and erosion might still occur but would have a negligible impact if effectively managed.		

5.7 Assessment of Impact Significance – Grid Connection Infrastructure

The assessment of impact significance was undertaken in consideration of the following:

- Extent of impact;
- Duration of impact;

- Magnitude of impact;
- Probability of impact; and
- Reversibility.

The assessment of impact significance considers pre-mitigation as well as implemented post-mitigation scenarios. Three phases were considered for the impact assessment:

- Construction Phase;
- Operational Phase; and
- Closure/Rehabilitation Phase.

5.7.1 Construction Phase

Impact Nature: Loss of habitat within development footprint		
There will be a loss of natural vegetation and habitat due to placement of pylons and construction of the access road.		
	Without mitigation	**With mitigation**
Extent	Low (2)	Very Low (1)
Duration	Long term (4)	Long term (4)
Magnitude	Very high (10)	Moderate (6)
Probability	Definite (5)	Definite (5)
Significance	High	Medium
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	
Mitigation:		
• Demarcate work areas during the construction phase to avoid affecting outside areas. Use physical barriers e.g., safety tape and signage. • No infrastructure to be located within water resource buffer zones. • Do not clear areas of indigenous vegetation outside of the direct project footprint. • Minimise vegetation clearing to the minimum required. • Existing roads/servitudes should be considered first option over the construction of new roads/servitudes and must only be made where necessary. • Compile and implement a Rehabilitation Plan from the onset of the project. • Rehabilitate areas as soon as they are no longer impacted by construction. • The rehabilitated areas must be revegetated with indigenous vegetation. • Progressive rehabilitation will enable topsoil to be returned more rapidly, thus ensuring more recruitment from the existing seedbank. Surplus rehabilitation material can be applied to other others in need of stabilisation and vegetation cover.		
Residual Impacts:		
The loss of indigenous vegetation is an unavoidable consequence of the development and cannot be entirely mitigated. The residual impact would be low.		

Impact Nature: Habitat degradation and/or destruction due to encroachment of Invasive Alien Plants, poor solid waste management and erosion		
Habitat degradation and/or destruction is likely to occur due to invasive plant encroachment and erosion because of disturbance from vegetation clearing and earthworks. Improper solid waste management from construction activity will also lead to habitat degradation and/or destruction.		
	Without mitigation	**With mitigation**
Extent	Moderate (3)	Low (2)
Duration	Permanent (5)	Very short term (1)
Magnitude	Very High (10)	Minor (2)
Probability	Highly probable (4)	Improbable (2)
Significance	**High**	**Low**
Status (positive or negative)	Negative	Negative
Reversibility	Low	High
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	
Mitigation:		
• Compile and implement a Rehabilitation Plant. • Compile and implement an Invasive Alien Plant Management Programme. The plan must identify areas for action (if any) and prescribe the necessary removal methods and frequencies to be applied. This plan must also prescribe a monitoring plan and be updated as/when new data is collated. • Compile and implement a Solid Waste Management Plan. Waste management must be a priority and all waste must be collected, stored and disposed of adequately. It is recommended that all waste be removed from site on a weekly basis as a minimum.		
Residual Impacts:		
There is still potential for erosion and invasive plant encroachment but is likely to be limited.		

Impact Nature: Direct mortality of fauna		
Construction activity will likely lead to direct mortality of fauna due to earthworks, vehicle collisions and persecution.		
	Without mitigation	**With mitigation**
Extent	Moderate (3)	Low (2)
Duration	Short term (2)	Short term (2)
Magnitude	Moderate (6)	Mlinor (2)
Probability	Highly probable (4)	Improbable (2)
Significance	Medium	Low
Status (positive or negative)	Negative	Negative
Reversibility	Moderate	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes, vehicle collisions, poaching, and persecution can be mitigated.	
Mitigation:		

Impact Nature: Direct mortality of fauna
• All personnel should undergo environmental induction with regards to fauna and awareness about not harming or collecting species. • Prior to commencing work each day, two individuals should traverse the working area in order to disturb any fauna and so they have a chance to vacate. • Any fauna threatened by the construction activities should be removed safely by an appropriately qualified environmental officer or removal specialist. • All construction vehicles should adhere to a speed limit of maximum 40 km/h to avoid collisions. Appropriate speed control measures and signs must be erected. • All hazardous materials, if any, should be stored in the appropriate manner to prevent contamination of the site. Any accidental chemical, fuel and oil spills that occur at the site should be cleaned up in the appropriate manner. • Any excavations should not be left open for extended periods of time as fauna may fall in and become trapped in them. Excavations should only be dug when they are required and should be used and filled shortly thereafter.
Residual Impacts:
It is probable that some individuals of susceptible species will be lost to construction-related activities despite mitigation. However, this is not likely to impact the viability of the local population of any fauna species.

5.7.2 Operational Phase

Impact Nature: Encroachment of Invasive Alien Plants into disturbed areas		
Invasive Alien Plants (IAPs) tend to encroach into disturbed areas and can outcompete/displace indigenous vegetation.		
	Without mitigation	**With mitigation**
Extent	Moderate (3)	Moderate (3)
Duration	Permanent (5)	Very short term (1)
Magnitude	High (8)	Minor (2)
Probability	Highly probable (4)	Improbable (2)
Significance	High	Low
Status (positive or negative)	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	
Mitigation:		
• An IAP Management Plan must be written and implemented for the development. The developer must contract a specialist to develop the plan and the developer is responsible for its implementation. • Regular monitoring for IAP encroachment during the operation phase to ensure that no alien invasion problems have developed as result of the disturbance. This should be every 3 months during the first two years of the operation phase and every six months for the life of the project. • All IAP species must be removed/controlled using the appropriate techniques as indicated in the IAP management plan.		
Residual Impacts:		
With the implementation of an IAP Management Plan there are unlikely to be residual impacts		

Impact Nature: Direct mortality of fauna		
Maintenance of infrastructure during the operational phase will likely lead to direct mortality of fauna due to earthworks, vehicle collisions and persecution.		
	Without mitigation	**With mitigation**
Extent	Moderate (3)	Low (2)
Duration	Short term (2)	Short term (2)
Magnitude	Moderate (6)	Mlinor (2)
Probability	Highly probable (4)	Improbable (2)

