ALLEPAD PV THREE, NORTHERN CAPE PROVINCE

ENVIRONMENTAL MANAGEMENT PROGRAMME:

February 2019

Prepared for
ILEnergy Development (Pty) Ltd

Prepared by:
Savannah Environmental (Pty) Ltd
First Floor, Block 2, 5 Woodlands Drive Office Park
Woodmead
Johannesburg, 2191
Tel: +27 (0)11 656 3237
Fax: +27 (0)86 684 0547
E-mail: info@savannahsa.com
www.savannahsa.com

PROJECT DETAILS

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Title	:	Environmental Impact Assessment Process Environmental Management Programme: Allepad PV Three, Northern Cape Province
Authors	:	Savannah Environmental Thalita Botha Karen Jodas
Specialists	:	3Foxes Biodiversity Solutions Agricultural Research Council (ARC) LOGIS CTS Heritage Dr. Neville Bews and Associates
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DEFINITIONS AND TERMINOLOGY

The following definitions and terminology may be applicable to this project and may occur in the report below:

Alien species: A species that is not indigenous to the area or out of its natural distribution range.

Alternatives: Alternatives are different means of meeting the general purpose and need of a proposed activity. Alternatives may include location or site alternatives, activity alternatives, process or technology alternatives, temporal alternatives or the 'do nothing' alternative.

Ambient sound level: The reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such meter was put into operation.

Assessment: The process of collecting, organising, analysing, interpreting and communicating information which is relevant.

Biological diversity: The variables among living organisms from all sources including, terrestrial, marine and other aquatic ecosystems and the ecological complexes they belong to.

Commence: The start of any physical activity, including site preparation and any other activity on site furtherance of a listed activity or specified activity, but does not include any activity required for the purposes of an investigation or feasibility study as long as such investigation or feasibility study does not constitute a listed activity or specified activity.

Construction: Construction means the building, erection or establishment of a facility, structure or infrastructure that is necessary for the undertaking of a listed or specified activity as per the EIA Regulations. Construction begins with any activity which requires Environmental Authorisation.

Cumulative impacts: The impact of an activity that in itself may not be significant, but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area.

Decommissioning: To take out of active service permanently or dismantle partly or wholly, or closure of a facility to the extent that it cannot be readily re-commissioned. This usually occurs at the end of the life of a facility.

Direct impacts: Impacts that are caused directly by the activity and generally occur at the same time and at the place of the activity (e.g. noise generated by blasting operations on the site of the activity). These impacts are usually associated with the construction, operation, or maintenance of an activity and are generally obvious and quantifiable.

Disturbing noise: A noise level that exceeds the ambient sound level measured continuously at the same measuring point by 7 dB or more.

'Do nothing' alternative: The 'do nothing' alternative is the option of not undertaking the proposed activity or any of its alternatives. The 'do nothing' alternative also provides the baseline against which the impacts of other alternatives should be compared.

Ecosystem: A dynamic system of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.

Endangered species: Taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating. Included here are taxa whose numbers of individuals have been reduced to a critical level or whose habitats have been so drastically reduced that they are deemed to be in immediate danger of extinction.

Endemic: An "endemic" is a species that grows in a particular area (is endemic to that region) and has a restricted distribution. It is only found in a particular place. Whether something is endemic or not depends on the geographical boundaries of the area in question and the area can be defined at different scales.

Environment: the surroundings within which humans exist and that is made up of:

i. The land, water and atmosphere of the earth;
ii. Micro-organisms, plant and animal life;
iii. Any part or combination of (i) and (ii) and the interrelationships among and between them; and
iv. The physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well-being.

Environmental Authorisation (EA): means the authorisation issued by a competent authority (Department of Environmental Affairs) of a listed activity or specified activity in terms of the National Environmental Management Act (No 107 of 1998) and the EIA Regulations promulgated under the Act.

Environmental assessment practitioner (EAP): An individual responsible for the planning, management and coordinating of environmental management plan or any other appropriate environmental instruments introduced by legislation.

Environmental Control Officer (ECO): An individual appointed by the Owner prior to the commencement of any authorised activities, responsible for monitoring, reviewing and verifying compliance by the EPC Contractor with the environmental specifications of the EMPr and the conditions of the Environmental Authorisation

Environmental impact: An action or series of actions that have an effect on the environment.

Environmental impact assessment: Environmental Impact Assessment, as defined in the NEMA EIA Regulations, is a systematic process of identifying, assessing and reporting environmental impacts associated with an activity.

Environmental management: Ensuring that environmental concerns are included in all stages of development, so that development is sustainable and does not exceed the carrying capacity of the environment.

Environmental Management Programme (EMPr): A plan that organises and co-ordinates mitigation, rehabilitation and monitoring measures in order to guide the implementation of a project or facility and its ongoing maintenance after implementation.

Environmental Officer (EO): The Environmental Officer (EO), employed by the Contractor, is responsible for managing the day-to-day on-site implementation of this EMPr, and for the compilation of regular (usually weekly) Monitoring Reports. The EO must act as liaison and advisor on all environmental and related issues and ensure that any complaints received from the public are duly recorded and forwarded to the Site Manager and Contractor.

Habitat: The place in which a species or ecological community occurs naturally.

Hazardous waste: Any waste that contains organic or inorganic elements or compounds that may, owing to the inherent physical, chemical or toxicological characteristics of that waste, have a detrimental impact on health and the environment.

Indigenous: All biological organisms that occurred naturally within the study area prior to 1800.

Incident: An unplanned occurrence that has caused, or has the potential to cause, environmental damage.

Indirect impacts: Indirect or induced changes that may occur because of the activity (e.g. the reduction of water in a stream that supply water to a reservoir that supply water to the activity). These types of impacts include all the potential impacts that do not manifest immediately when the activity is undertaken or which occur at a different place because of the activity.

Interested and affected party: Individuals or groups concerned with or affected by an activity and its consequences. These include the authorities, local communities, investors, work force, consumers, environmental interest groups, and the public.

Method Statement: a written submission by the Contractor in response to the environmental specification or a request by the Site Manager, setting out the plant, materials, labour and method the Contractor proposes using to conduct an activity, in such detail that the Site Manager is able to assess whether the Contractor's proposal is in accordance with the Specifications and/or will produce results in accordance with the Specifications.

Photovoltaic effect: Electricity can be generated using photovoltaic panels (semiconductors) which are comprised of individual photovoltaic cells that absorb solar energy to produce electricity. The absorbed solar radiation excites the electrons inside the cells and produces what is referred to as the Photovoltaic Effect.

Pre-construction: The period prior to the commencement of construction, which may include activities which do not require Environmental Authorisation (e.g. geotechnical surveys).

Pollution: A change in the environment caused by substances (radio-active or other waves, noise, odours, dust or heat emitted from any activity, including the storage or treatment or waste or substances.

Rare species: Taxa with small world populations that are not at present Endangered or Vulnerable, but are at risk as some unexpected threat could easily cause a critical decline. These taxa are usually localised within restricted geographical areas or habitats or are thinly scattered over a more extensive range. This category was termed Critically Rare by Hall and Veldhuis (1985) to distinguish it from the more generally used word "rare."

Red Data Species: Species listed in terms of the International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species, and/or in terms of the South African Red Data list. In terms of the South African Red Data list, species are classified as being extinct, endangered, vulnerable, rare, indeterminate, insufficiently known or not threatened (see other definitions within this glossary).

Significant impact: An impact that by its magnitude, duration, intensity, or probability of occurrence may have a notable effect on one or more aspects of the environment.

Vulnerable species: A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.

Waste: Any substance, material or object, that is unwanted, rejected, abandoned, discarded or disposed of, or that is intended or required to be discarded or disposed of, by the holder of that substance, material or object, whether or not such substance, material or object can be re-used, recycled or recovered and includes all wastes as defined in Schedule 3 to the Waste Amendment Act (as amended on June 2014); or any other substance, material or object that is not included in Schedule 3 that may be defined as a waste by the Minister by notice in the *Gazette*.

ABBREVIATIONS

The following abbreviations may be applicable to this project and may occur in the report below:

AIA	Archaeological Impact Assessment
BGIS	Biodiversity Geographic Information System
CDSM	Chief Directorate Surveys and Mapping
CEMP	Construction Environmental Management Plan
DBAR	Draft Basic Assessment Report
DEA	Department of Environmental Affairs
DME	Department of Minerals and Energy
EAP	Environmental Impact Practitioner
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
EMPr	Environmental Management Programme
GPS	Global Positioning System
GWh	Giga Watt hour
HIA	Heritage Impact Assessment
I&APs	Interested and Affected Parties
IDP	Integrated Development Plan
IFC	International Finance Corporation
IPP	Independent Power Producer
KNP	Karoo National Park
KOP	Key Observation Point
kV	Kilo Volt
LAeq,T	Time interval to which an equivalent continuous A-weighted sound level
LLRC	Low Level River Crossing
LUDS	Land Use Decision Support
LUPO	Land Use Planning Ordinance
MW	Mega Watt
NEMA	National Environmental Management Act
NEMAA	National Environmental Management Amendment Act
NEMBA	National Environmental Management: Biodiversity Act
NERSA	National Energy Regulator of South Africa
NHRA	National Heritage Resources Act
NID	Notice of Intent to Develop
NSBA	National Spatial Biodiversity Assessment
NWA	National Water Act
PIA	Paleontological Impact Assessment
PM	Post Meridiem; “Afternoon”
SACAA	South African Civil Aviation Authority
SAHRA	South African National Heritage Resources Agency
SANBI	South Africa National Biodiversity Institute
SANS	South Africa National Standards
SDF	Spatial Development Framework

SMME	Small, Medium and Micro Enterprise
SAPD	South Africa Police Department

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CHAPTER 1: INTRODUCTION

This Environmental Management Programme (EMPr) has been compiled for Allepad PV Three. The project site identified for the facility is located within the Remaining Extent of Erf 5315 Upington. The project site is located approximately 11km[1] north-west of Upington, and falls within Wards 11 and 13 of the Dawid Kruiper Local Municipality (LM),, of the ZF Mgcawu District Municipality (DM), in the Northern Cape Province. Allepad PV Three will be designed to have a contracted capacity of up to 100MW, and will make use of photovoltaic (PV) solar technology.

This EMPr has been developed on the basis of the findings of the Environmental Impact Assessment (EIA), and must be implemented to protect sensitive on-site and off-site features through controlling construction, operation and decommissioning activities that could have a detrimental effect on the environment, and through avoiding or minimising potential impacts. This EMPr is applicable to all ILEnergy Development (Pty) Ltd employees and contractors working on the pre-construction, construction, and operation and maintenance phases of Allepad PV Three. In terms of the Duty of Care provision in S28(1) of NEMA, the project proponent must ensure that reasonable measures are taken throughout the life cycle of this project to ensure that any pollution or degradation of the environment associated with this project is avoided, halted or minimised. The document must therefore be adhered to and updated as relevant throughout the project life cycle. This document fulfils the requirement of the EIA Regulations, 2014 (as amended) and forms part of the EIA Report for the project.

[1] Measured from the edge of the south-eastern corner of project site, i.e. the Remaining Extent of Erf 5315 Upington.

CHAPTER 2: PROJECT DETAILS

ILEnergy Development (Pty) Ltd proposes the development of Allepad PV Three on a site near Upington in the Northern Cape Province. Allepad PV Three comprises a commercial solar energy generation facility and associated infrastructure and is intended to form part of the Department of Energy's (DoE's) Renewable Energy Independent Power Producer Procurement (REIPPP) Programme. The REIPPP Programme aims to secure 14 725MW[2] of new generation capacity from Renewable Energy (RE) sources (in accordance with South Africa's Integrated Resource Plan for Electricity (IRP) 2010 – 2030)[3], while simultaneously diversifying South Africa's electricity mix, and positively contributing towards socio-economic, and environmentally sustainable growth. Allepad PV Three will be designed to have a contracted capacity of up to 100MW, and will make use of photovoltaic (PV) solar technology.

2.1 Project Site

The Allepad PV Three is proposed on the Remaining Extent of Erf 5315 Upington (the project site), which is located approximately 11km north-west of Upington, Northern Cape Province (refer to **Figure 2.1**). The project site identified for the Allepad PV Three falls within Ward 11 and 13 of the Dawid Kruiper LM, of the ZF Mgcawu DM. Access to the site is obtained via an existing official farm entrance point, which is accessed directly off the N10 national road.

Table 2.1 provides information regarding the proposed project site identified for the Allepad PV Three and the associated infrastructure.

Table 2.1: A description of the project site identified for the Allepad PV Three and associated infrastructure

Province	Northern Cape Province
District Municipality	ZF Mgcawu DM
Local Municipality	Dawid Kruiper LM
Ward Number(s)	Wards 11 and 13
Nearest Town(s)	» Upington (approximately 11km south-east of the project site)
Farm Portion(s), Name(s) and Number(s)	**Allepad PV Three:** » Remaining Extent of Erf 5315 Upington **Proposed grid connection:** » Remaining Extent of Erf 5315 Upington » Erf 01 Upington
SG 21 Digit Code (s)	**Allepad PV Three:** » C02800070000531500000 **Proposed grid connection:** » C02800070000531500000 » C02800070000000100000
Current Zoning	Agriculture

[2] Source: https://www.ipp-renewables.co.za/
[3] Several updates have been made to the promulgated IRP for electricity 2010 – 2030 released in 2011, the most recent of which was released for public comment on 22 August 2018 (Draft IRP 2018). None of these updates were promulgated to replace the IRP 2010 – 2030. The original IRP for electricity 2010 – 2030 released in 2011 therefore remains applicable until such time as an updated IRP is finalised, accepted by Cabinet and promulgated.

Current land use	Agriculture (i.e. Cattle grazing)		
Site Extent	**Allepad PV Three:** » 3 889ha		
Development Footprint	» ~250ha		
Project Site Co-ordinates		**Latitude**	**Longitude**
	Northern extent	28° 21' 21.62" S	21° 08' 16.64" E
	Western extent	28° 22' 05.50" S	21° 03' 13.23" E
	South-western extent	28° 23' 47.45" S	21° 04' 36.13" E
	Southern extent	28° 24' 20.20" S	21° 08' 21.81" E
	Eastern extent	28° 23' 13.52" S	21° 10' 04.64" E
Power Line Corridor Co-ordinates		**Latitude**	**Longitude**
	Northern extent	28° 23' 36.23" S	21° 04' 26.79" E
	Eastern extent	28° 24' 39.30" S	21° 11' 42.56" E
	Southern extent	28° 24' 48.31" S	21° 11' 36.54" E
	Western extent	28° 23' 47.46" S	21° 04' 36.11" E

2.2 Project Description

The proposed project will have a contracted capacity of up to 100MW, and will make use of PV solar technology for the generation of electricity. The project will comprise the following key infrastructure and components:

» Arrays of PV panels with a generation capacity of up to 100MW.
» Mounting structures to support the PV panels.
» Combiner boxes, on-site inverters (to convert the power from Direct Current (DC) to Alternating Current (AC)), and distribution power transformers.
» A 132kV on-site substation up to 1ha in extent to facilitate the connection between the solar energy facility and the Eskom electricity grid.
» A new 132kV double-circuit power line (which will make use of a loop-in and loop-out configuration utilising a double-circuit monopole construction), approximately 9.5km in length, between the on-site substation and Eskom grid connection point.
» Cabling between the project's components (to be laid underground where practical).
» Meteorological measurement station.
» An energy storage area up to 2ha in extent.
» Access road and internal access road network.
» On-site buildings and structures, including a control building and office, ablutions and guard house.
» Perimeter security fencing, access gates and lighting.
» Temporary construction camp up to 1ha in extent, including temporary site offices, parking and chemical ablution facilities.
» Temporary laydown area up to 1ha in extent, for the storage of materials during the construction and concrete batching plant.

Electricity generated by the project will feed into Eskom's national electricity grid via a new 132kV double-circuit power line which will connect the on-site substation to the upgraded 132kV double-circuit power line running between the new Upington Main Transmission Substation (MTS) (currently under construction approximately 15km south of the project site), and the Gordonia Distribution Substation (located in Upington town). The point of connection is located approximately 5km east of the project site and will make use of a loop-in and loop-out configuration, utilising a double-circuit monopole structure. The proposed power line required for the project will be constructed within a 31m wide servitude (31m in the Northern Cape and up to 36m in other areas of the country). A 300m wide power line corridor has been identified for investigation along the southern boundary of the site, running immediately north of, and parallel to, the N10 national road[4].

A summary of the associated infrastructure proposed as part of the Allepad PV Three is provided in **Table 2.2**, and described in more detail under the sub-headings below.

Table 2.2: Planned infrastructure proposed as part of the Allepad PV Three

Infrastructure	Dimensions/ Details
Solar Facility	» PV technology. » Solar panels up to 3.5m in height. » Fixed-tilt, single-axis tracking, or dual-axis (double-axis) tracking systems. » Combiner boxes, on-site inverters (to convert the power from DC to AC), and distribution power transformers. » PV structures / modules approximately 215ha in extent (depending on the type of support structure selected for implementation (i.e. static vs tracking)). » Centralised or distributed self-contained inverter stations approximately 2m tall.
Energy Storage	» Batteries will be utilised. » Up to 2ha in extent. » Batteries will be stored in self-contained units comprising of up to 40 standard ("45 foot") specially adapted shipping containers.
Supporting Infrastructure	» On-site buildings and structures up to 1ha in extent, including a control building and office, » Meteorological measurement station located close the control building. » Ablutions and guard house. » Perimeter security fencing, access gates and lighting up to 2.8m in height. » Temporary construction equipment camp up to 1ha in extent, including temporary site offices, parking and chemical ablution facilities. » Temporary laydown area up to 1ha in extent, for the storage of materials during the construction including a batching plant.
On-site substation	» On-site substation at 132kV and approximately 120MVA capacity. » Will occupy an area up to 1ha in extent.
Grid Connection	» A 132kV double-circuit power line, which will make use of a loop-in and loop-out configuration utilising a double-circuit monopole construction. » The power line will be approximately 7.3km in length. » A 300m wide power line corridor (i.e. 150m on either side of the centreline of the power line) has been identified along the southern boundary of the project site, immediately north of, and running parallel to, the N10 national road, within which a power line servitude will be established. » The power line servitude will be 31m (but could be up to 36m wide i.e. up to 18m on either side of the centre-line due to building restriction). » The towers required to support the power line will be 20m to 30m in height.

[4] A total of four 100MW PV projects are proposed for development on the project site (i.e. Allepad PV One, Allepad PV Two, Allepad PV Three and Allepad PV Four). Should more than one PV project be constructed on the site, the additional plants will be interconnected to each other via the on-site power line corridor (in loop-in and loop-out configurations), and then ultimately be connected to existing Eskom infrastructure in the area, including the possibility of a direct connection to the Upington MTS by additional power lines (the route and details of which are not known at this stage). This transmission inter-connection will be assessed through a separate application for EA at a later stage once routing information and design requirements are given by Eskom.

Infrastructure	Dimensions/ Details
Access road	» Access to the PV site will be via the existing official farm entrance which is accessed off the N10 national road. » Permanent access roads will be constructed as follows: ∗ Main access road (to be gravel) – 6m wide and approximately 2.3km in length. ∗ Internal access road – 6m wide and approximately 7.7km in length (to be gravel). ∗ Shared access road - 6m wide and approximately 4.5km in length (to be gravel).
Water Supply	» Approximately 2 800m³ of water per year is required during construction (up to18 months). ∗ Up to 800m³ for the batching plant ∗ Up to 2 000m³ for dust suppression » Up to 2 000m³ of water is required per year for operation (anticipated for at least 20 years) for washing of the solar panels. » The following water supply options are currently being considered: ∗ Sourcing potable water from the Dawid Kruiper LM (already piped on-site). ∗ Sourcing raw water from the Dawid Kruiper LM (Upington water treatment works or nearest bulk water supply point).

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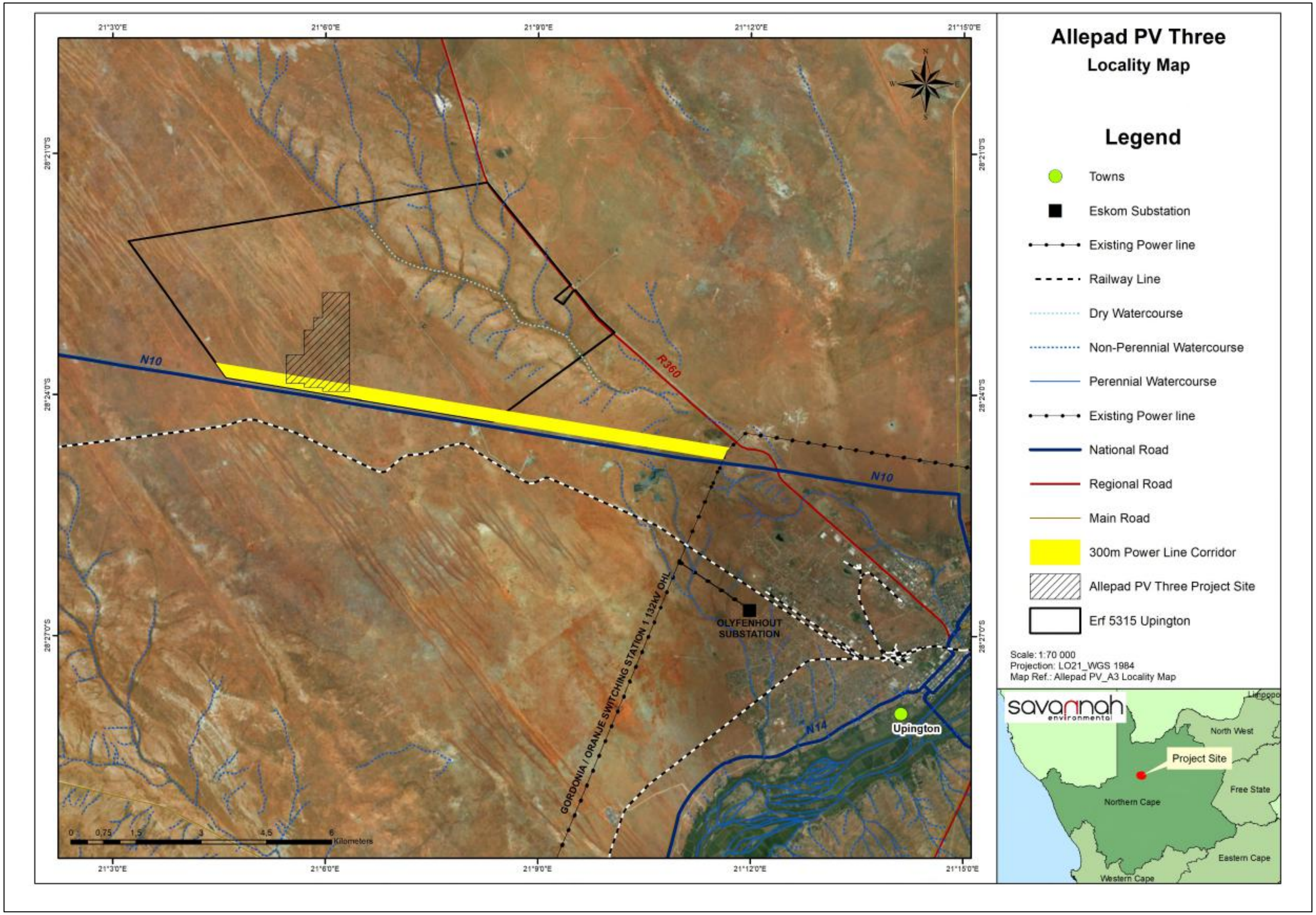

Figure 2.1: Locality map illustrating the location of the project site for the establishment of the Allepad PV Three.

2.3 Activities and Components Associated with the PV Facility

A series of activities are proposed as part of the design, pre-construction, construction, operation, and decommissioning phases associated with the development of Allepad PV Three. These are discussed in more detail under the respective sub-headings below.

2.3.1 Design and Pre-Construction Phase

Pre-planning

Several post-authorisation factors are expected to influence the final design of the facility and could result in small-scale modifications of the PV array or associated infrastructure. While an objective of the Engineering, Procurement and Construction (EPC) Contractor, who will be responsible for the overall construction of the project, will be to comply with the approved facility design as far as possible, it should be understood that the construction process is dynamic and that unforeseen changes to the project specifications may take place. This EIA Report therefore describes the project in terms of the best available knowledge at the time. The final facility design is required to be approved by the DEA. Importantly, should there be any substantive changes or deviations from the original scope or layout of the project, the DEA will need to be notified and where relevant, approval obtained.

Conduct Surveys

Prior to initiating construction, a number of surveys will be required including, but not limited to confirmation of the micro-siting footprint (i.e. the precise location of the PV panels, substation and the plant's associated infrastructure) and a geotechnical survey. Geotechnical surveys are executed by geotechnical engineers and geologists to acquire information regarding the physical characteristics of soil and rocks underlying a proposed project site. The purpose is to design earthworks and foundations for structures and to execute earthwork repairs necessitated due to changes in the subsurface environment.

2.3.2 Construction Phase

The construction phase will take approximately 18 months to complete, and will entail a series of activities including:

Procurement and employment

At the peak of construction the project is likely to create up to 300 direct employment opportunities. These employment opportunities will be temporary, and will last for a period of up to 18 months (i.e. the length of construction). Employment opportunities generated during the construction phase will include unskilled, semi-skilled, and highly-skilled opportunities. Solar PV projects make use of high levels of unskilled and semi-skilled labour so there will be good opportunity to use local labour. Employment opportunities for the proposed solar PV facility will peak during the construction phase and significantly decline during the operation phase. The injection of income into the area in the form of wages will represent an opportunity for the local economy and businesses in the area.

The majority of the labour force is expected to be sourced from the Upington area. No labour will be accommodated on-site during the construction period.

Establishment of an Access Road to the Site

Access to the project site will be established for the construction of the facility. Access to the project site is obtained via the existing official farm entrance which is accessed off the N10 national road. Within the facility development footprint itself, access will be required from new / existing roads for construction purposes (and limited access for maintenance during operation). The final layout will be determined following the identification of site related sensitivities.

Undertake Site Preparation

Site preparation activities will include clearance of vegetation. These activities will require the stripping of topsoil which will need to be stockpiled, backfilled and / or spread on site.

Transport of Components and Equipment to Site

The national, regional, secondary and proposed internal access roads will be used to transport all components and equipment required during the construction phase of the solar facility. Some of the components (i.e. substation transformer) may be defined as abnormal loads in terms of the National Road Traffic Act (No. 93 of 1996) (NRTA)[5] by virtue of the dimensional limitations. Typical civil engineering construction equipment will need to be brought to the site (e.g. excavators, trucks, graders, compaction equipment, cement trucks, etc.) as well as components required for the mounting of the PV support structures, construction of the substation and site preparation.

Establishment of Laydown Areas on Site

Laydown and storage areas will be required for typical construction equipment. Once the required equipment has been transported to site, a dedicated equipment construction camp and laydown area will need to be established adjacent to the workshop area. The equipment construction camp serves to confine activities and storage of equipment to one designated area to limit the potential ecological impacts associated with this phase of the development. The laydown area will be used for the assembly of the PV panels and the general placement / storage of construction equipment and batching plant. A temporary laydown area approximately 1ha in extent is required during construction. The temporary laydown area will be included within the 250ha development footprint.

Erect PV Cells and Construct Substation and Invertors

The construction phase involves installation of the PV solar panels and structural and electrical infrastructure required for the operation of the facility. In addition, preparation of the soil and improvement of the access roads is likely to continue for most of the construction phase. For array installations, vertical support posts are driven into the ground. Depending on the results of the geotechnical report, a different foundation method, such as screw pile, helical pile, micropile or drilled post / pile could be used. The posts will hold the support structures (tables) on which the PV modules would be mounted. Brackets attach the PV modules to the tables. Trenches are dug for the underground AC and DC cabling and the foundations of the inverter enclosures and transformers are prepared. While cables are being laid and combiner boxes are being installed, the PV tables are erected. Wire harnesses connect the PV modules to the electrical collection systems. Underground cables and overhead circuits connect the Power Conversion Stations (PCS) to the on-site AC electrical infrastructure and ultimately the solar facility's on-site substation.

[5] A permit will be required in accordance with Section 81 of the NRTA which pertains to vehicles and loads which may be exempted from provisions of Act.

The construction of the substation will require a survey of the site, site clearing and levelling and construction of access road(s) (where applicable), construction of a level terrace and foundations, assembly, erection, installation and connection of equipment, and rehabilitation of any disturbed areas, and protection of erosion sensitive areas.

Establishment of Ancillary Infrastructure
Ancillary infrastructure will include a power line for connection to the Eskom national grid, control room, workshop, storage and laydown areas, gatehouse and security complex, as well as a temporary contractor's equipment camp.

The establishment of the ancillary infrastructure and support buildings will require the clearing of vegetation and levelling of the development site, and the excavation of foundations prior to construction. Laydown areas for building materials and equipment associated with these buildings will also be required.

Construction of the power line
A power line is constructed by surveying the power line route, constructing foundations for the towers, installing the towers, stringing the conductors, and finally rehabilitating disturbed areas and protecting erosion sensitive areas.

Undertake Site Rehabilitation
Once construction is completed and all construction equipment has been removed, the site will be rehabilitated where practical and reasonable. In addition on full commissioning of the solar energy facility, any access points which are not required during operation must be closed and rehabilitated accordingly.

2.3.3 Operation Phase

The proposed solar energy facility is expected to operate for a minimum of 20 years. The facility will operate continuously, 7 days a week, during daylight hours. While the solar facility will be largely self-sufficient, monitoring and periodic maintenance activities will be required. Key elements of the Operation and Maintenance (O&M) plan include monitoring and reporting the performance of the solar facility, conducting preventative and corrective maintenance, receiving visitors, and maintaining security.

2.3.4 Decommissioning Phase

Depending on the continued economic viability of the solar energy facility following the initial 20-year operational lifespan, the facility will either be decommissioned or the operation phase will be extended. If it is deemed financially viable to extend the operation phase, existing components would either continue to operate, or be dissembled and replaced with new, more efficient technology / infrastructure available at the time. If the decision is made to decommission the solar facility, the following decommissioning activities will take place:

Site Preparation
Site preparation activities include confirming the integrity of the access to the site to accommodate the required decommissioning equipment.

Disassembly and Removal of Existing Components

When the solar energy facility is ultimately decommissioned, the equipment to be removed will depend on the land use proposed for the site at the time. All above ground facilities that are not intended for future use at the site will be removed. Much of the above ground wire, steel, and PV panels of which the system is comprised, are recyclable materials and would be recycled to the extent feasible. The components of the solar facility would be deconstructed and recycled, or disposed of in accordance with applicable regulatory requirements. The site will be rehabilitated and can be returned to agriculture or another beneficial land-use.

Future plans for the site and infrastructure after decommissioning

The generation capacity of the facility would have degraded by approximately 15% over the 20-year operations lifespan. The solar facility will potentially have the opportunity to generate power for a Merchant Market operation (i.e. the client would sell power on a bid basis to the market). Another option for the site after decommissioning is for agricultural activities to resume.

2.4 Findings of the Environmental Impact Assessment (EIA)

No environmental fatal flaws were identified in the detailed specialist studies conducted, provided that the recommended mitigation measures are implemented. These measures include, amongst others, the avoidance of highly sensitive features within the project site by the development footprint and the undertaking of monitoring, as specified by the specialists.

The potential environmental impacts associated with Allepad PV Three identified and assessed through the EIA process include:

» Impacts on ecology, flora and fauna.
» Impacts on avifauna.
» Impacts on heritage resources, including archaeology and palaeontology.
» Visual impacts on the area imposed by the components of the facility.
» Socio- economic impacts.

2.4.1 Impacts on Ecology

The Ecological Impact Assessment assessed the impact of Allepad PV Three on the sensitive ecological features present within the project site for the life-cycle of the project. The assessment identified impacts within the construction and operation phases of the project.

During the construction phase, the impacts expected to occur include impacts on vegetation and listed protected plant species and faunal impacts. The significance of the construction phase impacts ranges from medium to low, following the implementation of the recommended mitigation measures by the specialist. No impacts of a high significance were identified prior to the implementation of mitigation.

During the operation phase, the anticipated impacts include faunal impacts, negative impacts on broad-scale ecological processes, an increased erosion risk and potential for increased alien plant invasion. The significance of the impacts for the operation phase are low, following the implementation of the recommended mitigation measures by the specialist. No impacts of a high significance were identified for the project.

From the findings of the Ecological Impact Assessment (**Appendix D** of the EIA Report) it can be concluded that no impacts of high ecological significance were identified which would hinder the development of Allepad PV Three and its associated infrastructure within the proposed development area. The proposed development is considered to be appropriate and acceptable from an ecological perspective at the proposed location, and will not result in detrimental impacts to ecosystems and habitat features present within the project site and within the surrounding properties. The specialist has therefore indicated that the development may be authorised, constructed and operated, subject to the implementation of the recommended mitigation measures.

2.4.2 Impacts on Avifauna

The Avifauna Impact Assessment (**Appendix E** of the EIA Report) is based on the findings of two site visits undertaken in July 2018 and February 2019 (i.e. wet and dry season site visits), ecological and biodiversity information available in the literature and various spatial databases with mapping based on the satellite imagery of the site as well as personal knowledge of the site obtained during the site visits. The avifauna impacts identified to be associated with Allepad PV Three will be negative and local in extent. The duration of the impacts will be short to long-term, for the lifetime of the PV facility.

During the construction phase of Allepad PV Three and the grid connection, a loss of habitat and disturbance due to clearance of vegetation is expected to occur. The significance of these impacts can be reduced to medium to low with the implementation of the recommended mitigation measures.

Impacts associated with the operation phase of Allepad PV Three include disturbance and collision with PV panels, as well as disturbance, electrocution and collision with power line infrastructure. The significance of the impacts will be low with the implementation of mitigation measures.

From the results of the avifauna assessment, it can be concluded that no fatal-flaws will be associated with the development of Allepad PV Three from an avifaunal perspective. The specialist has therefore indicated that the development may be authorised, constructed and operated, subject to the implementation of the recommended mitigation measures.

2.4.3 Impacts on Heritage Resources

The area surrounding the town of Upington has a rich historical and archaeological past (Fourie, 2014 SAHRIS NID 174335) and several heritage sites have been identified in close proximity to the project site. A number of archaeological resources were identified during the site visit undertaken by the heritage specialist. Only two of these sites are sites of some heritage significance and included a possible burial site and a concentration of artefacts. Neither of these sites are directly affected by the PV facility or power line infrastructure. The impact of the proposed Allepad PV Three and associated infrastructure on significant archaeological resources is considered to be low with the implementation of mitigation measures.

Considering the palaeontology of the project site, it was identified that the area in question is underlain by unfossiliferous igneous and metamorphic basement rocks (granites, gneisses etc.) or mantled by superficial sediments (wind-blown sands, alluvium etc.) of low paleontological sensitivity. Considering the defined criteria, the potential impact to fossil heritage resources is considered to be low.

The Heritage Impact Assessment (**Appendix F** of the EIA Report) identified impacts associated with the construction and operation of Allepad PV Three. The impact on heritage resources include the archaeology and palaeontology of the project site.

Impacts on palaeontological and archaeological resources are expected to occur during the construction phase of Allepad PV Three. The impacts relate to the excavations required for the construction of the facility and will occur only in the event that an archaeological or palaeontological resource is present. The significance of the impact will be low and no mitigation has been recommended by the specialist due to the lack of significant heritage resources within the area. The requirement for the development and implementation of a chance find procedure in the event of a heritage find has been included.

2.4.4 Visual Impacts

The Visual Impact Assessment (**Appendix G** of the EIA Report) identified negative impacts on visual receptors during the undertaking of construction activities and the operation phase of Allepad PV Three.

During the construction phase the undertaking of construction activities will impact on sensitive visual receptors in close proximity to Allepad PV Three. The construction phase will result in a noticeable increase in heavy vehicles utilising the roads which may cause a visual nuisance to other road users and landowners in the area. The construction phase visual impacts will have a low significance following the implementation of the recommended mitigation measures.

Visual impacts expected to occur during the operation phase includes impact on sensitive visual receptors in close proximity (i.e. within 3km) of the facility, visual impact on sensitive visual receptors within the broader region (i.e. within 3-6km), lighting impacts, visual impact of the ancillary infrastructure, the visual impact on sensitive visual receptors located within a 500m radius of the associated power line infrastructure, and a visual impact on the sense of place in the region. The significance of the visual impacts range from low to moderate with the implementation of the recommended mitigation measures. Due to the limited number of sensitive receptors in the area, and due to the presence of other similar in the region, visual impacts are not considered to be a fatal flaw for the development. No mitigation is possible for the visual impact on sensitive visual receptors within 500m of the power line infrastructure, therefore only best practise measures can implemented and have been recommended by the specialist. The specialist has indicated support for the development of Allepad PV Three from a visual perspective provided that recommended mitigation measures are implemented.

2.4.6 Social Impacts

Traditionally, the construction phase of a PV solar development is associated with the majority of social impacts. Many of the social impacts are unavoidable and will take place to some extent, but can be managed through the careful planning and implementation of appropriate mitigation measures. A number of potential positive and negative social impacts have been identified for the project, however an assessment of the potential social impacts indicated that there are no perceived negative impacts that are sufficiently significant to allow them to be classified as fatal flaws.

The Social Impact Assessment (**Appendix H** of the EIA Report) identified positive and negative impacts which are expected to occur during the construction and operation phases of Allepad PV Three. The assessment identified that the expected benefits associated with the project, which include local economic and social development, is likely to outweigh the perceived impacts associated with the project.

During the construction phase the positive impacts expected to occur include direct and indirect employment opportunities and skills development and socio-economic stimulation. The significance of these impacts are medium with the implementation of the recommended enhancement measures. The negative social impacts expected to occur during the construction phase includes an influx of construction workers and change in population, increase in crime, increased risk of HIV infections, impacts on daily living and moving patterns, nuisance impacts (i.e. noise and dust), hazard exposure and disruption to social and community infrastructure and visual impacts. The significance of the negative construction phase impacts will be low to medium to high with the implementation of the recommended mitigation measures.

During the operation phase the positive impacts expected to occur includes direct and indirect employment opportunities and skills development and a contribution to Local Economic Development (LED) and social upliftment. The significance of the positive operation impacts will be medium to high with the implementation of the recommended enhancement measures. The negative impacts expected during the operation phase includes a visual and sense of place. The significance of the negative operation impacts will be high with the implementation of the recommended mitigation measures.

2.5 Environmental Sensitivity

From the specialist investigations undertaken for the Allepad PV Three, the following sensitive areas/environmental features have been identified and demarcated within the project site and avoided by the development footprint (where necessary):

» **Ecology** – The majority of the 300m power line corridor and the development footprint for Allepad PV One has been identified as being of a low ecological sensitivity based on the widely distributed habitat in the region and the fact that the area does not support an extensive tree layer, besides scattered *Parkinsonia africana*. A small section of sandy habitat is traversed by the development footprint of Allepad PV Three which is considered to be acceptable from an ecological perspective. The western half of the site on undulating sandy soils is considered to be low sensitivity and suitable for development apart from the extensive area of mobile dunes which is considered to be medium or high sensitivity and not suitable for development as the loose sands are very vulnerable to erosion. There are dunes located in the north west and central part of this area and then the shrubby plains of the south and central part of the site. The dunes are considered to be medium or high sensitivity and not suitable for development as the loose sands are very vulnerable to erosion. Isolated dunes of medium ecological sensitivity is situated within the 300m power line corridor located adjacent to the main entrance road. The dunes are unlikely to fulfil the same ecological services as the contiguous dune fields located well beyond the development footprint and is considered acceptable.

  The eastern half of the project site occurs on shallow calcrete soils and has numerous drainage lines as well as a few small pans present. Due to the presence of the drainage system and the difficulty involved in avoiding impact to this feature should development encroach on it, this area is considered to be of very high ecological sensitivity and largely unsuitable for development. Areas of very high and high ecological sensitivity have been avoided by the development footprint. A small pan of high sensitivity is located within the 300m power line corridor and can easily be avoided by the power line route.

» **Bird Habitat and Sensitive Areas** – The project site supports three main avifaunal microhabitats, i.e. the gravel plains, sandy plains, and dunes habitat. These three habitats have different sensitivities, due to the subtle differences in the avifaunal assemblages that they support, especially with respect to red-listed species. The gravel plains located within the eastern section of the project site are considered to be of high sensitivity, due firstly to the habitat diversity of the area and the fact that it supports several pairs of the Near-Threatened Karoo Korhaan (resident) and the Endangered Ludwig's Bustard (nomadic). The drainage lines also intersect the gravel plains throughout and therefore the ecological functioning of these two habitats are intertwined. The dune habitat located within the western portion of the project site is well represented within the bioregion, but due to the deeper soils, supports a number of protected tree species, such as the *Acacia erioloba, A. haematoxylon* and *Boscia albitrunca, B. foetida subsp. foetida.* These tree species, in turn, provide important nesting and roosting sites for birds, including large raptors. This habitat is therefore considered to be of medium sensitivity due to its importance to a wide variety of avifaunal species. The 300m power line corridor traverse some isolated dunes of medium sensitivity, which is considered acceptable due to the isolated location of the dune. These dunes is also located adjacent the main entrance road to the project site, and therefore is unlikely to fulfil the same ecological services as the contiguous dunes fields located well beyond the development footprint.

The sandy plains habitat represents the most widely distributed habitat in the region, and occurs primarily on shallower soils that do not support an extensive tree layer, besides scattered *Parkinsonia africana*. This habitat is therefore regarded to be of low sensitivity. The development footprint for Allepad PV Three is located within sandy plains considered to be of low sensitivity.

The 300m power line corridor traverse the sandy plains and gravel plains identified within the project site. There are also a number of minor features along the power line corridor, including a small rocky outcrop, a stand of *Acacia mellifera* shrubs, a stand of alien *Prosopis* trees near human habitation, a very small ephemeral pan, as well as some small sewage ponds. These features lie directly adjacent the N10 road and may attract raptors and waterbirds on occasion, although no large red-listed species are expected to be supported by these features. In particular, the small pan is considered far too insignificant in size to support either waterbirds when inundated or coursers when dry. Therefore, the entire length of the 300m power line corridor, which follows the N10 road, is considered to be of low ecological sensitivity.

» **Heritage:** Two heritage sites of some significance were identified within the broader project site and are avoided by the development footprint of Allepad PV Three and the 300m power line corridor. A possible burial site (Grade IIIA) (Site 0506) has been identified within the eastern section of the project site and a no-go buffer of 30m has been recommended by the specialist. A concentration of artefacts (Grade IIIB) (Site 0526) has been identified directly north of the possible burial site and a no-go buffer of a 100m was recommended by the specialist.

The layout and 300m power line corridor is considered to be acceptable from an environmental perspective and included in **Figure 2.2**. An environmental sensitivity map has been included as **Figure 2.3.** An environmental sensitivity map has been overlain with the preferred layout map is included as **Figure 2.4** and **Figure 2.5**.

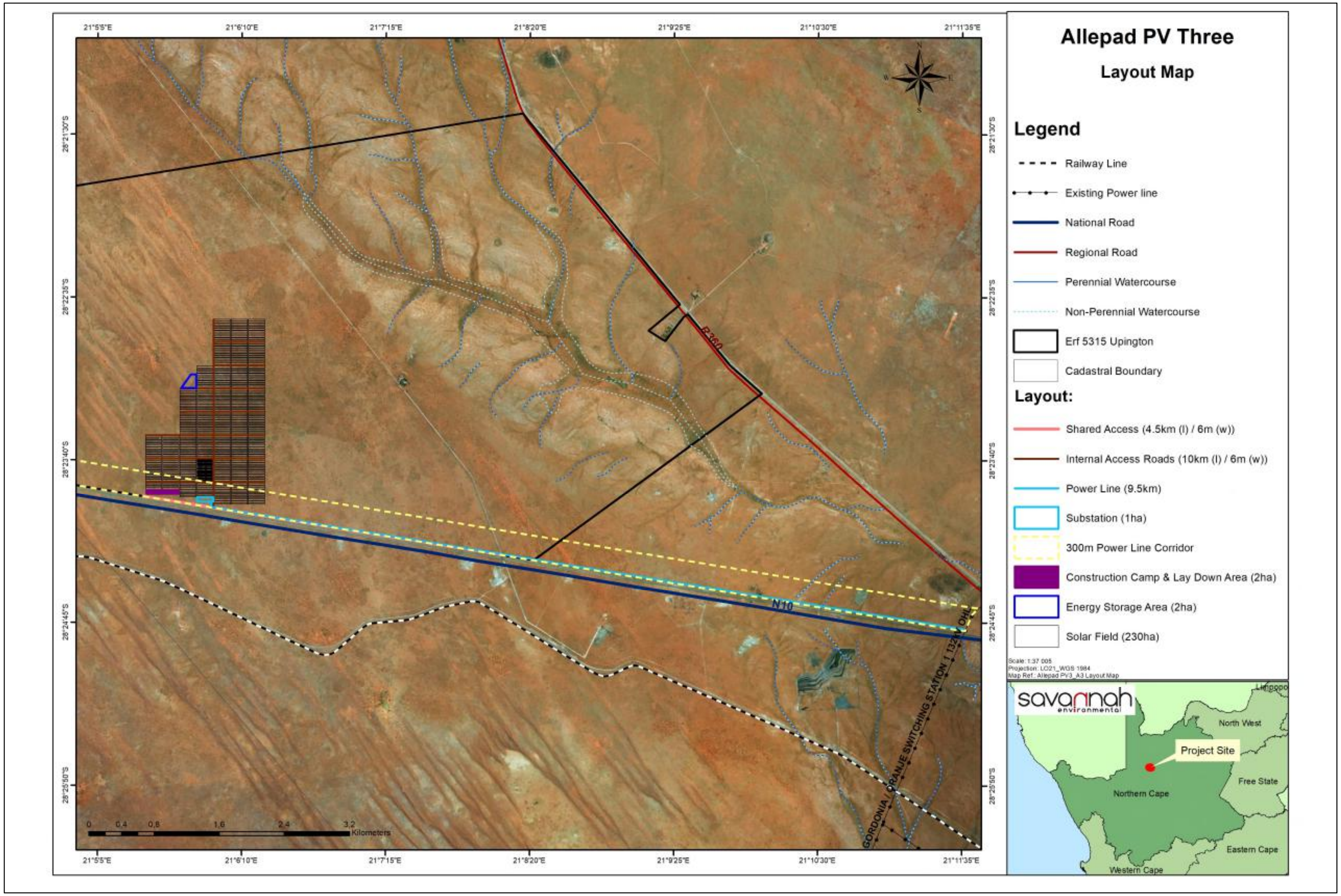

Figure 2.2: **Final preferred layout map of the preferred development footprint for Allepad PV Three, as was assessed as part of the EIA process.**

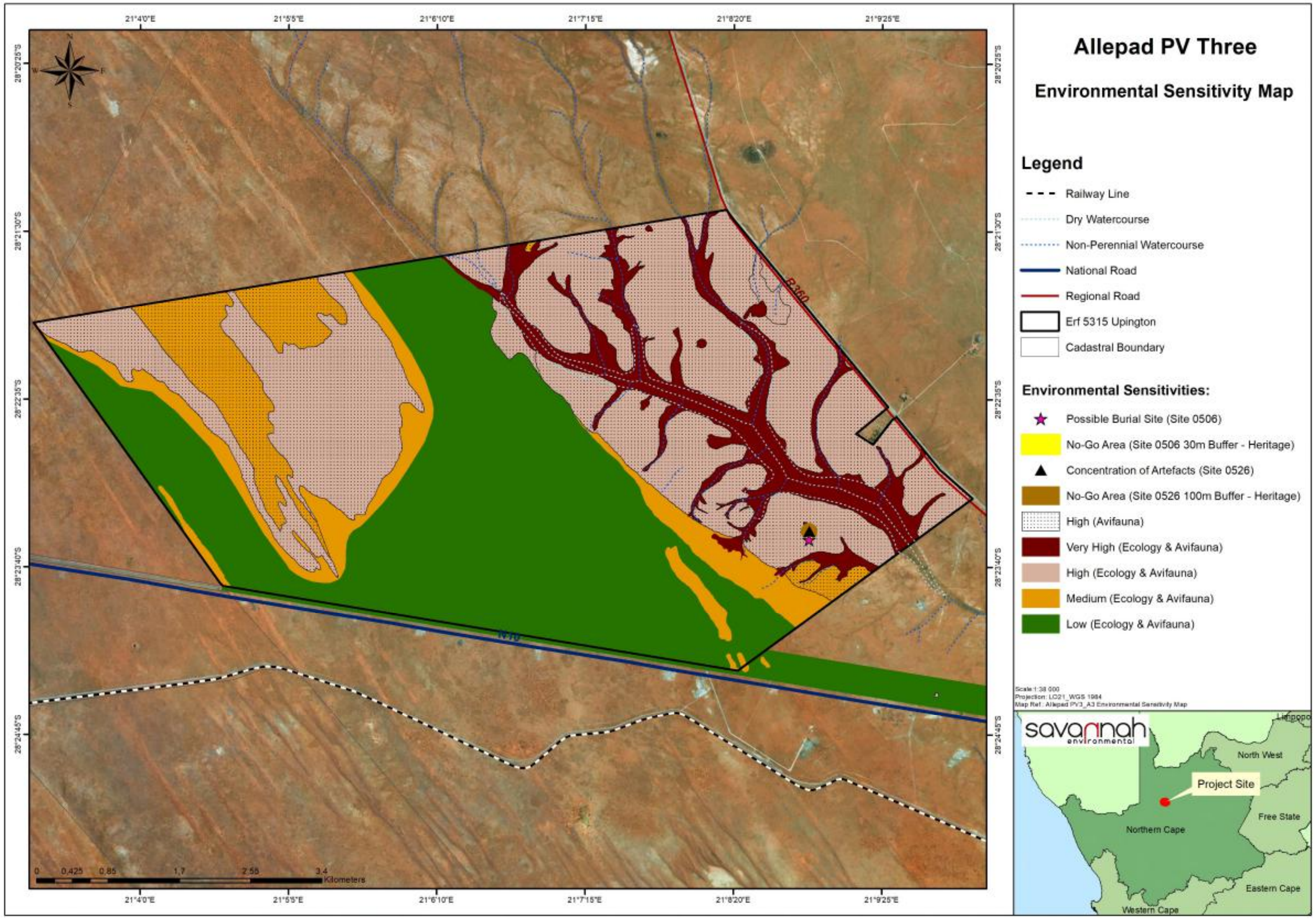

Figure 2.3: **Environmental sensitivity map of the project site considered for Allepad PV Three.**

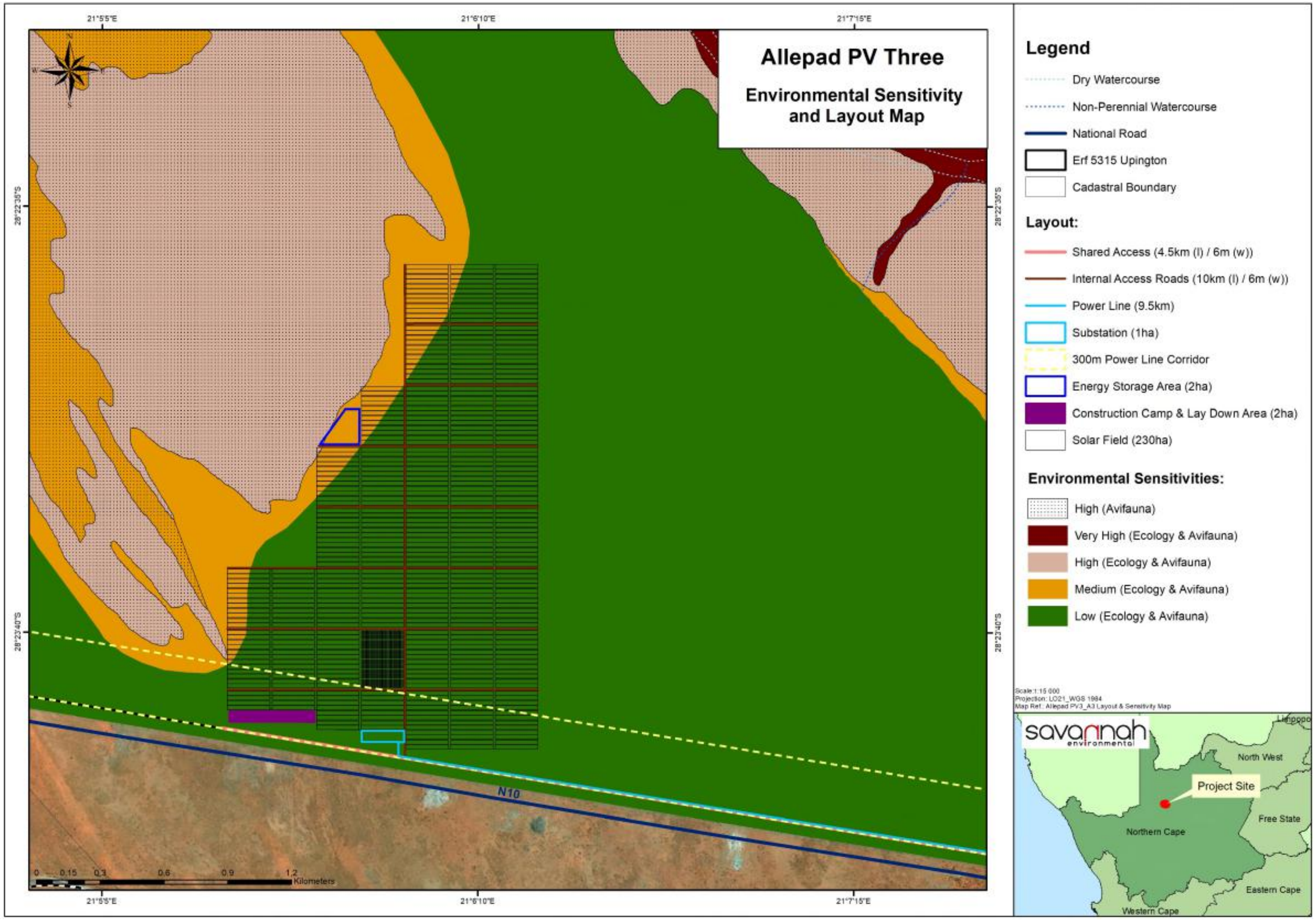

Figure 2.3: Final preferred layout map overlain by the environmental sensitivities for the Allepad PV Three.

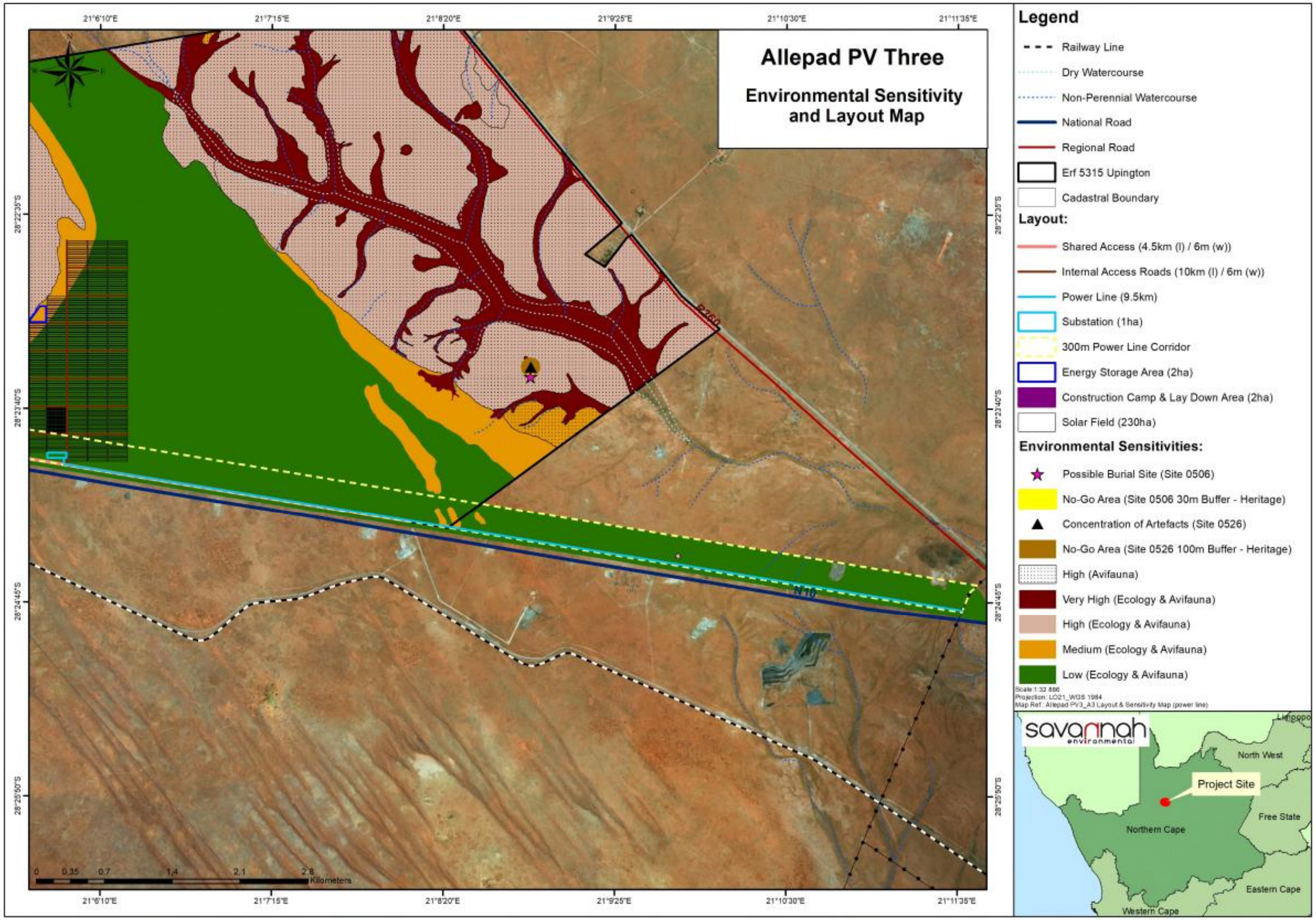

Figure 2.4: **Environmental sensitivity map of the project site and 300m power line corridor assessed for Allepad PV Three**

CHAPTER 3: PURPOSE AND OBJECTIVES OF THE EMPR

An Environmental Management Programme (EMPr) is defined as "an environmental management tool used to ensure that undue or reasonably avoidable adverse impacts of the construction, operation and decommissioning of a project are prevented or mitigated, and that the positive benefits of the projects are enhanced". The objective of this EMPr is to provide consistent information and guidance for implementing the management and monitoring measures established in the permitting process and help achieve environmental policy goals. The purpose of an EMPr is to help ensure continuous improvement of environmental performance, reducing negative impacts and enhancing positive effects during the construction and operation of the facility. An effective EMPr is concerned with both the immediate outcome as well as the long-term impacts of the project.

The EMPr provides specific environmental guidance for the construction and operation phases of a project, and is intended to manage and mitigate construction and operation activities so that unnecessary or preventable environmental impacts do not result. These impacts range from those incurred during start up (site clearing and site establishment) through to those incurred during the construction activities themselves (erosion, noise, dust) to those incurred during site rehabilitation (soil stabilisation, re-vegetation) and operation. The EMPr also defines monitoring requirements in order to ensure that the specified objectives are met.

This EMPr is applicable to all employees and contractors working on the pre-construction, construction, and operation and maintenance phases of Allepad PV Three. The document will be adhered to and updated as relevant throughout the project life cycle.

This EMPr has been compiled in accordance with Appendix 4 of the EIA Regulations, 2014 (as amended) (refer to **Table 2.3**). This is a dynamic document and will be further developed in terms of specific requirements listed in any authorisations issued for Allepad PV Three and/or as the project develops. This will ensure that the construction and operation activities are planned and implemented taking sensitive environmental features into account. The EMPr has been developed as a set of environmental specifications (i.e. principles of environmental management), which are appropriately contextualised to provide clear guidance in terms of the on-site implementation of these specifications (i.e. on-site contextualisation is provided through the inclusion of various monitoring and implementation tools).

The EMPr has the following objectives:

» Outline mitigation measures and environmental specifications which are required to be implemented for the planning, construction, rehabilitation and operation phases of the project in order to minimise the extent of environmental impacts, and to manage environmental impacts associated with Allepad PV Three.
» Ensure that the construction and operation phases do not result in undue or reasonably avoidable adverse environmental impacts, and ensure that any potential environmental benefits are enhanced.
» Identify entities who will be responsible for the implementation of the measures and outline functions and responsibilities.
» Propose mechanisms and frequency for monitoring compliance, and prevent long-term or permanent environmental degradation.
» Facilitate appropriate and proactive responses to unforeseen events or changes in project implementation that were not considered in the EIA process.

The mitigation measures identified within the EIA process are systematically addressed in the EMPr, ensuring the minimisation of adverse environmental impacts to an acceptable level.

ILEnergy Development (Pty) Ltd must ensure that the implementation of the project complies with the requirements of all environmental authorisations, permits, and obligations emanating from relevant environmental legislation. This obligation is partly met through the development and the implementation of this EMPr, and through its integration into the relevant contract documentation provided to parties responsible for construction and/or operation activities on the site. The adequacy and efficacy of implementation is to be monitored by an independent Environmental Control Officer (ECO). Since this EMPr is part of the EIA process for Allepad PV Three, it is important that this document be read in conjunction with the EIA Report compiled for this project. This will contextualise the EMPr and enable a thorough understanding of its role and purpose in the integrated environmental management process. Should there be a conflict of interpretation between this EMPr and the Environmental Authorisation, the stipulations in the Environmental Authorisation shall prevail over that of the EMPr, unless otherwise agreed by the authorities in writing. Similarly, any provisions in legislation overrule any provisions or interpretations within this EMPr.

This EMPr shall be binding on all the parties involved in the planning, construction and operational phases of the project, and shall be enforceable at all levels of contract and operational management within the project. The document must be adhered to and updated as relevant throughout the project life cycle.

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CHAPTER 4: STRUCTURE OF THIS EMPR

The preceding chapters provide background to the EMPr and the proposed project, while the chapters which follow consider the following:

» Planning and design activities;
» Construction activities;
» Operation activities; and
» Decommissioning activities.

These chapters set out the procedures necessary for the project owner to minimise environmental impacts and achieve environmental compliance. For each of the phases of implementation for the PV facility project, an overarching environmental **goal** is stated. In order to meet this goal, a number of **objectives** are listed. The management programme has been structured in table format in order to show the links between the goals for each phase and their associated objectives, activities/risk sources, mitigation actions, monitoring requirements and performance indicators. A specific EMPr table has been established for each environmental objective. The information provided within the EMPr table for each objective is illustrated below:

OBJECTIVE: Description of the objective, which is necessary to meet the overall goals; which take into account the findings of the EIA specialist studies

Project Component/s	List of project components affecting the objective, i.e.: » PV Panels » Access roads; and » Associated infrastructure.
Potential Impact	Brief description of potential environmental impact if objective is not met.
Activity/Risk Source	Description of activities which could affect achieving the objective.
Mitigation: Target/Objective	Description of the target and/or desired outcomes of mitigation.

Mitigation: Action/Control	Responsibility	Timeframe
List specific action(s) required to meet the mitigation target/objective described above.	Who is responsible for the measures	Time periods for implementation of measures

Performance Indicator	Description of key indicator(s) that track progress/indicate the effectiveness of the management programme.
Monitoring	Mechanisms for monitoring compliance; the key monitoring actions required to check whether the objectives are being achieved, taking into consideration responsibility, frequency, methods, and reporting.

The objectives and EMPr tables are required to be reviewed and possibly modified whenever changes, such as the following, occur:

» Planned activities change (i.e. in terms of the components and/or layout of the facility);
» Modification to or addition to environmental objectives and targets;
» Additional or unforeseen environmental impacts are identified and additional measures are required to be included in the EMPr to prevent deterioration or further deterioration of the environment.
» Relevant legal or other requirements are changed or introduced; and
» Significant progress has been made on achieving an objective or target such that it should be re-examined to determine if it is still relevant, should be modified, etc.

4.1 Contents of this Environmental Management Programme (EMPr)

This Environmental Management Programme (EMPr) has been prepared as part of the EIA process being conducted in support of the application for Environmental Authorisation (EA) for the Allepad PV Three. This EMPr has been prepared in accordance with DEA's requirements as contained in Appendix 4 of the 2014 EIA Regulations (GNR 326), and within the Acceptance of Scoping received on 05 December 2018. It provides recommended management and mitigation measures with which to minimise impacts and enhance benefits associated with the project.

An overview of the contents of this EMPr, as prescribed by Appendix 4 of the 2014 EIA Regulations (GNR 326), and where the corresponding information can be found within this EMPr is provided in **Table 4.1.**

Table 4.1: Summary of where the requirements of Appendix 4 of the 2014 NEMA EIA Regulations (GNR 326) are provided in this EMPr.

Requirement	Location in this EMPr
(1) An EMPr must comply with section 24N of the Act and include – (a) Details of – (i) The EAP who prepared the EMPr. (ii) The expertise of that EAP to prepare an EMPr, including a curriculum vitae.	Chapter 4 Appendix K
(b) A detailed description of the aspects of the activity that are covered by the EMPr as identified by the project description.	Chapter 2
(c) A map at an appropriate scale which superimposes the proposed activity, its associated structures, and infrastructure on the environmental sensitivities of the preferred site, indicating any areas that should be avoided, including buffers.	Chapter 2 Figure 2.3 and 2.4 Appendix A
(d) A description of the impact management outcomes, including management statements, identifying the impacts and risks that need to be avoided, managed and mitigated as identified through the environmental impact assessment process for all phases of the development including –	
(i) Planning and design.	Chapter 5
(ii) Pre-construction activities.	Chapter 5
(iii) Construction activities.	Chapter 6
(iv) Rehabilitation of the environment after construction and where applicable post closure.	Chapter 7
(v) Where relevant, operation activities.	Chapter 8

Requirement	Location in this EMPr
(f) A description of proposed impact management actions, identifying the manner in which the impact management outcomes contemplated in paragraph (d) will be achieved, and must, where applicable, include actions to – (i) Avoid, modify, remedy, control or stop any action, activity or process which causes pollution or environmental degradation. (ii) Comply with any prescribed environmental management standards or practices. (iii) Comply with any applicable provisions of the Act regarding closure, where applicable. (iv) Comply with any provisions of the Act regarding financial provision for rehabilitation, where applicable.	Chapters 5 - 8
(g) The method of monitoring the implementation of the impact management actions contemplated in paragraph (f).	Chapters 5 - 8
(h) The frequency of monitoring the implementation of the impact management actions contemplated in paragraph (f).	Chapters 5 - 8
(i) An indication of the persons who will be responsible for the implementation of the impact management actions.	Chapters 5 - 8
(j) The time periods within which the impact management actions contemplated in paragraph (f) must be implemented.	Chapters 5 - 8
(k) The mechanism for monitoring compliance with the impact management actions contemplated in paragraph (f).	Chapters 5 - 8
(l) A program for reporting on compliance, taking into account the requirements as prescribed by the Regulations.	Chapters 6
(m) An environmental awareness plan describing the manner in which – (i) The applicant intends to inform his or her employees of any environmental risk which may result from their work. (ii) Risks must be dealt with in order to avoid pollution or the degradation of the environment.	Chapter 6
(n) Any specific information that may be required by the competent authority.	None have been received to date
(2) Where a government notice gazetted by the Minister provides for a generic EMPr, such generic EMPr as indicated in such notice will apply.	N/A

An overview of the contents of this EMPr, as prescribed by DEA's Acceptance of Scoping received on 05 December 2018, and where the corresponding information can be found within this EMPr is provided in **Table 4.2**.

Table 4.2: Summary of where the requirements prescribed by DEA's Acceptance of Scoping are provided in the EMPr.

DEA requirement for EIA	Response / Location in this EMPr
The Environmental Management Programme (EMPr) to be submitted as part of the EIAr must include the following:	
i. All recommendations and mitigation measures recorded in the EIAr and the specialist studies conducted.	Chapters 5 - 8
ii. A good quality final site layout map with clear legend.	Chapter 2 Figure 2.2 Appendix A
iii. Measures as dictated by the final site layout map and micro-siting.	Chapters 5 - 8

DEA requirement for EIA	Response / Location in this EMPr
iv. An environmental sensitivity map indicating environmental sensitive areas and features identified during the EIA process.	Chapter 2 Figure 2.3 Appendix A
v. A map combining the final layout map superimposed (overlain) on the environmental sensitivity map.	Chapter 2 Figure 2.4 and 2.5 Appendix A
vi. An alien invasive management plan to be implemented during construction and operation of the facility. The plan must include mitigation measures to reduce the invasion of alien species and ensure that the continuous monitoring and removal of alien species is undertaken.	Appendix C
vii. A plant rescue and protection plan which allows for the maximum transplant of conservation important species from areas to be transformed. This plan must be compiled by a vegetation specialist familiar with the site and be implemented prior to commencement of the construction phase.	Appendix D
viii. A re-vegetation and habitat rehabilitation plan to be implemented during the construction and operation of the facility. Restoration must be undertaken as soon as possible after completion of construction activities to reduce the amount of habitat converted at any one time and to speed up the recovery to natural habitats.	Appendix E
ix. A traffic management plan for the site access roads to ensure that no hazards would result from the increased truck traffic and that traffic flow would not be adversely impacted. This plan must include measures to minimize impacts on local commuters e.g. limiting construction vehicles travelling on public roadways during the morning and late afternoon commute time and avoid using roads through densely populated built-up areas so as not to disturb existing retail and commercial operations.	Appendix I
x. A storm water management plan to be implemented during the construction and operation of the facility. The plan must ensure compliance with applicable regulations and prevent off-site migration of contaminated storm water or increased soil erosion. The plan must include the construction of appropriate design measures that allow surface and subsurface movement of water along drainage lines so as not to impede natural surface and subsurface flows. Drainage measures must promote the dissipation of storm water run-off.	Appendix G
xi. A fire management plan to be implemented during the construction and operation of the facility.	Appendix J
xii. Measures to protect archaeological sites, artefacts, paleontological fossils or graves from construction and operational impacts.	Chapter 6 Appendix M1 Objective 16

4.2 Project Team

In accordance with Regulation 12 of the 2014 EIA Regulations (GNR 326) the applicant appointed Savannah Environmental (Pty) Ltd as the independent environmental consultants responsible for managing the application for EA and the supporting EIA process. The application for EA and the EIA process, is being managed in accordance with the requirements of NEMA, the 2014 EIA Regulations (GNR 326), and all other relevant applicable legislation.

4.2.1 Details and Expertise of the Environmental Assessment Practitioner (EAP)

Savannah Environmental is a leading provider of integrated environmental and social consulting, advisory and management services with considerable experience in the fields of environmental assessment and management. The company is wholly woman-owned (51% black woman-owned), and is rated as a Level 2 Broad-based Black Economic Empowerment (B-BBEE) Contributor.

Karen Jodas and Thalita Botha are the EAPs responsible for preparing this EMPr. An overview of their expertise to prepare the EMPr is provided below, and copies of their Curricula Vitae (CVs) detailing the Savannah Environmental team's expertise and relevant experience are provided in **Appendix K** to this EMPr.

» **Karen Jodas** is a Director at Savannah Environmental (Pty) Ltd, and is the registered EAP for the EIA for this project. Karen holds a Master of Science Degree in Geography (M.Sc. Geomorphology) from Rhodes University, and is registered as a Professional Natural Scientist (Pr.Sci.Nat) with the South African Council for Natural Scientific Professions (SACNASP) in the field of Environmental Science (Registration No.: 400106/99). She has more than 20 years of consulting experience in the field of environmental management, impact assessment and compliance. Her key focus is on strategic environmental assessment and advice, management and co-ordination of environmental projects, which includes integration of environmental studies and environmental processes into larger engineering-based projects and ensuring compliance to legislation and guidelines, compliance reporting, the identification of environmental management solutions and mitigation / risk minimising measures, and strategy and guideline development. Karen is currently responsible for the project management of EIAs for several renewable energy projects across the country.

» **Thalita Botha** is an Environmental and GIS Consultant at Savannah Environmental. Thalita has a Bachelor of Science Honours Degree in Environmental Management (B.Sc. Honours) and 3 years of experience in the environmental field. Her key focus is on environmental impact assessments, public participation, environmental management plans and programmes, as well as mapping using ArcGIS for a variety of environmental projects. She is currently involved in several EIAs for energy generation projects across South Africa.

Savannah Environmental's team have been actively involved in undertaking environmental studies over the past 13 years, for a wide variety of projects throughout South Africa, including those associated with electricity generation and infrastructure development, and therefore have extensive knowledge and experience in EIAs and environmental management, having managed and drafted EMPrs for numerous other power generation projects throughout South Africa.

4.2.2 Details of the Specialist Consultants

A team of specialist consultants have been appointed as part of the EIA project team in order to adequately identify and assess potential impacts associated with the project, and have also provided input into this EMPr (refer to **Table 4.3**).

Table 4.3: Specialist Consultants which provided input into this EMPr.

Specialist Study	Specialist Company	Specialist Name
Ecology (Flora and Fauna)	3Foxes Biodiversity Solutions	Simon Todd
Avifauna	3Foxes Biodiversity Solutions	Simon Todd and Eric Hermann
Visual	LOGIS	Lourens du Plessis
Heritage (Archaeology and Palaeontology)	CTS Heritage	Jenna Lavin
Social	Dr. Neville Bews and Associates	Dr. Neville Bews

CHAPTER 5: PLANNING AND DESIGN MANAGEMENT PROGRAMME

Overall Goal: undertake the pre-construction activities (planning and design phase) in a way that:

» Ensures that the preferred design and layout of the PV panels, on-site substation and associated infrastructure responds to the identified environmental constraints and opportunities.
» Ensures that pre-construction activities are undertaken in accordance with all relevant legislative requirements.
» Ensures that adequate regard has been taken of any landowner and community concerns and that these are appropriately addressed through design and planning (where appropriate).
» Ensures that the best environmental options are selected for the linear components (underground cable network, short distribution power line), including the access roads.
» Enables the construction activities to be undertaken without significant disruption to other land uses and activities in the area.

In order to meet this goal, the following objectives have been identified, together with necessary actions and monitoring requirements.

5.1 Objectives

OBJECTIVE 1: Ensure the facility design responds to identified environmental constraints and opportunities

The western half of the site on undulating sandy soils is considered to be low sensitivity apart from the extensive area of mobile dunes which is considered to be medium or high sensitivity as the loose sands are very vulnerable to erosion. The dune habitat is well represented within the bioregion, but due to the deeper soils, supports a number of protected tree species, such as the *Acacia erioloba, A. haematoxylon* and *Boscia albitrunca, B. foetida subsp. foetida.* These tree species, in turn, provide important nesting and roosting sites for birds, including large raptors. The eastern half of the project site occurs on shallow calcrete soils and has numerous drainage lines as well as a few small pans present. Due to the presence of the drainage system and the difficulty involved in avoiding impact to this feature, this area is considered to be of very high ecological sensitivity. The gravel plains are also sensitive due to the habitat diversity of the area and the fact that it supports several pairs of the Near-Threatened Karoo Korhaan (resident) and the Endangered Ludwig's Bustard (nomadic). A small section of sandy habitat is traversed by the development footprint of Allepad PV Three which is considered to be acceptable from an ecological perspective(refer to **Figure 2.3**). The 300m power line corridor traverse some isolated dunes of medium sensitivity, which is considered acceptable due to the isolated location of the dune. These dunes is also located adjacent the main entrance road to the project site, and therefore is unlikely to fulfil the same ecological services as the contiguous dunes fields located well beyond the development footprint.

Project Component/s	» PV panels » Access roads » Power line » On-site substation » Inverter stations

	» Transformer » Underground cabling » Associated buildings (i.e. workshop, ablution facilities, control room, storage, fence).
Potential Impact	» Impact on identified sensitive areas. » Negative visual impact associated with the planning of the PV facility. » Increased risk of veld fire and damage to property as a result.
Activities/Risk Sources	» Positioning of all the facilities components and the viewing of the project components by observers. » Planning of the underground cabling. » Planning for the connection to the on-site substation. » Access road planning. » Positioning of temporary sites.
Mitigation: Target/Objective	» The design of the PV facility, power line responds to the identified environmental constraints and opportunities. » Optimal planning of infrastructure to minimise visual impact. » Site sensitivities are taken into consideration and avoided as far as possible, thereby mitigating potential impacts.

Mitigation: Action/Control	Responsibility	Timeframe
Plan and conduct pre-construction activities in an environmentally acceptable manner.	Developer Contractor	Pre-construction
Undertake a detailed geotechnical pre-construction survey.	Developer Geotechnical specialist	Pre-construction
Plan the placement of laydown areas and temporary construction equipment camps in order to minimise vegetation clearing (i.e. in already disturbed areas) wherever possible and to avoid habitat loss and disturbance to adjoining areas.	Developer	Pre-construction
The route that the power line must follow should be the shortest distance possible across an area where collisions are expected to be minimal, or follow existing power lines, and be marked with bird diverters to make the lines as visible as possible to collision-susceptible species. Recommended bird diverters such as brightly coloured 'aviation' balls, thickened wire spirals, or flapping devices that increase the visibility of the lines should be fitted were considered necessary.	Developer	Pre-construction
Bird friendly structure with a bird perch (as per standard Eskom guidelines) must be used for the tower infrastructure. All relevant perching surfaces should be fitted with bird guards and perch guards as deterrents. Installation of artificial bird space perches and nesting platforms, at a safe distance from energised components. Bird deterrent devices such as "bird diverters" and "flappers" can be used.	Contractor	Planning and design
The construction equipment camps must be planned as close to the site as possible to minimise impacts on the environment.	Developer	Pre-construction
Following the final design of the Allepad PV Three, a final layout must be submitted to DEA for review and approval prior to commencing with construction. No development is permitted	Developer	Pre-construction

Mitigation: Action/Control	Responsibility	Timeframe
within the identified no-go, very high and high sensitivity areas (as shown in **Figure 2.3**).		
An ecological pre-construction walkthrough of the final development footprint (including the final power line alignment and road footprint) must be undertaken prior to the commencement of the construction phase in order to locate species of conservation concern that would be affected and that can be translocated. Results of the walk through survey must be used to apply for the relevant Northern Cape Nature Conservation Act and DENC/DAFF permits.	Developer Specialist	Pre-construction
Ensure that laydown areas, construction camps and other temporary use areas are located in areas of low and are properly fenced or demarcated as appropriate and practically possible.	Developer	Project planning
Ensure that the construction site are fence off and controlled access to these sites are implemented.	Developer	Project planning
Obtain any additional environmental permits required (e.g. protected plant permits, etc.) prior to the commencement of construction. Copies of permits/licenses must be submitted to the Director: Environmental Impact Evaluation at the DEA.	Developer	Project planning
The fence around the facility should be designed with potential impacts on avifauna in mind, following recommendation by Visser (2016)[6] (included as **Appendix M3**. This includes the location and positioning of the electrified strands in relation to the fence as it has been shown that avifauna may become trapped in the gap between these two components of the fence (Visser, 2016).	Developer	Project planning
Access roads and entrances to the site should be carefully planned to limit any intrusion on the neighbouring property owners and road users.	Developer	Planning and design
Prior to construction, the design and layout of any proposed power lines must be endorsed by members of the Eskom-EWT Strategic Partnership, taking into account the mitigation guidelines recommended by Birdlife South Africa (refer to **Appendix M2**.	Developer	Planning and design
The potential to 'stagger' the position of the power line pylons in relation to existing telephone or power line poles/pylons should be investigated, as this may assist in increasing the visibility of power lines to large flying birds such as bustards, which may regularly fly through the area.	Developer	Planning and design
Plan all roads, ancillary buildings and ancillary infrastructure in such a way that clearing of vegetation is minimised. Consolidate infrastructure and make use of already disturbed sites rather than undisturbed areas.	Developer	Project planning
A designated access to the site must be created and clearly marked to ensure safe entry and exit.	Developer Contractor	Design

[6] Visser, E. 2016. The impact of South Africa's largest photovoltaic solar energy facility on birds in the Northern Cape, South Africa. Unpublished MSc thesis, University of Cape Town, Cape Town.