Impact Nature: Direct mortality of fauna		
Significance	Medium	Low
Status (positive or negative)	Negative	Negative
Reversibility	Moderate	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes, vehicle collisions, poaching, and persecution can be mitigated.	
Mitigation:		
• All personnel and contractors must undergo Environmental Awareness Training and must include awareness about not harming or collecting species. • All vehicles should adhere to a speed limit of maximum 40 km/h to avoid collisions. Appropriate speed control measures and signs must be erected. • Any excavations should not be left open for extended periods of time as fauna may fall in and become trapped in them. Excavations should only be dug when they are required and should be used and filled shortly thereafter.		
Residual Impacts:		
It is probable that some individuals of susceptible species will be lost to maintenance-related activities despite mitigation. However, this is not likely to impact the viability of the local population of any fauna species.		

5.7.3 Decommissioning/Rehabilitation Phase

Impact Nature: Direct mortality of fauna		
Decommissioning activity will likely lead to direct mortality of fauna due to earthworks, vehicle collisions and persecution.		
	Without mitigation	**With mitigation**
Extent	Moderate (3)	Low (2)
Duration	Short term (2)	Short term (2)
Magnitude	Moderate (6)	Mlinor (2)
Probability	Highly probable (4)	Improbable (2)
Significance	Medium	Low
Status (positive or negative)	Negative	Negative
Reversibility	Moderate	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes, vehicle collisions, poaching, and persecution can be mitigated.	
Mitigation:		
• All personnel should undergo environmental induction with regards to fauna and awareness about not harming or collecting species. • Prior to commencing work each day, two individuals should traverse the working area in order to disturb any fauna and so they have a chance to vacate. • Any fauna threatened by the construction activities should be removed safely by an appropriately qualified environmental officer or removal specialist. • All construction vehicles should adhere to a speed limit of maximum 40 km/h to avoid collisions. Appropriate speed control measures and signs must be erected. • All hazardous materials, if any, should be stored in the appropriate manner to prevent contamination of the site. Any accidental chemical, fuel and oil spills that occur at the site should be cleaned up in the appropriate manner. • Any excavations should not be left open for extended periods of time as fauna may fall in and become trapped in them. Excavations should only be dug when they are required and should be used and filled shortly thereafter.		
Residual Impacts:		
It is probable that some individuals of susceptible species will be lost to construction-related activities despite mitigation. However, this is not likely to impact the viability of the local population of any fauna species.		

Impact Nature: Continued habitat degradation		
Disturbance created during decommissioning will leave the development area vulnerable to erosion and alien plant invasion for several years.		
	Without Mitigation	**With Mitigation**
Extent	Moderate (3)	Local (1)
Duration	Permanent (5)	Long-term (3)
Magnitude	Very High (5)	Minor (2)
Probability	Highly Probable (4)	Improbable (2)
Significance	High	Low
Status	Negative	Negative
Reversibility	Low	High
Irreplaceable loss of resources	Yes	No
Can impacts be mitigated?	Yes, with proper management and avoidance, this impact can be mitigated to a low level.	
Mitigation:		
• Rehabilitation in accordance with the Rehabilitation Plan for the development must be undertaken in areas disturbed during the decommissioning phase. • Monitoring of the rehabilitated area must be undertaken at quarterly intervals for 3 years after the decommissioning phase. • All erosion problems observed should be rectified as soon as possible, using the appropriate erosion control structures and revegetation techniques. • There should be follow-up rehabilitation and revegetation of any remaining bare areas with indigenous flora. • Implementation of a Solid Waste Management Plan.		
Residual Impacts:		
No significant residual risks are expected, although IAP encroachment and erosion might still occur but would have a negligible impact if effectively managed.		

5.8 Cumulative Impacts

The impacts of projects are often assessed by comparing the post-project situation to a pre-existing baseline. Where projects can be considered in isolation this provides a good method of assessing a project's impact. However, in areas where baselines have already been affected, or where future development will continue to add to the impacts in an area or region, it is appropriate to consider the cumulative effects of development. This is similar to the concept of shifting baselines, which describes how the environmental baseline at a point in time may represent a significant change from the original state of the system.

This section describes the cumulative potential impacts of the project on biodiversity. Cumulative impacts are assessed in context of the extent of the proposed development area, other developments in the area, as well as general habitat loss and transformation resulting from other activities in the area.

Presently, the surrounding immediate and broader landscape consists of natural vegetation used for supporting livestock and to a lesser extent game. The Phase 1 and Phase 2 REDZs spatial files and the South African Renewable Energy EIA Application Database (DFFEb, 2021) was overlaid onto the Northern Upper Karoo remnants layer. The remnants layer was released as part of the NBA (Skowno *et al*, 2019) and provides the present spatial extent of vegetation. The South African Renewable Energy EIA Application Database contains spatial data for renewable energy applications for environmental authorisation. It includes spatial and attribute information for both active (in process and with valid authorisations) and non-active (lapsed or replaced by amendments) applications. Data is captured and managed on a parcels level as well as aggregated to the project level at the boundary level. Considering

the limited extent of approved and in process developments within the Northern Upper Karoo and its 'Not Protected' EPL (Figure 5-2), the expected cumulative impact is expected to be of a 'Medium' significance.