Mitigation: Action/Control	Responsibility	Timeframe
Internal access roads must be carefully planned to maximise road user safety and limit any intrusion on the neighbouring property owners and road users.	Developer Contractor	Design
Roads must be designed so that changes to surface water runoff are avoided and erosion is not initiated.	Developer Contractor	Design
Make use of existing roads wherever possible and plan the layout and construction of roads and infrastructure with due cognisance of the topography to limit cut and fill requirements.	Developer Contractor	Design
The road network to access the panel arrays should be established first and then all vehicular movement must be restricted to within this road network. This will minimise the impact of construction traffic.	Developer Contractor	Design and Planning
Construction vehicles carrying materials to the site must avoid using roads through densely populated built-up areas so as to not disturb existing retail and commercial operations.	Developer Contractor	Design and Planning
Contractors and construction workers must be clearly informed of the no-go, very high and high sensitivity areas.	Developer Contractor	Prior to the commencement of construction
The exact footprint of the construction area, including panel foundations and all roads and infrastructure which are to be surveyed and pegged before any physical construction commences on site.	Developer Contractor	Prior to the commencement of construction
A chance find procedure must be developed and implemented in the event that archaeological or palaeontological resources are found.	Developer Contractor	Pre-construction
Search and Rescue (S&R) of species of concern that will be affected by the development must be undertaken prior to the commencement of construction (**Appendix D**). This must be undertaken in line with the relevant permits issued by DAFF and/or DENC.	Developer Contractor Specialist	Pre-construction
An open space management plan should be developed for the site, which should include management of biodiversity within the affected areas, as well as that in the adjacent bushveld (**Appendix C**).	Contractor	Pre-construction
Plan and placement of light fixtures for the plant and the ancillary infrastructure in such a manner so as to minimise glare and impacts on the surrounding area.	Developer Contractor	Planning
Develop a plan to ensure the correct specification and placement of lighting and light fixtures for the solar energy facility and the ancillary infrastructure. The following is recommended: » Shield the sources of light by physical barriers (walls, vegetation, or the structure itself). » Limit mounting heights of fixtures, or use foot-lights or bollard lights. » Make use of minimum lumen or wattage in fixtures. » Making use of down-lighters or shielded fixtures. » Make use of Low Pressure Sodium lighting or other low impact lighting.	Developer	Planning

Mitigation: Action/Control	Responsibility	Timeframe
» Make use of motion detectors on security lighting, so allowing the site to remain in darkness until lighting is required for security or maintenance purposes.		
Reduce the construction period as far as possible through careful planning and productive implementation of resources.	Developer Contractor	Pre-construction
No temporary site camps must be allowed outside the development footprint of the project.	Developer	Design and planning
An experienced independent Environmental Control Officer (ECO) must be appointed for the construction phase. The ECO must remain employed until after rehabilitation is completed.	Developer	Pre-construction
Pre-construction environmental induction for all construction staff on site must be provided 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, minimising wildlife interactions, remaining within demarcated construction areas etc. Awareness about not harming or hunting ground-dwelling species (e.g. bustards, korhaans, thick-knees and coursers), and owls, which are often persecuted out of superstition, must be included in the induction.	EO	Pre-construction
The terms of this EMPr and the Environmental Authorisation must be included in all tender documentation and Contractors contracts.	Developer Contractor	Pre-construction
All areas to be cleared should be clearly demarcated. Highly sensitive areas as demarcated on the sensitivity map should be avoided, and where such areas occur within or near the development area, they should be clearly demarcated as no-go areas. Only those individuals of protected plant species directly within the development footprint should be cleared.	Developer Contractor Specialist	Design review phase
Areas outside of the footprint, including sensitive areas, must be clearly demarcated (using fencing and appropriate signage) before construction commences and must be regarded as no-go areas.	Developer Contractor	Pre-construction
Underground cables and internal access roads must be aligned as much as possible along existing infrastructure to limit damage to vegetation.	Developer Contractor	Design Pre-construction
Training and skills development programmes to be initiated prior to the commencement of the construction phase.	Developer Contractor	Pre-construction
A local procurement policy must be adopted to maximise the benefit to the local economy.	Developer Contractor	Pre-construction
Develop a database of local companies, specifically Historically Disadvantaged (HD) which qualify as potential service providers (e.g. construction companies, security companies, catering companies, waste collection companies, transportation companies etc.) prior to the tender process and invite them to bid for project-related work where applicable.	Developer	Pre-construction
Where applicable, any tender documentation which may be prepared for the project is to stipulate the use of local labour as far as possible. Tender documentation (if any are required)	Developer Contractor	Pre-Construction

Mitigation: Action/Control	Responsibility	Timeframe
should contain guidelines for the involvement of labour, entrepreneurs, businesses, and SMMEs from the local sector.		
Inform local community members of the construction schedule and exact size of workforce (e.g. Ward Councillor, surrounding landowners).	Developer Contractor	Pre-Construction
Recruitment of temporary workers onsite is not to be permitted. A recruitment office with a Community Liaison Officer should be established to deal with jobseekers.	Developer Contractor	Pre-Construction
Set up a labour desk in a secure and suitable area to discourage the gathering of people at the construction site.	Developer Contractor	Pre-Construction
Have clear rules and regulations for access to the proposed site.	Developer Contractor	Pre-Construction
Local community organisations and policing forums must be informed of construction times and the duration of the construction phase. Also procedures for the control and removal of loiters at the construction site should be established.	Developer Contractor	Pre-Construction
Security company must be appointed and appropriate security procedures to be implemented.	Developer Contractor	Pre-Construction
No unauthorised entry to the site is to be allowed. Appropriate access control must be implemented.	Developer Contractor	Pre-construction Construction
A comprehensive employee induction programme must be developed and utilised to cover land access protocols, fire management and road safety.	Contractor	Pre-construction
Prepare a Fire Management Plan (FMP) (**Appendix J**) in collaboration with surrounding landowners.	Developer	Pre-construction
Communicate the FMP to surrounding landowners and maintain records thereof.	Developer	Pre-construction Construction

Performance Indicator	» The design meets the objectives and does not degrade the environment. » Demarcated sensitive areas are avoided at all times. » Design and layouts respond to the mitigation measures and recommendations in the EIA Report. » Minimal exposure of ancillary infrastructure and lighting at night to observers on or near the site and within the region. » Employment and business policy document that sets out local employment and targets completed before the construction phase commences. » Training and skills development programme undertaken prior to the commencement of the relevant construction phase. » Employee induction programme, covering land access protocols, fire management and road safety. » Ensure a security company is appointed and appropriate security procedures and measures are implemented. » A local procurement policy is adopted.
Monitoring	» Review of the design by the Project Manager and the Environmental Control Officer (ECO) prior to the commencement of construction. » Monitor ongoing compliance with the FMP and method statements.

OBJECTIVE 2: Ensure the selection of the best environmental option for the alignment of the power line and underground cabling

Underground cables will be laid between the PV panels, the transformers and the switchgear. This will require the excavation of trenches within which they can then be laid. Electricity generated by the project will feed into Eskom's national electricity grid via a new 132kV double-circuit power line which will connect the on-site substation to the upgraded 132kV double-circuit power line running between the new Upington Main Transmission Substation (MTS) (currently under construction approximately 15km south of the project site), and the Gordonia Distribution Substation (located in Upington town). The point of connection is located approximately 5km east of the project site and will make use of a loop-in and loop-out configuration, utilising a double-circuit monopole construction. Access to the site is obtained via an existing farm entrance point, which is accessed directly from the N10 national road.

A small pan is located within the 300m power line corridor and is considered to be of high sensitivity and should be avoided by the power line route and associated access road.

Project Component/s	» Underground cabling. » Power line. » Temporary internal access roads.
Potential Impact	» Routes that degrade the environment unnecessarily, particularly with respect to loss of indigenous flora, and erosion. » Impact of the power line on sensitive features.
Activities/Risk Sources	» Alignment of underground cabling. » Alignment of power line. » Alignment of new access roads.
Mitigation: Target/Objective	» Ensure selection of best environmental option for alignment of the linear infrastructure. » Environmental sensitivities are taken into consideration and avoided as far as possible, thereby mitigating potential impacts.

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Select an alignment for the underground cabling, power line and any new access roads that minimises environmental impacts and enhances environmental benefits.	Developer Contractor	Prior to submission of the final construction layout plan
Consider design level mitigation measures recommended by the specialists as detailed within the EIA Report and relevant appendices regarding the associated infrastructure.	Developer Contractor	Design

Performance Indicator	» Underground cabling, power line and new access road alignments meet environmental objectives. » Selected linear alignments that minimise any negative environmental impacts and maximise any benefits.
Monitoring	» Ensure that the design implemented meets the objectives and mitigation measures in the EIA Report through review of the design by the Project Manager, and the ECO prior to the commencement of construction.

OBJECTIVE 3: Minimise storm water runoff

Project Component/s	» Storm water management components. » All hard engineered surfaces (i.e. new access roads).
Potential Impact	» Poor storm water management and alteration of the hydrological regime.
Activities/Risk Sources	» Construction of the facility (i.e. placement of hard engineered surfaces).
Mitigation: Target/Objective	» Appropriate management of storm water to minimise impacts on the environment.

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Appropriately plan hard-engineered erosion protection structures to be implemented in areas potentially susceptible to erosion.	Developer Contractor	Planning and design
Design an appropriate storm water management plan for implementation during construction and operation (**Appendix G**). This plan must ensure the suitable handling of storm water within the site.	Developer Contractor	Planning and design
Designs for the buildings and site development in general must avoid concentration of storm water runoff both spatially and in time and may be required to provide for attenuation of storm water	Contractor	Planning and design
Construction must include appropriate design measures that allow surface and sub-surface movement of water. Drainage measures must promote the dissipation of storm water runoff.	Developer Contractor	Planning and design

Performance Indicator	» Appropriate storm water management plan developed for implementation prior to commencement of construction. » Minimal erosion.
Monitoring	» Surface water quality monitoring plan.

OBJECTIVE 4: To ensure effective communication mechanisms

On-going communication with affected and surrounding landowners is important to maintain during the construction and operation phases of the development. Any issues and concerns raised should be addressed as far as possible in as short a timeframe as possible.

Project component/s	» PV panels » Access roads » Power line » Underground cabling » Laydown area » Associated buildings and associated infrastructure (workshop, storage facility, ablution facility, substation, inverters, transformers, energy storage area etc.).

Potential Impact	» Impacts on affected and surrounding landowners and land uses
Activity/risk source	» Activities associated with the PV facility construction » Activities associated with the PV facility operation
Mitigation: Target/Objective	» Effective communication with affected and surrounding landowners » Addressing of any issues and concerns raised as far as possible in as short a timeframe as possible

Mitigation: Action/control	**Responsibility**	**Timeframe**
Compile and implement a grievance mechanism procedure for the public (following the guidelines of the grievance mechanism in **Appendix B**) to be implemented during both the construction and operation phases of the facility. This procedure should include details of the contact person who will be receiving issues raised by interested and affected parties, and the process that will be followed to address issues.	Developer Contractor O&M Contractor	Pre-construction (construction procedure) Pre-operation (operation procedure)
Develop and implement a grievance mechanism for the construction, operation and closure phases of the project for all employees, contractors, subcontractors and site personnel. This procedure should be in line with the South African Labour Law.	Developer Contractor O&M Contractor	Pre-construction (construction procedure) Pre-operation (operation procedure)
Appoint a Community Liaison Officer (CLO) for implementing the grievance mechanism. A method of communication should be implemented whereby procedures to lodge complaints are set out in order for the local community and landowners to express any complaints or grievances with the construction process.	Contractor	Pre-construction and construction
Liaison with landowners must be undertaken prior to the commencement of construction in order to provide sufficient time for them to plan agricultural activities.	Developer Contractor	Pre-construction
Before construction commences, representatives from the local municipality, community leaders, community-based organisations and the surrounding property owners (of the larger area), must be informed of the details of the contractors, size of the workforce and construction schedules.	Developer Contractor	Pre-construction and construction

Performance Indicator	» Effective communication procedures in place.
Monitoring	» A Public Complaints register must be maintained, by the Contractor to record all complaints and queries relating to the project and the action taken to resolve the issue. » All correspondence should be in writing. » The developer and contractor must keep a record of local recruitments and information on local labour; to be shared with the ECO for reporting purposes during construction.

OBJECTIVE 5: Ensure that all relevant personnel and staff are familiar with the provisions of the EMPr, as well as the conditions of the Environmental Authorisation and requirement for environmental preservation

It is recommended that a pre-construction environmental compliance workshop be undertaken before any construction commences on site. This workshop can be combined with a site handover meeting, but must take place before any activities take place on site and before any equipment is moved onto site. Furthermore, all construction workers should receive an induction presentation, as well as on-going environmental education, awareness and training on the importance and implications of the EMPr and the environmental requirements it prescribes. The contractor should provide a translator from their staff for the purpose of translating should this be necessary.

Project Component/s	» All components and activity impacts mentioned in the EMPr » All components and activity impacts mentioned in the EIA Report
Potential Impact	» Positive impact on creating project awareness » Skills improvement » Project compliance
Activities/Risk Sources	» Compliance workshop » Slide presentations » On-going environmental education and awareness training
Mitigation: Target/Objective	» Environmental sensitivities are taken into consideration and avoided as far as possible, thereby mitigating potential impacts.

Mitigation: Action/Control	Responsibility	Timeframe
Induction training must ensure that construction workers/staff understand that no form of plant or wildlife poaching, collecting or other form of disturbance will be permitted on the construction site or the adjacent areas.	EO	Pre-construction
The ECO must be briefed by an archaeologist prior to construction activities commencing of any possible areas of heritage significance.	Archaeologist	Pre-construction
As a minimum, ongoing training should include: » Explanation of the importance of complying with the EMPr; » Explanation of the importance of complying with the Environmental Authorisation; » Discussion of the potential environmental impacts of construction activities; » Employees' roles and responsibilities, including emergency preparedness (this should be combined with this induction, but presented by the contractors Health and Safety Representative); » Explanation of the mitigation measures that must be implemented when carrying out activities; and » Explanation of the specifics of this EMPr and its specification (no-go areas, etc.).	Contractor EO	Pre-construction Construction Operation

Performance Indicator	» Staff Performance » Staff adherence » Staff attendance » The contractor must keep records of all environmental training sessions, including names, dates and the information presented. Details of the environmental induction must be included in the environmental control reports.
Monitoring	» Records of training are kept on site.

CHAPTER 6: MANAGEMENT PROGRAMME: CONSTRUCTION

Overall Goal: Undertake the construction phase in a way that:

» Ensures that construction activities are appropriately managed in respect of environmental aspects and impacts.
» Enables construction activities to be undertaken without significant disruption to other land uses and activities in the area, in particular concerning noise impacts, farming practices, traffic and road use, and effects on local residents.
» Minimises the impact on the indigenous natural vegetation, and habitats of ecological value.
» Minimises impacts on fauna (including birds) in the study area.
» Minimises the impact on heritage sites should they be uncovered.
» Establish an environmental baseline during construction activities on the site, where possible.

6.1 Institutional Arrangements: Roles and Responsibilities for the Construction Phase

As the proponent, the Developer must ensure that the project complies with the requirements of all environmental authorisations and permits, and obligations emanating from other relevant environmental legislation. This obligation is partly met through the development of the EMPr, and the implementation of the EMPr through its integration into the contract documentation. The Developer will retain various key roles and responsibilities during the construction phase.

OBJECTIVE 1: Establish clear reporting, communication, and responsibilities in relation to the overall implementation of the EMPr

Formal responsibilities are necessary to ensure that key procedures are executed. Specific responsibilities of the Technical Director/Manager, Site Manager, Internal Environmental Officer, Safety and Health Representative, Independent Environmental Control Officer (ECO) and Contractor for the construction phase of this project are as detailed below. Formal responsibilities are necessary to ensure that key procedures are executed. **Figure 6.1** provides an organogram indicating the organisational structure for the implementation of the EMPr.

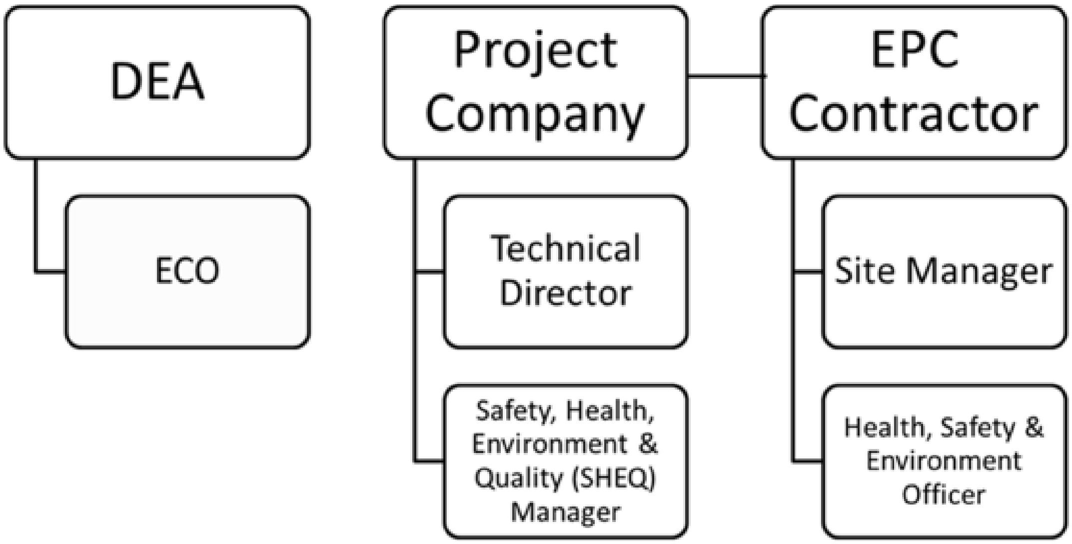


Figure 6.4: Organisational structure for the implementation of the EMPr

Construction Manager will:

- Ensure all specifications and legal constraints specifically with regards to the environment are highlighted to the Contractor(s) so that they are aware of these.
- Ensure that the Developer and its Contractor(s) are made aware of all stipulations within the EMPr.
- Ensure that the EMPr is correctly implemented throughout the project by means of site inspections and meetings. This will be documented as part of the site meeting minutes through input from the independent ECO.
- Be fully conversant with the EIA for the project, the EMPr, the conditions of the Environmental Authorisation, and all relevant environmental legislation.
- Be fully knowledgeable with the contents of all relevant licences and permits.

Site Manager (The Contractor's on-site Representative) will:

- Be fully knowledgeable with the contents of the EIA.
- Be fully knowledgeable with the contents and conditions of the Environmental Authorisation.
- Be fully knowledgeable with the contents of the EMPr.
- Be fully knowledgeable with the contents of all relevant environmental legislation, and ensure compliance with these.
- Have overall responsibility of the EMPr and its implementation.
- Conduct audits to ensure compliance to the EMPr.
- Ensure there is communication with the Technical Director, the ECO, the Internal Environmental Officer and relevant discipline engineers on matters concerning the environment.
- Be fully knowledgeable with the contents of all relevant licences and permits.
- Ensure that no actions are taken which will harm or may indirectly cause harm to the environment, and take steps to prevent pollution on the site.
- Confine activities to the demarcated construction site.

An independent **Environmental Control Officer (ECO)** must be appointed by the project proponent prior to the commencement of any authorised activities and will be responsible for monitoring, reviewing and verifying compliance by the Contractor with the environmental specifications of the EMPr and the conditions of the Environmental Authorisation. Accordingly, the ECO will:

» Be fully knowledgeable of the contents of the EIA.
» Be fully knowledgeable of the contents of the conditions of the EA (once issued).
» Be fully knowledgeable of the contents of the EMPr.
» Be fully knowledgeable of the contents of all relevant environmental legislation, and ensure compliance therewith.
» Be fully knowledgeable with the contents of all relevant licences and permits issued for the project.
» Ensure that the contents of the EMPr are communicated to the Contractors site staff and that the Site Manager and Contractors are constantly made aware of the contents through ongoing discussion.
» Ensure that compliance with the EMPr is monitored through regular and comprehensive inspection of the site and surrounding areas.
» Ensure that the Site Manager has input into the review and acceptance of construction methods and method statements.
» Ensure that activities on site comply with all relevant environmental legislation.
» Ensure that a removal is ordered of any person(s) and/or equipment responsible for any contravention of the specifications of the EMPr.
» Ensure that any non-compliance or remedial measures that need to be applied are reported.
» Keep records of all activities on site, problems identified, transgressions noted and a task schedule of tasks undertaken by the ECO.
» Independently report to the Department of Environmental Affairs (DEA) in terms of compliance with the specifications of the EMPr and conditions of the EA (once issued).
» Keep records of all reports submitted to DEA.

As a general mitigation strategy, the Environmental Control Officer (ECO) should be present for the site preparation and initial clearing activities to ensure the correct demarcation of no-go areas, facilitate environmental induction with construction staff and supervise any flora relocation and faunal rescue activities that may need to take place during the site clearing (i.e. during site establishment, and excavation of foundations). Thereafter, weekly site compliance inspections would probably be sufficient, which must be increased if required. However, in the absence of the ECO there should be a designated owner's environmental officer present to deal with any environmental issues that may arise such as fuel or oil spills. The ECO shall remain employed until all rehabilitation measures, as required for implementation due to construction damage, are completed and the site handed over for operation.

Contractor's Safety, Health and Environment Representative: The Contractor's Safety, Health and Environment (SHE) Representative, employed by the Contractor, is responsible for managing the day-to-day on-site implementation of this EMPr, and for the compilation of regular (usually weekly) Monitoring Reports. In addition, the SHE must act as liaison and advisor on all environmental and related issues and ensure that any complaints received from the public are duly recorded and forwarded to the Site Manager and Contractor. In some instances, a separate Environmental Officer (EO) may be appointed to support this function.

The Contractor's Safety, Health and Environment Representative and/or Environmental Officer should:

» Be well versed in environmental matters.
» Understand the relevant environmental legislation and processes and the implementation thereof.

- » Understand the hierarchy of Environmental Compliance Reporting, and the implications of Non-Compliance.
- » Know the background of the project and understand the implementation programme.
- » Be able to resolve conflicts and make recommendations on site in terms of the requirements of this specification.
- » Keep accurate and detailed records of all EMPr-related activities on site. The EO shall keep a daily diary for monitoring the site specific activities as per project schedule.
- » Supervise any flora relocation and faunal rescue activities that may need to take place during the site clearing (i.e. during site establishment, and excavation of foundations) and therefore needs the relevant training/ experience. The EO will have overall responsibility for day-to day environmental management and implementation of mitigations.
- » The EO is responsible for reporting to the ECO on the day-to-day on-site implementation of this EMPr and other Project Permits/Authorisations.
- » Ensure or otherwise train and induct all contractor's employees prior to commencement of any works.
- » Ensure that there is daily communication with the Site Manager regarding the monitoring of the site.
- » Compilation of Weekly and Monthly Monitoring Reports to be submitted to the ECO and Site Manager.
- » In addition, the EO/ Environmental Representative must act as project liaison and advisor on all environmental and related issues and ensure that any complaints received from the public are duly recorded and forwarded to the Site Manager, ECO and Contractor(s).

Contractors and Service Providers: It is important that Contractors are aware of the responsibilities in terms of the relevant environmental legislation and the contents of this EMPr. The Contractor must appoint an Internal Environmental Officer (EO) who will be responsible for informing contractor employees and sub-contractors of their environmental obligations in terms of the environmental specifications, and for ensuring that employees are adequately experienced and properly trained in order to execute the works in a manner that will minimise environmental impacts. The Internal Environmental Officer and Contractor's obligations in this regard include the following:

- » Must be fully knowledgeable on all environmental features of the construction site and the surrounding environment.
- » Be fully knowledgeable with the contents and the conditions of the Environmental Authorisation.
- » Be fully knowledgeable with the contents with the EMPr.
- » Be fully knowledgeable of all the licences and permits issued for the site.
- » Ensure a copy of the Environmental Authorisation and EMPr is easily accessible to all on-site staff members.
- » Ensure contractor employees are familiar with the requirements of this EMPr and the environmental specifications as they apply to the construction of the proposed facility.
- » Ensure that prior to commencing any site works, all contractor employees and sub-contractors must have attended environmental awareness training included in the induction training which must provide staff with an appreciation of the project's environmental requirements, and how they are to be implemented.
- » Ensure that any complaints received from the public are duly recorded and forwarded to the Site Manager and Contractor.
- » Manage the day-to-day on-site implementation of this EMPr, and the compilation of regular (usually weekly) Monitoring Reports.
- » Keep record of all activities on site, problems identified, transgressions noted and a task schedule of tasks undertaken, including those of the Independent ECO.
- » Inform staff of the environmental issues as deemed necessary by the Independent ECO.

All contractors (including sub-contractors and staff) and service providers are ultimately responsible for:

» Ensuring adherence to the environmental management specifications.
» Ensuring that Method Statements are submitted to the Site Manager (and ECO) for approval before any work is undertaken.
» Ensuring that any instructions issued by the Site Manager on the advice of the ECO are adhered to.
» Ensuring that a report is tabled at each site meeting, which will document all incidents that have occurred during the period before the site meeting.
» Ensuring that a register is kept in the site office, which lists all transgressions issued by the ECO.
» Ensuring that a register of all public complaints is maintained.
» Ensuring that all employees, including those of sub-contractors, receive training before the commencement of construction in order for the sub-contractors to constructively contribute towards the successful implementation of the EMPr (i.e. ensure their staff are appropriately trained on the environmental obligations).

6.2 Objectives

In order to meet the overall goal for construction, the following objectives, actions, and monitoring requirements have been identified.

OBJECTIVE 2: Minimise impacts related to inappropriate site establishment

Project Component/s	» Area infrastructure (i.e. PV panels, substation, inverters, transformers, switchgear and ancillary buildings). » Linear infrastructure (i.e. underground cabling, power line, main access road and internal access roads and fencing).
Potential Impact	» Hazards to landowners and the public. » Damage to indigenous natural vegetation. » Loss of threatened plant species. » Visual impact of general construction activities, and the potential scarring of the landscape due to vegetation clearing and resulting erosion.
Activities/Risk Sources	» Any unintended or intended open excavations (foundations and cable trenches). » Movement of construction vehicles in the area and on-site. » The viewing of the construction of the PV facilities by visually sensitive observers. » Transport to and from the temporary construction or storage area/s.
Mitigation: Target/Objective	» To secure the site against unauthorised entry. » To protect members of the public/landowners/residents. » No loss of or damage to sensitive vegetation in areas outside the immediate development footprint. » Minimal visual intrusion by construction activities and intact vegetation cover outside of the immediate construction work areas.

Mitigation: Action/Control	Responsibility	Timeframe
Secure site, working areas and excavations in an appropriate manner.	Contractor	Site establishment, and duration of construction

Mitigation: Action/Control	Responsibility	Timeframe
Ensure that no activities infringe on identified no-go, very high and high sensitivity areas.	Contractor	Duration of construction
The siting of the construction equipment camp/s must take cognisance of any sensitive areas identified in the EIA Report. The location of this construction equipment camp/s must be approved by the project EO.	Contractor	Pre-construction
Ensure that vegetation is not unnecessarily cleared or removed during the construction phase.	Contractor	Site establishment, and duration of construction
Any individuals of protected species affected by and observed within the development footprint during construction which cannot be avoided, should be translocated under the supervision of the Contractor's Environmental Officer (EO).	EO Specialist	Construction
Reduce the construction phase through careful logistical planning and productive implementation of resources.	Contractor	Construction
Restrict the activities and movement of construction workers and vehicles to the immediate construction site and existing access roads.	Contractor	Construction
Ensure that rubble, litter, and disused construction materials are appropriately stored (if not removed daily) and then disposed regularly at licensed waste facilities.	Contractor	Construction
Reduce and control construction dust through the use of approved dust suppression techniques as and when required (i.e. whenever dust becomes apparent).	Contractor	Construction
Restrict construction activities to daylight hours in order to negate or reduce the visual impacts associated with lighting.	Contractor	Construction
Rehabilitate all disturbed areas, construction areas, servitudes, etc. immediately after the completion of construction works. If necessary, an ecologist should be consulted to assist or give input into rehabilitation specifications.	Contractor	Construction
Adequate protective measures must be implemented to prevent unauthorised access to the working area and the internal access routes. The development (including the development footprint and contractor's equipment camp) must also be secured and fenced and clearly demarcated.	Contractor	Site establishment, and duration of construction
All unattended open excavations shall be adequately demarcated and/or fenced. Adequate protective measures must be implemented to prevent unauthorised access to the working area and the internal access/haul routes.	Contractor	Construction
Establish appropriately bunded areas for storage of hazardous materials (i.e. fuel to be required during construction).	Contractor	Site establishment
Visual impacts must be reduced during construction through minimising areas of surface disturbance, controlling erosion, using dust suppression techniques, and restoring exposed soil as closely as possible to their original contour and vegetation.	Contractor	Site establishment, and duration of construction
Cleared alien vegetation must not be dumped on adjacent intact vegetation during clearing but must be temporarily stored in a demarcated area.	Contractor	Site establishment, and duration of construction

Mitigation: Action/Control	Responsibility	Timeframe
Establish the necessary ablution facilities with chemical toilets and provide adequate sanitation facilities and ablutions for construction workers so that the surrounding environment is not polluted (at least one sanitary facility for each sex and for every 30 workers as per the 2014 Construction Regulations; Section 30(1)(b)) at appropriate locations on site). The facilities must be placed within the construction area and along the road.	Contractor	Site establishment, and duration of construction
Ablution or sanitation facilities must not be located within 100m from a watercourse or within the 1:100 year flood.	Contractor	Site establishment, and duration of construction
Supply adequate weather and vermin proof waste collection bins and skips (covered at minimum with secured netting or shade cloth) at the site where construction is being undertaken. Separate bins should be provided for general and hazardous waste. Provision should be made for separation of waste for recycling.	Contractor	Site establishment, and duration of construction
Foundations and trenches must be backfilled to originally excavated materials as much as possible. Excess excavation materials must be disposed of only in approved areas, or, if suitable, stockpiled for use in reclamation activities.	Contractor	Site establishment, and duration of construction and rehabilitation

Performance Indicator	» Site is secure and there is no unauthorised entry. » No members of the public/ landowners injured. » Appropriate and adequate waste management and sanitation facilities provided at construction site. » Vegetation cover on and in the vicinity of the site is intact (i.e. full cover as per natural vegetation within the environment) with no evidence of degradation or erosion.
Monitoring	» An incident reporting system is used to record non-conformances to the EMPr. » EO and ECO to monitor all construction areas on a continuous basis until all construction is completed. Non-conformances will be immediately reported to the site manager. » Monitoring of vegetation clearing during construction (by contractor as part of construction contract). » Monitoring of rehabilitated areas quarterly for at least a year following the end of construction (by contractor as part of construction contract).

OBJECTIVE 3: Appropriate management of the construction site and construction workers

At the peak of construction the proposed project is likely to create a maximum of 300 employment opportunities. These employment opportunities will be temporary, and will last for a period of approximately 18 months (i.e. the length of construction). Employment opportunities generated during the construction phase will include low skilled, semi-skilled, and skilled opportunities. Solar PV projects make use of large numbers of unskilled and semi-skilled labour so there will be good opportunity to use local labour from the surrounding towns.

Security personnel will be deployed on a shift basis. Contractors and their employees are expected to be accommodated at existing accommodation facilities in the surrounding towns (i.e. Upington, Keimoes). Construction equipment will need to be stored at appropriate locations on site.

Project Component/s	» PV facility. » Contractors' camp. » Laydown areas. » Access roads » Power line. » On-site substation. » Ancillary buildings.
Potential Impact	» Damage to indigenous natural vegetation and sensitive areas. » Damage to and/or loss of topsoil (i.e. pollution, compaction etc.). » Impacts on the surrounding environment due to inadequate sanitation and waste removal facilities. » Pollution/contamination of the environment. » Veld fires can pose a personal safety risk to local farmers and communities, and their homes, crops, livestock and farm infrastructure, such as gates and fences.
Activities/Risk Sources	» Vegetation clearing and levelling of equipment storage area/s. » Access to and from the equipment storage area/s. » Ablution facilities. » Contractors not aware of the requirements of the EMPr, leading to unnecessary impacts on the surrounding environment. » The presence of construction personnel and their activities on the site can increase the risk of veld fires.
Mitigation: Target/Objective	» Limit equipment storage within demarcated designated areas. » Ensure adequate sanitation facilities and waste management practices. » Ensure appropriate management of actions by on-site personnel in order to minimise impacts to the surrounding environment. » To avoid and or minimise the potential risk of veld fires on local communities and their livelihoods.

Mitigation: Action/Control	**Responsibility**	**Timeframe**
In order to minimise impacts on the surrounding environment, contractors must be required to adopt a certain Code of Conduct and commit to restricting construction activities to areas within the development footprint. Contractors and their sub-contractors must be familiar with the conditions of the Environmental Authorisation, the EIA Report, and this EMPr, as well as the requirements of all relevant environmental legislation.	Contractors	Construction
Ensure that the mitigation hierarchy is applied with a particular emphasis on reducing the development footprint, rehabilitating disturbed areas and minimising degradation around the site.	Contractors	Construction
Encourage local people to report any suspicious activity associated with the construction site to the community liaison officer.	Contractors	Construction
All construction vehicles must adhere to clearly defined and demarcated roads. No driving outside of the development boundary must be permitted.	Contractor	Construction

Mitigation: Action/Control	Responsibility	Timeframe
Ensure all construction equipment and vehicles are properly maintained at all times.	Contractor	Construction
Ensure that construction workers are clearly identifiable. All workers should carry identification cards and wear identifiable clothing.	Contractor	Construction
As far as possible, minimise vegetation clearing and levelling for equipment storage areas.	Contractor	Site establishment, and during construction
Ensure that operators and drivers are properly trained and make them aware, through regular toolbox talks, of any risk they may pose to the community. Emphasis should be placed on the vulnerable sector of the population such as children and the elderly.	Contractor	Construction
Open fires on the site for heating, smoking or cooking are not allowed, except in designated areas.	Contractor	Construction
Contractor must provide adequate firefighting equipment on site and provide firefighting training to selected construction staff.	Contractor	Construction
Personnel trained in first aid should be on site to deal with smaller incidents that require medical attention.	Contractor	Construction
Road borders must be regularly maintained to ensure that vegetation remains short to serve as an effective firebreak. An emergency fire plan (refer to **Appendix J**) must be developed with emergency procedures in the event of a fire.	Contractor	Erection: during site establishment Maintenance: duration of contract
Rehabilitate all disturbed areas at the construction equipment camp as soon as construction is complete within an area.	Contractor	Duration of Contract
Ensure waste storage facilities are maintained and emptied on a regular basis.	Contractor	Site establishment, and duration of construction
No liquid waste, including grey water, may be discharged into any water body or drainage line. All sewage disposal to take place at a registered and operational wastewater treatment works. Proof of disposal to be retained as proof of responsible disposal.	Contractor	Maintenance: duration of contract within a particular area
Ensure that all personnel have the appropriate level of environmental awareness and competence to ensure continued environmental due diligence and on-going minimisation of environmental harm. This can be achieved through the provision of appropriate environmental awareness training to all personnel. Records of all training undertaken must be kept.	Contractor	Duration of construction
Ensure compliance with all national, regional and local legislation with regard to the storage, handling and disposal of hydrocarbons, chemicals, solvents and any other harmful and hazardous substances and materials.	Contractor	During construction.
Ensure ablution facilities are appropriately maintained. Ablutions must be cleaned regularly and associated waste disposed of at a registered/permitted waste disposal site. Ablutions must be removed from site when construction is completed.	Contractor and sub-contractor/s	Duration of contract
Cooking and eating of meals must take place in a designated area. No fires are allowed on site. No firewood or kindling may be gathered from the site or surrounds.	Contractor and sub-contractor/s	Duration of contract

Mitigation: Action/Control	Responsibility	Timeframe
All litter must be deposited in a clearly marked, closed, animal-proof disposal bin in the construction area. Particular attention needs to be paid to food waste.	Contractor and sub-contractor/s	Duration of contract
Keep a record of all hazardous substances stored on site. Clearly label all the containers storing hazardous waste.	Contractor	Duration of contract
A Method Statement should be compiled for the management of pests and vermin within the site, specifically relating to the canteen area if applicable.	Contractor	Construction
No disturbance of flora or fauna must be undertaken outside of the demarcated construction area/s.	Contractor and sub-contractor/s	Duration of contract
Fire-fighting equipment and training must be provided before the construction phase commences.	Contractor and sub-contractor/s	Duration of contract
Workers must be aware of the importance of not watercourses and drainage systems (especially those located within and surrounding the project site) and the significance of not undertaking activities that could result in such pollution.	Contractor and EO	Pre-construction Construction
Contractors must ensure that all workers are informed at the outset of the construction phase of the conditions contained on the Code of Conduct, specifically consequences of stock theft and trespassing on adjacent farms.	Contractor and sub-contractor/s	Pre-construction
On completion of the construction phase, all construction workers must leave the site within one week of their contract ending.	Contractor and sub-contractor/s	Construction
When possible, no activity should be undertaken at the site between sunset and sunrise, except for security personnel guarding the development.	Contractor and sub-contractor/s	Construction
Prepare a Method Statement pertaining to the clearance of vegetation under solar panels in accordance with the Fire Management Plan (FMP).	Contractor	Construction

Performance Indicator	» The construction camps have avoided highly sensitive areas. » Ablution and waste removal facilities are in a good working order and do not pollute the environment due to mismanagement. » All areas are rehabilitated promptly after construction in an area is complete. » Excess vegetation clearing and levelling is not undertaken. » No complaints regarding contractor behaviour or habits. » Appropriate training of all staff is undertaken prior to them commencing work on the construction site. » Code of Conduct drafted before commencement of the construction phase. » Firefighting equipment and training provided before the construction phase commences.
Monitoring	» Regular audits of the construction camps and areas of construction on site by the EO. » Proof of disposal of sewage at an appropriate licensed wastewater treatment works. » Proof of disposal of waste at an appropriate licensed waste disposal facility. » An incident reporting system should be used to record non-conformances to the EMPr. » Observation and supervision of Contractor practices throughout the construction phase by the EO. » The Contractor must monitor indicators listed above to ensure that they have been met. » Complaints will be investigated and, if appropriate, acted upon.

OBJECTIVE 4: Maximise local employment, skills development and business opportunities associated with the construction phase

Employment opportunities will be created during the construction phase, specifically for semi-skilled and unskilled workers. Employment of locals and the involvement of local SMMEs would enhance the social benefits associated with the project, even if the opportunities are only temporary. The procurement of local goods could furthermore result in positive economic spin-offs.

Project Component/s	» Construction activities associated with the establishment of the PV facility. » Availability of required skills in the local communities for the undertaking of the construction activities.
Potential Impact	» The opportunities and benefits associated with the creation of local employment and business should be maximised.
Activities/Risk Sources	» Contractors who make use of their own labour for unskilled tasks, thereby reducing the employment and business opportunities for locals. » Potential local economic benefits. » Sourcing of individuals with skills similar to the local labour pool outside the municipal area. » Unavailability of locals with the required skills resulting in locals not being employed and labour being sourced from outside the municipal area. » Higher skilled positions might be sourced internationally, where required.
Enhancement: Target/Objective	» The developer should aim to employ as many low-skilled and semi-skilled workers from the local area as possible. This should also be made a requirement for all contractors. » Employment of a maximum number of the low-skilled and/or semi-skilled workers from the local area where possible. » Appropriate skills training and capacity building. » Increase in the procurement of goods and services, especially within the local economy.

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Employment of local community members (i.e. source labour from within the municipal area focused on the communities in closest proximity to the site) should be undertaken where possible.	Developer, Local Municipality, and Contractor	Duration of construction
Adopt a local employment policy to maximise the opportunities made available to the local labour force. Screening of applicants should be undertaken which may lessen perceived negative perceptions about the outside workforce.	Contractor	Construction
Set realistic local recruitment targets for the construction phase.	Contractor	Construction
A broad-based approach should be followed to identify and involve relevant organisations which could assist the main contractor and developer in identifying people whose skills may correspond with the required job specifications.	Developer, Local Municipality, and Contractor	Pre-construction
The developer, in discussions with the local municipality, should aim to employ a maximum number of the low-skilled and/or semi-skilled workers from the local area where possible.	The developer, Contractor, and Local Municipality	Duration of construction
Employ local contractors that are compliant with Broad Based Black Economic Empowerment (B-BBEE) criteria, as much as possible.	Contractor	Construction

Mitigation: Action/Control	Responsibility	Timeframe
Source as much goods and services as possible from the local area. Engage with local authorities and business organisations to investigate the possibility of procurement of construction materials, goods and products from local suppliers where feasible.	Contractor	Construction
A skills transfer plan should be put in place at an early stage and workers should be given the opportunity to develop skills which they can use to secure jobs elsewhere post-construction.	Developer	Post-construction
In cases for the semi-skilled jobs, where the relevant skills do not exist, training should be provided to willing local community members to enable them to fill the positions.	The developer, Contractor, and Local Municipality	Duration of construction
A proactive consultative skills-audit should be undertaken in the local communities where job creation is currently a significant need.	The developer, and Local Municipality	Pre-construction, and construction
Appropriate training should be provided as per a decided upon skills development plan to narrow the gap between skills and demand. It is preferable that training be of such a nature that the skills thereby acquired are transferable and of real benefit in other employment contexts.	The developer, and Local Municipality	Pre-construction, and construction
An equitable process should be promoted whereby locals and previously disadvantaged individuals (including women) are considered for employment opportunities.	Developer, and Local Municipality	Duration of construction
In the recruitment selection process, a minimum percentage of women must be employed.	Contractor	Pre-construction Construction
Women should be given equal employment opportunities and encouraged to apply for positions.	Contractor	Construction
Create conditions that are conducive for the involvement of entrepreneurs, small businesses, and SMMEs during the construction process.	Developer, Local Municipality, and Contractor	Pre-construction
Identify potential opportunities for local businesses.	Developer	Pre-construction
Tender documentation (if any are required) should contain guidelines for the involvement of labour, entrepreneurs, businesses, and SMMEs from the local sector.	Developer Contractor	Pre-construction
A procurement policy promoting the use of local business should, where possible, be put in place.	Contractor	Construction
A local labour desk should be set-up (if not already established) in the beneficiary communities to co-ordinate the process of involving local labour.	Developer Contractor	Pre-construction
Skills training and capacity building should be embarked upon from the onset of the construction phase and even prior to the construction phase if possible (as mentioned above).	Developer Contractor	Pre-construction and construction
Communication efforts concerning job creation opportunities should refrain from creating unrealistic expectations.	Developer	Pre-construction and construction
A Community Liaison Officer is to be appointed from the local community. A method of communication is to be implemented whereby procedures to lodge complaints are set out in order for the local community to express any complaints or grievances with the construction process.	Contractor	Pre-construction and construction phase

Performance Indicator	» Job opportunities, especially of low to semi-skilled positions, are primarily awarded to members of local communities as appropriate. » Locals and previously disadvantaged individuals (including women) are considered during the hiring process. » Labour, entrepreneurs, businesses, and SMMEs from the local sector are awarded jobs, where possible, based on requirements in the tender documentation. » The involvement of local labour is promoted. » Local goods and services are purchased from local suppliers where feasible. » Reports are not made from members of the local communities regarding unrealistic employment opportunities or that only outsiders were employed. » Employment and business policy document that sets out local employment and targets is completed before the construction phase commences. » Skills training and capacity building initiatives are developed and implemented.
Monitoring	» The developer and EPC contractor must keep a record of local recruitments and information on local labour to be shared with the ECO for reporting purposes.

OBJECTIVE 5: Minimise the impact of the inflow of an outside workforce and job seekers into the study area

The inflow of jobseekers to the proposed site would be the greatest during the peak construction period of the PV facility, but also when the construction activities of the other large construction projects are becoming less intensive. Other possible negative impacts due to the workforce's presence in the area and especially when jobseekers come to the area would include misconduct of workers, trespassing of workers on privately owned farms, the possible increase in crime, littering, increase in traffic, increase in noise, the development of informal vending stations, and poaching of livestock.

Project Component/s	» Inflow of an outside workforce and jobseekers.
Potential Impact	» The inflow of outsiders and jobseekers could result in negative impacts on the surrounding property owners and local communities, and could lead to conflict between the locals and these outsiders. » Population changes resulting in additional pressure on resources, service delivery, infrastructure maintenance and social dynamics during the construction phase as a result of an influx of construction workers into the area.
Activities/Risk Sources	» Outside workforce and jobseekers come into conflict with the locals, and their presence leads to environmental pollution and the possibility of them remaining in the area (without proper housing facilities) after construction has ceased. This would put additional pressure on the existing infrastructure and services. » Locals are not employed, which would increase the probability of conflict occurring.
Mitigation: Target/Objective	» A limited number of outsiders employed. » Pro-active measures in place to deal with possible jobseekers.

Mitigation: Action/Control	Responsibility	Timeframe
A 'locals first' policy is to be advertised for construction employment opportunities, especially for semi and low-skilled job categories.	Developer Contractor	Pre-construction and construction phase

Mitigation: Action/Control	Responsibility	Timeframe
Local labourers should remain at their existing residences.	Contractor	Construction
On-site security should be active prior to the construction phase.	Developer	Pre- construction
Tender document is to stipulate the use of local labour as far as possible.	Developer Contractor	Pre-construction and construction phase
Construction workers should be easily identifiable by wearing uniforms and even identity tags.	Contractor	Construction
The applicant, local leaders, and the Local Municipality should jointly develop a strategy to minimise the influx of jobseekers to the area.	The developer, local leaders and Local Municipality	Pre-construction and construction phase
Informal vending stations should not be allowed on or near the construction site.	Contractor	Construction
Develop a transparent communication and recruitment process to minimise the influx of jobseekers to the area.	Developer Contractor	Pre-construction
Draw up a recruitment policy in conjunction with the Community Leaders and Ward Councillors of the area and ensure compliance with this policy.	Developer	Pre-construction
The recruitment process and the use of contractors should be clearly communicated to the local communities.	Developer	Pre-construction
Recruitment of temporary workers at the gates of the development is not to be allowed. A recruitment office with a Community Liaison Officer is to be established in a nearby town to deal with jobseekers.	Contractor	Construction phase
Ensure no recruitment takes place on site.	Contractor	Construction phase
Implement procedures for the control and removal of loiters at the construction site needs to be established.	Contractor	Construction phase

Performance Indicator	» 'Locals first' policy is adopted. » Reports are not made from members of the local communities regarding unrealistic employment opportunities and/or negative intrusions or even possible increase in crime. » Sound environmental management of the construction site. » No conflict between outsiders, jobseekers, and local community members. » Control/removal of loiters.
Monitoring	» Appointed ECO must monitor indicators listed above to ensure that they have been implemented.

OBJECTIVE 6: Minimise impacts related to traffic management and transportation of equipment and materials to site

Increased traffic would include heavy and light vehicles transporting goods and building materials. At this stage it is not clear how many vehicles would make use of this road on a daily basis but it is expected that it would increase the traffic volume on the N10 national road aligned along the southern boundary of the project site. An increased risk of accidents is a concern, especially if vehicles overtake on the sections of the road where passing is not allowed. Additional pressure on the capacity and road surface of the N10 is also foreseen.

Project Component/s	» Delivery of any component required for the construction phase of the PV facility.
Potential Impact	» Impact of heavy construction vehicles on road surfaces, and possible increased risk in accidents involving people and animals. » Traffic congestion, particularly on narrow roads or on road passes where overtaking is not permitted. » Deterioration of road pavement conditions (both surfaced and gravel road) due to abnormal loads. » Increase in traffic disruptions, safety hazards, and impacts on movement patterns of local community as well as impact on private property due to the upgrade of the existing road and heavy vehicle traffic in the local area. » Heavy vehicles and construction activities can generate noise and dust impacts.
Activities/Risk Sources	» Construction vehicle movement. » Speeding on local roads. » Degradation of local road conditions. » Site preparation and earthworks. » Foundations or plant equipment installation. » Transportation of ready-mix concrete to the site. » Mobile construction equipment movement on-site.
Mitigation: Target/Objective	» Minimise impact of traffic associated with the construction of the facility on local traffic volumes, existing infrastructure, property owners, animals, and road users. » To minimise potential for negative interaction between pedestrians or sensitive users and traffic associated with the facility construction. » To ensure all vehicles are roadworthy and all materials/equipment are transported appropriately and within any imposed permit/licence conditions. » To avoid and minimise the potential noise and dust impacts associated with construction activities.

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Compile and implement a construction period traffic management plan for the site access roads to ensure that no hazards would result from the increased truck traffic and that traffic flow would not be adversely impacted (refer to **Appendix I**).	Contractor	Pre-construction
Should abnormal loads have to be transported by road to the site, a permit must be obtained from the relevant Provincial Government.	Contractor (or appointed transportation contractor)	Pre-construction
Ensure that, at all times, people have access to their properties as well as to social facilities.	Developer Contractor	Construction
Heavy vehicles used for construction purposes should be inspected regularly to ensure their road safety worthiness.	Contractor	Construction
Appropriate dust suppression must be implemented on gravel roads within the site to limit dust creation.	Developer Contractor	Construction
Dust suppression measures must be implemented for heavy vehicles such as wetting of gravel roads on a regular basis and ensuring that vehicles used to transport building materials are fitted with tarpaulins or covers.	Contractor	Construction
Ensure all vehicles are road worthy, drivers are qualified and are made aware of the potential noise and dust issues.	Contractor	Construction

Mitigation: Action/Control	Responsibility	Timeframe
Construction vehicles and those transporting materials and goods should be inspected by the contractor or a sub-contractor to ensure that these are in good working order and not overloaded.	Contractor	Construction
Strict vehicle safety standards should be implemented and monitored.	Contractor	Construction
No deviation from approved transportation routes must be allowed, unless roads are closed for whatever reason outside the control of the contractor.	Contractor	Duration of contract
Appropriate road management strategies must be implemented on external and internal roads with all employees and contractors required to abide by standard road and safety procedures.	Contractor (or appointed transportation contractor)	Pre-construction
Any traffic delays expected because of construction traffic must be co-ordinated with the appropriate authorities.	Contractor	Duration of contract
Visible signage must be established at appropriate points warning of turning traffic and the construction site (all signage to be in accordance with prescribed standards). Signage must be appropriately maintained throughout the construction period.	Contractor	Duration of contract
All vehicles of the contractor travelling on public roads must adhere to the specified speed limits and all drivers must be in possession of an appropriate valid driver's license.	Contractor	Duration of contract
Keep any new hard road surfaces as narrow as possible.	Contractor	Duration of contract
All construction vehicles must remain on properly demarcated roads. No off-road driving to be allowed.	Contractor	Duration of contract
Implement penalties for reckless driving for the drivers of heavy vehicles as a way to enforce compliance to traffic rules.	Contractor	Duration of contract
Staff and general trips must occur outside of peak traffic periods.	Contractor	Duration of contract
Ensure that damage caused by construction related traffic/ project activities to the existing roads is repaired before the completion of the construction phase.	Contractor	Construction
The movement of heavy vehicles associated with the construction phase should be timed to avoid weekends, public holidays and holiday periods where feasible.	Contractor	Construction
The developer and engineering, procurement and construction (EPC) contractors must ensure that there is a dedicated access and an access control point at the entrance gate off the N10.	Contractor	Construction phase
Ensure roads utilised are either maintained in the present condition or restored if disturbed from construction activities.	Contractor	Construction
Construction materials to be sourced from local suppliers as much as possible to limit the impact on the regional road network	Contractor	Duration of contract
Provide a comprehensive employee induction programme to cover land access protocols and road safety.	Contractor	Construction phase

Performance Indicator	» Vehicles keeping to the speed limits. » Vehicles are in good working order and safety standards are implemented. » Local residents and road users are aware of vehicle movements and schedules. » No construction traffic related accidents are experienced. » Local road conditions and road surfaces are up to standard.

	» Complaints of residents are not received (e.g. concerning the speeding of heavy vehicles). » Ensure that there are traffic warning signs along access roads, and ensure that these are well illuminated (especially at night).
Monitoring	» Developer and or appointed EO must monitor indicators listed above to ensure that they have been implemented.

OBJECTIVE 7: Minimise the potential impact on health, safety and security

An inflow of workers could, as a worst case scenario and irrespective of the size of the workforce, pose some security risks. Criminals could also use the opportunity due to "outsiders" being in the area to undertake their criminal activities. Employing local community members could minimise the potential for criminal activity or perceived perception of an increase in criminal activity due to the presence of an outside workforce.

The actual safety of construction workers is also of concern. Further health and safety issues associated with the actual construction site include unauthorised entry to the site and construction areas, the usage of large equipment on site, the risks associated with the storage of equipment and material on site, as well as the increased risk of accidents due to the increased movement of construction vehicles on the local roads.

Other concerns relate to littering, unwanted behaviour of construction workers, transmission of Sexually Transmitted Diseases (STDs), environmental pollution, an increased risk etc. Although such perceptions cannot be substantiated or be changed it should be sensitively dealt with. It is therefore clear that even though the construction phase, when these impacts could occur, is only of a short duration the effects of the impacts could remain.

Project Component/s	» PV panels. » Contractors' camps. » Access roads. » Laydown areas. » Power line.
Potential Impact	» Workers not from the local areas are involved in criminal activities and/or fires occur. » Inflow of workers could result in increased safety and security risks.
Activities/Risk Sources	» Theft of construction material. » On-site accidents. » Spread of sexually transmitted diseases. » Littering and environmental pollution. » Safety and security risks associated with construction activities.
Mitigation: Target/Objective	» Employment of local labour should be maximised and strict security measures should be implemented at the construction site.

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Employ local community members as far as possible. This could minimise the potential for criminal activity or perceived perception of an increase in criminal activity due to the presence of an outside workforce.	Contractor	Pre-construction

Mitigation: Action/Control	Responsibility	Timeframe
All staff should undergo a general Health and Safety induction and simplified environmental awareness training session.	Contractor (and sub-contractor/s)	Duration of contract
Working hours should be kept to daylight hours during the construction phase, and/or as any deviation that is approved by the affected and adjacent landowners.	Contractor	Construction phase
Safety representatives, managers and workers must be trained in workplace safety. The construction process must be compliant with all safety and health measures as prescribed by the relevant act.	Contractor (and sub-contractor/s)	Duration of contract
Local community members and property owners should be informed of the presence of the outside workforce, the construction schedule, and movement of workers.	Developer and Contractor	Construction
Procedures and measures to prevent, and in worst cases, attend to fires, must be developed in consultation with the surrounding property owners and the Local Municipality.	Developer, Local Municipality, and local communities	Pre- construction and when required
Contact details of emergency services should be prominently displayed on site.	Contractor	Construction
The perimeter of the construction site is to be appropriately secured to prevent any unauthorised access to the site; the fencing of the site should be maintained throughout the construction period.	Contractor	Construction phase
Appropriate fire-fighting equipment must be present on site and members of the workforce should be appropriately trained in using this equipment in the fighting of veld fires.	Contractor	Construction
The construction site should be properly managed to avoid any environmental pollution (due to inadequate water, sanitation and waste infrastructure and services) and littering.	Contractor	Construction phase
Construction activities should not interfere with the activities on surrounding properties.	Contractor	Construction phase
A security company must be appointed and appropriate security procedures implemented.	Contractor	Construction phase
Access in and out of the site must be strictly controlled by a security company.	Contractor	Construction phase
Ensure that an onsite HIV infections policy is in place and that construction workers have easy access to condoms.	Contractor	Construction phase
Expose workers to a health and HIV/AIDS awareness educational programme and consider the viability of extending the HIV/AIDS programme into the community with specific focus on schools and youth clubs.	Contractor	Construction phase

Performance Indicator	» No criminal activities and theft of livestock attributable to the construction workforce are reported. » Limited intrusions on surrounding property owners. » No reports from property owners regarding problems with construction activities and workforce. » No fires or on-site accidents occur.
Monitoring	» The Developer and appointed ECO must monitor indicators listed above to ensure that they have been implemented.

OBJECTIVE 8: Minimise the potential impact on the daily living and movement patterns

Changes or disruptions in the daily living and working activities of residents, especially the landowner, are most likely to occur during the construction phase and are likely to include the following:

» *Noise and dust pollution* - During the construction phase, limited gaseous or particulate emissions are anticipated from exhaust emissions from construction vehicles and equipment on-site, as well as vehicle entrained dust from the movement of vehicles on the site as well as main and internal access roads. The intensity of the negative impacts, would, however depend on the wind direction and timing of construction activities.

» *Transportation routes* - The number of vehicles resulting from the proposed project.

Project Component/s	» Construction activities associated with the PV facility and linear infrastructure. » Vegetation clearing. » Delivery of any component required within the construction phase.
Potential Impact	» Impact of heavy construction vehicles on road surfaces, and possible increased risk in accidents involving people and animals. » Traffic congestion, particularly on narrow roads or on road passes where overtaking is not permitted. » Deterioration of road pavement conditions (both surfaced and gravel road) due to abnormal loads. » Possible increase in dust, noise, and general intrusion.
Activities/Risk Sources	» Clearing of vegetation and topsoil. » Excavation, grading, scraping, levelling, digging, drilling. » Transport of materials, equipment, and components on internal access roads. » Re-entrainment of deposited dust by vehicle movements. » Wind erosion from topsoil and spoil stockpiles and unsealed roads and surfaces. » Fuel burning vehicle and construction engines. » Construction activities affecting daily living and movement patterns.
Mitigation: Target/Objective	» Limit any negative impacts on the surrounding property owners' daily living and movement patterns. » Minimise impact of traffic associated with the construction of the facility on local traffic volume, existing infrastructure, property owners, animals, and road users. » Minimise nuisance to the community from dust emissions and to comply with workplace health and safety requirements for the duration of the construction phase. » To avoid or minimise the potential impact on local infrastructure, services and local communities and their livelihoods.

Mitigation: Action/Control	Responsibility	Timeframe
Implement a transparent approach and open consultation with adjacent property owners, prior and throughout the construction period in order to provide a platform where grievances or requests can be addressed before issues become contentious.	Contractor	Pre-construction, construction

Mitigation: Action/Control	Responsibility	Timeframe
Adequate parking for all employees, contractors and sub-contractors must be made available and should not impact negatively on neighbouring farmers.	Contractor	Pre-construction and construction
Signs must be placed along construction roads to identify speed limits, travel restrictions, and other standard traffic control information. To minimise impacts on local commuters consideration must be given to limiting construction vehicles travelling on public roadways during the morning and late afternoon commute time.	Contractor	Duration of contract
Limit noise generating activities to normal daylight working hours and avoid undertaken construction activities on weekends and public holidays.	Contractor	Duration of contract
Communication, complaints and grievance channels must be implemented and contact details of the CLO are to be provided to the local community.	Contractor	Construction
Ensure that any damage to roads because of construction activities is repaired before completion of the construction phase.	Contractor	Duration of contract
Regularly monitor the effect that construction is having on public infrastructure and immediately report any damage of infrastructure to the appropriate authority.	Contractor	Duration of contract
Ensure that where communities' access is obstructed that this access is swiftly restored to an acceptable state.	Contractor	Duration of contract
Haul vehicles moving outside the construction site carrying material that can be wind-blown must be covered with suitable material.	Contractor	Duration of contract
Speed of construction vehicles must be restricted, to 30km/h.	Contractor	Duration of contract
Dust-generating activities or earthworks may need to be rescheduled or the frequency of application of dust control/suppressant increased during periods of high winds if visible dust is blowing toward nearby residences within and outside of the project site.	Contractor	Duration of contract
Dust suppression techniques must be implemented on all exposed surfaces during periods of high wind. Such measures may include wet suppression, chemical stabilisation, the use of a wind fence, covering surfaces with straw chippings and re-vegetation of open areas.	Contractor	Duration of contract

Performance Indicator	» No complaints from affected residents or the community regarding dust or vehicle emissions. » Dust does not cause health (inhaling, eye irritation) and safety risks (low visibility). » Dust suppression measures implemented for all areas that require such measures during the construction phase commences. » Drivers made aware of the potential safety issues and enforcement of strict speed limits when they are employed. » All heavy vehicles equipped with speed monitors before they are used in the construction phase in accordance with South African vehicle legislation. » Road worthy certificates in place for all heavy vehicles at the outset of construction phase and up-dated on a monthly basis.

	» A complaints register must be maintained, in which any complaints from neighbouring farmers will be logged, and thereafter complaints will be investigated and, where appropriate, acted upon. » Roads and electric fencing are maintained or improved upon if disturbed from project activities.
Monitoring	Monitoring must be undertaken to ensure emissions are not exceeding the prescribed levels via the following methods: » Immediate reporting to the Site Manager by personnel of any potential or actual issues with nuisance, dust or emissions. » A complaints register must be maintained, in which any complaints from residents/the community will be logged, and thereafter complaints will be investigated and, where appropriate, acted upon. » An incident and non-conformance register must be used to record incidents and non-conformances to the EMPr.

OBJECTIVE 9: Minimisation of the development footprint and disturbance of topsoil

Project Component/s	» PV panels » Underground cabling » Ancillary buildings » Access roads » On-site substation » Power line
Potential Impact	» Impacts on natural vegetation. » Loss of indigenous natural vegetation due to construction activities. » Impacts on soil. » Loss of topsoil
Activity/Risk Source	» Vegetation clearing. » Site preparation and earthworks. » Excavation of foundations. » Construction of the internal access road. » Construction of underground cabling. » Construction of power line and on-site substation. » Site preparation (e.g. compaction). » Foundations or PV panel equipment installation. » Stockpiling of topsoil, subsoil and spoil material.
Mitigation: Target/Objective	» To retain natural vegetation, where possible. » To retain full biological activity and functionality of topsoil. » To minimise footprints of disturbance of vegetation/habitats on-site » Remove and store all topsoil on areas that are to be excavated; and use this topsoil in subsequent rehabilitation of disturbed areas. » Minimise loss of topsoil. » Minimise spoil material.

Mitigation: Action/Control	Responsibility	Timeframe
In order to minimise impacts on flora, fauna, and ecological processes, the development footprint should be limited to the minimum necessary to accommodate the required infrastructure.	Contractor	Site establishment and duration of contract
Land clearance must only be undertaken immediately prior to construction activities. Unnecessary land clearance must be avoided.	Contractor	Construction
The extent of clearing and disturbance to the natural vegetation must be kept to a minimum so that impact on flora and fauna is restricted.	Contractor	Site establishment and duration of contract
Areas to be cleared must be clearly marked on-site to eliminate the potential for unnecessary clearing. No vegetation removal must be allowed outside the designated project development footprint.	Contractors in consultation with the EO	Duration of Construction
Topsoil must be removed and stored separately from subsoil and must be reapplied where appropriate as soon as possible in order to encourage and facilitate rapid regeneration of the natural vegetation on cleared areas.	EO and Contractor	Construction
All fill material must be sourced from a commercial off-site suitable/permitted and authorised source, quarry or borrow pit. Where possible, material from foundation excavations must be used as fill on-site.	EO and Contractor	Duration of contract
Topsoil and subsoil must be stockpiled separately and replaced according to the correct profile, i.e. topsoil replaced last. Stockpiles must not be situated such that they obstruct natural water pathways and drainage channels.	Contractor	Site establishment and duration of contract
Topsoil stockpiles must not exceed 2m in height.	Contractor	Site establishment and duration of contract
Soil stockpiles must be dampened with dust suppressant or equivalent to prevent erosion by wind.	Contractor	Construction
Excavated topsoil must be stockpiled in designated areas separate from base material and covered until replaced during rehabilitation. As far as possible, topsoil must not be stored for longer than 3 months. Stockpiles older than 6 months must be enriched before they can be used to ensure the effectiveness of the topsoil.	Contractor	Site establishment and duration of contract
All graded or disturbed areas which will not be covered by permanent infrastructure such as paving, buildings or roads must be stabilised with erosion control mats (geo-textiles) and revegetated.	Contractor	Construction
Areas which include protected and red data species must be avoided during construction, unless the necessary permits are obtained.	Contractor	Pre-construction; Site establishment
Topsoil must not be stripped or stockpiled when it is raining or when the soil is wet as compaction will occur.	Contractor	Site establishment Maintenance: for duration of contract
Topsoil must be stockpiled and managed in terms of the Erosion Management Plan (**refer to Appendix F**).	Contractor	Duration of contract

Mitigation: Action/Control	Responsibility	Timeframe
Topsoil used for rehabilitation purposes should be reused to mitigate disturbed areas and should not be mixed with sub-soils.	EO and Contractor	Rehabilitation; Post-construction
Re-applied topsoil need to be re-vegetated as soon as possible, following a revegetation and rehabilitation plan.	Contractor	Before and during construction, monitored during operational phase
Prior to the application of topsoil » subsoil shall be shaped and trimmed to blend in with the surrounding landscape or used for erosion mitigation measures; » ground surface or shaped subsoil shall be ripped or scarified with a mechanical ripper or by hand to a depth of 15 – 20 cm; » compacted soil shall be ripped to a depth greater than 25 cm and the trimmed by hand to prevent re-compacting the soil; » any foreign objects, concrete remnants, steel remnants or other objects introduced to the site during the construction process shall be cleared before ripping, or shaping and trimming of any landscapes to be rehabilitated takes place; » shaping will be to roughly round off cuts and fills and any other earthworks to stable forms, sympathetic to the natural surrounding landscapes.	Contractor	During and after construction
Application of topsoil » topsoil shall be spread evenly over the ripped or trimmed surface, if possible not deeper than the topsoil originally removed; » the final prepared surface shall not be smooth but furrowed to follow the natural contours of the land; » the final prepared surface shall be free of any pollution or any kind of contamination; » care shall be taken to prevent the compaction of topsoil.	Contractor	During and after construction
Soil stabilisation » mulch, if available from shredded vegetation, shall be applied by hand to achieve a layer of uniform thickness; » mulch shall be rotovated into the upper 10 cm layer of soil o this operation shall not be attempted if the wind strength is such as to remove the mulch before it can be incorporated into the topsoil; » measures shall be taken to protect all areas susceptible to erosion by installing temporary and permanent drainage work as soon as possible * where natural water flow-paths can be identified, subsurface drains or suitable surface drains and chutes need to be installed;	Contractor	Lifetime of the facility

Mitigation: Action/Control	Responsibility	Timeframe
» additional measures shall be taken to prevent surface water from being concentrated in streams and from scouring slopes, banks or other areas; » runnels or erosion channels developing shall be back-filled and restored to a proper condition ∗ such measures shall be effected immediately before erosion develops at a large scale » where erosion cannot be remedied with available mulch or rocks, geojute or other geotextiles shall be used to curtail erosion.		

Performance Indicator	» Zero disturbance outside of designated work areas. » Minimise clearing of existing vegetation. » Topsoil appropriately stored, managed and rehabilitated. » Minimal disturbance outside of designated work areas.
Monitoring	» Observation of vegetation clearing activities by EO throughout construction phase. » Supervision of all clearing and earthworks. » An incident reporting system will be used to record non-conformances to the EMPr.

OBJECTIVE 10: Minimise soil degradation and erosion and loss of land capability

The soil on site may be impacted in terms of:

» Uncontrolled run-off relating to construction activity (excessive wetting, uncontrolled discharge, etc.) which will also lead to accelerated erosion;
» Incorrect storage of topsoil;
» Accidental spillages;
» Poor rehabilitation;
» Erosion from rainwater;
» Soil degradation including erosion (by wind and water) and subsequent deposition elsewhere; and
» Degradation of the natural soil profile due to excavation, stockpiling, compaction, pollution and other construction activities which will affect soil forming processes and associated ecosystems. Degradation of parent rock is considered low as there are no deep excavations envisaged.

Project Component/s	» PV panels. » Underground cabling. » Ancillary buildings. » Construction of the internal access roads. » Power line. » On-site substation.
Potential Impact	» Soil and rock degradation. » Soil erosion. » Increased deposition of soil into drainage systems. » Increased run-off over the site.

Activities/Risk Sources	» Removal of vegetation, excavation, stockpiling, compaction, and pollution of soil. » Creation of impenetrable surfaces. » Bare soils surfaces due to the removal of vegetation. » Earthworks which destroy the natural layers of the soil profiles. » The construction of access roads and PV panels and associated infrastructure which will cover soil surfaces. » Rainfall - water erosion of disturbed areas. » Wind erosion of disturbed areas. » High velocity discharge of water from construction activities.
Mitigation: Target/Objective	» Minimise extent of disturbed areas. » Minimise activity within disturbed areas. » Minimise soil degradation (mixing, wetting, compaction, etc.). » Minimise soil erosion. » Minimise instability of embankments/excavations. » Revegetate, maintain and monitor the site. » Keep the project footprint as small as possible.

Mitigation: Action/Control	Responsibility	Timeframe
Restrict construction activity to demarcated areas.	EO and Contractor	Before and during construction
Practical phased development and vegetation clearing must be practiced so that cleared areas are not left un-vegetated and vulnerable to erosion for extended periods of time.	Contractor	Site establishment, and during construction
Any erosion problems within the development area as a result of the construction activities observed must be rectified immediately and monitored thereafter to ensure that they do not re-occur.	EO and Contractor	Construction Operation
All bare areas, resulting from the development, must be re-vegetated with locally occurring species, to bind the soil and limit erosion potential.	EO and Contractor	Construction Rehabilitation
Re-instate as much of the eroded area to its pre-disturbed, “natural” geometry (no change in elevation) as possible.	Contractor	Construction Rehabilitation
Roads and other disturbed areas within the development area must be regularly monitored for erosion problems and problem areas must receive follow-up monitoring by the EO to assess the success of the remediation.	EO and Contractor	Construction Rehabilitation
Practical phased development and vegetation clearing should be practiced so that cleared areas are not left un-vegetated and vulnerable to erosion for extended periods of time.	EO and Contractor	Construction
A method statement must be developed and submitted to the engineer to deal with erosion issues prior to bulk earthworks operations commencing.	EO and Contractor	Before and during construction
During construction the contractor shall protect areas susceptible to erosion by installing necessary temporary and permanent drainage works as soon as possible and by taking other measures necessary to prevent the surface water from being concentrated in streams and from scouring the slopes, banks or other areas.	EO and Contractor	During construction
Activity at the site must be reduced after large rainfall events when the soils are wet. No driving off of hardened roads should	Contractor	Construction

Mitigation: Action/Control	Responsibility	Timeframe
occur at any time and particularly immediately following large rainfall events.		
Access roads to be carefully planned and constructed to minimise the impacted area and prevent unnecessary excavation, placement, and compaction of soil.	Contractor	Design and construction
Minimise removal of vegetation which adds stability to soil.	EO and Contractor	Construction
Protective measures must be installed where there are possibilities of surface water sheet flow causing erosion.	EO and Contractor	Erection: Before construction Maintenance: Duration of contract
Stabilisation of cleared areas to prevent and control erosion must be actively managed. This includes: Brush cut packing, mulch or chip cover, straw stabilising, watering, planting/sodding, hand seed-sowing of locally-occurring indigenous species, hydroseeding of locally-occurring indigenous species, soil binders and anti-erosion compounds, gabion bolsters and mattresses for flow attenuation, geofabric, hessian cover and log/ pole fencing.	Contractor	Erection: Before construction Maintenance: Duration of contract
Erosion control measures to be implemented include Run-off attenuation (sand bags, logs), silt fences, storm water catch-pits, shade nets, gabions or temporary mulching over denuded area as required.	Contractor	Erection: Before construction Maintenance: Duration of contract
Construction of gabions and other stabilisation features must be undertaken to prevent erosion, where deemed necessary.	Contractor	Construction
Silt traps should be used where there is a danger of topsoil or material stockpiles eroding and entering watercourses and other sensitive areas.	Contractor	Construction
No soil is to be stripped from areas within the site that the contractor does not require for construction works.	Contractor	Construction
Anti-erosion measures such as silt fences must be installed in disturbed areas.	Contractor	Construction
Erosion control measures to be regularly maintained.	Contractor	Construction
Regular monitoring for erosion must take place to ensure that no erosion problems are occurring at the site as a result of the roads and other infrastructure. All erosion problems observed should be rectified as soon as possible as outlined in the Erosion Management Plan (**Appendix F**).	EO and Contractor	Construction and operation

Performance Indicator	» No activity outside demarcated disturbance areas. » Acceptable level of soil erosion around site due to construction activities. » Limited soil erosion around site. » No activity in restricted areas. » Minimal level of soil degradation.
Monitoring	» Limited level of soil erosion around the site. » Acceptable state of excavations, as determined by the EO. » Monthly inspections of sediment control devices by the EO. » Monthly inspections of surroundings, including washes (outside the development area) by the EO. » An incident reporting system will record non-conformances.

	» On-going visual assessment of compliance with erosion prevention by Contractor and ECO. » Monitor visual signs of erosion such as the formation of gullies after rainstorms and the presence of dust emissions during wind storms. » Any signs of soil erosion on site should be documented (including photographic evidence and coordinates of the problem areas) and submitted to the management team of the project. » Monitor compliance of construction workers to restrict construction work to the clearly defined limits of the construction site to keep footprint as small as possible. Monitoring to be undertaken by the ECO.

OBJECTIVE 11: Minimise the impacts on and loss of indigenous vegetation

Project Component/s	» Any infrastructure or activity that will result in disturbance to natural areas.
Potential Impact	» Loss of indigenous natural vegetation due to construction activities, or poor behaviour on the part of the construction team.
Activity/Risk Source	» Vegetation clearing. » Construction of the internal access roads. » Construction of the power line and on-site substation. » Chemical contamination of the soil by vehicles and machinery. » Operation of construction camps. » Storage of materials required for construction.
Mitigation: Target/Objective	» Minimise footprints of disturbance of vegetation/habitats. » Minimise loss of protected and indigenous vegetation. » Minimise loss of species of conservation concern.

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Areas to be cleared must be clearly marked in the field to eliminate unnecessary clearing.	Contractor	Construction
Vegetation clearing must be limited to the required footprint for actual construction works and operational activities. No unnecessary vegetation must be cleared. Mitigation measures must be implemented to reduce the risk of erosion and the invasion of alien species.	Contractor	Construction
Retain and maintain natural vegetation immediately adjacent to the development footprint and power line servitude.	Contractor	Construction
Limit unnecessary impacts on surrounding natural vegetation, e.g. driving around in the veld, use access roads only.	Contractor	Construction
Monitor and control declared weeds and invader species. Continually monitor the re-emergence of these species and manage according to the invasive species management plan.	Contractor	Duration of construction

Performance Indicator	» No disturbance outside of designated work areas. » Minimised clearing of existing/natural vegetation. » Limited impacts on areas of identified and demarcated sensitive habitats/vegetation. » Ecosystem fragmentation is kept to a minimum.

	» Ecosystem functionality is retained and any degradation prevented. » Re-establishment of rescued species.
Monitoring	» Observation of vegetation clearing activities by ECO throughout construction phase. » Monitoring of vegetation clearing activities in terms of permit conditions. » Supervision of all clearing and earthworks. » An incident reporting system will be used to record non-conformances to the EMPr. » Where vegetation is not re-establishing itself in areas where surface disturbance occurred, soil samples must be collected, analysed for pH levels, electrical conductivity (EC) and major plant nutrient levels (calcium, magnesium, potassium) and sodium. » When vegetation re-establishment still remains unsatisfactory, the bulk density of the soil should be measured with a penetrometer to determine whether compaction is an issue. » The results must be submitted to a professional soil or agricultural scientist for recommendations on the amendment of the issue to ensure that the vegetation cover is established and erosion prevented.

OBJECTIVE 12: Minimise the establishment and spread of alien invasive plants

Major factors contributing to invasion by alien invader plants include high disturbance activities and negative grazing practices. Consequences of this may include:

- Loss of indigenous vegetation;
- Change in vegetation structure leading to change in various habitat characteristics;
- Change in plant species composition;
- Change in soil chemical properties;
- Loss of sensitive habitats;
- Loss or disturbance to individuals of rare, endangered, endemic, and/or protected species;
- Fragmentation of sensitive habitats;
- Change in flammability of vegetation, depending on alien species; and
- Hydrological impacts due to increased transpiration and runoff.

Project Component/s	» Solar facility. » Subcontractor's camps. » Power line. » On-site substation. » Laydown areas. » Temporary access roads.
Potential Impact	» Invasion of natural vegetation surrounding the site by declared weeds or invasive alien species. » Impacts on soil. » Impact on faunal habitats. » Degradation and loss of agricultural potential.
Activities/Risk Sources	» Transport of construction materials to site. » Movement of construction machinery and personnel. » Site preparation and earthworks causing disturbance to indigenous vegetation. » Construction of site access roads. » Stockpiling of topsoil, subsoil and spoil material. » Routine maintenance work – especially vehicle movement.

Mitigation: Target/Objective	» To significantly reduce the presence of weeds and eradicate alien invasive species. » To avoid the introduction of additional alien invasive plants to the site. » To avoid distribution and thickening of existing alien plants in the site. » To complement existing alien plant eradication programs in gradually causing a significant reduction of alien plant species throughout the site.

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Avoid creating conditions in which alien plants may become established: » Keep disturbance of indigenous vegetation to a minimum. » Rehabilitate disturbed areas as quickly as possible. » Do not import soil from areas with alien plants.	Contractor	Construction and operation
When alien plants are detected, these must be controlled and cleared using the recommended control measures for each species to ensure that the problem is not exacerbated or does not re-occur.	Contractor	Construction and operation
Clearing methods must themselves aim to keep disturbance to a minimum.	Contractor	Construction
Establish an ongoing monitoring programme to detect and quantify any alien species that may become established and identify the problem species (as per Conservation of Agricultural Resources Act and Biodiversity Act).	Contractor	Construction and operation
Eradicate all weeds and alien invasive plants as far as practically possible and ensure that material from invasive plants are adequately destroyed and not further distributed. Continually monitor the re-emergence of these species and manage according to the invasive species management plan (refer to **Appendix C**).	Contractor ECO	Lifetime of the facility
Immediately control any alien plants that become established using registered control methods.	Contractor	Construction and operation
The use of herbicides and pesticides and other related horticultural chemicals should be carefully controlled and only applied by personnel adequately certified to apply pesticides and herbicides. It must be ensured that WHO Recommended Classification of Pesticides by Hazard Class 1a (extremely hazardous) or 1b (highly hazardous) are not purchased, stored or used on site along with any other nationally or internationally similarly restricted/banned products.	Contractor	Construction and rehabilitation

Performance Indicator	» For each alien species: number of plants and aerial cover of plants within the site and immediate surroundings.
Monitoring	» On-going monitoring of area by EO during construction. » On-going monitoring of area by environmental manager during operation. » Annual audit of development footprint and immediate surroundings by qualified botanist. » If any alien invasive species are detected then the distribution of these should be mapped (GPS co-ordinates of plants or concentrations of plants), number of individuals (whole site or per unit area), age and/or size classes of plants and aerial cover of plants. » The results should be interpreted in terms of the risk posed to sensitive habitats within and surrounding the site. » The environmental manager/site agent should be responsible for driving this process.

	» Reporting frequency depends on legal compliance framework.

OBJECTIVE 13: Minimise the impacts on fauna

Faunal species are indirectly affected by the overall loss of habitat as direct construction impacts can often limit the movement of individuals from the path of construction.

With respect to any threatened species, the loss of individuals or localised populations is unlikely to lead to a change in the conservation status of the species, unless they are classified as threatened. In the case of threatened animal species, the loss of a population or individual could lead to a direct change in its conservation status. This may arise if the proposed infrastructure is located where it will affect such individuals or populations or the habitat that they depend on. Consequences may include fragmentation of populations of affected species, reduction in area of occupancy of affected species, and loss of genetic variation within the affected species.

Project Component/s	» PV facility. » Power line. » On-site substation. » Contractor's camp and laydown area.
Potential Impact	» Loss or displacement of fauna. » Vegetation clearance and associated impacts on faunal habitats. » Traffic to and from site.
Activity/Risk Source	» Site preparation and earthworks. » Construction-related traffic. » Foundations or PV equipment installation. » Mobile construction equipment. » Underground cabling and road construction activities.
Mitigation: Target/Objective	» To minimise footprints of habitat destruction » To minimise disturbance to (and death of) resident and visitor faunal and avifaunal species

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Demarcate all areas to be cleared with construction tape or similar material where practical. However, caution should be exercised to avoid using material that might entangle fauna.	Contractor	Pre-construction
The extent of clearing and disturbance to the natural vegetation must be kept to a minimum so that impact on fauna and their habitats is restricted.	Contractor	Site establishment and duration of contract
Site access should be controlled and no unauthorised persons should be allowed onto the site.	Contractor	Site establishment and duration of contract
Any fauna directly threatened by the construction activities must be removed to a safe location by a suitably qualified person or allowed to passively vacate the area.	Suitably qualified person	Construction

Mitigation: Action/Control	Responsibility	Timeframe
The collection, hunting or harvesting of any plants or animals at the site must be strictly forbidden. Personnel must not be allowed to wander off of the demarcated construction site.	Contractor	Construction
All construction vehicles must adhere to a low speed limit (30km/h) to avoid collisions with susceptible species such as snakes and tortoises.	Contractor	Construction Operation
Ensure that known faunal movement corridors such as drainage lines and ridge systems are not developed.	Contractor	Duration of contract
All hazardous materials must be stored in the appropriate manner to prevent contamination of the site. Any accidental chemical, fuel and oil spills that occur at the site must be cleaned up in the appropriate manner as related to the nature of the spill.	Contractor	Construction Operation
The intentional harming or killing of animals will be prohibited through on-site supervision and worksite rules.	Contractor	Construction Operation
Implement a faunal removal plan/ rescue plan with designated/ trained personnel and contact numbers.	Contractor	Duration of contract
If trenches need to be dug for electrical cabling, these should not be left open for extended periods of time as fauna may fall in and become trapped in them. Trenches which are standing open should have places where there are soil ramps allowing fauna to escape the trench.	Contractor	Duration of contract
All cable trenches, excavations, etc., through sensitive areas should be excavated carefully in order to minimise damage to surrounding areas and biodiversity. » The trenches must be checked on a daily basis for the presence of trapped animals. » Any animals found must be removed by a suitably qualified person in a safe manner, unharmed, and placed in an area where the animal will be comfortable. » All mammal, large reptiles and avifauna species found injured during construction must be taken to a suitably qualified veterinarian or rehabilitation centre to either be euthanized in a humane manner or cared for until it can be released again.	Contractor	Duration of construction
All personnel must undergo environmental induction with regards to fauna and in particular awareness about not harming or collecting species such as snakes, tortoises and owls which are often persecuted out of superstition.	Contractor	Duration of construction

Performance Indicator	» No disturbance outside of designated work areas. » Minimised clearing of existing/natural vegetation and habitats for fauna. » Limited impacts on faunal species (i.e. noted/recorded fatalities).
Monitoring	» Observation of vegetation clearing activities by EO throughout construction phase. » Supervision of all clearing and earthworks. » Recording faunal fatalities to monitor success of relocation efforts. » An incident reporting system will be used to record non-conformances to the EMPr.