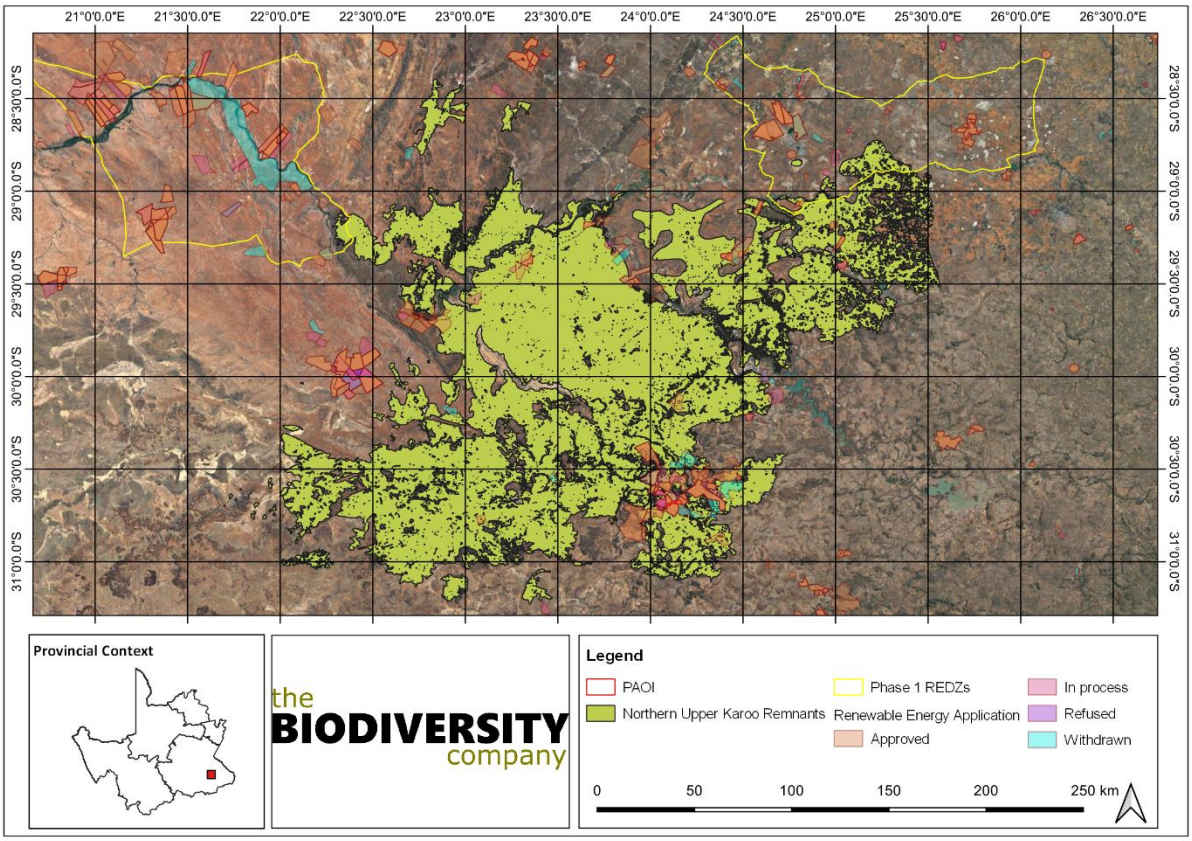


Figure 5-2 Map illustrating additional renewable energy developments within the Northern Upper Karoo vegetation type

Impact Nature: Cumulative habitat loss within the region		
The development of the proposed Carolus Solar PV1 Facility will contribute to cumulative habitat loss within the Northern Upper Karoo and Ecological Support Areas		
	Overall impact of the proposed development considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Very low (1)	Low (2)
Duration	Long term (4)	Long term (4)
Magnitude	Low (4)	Low (4)
Probability	Highly Probable (4)	Highly Probable (4)
Significance	Medium	Medium
Status	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	No	Yes, in certain cases
Can impacts be mitigated	Yes, to some degree. However, should the entirety of the REDZ areas be developed, the cumulative impacts on the receiving environment will be regarded as 'High'.	
Mitigation: Ensure that a rehabilitation plan and IAP management plan be compiled for each development and are effectively implemented. Set-aside areas (Avoidance areas) should be established in order to conserve natural habitats where possible.		

5.9 Unplanned Events

The planned activities will have known impacts as discussed above; however, unplanned events may occur on any project and may have potential impacts which will need mitigation and management.

Table 5-2 is a summary of the findings of an unplanned event assessment from a terrestrial ecology perspective. Note, not all potential unplanned events may be captured herein, and this must therefore be managed throughout all phases according to recorded events.

Table 5-2 Summary of unplanned events for terrestrial biodiversity

Unplanned Event	Potential Impact	Mitigation
Hydrocarbon spills into the surrounding environment from heavy machinery during the construction phase	Contamination of soil leading to mortality of flora and fauna.	A spill response kit must always be available. The incident must be reported on and if necessary, a biodiversity specialist must investigate the extent of the impact and provide rehabilitation recommendations.
Fire	Uncontrolled/unmanaged fire that spreads to surrounding natural habitats that result in habitat destruction and fauna mortality. Although fires are a feature of savannah habitats, incorrect timing of the fire can have considerably negative effects.	Appropriate/Adequate fire management plan needs to be implemented.

5.10 Biodiversity Impact Management Actions

The purpose of the Biodiversity Impact Management Actions to inform on the mitigations required to lower the risk of the impacts associated with the proposed activity, provide measures for improving the conservation value of the property and to be able to be inserted into the Environmental Management Programme (EMPr). The mitigation actions required to reduce the significance of the impacts associated with the development are provided in **Error! Not a valid bookmark self-reference.**.

Table 5-3 The Biodiversity Impact Management Actions for the proposed Carolus Solar PV1 Facility and associated grid connection infrastructure

Impact Management Actions	Implementation		Monitoring	
	Phase	Responsible Party	Aspect	Frequency
Management outcome: Vegetation and Habitats				
The areas to be developed must be specifically demarcated to prevent movement into surrounding environments. All destructive infrastructure is to be avoided in 'Very High' SEI areas and water resource buffers.	Life of operation	Project Manager Environmental Officer	Development footprint	Ongoing
Areas of indigenous vegetation, even secondary communities outside of the direct project footprint, should under no circumstances be fragmented or disturbed further.	Life of operation	Project Manager Environmental Officer	Areas of indigenous vegetation	Ongoing
Solar panels must be mounted on pile driven or screw foundations, such as post support spikes, rather than heavy foundations, such as trench-fill or mass concrete foundations, to reduce the negative effects on natural soil functioning, such as its filtering and buffering characteristics, while maintaining habitats for both below and above-ground biodiversity	Life of operation	Project Manager Environmental Officer	Development footprint	Ongoing
Indigenous vegetation to be maintained under the solar panels to ensure biodiversity is maintained and to prevent soil erosion (Beatty et al, 2017; Sinha et al, 2018).	Life of operation	Project Manager Environmental Officer	Areas of indigenous vegetation	Ongoing
Compile and implement a Rehabilitation Plan. Areas that are denuded during construction need to be re-vegetated with indigenous vegetation to prevent erosion. This will also reduce the likelihood of encroachment by alien invasive plant species. Topsoil must also be utilised, and any disturbed area must be re-vegetated with plant and grass species which are indigenous to this vegetation type.	Decommissioning /Rehabilitation	Project Manager Environmental Officer	Assess the state of rehabilitation and encroachment of alien vegetation and erosion	Quarterly for up to three years after the closure
A hydrocarbon spill management plan must be put in place to ensure that should there be any chemical spill out or over that it does not run into the surrounding areas. The Contractor shall be in possession of an emergency spill kit that must always be complete and available on site. Drip trays or any form of oil absorbent material must be placed underneath vehicles/machinery and equipment when not in use. No	Life of operation	Environmental Officer Contractor	Spill events, Vehicles dripping.	Ongoing

Impact Management Actions	Implementation		Monitoring	
	Phase	Responsible Party	Aspect	Frequency
servicing of equipment on site unless necessary. All contaminated soil / yard stone shall be treated *in situ* or removed and be placed in containers. Appropriately contain any generator diesel storage tanks, machinery spills (e.g., accidental spills of hydrocarbons oils, diesel etc.) in such a way as to prevent them leaking and entering the environment.				
Leaking equipment and vehicles must be repaired immediately or be removed from project area to facilitate repair.	Life of operation	Environmental Officer Contractor	Leaks and spills	Ongoing
A fire management plan needs to be complied to restrict the impact of fire. This is especially concerning stochastic fire events such as discarding of lit cigarette butts and/or glowing embers from cooking fires.	Life of operation	Environmental Officer Contractor	Fire Management	During Phase
Management outcome: Fauna				
Impact Management Actions	Implementation		Monitoring	
	Phase	Responsible Party	Aspect	Frequency
Noise must be kept to an absolute minimum during the evenings and at night to minimize all possible disturbances to amphibian species and nocturnal mammals	Construction	Environmental Officer	Noise levels	Ongoing
No trapping, killing, or poisoning of any wildlife is to be allowed Signs must be put up to enforce this and must be made a punishable offence	Life of operation	Environmental Officer	Evidence of trapping, dead animals, etc.	Ongoing
The duration of the construction should be minimized to as short term as possible, to reduce the period of disturbance on fauna	Construction/Operational	Project Manager Environmental Officer	Construction/Closure Phase	Ongoing
Outside lighting should be designed and limited to minimize impacts on fauna. Fluorescent and mercury vapor lighting should be avoided, and sodium vapor (yellow) lights should be used wherever possible.	Construction/Operational	Project Manager Environmental Officer	Light pollution and period of light.	Ongoing
Wildlife friendly fences must be incorporated into the design. A tunnel underpass of a height of 500 mm will be acceptable for small mammals. Pre-fabricated concrete elements are appropriate for rectangular tunnels. Metal pipes must be avoided. This will also ensure fences are not damaged by burrowing activity.	Operational	Project Manager Environmental Officer Design Engineer	Fauna movement	Ongoing
Management outcome: Invasive Alien Species				
Impact Management Actions	Implementation		Monitoring	
	Phase	Responsible Party	Aspect	Frequency
Compilation of and implementation of an Invasive Alien Plant Management Plan	Life of operation	Project Manager Environmental Officer	Assess presence and encroachment of alien vegetation	Quarterly monitoring

Impact Management Actions	Implementation		Monitoring	
	Phase	Responsible Party	Aspect	Frequency
A pest control plan must be put in place and implemented; it is imperative that poisons not be used due to the presence of indigenous fauna.	Life of operation	Environmental Officer Health and Safety Officer	Evidence or presence of pests	Ongoing
Management outcome: Dust				
Impact Management Actions	Implementation		Monitoring	
	Phase	Responsible Party	Aspect	Frequency
Reducing the dust generated by construction activities, especially the earth moving machinery, through wetting the soil surface (with "dirty water") and putting up signs to enforce speed limit as well as speed.	Life of operation	Project Manager Environmental Officer	Dust pollution levels	Ongoing
Management outcome: Waste Management				
Impact Management Actions	Implementation		Monitoring	
	Phase	Responsible Party	Aspect	Frequency
Waste management must be a priority and all waste must be collected and stored adequately. Refuse bins must be secured. Temporary storage of domestic waste shall be in covered waste skips.	Life of operation	Environmental Officer Health and Safety Officer	Presence of waste	Life of operation
The ratio of toilets to staff must be provided as per the requirements in the Health and Safety Act. Portable toilets must be pumped dry to ensure the system does not degrade over time and spill into the surrounding area.	Life of operation	Environmental Officer Health and Safety Officer	Number of toilets per staff member. Waste levels	Daily
Refuse bins must be secured. Temporary storage of domestic waste shall be in covered waste skips. Maximum domestic waste storage period will be 10 days.	Life of operation	Environmental Officer Contractor Health and Safety Officer	Management of bins and collection of waste	Ongoing, every 10 days
All solid waste collected shall be disposed of at a licensed disposal facility. Under no circumstances may domestic waste be burned on site	Life of operation	Environmental Officer Health and Safety Officer	Availability of bins and the collection of the waste.	Ongoing
Management outcome: Environmental Awareness Training				
Impact Management Actions	Implementation		Monitoring	
	Phase	Responsible Party	Aspect	Frequency
All personnel and contractors to undergo Environmental Awareness Training. A signed register of attendance must be kept for proof. Discussions are required on sensitive environmental receptors within the project area to inform contractors and site staff on the importance,	Life of operation	Health and Safety Officer	Compliance to the training.	Ongoing