OBJECTIVE 14: Limit direct and indirect avifaunal impacts

The project site lies within the Kalahari bioregion with elements of the Nama-Karoo, and supports a fairly typical avifaunal assemblage expected for the area. Although six threatened and three Near-Threatened species are known to occur within the broader study area, most of these are not common in the area and probably occur in low numbers.

Project component/s	Construction activities and human presence.
Potential Impact	» Decrease in avifaunal populations. » Decrease in avifaunal species diversity. » Habitat loss and disturbance on avifauna due to the removal of vegetation. » Displacement of birds from their habitat. » Negative avian interactions with project components: substation infrastructure, power line infrastructure, solar panels, or other project components (e.g. fences)
Activity/risk source	Habitat transformation during construction, site fencing, and the presence of construction and operation personnel.
Mitigation: Target/Objective	» Low faunal impact during construction and operation. » To minimise injury and death to avifaunal species. » To minimise loss of avifaunal populations. » To minimise loss of species diversity.

Mitigation: Action/control	**Responsibility**	**Timeframe**
Environmental induction must be given to all staff regarding the impacts on fauna and avifauna. This should include an adequate briefing for site personnel on the possible important (Red Data) species occurring and/or nesting in the area and the procedures to be followed.	Contractor	Construction and Operation
All internal electrical reticulation should be placed underground where applicable, while the alignment of the power line and substation should be placed parallel to existing lines, as far as possible.	Contractor	Construction
Reservoirs or ponds (evaporative or other) should be covered with fine mesh or other exclusion material in order to exclude and prevent birds from accessing potentially contaminated water contained therein.	Contractors	Construction
EO to monitor and enforce ban on hunting, collecting or harvesting etc. of all plants and animals or their products.	EO	Construction and Operation
Reservoirs or ponds (evaporative or other) should be covered with fine mesh or other exclusion material in order to exclude and prevent birds from accessing potentially contaminated water contained therein.	EO	Construction and Operation
Any bird nests are found during the construction period must be reported to the Environmental Officer (EO) and where deemed necessary an appropriate buffer should be placed around the nest.	Contractor EO	Construction

Mitigation: Action/control	Responsibility	Timeframe
No construction activity should occur near to active raptor nests should these be discovered prior to or during the construction phase. If there are active nests near construction areas, these should be reported to EO and should be monitored until the birds have finished nesting and the fledglings left the nest	Contractor EO	Construction
Any avifauna threatened by the construction activities should be removed to safety.	EO Specialist	Construction
Trenches must not be left open for extended periods of time as ground-dwelling avifauna or their flightless young may fall in and become trapped in them. Holes should only be dug when they are required and should be used and filled shortly thereafter.	Contractor	Construction
The power line should be monitored on a regular basis to determine potential areas of high collision rates, especially involving red-listed species (e.g. Ludwig's Bustard). Bird diverters should be fitted to the power line in areas where high collisions rates are detected.	Contractor	Construction
Bird friendly structure with a bird perch (as per standard Eskom guidelines) must be used for the tower infrastructure. All relevant perching surfaces should be fitted with bird guards and perch guards as deterrents. Installation of artificial bird space perches and nesting platforms, at a safe distance from energised components. Bird deterrent devices such as "bird diverters" and "flappers" can be used.	Contractor	Construction
Deterrent devices such as bird guards should be mounted on relevant parts of the pylons to reduce the possibility of electrocutions.	Contractor	Construction
Insulate live components at support structures.	Contractor	Construction
All construction vehicles should adhere to a low speed limit (30km/h on site) to avoid collisions with susceptible species such nocturnal and crepuscular species (e.g. nightjars, thick-knees and owls) which sometimes forage or rest along roads.	Contractor	Construction

Performance Indicator	» Minimised clearing of existing/natural vegetation and habitats for fauna and avifauna. » Limited impacts on faunal species (i.e. noted/recorded fatalities), especially those of conservation concern.
Monitoring	» Monitoring for compliance during the construction phase. All incidents to be noted.

OBJECTIVE 15: Appropriate Storm Water Management

The storm water management is covered under the Pre-construction and Construction Phase management, but aspects thereof will also continue into the Operation Phase. It is important that the engineers and contractors responsible for the detailed design of the storm water systems take into account the requirements of this EMPr, as well as the recommendations by the participating specialists. A Storm water Management Plan is attached as **Appendix G**.

Project Component/s	» Alteration of natural areas into hard surfaces impacting on the local hydrological regime of the area.
Potential Impact	» Poor storm water management and alteration of the hydrological regime.
Activities/Risk Sources	» Placement of hard engineered surfaces.
Mitigation: Target/Objective	» Reduce the potential increase in surface flow velocities and the impact on localised drainage systems.

Mitigation: Action/Control	Responsibility	Timeframe
Any storm water within the site must be handled in a suitable manner, i.e. separate clean and dirty water streams around the plant and install stilling basins to capture large volumes of run-off, shade nets, or gabions trapping sediments and reduce flow velocities.	Contractor and Engineers	Construction
All roads and other hardened surfaces must have runoff control features which redirect water flow and dissipate any energy in the water which may pose an erosion risk.	Contractor	Construction
Storm water control systems must be implemented to reduce erosion on the project site.	Contractor	Construction
New access roads within the site are to be constructed according to design and contract specifications. The access routes must have suitable storm water management plans and erosion control measures.	Contractor	Construction
Drainage measures must promote the dissipation of storm water run-off.	Contractor	Construction
All storm water mitigation measures must be implemented according to the Storm water Management Plan (**Appendix G**).	Contractor	Construction

Performance Indicator	» No impacts due to runoff. » Minimise erosion as far as possible.
Monitoring	» Appropriate storm water management system in place.

OBJECTIVE 16: Protection of heritage resources

Two heritage sites of some significance were identified within the broader project site. Both sites are, however, located outside of the development footprint and 300m power line corridor for Allepad PV Three:

- » A possible burial site (Grade IIIA) (Site 0506).
- » By far the largest number of artefacts – mostly MSA, but also some LSA including a large ESA flake/large cutting tools (LCT). The majority of artefacts were flakes and chunks, but also a weathered core, among an extensive scatter of surface quartz, scraped top soils, large piles of stone and gravel, and large scale diggings. A small dry pan with many scattered tools lying around, in majority in quartzite, but also quartz, banded ironstone, chalcedony, hornfels/lydianite and 1-2 opaline were identified within the eastern section of the project site (Grade IIIB) (Site 0526).

These sites do not fall within the development footprint of the PV facility or the power line. Appropriate buffers have however been identified to minimise potential impacts:

- The archaeological Site 0526 (graded IIIB) must not be impacted by the proposed development and a 100m no-go buffer must be implemented around this site.
- The possible burial site identified as Site 0506 must not be impacted by the proposed development and a 30m no-go buffer must be implemented.

Most of the project site is underlain by un-fossiliferous igneous and metamorphic basement rocks (granites, gneisses etc.) or mantled by superficial sediments (wind-blown sands, alluvium etc.) of low paleontological sensitivity. Extensive, deep excavations are unlikely to be required for the development of a solar energy facility. Significant negative impacts on local fossil heritage are therefore unlikely to result from the proposed development. The overall impact significance of the proposed development on paleontology is likely to be low.

Project Component/s	» PV panels. » Transformers and switchgear etc. » Underground cabling. » Ancillary buildings. » Access roads. » Power line. » On-site substation.
Potential Impact	» Heritage objects or artefacts found on site are inappropriately managed or destroyed.
Activity/Risk Source	» Site preparation and earthworks. » Foundations or plant equipment installation. » Mobile construction equipment movement on site. » Power line construction activities.
Mitigation: Target/Objective	» To ensure that any heritage objects found on site are treated appropriately and in accordance with the relevant legislation.

Mitigation: Action/control	**Responsibility**	**Timeframe**
Areas required to be cleared during construction must be clearly marked in the field to avoid unnecessary disturbance of adjacent areas.	Contractor in consultation with Heritage Specialist	Pre-construction
No activities may be undertaken within the no-go buffer areas around the identified archaeological sites. Construction workers should be made aware of where these sites and buffer areas are located.	Contractor	Construction
A chance find procedure must be developed and implemented in the event that archaeological or palaeontological resources are found. In the case where the proposed development activities bring these materials to the surface, work must cease and SAHRA must be contacted immediately. Should any unmarked human remains or ostrich eggshell caches for example are exposed or uncovered during construction activities, or earth moving, operations during preparation of the site for development, work must cease and these must immediately be reported to the South Africa Heritage Resources Agency/SAHRA (Att: Ms Natasha Higgit tel 021 462 4502).	Contractor Heritage specialist	Pre-construction Construction

Mitigation: Action/control	Responsibility	Timeframe
Contractors must be informed before construction starts on the possible types of heritage sites and cultural material they may encounter and the procedures to follow if they find sites. All staff should also be familiarised with procedures for dealing with heritage objects/sites.	Contractor, ESA and heritage specialist	Duration of contract, particularly during excavations
Familiarise all staff and contractors with procedures for dealing with heritage objects/sites.	Heritage Specialist	Pre-construction
In the event that fossils resources are discovered during excavations, immediately stop excavation in the vicinity of the potential material. Mark (flag) the position and also spoil material that may contain fossils. Inform the site foreman and the EO. EO to inform the developer, the developer contacts the standby archaeologist and/or palaeontologist. EO to describe the occurrence and provide images by email.	Contractor and EO	Construction

Performance Indicator	» No disturbance outside of designated work areas. » All heritage items located are dealt with as per the legislative guidelines.
Monitoring	» Observation of excavation activities by the EO throughout construction phase. » Supervision of all clearing and earthworks. » Due care taken during earthworks and disturbance of land by all staff and any heritage objects found reported. » Appropriate permits obtained from SAHRA prior to the disturbance or destruction of heritage sites (if required). » An incident reporting system will be used to record non-conformances to the EMPr.

OBJECTIVE 17: Appropriate handling and management of waste

The construction of the PV facility will involve the generation of various wastes. In order to manage the wastes effectively, guidelines for the assessment, classification, and management of wastes, along with industry principles for minimising construction wastes must be implemented. The main wastes expected to be generated by the construction of the PV facility will include:

» general solid waste
» hazardous waste
» inert waste (rock and soil)
» liquid waste (including grey water and sewage)

An Waste Management Plan is attached as **Appendix H**.

Project Component/s	» PV Facility. » Underground cabling. » Ancillary buildings. » Access roads. » Power line.

	» On-site substation.
Potential Impact	» Inefficient use of resources resulting in excessive waste generation. » Litter or contamination of the site or water through poor waste management practices.
Activity/Risk Source	» Packaging. » Other construction wastes. » Hydrocarbon use and storage. » Spoil material from excavation, earthworks and site preparation.
Mitigation: Target/Objective	» To comply with waste management legislation. » To minimise production of waste. » To ensure appropriate waste storage and disposal. » To avoid environmental harm from waste disposal. » A waste manifests should be developed for the ablutions showing proof of disposal of sewage at appropriate water treatment works.

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Construction method and materials should be carefully considered in view of waste reduction, re-use, and recycling opportunities.	Contractor	Duration of contract
Construction contractors must provide specific detailed waste management plans to deal with all waste streams.	Contractor	Duration of contract
Waste disposal at the construction site must be avoided by separating and trucking out of waste.	Contractor	Construction
Specific areas must be designated on-site for the temporary management of various waste streams, i.e. general refuse, construction waste (wood and metal scrap), and contaminated waste as required. Location of such areas must seek to minimise the potential for impact on the surrounding environment, including prevention of contaminated runoff, seepage, and vermin control.	Contractor	Duration of contract
Where practically possible, construction and general wastes on-site must be reused or recycled. Bins and skips must be available on-site for collection, separation, and storage of waste streams (such as wood, metals, general refuse etc.).	Contractor	Duration of contract
Disposal of waste must be in accordance with relevant legislative requirements, including the use of licensed contractors.	Contractor	Duration of contract
Uncontaminated waste must be removed at least weekly for disposal, if feasible; other wastes must be removed for recycling/ disposal at an appropriate frequency.	Contractor	Duration of contract
Hydrocarbon waste must be contained and stored in sealed containers within an appropriately bunded area and clearly labelled.	Contractor	Duration of contract
Waste must be kept to a minimum and must be transported by approved waste transporters to sites designated for their disposal.	Contractor	Duration of contract
No liquid waste, including grey water, may be discharged into any water body or drainage line. All sewage disposal to take place at a registered and operational wastewater treatment works. Slips of disposal to be retained as proof of responsible disposal.	Contractor	Maintenance: duration of contract within a particular area
All liquid wastes should be contained in appropriately sealed vessels/ponds within the footprint of the development, and be disposed of at a designated waste management facility after use.	Contractor	Duration of contract

Mitigation: Action/Control	Responsibility	Timeframe
Ensure compliance with all national, regional and local legislation with regard to the storage, handling and disposal of hydrocarbons, chemicals, solvents and any other harmful and hazardous substances and materials. The onus is on the Contractor to identify and interpret the applicable legislation. Hazardous waste to be disposed of at a registered landfill site.	Contractor	During and post construction.
Documentation (waste manifest) must be maintained detailing the quantity, nature, and fate of any regulated waste. Waste disposal records must be available for review at any time.	Contractor	Duration of contract
SABS approved spill kits to be available and easily accessible.	Contractor	Duration of contract
Regularly serviced chemical toilet facilities and/or septic tank must be used to ensure appropriate control of sewage.	Contractor	Duration of contract
Daily inspection of all chemical toilets and septic tanks must be performed by environmental representatives on site.	Contractor	Duration of contract
In the event where sewage is discharged into the environment, all contaminated vegetation/ rock and soil must be removed immediately and treated as hazardous waste.	Contractor	Duration of construction
Ensure that the below ground storage of the septic tank can withstand the external forces of the surrounding pressure. The area above the tank must be demarcated to prevent any vehicles or heavy machinery from driving around the tank.	Contractor	Duration of construction
Under no circumstances may waste be burnt on site.	Contractor	Duration of construction
Where a registered waste site is not available close to the construction site, provide a method statement with regard to waste management.	Contractor	Duration of construction
Waste manifests must be provided for all waste streams generated on site, and must be kept on site.	Contractor	Duration of construction
Implement an integrated waste management approach that is based on waste minimisation and incorporates reduction, recycling, re-use and disposal where appropriate. Where solid waste is disposed of, such disposal shall only occur at a landfill licensed in terms of section 20(b) of the National Environmental Management Waste Act, 2008 (Act 59 of 2008).	Contractor	Duration of construction
Upon the completion of construction, the area must be cleared of potentially polluting materials. Spoil stockpiles must also be removed and appropriately disposed of or the materials re-used for an appropriate purpose.	Contractor	Completion of construction
Upon the completion of construction, all sanitation facilities (including chemical toilets) must be removed, as well as the associated waste to be disposed of at a registered waste disposal site.	Contractor	Completion of construction

Performance Indicator	» No complaints received regarding waste on site or indiscriminate dumping. » Internal site audits ensuring that waste segregation, recycling and reuse is occurring appropriately. » Provision of all appropriate waste manifests for all waste streams.

Monitoring	» Observation and supervision of waste management practices throughout construction phase. » Waste collection will be monitored on a regular basis. » Waste documentation completed. » Proof of disposal of sewage at an appropriate wastewater treatment works. » A complaints register will be maintained, in which any complaints from the community will be logged. Complaints will be investigated and, if appropriate, acted upon. » An incident reporting system will be used to record non-conformances to the EMPr.

OBJECTIVE 18: Appropriate handling and storage of chemicals, hazardous substances

The construction phase may involve the storage and handling of a variety of chemicals including adhesives, abrasives, oils and lubricants, paints and solvents.

Project Component/s	» Laydown areas. » Subcontractors' camps. » Temporary hydrocarbon and chemical storage areas.
Potential Impact	» Release of contaminated water from contact with spilled chemicals. » Generation of contaminated wastes from used chemical containers. » Soil pollution.
Activity/Risk Source	» Vehicles associated with site preparation and earthworks. » Construction activities of area and linear infrastructure. » Hydrocarbon spills by vehicles and machinery during levelling, vegetation clearance and transport of workers, materials and equipment and fuel storage tanks. » Accidental spills of hazardous chemicals. » Polluted water from wash bays and workshops. » Pollution from concrete mixing and damaged PV panels.
Mitigation: Target/Objective	» To ensure that the storage and handling of chemicals and hydrocarbons on-site does not cause pollution to the environment or harm to persons. » To ensure that the storage and maintenance of machinery on-site does not cause pollution of the environment or harm to persons. » Prevent and contain hydrocarbon leaks. » Undertake proper waste management. » Store hazardous chemicals safely in a bunded area.

Mitigation: Action/Control	Responsibility	Timeframe
Implement an emergency preparedness plan (refer to **Appendix J** for the Emergency Preparedness and Fire Management Plan) during the construction phase.	EPC Contractor	Pre-construction and implement for duration of Contract
Any liquids stored on site, including admixtures, fuels and lubricants, should be stored in accordance with applicable legislation.	Contractor	Pre-construction and implement for duration of Contract
Spill kits must be made available on-site for the clean-up of spills and leaks of contaminants.	Contractor	Duration of contract
Losses of fuel and lubricants from the oil sumps and steering racks of vehicles and equipment must be contained using a drip tray	Contractor	Construction Operation

Mitigation: Action/Control	Responsibility	Timeframe
with plastic sheeting filled with absorbent material when not parked on hard standing.		
Establish an appropriate Hazardous Stores which is in accordance with the Hazardous Substance Amendment Act, No. 53 of 1992. This should include but not be limited to: » Designated area; » All applicable safety signage; » Firefighting equipment; » Enclosed by an impermeable bund; » Protected from the elements, » Lockable; » Ventilated; and » Has adequate capacity to contain 110% of the largest container contents.	Contractor	Pre-construction and implement for duration of Contract
Corrective action must be undertaken immediately if a complaint is made, or potential/actual leak or spill of polluting substance identified. This includes stopping the contaminant from further escaping, cleaning up the affected environment as much as practically possible and implementing preventive measures. Where required, a NEMA Section 30 report must be submitted to DEA within 14 days of the incident.	Contractor	Duration of contract
In the event of a major spill or leak of contaminants, the relevant administering authority must be immediately notified as per the notification of emergencies/incidents.	Contractor	Duration of contract
Spilled concrete must be cleaned up as soon as possible and disposed of at a suitably licensed waste disposal site.	Contractor	Duration of contract
Accidental spillage of potentially contaminating liquids and solids must be cleaned up immediately in line with procedures by trained staff with the appropriate equipment.	Contractor	Duration of contract
Any contaminated/polluted soil removed from the site must be disposed of at a licensed hazardous waste disposal facility.	Contractor	Duration of contract
Routine servicing and maintenance of vehicles must not to take place on-site (except for emergencies). If repairs of vehicles must take place, an appropriate drip tray must be used to contain any fuel or oils.	Contractor	Duration of contract
All stored fuels to be maintained within an appropriate bund and on a sealed surface as per the requirements of SABS 089:1999 Part 1 and any relevant by-laws.	Contractor	Duration of contract
Fuel storage areas must be inspected regularly to ensure bund stability, integrity, and function.	Contractor	Duration of contract
Construction machinery must be stored in an appropriately sealed area.	Contractor	Duration of contract
Oily water from bunds at the substation must be removed from site by licensed contractors.	Contractor	Duration of contract
Fuel storage areas must be inspected regularly to ensure bund stability, integrity, and function.	Contractor	Duration of contract
The storage of flammable and combustible liquids such as oils will be in designated areas which are appropriately bunded, and	Contractor	Duration of contract

Mitigation: Action/Control	Responsibility	Timeframe
stored in compliance with Material Safety Data Sheets (MSDS) files.		
Any storage and disposal permits/approvals which may be required must be obtained, and the conditions attached to such permits and approvals will be compiled with.	Contractor	Duration of contract
Transport of all hazardous substances must be in accordance with the relevant legislation and regulations.	Contractor	Duration of contract
The sediment control and water quality structures used on-site must be monitored and maintained in an operational state at all times.	Contractor	Duration of contract
An effective monitoring system must be put in place to detect any leakage or spillage of all hazardous substances during their transportation, handling, installation and storage.	Contractor	Construction
Precautions must be in place to limit the possibility of oil and other toxic liquids from entering the soil or clean stormwater system.	Contractor	Construction

Performance Indicator	» No chemical spills outside of designated storage areas. » No water or soil contamination by spills. » No complaints received regarding waste on site or indiscriminate dumping. » Safe storage of hazardous chemicals. » Proper waste management.
Monitoring	» Observation and supervision of chemical storage and handling practices and vehicle maintenance throughout construction phase. » A complaints register must be maintained, in which any complaints from the community will be logged. » An incident reporting system will be used to record non-conformances to the EMPr. » On-going visual assessment to detect polluted areas and the application of clean-up and preventative procedures. » Monitor hydrocarbon spills from vehicles and machinery during construction continuously and record volume and nature of spill, location and clean-up actions. » Monitor maintenance of drains and intercept drains weekly. » Analyse soil samples for pollution in areas of known spills or where a breach of containment is evident when it occurs. » Records of accidental spills and clean-up procedures and the results thereof must be audited on an annual basis by the ECO. » Records of all incidents that caused chemical pollution must be kept and a summary of the results must be reported to management annually.

OBJECTIVE 19: Effective management of concrete batching plants

A considerable amount of concrete is required during the construction of the PV facility. In this regard there could be a need to establish a batching plant within the site. Turbid and highly alkaline wastewater, dust emissions and noise are the key potential impacts associated with concrete batching plants. Concrete batching plants, cement, sand and aggregates can produce dust. Potential pollutants in batching plant wastewater and storm water include cement, sand, aggregates, chemical additive mixtures, fuels and lubricants.

Project component/s	» Batching plant. » Storm water system.
Potential Impact	» Dust emissions. » Release of contaminated water. » Generation of contaminated wastes from used chemical containers. » Inefficient use of resources resulting in excessive waste generation.
Activity/risk source	» Operation of the batching plant. » Packaging and other construction wastes. » Hydrocarbon use and storage.
Mitigation: Target/Objective	» To ensure that the operation of the batching plant does not cause pollution to the environment or harm to persons.

Mitigation: Action/control	**Responsibility**	**Timeframe**
Concrete batching plants should be sited such that impacts on the environment or the amenity of the local community from noise, odour or polluting emissions are minimised.	Contractor	Construction phase
Where there is a regular movement of vehicles, access and exit routes for heavy transport vehicles should be planned to minimise noise and dust impacts on the environment.	Contractor	Construction phase
Good maintenance practices must be implemented, including regular sweeping to prevent dust build-up.	Contractor	Construction phase
The prevailing wind direction should be considered to ensure that bunkers and conveyors are sited in a sheltered position to minimise the effects of the wind.	Contractor	Construction phase
Aggregate material should be delivered in a damp condition, and water sprays or a dust suppression agent should be correctly applied to reduce dust emissions and reduce water usage.	Contractor	Construction phase
Process wastewater collected from the entire batching plant area should be diverted to an impervious settling tank or pond. Water should be reused in the concrete batching process, where possible.	Contractor	Construction phase
A contaminated storm water system must be specifically designed for the batching plant to ensure effective control of contaminated storm water originating from the batching plant and prevent contamination to the surrounding environment.	Contractor	Construction phase
Where possible, waste concrete should be used for construction purposes at the batching plant or project site.	Contractor	Construction phase
Artificial wind barriers must be installed around the batching plant to minimise air, land and water pollution. Wind barriers must enclose the entire batching plant and not allow fly ash and other dusts from moving through the barrier. The artificial barrier must be maintained daily for any defects and corrected when necessary.	Contractor	Pre-construction/ construction

Mitigation: Action/control	Responsibility	Timeframe
The concrete wash bay structure must be constructed in a double brick arrangement or be reinforced to maintain its integrity throughout operation.	Contractor	Construction phase

Performance Indicator	» No complaints regarding dust » No water or soil contamination by chemical spills » No complaints received regarding waste on site or indiscriminate dumping
Monitoring	» Observation and supervision of chemical storage and handling practices and vehicle maintenance throughout construction phase. » A complaints register will be maintained, in which any complaints from the community will be logged. Complaints will be investigated and, if appropriate, acted upon. » An incident and non-conformance register will be used to record incidents and non-conformances to the EMPr. » The appointed ECO must monitor indicators listed above to ensure that they have been met for the construction phase.

OBJECTIVE 20: Minimise impacts on water resources

Project component/s	» Construction activities » Storage of dangerous goods. » Ablution facilities.
Potential Impact	» Pollutants such as lime-containing (high pH) construction materials such as concrete, cement, grouts, etc. could be harmful to aquatic biota, particularly during low flows when dilution is reduced.
Activity/risk source	» Fuelling, usage and maintenance of construction vehicles. » Cement batching and usage. » Labourer using ablution facilities. » Use of any chemicals or hazardous materials/dangerous goods during construction.
Mitigation: Target/Objective	» No incidents related to spills of chemicals and hazardous materials. » No release of contaminated water in watercourses including streams and pans. » No misbehaviour of construction workers (i.e. ablution activities, washing).

Mitigation: Action/control	Responsibility	Timeframe
Implement strict management of all hazardous materials/dangerous goods used on site. Spilled fuel, oil or grease is retrieved where possible, and contaminated soil removed, cleaned and replaced. Contaminated soil to be collected by the Contractor and disposed of at a waste site designated for this purpose.	Contractor	Construction
Ensure strict management of potential sources of pollution (hydrocarbons from vehicles and machinery, cement during construction, etc.). Bunded containment to be provided below and around any fuel storage containers.	Contractor	Construction

Mitigation: Action/control	Responsibility	Timeframe
Construction equipment is to be checked daily (by Contractor) to ensure that no fuel spillage takes place from construction vehicles or machinery.	Contractor	Construction
Proper use of chemical toilets should be strictly enforced.	Contractor	Construction
No activities shall be allowed to encroach into a watercourse or wetland/stream/pan.	Contractor	Construction
If any concrete mixing takes place on site, this is to be done on a board or plastic sheeting, which is to be removed from the site once concreting is completed; or in areas to be covered by further construction.	Contractor	Construction
Sand, stone and cement are stored in demarcated areas, and are covered or sealed to prevent wind erosion and resultant deposition of dust on the surrounding indigenous vegetation.	Contractor	Construction
Any excess sand, stone and cement must be removed from site at the completion of the construction period.	Contractor	Construction
Implement strict management of all hazardous materials/dangerous goods used on site. Spilled fuel, oil or grease is retrieved where possible, and contaminated soil removed, cleaned and replaced. Contaminated soil to be collected by the Contractor and disposed of at a waste site designated for this purpose.	Contractor	Construction
Any areas disturbed during the construction phase should be encouraged to rehabilitate as fast and effective as possible and were deemed necessary by the ECO or Contractor's EO, artificial rehabilitation (e.g. re-seeding with collected or commercial indigenous seed mixes) should be applied in order to speed up the rehabilitation process in critical areas (e.g. steep slopes and unstable soils).	Contractor	Construction
No unnecessary vegetation clearance may be allowed and vegetation should be allowed to persist under and around the PV panels once operational.	Contractor	Construction

Performance Indicator	» No major preventable spillages are recorded.
Monitoring	» Monitor management measures in place for potentially hazardous materials.

OBJECTIVE 21: Management of dust and air emissions

During the construction phase, limited gaseous or particulate emissions are anticipated from exhaust emissions from construction vehicles and equipment on-site, as well as vehicle entrained dust from the movement of vehicles on the main and internal access roads.

Project component/s	» Solar field. » Temporary access roads.

	» Batching plant. » Vegetation clearing.
Potential Impact	» Dust generation and particulates from vehicle movement to and on-site, foundation excavation, road construction activities, road maintenance activities, temporary stockpiles, and vegetation clearing affecting the surrounding residents and visibility. » Release of minor amounts of air pollutants (for example NO_2, CO and SO_2) from vehicles and construction equipment.
Activity/risk source	» Clearing of vegetation and topsoil. » Excavation, grading, scraping, levelling, digging, drilling and associated construction activities. » Transport of materials, equipment, and components on internal access roads and the associated increased traffic. » Vehicle movement on gravel roads. » Re-entrainment of deposited dust by vehicle movements. » Wind erosion from topsoil and spoil stockpiles and unsealed roads and surfaces. » Fuel burning vehicle and construction engines.
Mitigation: Target/Objective	» To ensure emissions from all vehicles and construction engines are minimised, where possible, for the duration of the construction phase. » To minimise nuisance to the community from dust emissions and to comply with workplace health and safety requirements for the duration of the construction phase. » Suppression of dust, pollution control and minimise dust generation.

Mitigation: Action/control	Responsibility	Timeframe
Implement appropriate dust suppression measures on a regular basis along the gravel access road and on the proposed site.	Contractor	Construction
Use of dust suppressants on roads and limit development of new roads.	Contractor	Lifetime of the facility
Areas to be cleared in a progressive manner. Road surfaces and other infrastructure to be constructed as soon as possible after vegetation clearing in order to minimise exposed ground surfaces, specifically roads which carry traffic.	Contractor	Duration of contract
Roads must be maintained to a manner that will ensure that nuisance to the community from dust emissions from road or vehicle sources is not visibly excessive.	Contractor	Site establishment and construction
Appropriate dust suppressant must be applied on all gravel roads associated, exposed areas and stockpiles associated to the project as required to minimise/control airborne dust.	Contractor	Duration of contract
Height of spoil/subsoil/overburden (not topsoil) stockpiles to be limited to 3m. Spoil and subsoil to be compacted and watered down as necessary.	Contractor	Duration of contract
Haul vehicles moving outside the construction site carrying material that can be wind-blown will be covered with suitable material tarpaulins shade cloth.	Contractor	Duration of contract
Speed of construction vehicles must be restricted, as defined by the Health and Safety Manager.	Contractor	Duration of contract
Dust-generating activities or earthworks may need to be rescheduled or the frequency of application of dust	Contractor	Duration of contract

Mitigation: Action/control	Responsibility	Timeframe
control/suppressant increased during periods of high winds if visible dust is blowing toward nearby residences outside the site.		
Disturbed areas must be re-vegetated as soon as practicable in line with the progression of construction activities.	Contractor	Completion of construction
Vehicles and equipment must be maintained in a road-worthy condition at all times.	Contractor	Duration of contract
All vehicles and containers used for moving waste must encapsulate the waste, which prevents the waste from causing odours and from escaping or blowing around the site. This will also prevent leachate material from spilling out of the containers, which is hazardous.	Contractor	Duration of contract
The batching plant must be enclosed with shade cloth to reduce the amount of cement particulates/ particles released into the environment.	Contractor	Duration of contract
Roads must be maintained to a manner that will ensure that nuisance to the neighbouring farmers from dust is not visibly excessive.	Owner/Contractor	Site establishment and construction

Performance Indicator	» No complaints from affected residents or community regarding dust or vehicle emissions. » Visual presence of dust and air quality. » Dust does not cause health (inhaling, eye irritation) and safety risks (low visibility). » Dust suppression measures implemented for all heavy vehicles that require such measures during the construction phase. » Drivers made aware of the potential safety issues and enforcement of strict speed limits when they are employed. » All heavy vehicles equipped with speed monitors before they are used in the construction phase in accordance with South African vehicle legislation. » Road worthy certificates in place for all heavy vehicles at outset of construction phase and up-dated on a monthly basis. » A complaints register must be maintained, in which any complaints from neighbouring farmers will be logged, and thereafter complaints will be investigated and, where appropriate, acted upon.
Monitoring	Monitoring must be undertaken to ensure emissions are not exceeding the prescribed levels via the following methods: » Immediate reporting by personnel of any potential or actual issues with nuisance dust or emissions to the Site Manager. » A complaints register must be maintained, in which any complaints from residents/the community will be logged, and thereafter complaints will be investigated and, where appropriate, acted upon. » An incident register and non-conformance must be used to record incidents and non-conformances to the EMPr. » A complaints register must be used to record grievances by the public.

6.3 Detailing Method Statements

OBJECTIVE 22: Ensure all construction activities are undertaken with the appropriate level of environmental awareness to minimise environmental risk

The environmental specifications are required to be underpinned by a series of Method Statements, within which the Contractors and Service Providers are required to outline how any identified environmental risks will practically be mitigated and managed for the duration of the contract, and how specifications within this EMPr will be met. That is, the Contractor will be required to describe how specified requirements will be achieved through the submission of written Method Statements to the Site Manager and ECO.

A Method Statement is defined as "a written submission by the Contractor in response to the environmental specification or a request by the Site Manager, setting out the plant, materials, labour and method the Contractor proposes using to conduct an activity, in such detail that the Site Manager is able to assess whether the Contractor's proposal is in accordance with the Specifications and/or will produce results in accordance with the Specifications". The Method Statement must cover applicable details with regard to:

» Responsible person/s;
» Construction procedures;
» Materials and equipment to be used;
» Getting the equipment to and from site;
» How the equipment/material will be moved while on-site;
» How and where material will be stored;
» The containment (or action to be taken if containment is not possible) of leaks or spills of any liquid or material that may occur;
» Timing and location of activities;
» Compliance/non-compliance with the Specifications; and
» Any other information deemed necessary by the Site Manager.

Method Statements must be compiled for all activities which affect any aspect of the environment and should be applied consistently to all activities. Specific areas to be addressed in the method statement: pre, during and post construction include:

» Site establishment (which explains all activities from induction training to offloading, construction sequence for site establishment and the different amenities and to be established etc. Including a site camp plan indicating all of these).
» Preparation of the site (i.e. clearing vegetation, compacting soils and removing existing infrastructure and waste).
» Soil management/stockpiling and erosion control.
» Excavations and backfilling procedure.
» Stipulate norms and standards for water supply and usage (i.e.: comply strictly to licence and legislation requirements and restrictions).
» Storm water method statement.
» Ablution facilities (placement, maintenance, management and servicing).

- » Solid Waste Management:
  - ∗ Description of the waste storage facilities (on site and accumulative).
  - ∗ Placement of waste stored (on site and accumulative).
  - ∗ Management and collection of waste process.
  - ∗ Recycle, re-use and removal process and procedure.
- » Liquid waste management.
- » Design, establish, maintain and operate suitable pollution control facilities necessary to prevent discharge of water containing polluting matter or visible suspended materials into the surrounding environment. Should grey water (i.e. water from basins, showers, baths, kitchen sinks etc.) need to be disposed of, link into an existing facility where possible. Where no facilities are available, grey water runoff must be controlled to ensure no seepage into the surrounding environment occurs.
- » Dust and noise pollution:
  - ∗ Describe the necessary measures to ensure that noise from construction activities is maintained within lawfully acceptable levels.
  - ∗ Procedure to control dust at all times on the site, access roads and spoil sites (dust control shall be sufficient so as not to have significant impacts in terms of the biophysical and social environments). These impacts include visual pollution, decreased safety due to reduced visibility, negative effects on human health and the ecology due to dust particle accumulation.
- » Hazardous substance storage (ensure compliance with all national, regional and local legislation with regard to the storage of oils, fuels, lubricants, solvents, wood treatments, bitumen, cement, pesticides and any other harmful and hazardous substances and materials. South African National Standards apply).
  - ∗ Lists of all potentially hazardous substances to be used.
  - ∗ Appropriate handling, storage and disposal procedures.
  - ∗ Prevention protocol of accidental contamination of soil at storage and handling areas.
  - ∗ All storage areas, (i.e. for harmful substances appropriately bunded with a suitable collection point for accidental spills must be implemented and drip trays underneath dispensing mechanisms including leaking engines/machinery).
- » Fire prevention and management measures on site.
- » Fauna and flora protection process on and off site (i.e. removal to reintroduction or replanting, if necessary).
  - ∗ Rehabilitation, re-vegetation process and bush clearing.
- » Incident and accident reporting protocol.
- » General administration.
- » Designate access road and the protocols while roads are in use.
- » Requirements on gate control protocols.

The Contractor may not commence the activity covered by the Method Statement until it has been approved by the Site Manager (with input from the ECO), except in the case of emergency activities and then only with the consent of the Site Manager. Approval of the Method Statement will not absolve the Contractor from their obligations or responsibilities in terms of their contract. Failure to submit a method statement may result in suspension of the activity concerned until such time as a method statement has been submitted and approved.

6.4 Awareness and Competence: Construction Phase

OBJECTIVE 23: To ensure all construction personnel have the appropriate level of environmental awareness and competence to ensure continued environmental due diligence and on-going minimisation of environmental harm

To achieve effective environmental management, it is important that all personnel involved in the project are aware of the responsibilities in terms of the relevant environmental legislation and the contents of this EMPr. The ECO is responsible for monitoring compliance pre, during and post construction. The contractor is responsible for informing employees and sub-contractors of their environmental obligations in terms of the environmental specifications, and for ensuring that employees are adequately experienced and properly trained in order to execute the works in a manner that will minimise environmental impacts.

The Contractors obligations in this regard include the following:

» All Employees must have a basic understanding of the key environmental features of the construction site and the surrounding environment. This includes the discussion/explanation of site environmental matters during toolbox talks.
» The content and requirements of Method Statements are to be clearly explained to all plant operators and general workers. All staff acting in a supervisory capacity are to have copies of the relevant Method Statements and be aware of the contents thereof.
» Ensuring that a copy of the EMPr is readily available on-site, and that all senior site staff are aware of the location and have access to the document. Senior site staff will be familiar with the requirements of the EMPr and the environmental specifications as they apply to the construction of the facility.
» Ensuring that, prior to commencing any site works, all employees and sub-contractors have attended an Environmental Awareness Training session. The training session must provide the site staff with an appreciation of the project's environmental requirements, and how they are to be implemented.
  * Records must be kept of those that have completed the relevant training.
  * Training should be done either in a written or verbal format but must be appropriate for the receiving audience.
  * Refresher sessions must be held to ensure the contractor staff are aware of their environmental obligations as practically possible.
» All sub-contractors must have a copy of the EMPr and sign a declaration/ acknowledgement that they are aware and familiar with the contents and requirements of the EMPr and that they will conduct work in such a manner as to ensure compliance with the requirements of the EMPr.
» Contractors and main sub-contractors should have a basic training in the identification of archaeological sites/objects, and protected flora and fauna that may be encountered on the site.
» Awareness of any other environmental matters, which are deemed to be necessary by the ECO.
» Ensuring that employee information posters, outlining the environmental “do’s” and “don’ts” (as per the environmental awareness training course) are erected at prominent locations throughout the site.

Therefore, prior to the commencement of construction activities on site and before any person commences with work on site thereafter, adequate environmental awareness and responsibility are to be appropriately presented to all staff present onsite, clearly describing their obligations towards environmental controls and methodologies in terms of this EMPr. This training and awareness will be achieved in the following ways:

6.4.1 Environmental Awareness and Induction Training

The EO, in consultation with the contractor, shall ensure that all construction workers receive an induction presentation, as well as on-going environmental education and awareness, on the importance and implications of the EMPr and the environmental requirements it prescribes. The presentation shall be conducted, as far as is possible, in the employees' language of choice. The contractor should provide a translator from their staff for the purpose of translating should this be necessary.

As a minimum, induction training should include:

- Explanation of the importance of complying with the EMPr;
- Explanation of the importance of complying with the Environmental Authorisation;
- Discussion of the potential environmental impacts of construction activities;
- Awareness regarding sensitivities on the site, including sensitive plant species (including the use of visual aids and on-site identification);
- The benefits of improved personal performance;
- Employees' roles and responsibilities, including emergency preparedness (this should be combined with this induction, but presented by the contractor's Health and Safety Representative);
- Explanation of the mitigation measures that must be implemented when carrying out their activities; and
- Explanation of the specifics of this EMPr and its specification (no-go areas, etc.).

Environmental Awareness Training must take the form of an on-site talk and demonstration by the EO/ECO before the commencement of site establishment and construction on site. The education/awareness programme should be aimed at all levels of management and construction workers within the contractor team. A record of attendance of this training must be maintained by the EO/ECO on site. Proof of awareness training should be kept on record. Environmental induction training must be presented to all persons who are to work on the site – be it for short or long durations; Contractor's or Engineer's staff; administrative or site staff; sub-contractors or visitors to site.

This induction training should be undertaken by the Contractor's Environmental Officer and should include discussing the developer's environmental policy and values, the function of the EMPr and Contract Specifications and the importance and reasons for compliance to these. The induction training must highlight overall do's and don'ts on site and clarify the repercussions of not complying with these. The non-conformance reporting system must be explained during the induction as well. Opportunity for questions and clarifications must form part of this training. A record of attendance of this training must be maintained by the EO/ECO on site.

6.4.2 Toolbox Talks

Toolbox talks should be held on a scheduled and regular basis (at least twice a month) where foremen, environmental and safety representatives of different components of the works and sub-consultants hold talks relating to environmental practices and safety awareness on site. These talks should also include discussions on possible common incidents occurring on site and ones recommended by the on site EO and the prevention of reoccurrence thereof. Records of attendance and the awareness talk subject must be kept on file.

6.5 Monitoring Programme: Construction Phase

OBJECTIVE 24: To monitor the performance of the control strategies employed against environmental objectives and standards

A monitoring programme must be in place not only to ensure conformance with the EMPr, but also to monitor any environmental issues and impacts which have not been accounted for in the EMPr that are, or could result in significant environmental impacts for which corrective action is required. The period and frequency of monitoring will be stipulated by the Environmental Authorisation (once issued). Where this is not clearly dictated, the Developer will determine and stipulate the period and frequency of monitoring required in consultation with relevant stakeholders and authorities. The Technical Director/ Project Manager will ensure that the monitoring is conducted and reported.

The aim of the monitoring and auditing process would be to monitor the implementation of the specified environmental specifications, in order to:

» Monitor and audit compliance with the prescriptive and procedural terms of the environmental specifications
» Ensure adequate and appropriate interventions to address non-compliance
» Ensure adequate and appropriate interventions to address environmental degradation
» Provide a mechanism for the lodging and resolution of public complaints
» Ensure appropriate and adequate record keeping related to environmental compliance
» Determine the effectiveness of the environmental specifications and recommend the requisite changes and updates based on audit outcomes, in order to enhance the efficacy of environmental management on site
» Aid in communication and feedback to authorities and stakeholders

All documentation e.g. audit/monitoring/compliance reports and notifications, required to be submitted to the DEA in terms of the Environmental Authorisation, must be submitted to the Director: Compliance Monitoring of the Department.

Records relating to monitoring and auditing must be kept on site and made available for inspection to any relevant and competent authority in respect of this development.

6.5.1. Non-Conformance Reports

All supervisory staff including Foremen, Engineers, and the ECO must be provided the means to be able to submit non-conformance reports to the Site Manager. Non-conformance reports will describe, in detail, the cause, nature and effects of any environmental non-conformance by the Contractor.

The non-conformance report will be updated on completion of the corrective measures indicated on the finding sheet. The report must indicate that the remediation measures have been implemented timeously and that the non-conformance can be closed-out to the satisfaction of the Site Manager and ECO.

6.5.2. Monitoring Reports

A monitoring report will be compiled by the ECO on a monthly basis and must be submitted to the Director: Compliance Monitoring at DEA for their records. This report should include details of the activities undertaken in the reporting period, any non-conformances or incidents recorded, corrective action required, and details of those non-conformances or incidents which have been closed out. The contractor must ensure that all waste manifests are provided to the ECO on a monthly basis in order to inform and update the DEA regarding waste related activities.

6.5.3. Audit Reports

The holder of the Environmental Authorisation must, for the period during which the Environmental Authorisation and EMPr remain valid, ensure that project compliance with the conditions of the Environmental Authorisation and the EMPr are audited, and that the audit reports are submitted to the Director: Compliance Monitoring of the DEA.

An environmental internal audit must be conducted and submitted every 3 months and an external audit must be conducted once a year. An annual audit report must be compiled and submitted to DEA until the completion of the construction and rehabilitation. This report must be compiled in accordance with Appendix 7 of the EIA Regulations, 2014, as amended, and indicate the date of the audit, the name of the auditor and the outcome of the audit in terms of compliance with the environmental authorisation conditions and the requirements of the EMPr.

6.5.4. Final Audit Report

A final environmental audit report must be compiled by an independent auditor and be submitted to DEA upon completion of the construction and rehabilitation activities. The report must be submitted within 30 days of completion of rehabilitation activities. This report must indicate the date of the audit, the name of the auditor and the outcome of the audit in terms of compliance with the environmental authorisation conditions and the requirements of the EMPr.

CHAPTER 7: MANAGEMENT PROGRAMME: REHABILITATION

Overall Goal: Undertake the rehabilitation measures in a way that:

» Ensures rehabilitation of disturbed areas following the execution of the works, such that residual environmental impacts are remediated or curtailed.

7.1. Objectives

In order to meet this goal, the following objective, actions and monitoring requirements are relevant:

OBJECTIVE 1: Ensure appropriate rehabilitation of disturbed areas such that residual environmental impacts are remediated or curtailed

Areas requiring rehabilitation will include all areas disturbed during the construction phase and that are not required for regular operation and maintenance operations. Rehabilitation should be undertaken in an area as soon as possible after the completion of construction activities within that area.

Project Component/s	» Construction camps. » Laydown areas. » Access roads. » Ancillary buildings. » Power line. » On-site substation.
Potential Impact	» Environmental integrity of the site undermined resulting in reduced visual aesthetics, erosion and increased runoff, and the requirement for on-going management intervention.
Activity/Risk Source	» Temporary construction areas. » Temporary access roads/tracks. » Other disturbed areas/footprints.
Mitigation: Target/Objective	» Ensure and encourage site rehabilitation of disturbed areas. » Ensure that the site is appropriately rehabilitated following the execution of the works, such that residual environmental impacts (including erosion) are remediated or curtailed.

Mitigation: Action/Control	Responsibility	Timeframe
Implement an appropriate Revegetation and Rehabilitation Plan (**refer to Appendix E**).	Contractor	Following execution of the works
All temporary facilities, equipment, and waste materials must be removed from site as soon as construction is completed.	Contractor	Following execution of the works
All temporary fencing and danger tape must be removed once the construction phase has been completed.	Contractor	Following completion of construction activities in an area

Mitigation: Action/Control	Responsibility	Timeframe
The area that previously housed the construction equipment camp is to be checked for spills of substances such as oil, paint, etc. Any spills recorded must be cleaned up and the contaminated soil appropriately disposed of.	Contractor	Following completion of construction activities in an area
No planting or importing any listed invasive alien plant species (all Category 1a, 1b and 2 invasive species) to the site for landscaping, rehabilitation or any other purpose must be undertaken.	Contractor	Following completion of construction activities in an area
All hardened surfaces within the construction equipment camp area should be ripped, all imported materials removed, and the area shall be top soiled and re-vegetated.	Contractor	Following completion of construction activities in an area
Temporary roads must be closed and access across these blocked. The temporary access roads must be rehabilitated.	Contractor	Following completion of construction activities in an area
Necessary drainage works and anti-erosion measures must be installed, where required, to minimise loss of topsoil and control erosion.	Contractor	Following completion of construction activities in an area
Remove all temporary works.	Contractor	Following completion of construction activities in an area
Topsoil from all excavations and construction activities must be salvaged and reapplied during reclamation.	Contractor	Following completion of construction activities in an area
Disturbed areas must be rehabilitated as soon as possible after construction and local indigenous plants must be used to enhance the conservation of the existing natural vegetation on site.	Contractor	Following completion of construction activities in an area
Where disturbed areas are not to be used during the operation of the proposed PV facility, power line and on-site substation, these areas must be rehabilitated/re-vegetated with appropriate natural indigenous vegetation and/or local seed mix. Re-use of native/indigenous plant species removed from disturbance areas in the rehabilitation phase to be determined by a botanist, as applicable. No exotic plants must be used for rehabilitation purposes.	Contractor in consultation with rehabilitation specialist	Following completion of construction activities in an area
Disturbed areas containing no infrastructure and hard surfaces must be rehabilitated with natural vegetation as soon as possible to avoid the potential of erosion and invasion with alien plants. The area should be monitored (responsibility of EO) on a weekly basis throughout the construction phase and on a monthly basis thereafter and to the point where the area has rehabilitated to a satisfactory level.	Contractor in consultation with rehabilitation specialist	Following completion of construction activities in an area
Re-vegetated areas may need to be protected from wind erosion and maintained until an acceptable plant cover has been achieved.	Proponent in consultation with rehabilitation specialist	Post-rehabilitation
Erosion control measures should be used in sensitive areas such as steep slopes, hills, and drainage systems if necessary.	Proponent in consultation with EO and rehabilitation specialist (if required)	Post-rehabilitation

Mitigation: Action/Control	Responsibility	Timeframe
On-going alien plant monitoring and removal must be undertaken on all areas of natural vegetation on an annual basis.	Proponent	Post-rehabilitation
It can be anticipated that invasive species and weeds will germinate on rehabilitated soils; these need to be hand-pulled before they are fully established and/or reaching a mature stage where they can regenerate. Where invasive shrubs re-grow, they will have to be eradicated according to the Working for Water specifications.	Contractor/ Developer	Construction/ Operation
A site rehabilitation programme should be implemented and this will be developed in collaboration with specialists following completion of construction	Contractor in consultation with Specialist	Duration of contract

Performance Indicator	» All portions of the site, including construction equipment camp and working areas, cleared of equipment and temporary facilities. » Topsoil replaced on all areas and stabilised where practicable or required after construction and temporally utilised areas. » Disturbed areas rehabilitated and acceptable plant cover achieved on rehabilitated sites. » Completed site free of erosion and alien invasive plants.
Monitoring	» On-going inspection of rehabilitated areas in order to determine effectiveness of rehabilitation measures implemented during the operational lifespan of the facility. » On-going alien plant monitoring and removal should be undertaken on an annual basis.

CHAPTER 8: OPERATION MANAGEMENT PROGRAMME

Overall Goal: To ensure that the operation of the PV facility does not have unforeseen impacts on the environment and to ensure that all impacts are monitored and the necessary corrective action taken in all cases. In order to address this goal, it is necessary to operate the facility in a way that:

» Ensures that operation activities are properly managed in respect of environmental aspects and impacts.
» Enables the operation activities to be undertaken without significant disruption to other land uses in the area, in particular with regard to farming practices, traffic and road use, and effects on local residents.
» Minimises impacts on fauna using the site.
» Establish an environmental baseline for solar energy sites in South Africa.

An environmental manager must be appointed during operation whose duty it will be to ensure the implementation of the operational EMPr.

8.1. Objectives

In order to meet this goal, the following objectives have been identified, together with necessary actions and monitoring requirements.

OBJECTIVE 1: Establish clear reporting, communication, and responsibilities in relation to overall implementation of the EMPr during operation

Formal responsibilities are necessary to ensure that key procedures are executed. Specific responsibilities of the Operations Manager, and Environmental Manager for the operation phase of this project are detailed below.

The **Operations Manager** will:
» Ensure that adequate resources (human, financial, technology) are made available and appropriately managed for the successful implementation of the operational EMPr.
» Conduct annual basis reviews of the EMPr to evaluate its effectiveness.
» Take appropriate action as a result of findings and recommendations in management reviews and audits.
» Provide forums to communicate matters regarding environmental management.

The **Technical/SHEQ Manager** will:

» Develop and Implement an Environmental Management System (EMS) for the PV facility and associated infrastructure.
» Manage and report on the facility's environmental performance.
» Maintain a register of all known environmental impacts and manage the monitoring thereof.
» Conduct internal environmental audits and co-ordinate external environmental audits.
» Liaise with statutory bodies such as the National and Provincial Department of Environmental Affairs (DEA) on environmental performance and other issues.

- Conduct environmental training and awareness for the employees who operate and maintain the PV facility.
- Compile environmental policies and procedures.
- Liaise with interested and affected parties on environmental issues of common concern.
- Track and control the lodging of any complaints regarding environmental matters.

The Technical/SHEQ Manager must provide fourteen (14) days written notification to the DEA that the operation phase will commence.

OBJECTIVE 2: Protection of indigenous natural vegetation, fauna and maintenance of rehabilitation

Indirect impacts on vegetation and terrestrial fauna during operation could result from maintenance activities and the movement of people and vehicles on site. In order to ensure the long-term environmental integrity of the site following construction, maintenance of the areas rehabilitated post-construction must be undertaken until these areas have successfully re-established.

Project Component/s	» Rehabilitated areas. » Areas along the perimeter fence. » Areas between PV panels. » Topsoil stockpile areas. » Power line.
Potential Impact	» Disturbance to or loss of vegetation and/or habitat. » Environmental integrity of the site undermined resulting in reduced visual aesthetics, erosion, compromised land capability and the requirement for on-going management intervention.
Activities/Risk Sources	» Movement of employee vehicles within and around the site.
Mitigation: Target/Objective	» Maintain minimised footprints of disturbance of vegetation/habitats on-site. » Ensure and encourage plant regrowth in non-operational areas of post-construction rehabilitation.

Mitigation: Action/Control	Responsibility	Timeframe
Rehabilitate disturbed areas should the previous attempt be unsuccessful.	O&M Contractor	Operation
Shading from PV panels may prevent or slow down the re-establishment of some desirable vegetation species, therefore re-establishment should be monitored and species composition adapted if vegetation fails to establish sufficiently.	O&M Contractor	Operation
Any movements by vehicle and personnel should be limited to within the footprint of the power line corridor and other associated infrastructure, especially during routine maintenance procedures.	O&M Contractor	Operation
Any raptor nests that are discovered on the power line structures should be reported, while utmost care should be taken to not disturb these nests during routine maintenance procedures.	O&M Contractor	Operation
All vehicles accessing the site should adhere to a low speed limit (30km/h max) to avoid collisions with susceptible species such as snakes and tortoises.	O&M Contractor	Operation

Mitigation: Action/Control	Responsibility	Timeframe
It may be necessary to routinely trim vegetation growing between the PV panel rows and/or the plant screens planted along the development site fencing. This is to avoid shading of the panels and reduce fire risks.	O&M Contractor	Operation
The use of herbicides and pesticides and other related horticultural chemicals should be carefully controlled and only applied by personnel adequately certified to apply pesticides and herbicides. It must be ensured that WHO Recommended Classification of Pesticides by Hazard Class 1a (extremely hazardous) or 1b (highly hazardous) are not purchased, stored or used on site along with any other nationally or internationally similarly restricted/banned products.	O&M Contractor	Operation
Soil surfaces where no revegetation seems possible will have to be covered with gravel or small rock fragments to increase porosity of the soil surface, slow down runoff and prevent wind and water erosion.	O&M Contractor	Operation
Any vegetation clearing that needs to take place as part of the maintenance activities must be done in an environmentally friendly manner, including avoiding the use of herbicides and using manual clearing methods wherever possible.	O&M Contractor	Operation and maintenance
If the site must be lit at night for security purposes, this should be done with downward-directed low-UV type lights (such as most LEDs), which do not attract insects.	O&M Contractor	Operation
Vehicle movements must be restricted to designated access roads.	O&M Contractor	Operation
No electrified strands should be placed within 30cm of the ground as some species such as tortoises are susceptible to electrocution from electric fences. Alternatively, the electrified strands should be placed on the inside of the fence (facility and substation) and not the outside as is the case on the majority of already constructed PV plants.	O&M Contractor	Operation
Existing roads must be maintained to ensure limited erosion and impact on areas adjacent to roadways.	O&M Contractor	Operation
Maintain erosion control measures implemented during the construction phase (i.e. run-off attenuation on slopes (bags, logs), silt fences, storm water catch-pits, and shade nets).	O&M Contractor	Operation
Develop and implement an appropriate stormwater management plan for the operation phase of the power line and on-site substation.	O&M Contractor	Operation
Site access should be controlled and only authorised staff and contractors should be allowed on-site.	O&M Contractor	Operation
Notice boards stating that fauna and flora may not be collected, harvested etc. should be placed at the entrances to the site.	O&M Contractor	Operation
Any maintenance activities should avoid listed plant species and strive to keep the footprint as low as possible.	O&M Contractor	Operation
No herbicides should be used and if vegetation clearing needs to take place, this should be done by hand.	O&M Contractor	Operation

Mitigation: Action/Control	Responsibility	Timeframe
An on-going alien plant monitoring and eradication programme must be implemented, where necessary.	O&M Contractor	Operation
The collection, hunting or harvesting of any plants or animals at the site should be strictly forbidden.	O&M Contractor	Operation
A botanist and/or ecologist familiar with the vegetation of the area should monitor the rehabilitation success and alien plant removal on an annual basis. The monitoring should be undertaken until the rehabilitation is considered adequate and sufficient.	Specialist	Annual monitoring until successful re-establishment of vegetation in an area
All hazardous materials 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 as related to the nature of the spill.	O&M Contractor	Operation
Spill kits must be kept on-site.	O&M Contractor	Operation
A botanist familiar with the vegetation of the area should monitor the rehabilitation success and alien plant removal on an annual basis.	Developer in consultation with Specialist	Annual monitoring until successful re-establishment of vegetation in an area
A faunal/ avifauna incident register must be maintained on site.	O&M Contractor SHEQ Manager	Operation
Implement an animal removal plan to ensure safety of workers and fauna.	O&M Contractor	Operation
Any potentially dangerous fauna such as snakes or fauna threatened by the maintenance and operational activities should be removed to a safe location.	Low-U	Operation
Regular monitoring for erosion post-construction to ensure that no erosion problems have developed as a result of the past disturbance.	O&M Contractor	Operation
All declared alien species must be identified and managed in accordance with the Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983). There must be an alien species monitoring and eradication programme to prevent encroachment of these problem plants for the duration of the operation.	O&M Contractor	Operation
Regular monitoring must be undertaken for alien plant invasion, which is likely to occur in previously disturbed areas or in areas receiving runoff from the hardened surfaces of the infrastructure.	O&M Contractor	Operation
The washing of panels during maintenance must be done with biodegradable soaps to avoid soil contamination and the poisoning of small animals.	O&M Contractor	Operation
Any potentially dangerous fauna such as snakes or fauna threatened by the maintenance and operational activities must be removed to a safe location.	O&M Contractor	Operation

Performance Indicator	» Acceptable level of soil erosion around site, as determined by the site manager. » Acceptable level of increased siltation in washes, as determined by the site manager. » No further disturbance to vegetation or terrestrial faunal habitats. » Continued improvement of rehabilitation efforts.

Monitoring	» Observation of vegetation on-site by the facility manager and environmental manager. » Regular inspections to monitor plant regrowth/performance of rehabilitation efforts and weed infestation compared to natural/undisturbed areas. » Inspections of the site on a bi-annual basis. » Storm water Management Plan.

OBJECTIVE 3: Protection of avifauna from collision and electrocution

During the operation, the threat of collision with the proposed 132kV double-circuit power line is a potential threat to avifauna, particularly sensitive, collision prone species that may occur in the study area. The threat of electrocution while perching on the power line and associated infrastructure serves as a threat to certain sensitive species, depending on the power line structures implemented.

Project Component/s	» Power line.
Potential Impact	» Collision and electrocution events with the power line.
Activities/Risk Sources	» Operation of the power line without appropriate mitigation measures.
Mitigation: Target/Objective	» Maintain a low number of collision, and electrocution events.

Mitigation: Action/Control	Responsibility	Timeframe
Minor features along the proposed route include the following, a stand of *Acacia mellifera* shrubs, a stand of alien *Prosopis* trees near human habitation, a small rocky outcrop and some small sewage ponds. These may attract raptors and waterbirds on occasion, although no large red-listed species are expected to be attracted to these features. Areas where the power line should be fitted with bird flight diverters to reduce collision risk should be identified post-construction through searches for bird carcasses along the power line, and particularly in the vicinity of the above mentioned features.	O&M Contractor	Post-construction
Any electrocution and collision events that occur should be recorded, including the species affected and the date. If repeated collisions occur within the same area, then further mitigation and avoidance measures may need to be implemented.	O&M Contractor	Operation
If birds are nesting on the infrastructure of the facility and cannot be tolerated due to operational risks of fire, electrical short, soiling of panels or other problems, birds must be prevented from accessing nesting sites by using mesh or other manner of excluding them. Birds should not be shot, poisoned or harmed as this is not an effective control method and has negative ecological consequences. Birds with eggs or nestlings should be allowed to fledge their young before nests are removed.	O&M Contractor	Operation
If there are any persistent problems with avifauna, then an avifaunal specialist should be consulted for advice on further mitigation.	Avifauna Specialist	Operation
Bird nests must be removed when nest-building attempts are noticed.	O&M Contractor	Operation

Mitigation: Action/Control	Responsibility	Timeframe
Reduce or minimise the use of outdoor lighting to avoid attracting birds to the lights or to reduce potential disorientation to migrating birds.	O&M Contractor	Operation
Power line inspections / monitoring should be ongoing for the operational life of the line detect bird carcasses, to enable the identification of any areas of high impact to be marked with bird diverters. Report avifauna mortalities (number locality and species) to the Electrical Energy Mortality Register at the Endangered Wildlife Trust.	O&M Contractor	Operation
All incidents of collision with panels should be recorded as meticulously as possible, including data related to the species involved, the exact location of collisions within the facility, and suspected cause of death. Post-construction monitoring with the aid of video surveillance should be considered, as this will contribute towards understanding bird interactions with solar panels.	O&M Contractor	Operation
Any movements by vehicle and personnel should be limited to within the footprint of power lines and other associated infrastructure, especially during routine maintenance procedures. Utmost care should be taken to not disturb nests that may be constructed on power line structures.	O&M Contractor	Operation
All vehicles accessing the site should adhere to a low speed limit (30km/h max) to avoid collisions with susceptible species such nocturnal and crepuscular species (e.g. nightjars, thick-knees and owls) which sometimes forage or rest on roads at night.	O&M Contractor	Operation
The use of lighting at night should be kept to a minimum, so as not to unnecessarily attract invertebrates to the solar facility and possibly their avian predators, and to minimise disturbance to birds flying over the facility at night	O&M Contractor	Operation
Maintenance of the perimeter fencing must ensure that it fulfils the guidelines suggested by Visser (2016) (refer to **Appendix M3**), to minimise impacts to korhaans susceptible to entrapment between the fencing and electrical components of perimeter fencing.	O&M Contractor	Operation

Performance Indicator	» Minimal collision, or electrocution events. » Reduced statistical detection/observation of bird mortalities.
Monitoring	» Observation of electrocution or collision events with the power line. » Monitor power line servitude for mortalities.

OBJECTIVE 4: Minimise soil degradation, erosion and alien plant invasion

The soil on site may be impacted in terms of:

» *Soil degradation including erosion* - by wind and water and subsequent deposition elsewhere is of a concern across the entire site.

» *Uncontrolled run-off* - relating to construction activity (excessive wetting, uncontrolled discharge, etc.) will also lead to accelerated erosion and possible sedimentation of drainage systems outside of the project site during operation.
» *Degradation* - of the natural soil profile due to pollution.

Project Component/s	» PV facility » Ancillary buildings. » Access roads. » Power line.
Potential Impact	» Soil degradation. » Soil erosion. » Increased deposition of soil into drainage systems. » Increased run-off over the site.
Activities/Risk Sources	» Poor rehabilitation of cleared areas. » Rainfall - water erosion of disturbed areas. » Wind erosion of disturbed areas. » Concentrated discharge of water from construction activity.
Mitigation: Target/Objective	» Ensure rehabilitation of disturbed areas is maintained. » Minimise soil degradation (i.e. wetting). » Minimise soil erosion. » Ensure continued stability of embankments/excavations.

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Ensure dust control on site through wetting of denuded areas or the use of an appropriate dust suppression measure.	O&M Contractor	Operation
Monitor the area below and around the panels regularly after larger rainfall events to determine where erosion may be initiated and then mitigate by modifying the soil micro-topography and revegetation efforts accordingly.	O&M Contractor	Operation
Runoff may have to be specifically channelled or storm water adequately controlled to prevent localised rill and gully erosion.	O&M Contractor	Operation
Maintain erosion control measures implemented during the construction phase (i.e. run-off attenuation on slopes (sand bags, logs), silt fences, stormwater catch-pits, and shade nets).	O&M Contractor	Operation
Control depth of excavations and stability of cut faces/sidewalls.	O&M Contractor	Operation
Regular monitoring by the operation and maintenance team for alien plants at the site should occur and could be conducted simultaneously with erosion monitoring.	O&M Contractor	Operation
Regular monitoring of the site (minimum of twice annually) to identify possible areas of erosion is recommended, particularly after large summer thunder storms have been experienced. Follow up remedial action where problems are identified, should be provided.	O&M Contractor	Operation
Roads and other disturbed areas within the development site should be regularly monitored for erosion problems and problem areas should receive follow-up monitoring to assess the success of the remediation.	O&M Contractor	Operation

Performance Indicator	» Acceptable level of soil erosion around the site, as determined by the site manager. » Minimal issues related to alien plant invasion.
Monitoring	» Inspections of the site on a bi-annual basis. » Water management plan developed and implemented.

OBJECTIVE 5: Minimise dust and air emissions

During the operation phase, limited gaseous or particulate emissions are anticipated from exhaust emissions (i.e. from operational vehicles). Windy conditions and the movement of vehicles on site may lead to dust creation.

Project Component/s	» On-site vehicles.
Potential Impact	» Dust and particulates from vehicle movement to and on-site. » Release of minor amounts of air pollutants (for example NO_2, CO and SO_2) from vehicles.
Activities/Risk Sources	» Re-entrainment of deposited dust by vehicle movements. » Wind erosion from unsealed roads and surfaces. » Fuel burning vehicle and construction engines.
Mitigation: Target/Objective	» To ensure emissions from all vehicles are minimised, where possible. » To minimise nuisance to the community from dust emissions and to comply with workplace health and safety requirements.

Mitigation: Action/Control	Responsibility	Timeframe
Roads must be maintained to ensure that nuisance to the community from dust is not visibly excessive.	O&M Contractor	Operation
Appropriate dust suppression must be applied to all gravel roads within the site as required to minimise/control airborne dust.	O&M Contractor	Operation
Speed of vehicles must be restricted to 30km/h on site.	O&M Contractor	Operation
Vehicles and equipment must be maintained in a road-worthy condition at all times.	O&M Contractor	Operation

Performance Indicator	» No complaints from affected residents or community regarding dust or vehicle emissions. » Dust suppression measures implemented where required. » Drivers made aware of the potential safety issues and enforcement of strict speed limits when they are employed.
Monitoring	» Immediate reporting by personnel of any potential or actual issues with nuisance, dust or emissions to the Site Manager. » A complaints register must be maintained, in which any complaints from residents/the community will be logged, and thereafter complaints will be investigated and, where appropriate, acted upon. » An incident reporting system must be used to record non-conformances to the EMPr.

OBJECTIVE 6: Ensure the implementation of an appropriate fire management plan and general management measures during the operation phase

The following recommendations below must be considered with regards to fire protection on site:

- Alien Invasive species should be completely eradicated in order to decrease the fire risk associated with the site.
- Cigarette butts may not be thrown in the veld, but must be disposed of correctly. Designated smoking areas must be established with suitable receptacles for disposal.
- In case of a fire outbreak, contact details of the local fire and emergency services must be readily available.
- Contractors must ensure that basic firefighting equipment is available on site as per the specifications defined by the health and safety representative / consultant.
- The fire risk on site is a point of discussion that must take place as part of the environmental induction training prior to commencement of construction.
- The contractor must also comply with the requirements of the Occupational Health and Safety Act with regards to fire protection.

The following below can be used as a guide for appropriate fire management (also refer to **Appendix J**):

Project Component/s	» Operation and maintenance of the PV facility and associated infrastructure.
Potential Impact	» Veld fires can pose a personal safety risk to local farmers and communities, and their homes, crops, livestock and farm infrastructure, such as gates and fences. In addition, fire can pose a risk to the PV facility infrastructure.
Activities/Risk Sources	» The presence of operation and maintenance personnel and their activities on the site can increase the risk of veld fires.
Mitigation: Target/Objective	» To avoid and or minimise the potential risk of veld fires on local communities and their livelihoods.

Mitigation: Action/Control	Responsibility	Timeframe
Provide adequate firefighting equipment on site and establish a fire-fighting management plan during operation (**refer to Appendix J**).	O&M Contractor	Operation
Provide fire-fighting training to selected operation and maintenance staff.	O&M Contractor	Operation
Ensure that appropriate communication channels are established to be implemented in the event of a fire.	O&M Contractor	Operation
Fire breaks should be established where and when required. Cognisance must be taken of the relevant legislation when planning and burning firebreaks (in terms of timing, etc.).	Contractor	Operation
Upon completion of the construction phase, an emergency evacuation plan must be drawn up to ensure the safety of the staff and surrounding land users in the case of an emergency.	O&M Contractor	Operation

Mitigation: Action/Control	Responsibility	Timeframe
Contact details of emergency services should be prominently displayed on site.	O&M Contractor	Operation
Road borders must be regularly maintained to ensure that vegetation remains short and that they therefore serve as an effective firebreak.	O&M Contractor	Operation
Staff and general trips to the site should occur outside of peak traffic periods.	O&M Contractor	Operation
Should panels be required to be replaced, the following will apply: » Materials and panels are to be stored within the previously disturbed construction laydown area. No disturbance of areas outside of these areas should occur. » Full clean-up of all materials must be undertaken after the removal and replacement of the solar panel arrays and associated infrastructure is complete, and disturbed areas appropriately rehabilitated. » Most of the materials used for solar panel systems can be recycled. The majority of the glass and semiconductor materials can be recovered and re-used or recycled. Recyclable materials must be transported off-site by truck and managed at appropriate facilities in accordance with relevant waste management regulations. No waste materials may be left on-site. » Waste material which cannot be recycled shall be disposed of at an appropriately licensed waste disposal site or as required by the relevant legislation.	O&M Contractor	Operation

Performance Indicator	» Firefighting equipment and training provided before the operation phase commences. » Appropriate fire breaks in place.
Monitoring	» The O&M operator must monitor indicators listed above to ensure that they have been met.

OBJECTIVE 7: Minimise the potential impact on farming activities and on the surrounding landowners

Once operational, the impact on the daily living and movement patterns of neighbouring residents is expected to be minimal and intermittent (i.e. the increase in traffic to and from site, possible dust creation of vehicle movement on gravel roads on site and possible increase in criminal activities). The number of workers on site is anticipated to have minimal negative social impacts in this regard.

The operations at the PV facility is not anticipated to have severe negative impacts on the neighbouring farmers' living and movement patterns, apart from a limited increase in the movement of people to and from the site, as well as the presence of these employees on-site on a permanent basis.

Vehicle movement to and from the site (e.g. transportation of workers and goods) could influence road users' daily movement patterns, although it is anticipated that this impact would only materialise intermittently.

Project Component/s	» Possible negative impacts of activities undertaken on site on the activities of surrounding property owners. » Impact on farming activities on site.
Potential Impact	» Possible limited intrusion impact on surrounding landowners. » Visual impact of facility degradation and vegetation rehabilitation failure.
Activities/Risk Sources	» Traffic to and from site could affect daily living and movement patterns of surrounding residents. » Viewing of the facility by observers in a negative light due to degradation and rehabilitation failure.
Mitigation: Target/Objective	» Effective management of the facility. » Mitigation of intrusion impacts on property owners. » Mitigation of impact on farming activities. » Well maintained and neat facility.

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Effective management of the facility to avoid any environmental pollution focusing on water, waste and sanitation infrastructure and services.	Contractor and Security Contractor	Operation
Vehicle movement to and from the site should be minimised as far as possible.	Contractor and Security Contractor	Operation
Infrastructure such as fencing and/or gates must be maintained in the present condition or repaired if disturbed due to project activities.	O&M Contractor	Operation
Maintain the general appearance of the facility as a whole, including the PV panels, servitudes and the ancillary structures.	O&M Contractor	Operation
Maintain roads and servitudes to forego erosion and to suppress dust.	O&M Contractor	Operation
Monitor rehabilitated areas, and implement remedial action as and when required.	O&M Contractor	Operation
Investigate the potential to screen visual impacts at affected receptor sites, if requested by an affected party and if practicable..	O&M Contractor	Operation
Ensure that all affected land owners and tourist associations are regularly consulted.	O&M Contractor	Operation

Performance Indicator	» No environmental pollution occurs (i.e. waste, water, and sanitation). » No intrusion on private properties and on the activities undertaken on the surrounding properties. » Continuation of farming activities in surrounding areas. » Well maintained and neat facility with intact vegetation on and in the vicinity of the facility.
Monitoring	» The O&M operator should be able to demonstrate that the facility is well managed without environmental pollution and that the above requirements have been met. » Monitoring of the entire site on an ongoing basis (by the O&M Operator).

OBJECTIVE 8: Appropriate handling and management of hazardous substances, waste and dangerous goods

The operation of the PV facility will involve the storage of chemicals and hazardous substances, as well as the generation of limited waste products. The main wastes expected to be generated by the operation activities includes general solid waste, hazardous waste and sewage waste.

Project Component/s	» On-site substation. » PV facility. » Energy Storage. » Operation and maintenance staff. » Workshop / control room.
Potential Impact	» Inefficient use of resources resulting in excessive waste generation. » Litter or contamination of the site or water through poor waste management practices. » Contamination of water or soil because of poor materials management.
Activity/Risk Source	» Substation, transformers, switchgear and supporting equipment. » Workshop / control room.
Mitigation: Target/Objective	» Comply with waste management legislation. » Minimise production of waste. » Ensure appropriate waste disposal. » Avoid environmental harm from waste disposal. » Ensure appropriate storage of chemicals and hazardous substances.

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Hazardous substances (such as used/new transformer oils, etc.) must be stored in sealed containers within a clearly demarcated designated area.	O&M Contractor	Operation
Batteries must be stored in self-contained units comprising specially adapted shipping containers which includes chemical, mechanical, electrical, fire and environmental protection. Where required to be replaced, old batteries must be appropriately disposed of or recycled.	O&M Contractor	Operation
Spill kits must be made available on-site for the clean-up of spills and leaks of contaminants.	Owner O&M Operator	Operation and maintenance
Storage areas for hazardous substances must be appropriately sealed and bunded.	O&M Contractor	Operation
All hazardous materials 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 as related to the nature of the spill.	O&M Contractor	Operation
All structures and/or components replaced during maintenance activities must be appropriately disposed of at an appropriately licensed waste disposal site or sold to a recycling merchant for recycling.	O&M Contractor	Operation

Mitigation: Action/Control	Responsibility	Timeframe
Care must be taken to ensure that spillage of oils and other hazardous substances are limited during maintenance. Handling of these materials should take place within an appropriately sealed and bunded area. Should any accidental spillage take place, it must be cleaned up according to specified standards regarding bioremediation.	O&M Contractor	Operation and maintenance
Disposal of waste must be in accordance with relevant legislative requirements, including the use of licensed contractors.	Contractor, The developer / waste management contractor	Operation
All food waste and litter at the site should be placed in bins with lids and removed from the site on a regular basis.	Contractor, The developer / waste management contractor	Operation
Waste handling, collection, and disposal operations must be managed and controlled by a waste management contractor.	Contractor, waste management contractor	Operation
All sewage disposal to take place at a registered and operational wastewater treatment works. Proof of disposal to be retained as proof of responsible disposal.	O&M Contractor	Operation
Used oils and chemicals: » Appropriate disposal must be arranged with a licensed facility in consultation with the administering authority. » Waste must be stored and handled according to the relevant legislation and regulations.	O&M Contractor	Operation
General waste must be recycled where possible or disposed of at an appropriately licensed landfill.	O&M Contractor	Operation
Hazardous waste (including hydrocarbons) and general waste must be stored and disposed of separately.	O&M Contractor	Operation

Performance Indicator	» No complaints received regarding waste on site or indiscriminate dumping. » Internal site audits identifying that waste segregation recycling and reuse is occurring appropriately. » Provision of all appropriate waste manifests. » No contamination of soil or water.
Monitoring	» Waste collection must be monitored on a regular basis. » Waste documentation must be completed and available for inspection. » An incidents/complaints register must be maintained, in which any complaints from the community must be logged. » Complaints must be investigated and, if appropriate, acted upon. » Regular reports on exact quantities of all waste streams exiting the site must be compiled by the waste management contractor and monitored by the O&M operator. » All appropriate waste disposal certificates accompany the monthly reports.

OBJECTIVE 9: Enhancement of positive social impacts and mitigation of negative social impacts

During the operation phase of the Allepad PV Three, both positive and negative impacts are expected to occur. Positive impacts can be enhanced through the application of enhancement measures and negative impacts can be mitigated and the significance reduced through the application of mitigation measures.

Project Component/s	» Operational PV facility
Potential Impact	» Loss of opportunities to stimulate production and employment of the local economy
Activity/Risk Source	» Labour practices employed during operation
Mitigation: Target/Objective	» Maximise local community employment benefits in the local economy

Mitigation: Action/Control	**Responsibility**	**Timeframe**
Engagement and involvement of the Local Municipality and Ward Councillors with social responsibility plans.	O&M operator	Pre-Operation phase
An in-depth community needs analysis (CNA) will need to be carried out on the local area to make sure that the real needs of communities are addressed (in line with the local government) and the correct representatives of the community are appointed to run the community trust, dependant on possible new Department of Energy (DoE) Independent Power Producer (IPP) community and trust requirements.	O&M operator	Pre-Operation phase
Communicate the benefits associated with renewable energy to the broader community.	O&M operator	Operation
Adopt a local employment policy to maximise the opportunities made available to the local labour force.	O&M operator	Operation
Work closely with the appropriate municipal structures in regard to establishing a social responsibility programme. The social responsibility programme should either be in line with the REIPPP BID guidelines or equivalent.	O&M operator Local Municipality	Operation
Establish vocational training programs for the local labour force to promote the development of skills, depending on the CNA results.	O&M operator	Operation
Ensure that any trusts or funds are strictly managed in respect of outcomes and funds.	O&M operator	Operation
The recruitment selection process should seek to promote gender equality and the employment of women wherever possible.	O&M operator	Operation

Performance Indicator	» Percentage of workers that were employed from local communities. » Number of people attending vocational training on an annual basis, depending on CNA.
Monitoring	» The O&M operator must keep a record of local recruitments and information on local labour for reporting purposes.

CHAPTER 9: MANAGEMENT PROGRAMME: DECOMMISSIONING

The PV facility is expected to have a lifespan of 20 years (i.e. with routine maintenance). The infrastructure would only be decommissioned and rehabilitated once it has reached the end of its economic life. It is most likely that decommissioning activities of the infrastructure of the PV facility considered in the EIA process would comprise the disassembly and replacement of the individual components with more appropriate technology/infrastructure available at that time.

The relevant mitigation measures contained under the construction section should be applied during decommissioning and therefore are not repeated in this section.

» ***Site Preparation***
Site preparation activities will include confirming the integrity of the access to the site to accommodate required equipment, preparation of the site (e.g. laydown areas, construction platform) and the mobilisation of construction equipment.

» ***Disassemble and Remove Infrastructure***
Disassembled components will be reused, recycled, or disposed of in accordance with regulatory requirements.

9.1. Objectives

Within a period of at least 12 months prior to the decommissioning of the site, a Decommissioning Method Statement must be prepared and submitted to the Local Planning Authority, as well as the Provincial and National Environmental Authority. This method statement must cover site restoration, soil replacement, landscaping, conservation, and a timeframe for implementation. Furthermore, this decommissioning must comply with all relevant legal requirements administered by any relevant and competent authority at that time.

The objectives of the decommissioning phase of the proposed project are to:

» Follow a process of decommissioning that is progressive and integrated into the short- and long-term project plans that will assess the closure impacts proactively at regular intervals throughout project life.
» Implement progressive rehabilitation measures, beginning during the construction phase.
» Leave a safe and stable environment for both humans and animals and make their condition sustainable.
» Return rehabilitated land-use to a standard that can be useful to the post-project land user.
» Where applicable, prevent any further soil and surface water contamination by maintaining suitable storm water management systems.
» Maintain and monitor all rehabilitated areas following re-vegetation, and if monitoring shows that the objectives have been met, apply for closure.

9.2. Approach to the Decommissioning Phase

It is recommended that planning of the decommissioning of the project and rehabilitation of the site should take place well in advance (at least two years) of the planned decommissioning activities. Important factors that need to be taken into consideration are detailed below.

Two possible scenarios for this decommissioning phase are detailed below:

SCENARIO 1: TOTAL DECOMMISSIONING OF PV FACILITY.

If the decision is taken at the end of the project lifespan to totally decommission the facility, i.e. make the land available for an alternative land use, the following should take place:

» All concrete and imported foreign material must be removed from the PV facility i.e. panels, support structures etc.
» The holes where the panel support structures are removed must be levelled and covered with subsoil and topsoil.
» Infrastructure not required for the post-decommissioning use of the site must be removed and appropriately disposed of.
» Access roads and servitudes not required for the post-decommissioning use of the site must be rehabilitated. If necessary, an ecologist should be consulted to give input into rehabilitation specifications.
» Tracks that are to be utilised for the future land use operations should be left *in-situ*. The remainder of the tracks to be removed (ripped) and topsoil replaced.
» All ancillary buildings and access points are to be removed unless they can be used for the future land use.
» Underground electric cables are to be removed if they cannot be used in the future land use.
» All material (cables, PV Panels etc.) must be re-used or recycled wherever possible.
» The competent authority may grant approval to the owner not to remove the landscaping and underground foundations.
» The site must be seeded with locally sourced indigenous vegetation (unless otherwise dictated by the future land use) to allow revegetation of the site.
» Monitor rehabilitated areas quarterly for at least three years (expected) following decommissioning, and implement remedial action as and when required.

SCENARIO 2: PARTIAL DECOMMISSIONING OF ENERGY FACILITY.

Should more advanced technology become available it may be decided to continue to use the site as a PV facility. Much of the existing infrastructure is likely to be re-used in the upgraded facility. In this case, all infrastructure that will no longer be required for the upgraded facility must be removed as described for Scenario 1. The remainder of the infrastructure should remain in place or upgraded depending on the requirements of the new facility. Any upgrades to the facility at this stage must comply with relevant legislation.

9.2.1. Identification of structures for post-closure use

Access roads should be assessed in conjunction with the future land users to determine if these could be used. Where not required, these access roads should be decommissioned and rehabilitated.

9.2.2. *Removal of infrastructure*

All infrastructure must be dismantled and removed. Inert material must be removed from site and disposed of at a suitably registered landfill site. The PV facility components must be removed and recycled where possible or disposed of at a suitably registered landfill site. All foundations must be removed to a depth of 1m. Hard surfaces must be ripped to a depth of 1m and vegetated.

9.2.3. *Soil rehabilitation*

The steps that should be taken during the rehabilitation of soils are as follows:

- The deposited soils must be ripped to ensure reduced compaction;
- An acceptable seed bed should be produced by surface tillage;
- Restore soil fertility;
- Incorporate the immobile fertilisers in to the plant rooting zone before ripping; and
- Apply maintenance dressing of fertilisers on an annual basis until the soil fertility cycle has been restored.

9.2.4. *Establishment of vegetation*

The objective is to restore the project site to a self-sustaining cycle, i.e. to realise the re-establishment of the natural nutrient cycle with ecological succession initiated.

The objectives for the re-vegetation of reshaped and top-soiled land are to:

- Prevent erosion;
- Restore the land to the agreed land capability;
- Re-establish eco-system processes to ensure that a sustainable land use can be established without requiring fertilizer additions; and
- Restore the biodiversity of the area as far as possible.

9.2.5. *Maintenance*

Established vegetation requires regular maintenance. If the growth medium consists of low-fertility soils, then regular maintenance will be required until the natural fertility cycle has been restored.

9.2.6. *Monitoring*

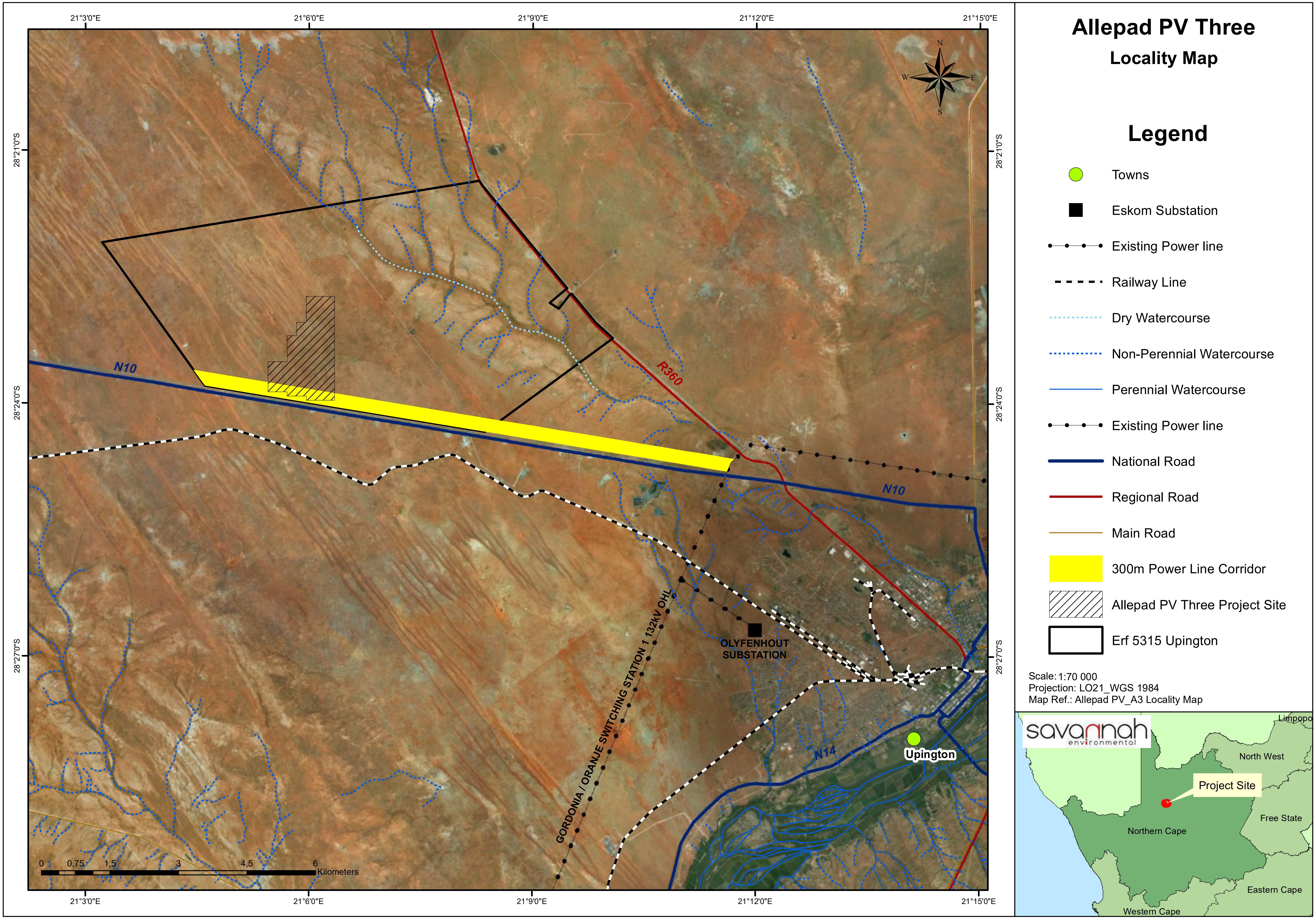
The purpose of monitoring is to ensure that the objectives of rehabilitation are met and that the rehabilitation process is followed. The physical aspects of rehabilitation should be carefully monitored during the progress of establishment of desired final ecosystems.

The following items should be monitored continuously:

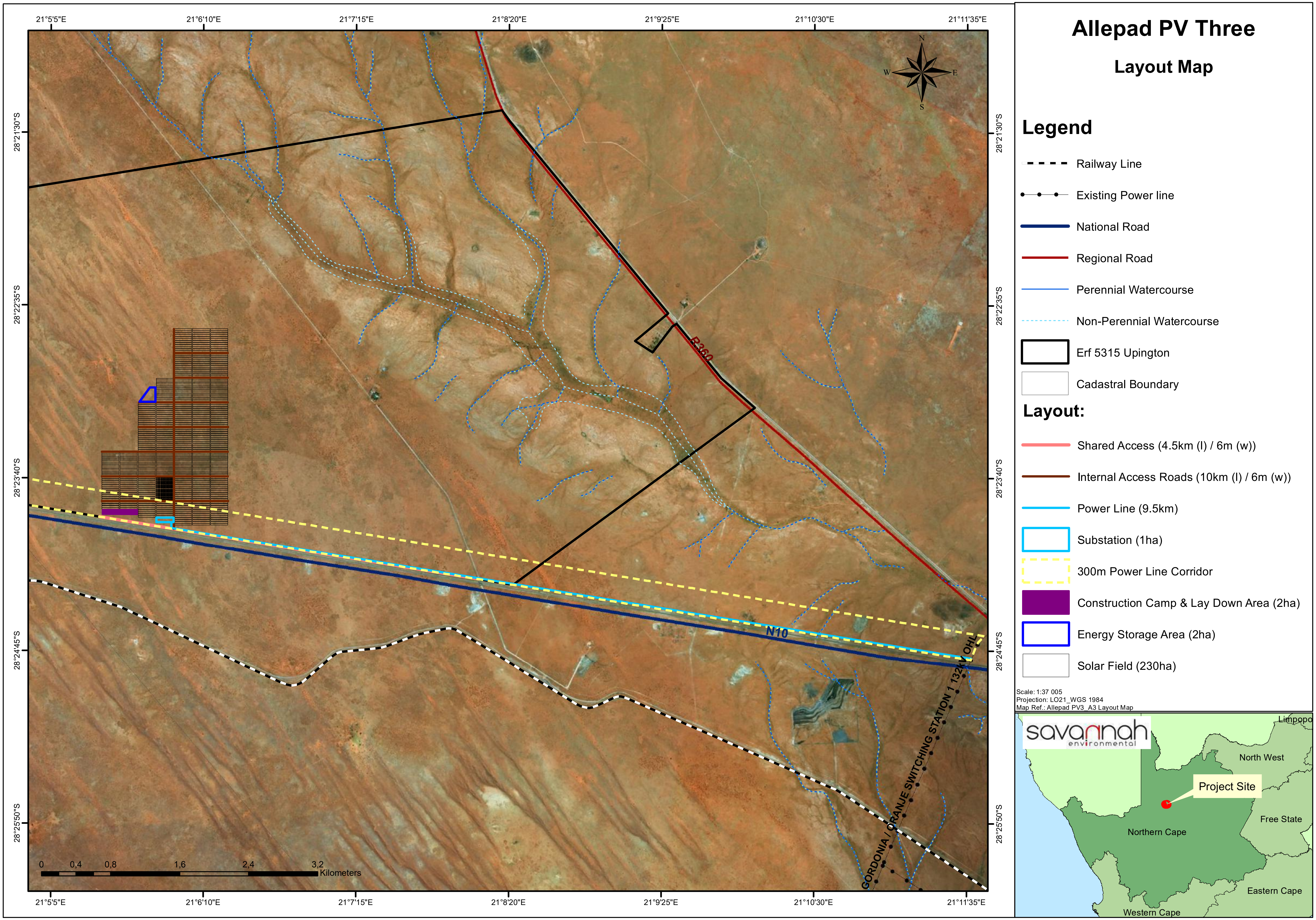
- Erosion status;
- Vegetation species diversity; and
- Faunal re-colonisation.

APPENDIX I(A):

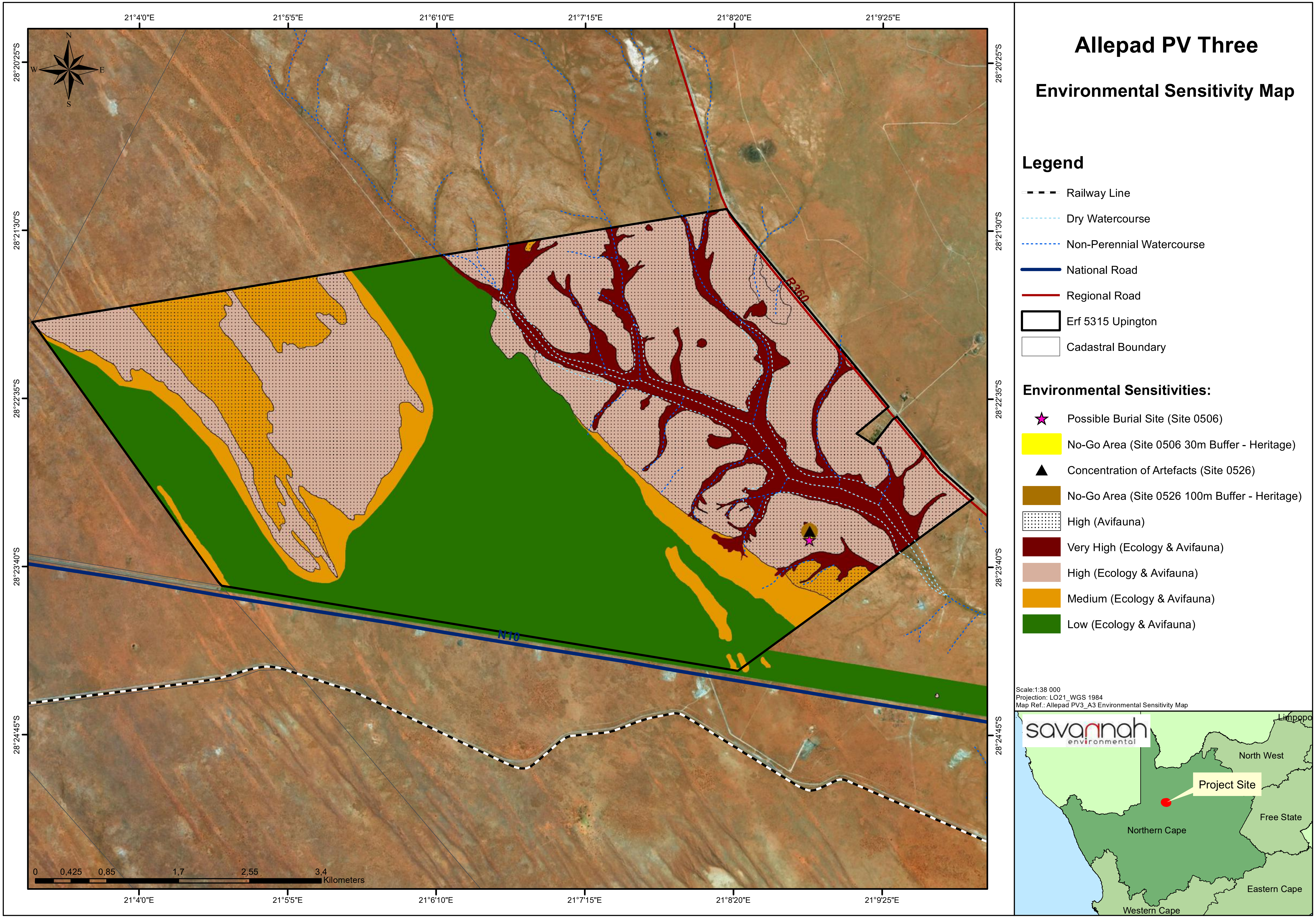
LAYOUT AND SENSITIVITY MAPS



Allepad PV Three
Locality Map
Legend
Towns
Eskom Substation
Existing Power line
Railway Line
Dry Watercourse
Non-Perennial Watercourse
Perennial Watercourse
Existing Power line
National Road
Regional Road
Main Road
300m Power Line Corridor
Allepad PV Three Project Site
Erf 5315 Upington
Scale: 1:70 000
Projection: LO21_WGS 1984
Map Ref.: Allepad PV_A3 Locality Map
savannah environmental
Limpopo
North West
Project Site
Free State
Northern Cape
Eastern Cape
Western Cape
N10
R360
N14
OLYFENHOUT SUBSTATION
GORDONIA / ORANJE SWITCHING STATION 1 132kV OHL
Upington
21°3'0"E
21°6'0"E
21°9'0"E
21°12'0"E
21°15'0"E
28°21'0"S
28°24'0"S
28°27'0"S
0 0,75 1,5 3 4,5 6
Kilometers
N
E
S
W



Allepad PV Three
Layout Map
Legend
Railway Line
Existing Power line
National Road
Regional Road
Perennial Watercourse
Non-Perennial Watercourse
Erf 5315 Upington
Cadastral Boundary
Layout:
Shared Access (4.5km (l) / 6m (w))
Internal Access Roads (10km (l) / 6m (w))
Power Line (9.5km)
Substation (1ha)
300m Power Line Corridor
Construction Camp & Lay Down Area (2ha)
Energy Storage Area (2ha)
Solar Field (230ha)
Scale: 1:37 005
Projection: LO21_WGS 1984
Map Ref.: Allepad PV3_A3 Layout Map
savannah environmental
Limpopo
North West
Project Site
Free State
Northern Cape
Eastern Cape
Western Cape
21°5'5"E
21°6'10"E
21°7'15"E
21°8'20"E
21°9'25"E
21°10'30"E
21°11'35"E
28°21'30"S
28°22'35"S
28°23'40"S
28°24'45"S
28°25'50"S
N
E
S
W
R360
N10
GORDONIA / ORANJE SWITCHING STATION 1 132kV OHL
0 0,4 0,8 1,6 2,4 3,2
Kilometers



Allepad PV Three
Environmental Sensitivity Map
Legend
Railway Line
Dry Watercourse
Non-Perennial Watercourse
National Road
Regional Road
Erf 5315 Upington
Cadastral Boundary
Environmental Sensitivities:
Possible Burial Site (Site 0506)
No-Go Area (Site 0506 30m Buffer - Heritage)
Concentration of Artefacts (Site 0526)
No-Go Area (Site 0526 100m Buffer - Heritage)
High (Avifauna)
Very High (Ecology & Avifauna)
High (Ecology & Avifauna)
Medium (Ecology & Avifauna)
Low (Ecology & Avifauna)
Scale:1:38 000
Projection: LO21_WGS 1984
Map Ref.: Allepad PV3_A3 Environmental Sensitivity Map
savannah environmental
Project Site
Limpopo
North West
Free State
Northern Cape
Eastern Cape
Western Cape
R360
N10
21°4'0"E
21°5'5"E
21°6'10"E
21°7'15"E
21°8'20"E
21°9'25"E
28°20'25"S
28°21'30"S
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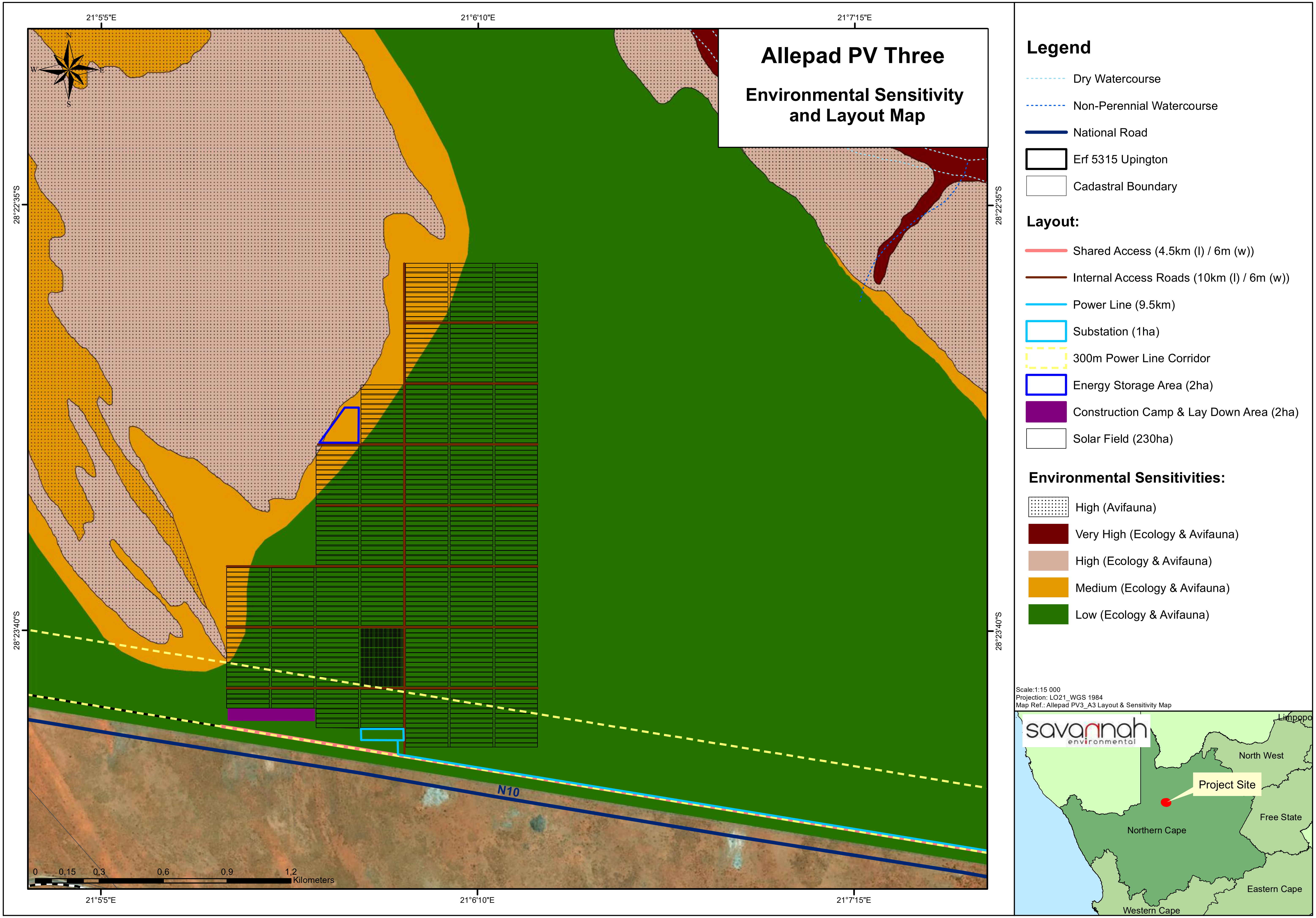
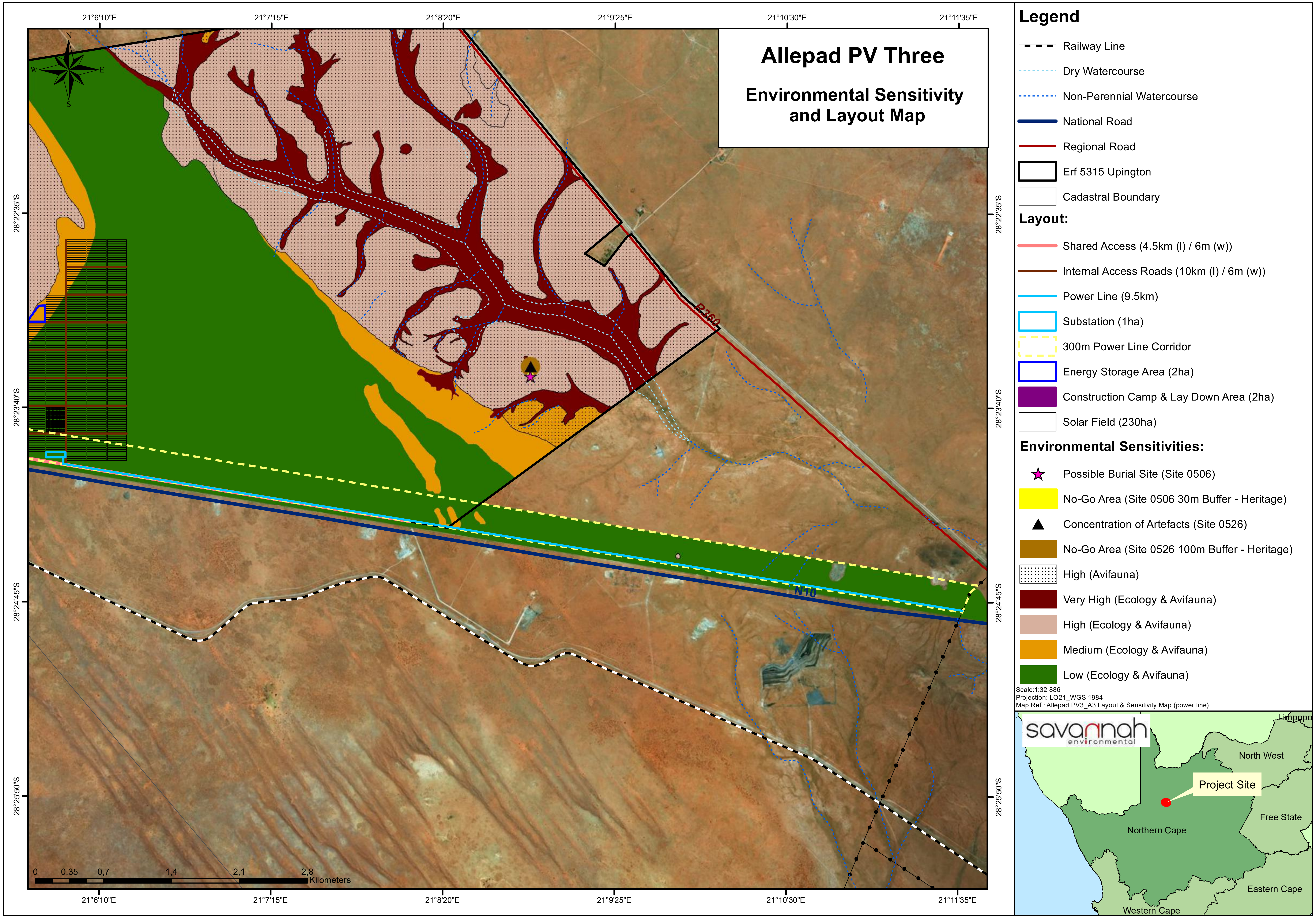
0,85
1,7
2,55
3,4
Kilometers



Allepad PV Three
Environmental Sensitivity and Layout Map
21°5'5"E
21°6'10"E
21°7'15"E
28°22'35"S
28°23'40"S
N10
0 0,15 0,3 0,6 0,9 1,2 Kilometers
Legend
Dry Watercourse
Non-Perennial Watercourse
National Road
Erf 5315 Upington
Cadastral Boundary
Layout:
Shared Access (4.5km (l) / 6m (w))
Internal Access Roads (10km (l) / 6m (w))
Power Line (9.5km)
Substation (1ha)
300m Power Line Corridor
Energy Storage Area (2ha)
Construction Camp & Lay Down Area (2ha)
Solar Field (230ha)
Environmental Sensitivities:
High (Avifauna)
Very High (Ecology & Avifauna)
High (Ecology & Avifauna)
Medium (Ecology & Avifauna)
Low (Ecology & Avifauna)
Scale:1:15 000
Projection: LO21_WGS 1984
Map Ref.: Allepad PV3_A3 Layout & Sensitivity Map
savannah environmental
Limpopo
North West
Project Site
Free State
Northern Cape
Eastern Cape
Western Cape



Allepad PV Three
Environmental Sensitivity and Layout Map
Legend
Railway Line
Dry Watercourse
Non-Perennial Watercourse
National Road
Regional Road
Erf 5315 Upington
Cadastral Boundary
Layout:
Shared Access (4.5km (l) / 6m (w))
Internal Access Roads (10km (l) / 6m (w))
Power Line (9.5km)
Substation (1ha)
300m Power Line Corridor
Energy Storage Area (2ha)
Construction Camp & Lay Down Area (2ha)
Solar Field (230ha)
Environmental Sensitivities:
Possible Burial Site (Site 0506)
No-Go Area (Site 0506 30m Buffer - Heritage)
Concentration of Artefacts (Site 0526)
No-Go Area (Site 0526 100m Buffer - Heritage)
High (Avifauna)
Very High (Ecology & Avifauna)
High (Ecology & Avifauna)
Medium (Ecology & Avifauna)
Low (Ecology & Avifauna)
Scale:1:32 886
Projection: LO21_WGS 1984
Map Ref.: Allepad PV3_A3 Layout & Sensitivity Map (power line)
savannah environmental
Project Site
Limpopo
North West
Free State
Northern Cape
Eastern Cape
Western Cape
21°6'10"E
21°7'15"E
21°8'20"E
21°9'25"E
21°10'30"E
21°11'35"E
28°22'35"S
28°23'40"S
28°24'45"S
28°25'50"S
R360
N10
N
S
E
W
0
0,35
0,7
1,4
2,1
2,8
Kilometers

APPENDIX I(B):

GRIEVANCE MECHANISM FOR PUBLIC COMPLAINTS AND ISSUES

GRIEVANCE MECHANISM / PROCESS

PURPOSE

This Grievance Mechanism has been developed to receive and facilitate the resolution of concerns and grievances regarding the project's environmental and social performance. The aim of the Grievance Mechanism is to ensure that grievances or concerns raised by stakeholders are addressed in a manner that:

» Provides a predictable, accessible, transparent, and credible process to all parties, resulting in outcomes that are fair and equitable, accountable and efficient.
» Promotes trust as an integral component of broader community relations activities.
» Enables more systematic identification of emerging issues and trends, facilitating corrective action and pre-emptive engagement.

The aim of this Grievance Mechanism is to provide a process to address grievances in a manner that does not require a potentially costly and time-consuming legal process. This plan should be updated through the project development process to ensure relevance at all project stages.

PROCEDURE FOR RECEIVING AND RESOLVING GRIEVANCES

The following proposed grievance procedures are to be complied with throughout the construction, operation and decommissioning phases of the project. These procedures should be updated as and when required to ensure that the Grievance Mechanism is relevant for the project and effective in providing the required processes.

» Local landowners, communities and authorities must be informed in writing by the Developer of the grievance mechanism and the process by which grievances can be brought to the attention of the Developer through its designated representative. This must be undertaken with the commencement of the construction phase.
» A company representative must be appointed as the contact person to which grievances can be directed. The name and contact details of the contact person must be provided to local landowners, communities and authorities when requested.
» Project related grievances relating to the construction, operation and or decommissioning phases must be addressed in writing to the contact person. The contact person should assist local landowners and/ or communities who may lack resources to submit/prepare written grievances, by recording grievances and completing written grievance notices where applicable, translating requests or concerns or by facilitating contact with relevant parties who can address the raised concerns. The following information should be obtained, as far as possible, regarding each written grievance, which may act as both acknowledgement of receipt as well as record of grievance received:
    a. The name and contact details of the complainant;
    b. The nature of the grievance;
    c. Date raised, received, and for which the meeting was arranged;
    d. Persons elected to attend the meeting (which will depend on the grievance); and
    e. A clear statement that the grievance procedure is, in itself, not a legal process. Should such avenues be desired, they must be conducted in a separate process and do not form part of this grievance mechanism.

» The grievance must be registered with the contact person who, within 2 working days of receipt of the grievance, must contact the Complainant to discuss the grievance and, if required, agree on suitable date and venue for a meeting in order to discuss the grievances raised. Unless otherwise agreed, the meeting should be held within 2 weeks of receipt of the grievance.
» The contact person must draft a letter to be sent to the Complainant acknowledging receipt of the grievance, the name and contact details of Complainant, the nature of the grievance, the date that the grievance was raised, and the date and venue for the meeting (once agreed and only if required).
» A grievance register must be kept on site (in electronic format, so as to facilitate editing and updating), and shall be made available to all parties wishing to gain access thereto.
» Prior to the meeting being held the contact person must contact the Complainant to discuss and agree on the parties who should attend the meeting, as well as a suitable venue. The people who will be required to attend the meeting will depend on the nature of the grievance. While the Complainant and or Developer are entitled to invite their legal representatives to attend the meeting/s, it should be made clear to all the parties involved in the process that the grievance mechanism process is not a legal process, and that if the Complainant invites legal representatives, the cost will be their responsibility. It is therefore recommended that the involvement of legal representatives be limited as far as possible, as a matter of last resort, and that this process be primarily aimed at stakeholder relationship management as opposed to an arbitration or litigation mechanism.
» The meeting should be chaired by the Developer's representative appointed to address grievances. The Developer must supply and nominate a representative to capture minutes and record the meeting/s.
» Draft copies of the minutes must be made available to the Complainant and the Developer within 5 working days of the meeting being held. Unless otherwise agreed, comments on the Draft Minutes must be forwarded to the company representative appointed to manage the grievance mechanism within 5 working days of receipt of the draft minutes.
» The meeting agenda must be primarily the discussion of the grievance, avoidance and mitigation measures available and proposed by all parties, as well as a clear indication of the future actions and responsibilities, in order to put into effect the proposed measures and interventions to successfully resolve the grievance.
» In the event of the grievance being resolved to the satisfaction of all the parties concerned, the outcome must be recorded and signed off by the relevant parties. The record should provide details of the date of the meeting/s, the names of the people that attended the meeting/s, the outcome of the meeting/s, and where relevant, the measures identified to address the grievance, the party responsible for implementing the required measures, and the agreed upon timeframes for the measures to be implemented.
» In the event of a dispute between the Complainant and the Developer regarding the grievance, the option of appointing an independent mediator to assist with resolving the issue should be discussed. The record of the meeting/s must note that a dispute has arisen and that the grievance has not been resolved to the satisfaction of all the parties concerned.
» In the event that the parties agree to appoint a mediator, the Developer will be required to identify three (3) mediators and forward the names and CVs to the Complainant within 2 weeks of the dispute being declared. The Complainant, in consultation with the Developer, must identify the preferred mediator and agree on a date for the next meeting. The cost of the mediator must be borne by the Developer. The Developer must supply and nominate a representative to capture minutes and record the meeting/s.

- In the event of the grievance, with the assistance of the mediator, being resolved to the satisfaction of all the parties concerned, the outcome must be recorded and signed off by the relevant parties, including the mediator. The record should provide details on the date of the meeting/s, the names of the people that attended the meeting/s, the outcome of the meeting/s, and where relevant, the measures identified to address the grievance, the party responsible for implementing the required measures, and the agreed upon timeframes for the measures to be implemented.
- In the event of the dispute not being resolved, the mediator must prepare a draft report that summaries the nature of the grievance and the dispute. The report should include a recommendation by the mediator on the proposed way forward with regard to the addressing the grievance.
- The draft report must be made available to the Complainant and the Developer for comment before being finalised and signed by all parties, which signature may not be unreasonably withheld by either party. Unless otherwise agreed, comments on the draft report must be forwarded to the company representative appointed to manage the grievance mechanism within 5 working days. The way forward will be informed by the recommendations of the mediator and the nature of the grievance.

A Complaint is closed out when no further action is required, or indeed possible. Closure status must be classified and captured following mediation or successful resolution in the Complaints Register as follows:

- Resolved. Complaints where a resolution has been agreed and implemented and the Complainant has signed the Confirmation Form.
- Unresolved. Complaints where it has not been possible to reach an agreed resolution despite mediation.
- Abandoned. Complaints where the Complainant is not contactable after one month following receipt of a Complaint and efforts to trace his or her whereabouts have been unsuccessful.

The grievance mechanism does not replace the right of an individual, community, group or organization to take legal action should they so wish. In the event of the grievance not being resolved to the satisfaction of Complainant and or the Developer, either party may be entitled to legal action if an appropriate option, however, this grievance mechanisms aims to avoid such interactions by addressing the grievances within a short timeframe, and to mutual satisfaction, where possible.

APPENDIX I(C):

ALIEN PLANT AND OPEN SPACE MANAGEMENT PLAN

ALIEN PLANT AND OPEN SPACE MANAGEMENT PLAN

1. PURPOSE

Invasive alien plant species pose the second largest threat to biodiversity after direct habitat destruction. The purpose of this Alien Plant and Open Space Management Plan is to provide a framework for the management of alien and invasive plant species during the construction and operation of Allepad PV Three and associated infrastructure. The broad objectives of the plan include the following:

» Ensure alien plants do not become dominant in parts of the site, or the whole site, through the control and management of alien and invasive species presence, dispersal and encroachment.
» Develop and implement a monitoring and eradication programme for alien and invasive plant species.
» Promote the natural re-establishment and planting of indigenous species in order to retard erosion and alien plant invasion.

This plan should be updated throughout the life-cycle of the PV facility, as required in order to ensure that appropriate measures are in place to manage and control the establishment of alien and invasive plant species and to ensure compliance with relevant legislation.

2. RELEVANT ASPECTS OF THE SITE

The current veld condition of the site can be considered to be fair and while there are some areas that have clearly suffered some degradation in the past, the vegetation cover and composition can be considered typical for the area. There are some localised areas of *Prosopis* invasion at the project site, usually around watering points, but in general there are few alien species present across most of the site and it can be considered to be largely intact and in moderate condition.

3. LEGISLATIVE CONTEXT

Conservation of Agricultural Resources Act (Act No. 43 of 1983)

In terms of the amendments to the regulations under the Conservation of Agricultural Resources Act (Act No. 43 of 1983), all declared alien plant species must be effectively controlled. Landowners are legally responsible for the control of invasive alien plants on their properties. In terms of this Act alien invasive plant species are ascribed to one of the following categories:

» Category 1: Prohibited and must be controlled.
» Category 2 (commercially used plants): May be grown in demarcated areas provided that there is a permit and that steps are taken to prevent their spread.
» Category 3 (ornamentally used plants): May no longer be planted. Existing plants may be retained as long as all reasonable steps are taken to prevent the spreading thereof, except within the flood line of watercourses and wetlands.

National Environmental Management: Biodiversity Act, 2004 (Act No.10 of 2004)

The National Environmental Management: Biodiversity Act (NEM:BA) regulates all invasive organisms in South Africa, including a wide range of fauna and flora. Regulations have been published in Government Notices R.506, R.507, R.508 and R.509 of 2013 under NEM:BA. According to this Act and the regulations, any species designated under Section 70 cannot be propagated, grown, bought or sold without a permit. Below is an explanation of the three categories:

» **Category 1a:** Invasive species requiring compulsory control. 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.

The following guide is a useful starting point for the identification of alien plant species: Bromilow, C. 2010. Problem Plants and Alien Weeds of South Africa. Briza, Pretoria.

It is important to note that alien plant species that are regulated in terms of the Conservation of Agricultural Resources Act (Act 43 of 1983) (CARA) as weeds and invader plants are exempted from NEM:BA. This implies that the provisions of the CARA in respect of listed weed and invader plants supersede those of NEM: BA.

4. ALIEN PLANT MANAGEMENT PRINCIPLES

4.1. Prevention and early eradication

A prevention strategy should be considered and established, including regular surveys and monitoring for invasive alien plants, effective rehabilitation of disturbed areas and prevention of unnecessary disturbance of natural areas.

Monitoring plans should be developed which are designed to identify Invasive Alien Plant Species already on site, as well as those that are introduced to the site by the construction activities. Keeping up to date on which weeds are an immediate threat to the site is important, but efforts should be planned to update this information on a regular basis. When additional Invasive Alien Plant Species are recorded on site, an immediate response of locating the site for future monitoring and either hand-pulling the weeds or an application of a suitable herbicide (where permissible only) should be planned. It is, however, better to monitor regularly and act swiftly than to allow invasive alien plants to become established on site.

4.2. Containment and control

If any alien invasive plants are found to become established on site, action plans for their control should be developed, depending on the size of the infestations, budgets, manpower considerations and time. Separate plans of control actions should be developed for each location and/or each species. Appropriate registered chemicals and other possible control agents should be considered in the action plans for each site/species. The uses of chemicals are not recommended for any wetland areas. Herbicides should be applied directly to the plant and not to the soil. The key is to ensure that no invasions get out of control. Effective containment and control will ensure that the least energy and resources are required to maintain this status over the long-term. This will also be an indicator that natural systems are impacted to the smallest degree possible.

4.3. General Clearing and Guiding Principles

Alien species control programmes are long-term management projects and should consist of a clearing plan which includes follow up actions for rehabilitation of the cleared area. The lighter infested areas should be cleared first to prevent the build-up of seed banks. Pre-existing dense mature stands ideally should be left for last, as they probably won't increase in density or pose a greater threat than they are currently. Collective management and planning with neighbours may be required in the case of large woody invaders as seeds of alien species are easily dispersed across boundaries by wind or watercourses. All clearing actions should be monitored and documented to keep records of which areas are due for follow-up clearing.

i. <u>Clearing Methods</u>

Different species require different clearing methods such as manual, chemical or biological methods or a combination of both. Care should however be taken that the clearing methods used do not encourage further invasion and that they are appropriate to the specific species of concern. As such, regardless of the methods used, disturbance to the soil should be kept to a minimum.

Fire should not be used for alien species control or vegetation management at the site. The best-practice clearing method for each species identified should be used.

» **<u>Mechanical control</u>**
This entails damaging or removing the plant by physical action. Different techniques could be used, e.g. uprooting, felling, slashing, mowing, ringbarking or bark stripping. This control option is only really feasible in sparse infestations or on a small scale, and for controlling species that do not coppice after cutting. Species that tend to coppice, need to have the cut stumps or coppice growth treated with herbicides following the mechanical treatment. Mechanical control is labour intensive and therefore expensive, and could cause severe soil disturbance and erosion.

» **<u>Chemical Control</u>**
Although it is usually preferable to use manual clearing methods where possible, such methods may create additional disturbance which stimulates alien plant invasion and may also be ineffective for many woody species which re-sprout. Where herbicides are to be used, the impact of the operation on the natural environment should be minimised by observing the following:

* Area contamination must be minimised by careful, accurate application with a minimum amount of herbicide to achieve good control.
* All care must be taken to prevent contamination of any water bodies. This includes due care in storage, application, cleaning equipment and disposal of containers, product and spray mixtures.
* Equipment should be washed where there is no danger of contaminating water sources and washings carefully disposed of at a suitable site.
* To avoid damage to indigenous or other desirable vegetation, products should be selected that will have the least effect on non-target vegetation.
* Coarse droplet nozzles should be fitted to avoid drift onto neighbouring vegetation.
* The appropriate health and safety procedures should also be followed regarding the storage, handling and disposal of herbicides.
* The use of chemicals is not recommended for wetland areas.

For all herbicide applications, the following Regulations and guidelines should be followed:

* Working for Water: Policy on the Use of Herbicides for the Control of Alien Vegetation.
* Pesticide Management Policy for South Africa published in terms of the Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947 (Act No. 36 of 1947) – GNR 1120 of 2010.
* South African Bureau of Standards, Standard SANS 10206 (2010).

According to Government Notice No. 13424 dated 26 July 1992, it is an offence to "*acquire, dispose, sell or use an agricultural or stock remedy for a purpose or in a manner other than that specified on the label on a container thereof or on such a container*".

Contractors using herbicides need to have a valid Pest Control Operators License (limited weeds controller) according to the Fertilizer, Farm Feeds, Agricultural Remedies and Stock Remedies Act (Act No. 36 of 1947). This is regulated by the Department of Agriculture, Forestry and Fisheries.

» **Biological control**

Biological weed control consists of the use of natural enemies to reduce the vigour or reproductive potential of an invasive alien plant. Biological control agents include insects, mites, and micro-organisms such as fungi or bacteria. They usually attack specific parts of the plant, either the reproductive organs directly (flower buds, flowers or fruit) or the seeds after they have dropped. The stress caused by the biological control agent may kill a plant outright or it might impact on the plant's reproductive capacity. In certain instances, the reproductive capacity is reduced to zero and the population is effectively sterilised. All of these outcomes will help to reduce the spread of the species.

To obtain biocontrol agents, provincial representatives of the Working for Water Programme or the Directorate: Land Use and Soil Management (LUSM), Department of Agriculture, Forestry and Fisheries (DAFF) can be contacted.

4.4. General management practices

The following general management practices should be encouraged or strived for:

» Establish an on-going monitoring programme for construction phase to detect and quantify any alien species that may become established.

- Alien vegetation regrowth on areas disturbed by construction must be immediately controlled.
- Care must be taken to avoid the introduction of alien invasive plant species to the site. Particular attention must be paid to imported material such as building sand or dirty earth-moving equipment. Stockpiles should be checked regularly and any weeds emerging from material stockpiles should be removed.
- Cleared areas that have become invaded by alien species can be sprayed with appropriate herbicides provided that these herbicides break down on contact with the soil. Residual herbicides should not be used.
- The effectiveness of vegetation control varies seasonally and this is also likely to impact alien species. Control early in the wet season will allow species to re-grow, and follow-up control is likely to be required. It is tempting to leave control until late in the wet season to avoid follow-up control. However, this may allow alien species to set seed before control, and hence will not contribute towards reducing alien species abundance. Therefore, vegetation control should be aimed at the middle of the wet season, with a follow-up event towards the end of the wet season. There are no exact dates that can be specified here as each season is unique and management must therefore respond according to the state and progression of the vegetation.
- Alien plant management is an iterative process and it may require repeated control efforts to significantly reduce the abundance of a species. This is often due to the presence of large and persistent seed banks. However, repeated control usually results in rapid decline once seed banks become depleted.
- Some alien species are best individually pulled by hand. Regular vegetation control to reduce plant biomass within the site should be conducted. This should be timed so as to coincide with the critical growth phases of the most important alien species on site. This will significantly reduce the cost of alien plant management as this should contribute towards the control of the dominant alien species and additional targeted control will be required only for a limited number of species.
- No alien species should be cultivated on-site. If vegetation is required for aesthetic purposes, then non-invasive, water-wise locally-occurring species should be used.
- During operation, surveys for alien species should be conducted regularly. It is recommended that this be undertaken every 6 months for the first two years after construction and annually thereafter. All alien plants identified should be cleared using appropriate means.

4.5. Monitoring

In order to assess the impact of clearing activities, follow-ups and rehabilitation efforts, monitoring must be undertaken. This section provides a description of a possible monitoring programme that will provide an assessment of the magnitude of alien plant invasion on site, as well as an assessment of the efficacy of the management programme.

In general, the following principles apply for monitoring:

- Photographic records must be kept of areas to be cleared prior to work starting and at regular intervals during initial clearing activities. Similarly, photographic records should be kept of the area from immediately before and after follow-up clearing activities. Rehabilitation processes must also be recorded.
- Simple records must be kept of daily operations, e.g. area/location cleared, labour units and, if ever used, the amount of herbicide used.
- It is important that, if monitoring results in detection of invasive alien plants, that this leads to immediate action.

The following monitoring should be implemented to ensure management of alien invasive plant species.

Construction Phase

Monitoring Action	Indicator	Timeframe
Document alien species present at the site	List of alien plant species	Preconstruction Monthly during Summer and Autumn (Middle November to end March) 3 Monthly during Winter and Spring
Document alien plant distribution	Alien plant distribution map within priority areas	3 Monthly
Document & record alien plant control measures implemented	Record of clearing activities	3 Monthly

Operation Phase

Monitoring Action	Indicator	Timeframe
Document alien plant species distribution and abundance over time at the site	Alien plant distribution map	Biannually
Document alien plant control measures implemented & success rate achieved	Records of control measures and their success rate. A decline in alien distribution and cover over time at the site	Biannually
Document rehabilitation measures implemented and success achieved in problem areas	Decline in vulnerable bare areas over time	Biannually

APPENDIX I(D):

PLANT RESCUE AND PROTECTION PLAN

ALLEPAD SOLAR

PLANT RESCUE & PROTECTION PLAN

PRODUCED FOR SAVANNAH ENVIRONMENTAL;

ON BEHALF OF ILENERGY DEVELOPMENT (PTY) LTD

BY

3Foxes Biodiversity Solutions

Simon.Todd@3foxes.co.za

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MANAGEMENT PLAN OBJECTIVES

The purpose of the Allepad Solar plant rescue and protection plan is to implement avoidance and mitigation measures to reduce the impact of the development of the Allepad Solar Facility on listed and protected plant species and their habitats during construction and operation. This subplan is a requirement of the EIA process and is also required in order to ensure compliance with national and provincial legislation for vegetation clearing and any required destruction or translocation of provincially and nationally protected species within the footprint of the Solar Facility.

The Plan first provides some legislative background on the regulations relevant to listed and protected species, under the Northern Cape Conservation Act (2009) and trees protected under the DAFF National List of Protected Tree Species. This is followed by an identification of protected species present at the Allepad Solar site and actions that should be implemented to minimise impact on these species and comply with legislative requirements.

IDENTIFICATION OF SPECIES OF CONSERVATION CONCERN

Plant species are protected at the national level as well as the provincial level and different permits may be required for different species depending on their protection level. At the national level, protected trees are listed by DAFF under the National List of Protected Trees, which is updated on a regular basis. Any clearing of nationally protected trees requires a permit from DAFF. At the provincial level, all species red-listed under the Red List of South African plants (http://redlist.sanbi.org/) as well as species listed under the Northern Cape Nature Conservation Act (No. 9 of 2009) are protected and require provincial permits. The Northern Cape Conservation Act lists a variety of species as protected but also several whole families and genera as protected. Of particular relevance to the current study are the following, which are extracted from the legislation and are not intended to provide a comprehensive list of all protected species, only those which are likely to be encountered in the area. The reader is referred to the schedules of the Act for a full list of species listed under the act.

Under the Northern Cape Nature Conservation Act (No. 9 of 2009), the following are highlighted as potentially being present at the site:

Schedule 1: Specially Protected Flora

- Family GERANIACEAE - *Pelargonium* spp. all species

Schedule 2 Protected Flora

- *Amaryllidaceae* – All species
- *Apiaceae* – All Species
- *Apocynaceae* – All Species
- *Asphodelaceae* – All species except *Aloe ferox*
- *Iridaceae* – All species
- *Mesembryanthemaceae* – All species
- *Androcymbium* spp. - All species
- *Crassulaceae* - All species except those listed in Schedule 1
- *Euphorbiaceae* - *Euphorbia* spp. All species
- *Oxalidaceae* - *Oxalis* spp - All species
- *Portulacaceae* - *Anacampseros* spp. - All species

A full list of plant species known from the broad area around Allepad Solar site is provided in Annex 1. This includes their protection status according to the Northern Cape Conservation Act and whether they are listed under the national list of protected trees. It is important to note that authorisation of the project by DEA does not free the developer from complying with the provincial legislation and permitting requirements with regards to protected species.

MITIGATION & AVOIDANCE OPTIONS

The primary mitigation and avoidance measure that must be implemented at the preconstruction phase is the Preconstruction Walk-Through of the development footprint. This defines which and how many individuals of listed and protected species are found within the development footprint. This information is required for the DAFF and Northern Cape Nature Conservation permits which must be obtained before construction can commence.

Where listed plant species fall within the development footprint and avoidance is not possible, then it may be possible to translocate the affected individuals outside of the development footprint. However, not all species are suitable for translocation as only certain types of plants are able to survive the disturbance. Suitable candidates for translocation include most geophytes and succulents. Although there are exceptions, the majority of woody species do not survive translocation well and it is generally not recommended to try and attempt to translocate such species. Recommendations in this regard would be made following the walk-through of the facility footprint before construction, where all listed and protected species within the development footprint will be identified and located.

RESCUE AND PROTECTION PLAN

Preconstruction

- Identification of all listed species which may occur within the site, based on the SANBI POSA database as well as the specialist EIA studies for the site and any other relevant literature.

Before construction commences at the site, the following actions should be taken:

- A walk-through of the final development footprint by a suitably qualified botanist/ecologist to locate and identify all listed and protected species which fall within the development footprint. This should happen during the flowering season at the site which depending on rainfall is likely to be during spring to early summer (August-October).
- A walk-through report following the walk-through which identifies areas where minor deviations to roads and other infrastructure can be made to avoid sensitive areas and important populations of listed species. The report should also contain a full list of localities where listed species occur within the development footprint and the number of affected individuals in each instance, so that this information can be used to comply with the permit conditions required by the authorization as well as provincial requirements.
- A permit to clear the site and relocated species of concern is required from Northern Cape DENC before construction commences. A tree clearing permit is also required from DAFF to clear protected trees from the site.
- Once the permits have been issued, there should be a search and rescue operation of all listed species which have been identified in the walk-through report as being suitable for search and rescue within the development footprint that cannot be avoided. Affected individuals should be translocated to a similar habitat outside of the development footprint and marked for monitoring purposes. Those species suitable for search as rescue should be identified in the walk-through report. It is important to note that a permit is required to translocate or destroy any listed and protected species even if they do not leave the property.

Construction

- Vegetation clearing should take place in a phased manner, so that large cleared areas are not left standing with no activity for long periods of time and pose a wind and water erosion risk. This will require coordination between the contractor and ECO, to ensure that the ECO is able to monitor activities appropriately.

- All cleared material should be handled according to the Revegetation and Rehabilitation Plan and used to encourage the recovery of disturbed areas.
- ECO to monitor vegetation clearing at the site. Any deviations from the plans that may be required should first be checked for listed species by the ECO and any listed species present which are able to survive translocation should be translocated to a safe site.
- All areas to be cleared should be demarcated with construction tape, survey markers or similar. All construction vehicles should work only within the designated area.
- Plants suitable for translocation or for use in rehabilitation of already cleared areas should be identified and relocated before general clearing takes place.
- Any listed species observed within the development footprint that were missed during the preconstruction plant sweeps should be translocated to a safe site before clearing commences.
- Many listed species are also sought after for traditional medicine or by collectors and so the ECO should ensure that all staff attend environmental induction training in which the legal and conservation aspects of harvesting plants from the wild are discussed.
- The ECO should monitor construction activities in sensitive habitats such as in dune areas carefully to ensure that impacts to these areas are minimised.

Operation

- Access to the site should be strictly controlled and all personnel entering or leaving the site should be required to sign and out with the security officers.
- The collecting of plants of their parts should be strictly forbidden and signs stating so should be placed at the entrance gates to the site.

IDENTIFICATION OF LISTED SPECIES

In this section, the listed species observed to occur within the broader site are identified and listed below. Those present and the number affected within the development footprint would be clarified following the preconstruction walk-through. The list is not considered exhaustive and additional species may be observed to be present during the preconstruction walk-through, which should be conducted at a favourable time of year, such that there is a maximal chance of picking up geophytes and other species which may not be easily observed at other times of the year.

Family	Species	IUCN Status	NC Status	DAFF Status
AMARYLLIDACEAE	*Boophone disticha*	LC	Schedule 2	
APOCYNACEAE	*Hoodia gordonii*	LC	Schedule 2	
CELASTRACEAE	*Gymnosporia buxifolia*	LC	Schedule 2	
FABACEAE	*Vachellia erioloba*	LC		Protected
FABACEAE	*Vachellia haematoxylon*	LC		Protected
OXALIDACEAE	*Oxalis lawsonii*	LC	Schedule 2	
CAPPARACEAE	*Boscia albitrunca*	LC		Protected
CAPPARACEAE	*Boscia foetida subsp. foetida*	LC	Schedule 2	

MONITORING & REPORTING REQUIREMENTS

The following reporting and monitoring requirements are recommended as part of the plant rescue and protection plan:

- Preconstruction walk-through report detailing the location and distribution of all listed and protected species. This should include a walk-through of all infrastructure including all new access roads, cables, power line routes, buildings and substations. The report should include recommendations of route adjustments where necessary, as well as provide a full accounting of how many individuals of each listed species will be impacted by the development.
- Permit application to NC-DENC. This requires the walk-through report as well as the identification and quantification of all listed and protected species within the development footprint. The permit is required before and search and rescue can take place. Where large numbers of listed species are affected a site inspection and additional requirements may be imposed by NC-DENC as part of the permit conditions. All documentation associated with this process needs to be retained and the final clearing permit should be kept at the site.
- Active daily monitoring of clearing during construction by the ECO to ensure that listed species and sensitive habitats are avoided. All incidents should be recorded along with the remedial measures implemented.
- Post construction monitoring of plants translocated during search and rescue to evaluate the success of the intervention. Monitoring for a year post-transplant should be sufficient to gauge success.

ANNEX 1. LIST OF PLANT SPECIES

List of plant species known from the broad area around the Allepad Solar site based on records from the SANBI POSA database.

Family	Species
ACANTHACEAE	*Acanthopsis disperma*
ACANTHACEAE	*Acanthopsis hoffmannseggiana*
ACANTHACEAE	*Barleria lichtensteiniana*
ACANTHACEAE	*Barleria rigida*
ACANTHACEAE	*Blepharis mitrata*
ACANTHACEAE	*Monechma genistifolium subsp. australe*
ACANTHACEAE	*Monechma genistifolium subsp. genistifolium*
ACANTHACEAE	*Monechma incanum*
ACANTHACEAE	*Monechma spartioides*
AIZOACEAE	*Aizoon asbestinum*
AIZOACEAE	*Aizoon schellenbergii*
AIZOACEAE	*Galenia africana*
AIZOACEAE	*Galenia crystallina*
AIZOACEAE	*Galenia sarcophylla*
AIZOACEAE	*Plinthus cryptocarpus*
AIZOACEAE	*Plinthus karooicus*
AIZOACEAE	*Plinthus sericeus*
AIZOACEAE	*Tetragonia arbuscula*
AIZOACEAE	*Tetragonia reduplicata*
AIZOACEAE	*Trianthema parvifolia var. parvifolia*
AMARANTHACEAE	*Amaranthus praetermissus*
AMARANTHACEAE	*Amaranthus thunbergii*
AMARANTHACEAE	*Leucosphaera bainesii*
AMARANTHACEAE	*Sericocoma avolans*
AMARANTHACEAE	*Sericocoma pungens*
AMARYLLIDACEAE	*Boophone disticha*
AMARYLLIDACEAE	*Crinum bulbispermum*
AMARYLLIDACEAE	*Haemanthus humilis subsp. humilis*
AMARYLLIDACEAE	*Nerine laticoma*
ANACARDIACEAE	*Searsia lancea*
ANACARDIACEAE	*Searsia pendulina*
APOCYNACEAE	*Adenium oleifolium*
APOCYNACEAE	*Cynanchum orangeanum*
APOCYNACEAE	*Gomphocarpus fruticosus subsp. fruticosus*
APOCYNACEAE	*Hoodia gordonii*
APOCYNACEAE	*Larryleachia marlothii*
APOCYNACEAE	*Sarcostemma viminale subsp. viminale*
APOCYNACEAE	*Tridentea marientalensis subsp. marientalensis*
ASPARAGACEAE	*Asparagus denudatus*

ASPARAGACEAE	*Asparagus pearsonii*
ASPHODELACEAE	*Aloe claviflora*
ASPHODELACEAE	*Aloe dichotoma*
ASPHODELACEAE	*Aloe gariepensis*
ASPHODELACEAE	*Aloe hereroensis var. hereroensis*
ASTERACEAE	*Amellus tridactylus subsp. arenarius*
ASTERACEAE	*Arctotis leiocarpa*
ASTERACEAE	*Berkheya annectens*
ASTERACEAE	*Berkheya spinosissima subsp. namaensis var. namaensis*
ASTERACEAE	*Berkheya spinosissima subsp. spinosissima*
ASTERACEAE	*Bidens bipinnata*
ASTERACEAE	*Dicoma capensis*
ASTERACEAE	*Dimorphotheca polyptera*
ASTERACEAE	*Eriocephalus ambiguus*
ASTERACEAE	*Eriocephalus microphyllus var. pubescens*
ASTERACEAE	*Felicia deserti*
ASTERACEAE	*Felicia muricata subsp. cinerascens*
ASTERACEAE	*Felicia muricata subsp. muricata*
ASTERACEAE	*Geigeria filifolia*
ASTERACEAE	*Geigeria ornativa*
ASTERACEAE	*Geigeria pectidea*
ASTERACEAE	*Helichrysum gariepinum*
ASTERACEAE	*Helichrysum micropoides*
ASTERACEAE	*Hirpicium echinus*
ASTERACEAE	*Ifloga molluginoides*
ASTERACEAE	*Kleinia longiflora*
ASTERACEAE	*Laggera decurrens*
ASTERACEAE	*Leysera tenella*
ASTERACEAE	*Litogyne gariepina*
ASTERACEAE	*Nolletia arenosa*
ASTERACEAE	*Osteospermum microcarpum subsp. microcarpum*
ASTERACEAE	*Pegolettia retrofracta*
ASTERACEAE	*Pentzia pinnatisecta*
ASTERACEAE	*Pentzia sp.*
ASTERACEAE	*Pentzia spinescens*
ASTERACEAE	*Pteronia leucoclada*
ASTERACEAE	*Pteronia mucronata*
ASTERACEAE	*Pteronia unguiculata*
ASTERACEAE	*Rosenia oppositifolia*
ASTERACEAE	*Senecio consanguineus*
ASTERACEAE	*Senecio glutinarius*
ASTERACEAE	*Tripteris microcarpa subsp. microcarpa*
ASTERACEAE	*Verbesina encelioides var. encelioides*
AZOLLACEAE	*Azolla filiculoides*
BIGNONIACEAE	*Rhigozum obovatum*

BIGNONIACEAE	*Rhigozum trichotomum*
BORAGINACEAE	*Codon royenii*
BORAGINACEAE	*Ehretia rigida subsp. rigida*
BRASSICACEAE	*Heliophila carnosa*
BRASSICACEAE	*Heliophila minima*
BRASSICACEAE	*Heliophila sp.*
BRASSICACEAE	*Heliophila trifurca*
BRASSICACEAE	*Sisymbrium burchellii var. burchellii*
BURSERACEAE	*Commiphora gracilifrondosa*
CAMPANULACEAE	*Wahlenbergia denticulata var. denticulata*
CAPPARACEAE	*Boscia foetida subsp. foetida*
CAPPARACEAE	*Boscia albitrunca*
CAPPARACEAE	*Cadaba aphylla*
CAPPARACEAE	*Cleome angustifolia subsp. diandra*
CAPPARACEAE	*Cleome gynandra*
CARYOPHYLLACEAE	*Pollichia campestris*
CELASTRACEAE	*Gymnosporia linearis subsp. lanceolata*
CHENOPODIACEAE	*Atriplex semibaccata var. appendiculata*
CHENOPODIACEAE	*Atriplex semibaccata var. typica*
CHENOPODIACEAE	*Chenopodium glaucum*
CHENOPODIACEAE	*Salsola barbata*
CHENOPODIACEAE	*Salsola glabrescens*
CHENOPODIACEAE	*Salsola kali*
CHENOPODIACEAE	*Salsola namibica*
CHENOPODIACEAE	*Salsola rabieana*
CHENOPODIACEAE	*Salsola tuberculata*
CHENOPODIACEAE	*Suaeda caespitosa*
CHENOPODIACEAE	*Suaeda merxmuelleri*
COLCHICACEAE	*Androcymbium melanthioides subsp. melanthioides*
COLCHICACEAE	*Colchicum melanthoides subsp. melanthoides*
COLCHICACEAE	*Ornithoglossum vulgare*
CONVOLVULACEAE	*Convolvulus sagittatus*
CRASSULACEAE	*Adromischus sp.*
CRASSULACEAE	*Cotyledon orbiculata var. dactylopsis*
CRASSULACEAE	*Crassula muscosa var. muscosa*
CUCURBITACEAE	*Coccinia rehmannii*
CUCURBITACEAE	*Cucumis africanus*
CUCURBITACEAE	*Kedrostis capensis*
CYPERACEAE	*Bulbostylis hispidula*
CYPERACEAE	*Cyperus capensis*
CYPERACEAE	*Cyperus fulgens var. contractus*
CYPERACEAE	*Cyperus longus var. tenuiflorus*
CYPERACEAE	*Cyperus marginatus*
CYPERACEAE	*Cyperus usitatus*
CYPERACEAE	*Scirpoides dioecus*

ERIOSPERMACEAE	*Eriospermum bakerianum subsp. bakerianum*
EUPHORBIACEAE	*Euphorbia glanduligera*
EUPHORBIACEAE	*Euphorbia inaequilatera var. inaequilatera*
EUPHORBIACEAE	*Euphorbia rudis*
EUPHORBIACEAE	*Euphorbia spinea*
FABACEAE	*Acacia erioloba*
FABACEAE	*Acacia karroo*
FABACEAE	*Acacia mellifera subsp. detinens*
FABACEAE	*Acacia pendula*
FABACEAE	*Adenolobus garipensis*
FABACEAE	*Cullen tomentosum*
FABACEAE	*Cyamopsis serrata*
FABACEAE	*Hoffmannseggia lactea*
FABACEAE	*Indigastrum argyraeum*
FABACEAE	*Indigofera alternans var. alternans*
FABACEAE	*Indigofera auricoma*
FABACEAE	*Indigofera heterotricha*
FABACEAE	*Indigofera pungens*
FABACEAE	*Indigofera rhytidocarpa subsp. rhytidocarpa*
FABACEAE	*Lebeckia spinescens*
FABACEAE	*Lotononis platycarpa*
FABACEAE	*Lotononis rabenaviana*
FABACEAE	*Melolobium candicans*
FABACEAE	*Melolobium macrocalyx*
FABACEAE	*Parkinsonia africana*
FABACEAE	*Prosopis chilensis*
FABACEAE	*Prosopis glandulosa var. glandulosa*
FABACEAE	*Prosopis glandulosa var. torreyana*
FABACEAE	*Prosopis sp.*
FABACEAE	*Prosopis velutina*
FABACEAE	*Ptycholobium biflorum subsp. biflorum*
FABACEAE	*Requienia sphaerosperma*
FABACEAE	*Senna italica subsp. arachoides*
FABACEAE	*Tephrosia burchellii*
FABACEAE	*Tephrosia dregeana var. dregeana*
GERANIACEAE	*Monsonia burkeana*
GERANIACEAE	*Monsonia luederitziana*
GERANIACEAE	*Sarcocaulon patersonii*
GISEKIACEAE	*Gisekia africana var. africana*
GISEKIACEAE	*Gisekia pharnacioides var. pharnacioides*
HYACINTHACEAE	*Dipcadi ciliare*
HYACINTHACEAE	*Dipcadi glaucum*
HYACINTHACEAE	*Dipcadi gracillimum*
HYACINTHACEAE	*Dipcadi papillatum*
HYACINTHACEAE	*Drimia intricata*

HYACINTHACEAE	*Drimia physodes*
HYACINTHACEAE	*Ledebouria sp.*
HYACINTHACEAE	*Ledebouria undulata*
HYACINTHACEAE	*Ornithogalum suaveolens*
HYACINTHACEAE	*Ornithogalum tenuifolium subsp. aridum*
HYACINTHACEAE	*Ornithogalum tenuifolium subsp. tenuifolium*
IRIDACEAE	*Ferraria variabilis*
IRIDACEAE	*Gladiolus saccatus*
IRIDACEAE	*Moraea polystachya*
LAMIACEAE	*Leucas capensis*
LAMIACEAE	*Salvia verbenaca*
LOASACEAE	*Kissenia capensis*
LOPHIOCARPACEAE	*Lophiocarpus polystachyus*
LORANTHACEAE	*Tapinanthus oleifolius*
MALVACEAE	*Abutilon angulatum var. angulatum*
MALVACEAE	*Corchorus asplenifolius*
MALVACEAE	*Hermannia abrotanoides*
MALVACEAE	*Hermannia bicolor*
MALVACEAE	*Hermannia coccocarpa*
MALVACEAE	*Hermannia minutiflora*
MALVACEAE	*Hermannia modesta*
MALVACEAE	*Hermannia sp.*
MALVACEAE	*Hermannia spinosa*
MALVACEAE	*Hermannia stricta*
MALVACEAE	*Hermannia tomentosa*
MALVACEAE	*Melhania didyma*
MALVACEAE	*Sida rhombifolia subsp. rhombifolia*
MELIACEAE	*Nymania capensis*
MESEMBRYANTHEMACEAE	*Dinteranthus wilmotianus*
MESEMBRYANTHEMACEAE	*Lithops bromfieldii*
MESEMBRYANTHEMACEAE	*Mesembryanthemum crystallinum*
MESEMBRYANTHEMACEAE	*Mesembryanthemum guerichianum*
MESEMBRYANTHEMACEAE	*Prenia tetragona*
MESEMBRYANTHEMACEAE	*Psilocaulon articulatum*
MESEMBRYANTHEMACEAE	*Psilocaulon coriarium*
MESEMBRYANTHEMACEAE	*Psilocaulon subnodosum*
MESEMBRYANTHEMACEAE	*Ruschia barnardii*
MESEMBRYANTHEMACEAE	*Ruschia divaricata*
MESEMBRYANTHEMACEAE	*Ruschia kenhardtensis*
MOLLUGINACEAE	*Limeum aethiopicum subsp. aethiopicum var. aethiopicum*
MOLLUGINACEAE	*Limeum argute-carinatum var. argute-carinatum*
MOLLUGINACEAE	*Limeum fenestratum var. fenestratum*
MOLLUGINACEAE	*Limeum myosotis var. confusum*
MOLLUGINACEAE	*Limeum sulcatum var. gracile*
MOLLUGINACEAE	*Mollugo cerviana var. cerviana*

MONTINIACEAE	*Montinia caryophyllacea*
NEURADACEAE	*Grielum humifusum var. humifusum*
NYCTAGINACEAE	*Phaeoptilum spinosum*
OXALIDACEAE	*Oxalis lawsonii*
PAPAVERACEAE	*Argemone mexicana forma mexicana*
PEDALIACEAE	*Pterodiscus luridus*
PEDALIACEAE	*Sesamum capense*
PHYLLANTHACEAE	*Phyllanthus humilis*
PHYLLANTHACEAE	*Phyllanthus maderaspatensis*
PLUMBAGINACEAE	*Dyerophytum africanum*
POACEAE	*Anthephora pubescens*
POACEAE	*Aristida adscensionis*
POACEAE	*Aristida congesta subsp. barbicollis*
POACEAE	*Aristida congesta subsp. congesta*
POACEAE	*Aristida diffusa subsp. burkei*
POACEAE	*Aristida engleri var. engleri*
POACEAE	*Aristida vestita*
POACEAE	*Brachiaria glomerata*
POACEAE	*Cenchrus ciliaris*
POACEAE	*Centropodia glauca*
POACEAE	*Digitaria sanguinalis*
POACEAE	*Digitaria sp.*
POACEAE	*Dinebra retroflexa*
POACEAE	*Echinochloa holubii*
POACEAE	*Echinochloa stagnina*
POACEAE	*Enneapogon cenchroides*
POACEAE	*Enneapogon desvauxii*
POACEAE	*Enneapogon scaber*
POACEAE	*Eragrostis annulata*
POACEAE	*Eragrostis aspera*
POACEAE	*Eragrostis biflora*
POACEAE	*Eragrostis brizantha*
POACEAE	*Eragrostis lehmanniana var. lehmanniana*
POACEAE	*Eragrostis porosa*
POACEAE	*Eragrostis procumbens*
POACEAE	*Eragrostis rotifer*
POACEAE	*Eriochloa fatmensis*
POACEAE	*Fingerhuthia africana*
POACEAE	*Melinis repens subsp. grandiflora*
POACEAE	*Melinis repens subsp. repens*
POACEAE	*Melinis sp.*
POACEAE	*Phalaris canariensis*
POACEAE	*Schmidtia kalahariensis*
POACEAE	*Setaria italica*
POACEAE	*Setaria pumila*

POACEAE	*Setaria sp.*
POACEAE	*Setaria verticillata*
POACEAE	*Stipagrostis amabilis*
POACEAE	*Stipagrostis anomala*
POACEAE	*Stipagrostis ciliata var. capensis*
POACEAE	*Stipagrostis hochstetteriana var. hochstetteriana*
POACEAE	*Stipagrostis obtusa*
POACEAE	*Stipagrostis uniplumis var. neesii*
POACEAE	*Stipagrostis uniplumis var. uniplumis*
POACEAE	*Tragus berteronianus*
POACEAE	*Tragus racemosus*
POACEAE	*Triraphis purpurea*
POACEAE	*Triraphis ramosissima*
POACEAE	*Urochloa panicoides*
POLYGALACEAE	*Polygala seminuda*
POLYGONACEAE	*Oxygonum alatum var. alatum*
PORTULACACEAE	*Anacampseros baeseckei*
PORTULACACEAE	*Anacampseros filamentosa subsp. filamentosa*
PORTULACACEAE	*Anacampseros filamentosa subsp. namaquensis*
PORTULACACEAE	*Anacampseros filamentosa subsp. tomentosa*
PORTULACACEAE	*Avonia albissima*
PORTULACACEAE	*Portulaca hereroensis*
PORTULACACEAE	*Portulaca kermesina*
PORTULACACEAE	*Portulaca pilosa*
PORTULACACEAE	*Portulaca quadrifida*
PORTULACACEAE	*Talinum arnotii*
RESEDACEAE	*Oligomeris dipetala var. dipetala*
RHAMNACEAE	*Ziziphus mucronata subsp. mucronata*
RUBIACEAE	*Kohautia cynanchica*
RUBIACEAE	*Kohautia ramosissima*
SALICACEAE	*Salix mucronata subsp. mucronata*
SANTALACEAE	*Thesium hystricoides*
SANTALACEAE	*Thesium lineatum*
SCROPHULARIACEAE	*Aptosimum albomarginatum*
SCROPHULARIACEAE	*Aptosimum elongatum*
SCROPHULARIACEAE	*Aptosimum junceum*
SCROPHULARIACEAE	*Aptosimum lineare*
SCROPHULARIACEAE	*Aptosimum lineare var. lineare*
SCROPHULARIACEAE	*Aptosimum marlothii*
SCROPHULARIACEAE	*Aptosimum procumbens*
SCROPHULARIACEAE	*Aptosimum spinescens*
SCROPHULARIACEAE	*Jamesbrittenia argentea*
SCROPHULARIACEAE	*Jamesbrittenia aridicola*
SCROPHULARIACEAE	*Jamesbrittenia integerrima*
SCROPHULARIACEAE	*Manulea schaeferi*

SCROPHULARIACEAE	*Peliostomum leucorrhizum*
SCROPHULARIACEAE	*Selago divaricata*
SCROPHULARIACEAE	*Selago paniculata*
SOLANACEAE	*Lycium bosciifolium*
SOLANACEAE	*Lycium cinereum*
SOLANACEAE	*Lycium oxycarpum*
SOLANACEAE	*Lycium pumilum*
SOLANACEAE	*Nicotiana glauca*
SOLANACEAE	*Solanum burchellii*
SOLANACEAE	*Solanum capense*
TAMARICACEAE	*Tamarix usneoides E.Mey. ex Bunge x T. ramosissima Ledeb.*
TECOPHILAEACEAE	*Cyanella lutea*
THYMELAEACEAE	*Gnidia polycephala*
URTICACEAE	*Forsskaolea candida*
VERBENACEAE	*Chascanum garipense*
VERBENACEAE	*Chascanum incisum*
VERBENACEAE	*Chascanum pumilum*
ZYGOPHYLLACEAE	*Augea capensis*
ZYGOPHYLLACEAE	*Fagonia sinaica var. minutistipula*
ZYGOPHYLLACEAE	*Tribulus cristatus*
ZYGOPHYLLACEAE	*Tribulus pterophorus*
ZYGOPHYLLACEAE	*Tribulus terrestris*
ZYGOPHYLLACEAE	*Tribulus zeyheri subsp. zeyheri*
ZYGOPHYLLACEAE	*Zygophyllum dregeanum*
ZYGOPHYLLACEAE	*Zygophyllum flexuosum*
ZYGOPHYLLACEAE	*Zygophyllum simplex*
ZYGOPHYLLACEAE	*Zygophyllum sp.*
ASTERACEAE	*Geigeria ornativa subsp. ornativa*

APPENDIX I(E):

RE-VEGETATION AND REHABILITATION PLAN

REVEGETATION AND REHABILITATION PLAN

1. PURPOSE

The purpose of the Revegetation and Rehabilitation Plan is to ensure that areas cleared or impacted during construction activities within the site for Allepad PV Three, and that are not required for operation are rehabilitated to their original state before the operation phase commences, and that the risk of erosion from these areas is reduced. The purpose of the Rehabilitation Plan for the site can be summarised as follows:

» Achieve long-term stabilisation of all disturbed areas.
» Re-vegetate all disturbed areas with suitable local plant species.
» Minimise visual impact of disturbed areas.
» Ensure that disturbed areas are rehabilitated to a condition similar to that found prior to disturbance.

This Revegetation and Rehabilitation Plan should be read in conjunction with other site-specific plans, including the Erosion Management Plan, Soil Management Plan, Alien Invasive Management Plan and Plant Rescue and Protection Plan. Prior to the commencement of construction, a detailed Revegetation and Rehabilitation Plan and Method Statement for the site should be compiled with the aid of a suitably qualified, professionally registered specialist (with a botanical or equivalent qualification).

2. RELEVANT ASPECTS OF THE SITE

Two vegetation types have been identified within the project site namely Kalahari Karroid Shrubland in the eastern extent of the project site, and Gordonia Duneveld in the western extent of the project site (Mucina & Rutherford 2006). Both Kalahari Karroid Shrubland and Gordonia Duneveld are classified as Least Threatened and have been impacted little by transformation, with more than 99% of their original extent is still intact. Kalahari Karroid Shrubland is considered Hardly Protected within formal conservation areas, while Gordonia Duneveld is Moderately Protected. The biogeographically important and endemic species known from these vegetation types tend to be widespread within the vegetation type itself and local-level impacts are not likely to be of significance for any of these vegetation types or species concerned. Gordonia Duneveld is widely distributed and is among the most extensive vegetation types in South Africa while Kalahari Karroid Shrubland is less extensive, but represents a transitional vegetation type between the northern Nama Karoo and Kalahari (Savannah) vegetation types.

Species commonly observed within the areas of Kalahari Karroid Shrubland on nearby sites include shrubs such as *Leucosphaera bainesii*, *Hermannia spinosa*, *Monoechma genistifoilium*, *Salsola rabieana*, *Aptosimum albomarginatum*, *A.spinecens*, *Kleinia longiflora*, *Limeum argute-carinatum*, *Phyllanthus maderaspatensis*, *Zygophyllum dregeanum* and grasses such as *Stipagrostis anomala*, *S.ciliata*, *S.uniplumis*, *S.hochstetteriana* and *Schmidtia kalariensis*. The proportion of shrubs in this vegetation type is usually related to soil depth and texture, with the proportion of grass increasing as the soils become deeper or more sandy. Species of conservation concern that are often present include *Adenium oleifolium*, *Aloe claviflora* and *Hoodia gordonii*.

The areas of Gordonia Duneveld consists of several different habitats. The most obvious of which are the dunes and the inter-dune areas. The dunes and areas of deep sand are usually dominated by species such as *Crotalaria orientalis*, *Stipagrostis amabilis*, *Centropodia glauca*, *Acacia haematoxylon* (*A. haematoxylon)* and various forbs. The interdune slacks are usually dominated by grasses or *Rhigozum trichotomum* depending on the substrate conditions as well as the history of land use. Other common species associated with the areas of Gordonia Duneveld include trees such as *Parkinsonia africana*, *Boscia foetida*, *Boscia albitrunca* and *Acacia erioloba*, shrubs such as *Phaeoptilum spinosum*, *Rhigozum trichotomum*, and *Lycium bosciifolium*, grasses such as *Stipagrostis ciliata*, *S.uniplumis*, *S.amabilis*, *Schmidtia kalahariensis*, and forbs such as *Senna italica*, *Tribulis pterophorus*, *Hermannia tomentosa* and *Requienia sphaerosperma*. Species of conservation concern associated with this habitat include the nationally protected trees *Acacia erioloba* (*A. erioloba*), *A. haematoxylon* and *Boscia albitrunca*.

In terms of the project site, the areas of Kalahari Karroid Shrubland in the east of the site are considered moderate sensitivity due to their higher diversity, and the potential presence of several species of conservation concern. The flatter areas of Gordonia Duneveld dominated by *Rhigozum trichotomum* are considered relatively low sensitivity, while the more extensive area of contiguous dunes in the west of the site, are considered to be medium high sensitivity due to the vulnerability of this habitat to disturbance.

3. REHABILITATION METHODS AND PRACTISES

The following general management practices should be encouraged or strived for:

- Clearing of invaded areas should be conducted as per the Alien Management Plan, included in the EMPr.
- No harvesting of vegetation may be undertaken outside the area to be disturbed by construction activities.
- Indigenous plant material must be kept separate from alien material.
- Indigenous seeds may be harvested for purposes of revegetation in areas that are free of alien invasive vegetation, either at the site prior to clearance or from suitable neighbouring sites.
- Topsoil should be reserved wherever possible on site, to be utilised during rehabilitation.
- Sods used for revegetation should be obtained directly from the site, but not from the sensitive areas. Sods should contain at least a 50 mm topsoil layer and be minimally disturbed, in particular to existing root systems. Sods must ideally be obtained from areas as close as possible to the region that is to be rehabilitated.
- Water used for the irrigation of re-vegetated areas should be free of chlorine and other pollutants that might have a detrimental effect on the plants.
- All seeded, planted or sodded grass areas and all shrubs or trees planted are to be irrigated at regular intervals.
- On steep slopes and areas where seed and organic matter retention is low, it is recommended that soil savers are used to stabilise the soil surface. Soil savers are man-made materials, usually constructed of organic material such as hemp or jute and are usually applied in areas where traditional rehabilitation techniques are not likely to succeed.
- In areas where soil saver is used, it should be pegged down to ensure that it captures soil and organic matter flowing over the surface.
- The final rehabilitated area should resemble the current composition and structure of the soil as far as practicably possible.
- Progressive rehabilitation is an important element of the rehabilitation strategy and should be implemented where feasible.

- No construction equipment, vehicles or unauthorised personnel should be allowed onto areas that have been rehabilitated.
- Where rehabilitation sites are located within actively grazed areas, they should be fenced off, this must be undertaken in consultation with the landowner.
- Any runnels, erosion channels or wash-aways developing after revegetation should be backfilled and consolidated and the areas restored to a proper stable condition.
- Re-vegetated areas should be monitored frequently and prepared and revegetation from scratch should inadequate signs of surface coverage or grown be evident after two growth seasons. Adequate recovery must be assessed by a qualified botanist or rehabilitation specialist.
- The stockpiled vegetation from the clearing operations should be reduced to mulch where possible, and retained along with topsoil to encourage seedbank regrowth and soil fertility.
- Mulches must be collected in such a manner as to restrict the loss of seed.
- Mulch must be stored for as short a period as possible.
- Mulch is to be harvested from areas that are to be denuded of vegetation during construction activities, provided that they are free of seed-bearing alien invasive plants.
- Where herbicides are used to clear vegetation, species-specific chemicals should be applied to individual plants only. General spraying should be strictly prohibited, and only the correct herbicide type should be applied.
- Once rehabilitated, areas should be protected to prevent trampling and erosion.
- Fencing should be removed once a sound vegetative cover has been achieved.