Impact Management Actions	Implementation		Monitoring	
	Phase	Responsible Party	Aspect	Frequency
biology, habitat requirements and management requirements of the Environmental Authorisation.				
Management outcome: Erosion				
Impact Management Actions	Implementation		Monitoring	
	Phase	Responsible Party	Aspect	Frequency
Appropriate drainage must be constructed along the access roads in order to slow the flow of water run-off from the road surface.	Operational	Project Manager Design Engineer	Water runoff from road surfaces	Ongoing
Areas that are denuded during construction that do not have infrastructure during the operational phase must be re-vegetated with indigenous vegetation to prevent erosion.	Operational	Project Manager Environmental Officer	Re-establishment of indigenous vegetation	Quarterly for the first 2 years. Thereafter, annually for the life of the project
A row of indigenous trees can be planted along the boundary to act as wind break to impede erosion.	Operational	Project Manager Environmental Officer	Re-establishment of indigenous vegetation	Quarterly for the first 2 years. Thereafter, annually for the life of the project
All areas affected by the development must be re-vegetated with indigenous vegetation to prevent erosion on an extensive temporal scale.	Rehabilitation	Project Manager Environmental Officer	Re-establishment of indigenous vegetation	Quarterly for 3 years after decommissioning

6 Conclusion and Impact Statement

6.1 Conclusion

The aim of this Biodiversity Impact Assessment was to provide information to guide the risk of the proposed Carolus Solar PV1 Facility and associated grid connection infrastructure to the ecosystems affected by its development and their inherent fauna and flora.

Based on the latest available ecologically relevant spatial data the following information is pertinent to the project area:

- It is recognised as an Ecological Support Area as per the Northern Cape Critical Biodiversity Areas spatial database;
- The Combined Terrestrial Biodiversity Theme Sensitivity was rated as 'Very High' according to the Environmental Screening Tool;
- The Ecosystem Protection Level for the vegetation type associated with the development footprint is regarded as Not Protected; and
- It is regarded as an Upstream Management Area according to the NFEPA database.

The habitat physiognomy within the PAOI is diverse and, based on the fauna components recorded within the PAOI and proximal landscape, the area provides important ecosystem services, particularly with regards to the maintenance of dynamic soil properties and pollination services. The SEI of the PAOI was determined to vary from 'Very Low' to 'Very High' based on the high likelihood of occurrence for NT species, the extent of the area considered and its connectivity to natural areas within the landscape, and the low resilience of the vegetation type.

6.2 Impact Statement

The main expected impacts of the proposed Carolus Solar PV1 Facility and associated grid connection infrastructure will be the loss of habitat and emigration of fauna. Based on the outcomes of the SEI determination, there are areas within the PAOI that possess a 'Very High' SEI. This denotes that avoidance mitigation is the only appropriate option for these areas and no destructive development activities should be considered.

There are areas within the PAOI that possess a 'High' SEI. This denotes that avoidance mitigation wherever possible must be implemented. This includes changes to project infrastructure design to limit the amount of habitat impacted. Moreover, the avoidance and minimisation mitigation measures are the most important with respect to the mitigation hierarchy (Figure 6-1).

In order to evaluate the extent of 'avoidance' achieved for the project, the following is noteworthy:

- The total extent of the entire project area is 8 200 ha;
- The footprint of the Carolus Solar PV1 is 285 ha, thus in isolation approximately 3% of the total project area will be developed; and
- The footprint areas for the four proposed solar facilities amounts to 2 103 ha, thus approximately 26% of the total project area will be developed.

Taking into consideration the extent of 'avoidance' achieved for the project, it is the opinion of the specialist that the authorisation of the proposed project may be favourably considered, under condition that all mitigation and impact management actions provided within this report are implemented. It is

recommended that should any future developments be proposed for the remaining extent of any 'Very High' or 'High' SEI areas within the associated properties, that offset strategies be required for these authorisations.

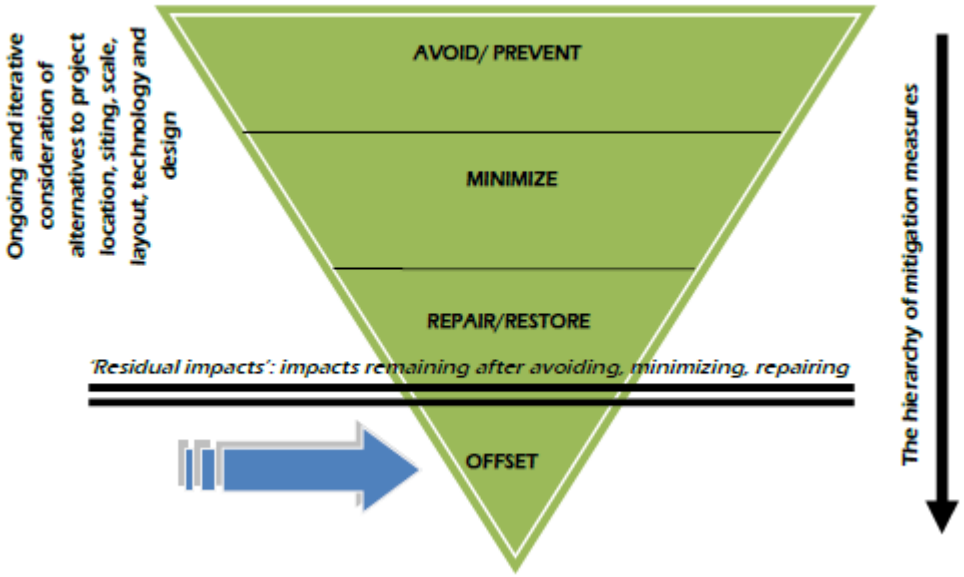


Figure 6-1 Schematic diagram illustrating the mitigation hierarchy indicating where residual impacts are considered. Source: (DFFE, 2021d)

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8 Appendix Items

8.1 Appendix A – Protocol Checklist

"Protocol for the Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Terrestrial Biodiversity" gazetted 20 March 2020, published in Government Notice No. 320