4. MONITORING AND FOLLOW-UP ACTION

Throughout the lifecycle of the development, regular monitoring and adaptive management must be in place to detect any new degradation of rehabilitated areas. During the construction phase, the Environmental Officer (EO) and EPC Contractor will be responsible for initiating and maintaining a suitable monitoring system. Once the development is operational, the Developer will need to identify a suitable entity that will be able to take over and maintain the monitoring cycle and initiate adaptive management as soon as it is required. Monitoring personnel must be adequately trained.

The following are the minimum criteria that should be monitored:

- Associated nature and stability of surface soils.
- Re-emergence of alien and invasive plant species. If noted, remedial action must be taken immediately, as per the alien management plan and mitigation measures contained within the EMPr.

Rehabilitation success, monitoring and follow-up actions are important to achieve the desired cover and soil protection. The following monitoring protocol is recommended:

- Rehabilitation areas should be monitored every 4 months for the first 12 months following construction, or as per the recommendations of specialist.
- Ensure that steep slopes are not de-vegetated unnecessarily and subsequently become hydrophobic (i.e. have increased runoff and a decreased infiltration rate) increasing the erosion potential.
- Soil loss is related to the length of time that soils are exposed prior to rehabilitation or stabilisation. Therefore, the timeframe between construction activities and rehabilitation should be minimised. Phased construction and progressive rehabilitation, where practically possible, are therefore important elements of the erosion control and rehabilitation strategy.

» Any areas showing erosion, should be adaptively managed with particular erosion control measures, depending on the situation.

If the current state of the environment prior to construction (which will be disturbed during the construction phase) is not achieved post impact, within the specified rehabilitation period, maintenance of these areas must continue until an acceptable state is achieved (excluding alien plant species or weeds). Additional rehabilitation methods may be necessary to achieve the current state before construction commenced.

Monitoring of the rehabilitation success, as well as follow-up adaptive management, combined with the clearing of emerging alien plant species should all continue for as long as is considered necessary, depending on regrowth rates.

APPENDIX I(F):

EROSION MANAGEMENT PLAN

PRINCIPLES FOR EROSION MANAGEMENT

1. PURPOSE

Exposed and unprotected soils are the main cause of erosion in most situations. Therefore, this Erosion Management Plan, the Storm Water Management Plan and the Revegetation and Rehabilitation Plan are closely linked to one another and should not operate independently, but should rather be seen as complementary activities within the broader environmental management of the site and should therefore be managed together.

This Erosion Management Plan addresses the management and mitigation of potential impacts relating to soil erosion. The objective of the plan is to provide:

» A general framework for soil erosion and sediment control, which enables the contractor to identify areas where erosion can occur and is likely to be accelerated by construction related activities.
» An outline of general methods to monitor, manage and rehabilitate erosion prone areas, ensuring that all erosion resulting from all phases of the development is addressed.

This plan must be updated and refined once the construction/ civil engineering plans have been finalised following detailed design.

2. RELEVANT ASPECTS OF THE SITE

The project site is generally flat to gently undulating and lies at a height of approximately 860m – 920m above mean sea level, sloping to the south. Dunes (trending in a north-west / south-east direction) occur in the western half of the project site, while there is a network of dry watercourses in the east. Although these stream beds will be dry in most years, they are a sign of possible water accumulation in the occasional years with above average rainfall. The extensive area of mobile dunes consist of loose sands which are very vulnerable to erosion.

During construction, there will be a lot of disturbed and loose soil at the site which will render the area vulnerable to erosion. Erosion is one of the greater risk factors associated with the development and it is therefore critically important that proper erosion control structures are built and maintained over the lifespan of the project.

Soil compaction and increased erosion risk would occur due to the loss of plant cover and soil disturbance created during the construction phase. This may potentially impact the downstream watercourses, wetlands and aquatic habitats, mainly due to an increase of surface water and silt inflow from the surrounding disturbed areas. These potential impacts may result in a reduction in the buffering capacities of the landscape during extreme weather events.

3. EROSION AND SEDIMENT CONTROL PRINCIPLES

The goals of erosion control during and after construction at the site should be to:

» Protect the land surface from erosion;

- Intercept and safely direct run-off water from undisturbed upslope areas through the site without allowing it to cause erosion within the site or become contaminated with sediment; and
- Progressively revegetate or stabilise disturbed areas.

These goals can be achieved by applying the management practices outlined in the following sections.

3.1. On-Site Erosion Management

General factors to consider regarding erosion risk at the site includes the following:

- Due to the sandy nature of soils in the study area, soil loss will be greater during dry periods as it is more prone to wind erosion. Therefore, precautions to prevent erosion should be present throughout the year.
- Soil loss will be greater on steeper slopes. Ensure that steep slopes are not de-vegetated unnecessarily and subsequently become hydrophobic (i.e. have increased runoff and a decreased infiltration rate) increasing the erosion potential.
- Soil loss is related to the length of time that soils are exposed prior to rehabilitation or stabilisation. Therefore, the gap between construction activities and rehabilitation should be minimised. Phased construction and progressive rehabilitation, where practically possible, are therefore important elements of the erosion control strategy.
- The extent of disturbance will influence the risk and consequences of erosion. Therefore, site clearing should be restricted to areas required for construction purposes only. As far as possible, large areas should not be cleared all at once, especially in areas where the risk of erosion is higher.
- Roads should be planned and constructed in a manner which minimises their erosion potential. Roads should therefore follow the natural contour as far as possible. Roads parallel to the slope direction should be avoided as far as possible.
- Where necessary, new roads constructed should include water diversion structures with energy dissipation features present to slow and disperse the water into the receiving area.
- Roads used for project-related activities and other disturbed areas should be regularly monitored for erosion. Any erosion problems recorded should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur.
- Runoff may have to be specifically channeled or storm water adequately controlled to prevent localised rill and gully erosion.
- Compacted areas should have adequate drainage systems to avoid pooling and surface flow. Heavy machinery should not compact those areas which are not intended to be compacted as this will result in compacted hydrophobic, water repellent soils which increase the erosion potential of the area. Where compaction does occur, the areas should be ripped.
- All bare areas should be revegetated with appropriate locally occurring species, to bind the soil and limit erosion potential.
- Silt fences should be used where there is a danger of topsoil or material stockpiles eroding and entering streams and other sensitive areas.
- Gabions and other stabilisation features must be used on steep slopes and other areas vulnerable to erosion to minimise erosion risk as far as possible.
- Activity at the site after large rainfall events when the soils are wet and erosion risk is increased should be reduced. No driving off of hardened roads should occur at any time, and particularly immediately following large rainfall events.

- Topsoil should be removed and stored in a designated area separately from subsoil and away from construction activities (as per the recommendations in the EMPr). Topsoil should be reapplied where appropriate as soon as possible in order to encourage and facilitate rapid regeneration of the natural vegetation in cleared areas.
- Regular monitoring of the site for erosion problems during construction (on-going) and operation (at least twice annually) is recommended, particularly after large summer thunderstorms have been experienced. The ECO will determine the frequency of monitoring based on the severity of the impacts in the erosion prone areas.

3.1.1. Erosion control mechanisms

The contractor may use the following mechanisms (whichever proves more appropriate/ effective) to combat erosion when necessary:

- Reno mattresses;
- Slope attenuation;
- Hessian material;
- Shade catch nets;
- Gabion baskets;
- Silt fences;
- Storm water channels and catch pits;
- Soil bindings;
- Geofabrics;
- Hydro-seeding and/or re-vegetating;
- Mulching over cleared areas;
- Boulders and size varied rocks; and
- Tilling.

3.2. Engineering Specifications

A detailed engineering specifications Storm Water Management Plan describing and illustrating the proposed stormwater control measures must be prepared by the Civil Engineers during the detailed design phase and should be based on the underlying principles of the Storm Water Management Plan (**Appendix G** of the EMPr) and this should include erosion control measures. Requirements for project design include:

- Erosion control measures to be implemented before and during the construction period, including the final storm water control measures (post construction).
- All temporary and permanent water management structures or stabilisation methods must be indicated within the Storm water Management Plan.
- An on-site Engineer or Environmental Officer (EO)/ SHE Representative to be responsible for ensuring implementation of the erosion control measures on site during the construction period. The ECO should monitor the effectiveness of these measures on the interval agreed upon with the Site Manager and EO.
- The EPC Contractor holds ultimate responsibility for remedial action in the event that the approved Storm water Management Plan is not correctly or appropriately implemented and damage to the environment is caused.

3.3. Monitoring

The site must be monitored continuously during construction and operation in order to determine any indications of erosion. If any erosion features are recorded as a result of the activities on-site the Environmental Officer (EO)/ SHE Representative (during construction) or Environmental Manager (during operation) must:

» Assess the significance of the situation.
» Take photographs of the soil degradation.
» Determine the cause of the soil erosion.
» Inform the contractor/operator that rehabilitation must take place and that the contractor/operator is to implement a rehabilitation method statement and management plan to be approved by the Site/Environmental Manager in conjunction with the ECO.
» Monitor that the contractor/operator is taking action to stop the erosion and assist them where needed.
» Report and monitor the progress of rehabilitation weekly and record all the findings in a site register (during construction).
» All actions with regards to the incidents must be reported on a monthly compliance report which should be kept on file for if/when the Competent Authority requests to see it (during construction) and kept on file for consideration during the annual audits (during construction and operation).

The Contractor (in consultation with an appropriate specialist, e.g. an engineer) must:

» Select a system/mechanism to treat the erosion.
» Design and implement the appropriate system/mechanism.
» Monitor the area to ensure that the system functions like it should. If the system fails, the method must be adapted or adjusted to ensure the accelerated erosion is controlled.
» Continue monitoring until the area has been stabilised.

4. CONCLUSION

The Erosion Management Plan is a document to assist the Proponent/ EPC Contractor with guidelines on how to manage erosion during all phases of the project. The implementation of management measures is not only good practice to ensure minimisation of degradation, but also necessary to ensure compliance with legislative requirements. This document forms part of the EMPr, and is required to be considered and adhered to during the design, construction, operation and decommissioning phases of the project (if and where applicable). During the construction phase, the contractor must prepare an Erosion Control Method Statement to ensure that all construction methods adopted on site do not cause, or precipitate soil erosion and shall take adequate steps to ensure that the requirements of this plan are met before, during and after construction. The designated responsible person on site, must be indicated in the Method Statement and shall ensure that relevant erosion control measures are in place throughout the construction phase.

An operation phase Erosion Management Plan should be designed and implemented if not already addressed by the mitigations implemented as part of construction, with a view to preventing the passage of concentrated flows off hardened surfaces and onto natural areas.

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APPENDIX I(G):

STORM WATER MANAGEMENT PLAN

Activity: Allepad PV (I,II,III,IV) Storm Water Management Plan

Deliverable: Draft Report

Submitted to: ILEnergy Development

Compiled by:	**Accepted by:**
__________________	____________________
ILEnergy (Pty) Ltd Ian Smit	ILEnergy Development (Pty) Ltd Dr. Louis van Heerden
Date:	Date:

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Key Abbreviations

BMP - Best Management Practice

CBA - Critical Biodiversity area

DAFF - Department of Agriculture Forests and Fisheries

DRDLR - Department of Rural Development and Land Reform

ESA - Ecological Support Area

EPC - Engineer, Procurement and Construction Company

LM - Local Municipality

MPRD - Mineral and Petroleum Resources Development

NHRA - National Heritage Resources Act

RE - Remaining Extent

SALA - Subdivision of Agricultural Land Act

SWMP - Storm Water Management Plan

WMA - Water Management Area

WUL - Water Use License

1. Approach

This Storm Water Management Plan has been prepared by ILEnergy (Pty) Ltd, based on their experience gained with multiple solar power construction projects in Upington and the Northern Cape Province, to describe how the EPC will safely and effectively control and minimize storm water impacts arising from the construction of the proposed Allepad PV solar power generation projects (I, II, III, IV), located approximately 15km Northwest of Upington, just off the N10 in the Northern Cape Province.

2. Purpose

The purpose of this document is to describe the methodology or procedures to manage rain water on the project site.

Construction activity refers to ground surface disturbing activities, which include, but are not limited to, clearing, grading, excavation, demolition, installation of new or improved internal roads and access roads, staging areas, stockpiling of fill materials, and borrow areas.

Storm water is defined as water originating during precipitation events. Storm water that does not soak into the ground becomes surface runoff, which either flows directly into surface waterways or is channelled into storm sewers, which eventually discharge to surface waterways.

Storm water is of concern for two main reasons namely: the volume and timing of runoff water (flood control), and the potential contaminants that the water could carry, i.e. water pollution due to construction waste.

Storm water is also a resource and ever growing in importance as the Upington area is an extremely arid area. Techniques of storm water harvesting with point source water management and purification that can potentially make environments self-sustaining should always be considered and utilised where practical.

3. Methodology

The return period considered for the Allepad PV Plants and the access road is 25 years (as indicated in the Drainage Manual of The South African National Roads Agency Limited). The procedures that was used to determine the design flood peaks, for hydraulic structures (culverts and ditches) are based on the deterministic methods:

3.1 The Rational Method

The Rational method is based on a simplified representation of the law of conservation of mass. Rainfall intensity is an important input into the calculations due to the fact that uniform aerial and time distributions of rainfall have to be assumed. The method is normally only recommended for catchments smaller than about 15 km^2. Only flood peaks and empirical hydrographs can be determined by means of the rational method. Judgement and experience on the part of the user with regard to the run-off coefficient selection is important in this method.

3.2 Alternative Rational Method

The Alternative Rational method is an adaptation of the standard rational method. Where the rational method uses the depth-duration-return period diagram to determine the point precipitation, the alternative method uses the modified recalibrated Hershfield equation as proposed by Alexander in 2001, “Flood Risk Reduction Measures incorporating Flood Hydrology for Southern Africa”, S.A. National Committee on Large Dams, Pretoria for storm durations up to 6 hours, and the Department of Water Affairs’ technical report TR102.

3.3 Standard Design Flood Method

The Standard Design Flood (SDF), method was developed by Alexander in 2002, “The Standard Design Flood”, Journal of the South African Institution of Civil Engineering, Volume 44, No 1, SAICE, to provide a uniform approach to flood calculations. The method is based on a calibrated discharge coefficient for a recurrence period of 2 and 100 years. Calibrated discharge parameters are based on historical data and were determined for 29 homogeneous basins in South Africa.

Peak discharge (the maximum flow rate during the flood), is the most useful parameter in the calculation of the required cross-sectional area to convey a flood and to determine the upstream influence of any structure that affects the normal flow conditions. The peak discharge is directly related to the characteristics of the storm event and response of the contributing catchment area.

Although the peak discharge does not remain constant as the flood progresses along a watercourse, changes are fairly gradual where there are no tributaries or local temporary storage. It could, therefore, be postulated that the peak discharge is independent of local changes in the watercourse, such as bed slope and cross-sectional shape. With the peak discharge having been determined, the high-flood level (flood line), and associated flow velocities may be determined by means of hydraulic calculations (uniform or gradually varied flow relationships). The flood volume and temporal variance of the flow rate can then be derived from the hydrograph.

The figure below lists the methods, input data requirements, maximum recommended catchment area for which each procedure can be used, and references related to the procedures.

Method	Input data	Recommended maximum area (km2)	Return period of floods that could be determined (years)
Rational method	Catchment area, watercourse length, average slope, catchment characteristics, rainfall intensity	< 15	2 – 100
Alternative Rational method		No limitation	2 – 100
Standard Design Flood method	Catchment area, slope and SDF basin number	No limitation	2 – 200

Figure 1. Deterministic Methods for Flow Calculations.

4. Storm Water Management Plan

4.1 Introduction

Managing the quantity and quality of storm water is termed, "Storm Water Management". The term Best Management Practice (BMP), is often used to refer to both structural or engineered control devices and systems (e.g. retention ponds), to treat polluted storm water, as well as operational or procedural practices.

The Storm Water Management Plan (SWMP), will also identify possible pollutant sources that may contribute pollutants to storm water, and identify Best Management Practices (BMP's) that, when implemented, will reduce or eliminate any possible water quality impacts. The SWMP must be completed and implemented at the time the project breaks ground, and revised as construction proceeds, to accurately reflect the conditions and practices at the site at the time.

There are many forms of storm water management and BMP's, including:

- Management of storm water to control flooding and erosion;
- Management and control of hazardous materials to prevent release of pollutants into the environment (source control);
- Planning and construction of storm water systems so contaminants are removed before they pollute surface waters or groundwater resources;
- Use and protect natural waterways where they still exist or can be rehabilitated;
- Building "soft" structures such as ponds, swales or wetlands to work with existing features or "hard" drainage structures, such as pipes and concrete channels;
- Revising current storm water regulations to address comprehensive storm water needs;
- Enhancing and enforcing existing ordinances to make sure property owners consider the effects of storm water before, during and after development of their land;
- Educating the community at large about how it's actions affect water quality, and about what it can do to improve water quality; and
- Planning carefully to create solutions before problems occur.

4.2 Risk and The Affected Environment

Construction activities use and produce many different kinds of pollutants which may impact water quality. The main pollutant of concern at construction sites is sediment.

Grading or clearing activities remove grass, rocks, pavement and other protective ground covers, resulting in the exposure of underlying soil to the elements. The soil is then easily picked up by wind and/or washed away by rain. For example, sediment runoff rates from construction sites are typically 10 to 20 times greater than those from agricultural lands, and 1,000 to 2,000 times greater than those of forest lands.

During a short period of time, construction activity can contribute more sediment to streams than would normally be deposited over several decades, causing physical and biological harm. The added sediment chokes the river channels and covers the areas where fish spawn and plants grow. Excess sediment can cause a number of other problems for waterbodies, such as increased difficulty in filtering drinking water, and clouding the waters which can kill plants growing in the river and suffocate fish. A number of pollutants, such as nutrients, are absorbed into sediment particles and also are also a source of pollution associated with sediment discharged from construction sites.

In addition, construction activities often require the use of toxic or hazardous materials such as petroleum products, and building materials such as asphalt, sealants and cement, which may pollute storm water. These materials can be harmful to humans, plants and aquatic life.

Although the expected amount of storm water in the Upington area during construction is relatively low, uncontrolled storm water discharges from construction activity can cause negative impacts on receiving waters by changing the physical, biological, and chemical composition of the water, resulting in an unhealthy environment for aquatic organisms, wildlife, and humans.

The majority of the site area is characterised by gentle slopes which drain into small ephemeral tributaries and a major drainage line to the North East of the proposed development running in a South Easterly direction (refer to the figure below). Several small dunes are dotted around the site.

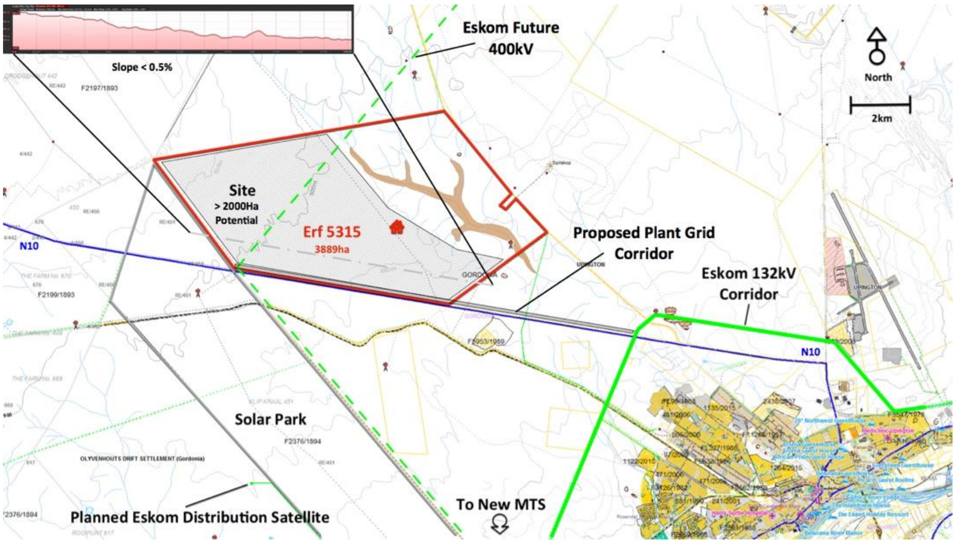

Figure 2. Site Topography and Locality to the Gariep (Orange) River.

The Weinert Climatic N-number for the area is higher than 10 (typically 12 to 14), indicating that the climate is semi-arid and mechanical weathering processes are dominant. Mean annual precipitation for this region is less than 300mm and the mean annual potential evaporation (S-Pan) is greater than 2600mm.

The study area falls within the catchment area of the Gariep (Orange) River (Quaternary Drainage Region D73E).

Although the region has a typically dry climate, flash-floods do occur now and then, and it is important not to underestimate this in the assessment of water erosion potential. Water erosion potential is directly related to the hydrology of the site which is, in turn largely affected by the geology. Infiltration of rainfall into the ground is largely determined by the thickness and permeability of the sandy soil cover. Infiltration is likely to be higher where the soil cover is thicker and relatively low in areas where the granite bedrock and calcrete or hardpan layers are near or at surface. Infiltration is inversely proportional to run-off, therefore in areas where infiltration into the ground is high, run-off is generally low, up to a point where the amount of rainfall exceeds the infiltration rate, and beyond that point excess rainfall ends up as run-off. Run-off is the primary trigger of erosion.

4.3 Management

4.3.1. General

The storm water management system consists of any measures provided to accommodate storm water runoff within project. These measures include gutters, conduits and infiltration structures.

In all the areas of the project, the water courses and built storm water infrastructure must be maintained in a clean state, free of any rubbish, debris and matter likely to pose any pollution threat to courses of the water.

The following will be achieved by storm water management to:

- Maintain adequate ground cover at all places and at all times to negate the erosive forces of wind, water and all forms of traffic.
- Prevent concentration of storm water flow at any point where the ground is susceptible to erosion.
- Reduce storm water flows as much as possible by the effective use of attenuating devices.
- Study the possibility to create systems of rainwater harvesting in order to reduce erosion and allow natural water flow during rainfalls.
- Ensure that all storm water control works are constructed in a safe and aesthetic manner in keeping with the overall development theme for the project area.
- Prevent pollution of water ways and water features by suspended solids and dissolved solids in storm water discharges.
- Contain soil erosion, whether induced by wind or water forces, by constructing protective works to trap sediment at appropriate locations.
- Avoid situations where natural or artificial slopes may become saturated and unstable, both during and after the construction process.

The following rules are to be observed by the EPC and subcontractors:

- Designs for the buildings and site development in general must avoid concentration of storm water runoff both spatially and in time and may be required to provide for attenuation of storm water.
- Detailed plans to control and prevent erosion by water must be agreed with prior to the commencement of works, including site clearance on any portion of the site.
- Removal of vegetation cover must be carried out with care and attention to the effect, whether temporary or long term, that this removal will have on erosion potential.
- Precautions shall be taken at all times on building sites to contain soil erosion and prevent any eroded material from being removed from the site.
- On-site storm water control systems, such as swales, berms, soil fences and detention ponds are to be constructed before any construction commences on the site. As construction progresses, the storm water control measures are to be monitored and adjusted to ensure complete erosion and pollution control at all times.
- Earthworks on sites are to be kept to a minimum. Where embankments have to be formed, stabilisation and erosion control measures shall be implemented immediately.
- Storm water must not be allowed to pond in close proximity to existing building foundations.
- It is important that all building designs provide for maximum on-site storm water attenuation and that the EPC instructs it's professional teams accordingly.
- It is important that level and near-level areas, such as building roofs and parking areas, are used to best take advantage of storm runoff.

Refer to Appendix A for Best Practice Guidelines.

4.3.2. Erosion Control

Access of trucks and vehicles to the site as a result of construction activities and associated earth disturbance activities may potentially increase levels of soil erosion on the project site. In addition, the occurrence of rainfall may potentially result in significant levels of erosion due to the lack of vegetation cover and the dryness of the soil at the project site. However, the likelihood of rainfall is very low in the area and thus the risk of erosion by storm water is significantly reduced.

Nevertheless, the dry and windy climate and conditions (flat topography, low vegetation cover and dryness of soil), at the project site are conducive to wind erosion of soils.

This Erosion Control Plan covers all activities with potential to cause sedimentation and erosion impacts within and surrounding the project site. This Plan establishes a series of mitigation and management measures to control and minimize these issues where required. The objective of this plan is to minimize soil erosion. Best Management Practices (BMP's), encompass a wide range of erosion and sediment control practices, both structural and non-structural in nature, that are intended to reduce or eliminate any possible water quality impacts from storm water leaving the construction site. The BMP's shall be classified in:

- Non-structural BMP's, such as preserving natural vegetation, preventive maintenance and spill response procedures, schedules of activities, prohibition of specific practices, education, and other management practices which are mainly operational or managerial techniques.

- Structural BMP's include treatment processes and practices ranging from diversion structures and silt fences, to retention ponds and inlet protection.

This Plan is based primary on controls used during ground surface disturbing activities. This focus means that many sediment control BMP's, such as silt fence and inlet protection, must be installed before disturbing activities begins, not after.

4.3.3. Pollution Prevention

Soil and groundwater pollution can occur as a result of chemical or fuel spills or inadequate disposal of waste.

The direct impact of such spills or leaks is soil contamination and the possibility of percolation of the spilled oil or fuel to groundwater. The indirect impact of spills and leaks will be on animals through exposure to the toxic pollutants from soil or water by ingestion, inhalation or skin contact with those receptors. Potential sources/activities include:

- Use, storage and disposal of oil, fuel and chemical materials;
- Operation of mobile and fixed machinery and equipment;
- Assembly Plant;
- Substation;
- Vehicle wash-down facilities;
- Concrete and cement wash-down facilities; and
- Solid waste storage and sanitary facilities.

This Storm water management plan covers all project construction activities with the potential to cause pollution to the groundwater and/or soils. This establishes a series of mitigation measures as a guide to minimizing the likelihood of occurrence of spills, the volume of spills and the contingency measures following a spill occurrence. The objective of this plan is to minimize the risk of pollution of the groundwater and soils.

Appendix A – Best Practice Guidelines

The following guidelines are intended to assist with the planning of site layouts, the design of the major and minor storm water systems infrastructure and to ensure that the objectives of this Storm Water Management Plan are met during the planning, design, construction and operational phases of the proposed Allepad PV developments.

1. Storm Water Runoff Control

Formal surface and underground storm water systems are provided in the overall development for the acceptance of storm water drainage from the project site, but it is important that the peak runoff rate does not exceed the hydraulic capacities of the individual elements in the total storm water system. The following are general guidelines for storm water control:

1.1. Buildings

Any building will inevitably result in some degree of flow concentration, or deflection of flow around the building.

The EPC shall ensure that the flow path of the storm water on his site is adequately protected against erosion and is sufficiently roughened to retard storm water flow to the same degree, or more, as that found in the natural predevelopment state of the site.

Where the construction of a building causes a change in the natural flora of the site that might result in soil erosion, the risk of soil erosion by storm water must be eliminated by the provision of approved artificial soil stabilization devices, or alternative flora suited to the changed conditions on the site.

Any inlet to a piped system shall be fitted with a screen or grating to prevent debris and refuse from entering the storm water system. This must be done immediately on installation of the piped system.

No building works, earthworks, walls or fences may obstruct or encroach on a watercourse inside or outside the site without approved plans and an approved WUL (Sec 21 C&I).

1.2. Parking Areas and Yards

Any external parking area, yard or other paved area must be designed to attenuate storm water runoff from a major storm to an acceptable degree.

1.3. Internal Tracks

Internal tracks shall not be constructed to deflect or channel runoff onto a roadway, or to concentrate runoff along a particular path that is not a natural water course, without prior consent.

Internal tracks and paths should be designed and constructed such that the rate of flow of storm water across and along the driveway or path is not increased when compared with the pre-development state.

Where the internal tracks join the main roads, they must not obstruct the flow in any open channel, whether lined or unlined, found along the road verge.

1.4. Roads

The principle of overland flow should apply to roadways where possible and roads should be designed and graded to avoid concentration of flow along and off the road.

Where flow concentration is unavoidable, measures to incorporate the road into the major storm water system should be taken, with the provision of storage facilities at suitable points.

Inlet structures at culverts must be designed to ensure that the capacity of the culvert does not exceed the pre-development storm water flow at that point and sump storage should be provided on the road and/or upstream of the storm water culvert.

Outlet structures at a road culvert or a natural watercourse must be designed to dissipate flow energy and any unlined downstream channel must be adequately protected against soil erosion.

1.5. Storm Water Facilities

The effectiveness of on-site storage to meet storm water reduction requirements within the minor and major storm water systems is the responsibility of the EPC.

Any storage sump shall be integrated with the landscape on the site and maintained in good condition.

Storage sumps shall be maintained in good condition and shall not be permitted to become a health hazard or nuisance.

1.6. Subsurface Removal of Storm Water

Any construction providing for the subsurface disposal of storm water should be designed to ensure that such disposal does not cause slope instability, or areas of concentrated saturation or inundation.

Infiltration structures should be integrated into the terrain so as to be unobtrusive and in keeping with the natural surroundings.

1.7. Channels

Lined and unlined channels may be constructed to convey storm water to a natural watercourse where deemed necessary and unavoidable.

Channels must be constructed with rough artificial surfaces, or lined with suitable, hardy vegetation, to be non-erodible and to provide maximum possible energy dissipation to the flow.

1.8. Energy of flow

Measures should be taken to dissipate flow energy wherever concentrated storm water flow is discharged down an embankment or erodible slope and the resulting supercritical flow poses a significant risk to the stability of the waterway.

1.9. Flow Retarders and Diverters

Storm water flow should be retarded wherever possible through the use of surface roughening or other flow restricting devices (gabions, rip-rap et al), provided these are designed and built to avoid blockages that could result in environmental and structural damage.

All such devices must be regularly maintained by the EPC.

APPENDIX I(H):

WASTE MANAGEMENT PLAN

WASTE MANAGEMENT PLAN

1. PURPOSE

A Waste Management Plan (WMP) plays a key role in achieving sustainable waste management throughout all phases of the project. The plan prescribes measures for the collection, temporary storage and safe disposal of the various waste streams associated with the project and includes provisions for the recovery, re-use and recycling of waste. The purpose of this plan is therefore to ensure that effective procedures are implemented for the handling, storage, transportation and disposal of waste generated from the project activities on site.

This WMP has been compiled as part of the project EMPr and is based on waste stream information available at the time of compilation. Construction and operation activities must be assessed on an ongoing basis in order to determine the efficacy of the plan and whether further revision of the plan is required. This plan should be updated once further detail regarding waste quantities and categorisation become available, during the construction and/or operation stages. This plan should be updated throughout the life-cycle of the PV facility, as required in order to ensure that appropriate measures are in place to manage and control waste and to ensure compliance with relevant legislation.

Prior to the commencement of construction, a detailed Waste Management Method Statement for the site should be compiled by the Contractor.

2. RELEVANT ASPECTS OF THE SITE

It is expected that the development of Allepad PV Three will generate construction solid waste, as well as general waste and hazardous waste during the lifetime of the solar energy facility.

Waste generated on site, originates from various sources, including but not limited to:

- Concrete waste generated from spoil and excess concrete.
- Contaminated water, soil, rocks and vegetation due to hydrocarbon spills.
- Hazardous waste from vehicle, equipment and machinery parts and servicing, fluorescent tubes, used hydrocarbon containers, batteries situated in specially adapted shipping containers, and waste ink cartridges.
- Recyclable waste in the form of paper, glass, steel, aluminium, wood/ wood pallets, plastic (PET bottles, PVC, LDPE) and cardboard.
- Organic waste from food waste as well as alien and endemic vegetation removal.
- Sewage from portable toilets and septic tanks.
- Inert waste from spoil material from site clearance and trenching works.

3. LEGISLATIVE REQUIREMENTS

Waste in South Africa is currently governed by several regulations, including:

- National Environmental Management: Waste Act (NEM:WA), 2008 (Act 59 of 2008);
- National Environmental Management: Waste Amendment Act, 2014 (Act 26 of 2014);
- The South African Constitution (Act 108 of 1996);

- Hazardous Substances Act (Act 5 of 1973);
- Health Act (Act 63 of 1977);
- Environment Conservation Act (Act 73 of 1989);
- Occupational Health and Safety Act (Act 85 of 1993);
- National Water Act (Act 36 of 1998);
- The National Environmental Management Act (Act 107 of 1998) (as amended);
- Municipal Structures Act (Act 117 of 1998);
- Municipal Systems Act (Act 32 of 2000);
- Mineral and Petroleum Resources Development Act (Act 28 of 2002); and
- Air Quality Act (Act 39 of 2004).

Storage of waste must be conducted in accordance with the National Norms and Standards for the Storage of Waste, published in GNR 926.

4. WASTE MANAGEMENT PRINCIPLES

An integrated approach to waste management is needed on site. Such an approach is illustrated in **Figure 1**.

It is important to ensure that waste is managed with the following objectives in mind during all phases of the project:

- Reducing volumes of waste is the greatest priority;
- If reduction is not feasible, the maximum amount of waste is to be recycled; and
- Waste that cannot be recycled is to be disposed of in the most environmentally responsible manner.

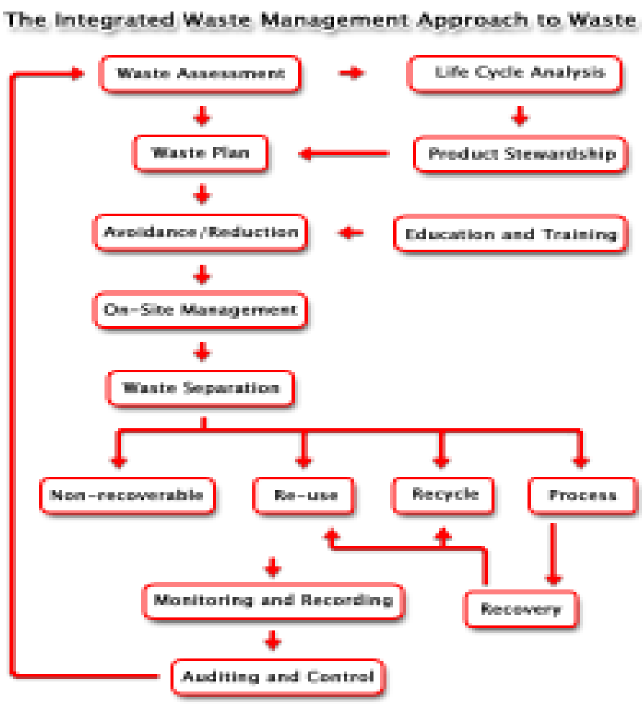

Figure 1: Integrated Waste Management Flow Diagram
(Source: http://www.enviroserv.co.za/pages/content.asp?SectionId=496)

4.1. Construction phase

A plan for the management of waste during the construction phase is detailed below. A Method Statement detailing specific waste management practices during construction should be prepared by the Contractor prior to the commencement of construction, for approval by the Resident Engineer.

4.1.1. Waste Assessment / Inventory

» The Environmental Officer (EO), or designated staff member, must develop, implement and maintain a waste inventory reflecting all waste generated during construction for both general and hazardous waste streams.
» Construction methods and materials should be carefully considered in view of waste reduction, re-use, and recycling opportunities, to be pro-actively implemented.
» Once a waste inventory has been established, targets for the recovery of waste (minimisation, re-use, recycling) should be set.
» The EO must conduct waste classification and rating in terms of SANS 10288 and Government Notice 634 published under the NEM: WA.

4.1.2. Waste collection, handling and storage

» It is the responsibility of the EO to ensure that each subcontractor implements their own waste recycling system, i.e. separate bins for food waste, plastics, paper, wood, glass cardboard, metals, etc. Such practises must be made contractually binding upon appointment of the subcontractors.
» Waste manifests and waste acceptance approvals (i.e. receipts) from designated waste facilities must be kept on file at the site office, in order to record and prove continual compliance for future auditing.
» Septic tanks and portable toilets must be monitored by the EO or responsible subcontractor and maintained regularly. Below ground storage of septic tanks must withstand the external forces of the surrounding environment. The area above the tank must be demarcated to prevent any vehicles or heavy machinery from moving around in the surrounding area.
» Waste collection bins and hazardous waste containers must be provided by the principal contractor and subcontractors and placed at strategic locations around the site for the storage of organic, recyclable and hazardous waste.
» A dedicated waste area must be established on site for the storage of all waste streams before removal from site. The storage period must not trigger listed waste activities as per the NEMWA, GN 921 of November 2013.
» Signage/ colour coding must be used to differentiate disposal areas for the various waste streams (i.e. paper, cardboard, metals, food waste, glass etc.).
» Hazardous waste must be stored within a bunded area constructed according to SABS requirements, and must ensure complete containment of the spilled material in the event of a breach. As such, appropriate bunding material, design, capacity and type must be utilised to ensure that no contamination of the surrounding environment will occur despite a containment breach. The net capacity of a bunded compound in a storage facility should be at least 120% of the net capacity of the largest tank.
» Take into consideration the capacity displaced by other tanks within the same bunded area and any foundations.

» Treat interconnected tanks as a single tank of equivalent total volume for the purposes of the bund design criteria.
» The location of all temporary waste storage areas must aim to minimise the potential for impact on the surrounding environment, including prevention of contaminated runoff, seepage, and vermin control, while being reasonably placed in terms of centrality and accessibility on site. Where required, an additional temporary waste storage area may be designated, provided identical controls are exercised for these locations.
» Waste storage shall be in accordance with all Regulations and best-practice guidelines and under no circumstances may waste be burnt on site.
» A dedicated waste management team must be appointed by the principal contractors' SHE Officer, who will be responsible for ensuring the continuous sorting of waste and maintenance of the area. The waste management team must be trained in all areas of waste management and monitored by the SHE Officer.
» All waste removed from site must be done by a registered/ licensed subcontractor, who must supply information regarding how waste recycling/ disposal will be achieved. The registered subcontractor must provide waste manifests for all removals at least once a month or for every disposal made, records of which must be kept on file at the site camp for the duration of the construction period.

4.1.3. Management of waste storage areas

» Waste storage must be undertaken in accordance with the relevant Norms and Standards.
» The position of all waste storage areas must be located so as to ensure minimal degradation to the environment. The main waste storage area must have a suitable storm water system separating clean and contaminated storm water.
» Collection bins placed around the site and at subcontractors' camps (if at a different location than the main site camp) must be maintained and emptied on a regular basis by the principal contractor to avoid overflowing receptacles.
» Inspections and maintenance of the main waste storage area must be undertaken daily. Skips and storage containers must be clearly marked or colour coded and well-maintained. Monitor for rodents and take corrective action if they become a problem.
» Waste must be stored in designated containers and not on the ground.
» Inspections and maintenance of bunds must be undertaken regularly. Bunds must be inspected for leaks or cracks in the foundation and walls.
» It is assumed that any rainwater collected inside the bund is contaminated and must be treated by oil/water separation (or similar method) prior to dewatering, or removed and stored as hazardous waste, and not released into the environment.
» If any leaks occur in the bund, these must be amended immediately.
» Bund systems must be designed to avoid dewatering of contaminated water, but to rather separate oil and hydrocarbons from water prior to dewatering.
» Following rainfall event bunds must always be dewatered in order to maintain a sufficient storage capacity in the event of a breach.
» No mixing of hazardous and general waste is allowed.

4.1.4. Disposal

» Waste generated on site must be removed on a regular basis. This frequency may change during construction depending on waste volumes generated at different stages of the construction process, however removal must occur prior to the storage capacity being reached to avoid overflow of containers and poor waste storage.

» Waste must be removed by a suitably qualified contractor and disposed of at an appropriately licensed landfill site. Proof of appropriate disposal must be provided by the contractor to the EO and ECO.

4.1.5. Record keeping

The success of the WMP is determined by measuring criteria such as waste volumes, cost recovery from recycling and cost of disposal. Recorded data can indicate the effect of training and education, or the need for education. It will provide trends and benchmarks for setting goals and standards. It will provide clear evidence of the success or otherwise of the plan.

» Documentation (waste manifest, certificate of issue or safe disposal) must be kept detailing the quantity, nature, and fate of any regulated waste for audit purposes.
» Waste management must form part of the monthly reporting requirements in terms of volumes generated, types, storage and final disposal.

4.1.6. Training

Training and awareness regarding waste management shall be provided to all employees and contractors as part of the toolbox talks or on-site awareness sessions with the EO and at the frequency as set out by the ECO.

4.2. Operation phase

It is expected that the operation phase will result in the production of limited amounts of general waste consisting mostly of cardboard, paper, plastic, tins, metals and a variety of synthetic compounds. Hazardous wastes (including grease, oils) will also be generated. All waste generated will be required to be temporarily stored at the facility in appropriate sealed containers prior to disposal at a permitted landfill site or other facilities.

The following waste management principles apply during the operation phase:

» The SHE Manager must develop, implement and maintain a waste inventory reflecting all waste generated during operation for both general and hazardous waste streams.
» Adequate waste collection bins at site must be supplied. Separate bins should be provided for general and hazardous waste.
» Recyclable waste must be removed from the waste stream and stored separately.
» All waste must be stored in appropriate temporary storage containers (separated between different operation wastes, and contaminated or wet waste).
» Waste storage shall be in accordance with all best-practice guidelines and under no circumstances may waste be burnt on site.
» Waste generated on site must be removed on a regular basis throughout the operation phase.
» Waste must be removed by a suitably qualified contractor and disposed of at an appropriately licensed landfill site. Proof of appropriate disposal must be provided by the contractor and kept on site.

5. Monitoring of Waste Management Activities

Records must be kept of the volumes/ mass of the different waste streams that are collected from the site throughout the life of the project. The appointed waste contractor is to provide monthly reports to the operator containing the following information:

- Monthly volumes/ mass of the different waste streams collected;
- Monthly volumes/ mass of the waste that is disposed of at a landfill site;
- Monthly volumes/ mass of the waste that is recycled;
- Data illustrating progress compared to previous months.

This report will aid in monitoring the progress and relevance of the waste management procedures that are in place. If it is found that the implemented procedures are not as effective as required, this WMP is to be reviewed and amended accordingly. This report must from part of the EO's reports to the ECO on a monthly basis.

APPENDIX I(I):

TRAFFIC MANAGEMENT PLAN

Activity: Allepad PV (I,II,III,IV) Traffic Management Plan

Deliverable: Draft Management Plan

Submitted to: ILEnergy Development

Compiled by:	**Accepted by:**
___________________	_____________________
ILEnergy (Pty) Ltd Ian Smit	ILEnergy Development (Pty) Ltd Dr. Louis van Heerden
Date:	Date:

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Key Abbreviations

ACT	-	Occupational Health and Safety Act, Act No 85 of 1993 & National Road Traffic Act, Act No 93 of 1996
CBA	-	Critical Biodiversity area
DAFF	-	Department of Agriculture Forests and Fisheries
DRDLR	-	Department of Rural Development and Land Reform
ESA	-	Ecological Support Area
LM	-	Local Municipality
LMV	-	Light Motor Vehicle
MPRD	-	Mineral and Petroleum Resources Development
NHRA	-	National Heritage Resources Act
PPE	-	Personal Protective Equipment
RE	-	Remaining Extent
SALA	-	Subdivision of Agricultural Land Act
SME	-	Surface Mobile Equipment
SMS	-	Short Message Service “Texting”
WMA	-	Water Management Area

1. Approach

This Traffic Management Plan has been prepared by ILEnergy (Pty) Ltd, based on their experience gained with multiple solar power construction projects in Upington and the Northern Cape Province, to describe how the EPC will safely and effectively control and minimize road-related impacts arising from the construction of the proposed Allepad PV solar power generation projects (I, II, III, IV), located approximately 15km Northwest of Upington in the Northern Cape Province just off the N10.

2. Purpose

The Traffic Management Plan is prepared for the road site access to make sure that no hazards would result from the increased traffic and that the normal traffic flow would not be adversely impacted by the project and its construction.

The objective of the Traffic Management Plan is to improve road safety, promote safety awareness, improve road traffic conditions, and implement improved road traffic management systems at the construction site.

Under this plan, informational and temporary signage will be used to inform the public of traffic hazards and convey safety measures in place, flaggers would be employed when significant equipment is delivered that may cause delays on throughways when such vehicles has to access the site and traffic cones could be used to identify any temporary changes in lane configuration necessary to minimize traffic impacts.

This plan will be submitted to SANRAL as the relevant authority for review and approval prior to construction being initiated.

The plan applies in conjunction with the relevant Acts namely:

- Occupational Health and Safety Act, Act No 85 of 1993
- National Road Traffic Act, Act No 93 of 1996

3. Project Description

The Allepad Solar Project proposes the construction of 4 by 100MWnet solar PV projects on the Farm Allepad in the Northern Cape Province, being the remaining extent of ERF 5315 (a portion of ERF 1 Upington with LPI code C02800070000531500000), approximately 15km NW of the town of Upington, the regional capital of the Dawid Kruiper municipality, in the Northern Cape Province.

4. Site Access

4.1. Description

The site of the proposed project borders the N10 national highway to Namibia in the South and the regional R360 road in the North. As the existing official SANRAL farm entrance is off the N10, this entrance will be maintained and used as the main access to the site.

Figure 1. Aerial View of the Existing Farm Entrance off the N10.

4.2. Suitability

The current access has been created to accommodate the commercial activities of the farm Allepad and as such is suitable for the use by cars, light delivery vehicles, trucks and heavy-duty motorised farm implements. As such no modifications are required to adapt the existing entrance to the requirements of the project.

4.3. Hazards

The view from the existing farm entrance in the SE and NW directions are presented below.

Figure 2. Existing Farm Entrance off the N10.

The road approaching the site access from both directions is straight with no turns or inclines impacting the drivers view. The access is further located on a flat potion of land, as such there are no topographic features that impairs visibility.

Taking the above into account, it can be concluded that the conditions of the existing access from the N10 national road does not present any hazards that are out of the ordinary and that industry standard practice should be applied in managing the site access and traffic calming requirements during construction.

5. Management Plan

5.1. Site access

Site access will at all times be controlled and limited by the appointed security entity including an alcohol and drug management and testing procedure.

5.2. Traffic control plan

5.2.1. General Requirements

5.2.1.1. Surface mobile equipment

This Traffic Management Plan applies to all surface mobile equipment (SME), ancillary and earthmoving equipment that is used for transport, operations and maintenance in and around the surface area of the site.

5.2.1.2. Light motor vehicles

This Traffic Management Plan applies to all light motor vehicles (LMV), that can be licensed under the ACT and are used for transporting people and light loads. Private vehicles will only be allowed to park within designated car parks and shall not be used when conducting work associated tasks.

5.2.1.3. Chocks

All Surface Mobile Equipment are required to carry and make use of Chocks / Stop Blocks. The chocks must be of the correct size and specification for the weight and tyre size of the SME as prescribed by the chock block manufacturers. Chocks must be placed at the front and rear of the wheels in such a way that the SME will be unable to move, in the event of other immobilizers or parking brakes failing.

5.2.1.4. Operating License

Employees may not drive or operate any vehicle and / or mobile equipment without an approved license under the Act or permit issued by the site operations management and authorised by the relevant manager. Such licenses are specific and restricted to, the class or type of vehicle or SME for which the person is trained and tested competent to drive and safely operate.

5.2.1.5. Fitness to Operate

Drivers and operators should not drive or operate vehicles and / or mobile equipment if they are impaired due to any reason, including but not limited to the influence of drugs and / or alcohol, fatigue, injury or any physical restriction that would impact on their ability to operate a particular vehicle or machine.

5.2.1.6. Defensive Driving

Drivers and operators should be trained in and practice the techniques of defensive driving and operation. This means driving well within the safe limits of the vehicle and equipment operating limits and leaving enough time and room to react in the event of an unexpected condition or movement of another person, vehicle or equipment to avoid a collision or out of control situation.

5.2.1.7. Pre-Use Check List

Drivers and operators should conduct a pre-use inspection of the vehicle or equipment prior to operation in accordance with the frequency and scope specified by the site procedure for this. A written pre-use checklist of that inspection should be available on the vehicle or equipment at all times. Damage and defects should be reported, and the vehicle or machine should not be operated.

5.2.1.8. Running Lights

Running Lights (low beam head lights), and yellow strobe lights shall be left on at all times during operation on the project site. Strobe lights must be turned off when leaving the project site and entering any Provincial or National road.

5.2.1.9. Mobile Phones

A mobile phone shall not be used whilst driving regardless of whether a hand free kit is used or not.

All vehicles shall be parked in a safe location before any calls are answered or made.

A mobile phone shall not be used to SMS (text), or for watching streaming content or listening to music whilst driving.

All SME operators will only answer their mobile phones in the hard park area whilst parked at the designated spots with the equipment switched off and park brake or equivalent applied.

Cellular phones shall not be used in any area where it is deemed unsafe to do so. These areas specifically include all areas where explosive charging and preparation activities are taking place, in areas where blasting operations are being conducted, in the vicinity of refuelling activities, or any other area demarcated as unsafe by management.

5.2.1.10. Safety of People

Personnel should not work on vehicle roadways without reflective clothing that meets the project requirements, specific reference is made to reflective vests.

A risk assessment of the work or operation, and of any proposed changes to traffic flows that may be required must be in place to manage the risks identified in the risk assessment.

These may include notification and communication, warning signs, lighting and traffic control systems to manage the risks of collision between vehicles/equipment and people.

Drivers and operators should exercise considerable caution in the vicinity of road construction and maintenance activities including but not restricted to road watering, grading, rolling, etc.

5.2.1.11. Pedestrian Interaction

Designated walkways for pedestrians and identified pedestrian crossings shall be provided where appropriate.

Pedestrians must only use demarcated cross walks where provided, and if traffic is present only cross on that cross walk once sure oncoming drivers and operators are aware of their presence and intention to cross.

Where there is no demarcated cross walk, cross roadways at right angles, and only when the roadway is clear of traffic.

Give way to vehicles and equipment if not on a defined and clearly marked pedestrian crossing.

Use a walkway where one is provided in preference to walking along a roadway.

Walk facing the oncoming traffic when using a roadway.

Avoid having mid roadway discussions/meetings or answering of calls.

Do not approach working mobile equipment closer than 50 meters until they have contacted or attracted the attention of the operator, and the operator has correctly parked the vehicle or equipment and acknowledged the pedestrian and signalled that it is safe to approach.

All pedestrian crossings will have a "Stop" sign on either side of the crossing.

Where visibility is obstructed, advance warning signage should be provided. Supplementary lighting may be provided at zebra crossings where practical.

Pedestrian crossing pavement markings should be maintained and kept clean so they are clearly visible to all road users. Safe pedestrian routes are to be clearly and consistently marked using a painted walking person symbol. Where necessary and possible the pedestrian route is to be protected from the encroachment of vehicles. Pedestrians should be able to escape quickly from the safe pedestrian route in an emergency.

5.2.1.12. Notification of accidents, incidents and near misses

All near misses, incidents and accidents shall be reported to the H&S department within 24 hours. Any incident involving a light or heavy vehicle will require the drivers involved to partake in a drug and alcohol test. Drivers shall report to their supervisor any damage to their vehicle or any injury resulting from an incident on site. This includes any incident operating or driving a company vehicle off site.

5.2.2. Limiting and Mitigating local Traffic Impact

Numerous local traffic impact assessments have been undertaken in the recent past, specifically for large and permanent proposed developments such as the Upington Solar Park and Northern Cape Economic Development Area and/or SEZ. Findings in these studies concluded that the current operating conditions on the road networks in and around Upington are acceptable with no level of service or capacity failures. The existing critical peaks, in terms of traffic volumes, were found to be the PM rush hour with the AM rush hour less but similar. Minimal traffic intersection upgrades were recommended in these studies to accommodate the anticipated roughly 2500 new daily vehicle trips. [1] This is substantially more traffic than anticipated for the construction of the Allepad PV projects.

In order to ensure that no hazards result from the increased truck traffic, that traffic flow is not adversely impacted and to minimise any impacts on local commuters, Upington CBD and local schools the following measures will be implemented.

[1] "Traffic Impact Study for Proposed Development of The NCEDA Solar and Special Economic Zone Upington within Dawid Kruiper Local Municipality", Emonti Consulting Engineers CC, November 2016.

5.2.2.1. Routes to be used

Main inbound traffic anticipated will be from either Johannesburg or Cape Town via the N14. These will mainly consist of standard shipping containers at roughly 600 to 800 loads over an 8 to 12-month construction period (ie less than 5 vehicles per day). Localised movement of construction workers are estimated at about 200 people at the height of construction, adding roughly 50 LMV's and small transporter busses.

Heavy vehicles will stay on main routes from the N14 directly to the N10 or via Dr Nelson Mandela Drive (all double carriageways). This will circumvent the CBD and major schools. Refer to Figure 3 below.

Figure 3. Truck Traffic Route around Upington.

5.2.2.2. Times of Use

Any heavy construction vehicles travelling to site, and any deliveries of equipment to the site by trucks, will be scheduled to occur during times that avoid morning and later afternoon peak traffic. It should be noted that equipment will be in standard shipping containers and as such no oversized loads are expected. Morning traffic volumes result from a combination of school and commercial traffic, set between 6:30 and 8:30 am. Late afternoon traffic is largely office and commercial based and the afternoon peak is set between 16:30 and 17:30 pm. Large vehicles that could negatively impact traffic flow will be prohibited during the periods identified.

5.2.3. Speed Management

The maximum permitted speed limits for vehicles and SME's travelling on the project site will be as follows:

- Light Motor Vehicles – 30km/h
- All other vehicles including SME's – 20km/h

Speed limit signs are to be erected on the left side of the carriageway and no other sign should be erected on any post carrying a speed limit sign. Sign posts must be clearly visible.

Speed limit signs are to be positioned where speed limits change from the general site speed limit.

Operators must operate according to the prevailing conditions, i.e. taking into account, dust and rain or other adverse weather conditions.

Operators of equipment carrying loads should adjust their speed in accordance with the load being carried to avoid loss of the load or control of the vehicle or equipment.

5.2.4. **Overtaking**

It is a driver's responsibility to ensure that overtaking of another vehicle is only undertaken when permitted and safe to do so.

Overtaking is only permitted on the right-hand side of the road.

No SME may overtake any other SME or Light Motor Vehicle.

No overtaking is permitted at any intersection.

Overtaking of stationary vehicles or SME's should be done with caution.

A vehicle or SME parked on the side of the road should be assumed to be potentially turning out or across the road unless it is displaying hazard lights or is marked with signs or cones as being broken down. It should not be overtaken until positive communication or indication has been established.

Water bowsers may not be overtaken when spraying is in process.

Vehicles that are being towed may not be overtaken.

5.2.5. Access to hazardous and restricted areas

Access to the project site is permitted only to persons appropriately inducted to the site as per the Site Access Procedure by the appointed security entity. Each person that is present on site shall be appropriately recorded by an access control management system and the visitor register located at the project site office.

Hazardous areas at the project site include, but are not restricted to:

- Areas of high forklift activity
- Drainage areas
- Temporary road works
- Stockpiles
- Laydown areas
- Stores
- Substation

Temporary Traffic Management (e.g. road closures or construction) may need to be enforced in certain areas from time to time around the site to prevent unnecessary access by vehicles and pedestrians. This can be provided either on a once off basis (e.g. using crash barriers), or can be provided regularly for operational purposes (e.g. boom gates).

5.2.6. Safe following distances

Safe following distance varies with the condition and construction of a road surface, the types of vehicles being used and operating speed. The safe following distance is that distance covered in two seconds whilst a vehicle is travelling at a particular speed.

The “two second rule” applies only for alert drivers, driving vehicles in good mechanical condition, fitted with good tyres and driving on a good road surface in good traffic and weather conditions. The safe following distance in the active construction area is 50m. Following distances should be increased in adverse weather conditions.

5.2.7. Road traffic control signage

Traffic control signs are positioned around the project site to control the safe flow and conduct of traffic. They should be complied with as indicated at all times.

All the signs should be supplied in accordance with the SABS 1519 (1,2) specifications. Refer to Appendix A & B below.

All signs (excluding danger and delineation signs), should be placed at a minimum of 1.5m from the edge of the road at a minimum height of 2.1 meters from the ground (bottom edge of the sign).

Danger ahead and delineation signs should be placed on a height of 600mm (ground to
bottom of sign).

Stop, Give Way, No Entry and advanced Pedestrians and Zebra Crossing warning signs should be provided on the left side of the roadway, with a second sign on the right if required to provide additional emphasis.

All road signs are to be made of reflective material so that they are highly visible at night and their daytime colours and shapes are displayed in the dark.

5.2.8. **Parking**

In the case of vehicle breakdowns, the area must be clearly demarcated. Demarcate the vehicle 25 meters in front and the rear with two red triangles and one triangle on the side one meter away from the vehicle.

Parked light vehicles shall have the engine turned off, the park brake engaged and 1st or reverse gear selected. All vehicles shall also be reversed parked in the bays and allocated areas. This excludes equipment that is equipped with a Power Take Off that requires the engine to be running. Additional safety precautions, e.g. warning triangles must be in place.

Parking areas shall not be used as storage areas. Where there is risk of vehicles hitting objects behind their backs whilst reversing, wheel stops or ”V” drains should be installed. The layout of parking bays should take into consideration the need to accommodate larger vehicles such as the larger four-wheel drives and / or light delivery vehicles.

5.2.9. **Seatbelts**

Seatbelts should be correctly adjusted and worn by the driver and all passengers at all times in a moving vehicle or SME.

The driver or operator should not move the vehicle or SME until all passengers are wearing their seatbelts as well.

5.2.10. **Overloading of vehicles**

Site specific loading and unloading procedures shall be followed.

Loads should be correctly covered and or secured as required by law. Personnel shall not violate working at height procedure when covering loads.

Loading of equipment shall be carried out without exceeding the limitations of the machinery.

Trucks and other equipment that carry loads should be parked according to the parking standard whilst being loaded and unloaded.

A level working area should be selected. Drivers and operators should remain in their vehicle whilst being loaded.

Operators should ensure that mobile equipment are not overloaded and meet the load carrying capacity of the equipment.

5.2.11. **Give way**

There is no "right" of way as it is every driver, operator and pedestrian's responsibility to give way to avoid a collision. Drivers and operators should give way to pedestrians at defined and demarcated cross walks. Pedestrians should give way to vehicles and equipment when crossing a roadway away from a defined and demarcated cross walk. Drivers of light vehicles should be prepared to give way to SME's even at intersections where the mobile equipment is facing a give way sign. Mobile equipment may have limited operator visibility and light vehicles should never proceed through an intersection where they have priority over mobile equipment until they are sure the operator has seen or acknowledges them.

Most intersections on site are controlled with either "STOP" or "Give Way" signs, however where intersections have not been signposted, "STOP" must be adhered to.

All vehicles and equipment should give way to Emergency Vehicles when their flashing lights are illuminated.

5.2.12. Approaching, boarding, disembarking and isolating

Personnel may not board or disembark moving equipment. The equipment must be brought to a safe stop. Any personnel other than the operator may only board or disembark the equipment once they have received authorisation from the operator.

SME's must maintain a minimum 5-meter clearance from each other when loading.

Personnel shall make use of the designated access stairways, ladders etc. If ladder access is available, personnel should face the ladder when using this access.

Footholds or steps that are covered in mud or other material should be cleaned prior to use.

Hand rails should be used as designed and three-point contacts should be maintained at all times. Special care must be taken when tools and other items are carried abourd.

Personnel intending to work in the vicinity of operating vehicles or equipment should control and assess the risk of that activity as per H&S procedures.

Personnel interaction with equipment (loading / unloading, refuelling, directing into work areas), must wear high visibility clothing and meet all other operational PPE requirements.

5.2.13. Wide or abnormal loads

An abnormal load Permit to Work shall be obtained for loads that are not directly related to the process and which are considered to have abnormal speed restriction, width, height, weight or shape that would present a hazard to other site traffic.

Wide and abnormal loads should be clearly demarcated, and an escort should be provided in front of and at the back of the vehicle carrying the wide or abnormal load.

5.2.14. Overhead power lines

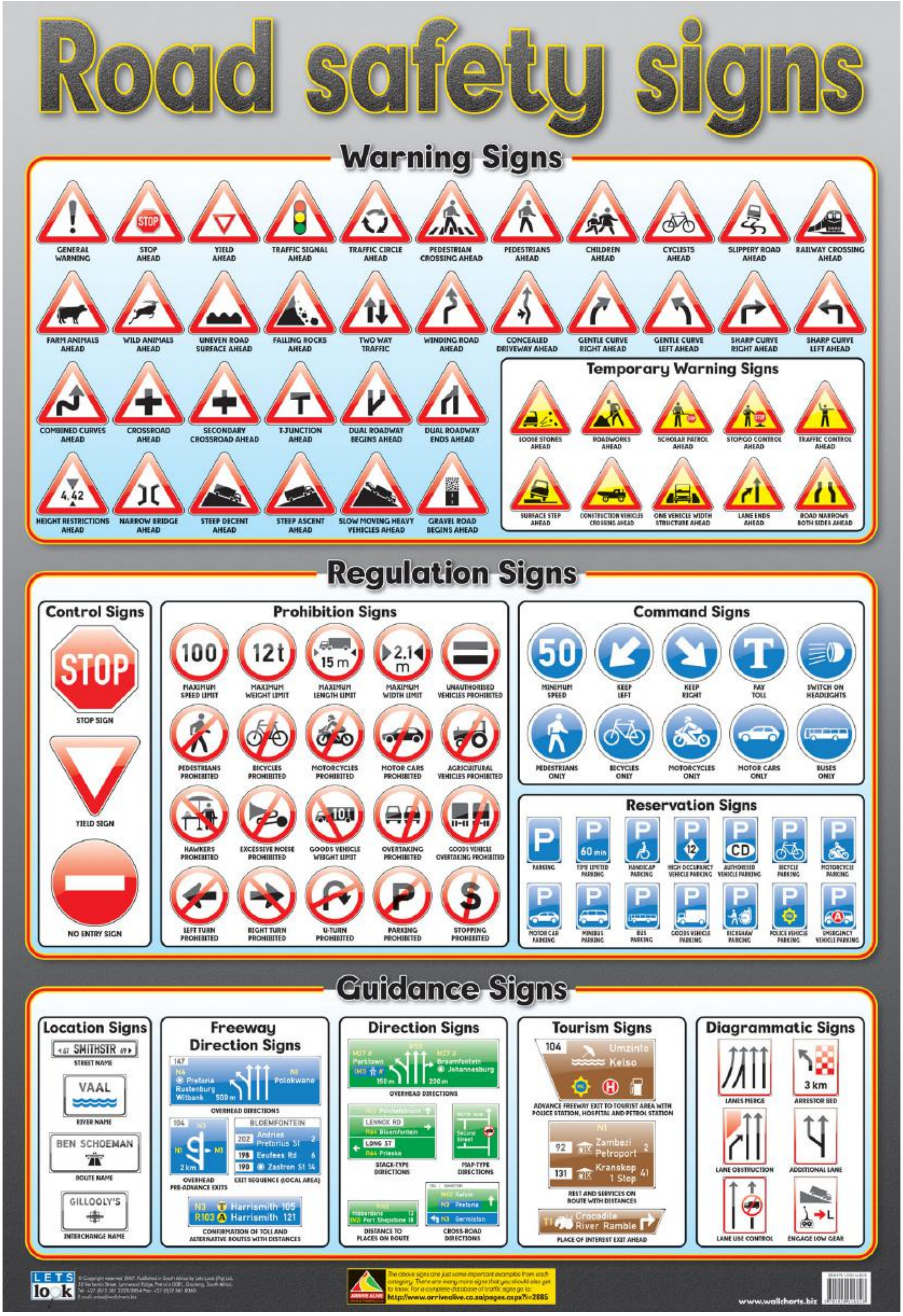
All work shall be done according to the OHS Act and EPC Temporary On-Site Electrical Installations and Electrical Safety standards, which will include the following:

Operation of equipment in the vicinity of overhead power lines shall not commence unless an access permit to do so has been issued by an authorised person nominated by the relevant authority.

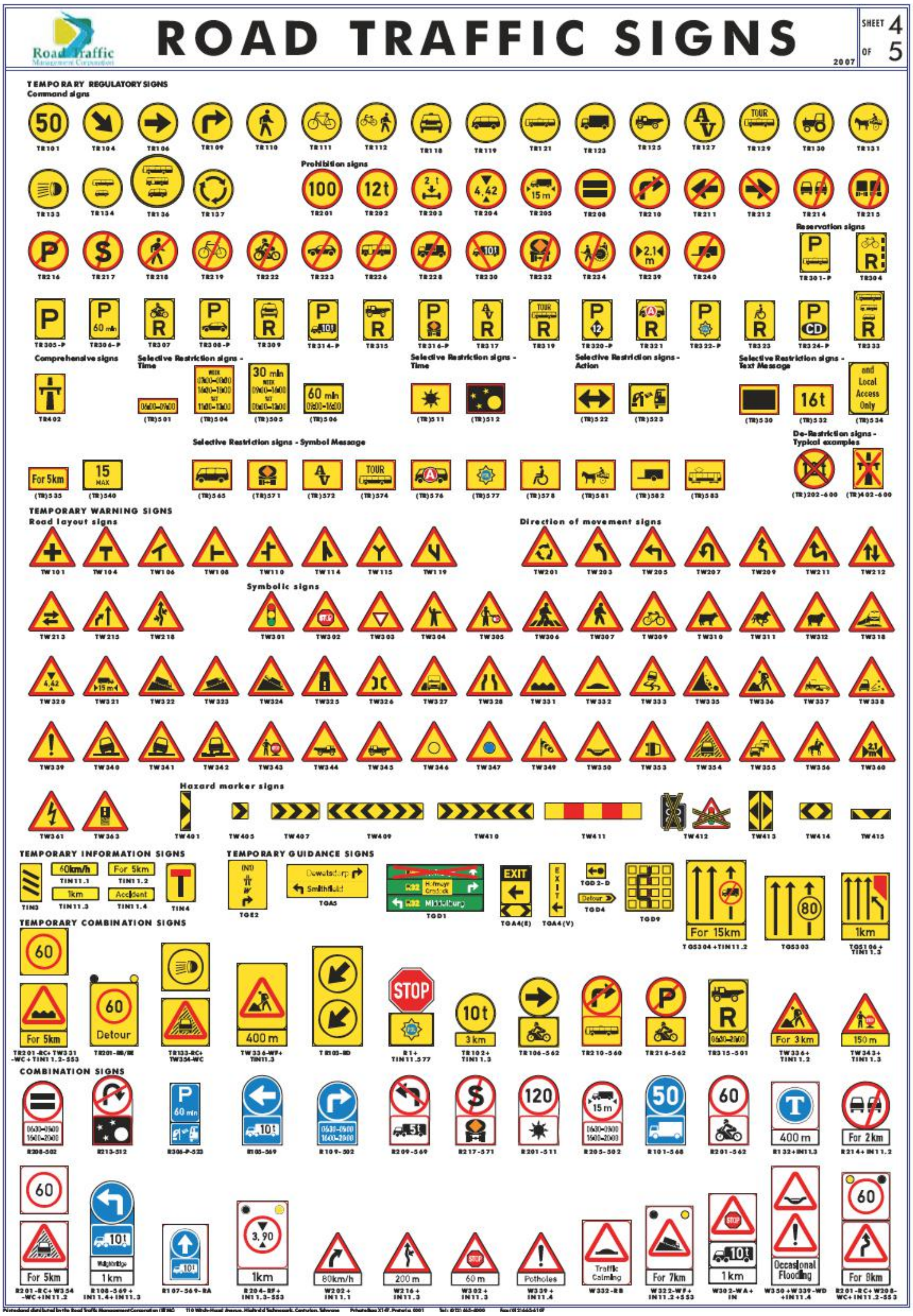
All underground cables have identification markers to indicate their locations.

Excavation work is not to commence within the vicinity of buried cables unless a permit to do so has been issued by the relevant authority.

Annexure A – Basic Road Signs



Annexure B – Temporary Road Signs



APPENDIX I(J):

EMERGENCY PREPAREDNESS, RESPONSE AND FIRE MANAGEMENT PLAN

EMERGENCY PREPAREDNESS, RESPONSE AND FIRE MANAGEMENT PLAN

1. PURPOSE

The purpose of the Emergency Preparedness and Response Plan is:

- To assist contractor personnel to prepare for and respond quickly and safely to emergency incidents, and to establish a state of readiness which will enable prompt and effective responses to possible events.
- To control or limit any effect that an emergency or potential emergency may have on site or on neighbouring areas.
- To facilitate emergency responses and to provide such assistance on the site as is appropriate to the occasion.
- To ensure communication of all vital information as soon as possible.
- To facilitate the reorganisation and reconstruction activities so that normal operations can be resumed.
- To provide for training so that a high level of preparedness can be continually maintained.

This plan outlines response actions for potential incidents of any size. It details response procedures that will minimise potential health and safety hazards, environmental damage, and clean-up efforts. The plan has been prepared to ensure quick access to all the information required in responding to an emergency event. The plan will enable an effective, comprehensive response to prevent injury or damage to the construction personnel, public, and environment during the project. Contractors are expected to comply with all procedures described in this document. A Method Statement should be prepared at the commencement of the construction phase detailing how this plan is to be implemented as well as details of relevant responsible parties for the implementation. The method statement must also reflect conditions of the IFC Performance Standard 1 and include the following:

- Identification of areas where accidents and emergency situations may occur;
- Communities and individuals that may be impacted;
- Response procedure;
- Provisions of equipment and resources;
- Designation of responsibilities;
- Communication; and
- Periodic training to ensure effective response to potentially affected communities.

2. PROJECT-SPECIFIC DETAILS

ILEnergy Development (Pty) Ltd proposes the development of Allepad PV Three, a solar energy facility and associated infrastructure on a site near Upington, in the Northern Cape Province. The solar facility will be designed to have a contracted capacity of up to 100MW, and will make use of photovoltaic (PV) solar technology. The project will comprise the following key infrastructure and components:

- Arrays of PV panels with a generation capacity of up to 100MW.
- Mounting structures to support the PV panels.

- Combiner boxes, on-site inverters (to convert the power from Direct Current (DC) to Alternating Current (AC)), and distribution power transformers.
- A 132kV on-site substation up to 1ha in extent to facilitate the connection between the solar energy facility and the Eskom electricity grid.
- A new 132kV double-circuit power line (which will make use of a loop-in and loop-out configuration utilising a double-circuit monopole construction), up to 5km in length, between the on-site substation and Eskom grid connection point.
- Cabling between the project's components (to be laid underground where practical).
- Meteorological measurement station.
- An energy storage area up to 2ha in extent.
- Access road and internal access road network.
- On-site buildings and structures, including a control building and office, ablutions and guard house.
- Perimeter security fencing, access gates and lighting.
- Temporary construction camp up to 1ha in extent, including temporary site offices, parking and chemical ablution facilities.
- Temporary laydown area up to 1ha in extent, for the storage of materials during the construction and concrete batching plant.

Due to the scale and nature of this development, it is anticipated that the following risks could potentially arises during the construction and operation phases:

- Fires;
- Leakage of hazardous substances;
- Storage of flammable materials and substances;
- Flood events;
- Accidents; and
- Natural disasters.

3. EMERGENCY RESPONSE PLAN

There are three levels of emergency as follows:

- Local Emergency: An alert confined to a specific locality.
- Site Emergency: An alert that cannot be localised and which presents danger to other areas within the site boundary or outside the site boundary.
- Evacuation: An alert when all personnel are required to leave the affected area and assemble in a safe location.

If there is any doubt as to whether any hazardous situation constitutes an emergency, then it must be treated as an Evacuation.

Every effort must be made to control, reduce or stop the cause of any emergency provided it is safe to do so. For example, in the event of a fire, isolate the fuel supply and limit the propagation of the fire by cooling the adjacent areas. Then confine and extinguish the fire (where appropriate) making sure that re-ignition cannot occur.

3.1. Emergency Scenario Contingency Planning

3.1.1. Scenario: Spill which would result in the contamination of land, surface or groundwater

i. Spill Prevention Measures

Preventing spills must be the top priority at all operations which have the potential of endangering the environment. The responsibility to effectively prevent and mitigate any scenario lies with the Contractor and the ECO. In order to reduce the risk of spills and associated contamination, the following principles should be considered during construction and operation activities:

» All equipment refuelling, servicing and maintenance activities should only be undertaken within appropriately sealed/contained or bunded designated areas.
» All maintenance materials, oils, grease, lubricants, etc. should be stored in a designated area in an appropriate storage container.
» No refuelling, storage, servicing, or maintenance of equipment should take place within sensitive environmental resources in order to reduce the risk of contamination by spills.
» No refuelling or servicing should be undertaken without absorbent material or drip pans properly placed to contain spilled fuel.
» Any fluids drained from the machinery during servicing should be collected in leak-proof containers and taken to an appropriate disposal or recycling facility.
» If these activities result in damage or accumulation of product on the soil, the contaminated soil must be disposed of as hazardous waste. Under no circumstances shall contaminated soil be added to a spoils pile and transported to a regular disposal site.
» Chemical toilets used during construction must be regularly cleaned. Chemicals used in toilets are also hazardous to the environment and must be controlled. Portable chemical toilets could overflow if not pumped regularly or they could spill if dropped or overturned during moving. Care and due diligence should be taken at all times.
» Contact details of emergency services and HazMat Response Contractors are to be clearly displayed on the site. All staff are to be made aware of these details and must be familiar with the procedures for notification in the event of an emergency.

ii. Procedures

The following action plan is proposed in the event of a spill:

1. Spill or release identified.
2. Assess person safety, safety of others and environment.
3. Stop the spill if safely possible.
4. Contain the spill to limit entering surrounding areas.
5. Identify the substance spilled.
6. Quantify the spill (under or over guideline/threshold levels).
7. Notify the Site Manager and emergency response crew and authorities (in the event of major spill).
8. Inform users (and downstream users) of the potential risk.
9. Clean up of the spill using spill kit or by HazMat team.
10. Record of the spill incident on company database.

a) Procedures for containing and controlling the spill (i.e. on land or in water)

Measures can be taken to prepare for quick and effective containment of any potential spills. Each contractor must keep sufficient supplies of spill containment equipment at the construction sites, at all times during and after the construction phase. These should include specialised spill kits or spill containment equipment. Other spill containment measures include using drip pans underneath vehicles and equipment every time refuelling, servicing, or maintenance activities are undertaken.

Specific spill containment methods for land and water contamination are outlined below.

Containment of Spills on Land

Spills on land include spills on rock, gravel, soil and/or vegetation. It is important to note that soil is a natural sorbent, and therefore spills on soil are generally less serious than spills on water as contaminated soil can be more easily recovered. It is important that all measures be undertaken to avoid spills reaching open water bodies located outside of the project site. The following methods could be used:

» *Dykes* - Dykes can be created using soil surrounding a spill on land. These dykes are constructed around the perimeter or down slope of the spilled substance. A dyke needs to be built up to a size that will ensure containment of the maximum quantity of contaminant that may reach it. A plastic tarp can be placed on and at the base of the dyke such that the contaminant can pool up and subsequently be removed with sorbent materials or by pump into barrels or bags. If the spill is migrating very slowly, a dyke may not be necessary and sorbents can be used to soak up contaminants before they migrate away from the source of the spill.

» *Trenches* - Trenches can be dug out to contain spills. Spades, pick axes or a front-end loader can be used depending on the size of the trench required. Spilled substances can then be recovered using a pump or sorbent materials.

b) Procedures for transferring, storing, and managing spill related wastes

Used sorbent materials are to be placed in plastic bags for future disposal. All materials mentioned in this section are to be available in the spill kits. Following clean up, any tools or equipment used must be properly washed and decontaminated, or replaced if this is not possible.

Spilled substances and materials used for containment must be placed into empty waste oil containers and sealed for proper disposal at an approved disposal facility.

c) Procedures for restoring affected areas

Criteria that may be considered include natural biodegradation of oil, replacement of soil and revegetation. Once a spill of reportable size has been contained, the ECO and the relevant Authority must be consulted to confirm that the appropriate clean up levels are met.

3.1.2. Scenario: Fire (and fire water handling)

i. Action Plan

The following action plan is proposed in the event of a fire:

1. Quantify risk.
2. Assess person safety, safety of others and environment.
3. If safe – attempt to extinguish the fire using appropriate equipment.
4. If not safe to extinguish, contain fire.
5. Notify the Site Manager and emergency response crew and authorities.
6. Inform users of the potential risk of fire.
7. Record the incident on the company database or filing register.

ii. Procedures

Because large scale fires may spread very fast it is most advisable that the employee/contractor not put his/her life in danger in the case of an uncontrolled fire.

Portable firefighting equipment must be provided at strategic locations throughout the site, in line with the Building Code of South Africa and the relevant provincial building code. All emergency equipment including portable fire extinguishers, hose reels and hydrants must be maintained and inspected by a qualified contractor in accordance with the relevant legislation and national standards.

Current evacuation signs and diagrams for the building or site that are compliant to relevant state legislation must be provided in a conspicuous position, on each evacuation route. Contact details for the relevant emergency services should be clearly displayed on site and all employees should be aware of procedures to follow in the case of an emergency.

a) Procedures for initial actions

Persons should not fight the fire if any of the following conditions exist:

» They have not been trained or instructed in the use of a fire extinguisher.
» They do not know what is burning.
» The fire is spreading rapidly.
» They do not have the proper equipment.
» They cannot do so without a means of escape.
» They may inhale toxic smoke.

b) Reporting procedures

In terms of the requirements of NEMA, the responsible person must, within 14 days of the incident, report to the Director General, provincial head of department and municipality.

» Report fire immediately to the site manager, who will determine if it is to be reported to the relevant emergency services and authorities.
» The site manager must have copies of the Report form to be completed.