Paragraph	Item	Pages	Comment
2.1	The assessment must be prepared by a specialist registered with the South African Council for Natural Scientific Professionals (SACNASP) with expertise in the field of terrestrial biodiversity.	i	
2.2	The assessment must be undertaken on the preferred site and within the proposed development footprint.	5, 12	
2.3.1	A description of the ecological drivers or processes of the system and how the proposed development will impact these.	23, 35, 44, 51	
2.3.2	Ecological functioning and ecological processes (e.g., fire, migration, pollination, etc.) that operate within the preferred site	23, 35, 44, 51	
2.3.3	The ecological corridors that the proposed development would impede including migration and movement of flora and fauna.	21-22	
2.3.4	The description of any significant terrestrial landscape features (including rare or important flora-faunal associations, presence of strategic water source areas (SWSAs) or freshwater ecosystem priority area (FEPA) sub catchments.	22-23	
2.3.5	A description of terrestrial biodiversity and ecosystems on the preferred site, including: (a) main vegetation types; (b) threatened ecosystems, including listed ecosystems as well as locally important habitat types identified.	18-20, 23-25	
2.3.6	The assessment must identify any alternative development footprints within the preferred site which would be of a "low" sensitivity as identified by the screening tool and verified through the site sensitivity verification.	-	No "low" sensitivity areas suitable for development were identified due to the ecological condition of the site.
2.3.7.1	Terrestrial Critical Biodiversity Areas (CBAs), including: (a) the reasons why an area has been identified as a CBA; (b) an indication of whether or not the proposed development is consistent with maintaining the CBA in a natural or near natural state or in achieving the goal of rehabilitation; (c) the impact on species composition and structure of vegetation with an indication of the extent of clearing activities in proportion to the remaining extent of the ecosystem type(s); (d) the impact on ecosystem threat status; (e) the impact on explicit subtypes in the vegetation; (f) the impact on overall species and ecosystem diversity of the site; and (g) the impact on any changes to threat status of populations of species of conservation concern in the CBA.	-	No CBAs recorded within the assessment area
2.3.7.2	Terrestrial ecological support areas (ESAs), including: (a) the impact on the ecological processes that operate within or across the site; (b) the extent the proposed development will impact on the functionality of the ESA; and (c) loss of ecological connectivity (on site, and in relation to the broader landscape) due to the degradation and severing of ecological corridors or introducing barriers that impede migration and movement of flora and fauna.	21-22	
2.3.7.3	Protected areas as defined by the National Environmental Management: Protected Areas Act, 2004 including- (a) an opinion on whether the proposed development aligns with the objectives or purpose of the protected area and the zoning as per the protected area management plan.	20-21	
2.3.7.4	Priority areas for protected area expansion, including-	-	Does not overlap NPAES areas

	(a) the way in which in which the proposed development will compromise or contribute to the expansion of the protected area network.		
2.3.7.5	SWSAs including: (a) the impact(s) on the terrestrial habitat of a SWSA; and (b) the impacts of the proposed development on the SWSA water quality and quantity (e.g. describing potential increased runoff leading to increased sediment load in water courses)	-	Does not overlap a SWSA
2.3.7.6	FEPA sub catchments, including- (a) the impacts of the proposed development on habitat condition and species in the FEPA sub catchment	22-23	
2.3.7.7	indigenous forests, including: (a) impact on the ecological integrity of the forest; and (b) percentage of natural or near natural indigenous forest area lost and a statement on the implications in relation to the remaining areas.	-	No forest habitats within the area
3.1.1.	Contact details of the specialist, their SACNASP registration number, their field of expertise and a curriculum vitae.	Cover page i	
3.1.2	A signed statement of independence by the specialist.	86	
3.1.3	A statement on the duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment.	5, 12	
3.1.4	A description of the methodology used to undertake the site verification and impact assessment and site inspection, including equipment and modelling used, where relevant.	12-14	
3.1.5	A description of the assumptions made and any uncertainties or gaps in knowledge or data as well as a statement of the timing and intensity of site inspection observations.	5	
3.1.6	A location of the areas not suitable for development, which are to be avoided during construction and operation (where relevant).	41-42	
3.1.7	Additional environmental impacts expected from the proposed development.	51-52	
3.1.8	Any direct, indirect and cumulative impacts of the proposed development.	52-66	
3.1.9	The degree to which impacts and risks can be mitigated.	52-66	
3.1.10	The degree to which the impacts and risks can be reversed.	52-66	
3.1.11	The degree to which the impacts and risks can cause loss of irreplaceable resources.	52-66	
3.1.12	Proposed impact management actions and impact management outcomes proposed by the specialist for inclusion in the Environmental Management Programme (EMPr).	67-70	
3.1.13	A motivation must be provided if there were development footprints identified as per paragraph 2.3.6 above that were identified as having a “low” terrestrial biodiversity sensitivity and that were not considered appropriate.	-	N/A
3.1.14	A substantiated statement, based on the findings of the specialist assessment, regarding the acceptability, or not, of the proposed development, if it should receive approval or not;	71-72	
3.1.15	any conditions to which this statement is subjected	71-72	