SUMMARY: RESPONSE PROCEDURE

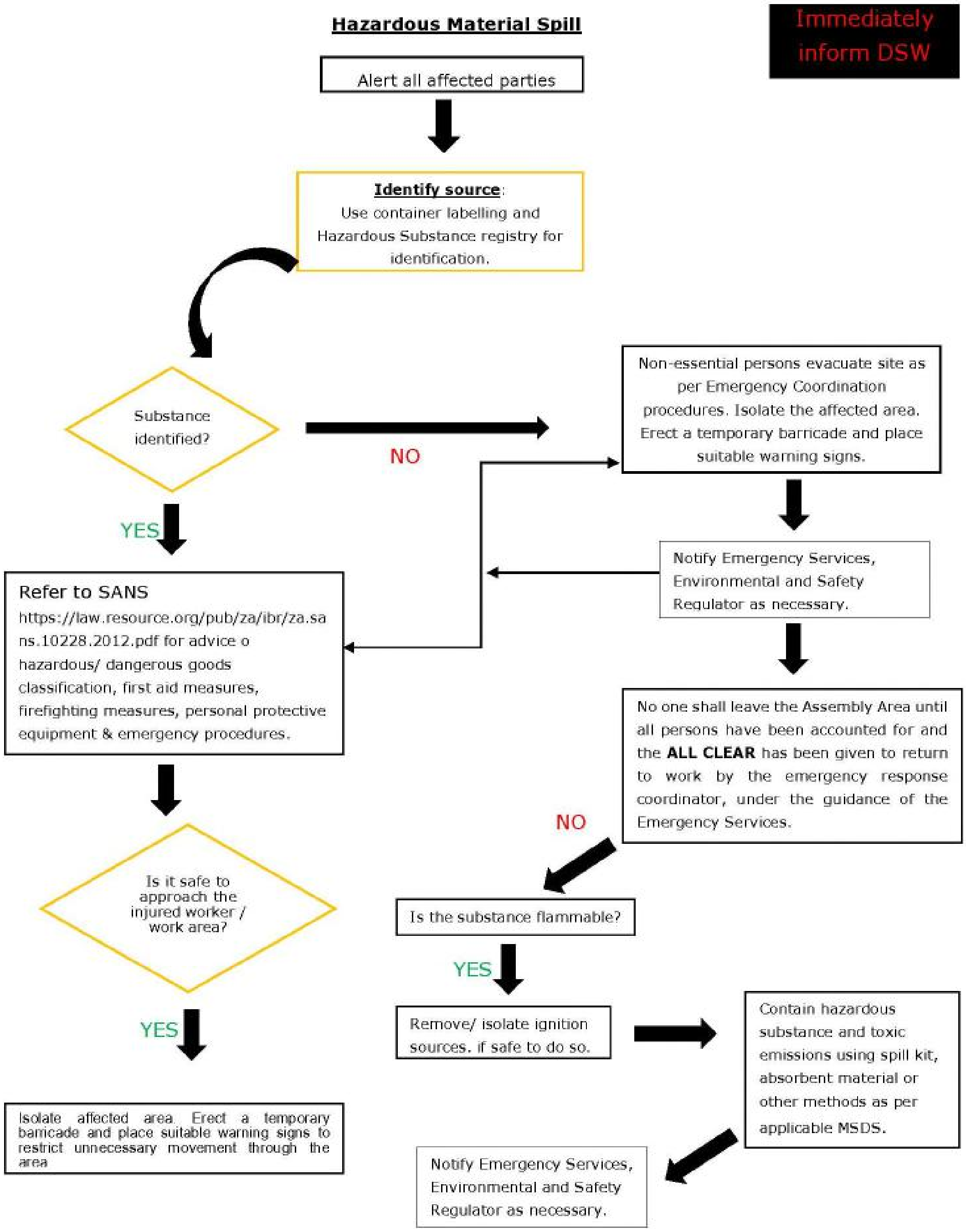


Figure 1: Hazardous Material Spill

Fire/Medical Emergency Situation

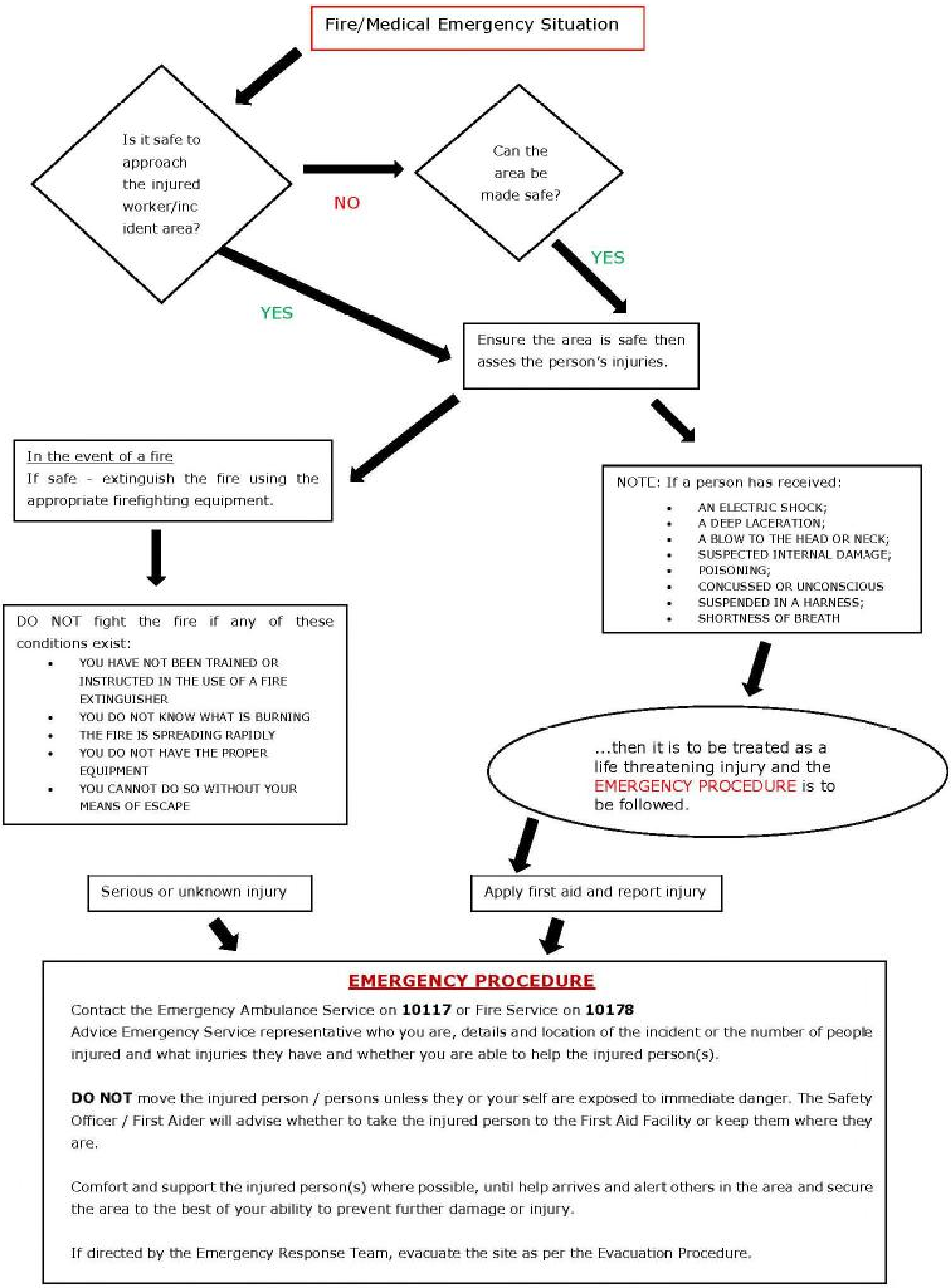


Figure 2: Emergency Fire/Medical

4. PROCEDURE RESPONSIBILITY

The Contractor's Safety, Health and Environment (SHE) Representative, employed by the Contractor, is responsible for managing the day-to-day on-site implementation of this Plan, and for the compilation of regular (usually weekly) Monitoring Reports. In addition, the SHE must act as liaison and advisor on all environmental and related issues.

The local authorities will provide their assistance when deemed necessary, or when it has been requested and/or indicated in Section 30 (8) of NEMA. The provincial authority will provide assistance and guidance where required and conduct awareness programmes.

APPENDIX I(K):
CURRICULUM VITAE

1st Floor, Block 2, 5 Woodlands Drive Office Park
Woodlands Drive, Woodmead
Johannesburg, South Africa

Email: joanne@savannahsa.com
Tel: +27 (11) 656 3237

CURRICULUM VITAE OF KAREN JODAS

Profession: Environmental Management and Compliance Consultant; Environmental Assessment Practitioner. Professional Natural Scientist: Environmental Science since 1999.

Specialisation: Strategic environmental assessment and advice; development of plans and guidelines; environmental compliance advise and monitoring; Environmental Impact Assessment; environmental management; project management and co-ordination of environmental projects; peer review; policy, strategy and guideline formulation; renewable energy projects; water resources management.

VOCATIONAL EXPERIENCE

Provide technical input for projects in the environmental management field, specialising in strategic evaluation, Environmental Impact Assessment studies, environmental management plans, programmes and guidelines, integrated environmental management, environmental compliance monitoring; peer review of EIA reports and processes, strategy and guideline development, and public participation. Key focus on overall Project Management, integration of environmental studies and environmental processes into larger engineering-based projects, strategic assessment, and the identification of environmental management solutions and mitigation/risk minimising measures.

Excellent working knowledge of environmental legislation, strategies, guidelines and policies. Compilation of the reports for environmental studies are in accordance with the all relevant environmental legislation under the National Environmental Management Act. Due consideration of Equator Principles and compliance with IFC performance standards is now a part of all projects.

SKILLS BASE AND CORE COMPETENCIES

Provide technical input for projects in the environmental management field, specialising in strategic evaluation, Environmental Impact Assessment studies, environmental management plans, programmes and guidelines, integrated environmental management, environmental compliance monitoring; peer review of EIA reports and processes, strategy and guideline development, and public participation. Key focus on overall Project Management, integration of environmental studies and environmental processes into larger engineering-based projects, strategic assessment, and the identification of environmental management solutions and mitigation/risk minimising measures.
Excellent working knowledge of environmental legislation, strategies, guidelines and policies. Compilation of the reports for environmental studies are in accordance with the all relevant environmental legislation
under the National Environmental Management Act. Due consideration of Equator Principles and compliance with IFC performance standards is now a part of all projects.

SKILLS BASE AND CORE COMPETENCIES

- Twenty years (20) of experience in the environmental management, impact assessment and compliance fields
- Eighteen (18) years of experience in Project Management - Project management of large environmental assessment and management projects
- Strategic and compliance advise for all aspects of environmental assessment and management
- External and peer review of environmental assessment and compliance reporting as well as EIA processes
- Working knowledge of environmental planning policies, regulatory frameworks and legislation

- Input and review of Environmental Management Plans and Programmes, including Invasive Species Monitoring, Control and Eradication Plans
- Identification and assessment of potential environmental impacts and benefits
- Development of practical and achievable mitigation measures and management plans and evaluation of risk to project execution
- Experienced in environmental compliance advise, monitoring and reporting for construction projects
- Compilation and review of the reports in accordance with all relevant environmental legislation
- Public participation/involvement and stakeholder consultation
- Environmental strategy, policy and guidelines development
- Experienced in assessments for both linear developments and nodal developments
- Key experience in the assessment of impacts associated with renewable energy projects
- Wide range of experience for public and private sector projects
- Experienced consultant in projects in Sub-Saharan Africa.

EDUCATION AND PROFESSIONAL STATUS

Degrees:
- B.Sc Earth Sciences, majoring in Geography and Zoology, Rhodes University, Grahamstown, 1993
- B.Sc Honours in Geography (in Environmental Water Management), Rhodes University, Grahamstown, 1994. Major subjects included Water Resources Management, Streams Ecology, Fluvial Geomorphology and Geographic Information Systems.
- M.Sc in Geography (Geomorphology), Rhodes University, Grahamstown, 1996

Short Courses:

- Environmental and Social Risk Management (ESRM), International Finance Corporation, 2018
- Integrated Water Resource Management, the National Water Act, and Water Use Authorisations, CSBSS, 2017
- WindFarmer Wind Farm Design course, Garrad Hassan, 2009
- Environmental Law Course, Aldo Leopold Institute, 2002
- Water Quality Management, Potchefstroom University, 1998

Professional Society Affiliations:
- Registered with the South African Council for Natural Scientific Professions as a Professional Natural Scientist: Environmental Science (400106/99)
- Registered with the International Associated for Impact Assessment South Africa (IAIAsa): 5888

Other Relevant Skills:
- Xtrack Extreme – Advanced Off-Road Driving Course (2003)

EMPLOYMENT

Date	Company	Roles and Responsibilities
2006 - Current:	Savannah Environmental (Pty) Ltd	Director *Independent specialist environmental consultant, Environmental Assessment Practitioner (EAP) and advisor*
1997 – 2005:	Bohlweki Environmental (Pty) Ltd	Associate *Environmental Management Unit: Manager; Principle Environmental Scientist focussing on Environmental Management and Project Management*

PROJECT EXPERIENCE

Experience includes projects associated with electricity generation and transmission, wastewater treatment facilities, mining and prospecting activities, property development, and national roads, as well as strategy and guidelines development.

RENEWABLE POWER GENERATION PROJECTS: PHOTOVOLTAIC SOLAR ENERGY FACILITIES

Environmental Impact Assessments and Environmental Management Programmes

Project Name & Location	Client Name	Role
Aggeneys PV Plant, Northern Cape	Solar Capital	Project Manager & EAP
Blackwood PV SEF, Free State	VentuSA Energy	Project Manager & EAP
Bloemsmond PV 1 & PV 2 SEF's, Northern Cape	Atlantic Energy Partners	Project Manager & EAP
Bosjesmansberg PV SEF, Northern Cape	Networx	Project Manager & EAP
Boundary PV SEF, Northern Cape	VentuSA Energy	Project Manager & EAP
Buffels PV 1 & PV 2 SEF's, North West	Kabi Energy	Project Manager & EAP
De Aar PV SEF, Northern Cape	African Clean Energy Developments (ACED)	Project Manager & EAP
De Aar PV Solar Energy Plant, Northern Cape	Solar Capital	Project Manager & EAP
Gihon& Kison PV SEF's, Limpopo	Networx	Project Manager & EAP
Gunstfontein PV SEF, Northern Cape	Networx / Prana Energy	Project Manager & EAP
Harmony Eland, Nyala & Tshepong PV SEF's, Free State	BEEEntropie Renewable Innovation	Project Manager & EAP
Hibernia SEF, North West	EA Energy	Project Manager & EAP
Iziko PV SEF, Mpumalanga	VentuSA Energy	Project Manager & EAP
Kabi Kimberley PV Facility at DeBeers, Northern Cape	Kabi Solar	Project Manager & EAP
Karoo Renewables PV SEF, Northern Cape	SARGE	Project Manager & EAP
Kheis Phase 1, 2 & 3 PV SEF, Northern Cape	GeStamp Solar	Project Manager & EAP
Klipgat PV SEF, Northern Cape	Terra Solar	Project Manager & EAP
Loeriesfontein/Helios PV SEF, Northern Cape	Solar Capital	Project Manager & EAP
Naauwpoort PV SEF , Northern Cape	Terra Solar	Project Manager & EAP
Orkney PV SEF, North West	Genesis Eco-Energy	Project Manager & EAP
Pofadder SEF, Northern Cape	Mainstream Renewable	Project Manager & EAP
Prieska North PV SEF, Northern Cape	VentuSA Energy	Project Manager & EAP
Prieska PV SEF, Northern Cape	VentuSA Energy	Project Manager & EAP
Ritchie PV SEF, Northern Cape	Solar Capital	Project Manager & EAP
San Solar PV SEF, Northern Cape	VentuSA Energy	Project Manager & EAP
Sirius (Tungston Lodge) PV Solar Plants (x2, Northern Cape	Aurora Power Solutions	Project Manager & EAP
Sol Invictus x4 PV Developments, Northern Cape	Building Energy	Project Manager & EAP
Solar Plant at Kathu (Wincanton), Northern Cape	REISA	Project Manager & EAP
Solar Plant at Sishen (Wincanton), Northern Cape	VentuSA Energy	Project Manager & EAP
Solar Plant at Sishen (Wincanton), Northern Cape	*VentuSA Energy*	Project Manager & EAP
SolarReserve Kotulo Tsatsi PV1 SEF, Northern Cape	*Kotulo Tsatsi Energy and SolarReserve South Africa*	Project Manager & EAP
SolarReserve Kotulo Tsatsi PV2 Facility, Northern Cape province	*Kotulo Tsatsi Energy and SolarReserve South Africa*	Project Manager & EAP
Stormberg Solar PV SEF, Eastern Cape	Networx / Prana Energy	Project Manager & EAP
Tewa Isitha (Grootdrink/Albany) PV SEF, Northern Cape	Africoast Engineers	Project Manager & EAP

Project Name & Location	Client Name	Role
Tiger Kloof PV SEF near Vryburg, North West	Kabi Energy	Project Manager & EAP
Tiger Solar PV SEF, Northern Cape	Kabi Energy	Project Manager & EAP
Vaalkop and Witkop PV SEF's, North West	Kabi Solar	Project Manager & EAP
Wagnbietjiespan PV SEF, Free State	VentuSA	Project Manager & EAP
Wolmaransstad Municipality PV SEF, North West	BlueWave	Project Manager & EAP
Woodhouse PV 1 & PV 2 SEF's, North West	Genesis Eco-Energy	Project Manager & EAP
Zuurwater PV SEF's (x4), Northern Cape	Solafrica / BlueWave	Project Manager & EAP
Three PV SEF facilities in Lichtenburg, North West	Atlantic Energy Partners	Project Manager & EAP

Basic Assessments

Project Name & Location	Client Name	Role
Amandla Welanga & Dida PV SEF's near Noupoort, Northern Cape	Terra Solar	Project Manager & EAP
Carolusberg PV SEF, Northern Cape	Ilio Energy (SARGE)	Project Manager & EAP
Gosforth Park and Kynoch Rooftop PV SEF's Northern Cape	Building Energy	Project Manager & EAP
Hennenman PV SEF, Free State	BlueWave	Project Manager & EAP
Hibernia PV SEF near Lichtenburg, North West	EA Energy	Project Manager & EAP
Inkulukelo PV SEF, Northern Cape	Terra Solar	Project Manager & EAP
Kabi Kimberley PV SEF, Northern Cape	Kabi Energy	Project Manager & EAP
Kokerboom & Boabab PV Solar Energy Plants, Northern Cape	Brax Energy	Project Manager & EAP
Middelburg PV SEF, Mpumalanga	African Clean Energy Developments (ACED)	Project Manager & EAP
Nigramoep PV Solar Energy Plant, Northern Cape	SARGE	Project Manager & EAP
Noupoort (Kleinfontein and Toitdale) CPV, Northern Cape	Terra Power	Project Manager & EAP
O'Kiep 1 PV Solar Energy Plant, Northern Cape	Ilio Energy (SARGE)	Project Manager & EAP
O'Kiep 2 PV Solar Energy Plant, Northern Cape	BluePort Trade 118 (SARGE)	Project Manager & EAP
O'Kiep 3 PV Solar Energy Plant, Northern Cape	Ilio Energy (SARGE)	Project Manager & EAP
Rodicon PV SEF, Mpumalanga	VentuSA Energy	
Slurry PV SEF, North West	PPC	Project Manager & EAP
Small projects for PV SEF's, North West	BlueWave	Project Manager & EAP
Son Sitrus Rooftop PV Installation, Eastern Cape	Building Energy	Project Manager & EAP
Tollie PV SEF, Northern Cape	Terra Solar	Project Manager & EAP
x2 Southern Farms PV Solar Energy Plants, Northern Cape	Southern Farms	Project Manager & EAP

Screening Studies

Project Name & Location	Client Name	Role
Allemans, Wonderheuwel, Damfontein & Dida PV SEF's, Northern Cape	Terra Solar	Project Manager & EAP
Amandla Welang, Gillmer & Inkululeko PV SEF's, Northern Cape	GeoSolar/ TerraSolar	Project Manager & EAP
Blouputs PV, Onseepkans PV, Hoogelegen PV & Boegoeberg PV projects, Northern Cape	Engineering Development Industrial Projects (EDIP)	Project Manager & EAP
Bobididi PV SEF, Limpopo	Root 60Four Energy	Project Manager & EAP
Boshof-Les Marais / Buitenfontein SEF, Free State	Bluewave Capital	Project Manager & EAP
Bosjesmansberg PV SEF, Northern Cape	Networx	Project Manager & EAP

Project Name & Location	Client Name	Role
Class 2 & Class 3 Road Networks in the vicinity of the proposed Tambo Springs Freight Hub, Gauteng	SMEC South Africa (on behalf of Gauteng Department of Roads & Transport)	Project Manager & EAP
Hibernia SEF, North West	EA Energy	Project Manager & EAP
Lephalale PV SEF, Limpopo	Exxaro	Project Manager & EAP
Prieska PV SEF, Northern Cape	Terra SOlar	Project Manager & EAP
Proposed Solar Project near Hotazel, Northern Cape province	ABO Wind	Project Manager & EAP
Proposed Solar Project near Beaufort West, Western Cape	ABO Wind	Project Manager & EAP
Proposed Solar Project near Lichtenburg, North West province	ABO Wind	Project Manager & EAP
PV SEF's (x15) for the projects for the REIPP small scale BID, Nationwide	Building Energy	Project Manager & EAP
Senekal 1 & 2, Pongola & Newcastle PV SEF's, Kwa-Zulu-Natal	Building Energy	Project Manager & EAP
Small scale PV SEF project - 2nd Stage One	Bluewave Capital	Project Manager & EAP
Small scale PV SEF project - 2nd Stage One	Building Energy	Project Manager & EAP
Stella Helpmekaar SEF, North West	Bluewave Capital	Project Manager & EAP
Wolmaransstad Municipality SEF, North West	Bluewave Capital	Project Manager & EAP
Solar Project near Beaufort West, Western Cape	ABO Wind	Project Manager & EAP
Solar Project near Lichtenburg, Western Cape	ABO Wind	Project Manager & EAP
Solar Project near Hotazel, Western Cape	ABO Wind	Project Manager & EAP

Environmental Compliance, Auditing and ECO

Project Name & Location	Client Name	Role
ECO for the Contraction of the De Aar & Prieska PV Facilities, Northern Cape	GeStamp	Project Manager
ECO for the Construction of the Kathu PV Facility, Northern Cape	REISA / Building Energy	Project Manager

Compliance Advice and ESAP Reporting

Project Name & Location	Client Name	Role
ACWA Power SolarReserve Redstone Solar Plant, Northern Cape	SolarReserve	Environmental Advisor
Bokpoort PV SEF, Northern Cape	Solafrica	Environmental Advisor
Boshof PV SEF, Free State	BlueWave	Environmental Advisor
Hennenman PV SEF, Free State	BlueWave	Environmental Advisor
Kathu II SEF, Northern Cape	Building Energy	Environmental Advisor
Kathu PV SEF, Northern Cape	Building Energy / REISA	Environmental Advisor
Prieska PV SEF, Northern Cape	VentuSA	Environmental Advisor
San Solar SEF, Northern Cape	VentuSA / Acciona	Environmental Advisor
Sishen PV SEF Phase 1, Northern Cape	Aveng / Acciona	Environmental Advisor
Wolmaransstad Municipality Solar PV SEF, North West	BlueWave	Environmental Advisor
ESAP reporting for the opertaion phase of the Mulilo Solar PV De Aar and Mililo Solar PV Prieska	Mulilo and X-Elio	Environmental Advisor

Due Diligence Reporting

Project Name & Location	Client Name	Role
Kabi Kimberley PV Plant, Northern Cape	Enertis Solar	Environmental Advisor

Project Name & Location	Client Name	Role
Sishen Solar Farm, Northern Cape	Acciona (Windfall 59 Properties)	Environmental Advisor
Vaal River Solar 1 PV plant, North West	Enertis Solar	Environmental Advisor

Environmental Permitting & Water Use License (WUL) Applications

Project Name & Location	Client Name	Role
Permitting for the Kathu PV SEF, Northern Cape	Abengoa Solar	Project Manager & EAP
S53 application for Kabi Kimberley De Beers PV Plant, Northern Cape	Kabi Energy	Project Manager & EAP
S53 application for the Blackwood PV SEF, Free State	VentuSA Energy	Project Manager & EAP
S53 application for the Boundary PV SEF, Northern Cape	VentuSA Energy	Project Manager & EAP
S53 application for Vaalkop & Witkop PV SEF's, North West	Kabi Energy	Project Manager & EAP
S53 applications for various projects (Amandla Welang, Didar, Inkululeko, Kleinfontein, Klip Gat, Naau Poort, Toitdale & Tollie PV SEF's), Northern Cape	Terra Solar	Project Manager & EAP
WUL application for the Woodhouse PV1 & PV2 SEF's, North West	Genesis Eco-Energy	Project Manager & EAP

RENEWABLE POWER GENERATION PROJECTS: CONCENTRATED SOLAR FACILITIES (CSP)

Environmental Impact Assessments and Environmental Management Programmes

Project Name & Location	Client Name	Role
De Aar CSP Energy facility, Northern Cape	African Clean Energy Developments (ACED)	Project Manager & EAP
Khi Solar One CSP facility, Northern Cape	Abengoa Solar	Project Manager & EAP
Noupoort CSP facility, Northern Cape	Cresco	Project Manager & EAP
Paulputs CSP facility, Northern Cape	Abengoa Solar	Project Manager & EAP
Pofadder & Upington CSP facilities, Northern Cape	Abengoa Solar	Project Manager & EAP
SolarReserve Kotulo Tsatsi CSP facility, Northern Cape province	SolarReserve	Project Manager & EAP
SolarReserve Kotulo Tsatsi CSP1 facility, Northern Cape	Kotulo Tsatsi Energy and SolarReserve South Africa	Project Manager & EAP
SolarReserve Kotulo Tsatsi CSP2 facility, Northern Cape	Kotulo Tsatsi Energy and SolarReserve South Africa	Project Manager & EAP
SolarReserve Kotulo Tsatsi CSP3 facility, Northern Cape	Kotulo Tsatsi Energy and SolarReserve South Africa	Project Manager & EAP
Upington 2 CSP facility, Northern Cape	Abengoa Solar	Project Manager & EAP
Upington 3 CSP facility, Northern Cape	Abengoa Solar	Project Manager & EAP
Xina Solar One CSP facility, Northern Cape	Abengoa Solar	Project Manager & EAP

Environmental Compliance, Auditing and ECO

Project Name & Location	Client Name	Role
KaXu Solar One facility, Northern Cape	Abengoa Solar	Project Manager
Khi Solar One facility, Northern Cape	Abengoa Solar	Project Manager
Xina Solar One facility, Northern Cape	Abengoa Solar	Project Manager

Screening Studies

Project Name & Location	Client Name	Role
Site Identification Tool for Proposed CSP Projects, Limpopo	Exxaro	Environmental Advisor

Compliance Advice and ESAP reporting

Project Name & Location	Client Name	Role
Kaxu Solar One CSP facility, Northern Cape	*Abengoa Solar*	Environmental Advisor
Khi Solar One CSP facility, Northern Cape	*Abengoa Solar*	Environmental Advisor
SolarReserve Kotulo Tsatsi CSP facility, Northern Cape province	SolarReserve	Environmental Advisor
Xina One CSP facility, Northern Cape	Abengoa Solar	Environmental Advisor

RENEWABLE POWER GENERATION PROJECTS: WIND ENERGY FACILITIES

Environmental Impact Assessments and Environmental Management Programmes

Project Name & Location	Client Name	Role
ABs WEF near Indwe, Eastern Cape	Rainmaker Energy	Project Manager & EAP
Amakhala Emoyeni WEF, Eastern Cape	Windlab Developments	Project Manager & EAP
Amatole (2 phases) WEF, Eastern Cape	Genesis ECO-Energy	Project Manager & EAP
Boulders Wind Farm, Western Cape	IPD Power	Project Manager & EAP
Britannia Bay WEF, Western Cape	Terra Power Solutions	Project Manager & EAP
Castle WEF in De Aar, Northern Cape	Juwi Renewable Energies	Project Manager & EAP
Cookhouse WEF, Eastern Cape	African Clean Energy Developments (ACED) & Tertia Waters	Project Manager & EAP
Deep River Wind Energy Facility, Eastern Cape	VentuSA Energy	Project Manager & EAP
Dorper Phase 1 WEF, Eastern Cape	Rainmaker Energy	Project Manager & EAP
Elliot WEF, Eastern Cape	Rainmaker Energy	Project Manager & EAP
Garob WEF, Northern Cape	Juwi Renewable Energies	Project Manager & EAP
Gouda WEF, Western Cape	VentuSA Energy	Project Manager & EAP
Great Karoo WEF, Northern Cape	African Clean Energy Developments (ACED)	Project Manager & EAP
Gunstfontein WEF, Northern Cape	African Clean Energy Developments (ACED)	Project Manager & EAP
Happy Valley WEF, Eastern Cape	REISA	Project Manager & EAP
Hidden Valley WEF, Northern Cape	African Clean Energy Developments (ACED)	Project Manager & EAP
Hopefield WEF, Western Cape	Umoya Energy	Project Manager & EAP
Karoo Renewable Energy Facility, Northern & Western Cape	SARGE	Project Manager & EAP
Karreebosch Wind Farm (Roggeveld Phase 2), Northern Cape & Western Cape	G7 Renewable Energies	Project Manager & EAP
Karusa Wind Farm, Northern Cape	African Clean Energy Development	Project Manager & EAP
Klipheuwel / Dassiesfontein WEF, Western Cape	BioTherm Energy	Project Manager & EAP
Nojoli WEF , Eastern Cape	African Clean Energy Developments	Project Manager & EAP
Nxuba WEF , Eastern Cape	African Clean Energy Developments	Project Manager & EAP
Olifants River WEF, Western Cape	SARGE	Project Manager & EAP

Project Name & Location	Client Name	Role
Oyster Bay WEF, Eastern Cape	RES	Environmental Advisor
Pofadder x3 WEF's, Northern Cape	Mainstream Renewable	Project Manager & EAP
Project Blue WEF, Northern Cape	Windy World	Project Manager & EAP
Rheboksfontein WEF, Western Cape	Moyeng Energy	Project Manager & EAP
Riverbank WEF near Wesley, Eastern Cape	Just Energy	Project Manager & EAP
Sere WEF, Western Cape	Eskom Generation	Project Manager & EAP
Soetwater Wind Farm, Northern Cape	African Clean Energy Development	Project Manager & EAP
Springfontein WEF, Northern Cape	Mainstream Renewable	Project Manager & EAP
Stormberg WEF, Eastern Cape	Networx / Prana Energy	Project Manager & EAP
Suurplaat WEF, Western & Northern Cape	Moyneg Energy	Project Manager & EAP
Uiekraal WEF, Western Cape	Crenersol	Project Manager & EAP
West Coast One WEF, Western Cape	Moyeng Energy	Project Manager & EAP
West Coast WEF, Western Cape	Exxaro	Project Manager & EAP
Zen WEF near Gouda, Western Cape	VentuSA Energy	Project Manager & EAP

Basic Assessments

Project Name & Location	Client Name	Role
Britannia Bay Wind Monitoring Mast, Western Cape	Terra Power Solutions	Project Manager & EAP
Caledon, Worcester & Tulbach Wind Monitoring Masts, Western Cape	SAGIT	Project Manager & EAP
Deep River Wind monitoring Mast, Eastern Cape	VentuSA Energy	Project Manager & EAP
Denhami Wind Farm, Western Cape	Richard Young	Project Manager & EAP
Dorper, Abs & Dobos Wind Monitoring Masts, Eastern Cape	Rainmaker Energy	Project Manager & EAP
Hopefield Wind Monitoring Mast, Western Cape	Umoya Energy	Project Manager & EAP
Klawer Wind Energy Facility, Western Cape	Vendiwell	Project Manager & EAP
Klipheuwel / Dassiesfontein Wind Monitoring Mast, Western Cape	BioTherm Energy	Project Manager & EAP
Riverbank Wind Monitoring Mast, Eastern Cape	Just Energy	Project Manager & EAP
Wind Monitoring Masts near Suurplaat, Western Cape	Investec Bank	Project Manager & EAP
Wind Monitoring Masts on the West Coast & Darling, Western Cape	Investec Bank	Project Manager & EAP

Screening Studies

Project Name & Location	Client Name	Role
Cookhouse WEF, Eastern Cape	African Clean Energy Developments (ACED)	Project Manager & EAP
De Aar WEF, Northern Cape	African Clean Energy Developments (ACED)	Project Manager & EAP
Developments within identified areas in the Overberg, Western Cape	BioTherm Energy	Project Manager & EAP
Hopefield WEF, Western Cape	African Clean Energy Developments (ACED)	Project Manager & EAP
Juno WEF, Western Cape	AMDA Developments	Project Manager & EAP
Lambert's Bat WEF, Western Cape	Vaayu Energy SA	Project Manager & EAP
Prospect Sites for various WEF's	Thabo Consulting (on behalf of Eskom Holdings)	Project Manager & EAP
Struis Baai area WEF, Western Cape	Richards Young	Project Manager & EAP
Suurplat WEF, Western Cape	Investec Bank	Project Manager & EAP
Theewaterskloof Municipality WEF, Western Cape	Theewaterskloof Municipality	Project Manager & EAP

Project Name & Location	Client Name	Role
WEF's on x2 site on the West Coast, Western Cape	Investec Bank	Project Manager & EAP
Various WEF's in the Western Cape	Department of Environmental Affairs & Development Planning (DEA&DP)	Project Manager & EAP
Van Reenens WEF, Kwa-Zulu Natal & Free State	4GREEN Development Africa	Project Manager & EAP
WEF Development within the Sandveld area, Western Cape	Kovacs Investments (Nick Prium)	Project Manager & EAP

Environmental Compliance, Auditing and ECO

Project Name & Location	Client Name	Role
ECO for the Construction of the Dorper Phase 1 WEF, Eastern Cape	Rainmaker Energy	Project Manager
ECO for the Construction of the Gouda Wind Farm, Western Cape	Blue Falcon Trading	Project Manager
EO for the Construction of the Dassiesklip WEF, Western Cape	Group Five	Project Manager

Compliance Advice & ESAP Reporting

Project Name & Location	Client Name	Role
Amakhala Emoyeni WEF, Eastern Cape	Windlab Developments	Environmental Advisor
Cookhouse II WEF, Eastern Cape	African Clean Energy Developments	Environmental Advisor
Cookhouse WEF, Eastern Cape	African Clean Energy Developments	Environmental Advisor
Dorper Phase 1 WEF, Eastern Cape	Rainmaker Energy	Environmental Advisor
Garob WEF, Northern Cape	Juwi Renewable Energies	Environmental Advisor
Gouda WEF, Western Cape	Aveng / Acciona	Environmental Advisor
Happy Valley WEF, Eastern Cape	VentuSA Energy / EDPR	Environmental Advisor
Hidden Valley WEF, Northern Cape	African Clean Energy Developments (ACED)	Environmental Advisor
Hopefield WEF, Western Cape	Umoya Energy	Environmental Advisor
Karusa Wind Farm, Northern Cape	African Clean Energy Development	Environmental Advisor
Loperberg WEF, Eastern Cape	Rainmaker Energy	Environmental Advisor
Nobelsfontein WEF, Northern Cape	Coria / SARGE	Environmental Advisor
Nojoli WEF , Eastern Cape	African Clean Energy Developments (ACED)	Environmental Advisor
Nxuba WEF , Eastern Cape	African Clean Energy Developments	Environmental Advisor
Oyster Bay WEF, Eastern Cape	RES	Environmental Advisor
Riverbank Wind WEF, Eastern Cape	InnoWind	Environmental Advisor
Roggeveld Phase 1 WEF, Northern Cape	Building Energy	Environmental Advisor
Soetwater Wind Farm, Northern Cape	African Clean Energy Development	Environmental Advisor
Springfontein WEF, Northern Cape	Mainstream Renewable	Environmental Advisor
Zen WEF, Western Cape	VentuSA Energy	Environmental Advisor

Due Diligence Reporting

Project Name & Location	Client Name	Role
Gouda WEF, Western Cape	Blue Falcon Trading	Environmental Advisor

Project Name & Location	Client Name	Role
Loeriesfontein, Khobab & Noupoort WEF's, Northern Cape	Actis	Environmental Advisor
Roggeveld Wind Farm, Northern Cape	Building Energy	Environmental Advisor

Environmental Permitting & WUL Applications

Project Name & Location	Client Name	Role
Permitting for the Cookhouse WEF, Eastern Cape	African Clean Energy Developments (ACED)	Project Manager & EAP
Permitting for the Karusa Wind Farm, Northern Cape	African Clean Energy Development	Project Manager & EAP
Permitting for the Sere WEF, Western Cape	Eskom	Project Manager & EAP
Permitting for the Soetwater Wind Farm, Northern Cape	African Clean Energy Development	Project Manager & EAP
Permitting Riverbank WEF, Eastern Cape	Electrawinds	Project Manager & EAP
S24G for the Klipheuwel / Dassiesfontein WEF, Western Cape		Project Manager & EAP
S53 application for the Nxuba Wind Farm, Eastern Cape	African Clean Energy Developments (ACED)	Project Manager & EAP
S53 Application for the Zen WEF, Western Cape	VentuSA Energy	Project Manager & EAP
WUL application for the Oyster Bay WEF, Eastern Cape	RES	Project Manager & EAP

<u>CONVENTIONAL POWER GENERATION PROJECTS (COAL)</u>

Environmental Impact Assessments and Environmental Management Programmes

Project Name & Location	Client Name	Role
H2 Energy Power Station, Mpumalanga	H2 Energy	Project Manager & EAP

Screening Studies

Project Name & Location	Client Name	Role
Coal fired power station in the Bethal area, Mpumalanga	ISS Global	Project Manager & EAP
Indwe Power Station, Eastern Cape	IPSA	Project Manager & EAP
IPP Base Load Power Station Development in Lephalale, Limpopo	Exxaro	Project Manager & EAP

Environmental Compliance, Auditing and ECO

Project Name & Location	Client Name	Role
ISO 14001:2015 Audit for the Hendrina Power Station, Mpumalanga	Eskom Holdings	Project Manager

<u>CONVENTIONAL POWER GENERATION PROJECTS (GAS)</u>

Environmental Impact Assessments and Environmental Management Programmes

Project Name & Location	Client Name	Role
Ankerlig OCGT to CCGT Conversion project & the Transmission Power Line between Ankerlig and the Omega Substation, Western Cape	Eskom Generation	Project Manager & EAP
Gourikwa OCGT to CCGT Conversion project & the Transmission Power Line between Gourikwa and the Proteus Substation, Western Cape	Eskom Generation	Project Manager & EAP

Neopak Combined Heat and Power (CHP) Plant, Rosslyn, Gauteng	Neopak	Project Manager & EAP
Richards Bay Combined Cycle Gas Turbine (CCGT) Power Plant, Kwa-Zulu Natal	Eskom	Project Manager & EAP

Screening Studies

Project Name & Location	Client Name	Role
Environmental Analysis for gas transmission pipelines in the Clayville, Nigel, and Wadeville areas, Gauteng	Eskom Holdings	Project Manager

GRID INFRASTRUCTURE PROJECTS

Environmental Impact Assessments and Environmental Management Programmes

Project Name & Location	Client Name	Role
Kyalami/Midrand Substation and 3 Transmission Lines, Gauteng	Eskom Transmission	Project Manager & EAP
Steelpoort Integration Project, Limpopo	Eskom Transmission	Project Manager & EAP

Basic Assessments

Project Name & Location	Client Name	Role
Amakhala Emoyeni Power Line & Kopleegte Substation, Eastern Cape	Cennergi	Project Manager & EAP
Bon Espirange Substation & Overhead Power Line for the Roggeveld Wind Farm, Northern Cape	Building Energy (G7 Renewable Energies)	Project Manager & EAP
Castle WEF Powerline, Northern Cape	Juwi Renewable Energies	Project Manager & EAP
Cuprum-Burchell; Burchell-Mooidraai Power Line, Nothern Cape	Eskom	Project Manager & EAP
Expansion of the Komsberg Main Transmission Substation, Northern Cape	Enel Green Power	Project Manager & EAP
Garob-Kronos Power Line, Northern Cape	Juwi Renewable Energies	Project Manager & EAP
Golden Valley Dx-Poseidon Power Line Substation & Golden Valley-Kopleegte Power Line, Eastern Cape	BioTherm Energy	Project Manager & EAP
Gunstfontein Switching Station, Power Line & Ancillary Infrastructure, Northern Cape	African Clean Energy Developments (ACED)	Project Manager & EAP
Ilanga Lethemba-Hydra, Northern Cape	Solar Capital	Project Manager & EAP
Iziduli Emoyeni WEF on-site substation, Power Line & Switching station, Access Roads & Watercourse Crossings, Eastern Cape	Windlab	Project Manager & EAP
Khai-Ma WEF Power Line, Northern Cape	Mainstream Renewable	Project Manager & EAP
Korana WEF Power Line, Northern Cape	Mainstream Renewable	Project Manager & EAP
Korana SEF Power Line, Northern Cape	Mainstream Renewable	Project Manager & EAP
Nobelsfontein WEF Power Line & Substation, Northern Cape	Coria / SARGE	Project Manager & EAP
Nojoli WEF Substation & Power Line Grid Connection, Eastern Cape	African Clean Energy Developments (ACED)	Project Manager & EAP
Olifantshoek Substation & Powerline, Northern Cape	Eskom Holdings	Project Manager & EAP
Poortjies WEF Power Line, Northern Cape	Mainstream Renewable	Project Manager & EAP
Power Line & Substation for the Blackwood WEF, Northern Cape	VentuSA Energy	Project Manager & EAP

Power Line & Substation for the Khobab WEF in Loeriesfontein, Northern Cape	Mainstream Renewable	Project Manager & EAP
Power Line Connecting the Sishen SEF to the Ferrum MTS-UMTU Klip Kop Power Line, Northern Cape	Acciona (Windfall 59 Properties)	Project Manager & EAP
Power Line for the Grid Connection of the 2 SEF's near Kath and Dibeng, Northern Cape	VentuSA Energy	Project Manager & EAP
Power Line for the Rheboksfontein WEF, Western Cape	Moyeng Energy	Project Manager & EAP
Power Line from Aggeneys Solar One to Aggeneis MTS Substation, Northern Cape	BlueWave	Project Manager & EAP
Re-alignment of 3 Eskom Power Line Servitudes within the Hopefield WEF, Western Cape	Umoya Energy	Project Manager & EAP
Re-alignment of the Power Line & Watercourse Crossings for the Loeriesfontein 2 WEF, Northern Cape	Mainstream Renewable	Project Manager & EAP
Re-alignment of the Power Line from Loeriesfontein 1 WEF to the Helios Substation, Northern Cape	Mainstream Renewable	Project Manager & EAP
Re-alignment of the Power Line from Loeriesfontein 3 WEF to the Helios Substation, Northern Cape	Mainstream Renewable	Project Manager & EAP
Substation for the Aggeneys PV SEF, Northern Cape	BioTherm Energy	Project Manager & EAP
Substation, Power Line & Watercourse Crossings for the Springfontein WEF, Free State	Mainstream Renewable	Project Manager & EAP
Wesley-Peddie (Riverbank Phase 2) Power Line for the Uncedo Lwethu WEF, Eastern Cape	Just Energy	Project Manager & EAP

Environmental Compliance, Auditing and ECO

Project Name & Location	Client Name	Role
EO for the construction of the Neptune-Vuyani Transmission Line, Western Cape	Trans-Africa Projects on behalf of Eskom	Project Manager

<u>INFRASTRUCTURE DEVELOPMENT PROJECTS (BRIDGES, PIPELINES, ROADS, WATER RESOURCES, STORAGE, ETC)</u>

Environmental Impact Assessments and Environmental Management Programmes

Project Name & Location	Client Name	Role
Afguns Road Realignment Project, Limpopo	Eskom Holdings	Project Manager & EAP
Expansion of the existing Welgedacht Water Care Works, Gauteng	ERWAT	Project Manager & EAP
Industrial Metals Cluster, Northern Cape	Northern Cape Department of Economic Development and Tourism	Project Manager & EAP
Modification of the existing Hartebeestfontein Water Care Works, Gauteng	ERWAT	Project Manager & EAP

Basic Assessments

Project Name & Location	Client Name	Role
New Raw Water Reservoir & Pipeline for the Medupi Power Station, Limpopo	Eskom Holdings	Project Manager & EAP
Msenge Emoyeni WEF Watercourse Crossings, Eastern Cape	Windlab	Project Manager & EAP
Dilokong Transport Facility, Limpopo	South African National Roads Agency Limited (SANRAL)	Project Manager & EAP
Neopak Water Tratment Plant, Gauteng	Neopak	Project Manager & EAP

Project Name & Location	Client Name	Role
Realignment of MR73 Road for the Construction of the Paulputs CSP Facility, Northern Cape	Abengoa Solar	Project Manager & EAP
Biomass Storage Area in Support of the Mkuze Biomass Power Station, KwaZulu-Natal	Building Energy	Project Manager & EAP
Wastewater Dam & Pipeline in Support of the Mkuze Biomass Power Station, Kwa-Zulu Natal	Building Energy	Project Manager & EAP
Watercourse Crossings for the Klawer Wind Energy Facility, Western Cape	Vendiwell	Project Manager & EAP

Environmental Compliance, Auditing and ECO

Project Name & Location	Client Name	Role
ECO for the Construction of the Tiffindell Ski Resort, Eastern Cape	Tiffindell Ski	ECO
ECO for the Distribution centre & warehouse at Lords View Industrial Estate, Gauteng	Oliver & Partners	Project Manager
ECO for the Upgrade of the Waterval Wastewater Treatment Works, Gauteng	BCP Palace (on behalf of ERWAT)	Project Manager

Compliance Advice and reporting

Project Name & Location	Client Name	Role
Mkuze Biomass Plant, Kwa-Zulu Natal	Building Energy	Environmental Advisor
Tiffindell Ski, Eastern Cape	Tiffindell Ski	Environmental Advisor

Environmental Permitting & WUL Applications

Project Name & Location	Client Name	Role
Permitting, S53 & WULA for the Mkuze Biomass Plant, Kwa-Zulu Natal	Building Energy	Project Manager & EAP
WULA for the Visserhok Waste Tyre Depot, Western Cape	REDISA	Project Manager & EAP
WULA for the Witbank Waste Tyre Depot, Mpumalanga	REDISA	Project Manager & EAP

MINING

Environmental Compliance, Auditing and ECO

Project Name & Location	Client Name	Role
Compliance Audit for the Palesa Coal Mine WML, Mpumalanga province	HCI Coal	Project Manager
Compliance Audit Waste Use Licene for the Mbali Coal Mine, Mpumalanga province	HCI Coal	Project Manager

ENVIRONMENTAL MANAGEMENT TOOLS

Project Name & Location	Client Name	Role
Review the effectiveness *& efficiency of the environmental impact management (EIA) system in South Africa, and formulate an environmental impact management strategy and action plan	National Department of Environmental Affairs	Environmental Advisor
Drafting a Position Paper: Project Financing and Environmental Risk Management (considering IFC	Standard Bank Group	Environmental Advisor

1st Floor, Block 2, 5 Woodlands Drive Office Park
Woodlands Drive, Woodmead
Johannesburg, South Africa

Email: thalita@savannahsa.com
Tel: +27 (11) 656 3237

CURRICULUM VITAE OF THALITA BOTHA

Profession:	Environmental Assessment Practitioner (EAP)
Specialisation:	Environmental Assessments, Report writing, report reviewing, Geographical Information Systems (GIS), development of project proposals for procuring new projects, project administration
Work Experience:	3 and a half years' experience in Environmental Assessments and GIS

VOCATIONAL EXPERIENCE

Professional execution of consulting services for projects in the environmental management field, specialising in Environmental Impact Assessment studies, environmental permitting, public participation, compilation of Environmental Management Plans and Programmes, environmental policy, and integrated environmental management. Responsibilities include report writing, analysis and the manipulation of geographical and technical experience with the use of ArcGIS, project management, review of specialist studies and the identification and assessment of potential negative environmental impacts and benefits. Compilation of the reports for environmental studies is in accordance with all relevant environmental legislation.

Experience in conducting environmental impact assessments for Concentrated Solar Power (CSP) Projects, Wind Energy Projects and grid infrastructure projects as well as infrastructure projects. Recent projects have been undertaken for both the public- and private-sector, including electricity generation and transmission projects (wind and solar), linear developments (such local roads and power lines), as well as general environmental planning, development and management. The completion of a diverse set of environmental management studies has resulted in a good working knowledge of environmental legislation and policy requirements.

SKILLS BASE AND CORE COMPETENCIES

- Compilation of environmental impact assessment reports and environmental management programmes in accordance with relevant environmental legislative requirements;
- Analysis and manipulation of geographical information and data and technical experience with the use of ArcGIS;
- Identification and assessment of potential negative environmental impacts and benefits through the review of specialist studies;
- Public participation/involvement and stakeholder consultation;
- Identification of practical and achievable mitigation measures and the compilation of appropriate management plans; and
- Key experience in the assessment of impacts associated with renewable energy and large infrastructure projects.

EDUCATION AND PROFESSIONAL STATUS

Degrees:

- B.Sc. (Hons.) Environmental Management (2014), North-West University, Potchefstroom
- B.Sc. Environmental- and Biological Science (2013), North–West University, Potchefstroom

Courses:

- Integrated Water Resources Management, the National Water Act and Water Use Authorisations (2017), Carin Bosman Sustainable Solutions

EMPLOYMENT

Date	Company	Roles and Responsibilities
September 2015 - Current	Savannah Environmental (Pty) Ltd	Environmental Assessment Practitioner *Tasks include: Compilation of Environmental Impact Assessment (EIA) reports; Basic Assessment (BA) reports and Environmental Management Programmes; Environmental Screening reports; Co-ordination of the public participation process; Project management; project proposals and tenders; Client liaison and Marketing; Process EIA Applications.* GIS (utilising ArcGIS), *Tasks include: Analysis and manipulation of data, screening assessments; compilation of maps.*

PROJECT EXPERIENCE

<u>Renewable Power Generation Projects: Solar Energy Facilities</u>

Basic Assessments and Environmental Management Programmes

Project Name & Location	Client Name	Role
Thaba Eco Hotel SEF, Gauteng	*Camco Clean Energy*	*EAP*
Moeding Solar PV Facility, North West Province	*Moeding Solar*	*EAP*

Environmental Impact Assessments and Environmental Management Programmes

Project Name & Location	Client Name	Role
Hyperion Solar Development 1, Northern Cape Province	*Hyperion Solar Development 1*	*EAP*
Hyperion Solar Development 2, Northern Cape Province	*Cyraguard*	*EAP*
Hyperion Solar Development 3, Northern Cape Province	*Nomispark*	*EAP*
Hyperion Solar Development 4, Northern Cape Province	*Nomispan*	*EAP*
Allepad PV One, Northern Cape Province	*ILEnergy Development*	*EAP*

Allepad PV Two, Northern Cape Province	*ILEnergy Development*	*EAP*
Allepad PV Three, Northern Cape Province	*ILEnergy Development*	*EAP*
Allepad PV Four, Northern Cape Province	*ILEnergy Development*	*EAP*

Screening Studies

Project Name & Location	Client Name	Role
Pre-feasibility desktop screening and fatal flaw analysis for a solar PV project near Hotazel, Northern Cape Province	*ABO Wind*	*EAP*
Pre-feasibility desktop screening and fatal flaw analysis for a solar PV project near Vryburg, North West Province	*ABO Wind*	*EAP*

Geographical Information Systems (GIS)

Project Name & Location	Client Name	Role
Sol Invictus PV 1, Aggeneys, Northern Cape	*Cyraclox*	*GIS*
Sol Invictus PV 2, Aggeneys, Northern Cape	*Cyracraft*	*GIS*
Sol Invictus PV 3, Aggeneys, Northern Cape	*Cyrafusion*	*GIS*
Sol Invictus PV 4, Aggeneys, Northern Cape	*Cyralex*	*GIS*
Pre-feasibility desktop screening and fatal flaw analysis for a solar PV project near Hotazel, Northern Cape Province	*ABO Wind*	*GIS*
Pre-feasibility desktop screening and fatal flaw analysis for a solar PV project near Aggeneys, North West Province	*ABO Wind*	*GIS*
Moeding Solar PV Facility, North West Province	*Moeding Solar*	*GIS*
Hyperion Solar Development 1, Northern Cape Province	*Hyperion Solar Development 1*	*GIS*
Hyperion Solar Development 2, Northern Cape Province	*Cyraguard*	*GIS*
Hyperion Solar Development 3, Northern Cape Province	*Nomispark*	*GIS*
Hyperion Solar Development 4, Northern Cape Province	*Nomispan*	*GIS*
Allepad PV One, Northern Cape Province	*ILEnergy Development*	*GIS*
Allepad PV Two, Northern Cape Province	*ILEnergy Development*	*GIS*
Allepad PV Three, Northern Cape Province	*ILEnergy Development*	*GIS*
Allepad PV Four, Northern Cape Province	*ILEnergy Development*	*GIS*

<u>Renewable power generation projects: Wind Energy Facilities</u>

Environmental Impact Assessments and Environmental Management Programmes

Project Name & Location	Client Name	Role
Hartebeest WEF, Moorreesburg, Western Cape	*Hartebeest Wind Farm*	*EAP*

Environmental Permitting & WUL Applications

Project Name & Location	Client Name	Role
Karusa WEF WUL Application, Northern Cape	*ACED*	*EAP*
Soetwater WEF WUL Application, Northern Cape	*ACED*	*EAP*

Geographical Information Systems (GIS)

Project Name & Location	Client Name	Role
Hartebeest WEF, Moorreesburg, Western Cape	*Hartebeest Wind Farm*	*GIS*
Karusa WEF WUL Application, Northern Cape	*ACED*	*GIS*
Soetwater WEF WUL Application, Northern Cape	*ACED*	*GIS*

Renewable Power Generation Projects: Concentrated Solar Facilities (CSP)

Environmental Impact Assessments and Environmental Management Programmes

Project Name & Location	Client Name	Role
Ilanga CSP 9, Northern Cape	*Emvelo Holdings*	*EAP*
Noupoort CSP, Northern Cape	*CRESCO Energy*	*EAP*

Geographical Information Systems (GIS)

Project Name & Location	Client Name	Role
Noupoort CSP, Northern Cape	*CRESCO Energy*	*GIS*

Renewable Power Generation Projects: Hydroelectrical Power Generation Facilities

Environmental Impact Assessments and Environmental Management Programmes

Project Name & Location	Client Name	Role
Kruisvallei Hydroelectric Power Generation Scheme	*Zevobuzz*	*EAP*

Geographical Information Systems (GIS)

Project Name & Location	Client Name	Role
Kruisvallei Hydroelectric Power Generation Scheme	*Zevobuzz*	*GIS*

Environmental Permitting & WUL Applications

Project Name & Location	Client Name	Role
WULA for the Kruisvallei Hydroelectric Power Generation Scheme	*Zevobuzz*	*EAP*
GA for the power line associated with the Kruisvallei Hydroelectric Power Generation Scheme	*Zevobuzz*	*EAP*

Steam Generation Projects:

Environmental Impact Assessments and Environmental Management Programmes

Project Name & Location	Client Name	Role
Clayville Thermal Plant, Gauteng	*Bellmall Energy*	*EAP*

Screening Studies

Project Name & Location	Client Name	Role
Fatal flaw analysis for the Clayville Thermal Plant, Gauteng	*Bellmall Energy*	*EAP*

Geographical Information Systems (GIS)

Project Name & Location	Client Name	Role
Clayville Thermal Plant, Gauteng	*Bellmall Energy*	*GIS*

Grid Infrastructure Projects

Basic Assessments

Project Name & Location	Client Name	Role
Gunstfontein Switching Station and Power Line, Northern Cape	*ACED*	*EAP*
Zonnebloem Switching Station and Power Lines, Mpumalanga	*Eskom SOC Ltd*	*EAP*

Geographical Information Systems (GIS)

Project Name & Location	Client Name	Role
Zonnebloem Switching Station and Power Lines, Mpumalanga	*Eskom SOC Ltd*	*GIS*

Mining Sector Projects

Environmental Permitting & WUL Applications

Project Name & Location	Client Name	Role
S53 for Steynsrus PV 1, Western Cape	*Cronimet Power Solutions*	*EAP*
S53 for Steynsrus PV 2, Western Cape	*Cronimet Power Solutions*	*EAP*
S53 for Heuningspruit PV 1, Western Cape	*Cronimet Power Solutions*	*EAP*

Geographical Information Systems (GIS)

Project Name & Location	Client Name	Role
S53 for Steynsrus PV 1, Western Cape	*Cronimet Power Solutions*	*GIS*
S53 for Steynsrus PV 2, Western Cape	*Cronimet Power Solutions*	*GIS*
S53 for Heuningspruit PV 1, Western Cape	*Cronimet Power Solutions*	*GIS*

Infrastructure Development Projects (bridges, pipelines, roads, waste etc)

Basic Assessments

Project Name & Location	Client Name	Role
MN73 Road Realignment, Northern Cape	*Northern Cape Department of Roads and Public Works*	*EAP*
S24G for the unlawful commencement of activities within a watercourse, Honeydew, Gauteng	*Soror Language Services cc*	*EAP*
Access Roads and Watercourse Crossings for the Iziduli Emoyeni Wind Energy Facility	*Emoyeni Wind Farm Renewable Energy*	*EAP*
Access Roads and Watercourse Crossings for the Msenge Emoyeni Wind Energy Facility	*Amakhala Emoyeni Renewable Energy*	*EAP*
Masetjaba Water Reservoir and Elevated Tower, Gauteng	*City of Ekurhuleni Metropolitan Municipality*	*EAP*

Environmental Impact Assessments and Environmental Management Programmes

Project Name & Location	Client Name	Role
S24G for the operation of a Aluminium, Alumino-thermic, Briquetting, Separation and Manganese Plant, Gauteng Province	*GfE-MIR Alloys and Minerals SA*	*EAP*

Geographical Information Systems (GIS)

Project Name & Location	Client Name	Role
MN73 Road Realignment, Northern Cape	*Northern Cape Department of Roads and Public Works*	*GIS*
S24G for the unlawful commencement of activities within a watercourse, Honeydew, Gauteng	*Soror Language Services cc*	*GIS*
Access Roads and Watercourse Crossings for the Iziduli Emoyeni Wind Energy Facility	*Emoynei Wind Farm Renewable Energy*	*GIS*
Access Roads and Watercourse Crossings for the Msenge Emoyeni Wind Energy Facility	*Amakhala Emoyeni Renewable Energy*	*GIS*
S24G for the operation of a Aluminium, Alumino-thermic, Briquetting, Separation and Manganese Plant, Gauteng Province	*GfE-MIR Alloys and Minerals SA*	*GIS*
Masetjaba Water Reservoir and Elevated Tower, Gauteng	*City of Ekurhuleni Metropolitan Municipality*	*GIS*
Wilmar Vegetable Oil Pipeline, KwaZulu-Natal	*Wilmar Processing*	*GIS*
Desktop Screening Assessment for a Vegetable Oil Pipeline, KwaZulu-Natal	*Wilmar Processing*	*GIS*
Kriel Power Station Lime Plant Upgrade, Mpumalanga	*Eskom Holdings SOC*	*GIS*

Short CV/Summary of Expertise – Simon Todd

Simon Todd Pr.Sci.Nat
Director & Principle Scientist
C: 082 3326502
O: 021 782 0377
Simon.Todd@3foxes.co.za

60 Forrest Way
Glencairn
7975

Ecological Solutions for People & the Environment

Simon Todd is Director and principal scientist at 3Foxes Biodiversity Solutions Pty Ltd (Reg. 2016/467883/07) and has over 20 years of experience in biodiversity measurement, management and assessment. He has provided specialist ecological input on more than 200 different developments distributed widely across the country, but with a focus on the three Cape provinces. This includes input on the Wind and Solar SEA (REDZ) as well as the Eskom Grid Infrastructure (EGI) SEA and Karoo Shale Gas SEA. He is on the National Vegetation Map Committee as representative of the Nama and Succulent Karoo Biomes. Simon Todd is a recognised ecological expert and is a past chairman and current deputy chair of the Arid-Zone Ecology Forum. Simon Todd is registered with the South African Council for Natural Scientific Professions (No. 400425/11).

<u>Abbreviated CV:</u>

- Profession: Independent Ecological Consultant - Pr.Sci.Nat 400425/11
- Specialisation: Plant & Animal Ecology
- Years of Experience: 20 Years

Skills & Primary Competencies

- Research & description of ecological patterns & processes in Nama Karoo, Succulent Karoo, Thicket, Arid Grassland, Fynbos and Savannah Ecosystems.
- Ecological Impacts of land use on biodiversity
- Vegetation surveys & degradation assessment & mapping
- Long-term vegetation monitoring
- Faunal surveys & assessment.
- GIS & remote sensing

Tertiary Education:

- 1992-1994 – BSc (Botany & Zoology), University of Cape Town
- 1995 – BSc Hons, Cum Laude (Zoology) University of Natal
- 1996-1997- MSc, Cum Laude (Conservation Biology) University of Cape Tow

Employment History

- 2010-Present – Self-employed as consultant and sole proprietor of Simon Todd Consulting, which provides ecological specialist services for conservation, research, management and development projects. This has recently been upgraded to a fully registered and compliant company, 3Foxes Biodiversity Solutions.
- 2007-Present – Senior Scientist (Associate) – Plant Conservation Unit, Department of Botany, University of Cape Town.
- 2004-2007 – Senior Scientist (Contract) – Plant Conservation Unit, Department of Botany, University of Cape Town
- 2000-2004 – Specialist Scientist (Contract) - South African National Biodiversity Institute
- 1997 – 1999 – Research Scientist (Contract) – South African National Biodiversity Institute

General Experience & Expertise

- Conducted a large number of fauna and flora specialist assessments distributed widely across South Africa. Projects have ranged in extent from <50 ha to more than 50 000 ha.
- Widely-recognized arid ecology specialist. Published numerous peer-reviewed scientific publications based on various ecological studies across the country. Past chairman of the Arid Zone Ecology Forum and current executive committee member.
- Extensive experience in the field and exceptional level of technical expertise, particularly with regards to GIS capabilities which is essential with regards to producing high-quality sensitivity maps for use in the design of final project layouts.
- Strong research background which has proved invaluable when working on several ecologically sensitive and potentially controversial sites containing some of the most threatened fauna in South Africa.
- Published numerous research reports as well as two book chapters and a large number of papers in leading scientific journals dealing primarily with human impacts on the vegetation and ecology of the arid and semi-arid parts of South Africa.
- Maintain several long-term vegetation monitoring projects distributed across Namaqualand and the karoo.
- Guest lecturer at two universities and have also served as an external examiner.
- Reviewed papers for more than 10 international ecological journals.
- Past chairman and current committee member of the Arid Zone Ecological Forum.
- SACNASP registered as a Professional Natural Scientist, (Ecology) No. 400425/11.

A selection of recent work is as follows:

Specialist Assessments:

Strategic Environmental Assessments

Co-Author. Chapter 7 - Biodiversity & Ecosystems - Shale Gas SEA. CSIR 2016.

Co-Author. Chapter 1 Scenarios and Activities – Shale Gas SEA. CSIR 2016.

Co-Author – Ecological Chapter – Wind and Solar SEA. CSIR 2014.

Co-Author – Ecological Chapter – Eskom Grid Infrastructure SEA. CSIR 2015.

Contributor – Ecological & Conservation components to SKA SEA. CSIR 2017.

Specialist Fauna and Flora Assessments:

Electrical Transmission Infrastructure

Vryheid Grid Strengthening Project, near Swellendam. Nsovo Environmental Consultants. 2016.

Juno-Gromis 400kV Power Line. Ecological Walk-Through study for EMPr. Nsovo Environmental Consultants. 2017.

Proposed Weskusfleur Substation at Koeberg. Lidwala Consulting Engineers. 2015.

Proposed Juno-Aurora 765kV Power Line in the Western Cape: Fauna & Flora Specialist Report for Impact Assessment. Nzumbulolo Heritage Solutions 2015.

The proposed Mookodi Integration Phase 2 132kV Power Lines and Ganyesa Substation near Vryburg, North West Province: Fauna & Flora Specialist Basic Assessment Report. Sivest 2014.

Basic Assessment Process for the Proposed Construction of the Transnet 7km 50 kV Power Line from Eskom Juno Substation to the proposed new Transnet Juno Traction Feeder Substation. Nsovo Environmental Consulting. 2014.

Basic Assessment Process for the Proposed Construction of the Transnet 5km 50 kV Power Line from Eskom Aries Substation to the proposed new Transnet Aries Traction Feeder Substation. Nsovo Environmental Consulting. 2014.

Basic Assessment Process for the Proposed Construction of the Transnet 15km 50 kV Power Line from Eskom Helios Substation to the proposed new Transnet Helios Traction Feeder Substation. Nsovo Environmental Consulting. 2014.

Burchell-Caprum-Mooidraai 132kV Power Line - Fauna & Flora Specialist Report for Basic Assessment. Savannah Environmental 2014.

Proposed Re-Alignment Of The Koeberg – Ankerlig VPower Line: Fauna & Flora Specialist Report For Basic Assessment. Savannah Environmental 2014.

Grid Connection for Redstone Solar Thermal Energy Plant- Redstone Solar Thermal to Olien Mts: Fauna & Flora Specialist Basic Assessment Report. SiVest 2014.

Grid Connection for Mainstream South Africa Perdekraal Wind Energy Facility. Fauna & Flora Specialist Report for Basic Assessment. ERM 2014.

Karoshoek Grid Integration Infrastructure. Fauna & Flora Specialist Report for Basic Assessment. Specialist Report for Savannah Environmental. 2012.

Garob to Kronos Power Line - Fauna & Flora Specialist Report for Basic Assessment. Specialist Report for Savannah Environmental. 2012.

Loeriesfontein Wind Energy Facility – Substation & Grid Connection. Fauna & Flora Specialist Report for Basic Assessment. Specialist Report for Savannah Environmental. 2012.

Gouda Wind Energy Facility – Grid Connection. Walk-Through of Overhead Power Line - Gouda WEF to Eskom Windmill Substation. Specialist Report for Savannah Environmental. 2012.

Proposed Kappa-Omega 765 kV Transmission Line. Fauna, Flora & Ecology Walk-Through Report. Specialist Report for ACER Africa. 2013.

Infrastructure & Mining Developments:

Environmental Impact Assessment for the Proposed Putsberg Open Cast Mine Near Pofadder, Northern Cape. Fauna & Flora Specialist Report for EIA. Ecopartners 2013.

Proposed Establishment of the Gamsberg Zinc Mine, Concentrator Plant and Associated Infrastructure near the Town of Aggeneys, Northern Cape. Fauna & Flora Specialist Report For ESIA. ERM 2013.

Pella Water Board – Infrastructure Upgrade. Fauna & Flora Specialist Report for Basic Assessment. Environmental Resources Management 2012.

Transnet Manganese Ore Line Upgrade. Fauna & Flora Specialist Report for Basic Assessment. Environmental Resources Management 2012.

Proposed Vryburg Wastewater Treatment Works: Terrestrial Fauna & Flora Specialist Study for Basic Assessment. Endemic Vision 2013.

Proposed Mamatwane Compilation Yard, Northern Cape: Fauna & Flora Specialist Report for Impact Assessment. Environmental Resources Management 2013.

Rare Earth Separation Plant Near Vredendal, Western Cape Province. Fauna & Flora Specialist Report for Basic Assessment. Savannah Environmental 2012.

Proposed Mocke Poultry Farm: Fauna & Flora Specialist Report for Basic Assessment. Enviroworks 2015.

Basic Assessment for proposed Neotel Fibre Optic Cable Route 1 from George to Oudtshoorn. Fauna & Flora Specialist Report for Basic Assessment. Enviroworks 2015.

Basic Assessment for proposed Neotel Route 2 Fibre Optic Cables from Prince Albert Road to Oudtshoorn via the N12. Enviroworks 2015.

Basic Assessment for proposed Neotel Route 3 Fibre Optic Cables from Oudtshoorn to George via R328 and R102. Enviroworks 2015.

Basic Assessment for proposed Neotel Route 4 Fibre Optic Cables from Laingsburg to Oudtshoorn via Ladismith along the R323 and R62. Enviroworks 2015.

Improvements to the Ou Kaapse Weg / Silvermine Road Intersection. Specialist Faunal Study For Basic Assessment. Khula Environmental Consultants, 2012.

Upgrading of Tourism Facilities at Goegap Nature Reserve. Specialist Ecological Assesment. Van Zyl Environmental Consultants. 2012.

Plant Sweeps on Portion 2 of the Farm Demaneng 546, Kuruman District, Northern Cape Province for SA Manganese. 2011.

Solar Energy Developments:

Sol Invictus PV-1-4 Power Plants, near Aggeneys. Fauna and Flora Assessment. Savannah Environmental 2016.

Illanga Karoshoek CSP 1-5 near Upington. Fauna and Flora Assessment. Savannah Environmental 2016.

Mogobe, Legoko & Kathu 75MW Solar PV Plants, near Kathu, Northern Cape. Fauna and Flora Assessment. Cape EAPrac. 2015.

Environmental Impact Assessment for the Proposed Wolmarransstad Solar Energy Facility North West Province. Fauna & Flora Specialist Report for EIA. Savannah Environmental 2015

Environmental Impact Assessment for the proposed Humansrus Solar PV Energy Facility 1 Near Copperton, Northern Cape: Fauna & Flora Specialist Report for EIA. CapeEAPrac 2015.

Environmental Impact Assessment for the proposed Humansrus Solar PV Energy Facility 2 Near Copperton, Northern Cape: Fauna & Flora Specialist Report for EIA. CapeEAPrac 2015.

Environmental Impact Assessment for the proposed Dyasonsklip Solar Energy Facility 1 Near Upington, Northern Cape: Fauna & Flora Specialist Report for EIA. CapeEAPrac 2015.

Environmental Impact Assessment for the proposed Postmasburg Solar PV Energy Facility 2 and Associated Grid Connection Infrastructure, Postmasburg, Northern Cape. Fauna & Flora Specialist Report for EIA. CapeEAPrac 2015.

Environmental Impact Assessment for the proposed Joram Solar Vryheid PV Project, Northern Cape. Fauna & Flora Specialist Report for EIA. CapeEAPrac 2015.

Environmental Impact Assessment for the proposed Richtersveld Solar Farm and Associated Grid Connection Infrastructure. Fauna & Flora Specialist Report for EIA. CapeEAPrac 2015.

Environmental Impact Assessment for the Proposed Re Capital 3 Solar Energy Facility and Associated Grid Connection Infrastructure, Dyason's Klip, Northern Cape. Fauna & Flora Specialist Report for EIA. CapeEAPrac 2013.

Environmental Impact Assessment for the Proposed Richtersveld Solar Farm and Associated Grid Connection Infrastructure. Fauna & Flora Specialist Report for EIA. CapeEAPrac 2014.

Environmental Impact Assessment for the Proposed Bosjesmansberg Solar Energy Facility East of Copperton, Northern Cape Province. Fauna & Flora Specialist Report for EIA. Savannah Environmental 2013.

Specialist Vegetation Assessment for EIA. The Proposed Commercial Concentrated Solar Power Tower Facility and Concentrated Photovoltaic Facility at Van Roois Vley Near Upington. WSP 2012.

Proposed Les Marais \ Buitenfontein 5MW Solar Energy Facility in the Free State: Terrestrial Fauna & Flora Specialist Study for Basic Assessment. Savannah Environmental 2013.

Proposed Stella Helpmekaar Solar Energy Facility in the North West Province: Terrestrial Fauna & Flora Specialist Study for Basic Assessment. Savannah Environmental 2013.

Proposed Wolmaransstad Municipality 5MW Solar Energy Facility in the North West Province: Terrestrial Fauna & Flora Specialist Study for Basic Assessment. Savannah Environmental 2013.

Proposed Heuningspruit PV1 and PV2 Solar Energy Facilities Near Koppies, Free State Province: Terrestrial Fauna & Flora Specialist Study for Basic Assessment. Savannah Environmental 2013.

Proposed Hibernia PV Solar Energy Facility near Lichtenburg: Terrestrial Fauna & Flora Specialist Study For Basic Assessment. Savannah Environmental 2013.

Proposed Steynsrus PV1 And PV2 Solar Energy Facilities: Terrestrial Fauna & Flora Specialist Study for Basic Assessment. Savannah Environmental 2013.

Proposed Photovoltaic Solar Energy Facility on Konkoonsies, Northern Cape: Fauna & Flora Specialist Report for Impact Assessment. EScience Associates 2012.

Proposed Padrooi 13 Photovoltaic Solar Energy Facility, Northern Cape: Fauna & Flora Specialist Report for Impact Assessment. EScience Associates 2012.

Adams Photovoltaic Solar Energy Facility, Northern Cape: Fauna & Flora Specialist Report for Impact Assessment. EScience Associates 2012.

Proposed Photovoltaic Solar Energy Facility on Klein Swart Bast, Northern Cape: Fauna & Flora Specialist Report for Impact Assessment. EScience Associates 2012.

Proposed Khoi-Sun Solar Facility. Fauna & Flora Specialist Report for Impact Assessment. Cape EAPrac 2012.

Suurwater 62, Boesmanland 75mw Solar Farm, Aggeneys. Fauna & Flora Specialist Report for Impact Assessment. Cape EAPrac 2012.

Karoshoek Solar Valley Development, Upington: Fauna & Flora Specialist Impact Assessment Report. Savannah Environmental. 2012.

O'Kiep 3 PV Solar Energy Facility on a Site In O'kiep Near Springbok, Northern Cape Province. Fauna & Flora Specialist Report for Basic Assessment. Savannah Environmental 2012.

Photovoltaic Solar Energy Facility on Voëlklip, South of Springbok. Fauna & Flora Specialist Report for Basic Assessment. Savannah Environmental 2012.

Namaqua Photovoltaic Solar Energy Facility on a Site North of Kamieskroon. Fauna & Flora Specialist Report for Basic Assessment. Savannah Environmental 2012.

Inca Graafwater Photovoltaic Solar Energy Facility, Graafwater, Western Cape Province. Faunal Ecology Specialist Report for Impact Assessment. Savannah Environmental 2012.

Aberdeen Solar Facility. Fauna & Flora Specialist Report for Basic Assessment. Specialist Report for Savannah Environmental. 2012.

Venetia Solar Facility. Fauna & Flora Specialist Report for Basic Assessment. Specialist Report for Savannah Environmental. 2012.

Southern Cross Solar Energy Facility: Southern Farm 425. Fauna & Flora Specialist Report for Basic Assessment. Specialist Report for Savannah Environmental. 2012.

Tutwa Solar Energy Facility: Portion 4 of Narries 7. Fauna & Flora Specialist Report for Basic Assessment. Specialist Report for Savannah Environmental. 2012.

Valleydora Photovolataic Solar Power Plant, Free State. Fauna & Flora Specialist Report. CSIR, 2012.

Reddersburg Solar Facility - Fauna & Flora Specialist Assessment. CSIR, 2012.

Melkvlei Photovolataic Solar Power Plant. Fauna & Flora Specialist Report for Basic Assessment. Specialist report for ERM. 2012.

Ruinte Photovolataic Solar Power Plant. Fauna & Flora Specialist Report for Basic Assessment. Specialist report for ERM. 2012.

Genoegsaam Solar Park. Fauna & Flora Specialist Report for Basic Assessment. Specialist report for ERM. 2012.

Genoegsaam Solar Park. Fauna & Flora Specialist EIA Report. Specialist report for ERM. 2012.

Graspan Solar Facility. Fauna & Flora Specialist Report for Impact Assessment. Specialist report for ERM. 2012.

Olyven Kolk Solar Power Plant, Northern Cape: Botanical and Faunal Specialist Assessment. Specialist Report for Environmental Resources Management (ERM). 2011.

Skuitdrift Solar Facility. Fauna & Flora Specialist Report for Basic Assessment. Specialist Report for Cape EAPrac. 2012.

Beaufort West Solar Facility, Erf 7388 - Fauna & Flora Specialist Assessment. Specialist Report for Cape EAPrac. 2012.

Khoi-Sun Solar Facility. Fauna & Flora Specialist Scoping Report. Specialist Report for Cape EAPrac. 2012.

Boesmanland Solar Farm. Fauna & Flora Specialist Scoping Study. Specialist Report for Cape EAPrac. 2012.

Bitterfontein Solar Plant - Fauna & Flora Specialist Assessment. Specialist Report for Cape EAPrac. 2012.

Wind Farm Developments:

Environmental Impact Assessment for the Proposed Komsberg East and Komsberg West Wind Farms and Associated Grid Connection Infrastructure: Fauna & Flora Specialist Impact Assessment Report. Arcus 2014.

Proposed Rietkloof Wind Farm and Associated Grid Connection Infrastructure: Fauna & Flora Specialist Impact Assessment Report. EOH 2016.

Proposed Brandvallei Wind Farm and Associated Grid Connection Infrastructure: Fauna & Flora Specialist Impact Assessment Report. EOH 2016.

Proposed Gunstfontein Wind Farm and Associated Grid Connection Infrastructure: Fauna & Flora Specialist Impact Assessment Report. Savannah Environmental 2016.

Mainstream South Africa Dwarsrug Wind Energy Facility: Fauna & Flora Specialist Impact Assessment Report. Sivest 2014.

Proposed Spitskop Wind Energy Facility near Cookhouse: Fauna & Flora Specialist Study for Impact Assessment. Savannah Environmental 2013.

Environmental Impact Assessment for the Proposed Roggeveld Wind Energy Facility and Associated Grid Connection Infrastructure: Fauna & Flora Specialist Report for EIA. Savannah Environmental 2013.

Proposed Mainstream South Africa Springfontein Wind Energy Facility: Terrestrial Fauna & Flora Specialist Study for EIA. Savannah Environmental 2012.

Environmental Impact Assessment for the Establishment of the Wolseley Wind Farm, Western Cape Province. Fauna & Flora Specialist Report. Arcus Gibb 2012.

Proposed Eskom 300MW Kleinsee Wind Energy Facility. Fauna Specialist Report For Impact Assessment. Savannah Environmental 2012.

Proposed Inca Energy Swellendam Wind Energy Facility: Fauna Specialist Report For Impact Assessment. Savannah Environmental 2012.

Proposed Hartebeest Wind Energy Facility: Fauna & Flora Specialist EIA Report For Impact Assessment. Savannah Environmental 2016.

Terrestrial Ecology Specialist Study for the Proposed Establishment of a Renewable Energy Facility near Sutherland, Western and Northern Cape Provinces. Environmental Resources Management (ERM) 2011.

Roggeveld Wind Farm: Ecological and Biodiversity Assessment: Terrestrial Vertebrate Fauna & Botanical Specialist Study. Specialist Report for Environmental Resources Management (ERM). 2011.

Zen Wind Energy Facility. Fauna & Flora Specialist Impact Assessment Report. Savannah Environmental. 2012.

Proposed Project Blue Wind and Solar Energy Facility, Near Kleinsee. Fauna Specialist Report For Impact Assessment. Savannah Environmental 2012.

Garob Wind Farm: Fauna & Flora Specialist Report for Impact Assessment. Savannah Environmental 2012.

Loeriesfontein Wind Energy Facility – Substation & Grid Connection. Fauna & Flora Specialist Report for Basic Assessment. Savannah Environmental 2012.

Noblesfontein Wind Energy Facility, Victoria West. Ecological Walk-Through Report. Savannah Environmental 2012.

Gouda Wind Energy Facility. Fauna And Flora Walk Through Report. Savannah Environmental 2012.

Klawer Wind Farm: Ecological and Biodiversity Assessment: Terrestrial Vertebrate Fauna & Botanical Specialist Study. Specialist Report for Environmental Resources Management. 2011.

Lambert's Bay Wind Farm: Ecological and Biodiversity Assessment: Terrestrial Vertebrate Fauna & Botanical Specialist Study. Specialist Report for Environmental Resources Management. 2011.

Richtersveld Wind Farm: Ecological and Biodiversity Assessment: Terrestrial Vertebrate Fauna & Botanical Specialist Study. Specialist Report for Environmental Resources Management (ERM). 2011.

Witberg Wind Farm: Ecological and Biodiversity Assessment: Terrestrial Vertebrate Fauna & Botanical Specialist Study. Specialist Report for Environmental Resources Management (ERM). 2011.

3Foxes Biodiversity Solutions
ECOLOGICAL SPECIALIST SERVICES
Assessment/Management/Research

Simon Todd Pr.Sci.Nat
Director & Principle Scientist
C: 082 3326502
O: 021 782 0377
Simon.Todd@3foxes.co.za

60 Forrest Way
Glencairn
7975

Ecological Solutions for People & the Environment

Eric Herrmann

Eric Herrmann is an avifaunal specialist with over 15 years of experience in biodiversity research and conservation in the Northern Cape. He completed a B.Tech Degree in Nature Conservation (1997) at the Cape Technikon, followed by a Masters in Conservation Ecology at the University of Stellenbosch (2004). He has worked as a research assistant for the Endangered Wildlife Trust (1999-2001) in the Kgalagadi Transfrontier Park, and then for the Percy FitzPatrick Institute of African Ornithology (University of Cape Town) as project manager of a field research centre near Kimberley (2003 to 2006). In 2006 he joined the provincial Department of Environment and Nature Conservation (DENC) in Kimberley as a faunal scientist until 2012. Since 2016 he has been working independently as an avifaunal specialist largely on wind and solar energy projects in the Western and Northern Cape.

Tertiary Education:

- 1994 - 1997 – National Diploma: Nature Conservation (cum laude), Cape Technikon
- 1998 - 1999 – B.Tech Degree: Nature Conservation (cum laude), Cape Technikon
- 2000 - 2004 – MFor: Conservation Ecology (cum Laude), University of Stellenbosch

Employment History

- 2016 - Present – Independent contractor, avifaunal specialist for renewable energy projects.
- 2006 - 2012 – Senior Conservation Scientist, Department of Environment and Nature Conservation, Kimberley.
- 2003 - 2006 – Research Assistant and Field Projects Manager, Percy Fitzpatrick Institute of African Ornithology, Cape Town
- 2001 - 2002 – Field Researcher, Deciduous Fruit Producers Trust, Stellenbosch.
- 1999 - 2001 – Research Assistant, Endangered Wildlife Trust, Johannesburg.

Recent Specialist Avifaunal Studies include the following:

- Dassieklip Wind Facility. Avifaunal post-construction monitoring. BTE Wind Pty (Ltd). 2018/19.
- Excelsior Wind Facility. Avifaunal pre-construction monitoring. BTE Wind Pty (Ltd). 2018/19.
- Kathu Hyperion Solar PV Facility, Kathu. Fauna and Flora EIA Process. Cape EAPrac 2018.
- Gaetsewe Solar PV Facility, Kathu. Avifaunal Scoping Report. Cape EAPrac 2018.
- Mogara Solar PV Facility, Kathu. Avifaunal Scoping Report. Cape EAPrac 2018.

- Mamre Wind Facility. Avifaunal pre-construction monitoring. Mulilo Renewable Project Developments. 2017.
- Soventix Solar PV Facility (De Aar). Avifaunal Specialist Scoping and EIA Reports. Ecoleges. 2017.
- Olifantshoek-Emil 132kV power line, Olifantshoek. Fauna and Flora BA process. Savannah Environmental 2017.
- Klondike (Vryburg) Solar PV Facility. Ecological Specialist Report for EIA. Cape EAPrac 2016.

CURRICULUM VITAE

Jenna Lavin

Tel: 083 619 0854 (c)
E-mail address: jenna.lavin@gmail.com
ID number: 8512050014089

Address: 7 Carey Street, Woodstock, cape Town

EDUCATION:

Tertiary

2014 M.Phil in Conservation of the Built Environment (University of Cape Town)
- Not completed as of 2017

2011 Continued Professional Development Course in Urban Conservation Management (University of Cape Town) Part I and Part II

2010 M.Sc. with Distinction in Archaeology (University of Cape Town)
Title: *Palaeoecology of the KBS member of the Koobi Fora Formation: Implications for Pleistocene Hominin Behaviour*.

2007 B.Sc. Honours in Archaeology (University of Cape Town)
Title: *The Lost Tribes of the Peninsula: An Investigation into the historical distribution of Chacma baboons (Papio ursinus) at the Cape Peninsula, South Africa.*
Koobi Fora Field School, Rutgers University (U.S.A.)/ National Museums of Kenya

2006 B.Sc. Archaeology (University of Cape Town)
B.Sc. Environmental and Geographic Science (University of Cape Town)

Secondary

1999-2003 Rustenburg High School for Girls
Firsts in English, Afrikaans, Mathematics HG, Biology HG, History HG, Entrepreneurship.

EMPLOYMENT HISTORY:

PROFESSIONAL DEVELOPMENT
Environmental and Heritage Management:

- **Director: Heritage for CTS heritage and member of OpenHeritage NPC.**

July 2016 to present

I am a member of the senior management of the company. I am responsible for project management and quality control on all of our heritage-related projects. I provide specialist heritage expertise when required and assist with the drafting of management plans, impact assessments and other specialist reports. I liaise with clients, authorities and other specialists to ensure the highest quality product from CTS Heritage. I manage the budgets and financial compliance for all our projects and for the business in general. In addition, I manage a specialist team of two archaeologists. We have recently been involved in developing the online map for the National Resistance and Liberation Heritage Route with DAC.

Through OpenHeritage, I have been intimately involved with the development, and successful implementation of, of a digital heritage objects management system for the National Museum in Kenya as well as Tristan da Cuhna.

- **Assistant Director for Policy, Research and Planning at Heritage Western Cape (HWC).**

August 2014 to June 2016

As a member of the management structure of HWC, I was responsible for the drafting of new heritage related policy, the grading and declaration of Provincial Heritage Sites, the development of Conservation Management Plans, facilitating the development of inventories of heritage resources through local authorities as well as managing the development of the Western Cape's Heritage Information Management System (HIMS). I was also responsible for managing the project to nominate the Modern Human Origins proposed World Heritage Site.

I performed the role of Acting Deputy Director for HWC from April to December 2015, including financial management responsibilities, problem solving and the training of new staff.

- **Heritage Officer for Palaeontology and for the Mpumalanga Province at the South African Heritage Resources Agency (SAHRA).**

January 2013 to June 2014

Responsibilities include managing palaeontological permit applications in terms of Section 35 of the NHRA and development applications in terms of Section 38 of the NHRA. Projects included the development of a National Palaeotechnic Report identifying significant palaeontological deposits throughout SA, as well as developing professional relationships between SAHRA and the Palaeontological Society of South Africa (PSSA) and the Geological Society of South Africa (GSSA). During this time, I was part of the team that developed the digitised National Palaeontological Sensitvity Map, the first of its kind in the world.

- **Heritage Officer for Archaeology, Palaeontology and Meteorites at Heritage Western Cape (HWC).**

September 2010 to December 2012

HWC is a Public Entity that forms part of the Heritage Resource Management Component of the Provincial Governments' Department of Cultural Affairs and Sport (DCAS). Projects included the declaration of Pinnacle Point and the West Coast Fossil Park as Provincial Heritage Sites (PHSs), the management of the development of the Baboon Point PHS Conservation Management Plan as well as an educational outreach program as part of the DCAS MOD Centre Project.

- **Heritage Officer for the Archaeology, Palaeontology and Meteorites Unit of the South African Heritage Resources Agency (SAHRA) as part of a three month contract.**

January 2010 to March 2010

- **Environmental Control Officer, Amathemba Environmental Management Consulting**

Part time: 2007 to 2009

Field Work Experience:

2008-2009	Field Assistant, Dr. D. Braun, Elandsfontein Excavation Locality, University of Cape Town (UCT)
	Field Assistant, Dr. D. Braun, Koobi Fora Research Project (Kenya), Rutgers University, New Jersey
2006	Field Assistant, Damiana Ravasi (PhD), Zoology Department, University of Cape Town.
2005	Research Assistant, Dr. Becky Ackerman, Archaeology Department, University of Cape Town
2004	Field Assistant, Prestwich Place Excavation Locality, Archaeology Contracts Office, UCT

Teaching Positions:

2017	Guest Lecturer, South African Heritage Legislation, George Washington University Heritage Management Field School
2016	Guest Lecturer, South African Heritage Legislation, Archaeology Honours Course, University of Cape Town
2015	Guest Lecturer, South African Heritage Legislation, Archaeology Honours Course, University of Cape Town
2014	Guest Lecturer, South African Heritage Legislation, Archaeology Honours Course, University of Cape Town
2013	Guest Lecturer, South African Heritage Legislation, Archaeology Honours Course, University of Cape Town
2010	Teaching Assistant, Langebaanweg Field School, Arizona State University
2009	Demonstrator, Archaeology in Practice, University of Cape Town (AGE3013H)
	Demonstrator, Introduction to Geography, Earth and Environmental Science, University of Cape Town (GEO1009F)
	Teaching Assistant, Koobi Fora Field School (Kenya), Rutgers University, New Jersey
	Lecturer, Introduction to Geography, Earth and Environmental Science: Supplementary Course, University of Cape Town (EGS1004S)
	Demonstrator, Elandsfontein Honours Field School, University of Cape Town (AGE4000W)
2008	Demonstrator, Introduction to Geography, Earth and Environmental Science, University of Cape Town (ERT1000F)
	Demonstrator, Elandsfontein Honours Field School, University of Cape Town (AGE4000W)
	Teaching Assistant, Koobi Fora Field School (Kenya), Rutgers University, New Jersey

Conferences and Papers

2017	ASAPA, Pretoria, RSA: "*Using Heritage Data to Guide Responsible Development: Tools to ensure high quality recording of heritage sites"*
	ICAHM, Bagomoyo, Tanzania: "*OpenHeritage: Development and implementation of national heritage management systems - Lessons from South Africa, Namibia and Kenya"*
2016	ICAHM, Salalah, Oman: "*Straight to the (Baboon) Point: A look at the Conservation of Archaeological Landscapes in South Africa using Baboon Point as a Case Study*"
2015	Leakey Foundation, Sonoma County, San Fransisco, USA: ""*Straight to the (Baboon) Point: A look at the Conservation of Archaeological Landscapes in South Africa using Baboon Point as a Case Study*"
2012	PSSA, Johannesburg, RSA: *"SAHRIS Palaeosensitivity Map - Methodology and Implementation"*

Other
In 2013 I was asked to join the panel of judges for the Ministerial awards for Heritage in the Western Cape. From 2013 to July 2014, I was a member of the Heritage Western Cape Archaeology, Palaeontology and Meteorites Committee and I currently sit on the Heritage Western Cape Inventories, Gradings and Interpretations Committee.

In November 2013, I was awarded a bursary from the Department of Arts and Culture to complete a Masters in Philosophy in Conservation of the Built Environment through the UCT Faculty of Engineering and the Built Environment in 2014 and 2015. I was in the process of finalising this degree in 2017, however the arrival of my son has temporarily halted my progress.

I am a paid up member of the Association for Southern African Professional Archaeologists (ASAPA), the Association of Professional Heritage Practitioners (APHP) and I have been a member of the Executive Council of APHP since 2014.

In June 2017, I was selected as Chair of APHP. I am a member of the Palaeontological Society of South Africa (PSSA) and ICOMOS South Africa, for which I am Vice-President of the Board. I am also a member of the International Committee for Archaeological Heritage Management (ICAHM), a committee of UNESCO.

I am an active participant in a not-for-profit company called OpenHeritage which is dedicated to opening access to heritage resources through digital innovation. To this end, we have been involved in a number of projects including Wikipeadia Training with Africa Centre, the development and implementation of a Collections Management System for the National Museums of Kenya and the development of a digital Inventory of the Vernacular Architecture of the Eastern Cape.

Referees
Mary Leslie
mleslie.za@gmail.com
082 733 2611

Janette Deacon
janette@conjunction.co.za
082 491 5067

Laura Robinson
ctht@hertage.org.za
083 463 4765

Andrew Hall
waitabout191@gmail.com
(Currently based in Oman)

Wendy Black
wblack@iziko.org.za
021 481 3883

PROJECT	PROJECT DESCRIPTION	DURATION
SKA Scoping Project	**Provision of Heritage Specialist Assessment Services for SKA Scoping Phase**	09/2015 - 09/2016
National Liberation & Khoisan Heritage Routes	**Development of online mapping interface to promote national liberation and Khoisan heritage routes**	02/2017 - present
Western Cape Coastal Access Strategy	**Heritage statements describing changing utilisation of Western Cape coast through time**	01/2016 - 02/2017
Robben Island PV Facility	**Heritage survey, Heritage Impact Assessment, monitoring, mapping, report writing**	01/2016 - 02/2017
Stawelklip Rock Art Conservation Management Plan	**Site documentation, stakeholder consultation, CMP compilation, development of signage**	10/2015 - 01/2016
Phillipskop Rock Art Conservation Management Plan	**Site documentation, stakeholder consultation, CMP compilation, development of signage**	04/2016 - 08/2016
Cape Winelands Heritage Inventory	**Data processing, heritage management and mapping services**	08/2016 - 09/2017

CTS Heritage Impact Assessments

HIA Title	Date Completed
HIA: Brakke Kuyl Sand Mine	05/12/2016
HIA: Gouritz Abalone Farm	28/10/2016
HIA: Malmesbury Granite Quarry	28/11/2016
HIA: Expansion of Jacobsbaai Abalone Farm	26/08/2016
HIA: Mutsho Power Project near Makhado	02/02/2017
HIA: Vanrhynsdorp Prospecting	06/03/2017
HIA: Spitskop Power Lines	02/03/2007
Desktop HIA Namakwa Prospecting	21/06/2017
HIA: San Miguel Citrus	26/04/2017
HIA : Ash River Hydro	In process
HIA: 22kv Powerlines Eastern Cape	22/08/2017
HIA: Langa Telecommunications Mast	18/08/2017
HIA: Ouwerf HF Radar Wave Monitoring Antennae	In process

Lourens du Plessis

Professional GISc Practitioner

Personal Information:

- Date of Birth: 1969-11-13
- Marital Status: Married
- Nationality: South African
- Contact no: 082 922 9019
- Email: lou.dp@outlook.com

Years of Industry Experience

- 28 years'

Countries of Experience

- South Africa; Lesotho; Swaziland; Mozambique; Botswana; Zimbabwe; Namibia; Angola; Guinea; Ghana; Uganda

Qualifications and Memberships

- BA (University of Pretoria) Geography and Anthropology (Majors), 1993
- Professional Geo-Information Sciences (GISc) Practitioner registered with the South African Geomatics Council (SAGC). Membership no. PGP0147
- Member: GISSA

Key Skills and Competencies

- Arc/Info and ArcGIS
- Arcview
- QGIS
- Postflight Terra 3D
- PlanetGIS
- Vistapro
- Various GIS support applications
- Microsoft (Word/Excel/Access)

Professional Overview

Lourens provides professional Geographical Information Systems (GIS) services to a wide range of clients that require the processing, analysis and presentation of geospatial data. His overarching function is the application of GIS in environmental management and planning, impact assessments and spatial modelling, but his services often extend to a much broader range of business sectors. These include the application of GIS in:

- Agriculture
- Bulk service providers and utilities
- The renewable energy sector
- Electricity generation and distribution
- Mining and exploration
- Urban and rural development planning
- Conservation and tourism
- Strategic integrated planning
- Environmental education and social awareness
- Engineering, transport and infrastructure development

Lourens has a multi-disciplinary approach to projects and therefore specialises in creating synergy between planning professionals and project specialists (regardless of the type of project) in order to provide uniform, quality spatial data products, solutions and services.

Experience and expertise

- Data sourcing and acquisition
- Data capture and processing
- Data evaluation, conversion and transfer
- Geodatabase development/implementation/maintenance
- System design and development
- Spatial analysis/modelling (visibility, slope, aspect, etc.)
- Digital terrain modeling
- Terrain evaluation and site screening
- Image processing and analysis
- Impact assessment and impact management
- Environmental management
- GIS-based decision support systems development
- Project management and report writing
- Map production, display, queries and reporting
- Environmental sciences expertise
- Process development
- Visual impact assessment
- GPS fieldwork and aerial surveys
- Drone data processing

Project Experience

General projects *(A brief description of some prominent and relevant projects)*

GIS mapping and database for Black Eagle habitats and flight patterns in the Karoo National Park

Environmental planning and development control schemes for the Drakensberg Babangibone, Cathkin Peak and Garden Castle development nodes

Goukou River (Stilbaai) Environmental Structure Plan

Conservation and open space proposals for the Umhlanga Forest

Grootvlei mine water pumping operation (Blesbokspruit sub-catchment)

GIS services for the Saldanha steel plant

ENPAT Provincial (1:250,000 scale GIS decision support systems) based on an inventory of environmental and socio-economic geographic data

- ENPAT Northern Province (Limpopo Province)
- ENPAT Mpumalanga
- ENPAT North-West

ENPAT Metropolitan (1:50,000 scale GIS decision support systems) containing environmental and socio-economic geographic data that were evaluated for conservation opportunities, development constraints and agricultural constraints

- ENPAT Gauteng
- ENPAT Cape Town
- ENPAT Durban Functional Region (DFR)
- ENPAT Bloemfontein/Botshabello
- ENPAT Port Elizabeth

ENPAT National (1:1,000,000 scale GIS decision support system) and ENPAT publication

Environmental Management Frameworks (EMF). Frameworks of spatially represented information connected to environmental management parameters designed to aid in the pro-active identification of potential conflict between development proposals and critical and/or sensitive environments

- EMF Northern Province (Limpopo Province)
- EMF Mpumalanga
- EMF North-West

Spatial Development Initiatives (SDI). The fast tracking of the EMF concept for priority SDI's

- Lubombo Corridor SDI
- Coega Industrial Development Zone (IDZ)
- Wild Coast SDI
- West Coast Investment Initiative

Sigma colliery: North-West strip operation

Development masterplan for the Tswaing Crater Museum

Conservation plan for the Rietvlei Nature Reserve

GIS services for the planning and management of the Chobe National Park (Botswana)

GIS services for an environmental overview of South Africa

Demarcation/delineation of regions in South Africa

Orange-Vaal (ORVAAL) transfer scheme - Caledon cascades scheme

ENPAT Provincial (1:250,000 scale GIS decision support systems) based on an inventory of environmental and socio-economic geographic data

- ENPAT Eastern Cape
- ENPAT Free State
- ENPAT Kwa-Zulu Natal

Environmental Management Frameworks (EMF). Frameworks of spatially represented information connected to environmental management parameters designed to aid in the pro-active identification of potential conflict between development proposals and critical and/or sensitive environments

- EMF Eastern Cape
- EMF Free State
- EMF Kwa-Zulu Natal

Hennops River EMF (environmental inventory and management proposals in Centurion)

The Important Bird Areas (IBA) of South Africa map and database

Centurion Metropolitan Substructure Environmental Management Framework (EMF)

Alexandra renewal project EMF

Carbon Sinks and Sequestration - Eastern Cape Wild Coast. Information maps for the "Carbon Sinks - A Rehabilitation Option for South Africa's Natural Environment" report

Prince Edward and Marion Islands. Maps for the World Heritage Site (WHS) bid document

Theewaterskloof and Genadendal - Integrated spatial data management system

Gauteng Communication Network Strategy (GAUCONS). Environmental zones for the control of the construction of telecommunication structures

Gauteng Industries Buffer Zones. The mapping of industrial and mining activities, the creation of buffer control zones and the development of a GIS-based decision support system for the Gauteng Province

Limpopo National Park (LNP) Mozambique. Base maps for fieldwork and planning

Schmidtsdrift Environmental Management Program Report (EMPR)

Loch Vaal Environmental Management Framework (EMF)

Rustenburg - Strategic Environmental Assessment (SEA). The creation of environmental control zones, a GIS-based decision support system and information poster

Faerie Glen Nature Reserve Strategic Environmental Assessment (SEA)

Willow Quarries - Environmental Impact Assessment (EIA). Modeling of mining expansion plan and the potential impact on Golden Mole habitats

Ekurhuleni Metropolitan Municipality (EMM) Environmental Management Framework (EMF)

Limpopo - State of the Environment Report (SoER)

Windhoek (Namibia) - Environmental Structure Plan (ESP)

Gauteng Supplementation and Implementation of EIA Regulations Project (EIA SIP)

Siyanda District Municipality Environmental Management Framework (EMF)

Olifants and Letaba River Catchments Environmental Management Framework (EMF)

Barberton Nature Reserve environmental sensitivity mapping and land use zoning plan

Regional Strategic Environmental Assessments (Regional Assessments)

Regional assessment for the Eskom Wind Energy Facility (Sere) in the Western Cape

Regional assessments for the Eskom Wind Integration Project (WIP)
- Area 1: West Coast (Saldanha to Garies)
- Area 2: Overberg Region
- Area 3: Beaufort West region
- Area 4: Eastern Cape (Tsitsikamma to Port Elizabeth)
- Area 5: Northern Cape (Hondeklipbaai to Port Nolloth)

Sandveld wind energy Regional Assessment

West Coast National Park (Saldanha area) Regional Assessment

Regional Assessment for the Theewaterskloof Municipal area

Brand-se-Baai (Exxaro) wind energy regional assessment

Overberg (BioTherm) wind energy regional assessments
- Area 1: Gordons Bay to Pearly Beach)
- Area 2: Napier RA (Agulhas NP/Swellendal region)

Suurplaat/Sutherland (Investec Wind Energy Development) Regional Assessment

Waterberg (Limpopo) Concentrating Solar Power (CSP) Regional Assessment (Exxaro)

Western Cape Province Regional SEA for Wind Energy facility developments

ISS Global Mining Regional SEA for Power Station Developments in Mpumalanga Province

Northern Cape Province Regional SEA for Wind Energy facility developments

Etc. *(a comprehensive list of general projects can be provided upon request)*

Visual Impact Assessments (VIA), viewshed analyses and visual assessments
Some recent or current projects include:
- Coal strip mining in Zimbabwe viewshed analyses
- Viewshed analyses and sensitivity mapping for telecommunication masts in the northern provinces (Limpopo, Mpumalanga and North-West)
- Siemens 3rd license cellular communications infrastructure EIAs. Viewshed analyses and sensitivity mapping for over 4,000 telecommunication mast sites in all major metropolitan areas of South Africa.
- CSIR high mast viewshed analysis and sensitivity mapping
- Atlantis Open Cycle Gas Turbine power station VIA
- Kynoch Gypsum Tailings dam extension VIA
- N1 Western Bypass Shell service station VIA
- Coega regional hazardous waste processing facility VIA
- Robinson Deep landfill extension VIA
- Hazardous waste blending platform VIA
- Mercury-Ferrum-Garona transmission line integration VIA
- Matimba B (Medupi) coal-fired power station VIA
- Concentrating Solar Power (CSP) plant in Upington VIA
- Zeus to Mercury transmission line (comparative viewshed analyses)
- Mmamabula (Botswana) transmission line and power station viewshed analyses
- Petronet new multi-products pipeline VIA
- Wind energy facility (Sere) in the Western Cape province VIA
- Ankerlig power station conversion and transmission line VIA
- Gourikwa power station conversion and transmission line VIA
- Kyalami strengthening project VIA
- Steelpoort integration project VIA
- Medupi reservoir and telecommunication mast VIA
- VIA's for Basic Assessment Reports (wind monitoring masts)
    - Cookhouse, Hopefield, Amakhala, Caledon, Worcester, Tulbach, Overberg, Britannia Bay, Brand-se-Baai, Deep River, Happy Valley, River Bank, Uiekraal, Beaufort West, Laingsburg, Rheboksfontein, Suurplaat and West Coast
- Cookhouse wind energy facility VIA
- Hopefield wind energy facility VIA
- Mokopane Integration Project VIA
- Cradle of Humankind World Heritage Site (WHS) viewshed protection zone, visual character assessment and visual zonation plan
- Indwe wind energy facility VIA
- Amakhala wind energy facility VIA
- Boontjieskraal wind energy facility VIA
- Britannia Bay wind energy facility VIA
- Brand-se-Baai wind energy facility VIA
- Upington and Pofadder solar thermal facilities VIAs

- Dorper wind energy facility VIA
- Flagging Trees wind energy facility VIA
- Rheboksfontein, Suurplaat and West Coast wind energy facilities VIAs
- Riverbank wind energy facility VIA
- Waterberg photovoltaic plant VIA
- Eskom wind intergration projects VIAs
- Welgedacht water care works VIA
- Aberdeen wind energy facility
- Aggeneis-Oranjemund power line intergration
- Project Blue wind energy facility
- Inca De Aar solar energy facility
- Aced De Aar solar energy facility
- Exxaro Lephalale solar energy facility
- Happy Valley wind energy facility
- Hendrina power station ash dam extension
- Hidden Valley wind energy facility
- Kakamas photovoltaic plant
- Karoo renewable energy facility
- Ilanga (Karoskraal) solar thermal power plant
- Keimoes photovoltaic plants (Sonnenberg, Ofir and Geelkop)
- Kimberley photovoltaic solar plant
- Kleinbegin photovoltaic plant
- Kleinzee wind energy facility
- Koingnaas wind energy facility
- Oyster Bay wind energy facility
- Ilanga Lethemba (Paardevlei) PV solar energy facility
- Upington photovoltaic solar facility
- Ramphele (Ritchie) PV solar energy facility
- Ruukie (Mpumalanga) coal fired power station
- Saldanha Steel wind energy facility
- Spitskop wind energy facility
- Tsitsikamma community wind energy facility
- Uyekraal wind energy facility
- Veldrift and Saldanha wind energy facilities
- Vredendal photovoltaic solar energy facility
- Wag'nBiekiespan solar energy facility
- Walker Bay wind energy facility
- Etc. *(a comprehensive list can be provided upon request)*

Professional History

4/2017: Professional GISc Practitioner (sole proprietor/self employed)

1/2016 – 3/2017: SMEC South Africa, Pretoria – Technical Specialist

11/1999 – 12/2015: MetroGIS (Pty) Ltd, Pretoria – Director

10/1997 – 10/1999: GISBS (GIS Business Solutions - Q Data Consulting) – Project Manager

4/1990 - 9/1997: GisLAB CC (GIS Laboratory - University of Pretoria) – Member / Project Manager

Courses & Conferences attended

1997 ESRI International User Conference – United States of America

Publications & Papers presented

Name: Gateway to Kruger Map and Guide
Authors: Andy Tinker Photography
Publisher: ATP Publishing
Date: 2010

Name: Kruger National Park Map and Photographic Guide
Authors: Andy Tinker Photography
Publisher: ATP Publishing
Date: 2007

Name: Lowveld and Kruger Guide
Authors: High Branching Team
Publisher: Jacana Media (Pty) Ltd
Date: 2004

Name: Heights to Homes to Oceans (H2O) Water Wise information poster
Authors: Rand Water
Publisher: Rand Water
Date: 2004

Name: Garden Route - Still Bay to Storms River (Discover the Magic)
Authors: Jacana
Publisher: Jacana Media (Pty) Ltd
Date: 2003

Name: KwaZulu-Natal - A celebration of biodiversity
Authors: Jacana
Publisher: Jacana Media (Pty) Ltd
Date: 2001

Name: Pilanesberg Official Map and Park Guide
Authors: North-West Parks & Tourism Board and Jacana
Publisher: Jacana Media (Pty) Ltd
Date: 2001

Name: ESRI Map Book (Volume 13)
Authors: Various
Publisher: Environmental Systems Research Institute (ESRI)
Date: 1998

Name: Environmental Potential Atlas for South Africa
Authors: W. van Riet, J. van Rensburg, P. Claassen, L. du Plessis and T. van Viegen
Publisher: J.L. van Schaik
Date: 1997

Award: Best South African Environmental Technical Paper
Awarded for: National Environmental Potential Atlas (ENPAT National)
Awarded by: Environmental Planning Professions Interdisciplinary Committee (EPPIC)
Date: 1995

Award: Map Gallery Most Analytical Competition - 3rd Place
Awarded for: Environmental Potential Atlas for South Africa
Awarded by: Environmental Systems Research Institute (ESRI)
Date: 1997 International ESRI User Conference

Award: Best Cartographic Map Gallery Competition - 3rd Place
Awarded for: Environmental Potential Atlas for South Africa (Publication)
Awarded by: Environmental Systems Research Institute (ESRI)
Date: 1998 International ESRI User Conference

Award: QDC Performance Award
Awarded for: ENPAT Development
Awarded by: Q Data Consulting
Date: 1998

Award: Best South African Environmental Technical Paper
Awarded for: Environmental Potential Atlas for South Africa (Publication)
Awarded by: Environmental Planning Professions Interdisciplinary Committee (EPPIC)
Date: 1998

Language Skills

Mother Tongue: Afrikaans

Languages	Speak	Read	Write
English	Good	Good	Good
Afrikaans	Good	Good	Good

Dr Neville Bews & Associates
SOCIAL IMPACT ASSESSORS

Curriculum Vitae Neville Bews

Dr. Neville Bews & Associates – Johannesburg, South Africa

EDUCATION

- *B.A. (Soc), University of South Africa, 1980*
- *B.A. (Soc) (Hons), University of South Africa, 1984*
- *The Henley Post Graduate Certificate in Management, Henley Management College, United Kingdom*
- *M.A. (Cum Laude), Rand Afrikaans University, 1999*
- *D. Litt. et Phil., Rand Afrikaans University, 2000*

Dr Neville Bews is a senior social scientist and human resource professional with 36 years' experience. He consults in the fields of Social Impact Assessments and research, and human resource management. He has worked on a number of large infrastructure, mining and water resource projects. He at times lectures at both the Universities of Pretoria and Johannesburg and is a Senior Fellow in the Centre for Sociological Research, Department of Sociology, University of Johannesburg.

EMPLOYMENT HISTORY

Dr Neville Bews & Associates, Johannesburg, South Africa
Social Impact Assessment consultant and part-time lecturer, 2001 – date.
Leads social impact assessments, provides strategic social management advice to clients, acts as reviewer and mentor to young social scientists.

S A Eagle Company Ltd, Johannesburg, South Africa
Employee Relations Manager, 1992 - 2001
Human Resource management and administration; industrial relations; human resource related research projects; designing and leading implementation of research strategies; disciplinary and grievance hearings; negotiating with unions; corporate social responsibility.

Status Management Services
Human Resources Consultant, 1986 – 1992
Management training; employee assistance programmes; industrial relations; recruitment; disciplinary and grievance hearings; negotiating with unions; job evaluation.

City of Johannesburg
Professional Officer - Human Resources, 1977 - 1986
Industrial relations; disciplinary and grievance hearings; negotiating with unions; recruitment, selection and placement; management training; job evaluation.

EXPERIENCE – EXAMPLES

Water resources and regional planning Social Impact Assessments

Department of Water Affairs and Forestry **South Africa**
Social impact assessment for the Mokolo and Crocodile River (West) Water Augmentation Project for increased and assurance of water supply. Research socio-economic circumstances, data analysis, assessment, authored report.

The Aveng (Africa) Group Limited (Grinaker LTA) **South Africa**
Assisting the construction company with the social management of the Mokolo and Crocodile River (West) Water Augmentation Project. Consult and mediate between contractors and affected parties advise on strategies to reduce tensions between contractors and the public.

Department of Water Affairs and Forestry **South Africa**
Ncwabeni Off-Channel Storage Dam for security of water supply in Umzumbe, KwaZulu-Natal. Research socio-economic circumstances, data analysis, assessment, authored report.

Sedibeng District Municipality **South Africa**
Social impact assessment for the Environmental Management Plan for the Sedibeng District, on behalf of Felehetsa Environmental (Pty) Ltd. Research socio-economic circumstances, data analysis, assessment, authored report.

Felehetsa Environmental (Pty) Ltd **South Africa**
Social Impact Assessment for Waterfall Wedge housing and business development situated in Midrand Gauteng. Research socio-economic circumstances, data analysis, assessment, authored report.

NEMAI Consulting Environmental & Social Consultants **South Africa**
Ncwabeni: Off-Channel Storage Dam, KwaZulu-Natal. Research socio-economic circumstances, data analysis, assessment, authored report.

Department of Water and Sanitation **South Africa**
Mzimvubu Water Project Eastern Cape. Research socio-economic circumstances, data analysis, assessment, authored report.

Social Assessments for mining clients

Vale **Mozambique**
Socio-economic impact assessment of proposed Moatize power plant, Tete. Research socio-economic circumstances, data analysis, assessment, authored report.

Exxaro Resources Limited **South Africa**
Social impact assessment for the social and labour plan for Leeuwpan Coal Mine, Delmas. Research socio-economic circumstances, data analysis, assessment, authored report.

Exxaro Resources Limited **South Africa**
Social impact assessment for the social and labour plan for Glen Douglas Dolomite Mine, Henley-on-Klip. Research socio-economic circumstances, data analysis, assessment, authored report.

Exxaro Resources Limited **South Africa**
Social impact assessment for the social and labour plan for Grootegeluk Open Cast Coal Mine, Lephalale. Research socio-economic circumstances, data analysis, assessment, authored report.

Exxaro Resources Limited **South Africa**
Social and labour plan for the Paardekraal Project, Belfast. Research socio-economic circumstances, data analysis, assessment, authored report.

Exxaro Resources Limited **South Africa**
Social impact assessment for the Paardekraal Belfast Project Belfast. Research socio-economic circumstances, data analysis, assessment, authored report.

Kumba Resources Ltd **South Africa**
Social Impact Assessments for the Sishen Iron Ore Mine in Kathu Northern Cape. Research socio-economic circumstances, data analysis, assessment, authored report.

Kumba Resources Ltd **South Africa**
Social Impact Assessments for the Sishen South Project in Postmasburg, Northern Cape. Research socio-economic circumstances, data analysis, assessment, authored report.

Kumba Resources Ltd **South Africa**
Social Impact Assessments for the Dingleton resettlement project at Sishen Iron Ore Mine Kathu, Northern Cape. Research socio-economic circumstances, data analysis, assessment, authored report.

Gold Fields **South Africa**
Social Impact Assessment for the Gold Fields West Wits Project. Research socio-economic circumstances, data analysis, assessment, authored report.

Anglo Coal **South Africa**
Review of social impact assessment for the proposed Waterberg Gas 37-spot coalbed methane (CBM) bulk yield test project.

Sekoko Mining **South Africa**

Sekoko Wayland Iron Ore, Molemole Local Municipalities in Limpopo Province. Research socio-economic circumstances, data analysis, assessment, authored report.

Memor Mining (Pty) Ltd **South Africa**

Langpan Chrome Mine, Thabazimbi, Limpopo. Research socio-economic circumstances, data analysis, assessment, authored report.

Prescali Environmental Consultants (Pty) Ltd **South Africa**

Vlakpoort Open Cast Mine – Thabazimbi, Limpopo. Research socio-economic circumstances, data analysis, assessment, authored report.

Afrimat Ltd **South Africa**

1. Marble Hall Lime Burning Project: Social Impact Assessment – Limpopo.
2. Glen Douglas Lime Burning Project: Social Impact Assessment - Henley-on Klip, Midvaal

Social assessments for regional and linear projects

Gautrans **South Africa**

Social impact for the Gautrain Rapid Rail Link, Pretoria to Johannesburg and Kempton Park. Managed a team of 10 field workers, research socio-economic circumstances, data analysis, assessment, and co-authored report.

South African National Road Agency Limited **South Africa**

Social Impact of tolling the Gauteng Freeway Improvement Project. Research socio-economic circumstances, data analysis, assessment, authored report.

South African National Road Agency Limited **South Africa**

Social Impact of the N2 Wild Coast Toll Highway. Managed a team of three specialists. Research socio-economic circumstances, data analysis, assessment, co-authored report.

South African National Road Agency Limited **South Africa**

SIA for the N3 Keeversfontein to Warden (De Beers Pass Section). Research socio-economic circumstances, data analysis, assessment, authored report.

Transnet **South Africa**

Social impact assessment for the Transnet New Multi-Product Pipeline Project (555 km) (Commercial Farmers). Research socio-economic circumstances, data analysis, assessment, authored report.

Eskom Holdings Limited **South Africa**

Social Impact Assessment for the Ubertas 88/11kV Substation in Sandton, Johannesburg. Research socio-economic circumstances, data analysis, assessment, authored report.

Eskom Holdings Limited **South Africa**

Nuclear 1 Power Plant. Assisted with the social impact assessment consulting to Arcus GIBB Engineering & Science. Peer review and adjusted the report and assisted at the public participation feedback meetings.

Eskom Holdings Limited, Transmission Division **South Africa**
Social impact assessment for Eskom Holdings Limited, Transmission Division's Neptune-Poseidon 400kV Power Line in the Eastern Cape. Research socio-economic circumstances, data analysis, assessment, authored report.

Eskom Holdings Limited, Transmission Division **South Africa**
Social Impact assessment for Eskom Holdings Limited, Transmission Division, Forskor-Mernsky 275kV±130km Powerline and Associated Substation Works in Limpopo Province. Research socio-economic circumstances, data analysis, assessment, authored report.

MGTD Environmental **South Africa**
Social impact assessment for a 150MW Photovoltaic Power Plant and Associated Infrastructure in Mpumalanga. Research socio-economic circumstances, data analysis, assessment, authored report.

MGTD Environmental **South Africa**
10MWp Photovoltaic Power Plant & Associated Infrastructure, North West Province. Research socio-economic circumstances, data analysis, assessment, authored report.

eThekwini Municipality **South Africa**
Social impact assessment for the proposed infilling of the Model Yacht Pond at Blue Lagoon, Stiebel Place, Durban. Research socio-economic circumstances, data analysis, assessment, authored report.

MGTD Environmental **South Africa**
ABC Prieska Solar Project; Proposed 75 MWp Photovoltaic Power Plant and its associated infrastructure on a portion of the remaining extent of ERF 1 Prieska, Northern Cape. Research socio-economic circumstances, data analysis, assessment, authored report.

MGTD Environmental **South Africa**
ABC Prieska Solar Project; Proposed 75 MWp Photovoltaic Power Plant and its associated infrastructure on a portion of the remaining extent of ERF 1 Prieska, Northern Cape;

Assessments for social projects and social research

Australia – Africa 2006 Sport Development Program **South Africa**
To establish and assess the impact of the Active Community Clubs Initiative on the communities of NU2 (in the township of Mdantsane)*and Tshabo (a rural village). Lead researcher social, data collection and analysis, assessment.

United Nations Office on Drugs and Crime **South Africa**

Evaluation of a Centre for Violence Against Women in Upington. Research socio-economic circumstances, data analysis, assessment, co-authored report.

University of Johannesburg **South Africa**
Research into research outputs of academics working in the various departments of the university. Research socio-economic circumstances, data analysis, assessment, authored report.

Human Resource and management training

Various national companied **South Africa**
Developed and run various management courses such as, recruitment selection & placement; industrial relations / disciplinary hearings; team building workshops; multiculturalism workshop.
1986-2007

University of South Africa, Department of Industrial Psychology **South Africa**
Developed the performance development study guide for industrial psychology 3. 2000

Authored Chapters in HR books **South Africa**
In Slabbert J.A. de Villiers, A.S. & Parker A (eds.). Managing employment relations in South Africa.
Teamwork within the world-class organisation. 2005
In Muchinsky, P. M. Kriek, H. J. & Schreuder, A. M. G. Personnel Psychology 3rd Edition
Chapter 9 – Human resource planning.
Chapter 10 – The changing nature of work. 2005.
In Rossouw, G. J. and van Vuuren, L. Business Ethics - Made in Africa 4th Edition.
Chapter 11 – Building Trust with Ethics.

South African Management Development Institute (SAMDI) **Democratic Republic of the Congo**
Developed a course on Strategic Human Resource Planning for SAMDI and the Democratic Republic of the Congo as well as trainer's manuals for this course. 2006.

Competition Tribunal **South Africa**
Developed a Performance Management System and Policy for the Competition Tribunal South Africa.
2006

PUBLICATIONS

Bews, N. & Martins, N. 2002. An evaluation of the facilitators of trustworthiness. SA Journal of Industrial Psychology. 28(4), 14-19.

Bews, N. Martins, N. & von der Ohe, H. 2002. Editorial. SA Journal of Industrial Psychology. 28(4), 1.

Bews, N. & Rossouw, D. 2002. Contemporary organisational change and the importance of trust. SA Journal of Industrial Psychology. 28(4), 2-6.

Bews, N. & Uys, T. 2002. The impact of organisational restructuring on perceptions of trustworthiness. SA Journal of Industrial Psychology. 28(4), 21-28.

Bews, N & Rossouw, D. 2002. A role for business ethics in facilitating trustworthiness. Journal of Business Ethics. 39: 377-390.

Bews, N. 2009. A matter of trust – Gaining the confidence of the public and client. IAIA Newsletter Forthcoming (Spring 2009).

Bews, N. 2009. Does he who pays the bill call the shots? Sitting astride client and public interest – the dilemma of maintaining credibility in impact assessments. IAIA Newsletter Winter – 2009.

Bews, N. 2002. Reducing your company's risk of sexual harassment claims. HR Future. (2) 2 10-11.

Bews, N. & Martins, N. von der Ohe, H. 2002. Organisational change and trust: Experiences here and abroad. Management Today, (18) 8 34-35.

Martins, N. Bews, N. & von der Ohe, H. 2002. Organisational change and trust. Lessons from Europe and South African organisations. HR Future, (2)9 46-47.

Rossouw, D. & Bews, N. 2002. The importance of trust within a changing business environment. Management Today. 18(2) 26-27.

Bews, N. 2001. You can put a value to trust in the new economy. HR Future, (1)1 48-49.

Bews, N. 2001. Maintaining trust during organisational change. Management Today, (17) 2 36-39.

Bews, N. 2001. Business ethics, trust and leadership: how does Africa fare? Management Today, (17) 7 14-15.

Rossouw, D & Bews, N. 2001. Trust is on the decline in the workplace, yet it's vital for modern organisational success. People Dynamics. (18) 6 28-30.

Bews, N. & Uys, T. 2001. The effects of restructuring on organisational trust. HR Future, (1)8 50-52.

Rossouw, G. J. & Bews. N. F. 2010. Building Trust with Ethics. In Rossouw, G. J. and van Vuuren, L. Business Ethics - Made in Africa 4th Edition. Cape Town: Oxford University Press.

Bews N. 2005. Teamwork within the world-class organisation. In Slabbert J.A. de Villiers, A.S. & Parker A (eds.). Managing employment relations in South Africa. Durban : Butterworths.

Bews, N. F. 2005. Human resource planning. In Muchinsky, P. M. Kriek, H. J. & Schreuder, A. M. G. 2005. Personnel Psychology 3rd Edition. Cape Town; Oxford University Press.

Bews, N. F. 2005. The changing nature of work. In Muchinsky, P. M. Kriek, H. J. & Schreuder, A. M. G. 2005. Personnel Psychology 3rd Edition. Cape Town; Oxford University Press.

Bews, N. F. 2005. Chapter 9 & 13. In Muchinsky, P. M. Kriek, H. J. & Schreuder, A. M. G. 2005. Instructor’s Manual. Personnel Psychology 3rd Edition. Cape Town; Oxford University Press.

Bews, N. F., Schreuder, A. M. G. & Vosloo, S. E. 2000. Performance Development. Study guide for Industrial Psychology 3. Pretoria: University of South Africa.

Uys, T. and Bews, N. 2003. ''Not in my Backyard'': Challenges in the Social Impact Assessment of the Gautrain. Department of Sociology Seminar, RAU. 23 May 2003.

Bews, N. 2002. The value of trust in the new economy. Industrial Relations Association of South Africa (Irasa). Morning seminar 21 August 2002.

Bews. N, 2002. The issue of trust considered. Knowledge Recourses seminar on Absenteeism. The Gordon Institute of Business. 27 August 2002.

Bews, N. & Uys, T. 2001. The impact of organisational trust on perceptions of trustworthiness. South African Sociological Association Conference. Pretoria.

Bews, N. 2001. Business Trust, Ethics & Leadership:- Made in Africa. International Management Today/Productivity Development Conference. Hosted by Productivity Development (Pty) Ltd & Management Today. Best Knowledge in Leadership Practice Conference 23-24 July 2001.

Bews, N. 2001. Charting new directions in leading organisational culture and climate change. Workplace Transformation and Organisational Renewal. Hosted by The Renaissance Network. November 2001.

Bews, N. 2000. Towards a model for trust. South African Sociological Association Conference. Saldanha.

Bews, N. 2003. 'Social Impact Assessments, theory and practice juxtaposed – Experience from a South African rapid rail project.' New Directions in Impact Assessment for Development: Methods and Practice Conference. University of Manchester, Manchester, England.

MEMBERSHIP OF PROFESSIONAL BODIES

Member of South African Affiliate of the International Association for Impact Assessment (IAIAsa).
Membership Number: 2399
Registered on database for scientific peer review of iSimangaliso GEF project outputs

APPENDIX I(L):

KEY LEGISLATION

APPLICABLE LEGISLATION

Table 1: Applicable Legislation, Policies and/or Guidelines associated with the development of Allepad PV Three

Legislation	Applicable Requirements	Relevant Authority	Compliance Requirements
National Legislation			
Constitution of the Republic of South Africa (No. 108 of 1996)	In terms of Section 24, the State has an obligation to give effect to the environmental right. The environmental right states that: "*Everyone has the right –* » *To an environment that is not harmful to their health or well-being, and* » *To have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that:* ∗ *Prevent pollution and ecological degradation,* ∗ *Promote conservation, and* ∗ *Secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development*."	Applicable to all authorities	There are no permitting requirements associated with this Act. The application of the Environmental Right however implies that environmental impacts associated with proposed developments are considered separately and cumulatively. It is also important to note that the "right to an environment clause" includes the notion that justifiable economic and social development should be promoted, through the use of natural resources and ecologically sustainable development.
National Environmental Management Act (No 107 of 1998) (NEMA)	The 2014 EIA Regulations have been promulgated in terms of Chapter 5 of NEMA. Listed activities which may not commence without EA are identified within the Listing Notices (GNR 327, GNR 325 and GNR 324) which form part of these Regulations (GNR 326). In terms of Section 24(1) of NEMA, the potential impact on the environment associated with these listed activities must be assessed and reported on to the competent authority charged by NEMA with granting of the relevant environmental authorisation.	DEA – Competent Authority Northern Cape DENC – Commenting Authority	The listed activities triggered by the proposed project have been identified and are being assessed as part of the EIA process currently underway for the project. The Scoping and EIA process will culminate in the submission of a Final EIA Report to the competent and commenting authority in support of the application for EA.

Legislation	Applicable Requirements	Relevant Authority	Compliance Requirements
	In terms of the Listing Notices (GNR 327, GNR 325 and GNR 324), a full Scoping and EIA Process is required to be undertaken for the proposed project.		
National Environmental Management Act (No 107 of 1998) (NEMA)	In terms of the "Duty of Care and Remediation of Environmental Damage" provision in Section 28(1) of NEMA every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment. In terms of NEMA, it is the legal duty of a project proponent to consider a project holistically, and to consider the cumulative effect of a variety of impacts.	DEA Northern Cape DENC	While no permitting or licensing requirements arise directly by virtue of the proposed project, this section finds application during the EIA Phase through the consideration of potential cumulative, direct, and indirect impacts. It will continue to apply throughout the life cycle of the project.
Environment Conservation Act (No. 73 of 1989) (ECA)	The Noise Control Regulations in terms of Section 25 of the ECA contain regulations applicable for the control of noise in the Provinces of Limpopo, North West, Mpumalanga, Northern Cape, Eastern Cape, and KwaZulu-Natal Provinces. The Noise Control Regulations cover the powers of a local authority, general prohibitions, prohibitions of disturbing noise, prohibitions of noise nuisance, use of measuring instruments, exemptions, attachments, and penalties. In terms of the Noise Control Regulations, no person shall make, produce or cause a disturbing noise, or allow it to be made, produced or caused by any person, machine, device or apparatus or any combination thereof	DEA Northern Cape DENC Dawid Kruiper LM	Noise impacts are expected to be associated with the construction phase of the project. Provided that appropriate mitigation measures are implemented, construction noise is likely to present a significant intrusion to the local community. There is therefore no requirement for a noise permit in terms of the legislation.

Legislation	Applicable Requirements	Relevant Authority	Compliance Requirements
	(Regulation 04).		
National Water Act (No. 36 of 1998) (NWA)	A water use listed under Section 21 of the NWA must be licensed with the Regional DWS, unless it is listed in Schedule 1 of the NWA (i.e. is an existing lawful use), is permissible under a GA, or if a responsible authority waives the need for a licence. Water use is defined broadly, and includes consumptive and non-consumptive water uses, taking and storing water, activities which reduce stream flow, waste discharges and disposals, controlled activities (activities which impact detrimentally on a water resource), altering a watercourse, removing water found underground for certain purposes, and recreation. Consumptive water uses may include taking water from a water resource (Section 21(a)), and storing water (Section 21(b)). Non-consumptive water uses may include impeding or diverting of flow in a water course (Section 21(c)), and altering of bed, banks or characteristics of a watercourse (Section 21(i)).	Regional DWS	The development footprint avoids all watercourses and therefore Allepad PV Three will not have an impact on watercourses. In the event that development activities impede or divert the flow of water in a watercourse, or alter the bed, banks, course or characteristics of watercourse, Section 21(c) and 21 (i) of the NWA would be triggered, and the project proponent would need to apply for a WUL or register a GA with the DWS.
Minerals and Petroleum Resources Development Act (No. 28 of 2002) (MPRDA)	In accordance with the provisions of the MPRDA a mining permit is required in accordance with Section 27(6) of the Act where a mineral in question is to be mined, including the mining of materials from a borrow pit.	DMR	Any person who wishes to apply for a mining permit in accordance with Section 27(6) must simultaneously apply for an Environmental Authorisation in terms of NEMA. No borrow pits are expected to be required for the construction of the project, and as a result a mining permit or EA is not required to be obtained.
	Section 53 of the MPRDA states that any person who		In terms of Section 53 of the MPRDA approval

Legislation	Applicable Requirements	Relevant Authority	Compliance Requirements
	intends to use the surface of any land in any way which may be contrary to any object of the Act, or which is likely to impede any such object must apply to the Minister for approval in the prescribed manner.		is required from the Minister of Mineral Resources to ensure that the proposed development does not sterilise a mineral resource that might occur on site.
National Environmental Management: Air Quality Act (No. 39 of 2004) (NEM:AQA)	The National Dust Control Regulations (GNR 827) published under Section 32 of NEM:AQA prescribe the general measures for the control of dust in all areas, and provide a standard for acceptable dustfall rates for residential and non-residential areas. In accordance with the Regulations (GNR 827) any person who conducts any activity in such a way as to give rise to dust in quantities and concentrations that may exceed the dustfall standard set out in Regulation 03 must, upon receipt of a notice from the air quality officer, implement a dustfall monitoring programme. Any person who has exceeded the dustfall standard set out in Regulation 03 must, within three months after submission of the dustfall monitoring report, develop and submit a dust management plan to the air quality officer for approval.	Northern Cape DENC / ZF Mgcawu DM	In the event that the project results in the generation of excessive levels of dust the possibility could exist that a dustfall monitoring programme would be required for the project, in which case dustfall monitoring results from the dustfall monitoring programme would need to be included in a dust monitoring report, and a dust management plan would need to be developed. However granted that appropriate mitigation measures are implemented, the proposed project is not anticipated to result in significant dust generation.
National Heritage Resources Act (No. 25 of 1999) (NHRA)	Section 07 of the NHRA stipulates assessment criteria and categories of heritage resources according to their significance. Section 35 of the NHRA provides for the protection of all archaeological and palaeontological sites, and meteorites. Section 36 of the NHRA provides for the conservation and care of cemeteries and graves by SAHRA where this is not	SAHRA Ngwao Boswa Kapa Bokone (NBKB)	A full Heritage Impact Assessment (HIA) (with field work) has been undertaken as part of the EIA Phase (refer to **Appendix F** of this EIA Report). A possible burial site and a concentration of MSA, LSA including a large ESA flake have been identified within the project site. Both sites are of some heritage significance and applicable no-go buffer zones have been recommended by the specialist. Both sites and buffer zones are

Legislation	Applicable Requirements	Relevant Authority	Compliance Requirements
	the responsibility of any other authority. Section 38 of the NHRA lists activities which require developers or any person who intends to undertake a listed activity to notify the responsible heritage resources authority and furnish it with details regarding the location, nature, and extent of the proposed development. Section 44 of the NHRA requires the compilation of a Conservation Management Plan as well as a permit from SAHRA for the presentation of archaeological sites as part of tourism attraction.		avoided by the development footprint of Allepad PV Three and associated infrastructure. Should a heritage resource be impacted upon, a permit may be required from SAHRA or Ngwao Boswa Kapa Bokone (NBKB) in accordance with of Section 48 of the NHRA, and the SAHRA Permit Regulations (GNR 668). This will be determined once the final location of the project and its associated infrastructure within the project site has been determined.
National Environmental Management: Biodiversity Act (No. 10 of 2004) (NEM:BA)	Section 53 of NEM:BA provides for the MEC / Minister to identify any process or activity in such a listed ecosystem as a threatening process. Three government notices have been published in terms of Section 56(1) of NEM:BA as follows: » Commencement of TOPS Regulations, 2007 (GNR 150). » Lists of critically endangered, vulnerable and protected species (GNR 151). » TOPS Regulations (GNR 152). It provides for listing threatened or protected ecosystems, in one of four categories: critically endangered (CR), endangered (EN), and vulnerable (VU) or protected. The first national list of threatened terrestrial ecosystems has been gazetted, together with supporting information on the listing process including the purpose and rationale for listing ecosystems, the criteria used to identify listed ecosystems, the implications of listing ecosystems, and	DEA Northern Cape DENC	Under NEM:BA, a permit would be required for any activity which is of a nature that may negatively impact on the survival of a listed protected species. Although it was not observed, it is possible that Devils' Claw *Harpagophytum procumbens* is present at the project site, within the dune areas as this species is relatively common on Gordonia Duneveld in the Upington area.

Legislation	Applicable Requirements	Relevant Authority	Compliance Requirements
	summary statistics and national maps of listed ecosystems (NEM:BA: National list of ecosystems that are threatened and in need of protection, (Government Gazette 37596, GNR 324), 29 April 2014).		
National Environmental Management: Biodiversity Act (No. 10 of 2004) (NEM:BA)	Chapter 5 of NEM:BA pertains to alien and invasive species, and states that a person may not carry out a restricted activity involving a specimen of an alien species without a permit issued in terms of Chapter 7 of NEM:BA, and that a permit may only be issued after a prescribed assessment of risks and potential impacts on biodiversity is carried out. Applicable, and exempted alien and invasive species are contained within the Alien and Invasive Species List (GNR 864).	DEA Northern Cape DENC	Restricted Activities and the respective requirements applicable to persons in control of different categories of listed invasive species are contained within the Alien and Invasive Species Regulations (GNR 598) published under NEM:BA, together with the requirements of the Risk Assessment to be undertaken.
Conservation of Agricultural Resources Act (No. 43 of 1983) (CARA)	Section 05 of CARA provides for the prohibition of the spreading of weeds. Regulation 15 of GNR 1048 published under CARA provides for the classification of categories of weeds and invader plants, and restrictions in terms of where these species may occur. Regulation 15E of GNR 1048 published under CARA provides requirement and methods to implement control measures for different categories of alien and invasive plant species.	DAFF	CARA will find application throughout the life cycle of the project. In this regard, soil erosion prevention and soil conservation strategies need to be developed and implemented. In addition, a weed control and management plan must be implemented. The permission of DAFF will be required if the Project requires the draining of vleis, marshes or water sponges on land outside urban areas. However this is not anticipated to be required for the project. In terms of Regulation 15E (GNR 1048) where Category 1, 2 or 3 plants occur a land user is required to control such plants by means of one or more of the following methods:

Legislation	Applicable Requirements	Relevant Authority	Compliance Requirements
			» Uprooting, felling, cutting or burning. » Treatment with a weed killer that is registered for use in connection with such plants in accordance with the directions for the use of such a weed killer. » Biological control carried out in accordance with the stipulations of the Agricultural Pests Act (No. 36 of 1983), the ECA and any other applicable legislation. » Any other method of treatment recognised by the executive officer that has as its object the control of plants concerned, subject to the provisions of sub-regulation (4). » A combination of one or more of the methods prescribed, save that biological control reserves and areas where biological control agents are effective shall not be disturbed by other control methods to the extent that the agents are destroyed or become ineffective.
National Forests Act (No. 84 of 1998) (NFA)	According to this Act, the Minister may declare a tree, group of trees, woodland or a species of trees as protected. Notice of the List of Protected Tree Species under the National Forests Act (No. 84 of 1998) was published in GNR 734. The prohibitions provide that "no person may cut, damage, disturb, destroy or remove any protected tree, or collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any	DAFF	A licence is required for the removal of protected trees. It is therefore necessary to conduct a survey that will determine the number and relevant details pertaining to protected tree species present on the project site for the submission of relevant permits to authorities prior to the disturbance of these individuals. The ecological specialist study undertaken as

Legislation	Applicable Requirements	Relevant Authority	Compliance Requirements
	protected tree, except under a licence granted by the Minister".		part of the EIA Phase included a site visit which allowed for the identification of any protected tree species which may require a license in terms of the NFA within the project site (refer to **Appendix D** of this EIA Report). Three NFA-protected tree species occur within the project site; *Acacia erioloba*, *Acacia haematoxylon* and *Boscia albitrunca*. All three of these species are associated with the dune field areas located within the eastern portion of the project site.
National Veld and Forest Fire Act (No. 101 of 1998) (NVFFA)	Chapter 4 of the NVFFA places a duty on owners to prepare and maintain firebreaks, the procedure in this regard, and the role of adjoining owners and the fire protection association. Provision is also made for the making of firebreaks on the international boundary of the Republic of South Africa. The applicant must ensure that firebreaks are wide and long enough to have a reasonable chance of preventing a veldfire from spreading to or from neighbouring land, it does not cause soil erosion, and it is reasonably free of inflammable material capable of carrying a veldfire across it. Chapter 5 of the Act places a duty on all owners to acquire equipment and have available personnel to fight fires. Every owner on whose land a veldfire may start or burn or from whose land it may spread must have such equipment, protective clothing and trained personnel for extinguishing fires, and ensure that in his or her absence responsible persons are present on or near his or her land who, in the event of fire, will extinguish the fire or assist in	DAFF	While no permitting or licensing requirements arise from this legislation, this Act will be applicable during the construction and operation of the project, in terms of the preparation and maintenance of firebreaks, and the need to provide appropriate equipment and personnel for firefighting purposes.

Legislation	Applicable Requirements	Relevant Authority	Compliance Requirements
	doing so, and take all reasonable steps to alert the owners of adjoining land and the relevant fire protection association, if any.		
Hazardous Substances Act (No. 15 of 1973) (HAS)	This Act regulates the control of substances that may cause injury, or ill health, or death due to their toxic, corrosive, irritant, strongly sensitising or inflammable nature or the generation of pressure thereby in certain instances and for the control of certain electronic products. To provide for the rating of such substances or products in relation to the degree of danger, to provide for the prohibition and control of the importation, manufacture, sale, use, operation, modification, disposal or dumping of such substances and products. » Group I and II: Any substance or mixture of a substance that might by reason of its toxic, corrosive etc., nature or because it generates pressure through decomposition, heat or other means, cause extreme risk of injury etc., can be declared as Group I or Group II substance » Group IV: any electronic product, and » Group V: any radioactive material. The use, conveyance, or storage of any hazardous substance (such as distillate fuel) is prohibited without an appropriate license being in force.	Department of Health (DoH)	It is necessary to identify and list all Group I, II, III, and IV hazardous substances that may be on site and in what operational context they are used, stored or handled. If applicable, a license would be required to be obtained from the Department of Health (DoH).
National Environmental Management: Waste Act (No. 59 of 2008) (NEM:WA)	The Minister may by notice in the Gazette publish a list of waste management activities that have, or are likely to have, a detrimental effect on the environment. The Minister may amend the list by –	DEA – hazardous waste Northern Cape DENC – general waste	No listed activities are triggered by the project and therefore no Waste Management License is required to be obtained. General and hazardous waste handling, storage and disposal will be required during construction and operation. The National Norms and

Legislation	Applicable Requirements	Relevant Authority	Compliance Requirements
	» Adding other waste management activities to the list. » Removing waste management activities from the list. » Making other changes to the particulars on the list. In terms of the Regulations published in terms of NEM:WA (GNR 912), a BA or EIA is required to be undertaken for identified listed activities. Any person who stores waste must at least take steps, unless otherwise provided by this Act, to ensure that: » The containers in which any waste is stored, are intact and not corroded or in » Any other way rendered unlit for the safe storage of waste. » Adequate measures are taken to prevent accidental spillage or leaking. » The waste cannot be blown away. » Nuisances such as odour, visual impacts and breeding of vectors do not arise, and » Pollution of the environment and harm to health are prevented.		Standards for the Storage of Waste (GNR 926) published under Section 7(1)(c) of NEM:WA will need to be considered in this regard.
National Road Traffic Act (No. 93 of 1996) (NRTA)	The technical recommendations for highways (TRH 11): "Draft Guidelines for Granting of Exemption Permits for the Conveyance of Abnormal Loads and for other Events on Public Roads" outline the rules and conditions which apply to the transport of abnormal loads and vehicles on public roads and the detailed procedures to be followed in applying for exemption permits are described and discussed. Legal axle load limits and the restrictions imposed on	SANRAL – national roads Northern Cape DoT	An abnormal load / vehicle permit may be required to transport the various components to site for construction. These include route clearances and permits will be required for vehicles carrying abnormally heavy or abnormally dimensioned loads. Transport vehicles exceeding the dimensional limitations (length) of 22m. Depending on the trailer configuration and height when loaded, some of the substation components may not meet

Legislation	Applicable Requirements	Relevant Authority	Compliance Requirements
	abnormally heavy loads are discussed in relation to the damaging effect on road pavements, bridges, and culverts. The general conditions, limitations, and escort requirements for abnormally dimensioned loads and vehicles are also discussed and reference is made to speed restrictions, power/mass ratio, mass distribution, and general operating conditions for abnormal loads and vehicles. Provision is also made for the granting of permits for all other exemptions from the requirements of the National Road Traffic Act and the relevant Regulations.		specified dimensional limitations (height and width).
	Provincial Policies / Legislation		
Northern Cape Nature Conservation Act (Act No. 9 of 2009)	This Act provides for the sustainable utilisation of wild animals, aquatic biota and plants; provides for the implementation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora; provides for offences and penalties for contravention of the Act; provides for the appointment of nature conservators to implement the provisions of the Act; and provides for the issuing of permits and other authorisations. Amongst other regulations, the following may apply to the current project: » Boundary fences may not be altered in such a way as to prevent wild animals from freely moving onto or off of a property; » Aquatic habitats may not be destroyed or damaged; » The owner of land upon which an invasive species is found (plant or animal) must take the necessary steps to eradicate or destroy such species; The Act provides lists of protected species for the Province.	Northern Cape Department of Environment and Nature Conservation (DENC).	A collection/destruction permit must be obtained from Northern Cape Nature Conservation for the removal of any protected plant or animal species found on site. The Ecological Impact Assessment (**Appendix D**) did not identify any species protected under this Act within the development footprint. The provincially protected *Boscia foetida* subsp. *foetida* has been confirmed within the project site and is fairly widespread.

APPENDIX I(M):

OTHER

APPENDIX I(M1):

CHANCE FIND PROCEDURE

CTS HERITAGE

CHANCE FINDS OF PALAEONTOLOGICAL MATERIAL

(Adopted from the HWC Chance Fossils Finds Procedure: June 2016)

Introduction

This document is aimed to inform workmen and foremen working on a construction and/or mining site. It describes the procedure to follow in instances of accidental discovery of palaeontological material (please see attached poster with descriptions of palaeontological material) during construction/mining activities. This protocol does not apply to resources already identified under an assessment undertaken under s. 38 of the National Heritage Resources Act (no 25 of 1999).

Fossils are rare and irreplaceable. Fossils tell us about the environmental conditions that existed in a specific geographical area millions of years ago. As heritage resources that inform us of the history of a place, fossils are public property that the State is required to manage and conserve on behalf of all the citizens of South Africa. Fossils are therefore protected by the National Heritage Resources Act and are the property of the State. Ideally, a qualified person should be responsible for the recovery of fossils noticed during construction/mining to ensure that all relevant contextual information is recorded.

Heritage Authorities often rely on workmen and foremen to report finds, and thereby contribute to our knowledge of South Africa's past and contribute to its conservation for future generations.

Training

Workmen and foremen need to be trained in the procedure to follow in instances of accidental discovery of fossil material, in a similar way to the Health and Safety protocol. A brief introduction to the process to follow in the event of possible accidental discovery of fossils should be conducted by the designated Environmental Control Officer (ECO) for the project, or the foreman or site agent in the absence of the ECO It is recommended that copies of the attached poster and procedure are printed out and displayed at the site office so that workmen may familiarise themselves with them and are thereby prepared in the event that accidental discovery of fossil material takes place.

Actions to be taken

One person in the staff must be identified and appointed as responsible for the implementation of the attached protocol in instances of accidental fossil discovery and must report to the ECO or site agent. If the ECO or site agent is not present on site, then the responsible person on site should follow the protocol correctly in order to not jeopardize the conservation and well-being of the fossil material.

Once a workman notices possible fossil material, he/she should report this to the ECO or site agent.Procedure to follow if it is likely that the material identified is a fossil:

- The ECO or site agent must ensure that all work ceases immediately in the vicinity of the area where the fossil or fossils have been found;
- The ECO or site agent must inform SAHRA of the find immediately. This information must include photographs of the findings and GPS co-ordinates;
- The ECO or site agent must compile a Preliminary Report and fill in the attached Fossil Discoveries: Preliminary Record Form within 24 hours without removing the fossil from its original position. The Preliminary Report records basic information about the find including:
    - The date
    - A description of the discovery
    - A description of the fossil and its context (e.g. position and depth of find)
    - Where and how the find has been stored
    - Photographs to accompany the preliminary report (the more the better):
        - A scale must be used
        - Photos of location from several angles
        - Photos of vertical section should be provided
        - Digital images of hole showing vertical section (side);
        - Digital images of fossil or fossils.

Upon receipt of this Preliminary Report, SAHRA will inform the ECO or site agent whether or not a rescue excavation or rescue collection by a palaeontologist is necessary.

- Exposed finds must be stabilised where they are unstable and the site capped, e.g. with a plastic sheet or sand bags. This protection should allow for the later excavation of the finds with due scientific care and diligence. SAHRA can advise on the most appropriate method for stabilisation.
- If the find cannot be stabilised, the fossil may be collect with extreme care by the ECO or the site agent and put aside and protected until SAHRA advises on further action. Finds collected in this way must be safely and securely stored in tissue paper and an appropriate box. Care must be taken to remove the all fossil material and any breakage of fossil material must be avoided at all costs.

No work may continue in the vicinity of the find until SAHRA has indicated, in writing, that it is appropriate to proceed.

CTS HERITAGE

FOSSIL DISCOVERIES: PRELIMINARY RECORDING FORM		
Name of project:		
Name of fossil location:		
Date of discovery:		
Description of situation in which the fossil was found:		
Description of context in which the fossil was found:		
Description and condition of fossil identified:		
GPS coordinates:	*Lat:*	*Long:*
If no co-ordinates available then please describe the location:		
Time of discovery:		
Depth of find in hole		
Photographs (tick as appropriate and indicate number of the photograph)	*Digital image of vertical section (side)*	
	Fossil from different angles	
	Wider context of the find	
Temporary storage (where it is located and how it is conserved)		
Person identifying the fossil Name:		
Contact:		
Recorder Name:		
Contact:		
Photographer Name:		
Contact:		

APPENDIX I(M2):

BIRDLIFE SA SOLAR GUIDELINES

Guidelines to minimise the impact on birds of Solar Facilities and Associated Infrastructure in South Africa

Smit, Hanneline A.[1]
(Reviewed by Dr Phoebe Barnard[2], Dr Andrew Jenkins[3], Tania Anderson[4,] Jon Smallie[5] and Samantha Ralston[6])

[1] ***Conservation Manager, BirdLife South Africa (conservation@birdlife.org.za)***
[2] ***Birds & Environmental Change Programme, South African National Biodiversity Institute (P.Barnard@sanbi.org.za)***
[3] ***Avisense Consulting (andrew@avisense.co.za)***
[4]**Head of Botany, McGregor Museum *(spothil@gmail.com)***
[5] ***WildSkies Ecological Services (jonsmallie@gmail.com)***
[6]***Birds and Renewable Energy Manager, Birdlife South Africa (energy@birdlife.org.za)***

BirdLife South Africa supports the use of solar energy generation in the reduction of greenhouse gas emissions in South Africa, which has been identified as amongst the top 10 developing countries that need to reduce their carbon emissions significantly. It is highly likely that solar holds amongst the highest renewable potential for South Africa.

Two types of solar power generation or Solar Energy Facilities (SEF) are currently available in South Africa:

1. Solar photovoltaic (PV) electricity generation, which converts solar radiation directly into electricity through a solar panel.
2. Concentrated Solar Power (CSP) farms (plants), which consists of a series of mirrors/heliostats/trough panels that reflect sunlight. The reflected heat is mostly concentrated onto a central receiver tower and standby focal points (although other technology within CSP exists). The heat is used to raise steam to drive turbines and generators.

In its position statement[1], BirdLife South Africa states that its main concern about both types of solar power generation – photovoltaic and concentrated solar power – is that they can potentially cause the displacement or exclusion from important habitats of nationally and/or globally threatened, rare, endemic or range-restricted bird species. Other potential risks include collision with the reflective surfaces. After discussions with authorities, NGOs and the solar industry, BirdLife South Africa has drawn up the following Guidelines to Minimise the Impact on Birds of Solar Facilities and Associated Infrastructure in South Africa.

[1] http://www.birdlife.org.za/images/stories/conservation/birds_and_wind_energy/solar_power.pdf

Is an avifaunal specialist study a necessary part of the EIA?

The displacement or the exclusion of species, particularly threatened, endemic and range-restricted species, are potentially the most significant impacts SEF facilities can have on birds. As the introduction of this technology could result in a rapid alteration of large areas of habitat, this represents a potentially new threat to species. BirdLife South Africa therefore recommends that an avifaunal specialist be consulted for all proposed solar energy facilities.

We suggest that the specialist assessment should follow a two-phased approach:

1. A desktop analysis of existing literature and data (e.g. SABAP1, SABAP2, CWAC, CAR, distance to formal protected areas, wetlands and Important Bird Areas).
2. The desktop analysis should be followed by a site assessment of approximately 3-5 days[2].
    a. The site assessment should be designed to confirm the presence, abundance, habitat preferences and flyways of priority species (Priority species will include nationally and/or globally threatened, rare, endemic, or range-restricted bird species, or large numbers of other bird species).
    b. The duration of the site visit should be informed by information gaps for the area in question, as well as the sensitivity of the area and the species likely to be present.

The specialist should assess the significance of the likely impacts of the proposed facility and its associated infrastructure on the avifauna of priority and at highest risk, help identify alternative locations or layouts for the facility and recommend other mitigation measures that would help reduce the significance of negative impacts on birds.

[2] In exceptional circumstances a site assessment may not be necessary (e.g. if there is large amount of existing data for the area, and a desktop analysis by a specialist indicates that there is a low risk to avifauna). Please consult with BirdLife South Africa should you suspect a site visit is not required.

	Possible Impact on Birds[3]	Possible Mitigation	
		Photovoltaic (PV)	**Concentrated Solar Power (CSP)**
1.	**Displacement** of nationally and / or globally Threatened, Rare, Endemic or Range Restricted bird species from important habitats	Preconstruction Monitoring needed to determine the presence of Threatened, Rare, Endemic or Range Restricted bird species. Note: Species lists can be retrieved from the Southern African Bird Atlas Project 2 (SABAP2) for 5' x 5' minute grid cells (pentads). If SABAP2 data are unavailable for the site investigate whether alternative species lists or data from adjacent pentads can be used. Species lists can only be used to guide monitoring intensity of and must not replace comprehensive monitoring. Monitoring should take into account seasonal variation, fly paths and birds' behaviour.	Preconstruction Monitoring needed to determine the presence of Threatened, Rare, Endemic or Range Restricted bird species. Note: Species lists can be retrieved from the Southern African Bird Atlas Project 2 (SABAP2) for 5' x 5' minute grid cells (pentads). If SABAP2 data are unavailable for the site investigate whether alternative species lists or data from adjacent pentads can be used. Species lists can only be used to guide monitoring intensity of and must not replace comprehensive monitoring. Monitoring should take into account seasonal variation, fly paths and birds' behaviour.

[3] Summary adapted from Environmental Management Volume 7 Number 2 p.14 -16

2.	**Loss of habitat** for resident bird species caused by construction, operation and maintenance activities (of CSP and PV). Cumulative impacts due to habitat loss and displacement on threatened, endemic and range-restricted species should also be considered.	As above (see mitigation point 1)	As above (see mitigation point 1)
3.	**Disturbance** of resident bird species caused by construction, operation and maintenance activities (of CSP and PV).	As above (see mitigation point 1)	As above (see mitigation point 1)
4.	**CSP Infrastructure** farms carry an additional risk because of the associated central receiver tower, standby focal points and heliostats. **Collision** with the central receiver tower	Not applicable (associated PV infrastructure does not pose same avifaunal impact). Not applicable (associated PV infrastructure does not pose same avifaunal impact).	Some Parabolic Trough CSP plants are being developed without the associated central receiver tower, or use of standby focus points, or heliostats, it should however, be noted that the possible impact on avifauna should still be evaluated and documented in the EIA. The position and height of the receiver tower should be taken into account at Parabolic Trough CSP plants developed with a central receiver tower.
5.	**Reflective surfaces** act as attractants for approaching birds. These surfaces may be confused for large water bodies (with similar effects as windows) and can cause disorientation of flying birds, resulting in injury and/or death.	Not applicable (Photovoltaic panels are less reflective)	Reflective surfaces which are parabolic (curved) in shape reduce the likelihood of skyward reflection; whereas flat heliostats have an increased associated risk of being reflective.

6.	**Mirror collision.** Mirrors are used to concentrate sunlight which can create large amounts of heat, killing birds on collision.	Not applicable	Ensure that Trough Receivers use evacuated glass tubes (or similar technology) to reduce heat loss which result in low receiver temperatures which will not burn birds. In addition, Parabolic Trough CSP plants are being developed where sunlight is focused on a receiver which is very close to the mirror at the aperture of the mirror. As a result it is less likely that a bird will fly between the receiver and mirror. Note: Be sure to check the technology used.
7.	Birds could be **burnt** when in the vicinity of the central receiver or when entering the standby focal points (specifically relevant to swallows, swifts and martins which spend most of their time in flight).	Not applicable	Not applicable when Parabolic Trough CSP plants are developed which do not have a central receiver tower; otherwise a relevant concern for CSP.
8.	**Water pollution** caused by leaching of **lethal** chemical substances into waste water evaporation ponds. Artificial evaporation ponds attract waterbirds, which could increase cumulative collision, drowning, burning or poisoning impacts. **Water extraction -** be sure that the extraction method is environmentally friendly.	Not applicable (PV does not use evaporation ponds). Altered run off patterns could lead to changes in bird distribution and abundance, and possibly soil erosion.	Ensure that birds do not get in contact with evaporation ponds i.e. ponds should be covered with wire mesh or netting to reduce the possibilities of a) attracting; b) drowning and c) poisoning.

9.	**Roosting, foraging** and **nesting** on or around the CSP plant infrastructure (i.e. attracting more birds to the solar facility).	Birds will be likely to roost/perch/nest on the photovoltaic panels (if these are fixed in one angle) and associated infrastructure. Such behaviour could lead to panel obstruction and polluting. In e.g. the Northern Cape, colonies of sociable weavers could potentially use the associated infrastructure as a nesting place.	Unlikely (but not impossible) due to disturbance caused by the overall operation of the solar facility.
10.	**Electrocution and collision** caused when perching on, or flying into, the power line infrastructure.	Ensure that sites are close to existing power lines, so that few new lines are required.. If new lines are constructed, motivate the need for these lines to be marked with anti-collision marking devices & constructed with bird friendly designs to prevent electrocution.	Ensure that sites are close to existing power lines requiring negligible new lines. If new lines are constructed, motivate the need for these lines to be marked with anti- collision marking devices & constructed with bird friendly designs to prevent electrocution.
11.	**New power line construction:** Habitat destruction and disturbance/exclusion of avifauna through construction (short-term) and maintenance (long-term) of new power line infrastructure.	As above (see mitigation point 1)	As above (see mitigation point 1)
12.	**New road construction: habitat destruction** and **disturbance** of birds caused by the **construction** and maintenance of roads.	As above (see mitigation point 1)	As above (see mitigation point 1)

Monitoring

In order to for us to better understand and successfully mitigate the possible impacts solar energy facilities on both a regional and project specific scale, BirdLife South Africa recommends that the environmental management programme includes the requirement for annual post-construction monitoring by a avifaunal specialist. This should be based on a minimum of 3-5 days observations. Any avian mortality or injury at the facility should also be duly recorded and reported.

BirdLife South Africa requests that these reports are sent to us where they will be centrally housed. In this way we will be able to facilitate a better understanding of the nature, scale and duration of impacts on birds at a national level.

For further information, contact:

Samantha Ralston
Birds and Renewable Energy Manager
BirdLife South Africa
Email: energy@birdlife.org.za

or
Dr Hanneline Smit
Conservation Manager/Oppenheimer Fellow of Conservation
BirdLife South Africa
Email: conservation@birdlife.org.za

http://www.birdlife.org.za

Annexure 1: High level comparison between a Photovoltaic Solar Facility (PV) and a Concentrated Solar Power (CSP) Facility.

<u>Photovoltaic Solar Facility (PV)</u>

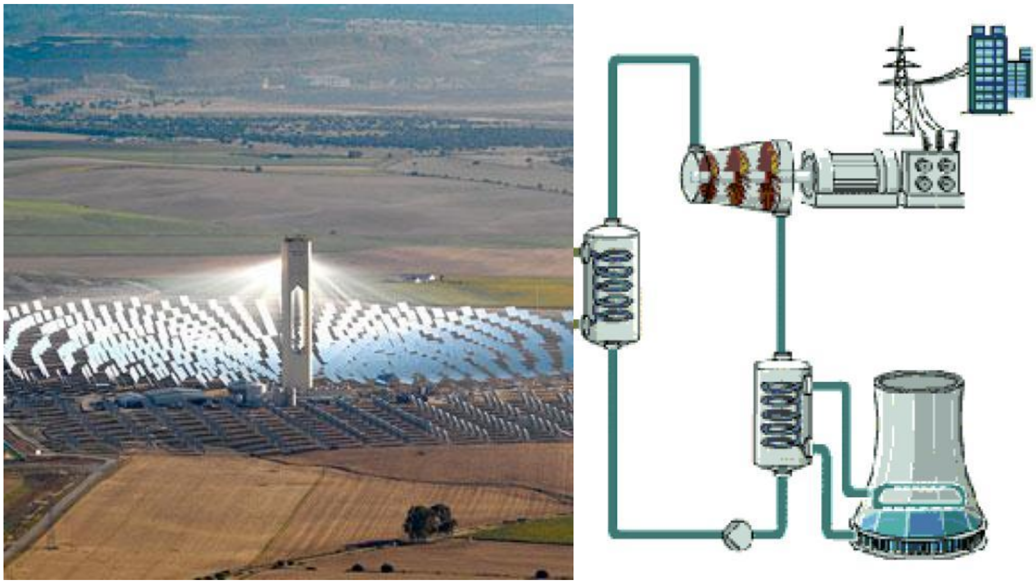
- A PV Solar Farm consist of an area covered by photovoltaic panels
- The size of the PV Solar Farm can vary in size
- PV uses semi-conductor materials to convert sunlight directly into electricity
- PV panels can be fixed or track the sun in one or two axes
- PV panels are less reflective

Figure 1: Photovolatic (PV) solar farm showing typical arrangement of photovoltaic panels.

<u>Concentrated Solar Power Facility (CSP)</u>

- CSP farms consist of a series of heliostats/trough panels with mirrors which concentrate sunlight on a receiver tower (although some CSP farms are developed without receiver towers).
- CSP farms potentially have greater impacts on birds than PV farms because of the associated central receiver tower, standby focal points and heliostats.
- CSP operates by concentrating the suns energy to produce heat which either drives a steam turbine or an external heat engine to produce electricity. A liquid [known as heat transfer fluid (HTF) which usually consists of a mix of oils] or a gas medium is heated and this is used to convert water to steam, which is used to generate electricity through a steam turbine generator. The heated liquid (HTF) or gas medium is then cooled, condensed and reused
- The need exists for waste water evaporation ponds to separate out sludge or solids containing hazardous chemicals from the chemical waste water, cycle

water blow down and cleaning liquids. Such materials are removed from the ponds by a licensed waste company. Hazardous waste should be disposed at a hazardous waste and if not hazardous, it should be disposed at a landfill site.



(a) (b)

Figure 2: (a) Concentrated Solar Power (CSP) Facility - Parabolic troughs concentrating sunlight on the central receiver tower. (b) Schematic presentation of CSP technology and the layout of a CSP Facility. CSP operates by concentrating the sun's energy to produce heat which either drives a steam turbine or an external heat engine to produce electricity. The heated liquid (HTF) or gas medium is then cooled, condensed and reused.

NOTE:

- Technology within PV and CSP also differs.
- Familiarise yourself with the technology being used.
- **For further information on technology contact SAPVIA – the South African Photo Voltaic Industry Association. http://www.sapvia.co.za/contact-us/**

Annexure 2: Minimising the Impacts on Birds (including Mitigation Measures)

- **Species lists** can only be used to guide the intensity of monitoring but should not replace **comprehensive monitoring**. Monitoring should take into account seasonal variation, fly paths and the behaviour of associated birds.

- Recommended use of existing degraded urban/industrial areas and transformed/sterile agricultural areas with no natural habitat remaining for the facility wherever possible; strictly avoid Important Bird Areas (IBAs), Critical Biodiversity Areas or protected areas.

- In **arid areas** (Nama-Karoo habitat for example): Avoid drainage lines as many bird species are associated with the drainage lines (due to presence of trees within the drainage lines).

- Larger species e.g. raptors nesting should be noted as trees are a limited resource in arid areas.

- Ensure that artificial evaporation ponds are **covered** (with wire mesh or netting to ensure that birds cannot enter or drink the water) and/or **free of pollutants.**

- Ensure that the solid concrete **tower (receiver tower)** is **visible** to birds. See e.g. http://www.reelwings.com/ and other similar web sources.

- Avoid constructing solar arrays in areas along known **waterbird flight paths** between pans/wetlands/dams.

- Avoid constructing solar arrays in areas close to roosting and breeding sites of significant populations of threatened, endemic, rare or range-restricted bird species their flight paths might be across the solar farm.

- **Limit the** amount of **vegetation that is** cleared to limit habitat loss.

- Use **grazing,** and **not chemicals,** to retard re-growth of vegetation.

- Recommend that the Solar Facility be designed from the start to feed into **existing power lines or is used locally and therefore independent of the grid.**

- Recommend that power lines follow **existing roads**.

- Be sure to check the technology used.
    - Reflective surfaces which are parabolic (curved) in shape reduce likelihood of sky reflection, relative to flat heliostats.

  - Ensure that trough receivers use evacuated glass tubes (or similar technology) to reduce heat loss allowing lower surface temperatures which will not burn birds.

- Propose that plant be upgraded after a (normal) 20 year lifespan.

Light Pollution and Reflective Surface Risks

- Reflective surfaces such as heliostats and parabolic trough panels represent a form of **light pollution** also brought by roadways, wet runways, windows, artificial light and cars.

- Windows and artificial light are ranked highly as contributing factors to bird mortalities.

- Reflective surfaces **disorientate** birds, are mistaken for large water bodies and are responsible for the 'Mirror Effect'.

- Lights at solar facilities will **attract insects** which in turn will attract foraging birds.

Important Additional Reading:

- Alice Ramsay (BirdLife International Report.)

Potential Impacts on Birds and Collation of Best Practice Guidelines

- *Main Literature:* ***BirdLife South Africa Position Statement on Possible Effects of Solar Energy on Birds***

http://www.birdlife.org.za/about/blsa/position-statements

APPENDIX I(M3):
ELKE VISSER THESIS (2016)

The impact of South Africa's largest photovoltaic solar energy facility on birds in the Northern Cape, South Africa

By Elke Visser

Minor Dissertation presented in partial fulfilment of the requirements for the degree of Masters of Science in Conservation Biology

Percy FitzPatrick Institute of African Ornithology, University of Cape Town, Rondebosch, 7701, South Africa

February 2016

Supervisors: P.G. Ryan, S. Ralston, and A.C. Cardenal

Plagiarism declaration

I know the meaning of plagiarism and declare that all of the work in the dissertation, save for that which is properly acknowledged, is my own.