8.2 Appendix B – Flora species expected to occur in the project area

Family	Species Name	Conservation Status	Endemism
Aizoaceae	*Mesembryanthemum coriarium*	LC	
Aizoaceae	*Oscularia deltoides*	LC	Endemic
Aizoaceae	*Tetragonia fruticosa*	LC	
Amaranthaceae	*Atriplex vestita var. appendiculata*	LC	
Amaranthaceae	*Bassia salsoloides*	LC	
Amaranthaceae	*Salsola calluna*	LC	Endemic
Amaryllidaceae	*Brunsvigia radulosa*	LC	
Apocynaceae	*Microloma armatum var. armatum*	LC	
Apocynaceae	*Pachypodium succulentum*	LC	Endemic
Apocynaceae	*Stapelia grandiflora var. grandiflora*	LC	
Asparagaceae	*Asparagus striatus*	LC	Endemic
Asparagaceae	*Asparagus suaveolens*	LC	
Asphodelaceae	*Haworthiopsis tessellata*	LC	
Asphodelaceae	*Haworthiopsis tessellata var. tessellata*	LC	
Asteraceae	*Arctotis leiocarpa*	LC	
Asteraceae	*Athanasia minuta subsp. minuta*	LC	
Asteraceae	*Berkheya eriobasis*	LC	Endemic
Asteraceae	*Chrysocoma ciliata*	LC	
Asteraceae	*Dimorphotheca cuneata*	LC	
Asteraceae	*Dimorphotheca zeyheri*	LC	
Asteraceae	*Felicia burkei*	LC	
Asteraceae	*Felicia filifolia subsp. filifolia*	LC	
Asteraceae	*Felicia muricata subsp. muricata*	LC	
Asteraceae	*Gazania jurineifolia subsp. jurineifolia*	LC	Endemic
Asteraceae	*Gazania krebsiana subsp. arctotoides*	LC	
Asteraceae	*Geigeria filifolia*	LC	
Asteraceae	*Geigeria ornativa subsp. ornativa*	LC	
Asteraceae	*Helichrysum asperum var. asperum*	LC	Endemic
Asteraceae	*Helichrysum dregeanum*	LC	
Asteraceae	*Helichrysum zeyheri*	LC	
Asteraceae	*Hertia kraussii*	LC	Endemic
Asteraceae	*Hertia pallens*	LC	
Asteraceae	*Leysera tenella*	LC	
Asteraceae	*Oedera humilis*	LC	
Asteraceae	*Osteospermum leptolobum*	LC	Endemic
Asteraceae	*Osteospermum scariosum var. scariosum*	NE	
Asteraceae	*Osteospermum spinescens*	LC	
Asteraceae	*Othonna pavonia*	LC	Endemic
Asteraceae	*Pentzia calcarea*	LC	
Asteraceae	*Pentzia elegans*	LC	Endemic
Asteraceae	*Pentzia incana*	LC	
Asteraceae	*Pentzia spinescens*	LC	
Asteraceae	*Phymaspermum parvifolium*	LC	Endemic
Asteraceae	*Pteronia glauca*	LC	

Family	Species Name	Conservation Status	Endemism
Asteraceae	*Pteronia glaucescens*	LC	Endemic
Asteraceae	*Pteronia sordida*	LC	
Asteraceae	*Senecio niveus*	LC	
Boraginaceae	*Heliotropium lineare*	LC	
Brassicaceae	*Erucastrum strigosum*	LC	
Campanulaceae	*Wahlenbergia nodosa*	LC	Endemic
Caryophyllaceae	*Dianthus micropetalus*	LC	
Colchicaceae	*Colchicum asteroides*	LC	Endemic
Colchicaceae	*Ornithoglossum vulgare*	LC	
Crassulaceae	*Crassula corallina subsp. corallina*	LC	
Cucurbitaceae	*Cucumis africanus*	LC	
Cucurbitaceae	*Cucumis heptadactylus*	LC	Endemic
Cucurbitaceae	*Cucumis myriocarpus subsp. leptodermis*	LC	
Euphorbiaceae	*Euphorbia arida*	LC	Endemic
Euphorbiaceae	*Euphorbia juttae*	LC	
Fabaceae	*Calobota spinescens*	LC	
Fabaceae	*Cullen tomentosum*	LC	
Fabaceae	*Leobordea platycarpa*	LC	
Fabaceae	*Lessertia annularis*	LC	
Fabaceae	*Melolobium candicans*	LC	
Gentianaceae	*Sebaea pentandra var. pentandra*	LC	
Geraniaceae	*Monsonia salmoniflora*	LC	
Geraniaceae	*Pelargonium tragacanthoides*	LC	
Gisekiaceae	*Gisekia pharnaceoides var. pharnaceoides*	LC	
Hyacinthaceae	*Daubenya comata*	LC	Endemic
Hyacinthaceae	*Dipcadi viride*	LC	
Hyacinthaceae	*Ornithogalum nanodes*	LC	
Iridaceae	*Gladiolus permeabilis subsp. edulis*	LC	
Kewaceae	*Kewa salsoloides*	LC	
Lamiaceae	*Stachys cuneata*	LC	Endemic
Leucobryaceae	*Campylopus robillardei*	LC	
Malvaceae	*Hermannia burkei*	LC	
Malvaceae	*Hermannia cuneifolia var. cuneifolia*	LC	
Malvaceae	*Hermannia erodioides*	LC	
Malvaceae	*Hermannia pulchella*	LC	
Malvaceae	*Radyera urens*	LC	
Poaceae	*Cenchrus ciliaris*	LC	
Poaceae	*Enneapogon scaber*	LC	
Poaceae	*Eragrostis bergiana*	LC	
Poaceae	*Eragrostis bicolor*	LC	
Poaceae	*Eragrostis curvula*	LC	
Poaceae	*Eragrostis homomalla*	LC	
Poaceae	*Eragrostis procumbens*	LC	
Poaceae	*Eragrostis truncata*	LC	
Poaceae	*Oropetium capense*	LC	

Family	Species Name	Conservation Status	Endemism
Poaceae	*Panicum impeditum*	LC	
Poaceae	*Puccinellia acroxantha*	LC	
Poaceae	*Sporobolus ioclados*	LC	
Poaceae	*Stipagrostis namaquensis*	LC	
Poaceae	*Stipagrostis obtusa*	LC	
Poaceae	*Tragus berteronianus*	LC	
Poaceae	*Tragus racemosus*	LC	
Polygalaceae	*Polygala ephedroides*	LC	
Polygonaceae	*Rumex lanceolatus*	LC	
Pteridaceae	*Cheilanthes eckloniana*	LC	
Ruscaceae	*Sansevieria aethiopica*	LC	
Santalaceae	*Osyris lanceolata*	LC	
Scrophulariaceae	*Aptosimum procumbens*	LC	
Scrophulariaceae	*Aptosimum spinescens*	LC	
Scrophulariaceae	*Jamesbrittenia tysonii*	LC	Endemic
Scrophulariaceae	*Manulea fragrans*	LC	Endemic
Scrophulariaceae	*Nemesia linearis*	LC	
Scrophulariaceae	*Peliostomum leucorrhizum*	LC	
Scrophulariaceae	*Peliostomum origanoides*	LC	Endemic
Scrophulariaceae	*Selago albida*	LC	
Scrophulariaceae	*Selago paniculata*	LC	Endemic
Scrophulariaceae	*Zaluzianskya karrooica*	LC	Endemic
Solanaceae	*Lycium horridum*	LC	
Solanaceae	*Lycium pumilum*	LC	
Tecophilaeaceae	*Cyanella lutea*	LC	
Thymelaeaceae	*Lasiosiphon polycephalus*	LC	
Zygophyllaceae	*Tetraena microcarpa*	LC	

8.3 Appendix C – Amphibian species expected to occur in the project area

Family	Scientific Name	Conservation Status	
		Regional	Global
Bufonidae	*Poyntonophrynus vertebralis*	LC	LC
Bufonidae	*Sclerophrys gutturalis*	LC	LC
Bufonidae	*Vandijkophrynus gariepensis*	LC	LC
Hyperoliidae	*Kassina senegalensis*	LC	LC
Pipidae	*Xenopus laevis*	LC	LC
Pyxicephalidae	*Cacosternum boettgeri*	LC	LC
Pyxicephalidae	*Pyxicephalus adspersus*	NT	LC
Pyxicephalidae	*Strongylopus grayii*	LC	LC
Pyxicephalidae	*Tomopterna cryptotis*	LC	LC
Pyxicephalidae	*Tomopterna tandyi*	LC	LC

8.4 Appendix D – Reptile species expected to occur in the project area

Family	Scientific Name	Common Name	Conservation Status	
			Regional	Global
Agamidae	*Agama aculeata aculeata*	Common Ground Agama	LC	LC
Agamidae	*Agama atra*	Southern Rock Agama	LC	LC
Cordylidae	*Karusasaurus polyzonus*	Karoo Girdled Lizard	LC	LC
Elapidae	*Aspidelaps lubricus lubricus*	Coral Shield Cobra	LC	LC
Elapidae	*Naja nivea*	Cape Cobra	LC	LC
Gekkonidae	*Chondrodactylus bibronii*	Bibron's Gecko	LC	LC
Gekkonidae	*Pachydactylus mariquensis*	Marico Gecko	LC	LC
Lacertidae	*Pedioplanis laticeps*	Karoo Sand Lizard	LC	LC
Lacertidae	*Pedioplanis lineoocellata lineoocellata*	Spotted Sand Lizard	LC	LC
Lacertidae	*Pedioplanis namaquensis*	Namaqua Sand Lizard	LC	LC
Lamprophiidae	*Psammophis notostictus*	Karoo Sand Snake	LC	LC
Lamprophiidae	*Pseudaspis cana*	Mole Snake	LC	LC
Scincidae	*Trachylepis sulcata sulcata*	Western Rock Skink	LC	LC
Scincidae	*Trachylepis variegata*	Variegated Skink	LC	LC
Testudinidae	*Psammobates tentorius verroxii*	Verrox's Tent Tortoise	NT	NT
Testudinidae	*Stigmochelys pardalis*	Leopard Tortoise	LC	LC
Typhlopidae	*Rhinotyphlops lalandei*	Delalande's Beaked Blind Snake	LC	LC
Varanidae	*Varanus albigularis albigularis*	Rock Monitor	LC	LC

8.5 Appendix E – Mammal species expected to occur within the project area

Family	Scientific Name	Conservation Status	
		Regional	Global
Bathyergidae	*Cryptomys hottentotus*	LC	LC
Bovidae	*Antidorcas marsupialis*	LC	LC
Bovidae	*Raphicerus campestris*	LC	LC
Bovidae	*Sylvicapra grimmia*	LC	LC
Canidae	*Canis mesomelas*	LC	LC
Canidae	*Otocyon megalotis*	LC	LC
Canidae	*Vulpes chama*	LC	LC
Cercopithecidae	*Papio ursinus*	LC	LC
Felidae	*Caracal caracal*	LC	LC
Felidae	*Felis nigripes*	VU	VU
Felidae	*Felis silvestris*	LC	LC
Felidae	*Leptailurus serval*	LC	LC
Felidae	*Panthera pardus*	VU	VU
Herpestidae	*Atilax paludinosus*	LC	LC
Herpestidae	*Cynictis penicillata*	LC	LC
Herpestidae	*Herpestes pulverulentus*	LC	LC
Herpestidae	*Suricata suricatta*	LC	LC
Hyaenidae	*Parahyaena brunnea*	NT	NT
Hyaenidae	*Proteles cristata*	LC	LC
Hystricidae	*Hystrix africaeaustralis*	LC	LC
Leporidae	*Lepus capensis*	LC	LC
Leporidae	*Lepus saxatilis*	LC	LC
Leporidae	*Pronolagus saundersiae*	LC	LC
Macroscelididae	*Elephantulus myurus*	LC	LC
Macroscelididae	*Elephantulus rupestris*	LC	LC
Macroscelididae	*Macroscelides proboscideus*	LC	LC
Muridae	*Aethomys namaquensis*	LC	LC
Muridae	*Desmodillus auricularis*	LC	LC
Muridae	*Gerbilliscus brantsii*	LC	LC
Muridae	*Gerbillurus paeba*	LC	LC
Muridae	*Mastomys coucha*	LC	LC
Muridae	*Otomys unisulcatus*	LC	LC
Muridae	*Parotomys brantsii*	LC	LC
Muridae	*Parotomys littledalei*	LC	LC
Muridae	*Rhabdomys pumilio*	LC	LC
Mustelidae	*Ictonyx striatus*	LC	LC
Mustelidae	*Mellivora capensis*	LC	LC
Mustelidae	*Poecilogale albinucha*	LC	LC
Nesomyidae	*Malacothrix typica*	LC	LC
Orycteropodidae	*Orycteropus afer*	LC	LC
Pedetidae	*Pedetes capensis*	LC	LC
Procaviidae	*Procavia capensis*	LC	LC
Sciuridae	*Xerus inauris*	LC	LC

Family	Scientific Name	Conservation Status	
		Regional	Global
Soricidae	*Suncus varilla*	LC	LC
Suidae	*Phacochoerus africanus*	LC	LC
Viverridae	*Genetta genetta*	LC	LC

8.6 Appendix F – Specialists Declarations

I, Mahomed Desai, declare that:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

Mahomed Desai

Biodiversity Specialist

The Biodiversity Company

June 2022