Signature: Signed ………………………………

Date: 15 February 2016 ………………………………

Abstract

Renewable energy is a promising alternative to alleviating fossil fuel-based dependencies, but its development can require a complex set of environmental trade-offs for bird communities in the area, ranging from effective and physical habitat loss to direct collision-related mortality. The wide variation in the nature and significance of predicted impacts of utility-scale photovoltaic (PV) facilities on birds, and the low levels of confidence attending these predictions, has emphasised the need for scientific research. This study assesses the risks to bird populations and guilds at one of South Africa's largest PV developments. Firstly, in order to identify functional and structural changes in bird communities in and around the development footprint, bird transect data were gathered, representing the solar development, boundary, and untransformed landscape. Secondly, to assess the risk of collision mortality with solar-related infrastructure, representative samples (core vs. edge) were surveyed for bird carcasses and other signs of collision for three months covering 20-30% of the facility at search intervals of 4, 7 and 14 days. In order to account for potential biases in carcass detection, searcher efficiency and carcass persistence trials were conducted. The distribution of birds in the landscape changed, from a shrubland to open country and grassland bird community, in response to changes in the distribution and abundance of habitat resources such as food, water and nesting sites. These changes in resource availability patterns were detrimental to some bird species and beneficial to others. Shrubland specialists, such as the black-chested prinia (*Prinia flavicans*) and chestnut-vented tit-babbler (*Parisoma subcaeruleum*), appeared to be negatively affected by the presence of the PV facility. In contrast, open country/grassland and generalist species, especially species such as the Cape sparrow (*Passer melanurus*) and familiar chat (*Cercomela familiaris*), were favoured by its development. Utility-scale PV facilities inevitably will not substitute for the natural habitats they have replaced, but might offer opportunities for climate protection that do not necessarily conflict with nature conservation. Monitoring success of avian mortality was significantly influenced by variation in detection rates by size class (60 and 95% for birds <100 g and >100 g, respectively) and the location of carcasses relative to the solar panel units (65 and 90% for birds adjacent and under the units, respectively) as well as decreasing persistence rates per search interval (57, 53, and 40% after 4, 7, and 14 days, respectively). Only injuries associated with non-fatal collision of large-bodied birds with the underside of the panels and entrapment between fencing could be concluded with reasonable certainty. An extrapolated fatality estimate of 4.53 fatalities.$MW^{-1}.yr^{-1}$ (95% CI 1.51-8.50), short study period, and lack of comparable results from other sources made it difficult to provide a meaningful assessment on avian mortality at PV facilities. Despite these limitations, the few bird fatalities that were recorded might suggest that there is no significant link with collision-related mortality at the study site. In order to fully understand the risk of solar energy development on birds, further collation and analysis of data from solar energy facilities across spatial and temporal scales, based on scientifically rigorous research designs, is required.

Keywords: Renewable energy, utility-scale photovoltaic facilities, bird communities, habitat change, collision mortality

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Introduction

South Africa's role in solar energy development

According to the 2015 Climate Change Performance Index (CCPI), South Africa's heavy reliance on fossil fuels has ranked the country among the poorest performers in terms of their emissions level, development of emissions, and efficiency (Burck et al. 2015). Therefore, the country's energy planning system now requires that renewable energy play a significant role in the nation's power generation mix. According to the Copenhagen Agreement, South Africa pledged in December 2009 to take mitigation action towards the reduction of carbon emissions by 34 and 42% below the business-as-usual trajectory by 2020 and 2025, respectively (Eberhard et al. 2014); a goal that the renewable energy sector plays a major role in attaining. The National Electricity Regulations Act (ERA) of 2006 and the new generation capacity regulations have been the crucial legal instruments used by the government to unlock the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). To date, three ministerial determinations have been issued for the procurement of 3 725 MW by 2016, 3 200 MW by 2020, and 6 300 MW by 2025 (DoE 2015). The allocated quantities are derived from the Integrated Resource Plan's (IRP) 2010-2030 target of 17 800 MW new generation capacity that has been set aside for renewables by 2030 (DoE 2015).

South Africa is well endowed with solar, biomass, and wind renewable energy sources where the geographic distribution of REIPPs broadly corresponds to the distribution of resource potential in the country. Most of South Africa is classified as semi-arid, with large expanses of flat terrain and high levels of irradiation, making it ideal for solar energy generation. South Africa has one of the highest potential solar energy regimes in the world with average daily direct normal radiation in excess of 7 KWh/m^2 (Eberhard et al. 2014). The Northern Cape, which has the most favourable radiation levels, has attracted the majority of the solar photovoltaic (PV) and all of the concentrated solar power (CSP) projects approved to date. The province hosts 48 of the 92 Independent Power Producers (IPP) projects in the country and is expected to contribute 3 566 MW to the total procured renewable energy capacity once construction is complete (DoE 2015).

Utility-scale solar developments are characterised by two basic types of technologies: photovoltaic and concentrated solar power. Photovoltaic systems convert solar radiation directly into electricity by exposing solar cells to incoming radiation. These cells are arranged conventionally in several flat panels, or include lenses or reflective surfaces to concentrate radiation onto a smaller group of more efficient cells (Hernandez et al. 2014). Concentrated solar power systems use arrays of reflective surfaces that are arranged as troughs, fresnels or dishes to focus the sun's heat onto a receiving element that contains a heat transfer fluid. The liquid is transferred to heat exchangers that produce steam in order to turn the turbines or generators that supply electricity (Hernandez et al. 2014). Out of the two technologies, PV has seen the most dramatic technological and cost advancements. Consequently, these facilities have contributed 2 292 MW in the five bid windows, which equates to more than a third of the total procured renewable energy capacity (DoE 2015). In terms of CSP, the total global capacity has remained relatively low mainly due to the comparatively high cost of the technology. However, CSP offers the added benefit of thermal storage with up to 12 hours supply capacity. Therefore, CSP technology has greater flexibility regarding the supply of electricity, making it a valuable contribution to the renewable energy portfolio (DoE 2015).

Solar energy development and birds

Despite the economic, social and environmental benefits of utility-scale solar facilities, its development can require a complex set of environmental trade-offs for bird populations and communities in the area. Direct impacts range from effective and physical habitat loss to collision or electrocution-related mortality, whereas the indirect impacts such as water depletion and dust deposition may extend beyond the development footprint (Lovich and Ennen 2011; Hernandez et al. 2014). However, the nature and magnitude of these impacts are generally related to the type of technology implemented. Each of the solar development systems have technological configurations that present markedly different hardware, and have widely differing spatial requirements per unit of power generated (Phillips 2013; Hernandez et al. 2014).

Impacts of PV developments

Utility-scale solar PV facilities tend to occupy large areas of approximately 2-5 ha per MW (Ong et al. 2013; Hernandez et al. 2014) and, in many cases, have involved the complete removal of vegetation from the inclusive footprint (Lovich & Ennen 2011; DeVault et al. 2014). It is this tendency to destroy, degrade, fragment or otherwise displace birds from large areas of their natural habitat that has stimulated most concern to date (Lovich & Ennen 2011), especially regarding species with restricted ranges and specific habitat requirements. In contrast, recent reports in Germany and the United Kingdom have provided empirical evidence indicating that utility-scale solar PV facilities enable the exploitation of synergies between climate protection and nature conservation. According to national studies conducted in 2005 to 2007 by the Federal Agency of Nature Conservation (BfN) and German Ministry of the Environment (BMU), brown sites such as landfills and previous agricultural fields were converted into biotopes of a higher value compared to its original state, e.g. Fürth-Atzenhof solar project (Peschel 2010; Parker & McQueen 2013), resulting in the attraction of novel species benefitting from the artificial provision of otherwise scarce resources such as perches, nest sites and shade (DeVault et al. 2014).

Recent findings at solar energy facilities in North America suggest that collision mortality impacts may be underestimated, especially at utility-scale PV facilities (Kagan et al. 2014). Hypotheses posit that collision trauma may be associated with polarised light pollution (PLP). Glare and polarised light emitted by the solar panels may attract insects to the development area as they perceive the panels as water bodies. This results in the aggregation of foraging birds, which could increase the risk of collision with solar-related infrastructure (Horváth et al. 2009, 2010; Lovich & Ennen 2011). The "lake-effect" hypothesis states that waterbirds themselves might mistake large expanses of solar arrays as water bodies, thereby colliding with the infrastructure as they attempt to land. This could either result in direct mortality or leave the individuals injured or stranded within the development area, rendering them unable to escape to safety or easily take-off from land when confronted by potential predators (Kagan et al. 2014). However, to date, there have been no studies to substantiate or refute either hypothesis (Lovich & Ennen 2011; Kagan et al. 2014; Waltson et al. 2015). The overall lack of evidence might be a reflection of the absence of monitoring effort rather than absence of collision risk.

Impacts of CSP developments

Similar to PV facilities, CSP developments include the use of large, reflective surfaces (heliostats or parabolic troughs) which can potentially introduce the risk of collision impact trauma by becoming ecological traps for insects and birds, especially aerial insectivores (McCrary et al. 1982). The extent thereof is comparable with high collision rates reported for large sections of exposed glass generally associated with high-rise buildings in the urban environment (Drewitt & Langston 2008). However, these reflective surfaces pose an additional source of avian mortality in the form of solar flux, which is concentrated in the airspace surrounding the receiver unit. To date, the power tower technology has stimulated most concern, exposing passing birds to the risk of being singed or incinerated as they aggregate close to the receiver that reaches temperatures exceeding 800°C (McCrary et al. 1982; Hernandez et al. 2014). Exposure to solar flux could either result in direct mortality or impairment of the individual's flight capability, with starvation or predation as a consequence (Kagan et al. 2014). Several monitoring programmes in the United States have reported high avian mortality rates comparable with, or in excess of, those estimated from some of the more impactful wind farms (Smallwood 2013; Kagan et al. 2014). A combination of these sources of injury or mortality is therefore considered to be one of the most obvious and potentially significant impacts of solar energy development on birds. Other known or perceived impacts of CSP facilities include the destruction or modification of extensive tracts of natural habitat, excessive use of water, and pollution resulting from the use of dust suppressants due to the lack of vegetation cover (Lovich and Ennen 2011; Hernandez et al. 2014).

Rationale behind this study

Utility-scale solar PV facilities are expanding rapidly in southern Africa, and while experiences in certain parts of the world suggest that the industry might be detrimental to bird populations and communities, the nature and implications of these effects remain poorly understood (Tsoutsos et al. 2005; Gunerhan et al. 2009; Lovich and Ennen 2011; Turney and Fthenakis 2011; Hernandez et al. 2014). Unlike some components generally associated with solar facilities (Bevanger 1994, 1998; Janss 2000; Anderson 2001; Gauthreaux & Belser 2006; Lehman et al. 2007; Drewitt & Langston 2008; Jenkins et al. 2010), there is presently no clear pattern in the types of birds negatively affected by the development as most peer-reviewed publications have only addressed the potential impacts that are yet to be proven by empirical evidence.

This study evaluated the risks to bird populations and guilds at one of South Africa's largest PV facilities by addressing the following: (1) the structural and functional changes in bird communities within and around the development footprint, (2) the extent of avian collision, and (3) how it compares to other PV facilities and energy sources, such as wind. Ultimately, the study attempts to improve the knowledge of the impacts of utility-scale PV facilities and assesses whether mitigation measures are warranted to ensure that the industry rolls out sustainably in South Africa.

Methodology

Study site

The study was conducted at the 96 MW Jasper PV solar facility (28°17′53″S, 23°21′56″E) which is located on the Humansrus Farm, approximately 4 km south-east of Groenwater and 30 km east of Postmasburg (Fig. 1). Construction at the site was completed in October 2014 and occupies the area alongside two other solar energy developments, namely the 75 MW Lesedi PV project, which has been operational since May 2014, and the 100 MW Redstone CSP power tower project, which will begin construction in 2016.

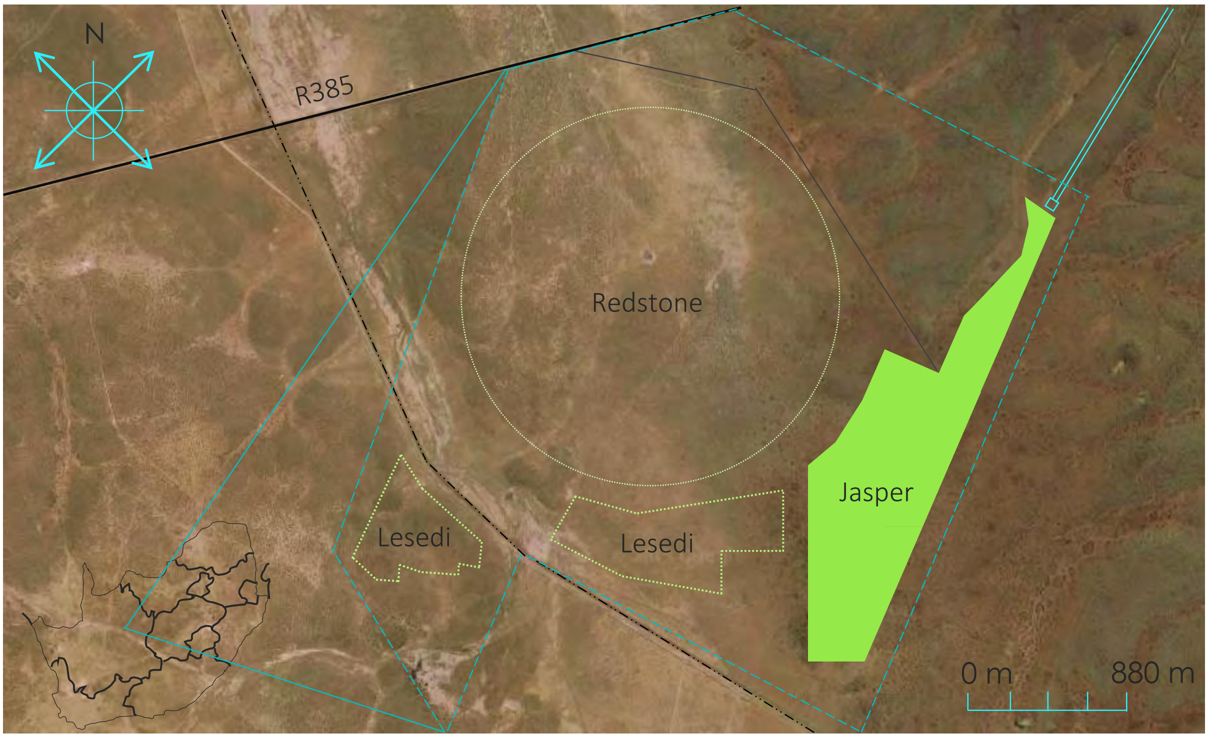


Figure 1: Layout of the three solar energy projects located between Postmasburg and Danielskuil in the Northern Cape, South Africa. This includes the 75 MW Lesedi and 96 MW Jasper solar photovoltaic facilities (operational) and the 100 MW Redstone concentrated solar power facility (planned). Map data©2015 AfriGIS (Pty) Ltd, Google.

About the Jasper PV facility

The Jasper PV facility contains 325 360 solar panels over a footprint of 180 hectares with the capacity to deliver 180 000 MWh of renewable electricity annually. The solar panel units (SPUs) face north at a fixed 20° angle, reaching a height of approximately 1.86 m relative to ground level with a distance of 3.11 m between successive rows of SPUs (Fig. 2a). Among the solar arrays, vegetation regrowth was promoted, where grass species such as *Eragrostis lehmanniana* and *Aristida congesta congesta* and forbs such as *Geigeria ornativa* and *Hermannia comosa* dominate the area. The facility, fence line, and roads remain largely free of any shrubs and woody vegetation through active removal and grazing practices. The facility is demarcated by a 7.28 km perimeter fence with a height of 3.35 m. The outer fence has a 100 × 50 mm ribbon mesh topped by three serrated ribbon strips, whereas the inner electric fence has horizontal slats of approximately 200 mm apart (Fig. 2b). Adjacent to the fence is a 20 × 20 m evaporation pond used to collect chemical-containing water from the panel cleaning process (Fig. 2c). A 50 to 150 m wide buffer zone, which remained untouched during the construction process, stretches around the facility and is demarcated by a fence separating the area from the Humansrus farm. The area north of the study site includes a 1 000 m^2 switchyard and 5 km transmission power lines (132kV) that join the Eskom Manganore-Silverstreams line onto the national grid. Bird flappers were installed on two transmission line sections of approximately 300 m, where visibility is impaired due to high background elevations.

Flora and avifauna

The study area lies within the Eastern Kalahari Bushveld bioregion of the Savanna Biome and consists of an open savannah grassland to dense bush with a well-developed tree layer, including species such as *Acacia luederitzii*, *Boscia albitrunca*, and *Rhus tenuinervis* (Mucina & Rutherford 2006; ERM 2011). The study area is characterised by one vegetation type, namely Olifantshoek Plains Thornveld. However, the higher rocky outcrops adjacent to the facility support Kuruman Mountain Bushveld where trees are less frequent, apart from *Searsia lancea* and *Olea europaea* subsp. *africana* (Mucina & Rutherford 2006; ERM 2011). The remainder of the farm is currently used for cattle and horse grazing. Based on the inspection of satellite imagery, there are no permanent or ephemeral rivers in the study area. However, there is a seasonal stream located south-west of the site, which is a tributary of the non-perennial Groenwaterspruit (ERM 2011). Several open water troughs are located at a communal area on the farm and could be used by various species, including large raptors, vultures, and smaller bird species such as the endemic and near-endemic sociable weaver (*Philetairus socius*), Cape sparrow (*Passer melanurus*), and red-headed finch (*Amadina erythrocephala*).

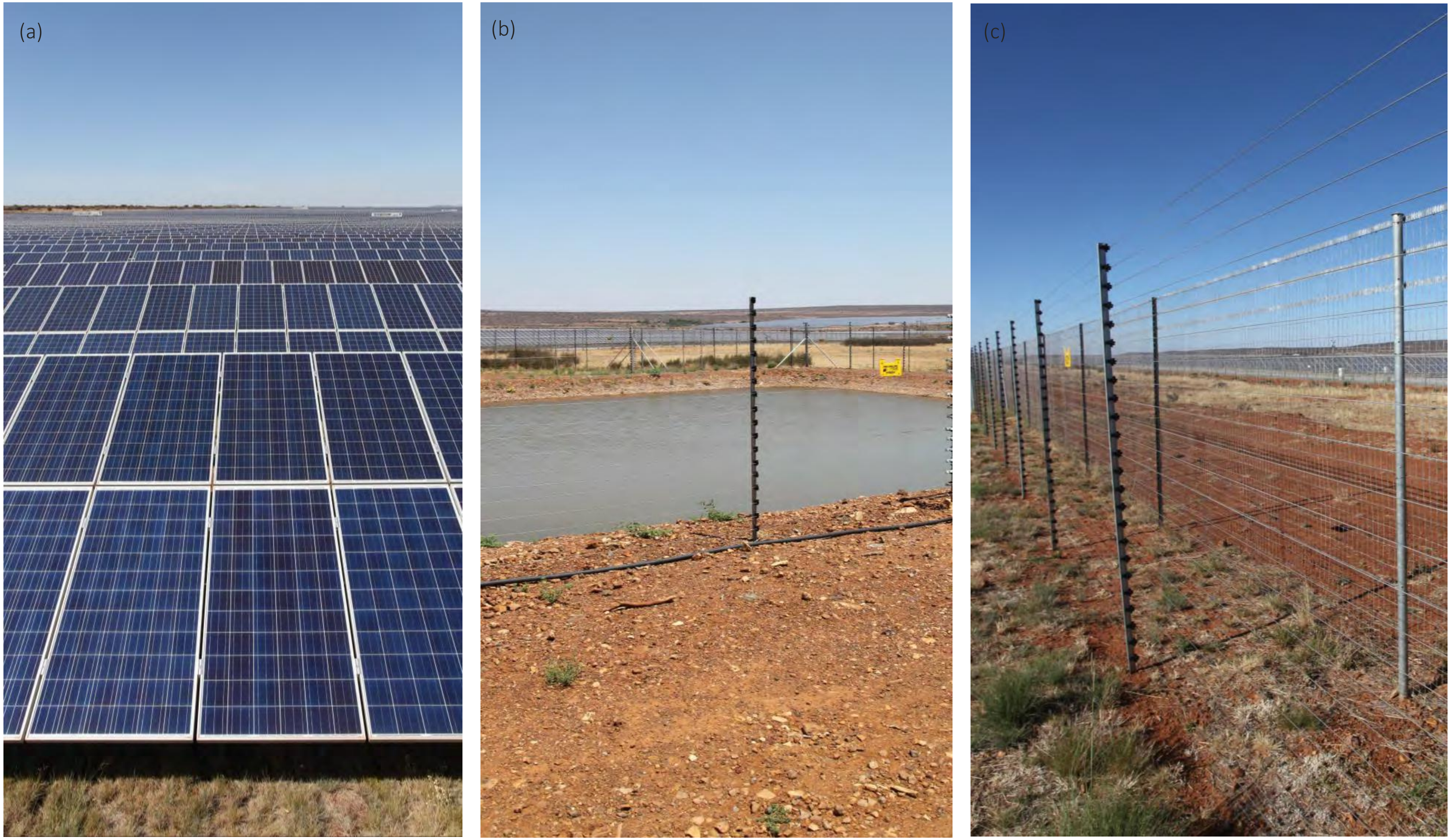


Figure 2: Visualisation of the solar-related infrastructure: (a) solar panels, (b) evaporation pond), and (c) perimeter fence at the Jasper PV solar facility in the Northern Cape, South Africa. Photos credited to P.G. Ryan.

The Savanna Biome is considered to have the most species-rich community in southern Africa and, although the study area does not overlap with any Important Bird Areas (IBAs), the habitat itself may be important for a suite of Red Data species. An estimate of 187 bird species could potentially occur within the study area, of which six are red-listed species and 53 are endemic/near-endemic to southern Africa (Appendix A; Taylor et al. 2015; SABAP2 2015). These include the white-backed (*Gyps africanus*) and lappet-faced vulture (*Torgos tracheliotos*), martial (*Polemaetus bellicosus*) and tawny eagle (*Aquila rapax*), and lanner falcon (*Falco biarmicus*) as well as the larger terrestrial secretarybird (*Sagittarius serpentarius*) and kori bustard (*Ardeotis kori*; ERM 2011). It also supports other raptor species such as the brown (*Circaetus pectoralis*) and black-chested snake eagle (*Circaetus pectoralis*), and the southern pale-chanting (*Melierax canorus*) and gabar goshawk (*Micronisus gabar*), and pygmy falcon (*Polihierax semitorquatus*). However, the scarcity of large trees means that large raptors and vultures are unlikely to breed in the study area. The habitat is also suitable for several non-Red Data endemic species such as the African red-eyed bulbul (*Pycnonotus nigricans*), ant-eating chat (*Myrmecocichla formicivora*), and northern black korhaan (*Afrotis afraoides*), and many near endemics namely the cape bunting (*Emberiza capensis*), yellow canary (*Crithagra flaviventris*), and Namaqua sandgrouse (*Pterocles namaqua*).

Changes in bird communities

Survey design

Bird community surveys were conducted from the 9th of November until the 6th of December 2015. The study site was classified into three habitat types: the solar facility, boundary (including the perimeter fence, evaporation pond, and buffer zone), and untransformed landscape (Fig. 3). Each survey was based on a regular sampling design with five 440-m transects per habitat type (2.2 km in total), ensuring at least 250 m between adjacent transects (Fig. 4). Each transect was surveyed for 40 minutes, with two 10-minute observations from elevated vantage points to allow for improved visibility, especially between the SPUs.

Control transects were selected based on information from the environmental impact assessment (EIA) to ensure that the physical conditions (slope, aspect, soil type, drainage) were similar to the solar facility and the habitat prior to construction (ERM 2011). Stratified sampling among major habitat types was not necessary due to the homogeneous nature of the terrain and vegetation type. The variation in habitat amounted to little more than subtle changes in the amount of ground cover and vegetation height. These types of physical differences were accounted for in order to reduce background variation, allowing any changes in bird communities to be more readily attributed to land management. The surveyed areas were monitored using identical methods to allow for comparable results.

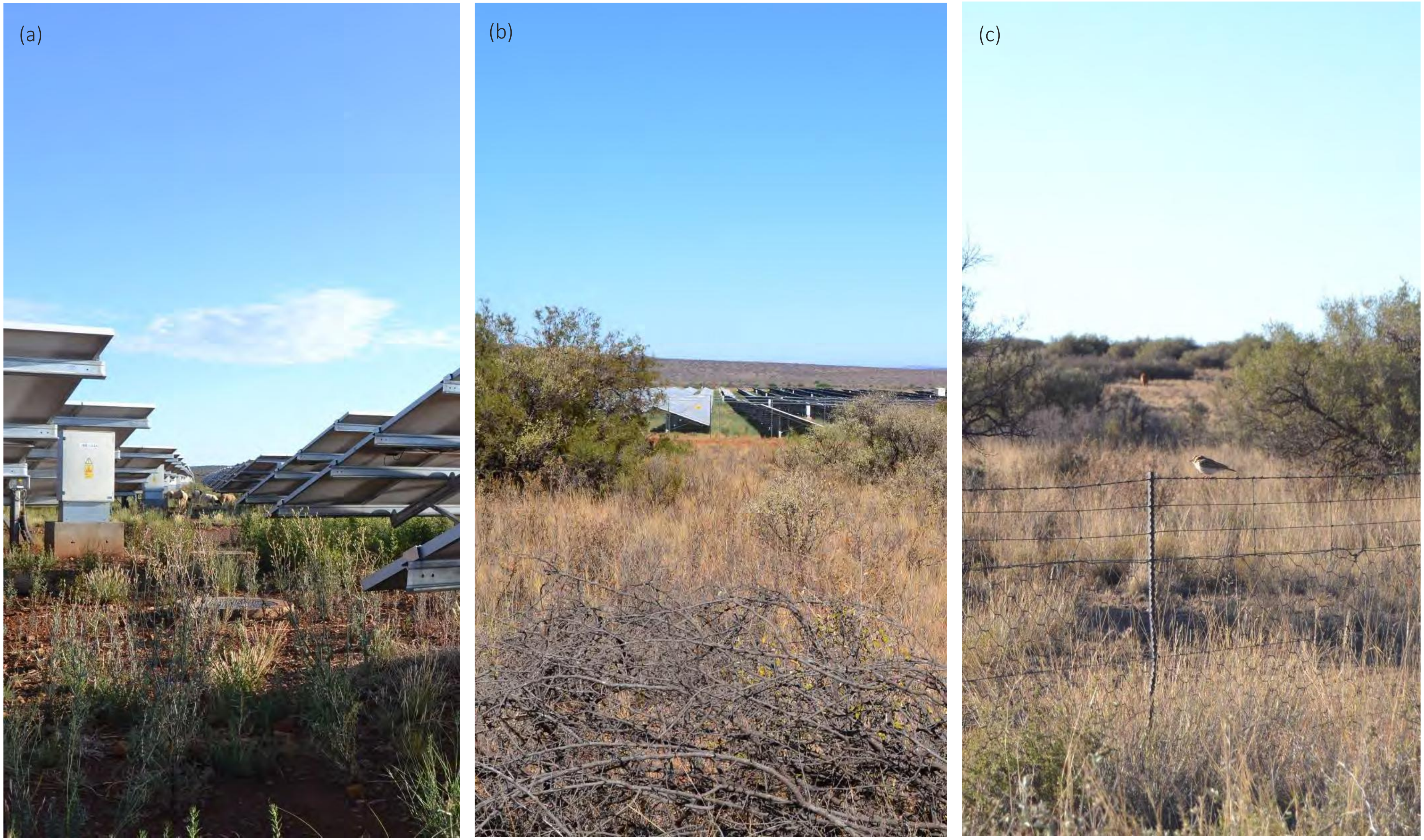


Figure 3: Visualisation of the three main habitat types: (a) The photovoltaic facility, (b) boundary (including the perimeter fence and the buffer zone), and (c) untransformed land adjacent to the buffer zone. Areas were surveyed to assess the changes in bird communities within and around the development footprint at the Jasper PV solar facility in the Northern Cape, South Africa.

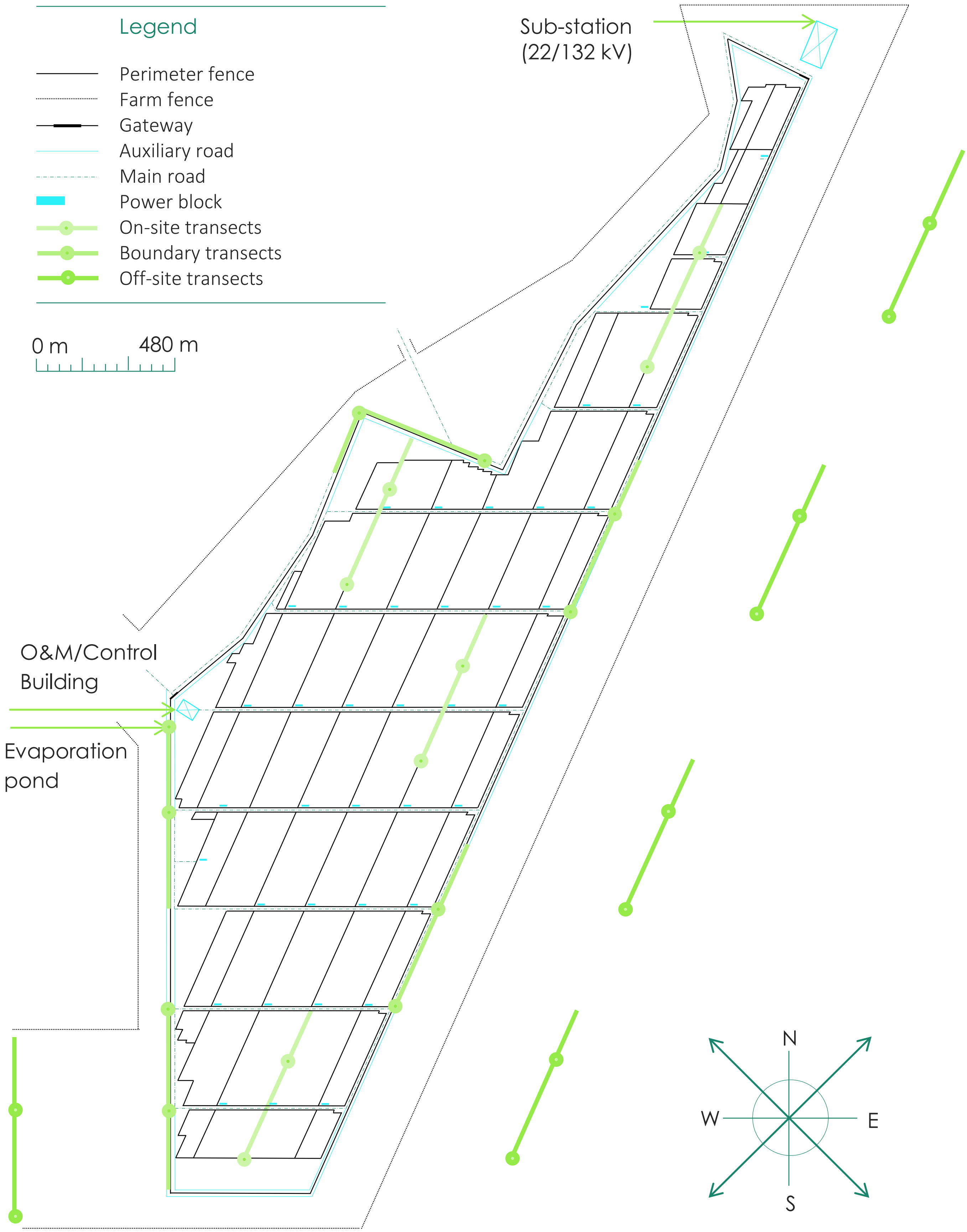


Figure 4: Sampling design to assess the changes in bird communities within and around the development footprint at the Jasper PV solar facility in the Northern Cape, South Africa. The linear transects, indicated in shades of green, represent the surveys conducted at the photovoltaic facility, boundary, and untransformed landscape.

Survey and data collection protocols

Transects were surveyed according to standard procedures and took into account possible biases caused by different observers, detectability, time of day, bird song activity and/or weather conditions (Bibby et al. 2000). All birds seen or heard were counted and identified with 8 x 40 Minolta binoculars, where the perpendicular distance between the transect line and observed bird was recorded. Surveys were conducted in the first four hours after sunrise when birds were most conspicuous and active, and were not conducted on days when weather conditions might affect bird activity, such as heavy rain, thunder storms, strong winds or thick mist (Bibby et al. 2000). The same surveyor was used to minimise observer bias and approximately two months, prior to the start of the surveys, was allocated to improve bird identification (Bibby et al. 2000). The sequence of observations was randomised among sites to ensure different starting points for each survey. This methodology was broadly consistent with those used in many other similar studies of small passerine densities in low shrubland (Bibby et al. 2000; Pearce-Higgins et al. 2006; Reinkensmeyer et al. 2008), and also generally compliant with the basic assumptions which must be met in order to analyse such data using Distance 6.0 software (Thomas et al. 2010). Additional observations were made regarding avian use at the PV facility, such as foraging and breeding.

Analysis

The Conventional Distance Sampling engine in Distance 6.2 release 1 was used to generate density estimates (birds.ha^{-1}) by search area (PV facility, boundary, and untransformed land) and most abundant species. Where relevant, evidence of heaping, responsive movement, outliers, and possible gross errors was investigated. Furthermore, suitable truncation points were determined and the grouping of exact distance data into appropriate intervals (0-20 m, 21-50 m, 51-100 m, 101-200 m, over 200 m) was performed (Buckland et al. 2001). Models were fitted to the data using all the available combinations of key functions and adjustment terms (uniform with cosine or simple polynomial, half-normal with cosine or Hermite polynomial and hazard-rate with cosine or simple polynomial) and assessed using the lowest Akaike's Information Criterion (AIC) values (Buckland et al. 2001). A Welch's t-test was used, through R 3.2.2 software, to assess the statistical difference of bird density (birds.ha^{-1}) between the three sample areas.

Correspondence Analysis (CA) was applied to the transect data to assess the variation in the distribution of bird species among the PV facility, boundary, and untransformed landscape by plotting the species and sample area scores on the first axis of the CA (e.g. Caplat & Fonderflick 2009). This allowed for further analysis in the magnitude of avoidance of certain species by selecting the 23 most abundant species within and around the development footprint, based on the density estimates. Each species *i* relative frequency within the development footprint γ_i (L_f) was compared to its frequency within the untransformed landscape γ_i (L_u) with the use of chi-square tests or Fisher exact tests (when one of the expected numbers was lower than 5) with a Bonferroni correction (e.g. Caplat & Fonderflick 2009). Species' individual frequency γ_i, was defined as the ratio of species *i*'s abundance on the total amount of individuals considered and plotted against each other. If species' scores are located at the straight line of equation $y = x$, species are indifferent. On the contrary, an effect of the solar development would split species above and under the identity line, placing overrepresented species amongst the facility above the line, and underrepresented species under the line. A low species frequency may account for two mechanisms: (1) A low density of the selected species, or (2) high densities of other species. Nevertheless, when compared to the reference frequency, it indicates how the local community differs from the regional species pool, which would be a measure of the relative effects of solar development on birds (e.g. Caplat & Fonderflick 2009).

Collision mortality

Survey design

Solar panel unit monitoring

Mortality surveys were conducted from the 14th of September 2015 until the 6th of December 2015, after the clearance surveys had been performed to remove any prior fatalities from the study area. Such fatalities occurred outside of known search intervals and, as a result, were not included in the fatality estimates. The study site was divided into three sample areas, each consisting of rows of SPUs arranged in solar arrays (Fig. 5). Each sample area was assigned ten arrays, which have been selected based on a spatial sampling design to ensure that the sample effort was distributed over the entire study area, representing the core, intermediate distance from the core, and edge (e.g. WEST 2015; Fig. 5).

Strickland et al. (2011) suggested that the search interval should ideally be shorter than the average carcass removal time. Therefore, the first set of solar arrays were searched every 4 days for the first six weeks and every 7 days thereafter, whereas the second set was surveyed every 14 days (Fig. 5). The area covered among the SPUs at the three sample areas amounted to 29920 panels (9%), 29920 panels (10%), and 29920 panels (9%), respectively, for the 4-and 7-day search interval and 24920 panels (8%), 32760 panels (10%), and 29560 panels (9%) for the 14-day search interval. This amounted to approximately 14 to 15 km of transects to be completed on the designated days. The coverage of each area, in terms of the aggregate solar energy hardware, ranged from 20 to 30% per search-interval category. The carcass searches consisted of surveying the area between every row of panels, where the area beneath the SPUs and the surfaces of the panels were checked for any signs of collision (feather sprays, blood spatter or dust imprints).

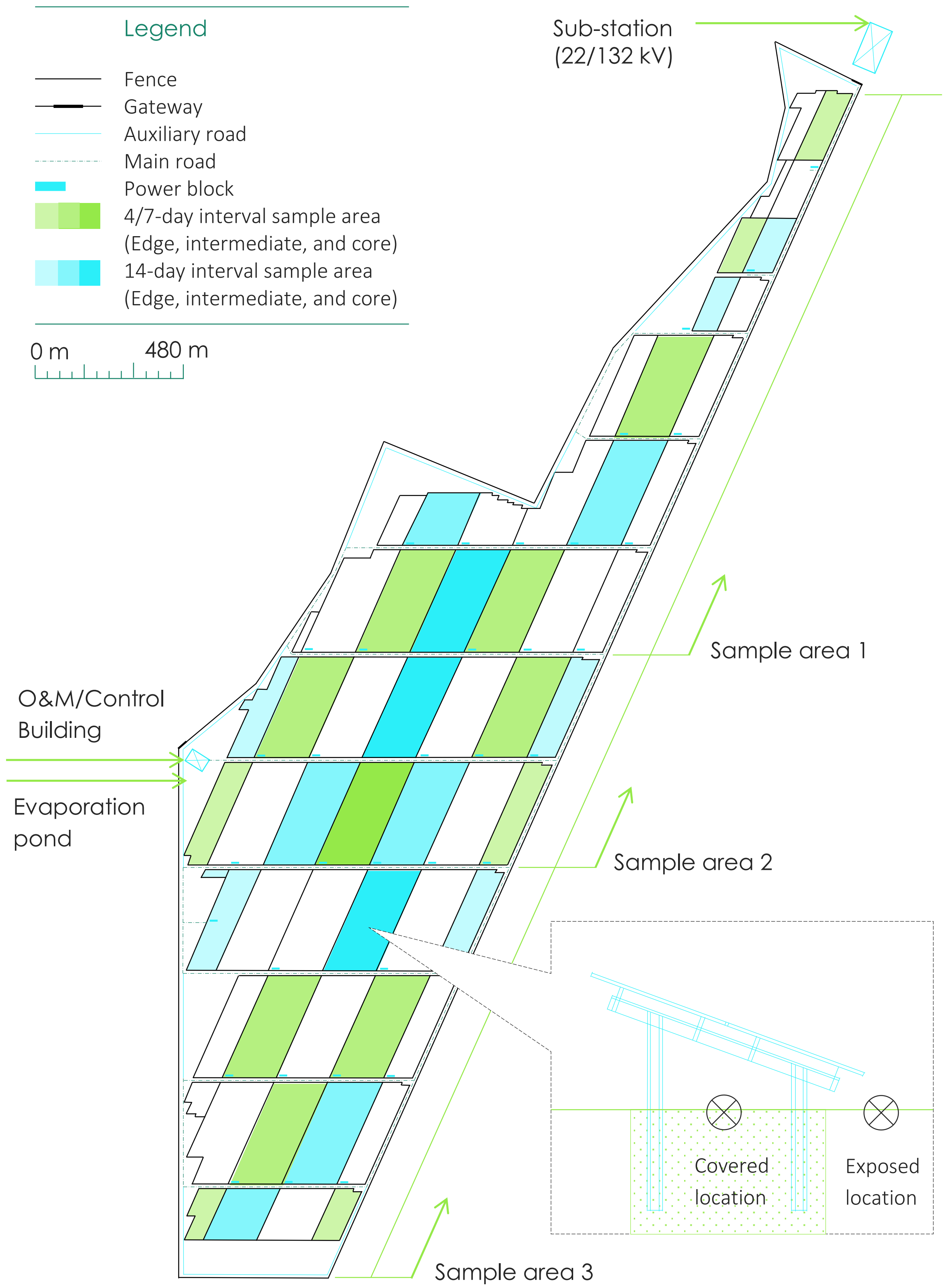


Figure 5: Sampling design to assess avian mortality at the Jasper PV solar facility in the Northern Cape, South Africa. The highlighted solar arrays indicate the samples, where the green and blue areas represent surveys conducted with a 4/7- and 14-day search interval, respectively. The enlarged PV panel schematic illustrates the placement of bird carcasses for the searcher efficiency and carcass persistence trials.

Substation and power line monitoring

In addition to monitoring the SPUs, the 1 000 m^2 substation was surveyed for bird carcasses or injured individuals. Surveys were conducted on foot, following the perimeter of the substation as access to the facility was restricted. The 5 km transmission power lines, which were erected to link the solar facility to the Eskom grid, were surveyed based on established protocols on the 21st of October, 12th of November, and 18th of November 2015. The surveys were conducted by two searchers on foot, following a meandering transect underneath the lines and surveying for fatalities within approximately 10-15 m of the transect line until the power lines merged with existing infrastructure (Anderson 2001; Shaw et al. 2010).

Perimeter fence and evaporation pond monitoring

The perimeter fence was segmented into and assigned to the three sample areas, with each section surveyed every 4, 7 and 14 days. The area covered at the perimeter fence amounted to 4.03 km (55%), 0.65 km (9%), and 2.60 km (36%) per sample area, respectively. Searches were conducted by vehicle, following the track alongside the inner fence. This proved to be suitable due to ease of navigation in close proximity to the fence line and the adequate level of visibility to detect fatalities. Travel speed did not exceed 10 km/h while conducting the surveys and the driver was always positioned closest to the perimeter fence to enhance visibility. In areas where the driving path diverged significantly from the fence, the survey was conducted by foot. The 20 × 20 m evaporation pond was checked every 4, 7 and 14 days, where each survey consisted out of walking adjacent to the fencing of the pond itself.

Survey and data collection protocols

Surveys were conducted before the heat of the day to limit fatigue due to heat exhaustion and, to ensure that data would be collected at different days and time frames, the sequence of surveys at the respective sample areas was randomised. All bird fatalities and injuries that were discovered during, or incidental to, the standard carcass surveys were recorded. Evidence of collision would be defined as: (i) smudge marks (e.g. blood or dust imprints) and feathers directly on solar hardware, (ii) feather spots consisting of at least two or more primary flight feathers, of at least five or more tail feathers, or two primaries within 5 m of each other, or a total of ten or more feathers of any type concentrated in an area less than 3 m^2, or (iii) whole or partial carcass with indications of predation, electrocution (e.g. burns) or collision (e.g. blunt force trauma). All data records included:

- Species classification based on identification, size class, taxonomic family, range (resident or diurnal/nocturnal migrant), and southern Africa Red list status
- Condition of remains: fresh (within a week old, with soft flesh remains and fresh feathers), recent (within two months old, with dried flesh remains and numerous feathers still present), fairly old (within a year old, with dry bones and possibly some old feathers remaining), or very old (older than one year, with bleached bones, no flesh or feathers)

- The suspected cause of fatality and level of certainty (Observed - 100%, valid - >90% certainty, probable - >50% certainty, possible - <50%, but > 0% certainty, not applicable - 0% certainty or unknown)
- Fatality location, which included the SPU number, the Global Positioning System (GPS) coordinates in Degrees Minutes (DM) with a Garmin nüvi, and where the fatality was found (e.g. underneath a SPU)
- Standardised description of the current habitat and visibility classes (Good, medium, or poor)
- Estimated weather conditions at time of mortality/injury

All physical evidence was photographed and either collected to avoid double-counting, bagged, carefully labelled, and frozen to await further examination, or marked on site if collection proved to be difficult. Handling of carcasses was limited, particularly when used in carcass persistence trials. Any carcasses found incidentally, was identified, photographed, and documented in the same manner as the regular surveys.

Searcher efficiency trials

The searcher efficiency trials were conducted on the 20th and 23rd of October 2015 to assess the probability of a carcass being detected among the SPUs (Morrison 2002; Barrios and Rodríguez 2004; Krijgsveld et al. 2009). Searcher efficiency rates can be estimated by several covariates such as season, habitat, and carcass size classes (Korner-Nievergelt et al. 2011; Strickland et al. 2011; Smallwood 2013). However, the trials of this study were managed in relation to SPU location (Adjacent or under the SPU) and size classes of birds (small, medium, and large) only. A total of 80 carcass detections per small (<100 g) size class, 40 for medium (100-1000 g), and 16 for large (>1000 g) was used during the trials (Appendix B). Placement at the perimeter fence, evaporation pond, substation, and power lines were not included in the study.

In order to account for potential biases, the placement of representative native or naturalised specimens for each trial did not exceed 24 hours in order to limit the number of trial carcasses placed on the landscape at any one time (Smallwood 2007). Another factor that influences carcass detectability is how fresh and intact the carcasses are (Smallwood 2007, 2013). However, in contrast to wind-energy projects, there is little expectation that the solar facility will cause injuries and fatalities that result in dismembered carcasses (Smallwood 2013). Therefore, the searcher efficiency trials conducted in this study only involved fresh intact carcasses. Trial specimens were marked with a plastic leg band, to distinguish trial specimens from natural fatalities, but without rendering the specimen unnaturally conspicuous (Smallwood 2007). To ensure a degree of "natural" placement, carcasses were tossed towards the designated, randomly chosen spot (Fig. 5). Any bird colliding with the panels is likely to slide off, down the 20° slope onto the ground as there is no lip on the lower edge, whereas birds that survive the initial impact might take shelter under the SPUs. Documentation of each location included GPS coordinates and notes about the substrate and carcass placement. Searchers moved through the area in the same manner as outlined in the standardised surveys, where specimens that were not observed, were recovered as quickly as possible to verify that carcasses had not been removed by scavengers during the trial. It should be noted that, due to the limited timeframe for the trial, searchers were aware that bird carcasses were placed on the study site. This limitation might therefore introduce a bias in the searcher efficiency results.

Carcass persistence trials

The carcass persistence trials were conducted from the 23rd of October 2015 until the 6th of December 2015 to assess the probability that a carcass persisted between search intervals. Carcass persistence is dependent on seasonal and inter-annual variation in habitat, climate, and the scavenger community (CEC and CDFG 2007, USFWS 2012, Smallwood 2013). For the purpose of this study, these factors were consistent and did not require any corrective measures as the study period represented only a single season. The trials did however estimate the influence of carcass size (Smallwood 2013). A total of 45 bird carcasses were randomly distributed and monitored among the SPUs and along the perimeter fence. This included 30 small (<100 g), 10 medium (100-1000 g), and 5 large (>1000 g) carcasses (Appendix B). Similar to the searcher efficiency trials, carcasses were tossed towards the designated, randomly chosen spot to ensure a degree of "natural" placement (Fig. 5).

In order to account for potential biases, such as scavenger swamping (Smallwood 2007, 2013), the specimens were distributed across the entire footprint of the solar farm where new specimens were placed every one to two weeks and never in excess of five individuals. All carcasses used in the trials were marked with a plastic leg band and handled with latex gloves, where the handling time was minimised to reduce the risk of leaving scent traces which may be used as cues by potential scavengers (Whelan et al. 1994). Bird carcasses were monitored per trial using Ltl-5310 ACORN motion-triggered scouting cameras and were visited on foot for the entire trial period or until the carcass disappeared or had deteriorated to a point where it would no longer qualify as a documentable fatality. GPS coordinates were taken from the specimens' locations which was visited daily for the first five days, every other day from day five to 15, and every seven days from day 15 and onwards (e.g. Ironwood Consulting 2013). Each trial specimen was classified into one of the following categories per visit (e.g. WEST 2015):

- Intact: Whole and unscavenged, other than by insects
- Scavenged/depredated: Carcass present but incomplete, dismembered, or flesh removed
- Feather spot: Carcass scavenged and removed, but sufficient feathers remain to qualify as a fatality
- Removed: Not enough remains to be considered a fatality during standard surveys

Analysis

The Huso (2011) estimator was adapted and applied to determine the total fatality at the Jasper PV facility (e.g. WEST 2015). For any arbitrary solar array *i*, the time period of three months was divided into S_i consecutive intervals of length I_{ij}, representing the total number of intervals and days per solar array. The total number of fatalities (F_{ij}) at the ith solar array in the jth interval was grouped by carcass size and search-interval category (4, 7, and 14 days), for which the probability of detection was the same for all carcasses in the set. The fatalities were calculated as the number of carcasses observed (c_{ijk}) over the probability of detection (g_{ijk}).

The probability of detection was calculated as the product of the probability of carcass persistence (r) and the probability of a carcass being observed (p), if it persist. Data from the carcass persistence trials were analysed by size class, where a chi-test was used to test significance in R version 3.2.2. The average probability of carcass persistence was estimated per size class for the given search intervals. This was applied to all birds found at the end of interval length *I*. For the searcher efficiency trials, the data were analysed by size class and the carcass' location relative to the SPU, where a standard 3×2 goodness of fit was used. The probability of a carcass being observed (p) was estimated as the number of carcasses found by searchers over the number of carcasses distributed and applied per size class and location for the given search intervals.

The total number of fatalities (F_{ijk}) was grouped into their respective sample area per search-interval category and adjusted by the proportion of the area sampled and duration of the searches per search interval. The total fatality at the Jasper PV facility was calculated as the sum of all grouped fatalities, of which 95% bootstrapped confidence intervals (CI) were estimated. Fatality rates were reported per GWh and MW.

Results

Changes in bird communities

Structural and functional differences

Over the study period, 53 bird species were recorded in and around the Jasper PV footprint of which 22 are endemic or near-endemic to southern Africa (Appendix C) and none are nationally threatened (Taylor et al. 2015). Thirty-two species were shared between the PV facility and the boundary and untransformed landscape (Fig. 6). Three species were recorded only in the development area and 15 species were recorded only in the boundary and untransformed land (Fig. 5). Based on the results, the overall density and diversity within the PV facility (38 species, 1.80 ± 0.50 birds.ha^{-1}), which is a subset of the native area, did not significantly differ ($t = -2.21$, $P = 0.06$) in comparison to the boundary (50 species, 2.63 ± 0.86 birds.ha^{-1}) and untransformed land adjacent to the boundary (47 species, 2.57 ± 0.86 birds.ha^{-1}).

The first axis of the CA, with an eigenvalue of 0.29, explains 96% of the variation in the data and differentiates the solar facility from the boundary and untransformed landscape, thereby highlighting the distribution of species among the areas (Fig. 6). Negative scores on the first axis indicate a higher presence at the solar facility such as the Cape bunting, rock martin (*Ptyonoprogne fuligula*), and Namaqua dove (*Oena capensis*). Whereas positive scores indicate a higher presence at the boundary and untransformed area such as the bokmakierie (*Telophorus zeylonus*), red-billed quelea (*Quelea quelea*), and violet-eared waxbill (*Uraeginthus granatinus*). Bird species with scores along the midpoint, such as the yellow canary, ant-eating chat (*Myrmecocichla formicivora*), and greater-striped swallow (*Hirundo cucullata*), represents an equal distribution in and around the development footprint. Since the second axis only explains 4% of the variation in the data, no definitive conclusions could further be made (Fig. 6). The results show that, there is a shift from a community preferring shrubland/woodland to one dominated by open country and grassland species, as well as those that generally associate with both habitat types and man-made structures (Fig. 6).

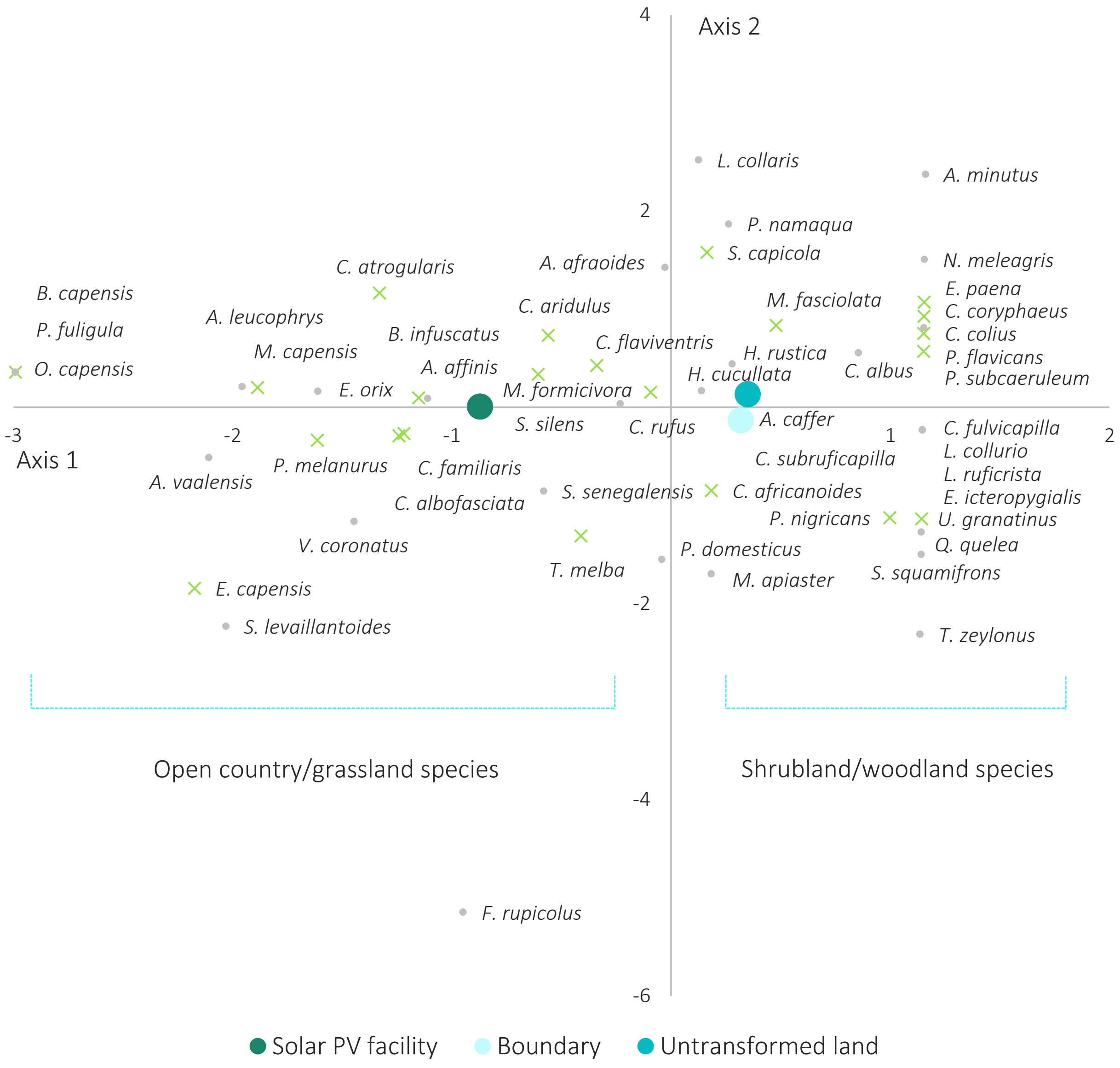


Figure 6: Biplot of the first two axes of the Correspondence Analysis (CA) representing the 53 bird species distributed over the solar facility, boundary, and untransformed landscape at the Jasper PV solar facility in the Northern Cape, South Africa. Crosses represent the 23 most abundant species within and around the development footprint, which were retained for further analysis.

The 23 most abundant bird species among the PV facility and untransformed land were retained for further analysis (Table 1). To avoid redundancy, the boundary was not included as it yielded similar results to the untransformed landscape. According to the CA-based classification, 7 species were considered to be strictly dependent on shrubland/woodland, 10 as open country/grassland and 6 as species tolerating broader habitat diversity (generalists). All shrubland/woodland species are situated under the identity straight line (y = x), signifying that they were underrepresented at the PV facility, while the open country/grassland species (75%) are located above the straight line. Most of the generalist species (67%) are found along the line itself (Fig. 7). Among the 23 studied bird species, 7 showed significant differences between their relative frequency in relation to the PV facility and untransformed landscape (Table 1), thereby revealing a higher sensitivity to the presence of the solar development than other species. It appears that shrubland/woodland species such as the black-chested prinia (*Prinia flavicans*) and chestnut-vented tit-babbler (*Parisoma subcaeruleum*) were negatively affected by the facility. In contrast, open country/grassland species and generalists were least affected, where species such as the Cape sparrow, and familiar chat (*Cercomela familiaris*) were favoured by the PV facility.

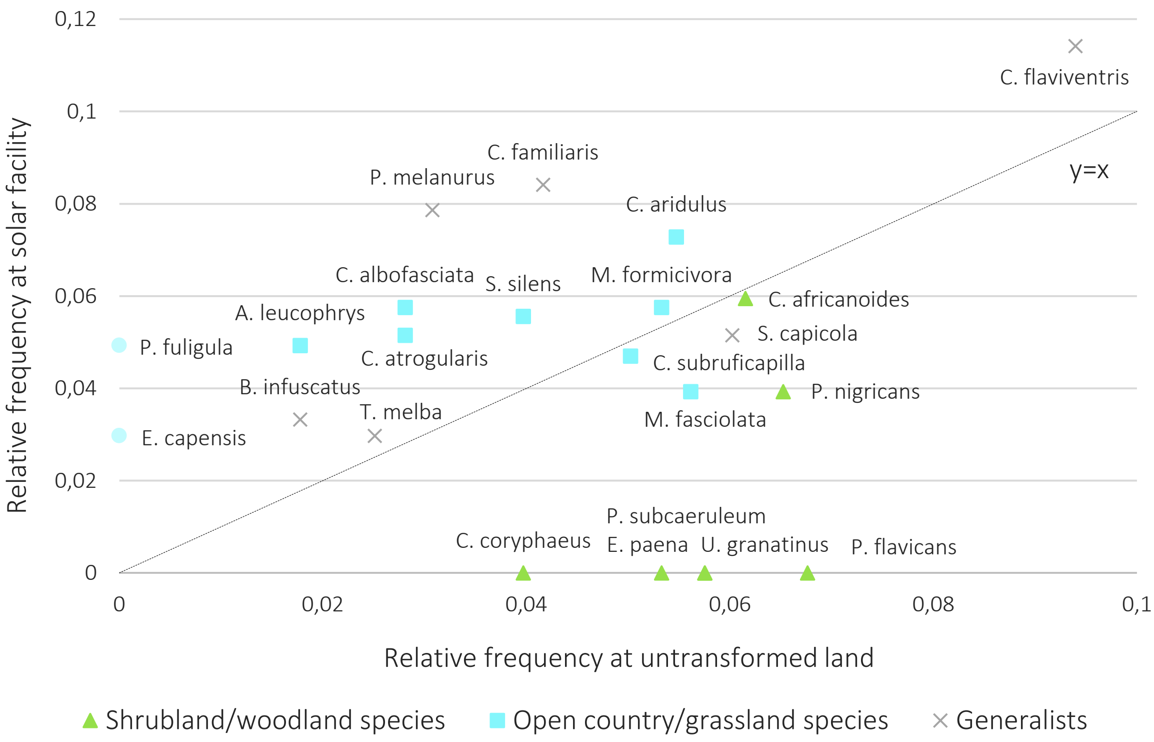


Figure 7: Comparison of relative frequencies between the Jasper PV solar facility and the untransformed landscape for each of the 23 studied species, grouped according to their habitat dependencies (Shrubland/woodland species, open country/grassland species, and generalists). The dots represent species generally associated with rocky outcrops.

Table 1: Twenty-three most abundant bird species retained for further analysis at Jasper PV solar facility in the Northern Cape South Africa. The variables N_f (D_f) and N_u (D_u) denote the species counts and density (birds.ha^{-1}) for the solar facility and untransformed landscape, respectively.

	Common name	Scientific name	N_f (D_f)	N_u (D_u)	p-value
		Shrubland/woodland species			
1	African red-eyed bulbul	*P. nigricans*	7 (NA)	25 (0.37±0.27)	n.s.
2	Black-chested prinia	*P. flavicans*	0 (NA)	29 (0.58±0.42)	<0,001
3	Chestnut-vented tit-babbler	*P. subcaeruleum*	0 (NA)	21 (0.99±0.35)	<0,001
4	Fawn-coloured lark	*C. africanoides*	16 (0.56±0.39)	24 (0.94±0.66)	n.s.
5	Kalahari scrub-robin	*E. paena*	0 (NA)	18 (0.80±0.54)	<0,001
6	Karoo scrub-robin	*C. coryphaeus*	0 (NA)	10 (0.29±0.55)	n.s.
7	Violet-eared waxbill	*U. granatinus*	0 (NA)	21 (0.62±0.98)	<0,001
		Open country/grassland			
8	Ant-eating chat	*M. formicivora*	15 (0.19±0.41)	18 (0.4±0.86)	n.s.
9	Black-throated canary	*C. atrogularis*	12 (0.52±0.59)	5 (NA)	n.s.
10	Cape bunting	*E. capensis*	4 (0.28±0.79)	0 (NA)	n.s.
11	Desert cisticola	*C. aridulus*	24 (1.27±1.21)	19 (0.5±0.31)	n.s.
12	Eastern clapper lark	*M. fasciolata*	7 (NA)	20 (0.78±0.82)	n.s.
13	Fiscal flycatcher	*S. silens*	14 (0.25±0.56)	10 (0.36±0.32)	n.s.
14	Greater-striped swallow	*C. subruficapilla*	10 (0.49±0.59)	16 (0.42±0.36)	n.s.
15	Plain-backed pipit	*A. leucophrys*	11 (0.31±0.59)	2 (NA)	n.s.
16	Rock martin	*P. fuligula*	11 (0.17±0.42)	0 (NA)	<0,01
17	Spike-heeled lark	*C. albofasciata*	15 (0.44±0.64)	5 (0.38±0.65)	n.s.
		Generalist species			
18	Alpine swift	*T. melba*	4 (0.19±0.41)	6 (NA)	n.s.
19	Cape sparrow	*P. melanurus*	28 (0.38±0.38)	6 (NA)	<0,001
20	Cape turtle dove	*S. capicola*	12 (NA)	23 (0.55±0.97)	n.s.
21	Chat flycatcher	*B. infuscatus*	5 (0.26±0.34)	2 (NA)	n.s.
22	Familiar chat	*C. familiaris*	32 (1.54±1.09)	11 (NA)	<0,01
23	Yellow canary	*C. flaviventris*	59 (0.50±0.62)	56 (0.93±0.66)	n.s.
		Total	286	347	

Figure 8: Avian use recorded during the bird community surveys at the Jasper PV solar facility in the Northern Cape, South Africa. The different areas of avian use represent (a) foraging (Orange River francolins *Scleroptila levaillantoides*), (b) hunting (rock kestrel *Falco rupicolus*), and (c) breeding (laughing dove *Spilopelia senegalensis*).

Avian use and behaviour

Several observations were made of birds using the facility as a foraging, hunting, and breeding site (Fig. 8). Vegetation regrowth between the solar arrays allowed for the presence of plant, invertebrate, and small reptile species, thereby providing a food source for the birds in the area. Several birds, including terrestrial feeders such as the Orange River francolin (*Scleroptila levaillantoides*), were observed to use the SPUs as shade and shelter, while the evaporation pond provided a drinking point for flocking species such as the Namaqua sandgrouse and scaly-feathered finch (*Sporopipes squamifrons*). Two species of raptors and one scavenger (Rock kestrel *Falco rupicolus*, pale-chanting goshawk *Melierax canorus*, and pied crow Corvus albus) were observed during the study period. The pale-chanting goshawk was mostly found at the water troughs outside of the study site and, on one occasion, at the PV facility scoping for prey. The rock kestrel was a regular visitor, observed at the evaporation pond and among the SPUs. Furthermore, eight nests of five known species were found located either directly on the mountings underneath the SPUs (n=5) or on the ground (n=3). This included the familiar chat (n=1), African red-eyed bulbul (n=1), laughing dove (*Spilopelia senegalensis*, n=1), Cape sparrow (n=2), and Cape wagtail (*Motacilla capensis*, n=1).

Collision mortality

Carcass searches

Twelve fatalities of six resident species were recorded during the study period, including one incidental (Appendix D; Table 2). The initial clearance surveys detected three of the fatalities among the SPUs and perimeter fence: One fiscal flycatcher (*Sigelus silens*), one Orange River francolin, and one African red-eyed bulbul. Thereafter, seven of the eight fatalities were detected among the SPUs, at an average rate of 0.003 birds per ha surveyed per month. The remaining fatality occurred along the fence-line at an average rate of 0.002 birds per km surveyed of fence per month. All fatalities were inferred from feather spots. Only two carcasses were found: One African red-eyed bulbul ≤2 months old, with dried flesh remains and numerous feathers, at the perimeter fence during the clearance surveys and one crowned lapwing ≤1 week old, with soft flesh remains and feathers, found incidentally next to the main road, probably due to a vehicle collision (Fig. 9).

Because no carcasses were found among the SPUs, it was impossible to assess whether impact trauma was the cause of death. There was no evidence of damaged or imprinted solar panels that might have suggested collision and since the fatalities were documented as feather spots, no further inspection could be performed. Most fatalities (n=7) were located under the SPUs, suggesting that either the birds did not collide with the upper surfaces of the panels, or they were moved by scavengers after collision. One of the fence-line fatalities (Orange River francolin) resulted from the bird being trapped between the inner and outer fence, where personnel observed the bird stunned after attempting to take flight between the fencing (Appendix D). This is further supported by observations of large-bodied birds unable to escape from between the two fences (e.g. red-crested korhaan, *Lophotis ruficrista*, n=3), except when prompted by personnel (Appendix D).

Table 2: Summary of fatalities detected during avian mortality surveys at the Jasper PV solar facility in the Northern Cape, South Africa.

Size class	Common name	Scientific name	Number detected	Total included
Small birds (<100 g)	Fiscal flycatcher	*Sigelus silens*	3[a]	2
	African red-eyed bulbul	*Pycnonotus nigricans*	1[a]	0
	Eastern clapper lark	*Mirafra apiata*	1	1
Medium birds (100-1000 g)	Orange river francolin	*Scleroptila levaillantoides*	5[a]	4
	Speckled pigeon	*Columba guinea*	1	1
	Crowned lapwing	*Vanellus coronatus*	1[b]	0
		Total	12	8[c]

[a] Fatalities detected during clearance surveys: one fiscal flycatcher, one African red-eyed bulbul, and one Orange River francolin
[b] Incidental record
[c] Fatalities included for fatality estimation (incidental and clearance survey records omitted)

Searcher efficiency trials

Searchers were able to detect 74% of the trial carcasses, where carcass size (χ^2 = 19.75, df = 2, P<0.001) and location relative to the SPUs (χ^2 = 9.26, df = 1, P<0.001) significantly influenced the probability of detection. Detection among size classes improved from 60 to 100% with increases in body mass, while location under the SPUs led to increases from 65 to 90% (Table 3).

Table 3: Results of searcher efficiency trials by size class and location of carcasses at the Jasper PV solar facility in the Northern Cape, South Africa.

	Location of carcasses detected/placed		
Size class	Adjacent to SPUs	Under SPUs	Total
Small birds (<100 g)	38/66	10/14	48/80
	58%	71%	60%
Medium birds (100-1000 g)	14/17	22/23	36/40
	82%	96%	90%
Large birds (>1000 g)	5/5	13/13	18/18
	100%	100%	100%
Total	57/88	45/50	102/138
	65%	90%	74%

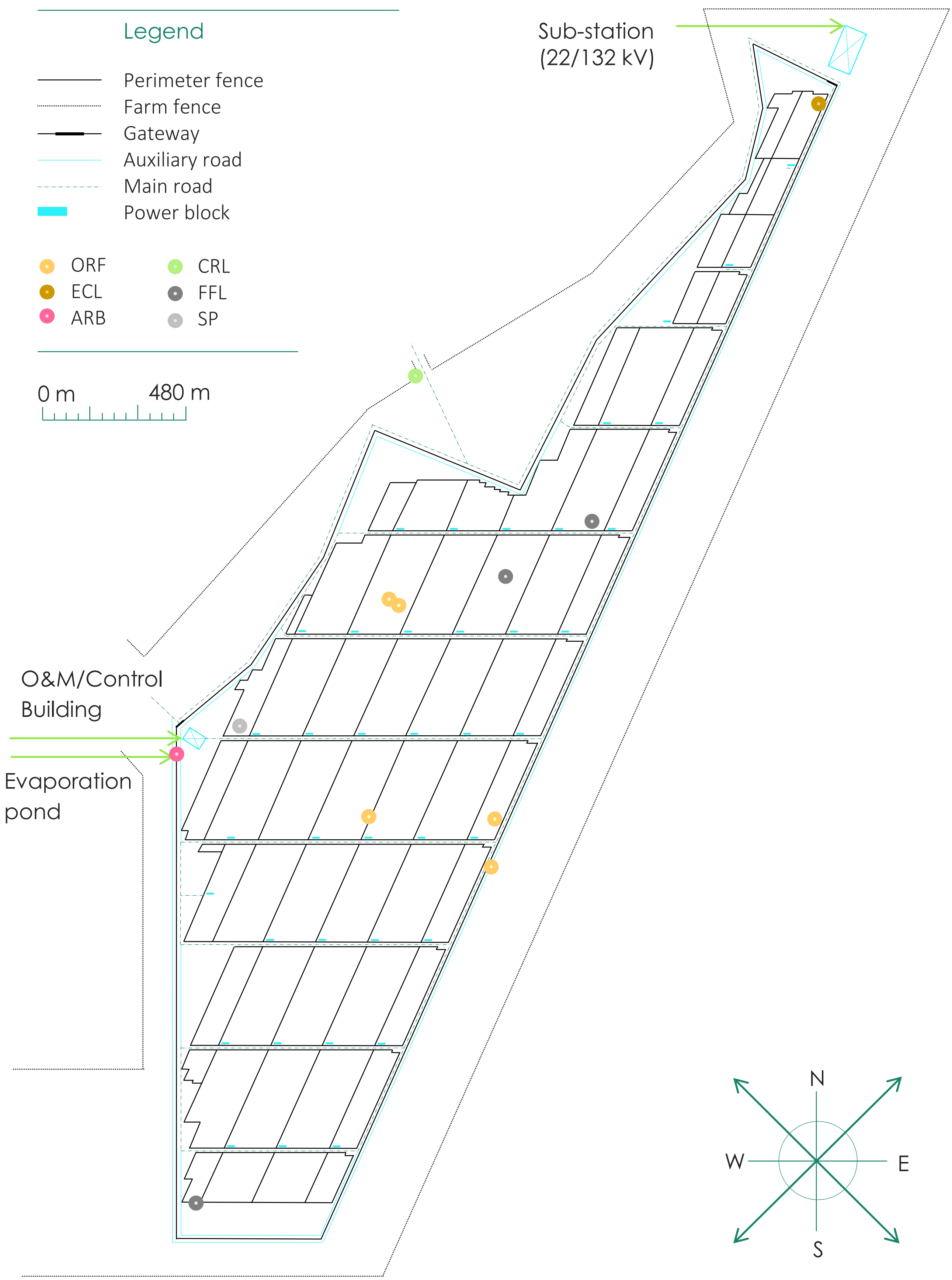
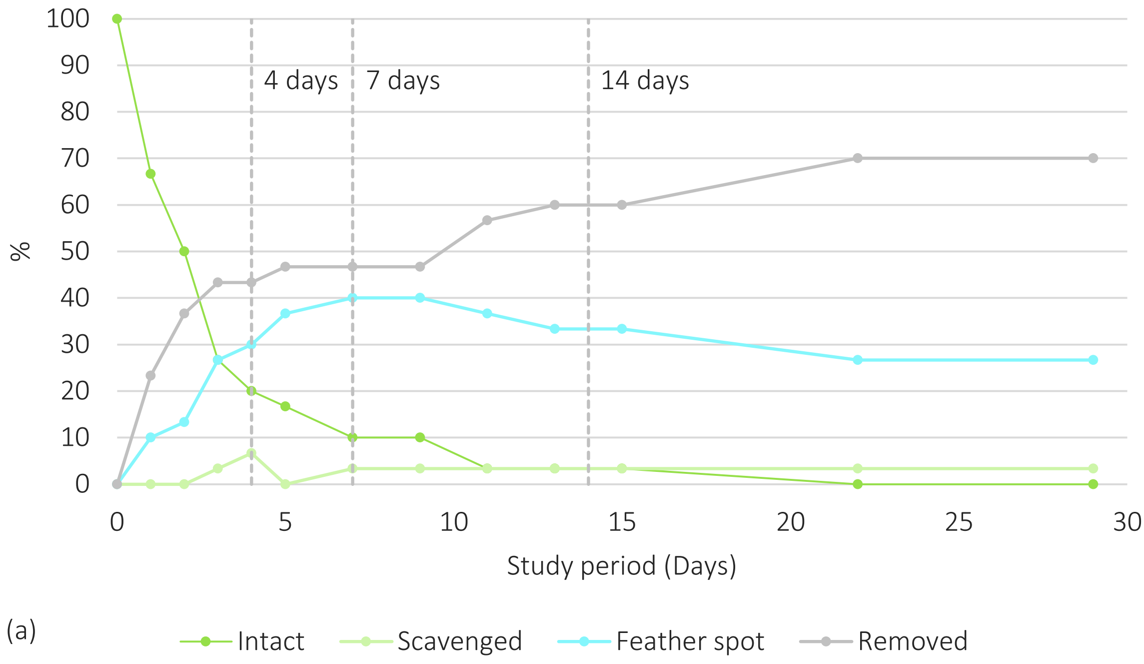


Figure 9: Distribution of avian fatalities detected, on a systematic and incidental basis, at the Jasper PV solar facility in the Northern Cape, South Africa. The 12 fatalities consists of six species, namely: Orange River francolin (ORF, *Scleroptila levaillantoides*), eastern clapper lark (ECL, *Mirafra apiata*), African red-eyed bulbul (ARB, *Pycnonotus nigricans*), crowned lapwing (CRL, *Vanellus coronatus*), fiscal flycatcher (FFL, *Sigelus silens*), and speckled pigeon (SP, *Columba guinea*).

Carcass persistence trials

During the persistence trials, 80% of the carcasses could be recorded as fatalities 24 hours after placement, 64% after one week, and 47% at the end of the full trial period. Carcass size affected the likelihood of remains still being present at the end of the trial period ($\chi^2 = 8.14$, df = 1, $P<0.01$, pooling medium and large birds; Fig 10). At the given 4, 7, and 14-day search intervals, small carcasses were still detectable at 57, 53, and 40%, respectively, primarily in the form of feather spots (Fig. 10). Whereas medium/large-sized carcasses remained largely intact at 87, 87, and 80%, respectively, either as partial remains or feather spots. After three weeks, there were minor changes observed in carcass status at both size classes. Little evidence of small carcasses remained at the end of the trial period (30%) in comparison to the medium/large-sized carcasses (80%), where evidence was mainly in the form of feather spots (27 and 47%, respectively).

Based on the camera traps, small carcasses were generally removed whole by scavengers. Medium-sized carcasses were reduced to large feather spots, usually after being moved to under the SPUs. Large carcasses were mostly reduced to scattered remains, including bones and feathers, after several visits by possibly the same scavenger. Multiple feather spots were recorded from the same carcass, which remained within a 1-5 m radius from initial placement. Three species of mammal scavengers were responsible for most carcass removal: African polecats (*Ictonyx striatus*, n=4 observations), yellow mongooses (*Cynictis penicillata*, n=3), and feral cats (*Felis catus*, n=2). Other scavenger species included pied crows (n=1) and Orange River francolins (n=2). Scavenging activity appeared to be greater at night time; only yellow mongooses, pied crows, and Orange River francolins were recorded during the day.



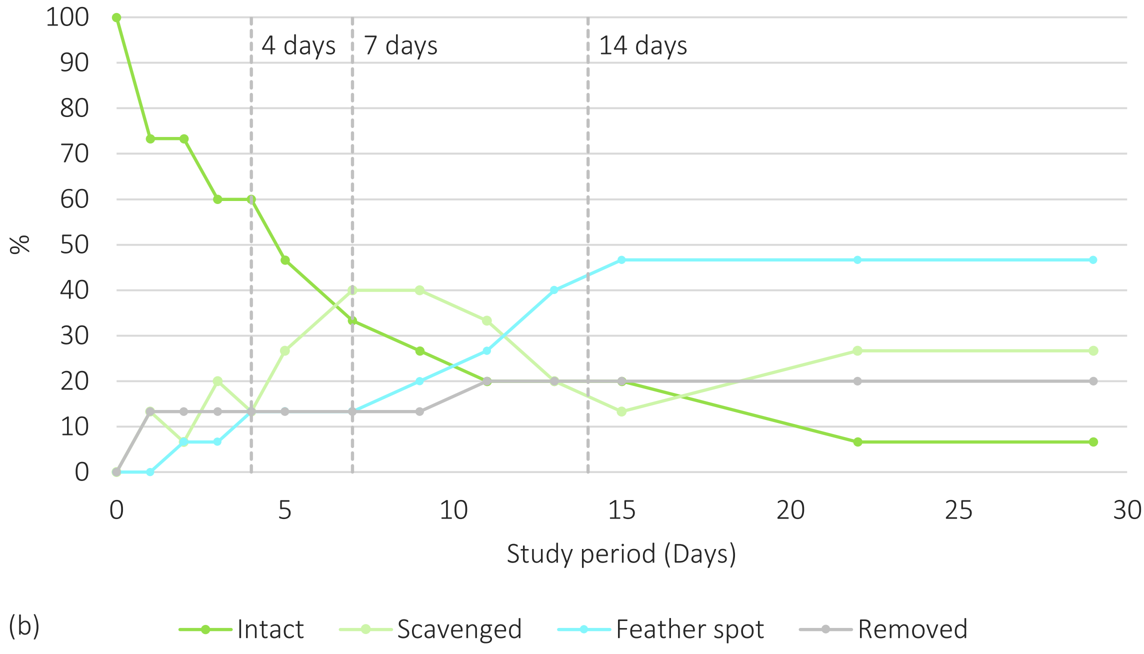


Figure 10: Percentage of (a) small (<100 g, n=30) and (b) medium/large (>100 g, n=15) bird carcasses still detectable at increasing intervals after deployment at the Jasper PV solar facility in the Northern Cape, South Africa.

Fatality estimation

The fatality estimate for the Jasper PV facility was 435 fatalities.yr^{-1} (95% CI 133-805) over 323 920 solar panels. The annual fatality rates were 2.42 fatalities.GWh^{-1} (95% CI 0.74-4.47) over 180 GWh, 4.53 fatalities.MW^{-1} (95% CI 1.51-8.50) over 96 MW, and 2.42 fatalities.GWh^{-1} (95% CI 0.74-4.47) over 180 ha. Fatality estimates were calculated for among the SPUs from known and unknown causes, with bootstrapped 95% confidence intervals (Table 4). Due to less than 5 fatality detections for the perimeter fence, evaporation pond, power lines, and substation, individual fatality estimates were not calculated.

Table 4: Variables used per size class, search interval, and sample area to calculate the overall annual avian fatality at the Jasper PV solar facility in the Northern Cape, South Africa. This includes number detected (c), searcher efficiency (p), carcass persistence (r), and detection probability (g).

Infrastructure	Size class	Search interval	Area covered[1]	Duration	c	p	r	g
Solar panel units (SPUs)	Small	4 days	28%	31 days	1	71%	57%	40%
		7 days	28%	52 days	1	71%	53%	38%
		14 days	27%	45 days	1	71%	40%	28%
	Medium/large	4 days	28%	31 days	2	98%	87%	85%
		7 days	28%	52 days	1	98%	87%	85%
		14 days	27%	45 days	1	98%	80%	78%
Perimeter fence and evaporation pond	Small	4 days	100%	31 days	1	71%	57%	40%
		7 days	100%	52 days	0	-	-	-
		14 days	100%	45 days	0	-	-	-
	Medium/large	4 days	100%	31 days	0	-	-	-
		7 days	100%	52 days	0	-	-	-
		14 days	100%	45 days	0	-	-	-
Power lines and substation	Small	14 days	100%	52 days	0	-	-	-
	Medium/large	14 days	100%	52 days	0	-	-	-
				Total:	8			

[1] The area covered among the SPUs at sample area 1, 2, and 3 is 29920 panels (9%), 29920 panels (10%), and 29920 panels (9%), respectively, for the 4-and 7-day search interval and 24920 panels (8%), 32760 panels (10%), and 29560 panels (9%) for the 14-day search interval.
The area covered at the perimeter fence and evaporation pond at sample area 1, 2, and 3 is 4.03 km (55%), 0.65 km (9%), and 2.60 km (36%), respectively, for the 4, 7, and 14-day search interval.

Discussion and recommendations

Changes in bird communities

Structural and functional differences

In previous studies on PV developments at airports and CSP facilities in the United States, research showed that solar developments had negative impacts on the abundance and diversity of bird communities in the area, especially among the heliostat units associated with CSP (DeVault et al. 2014; Harvey & Associates 2014). Consistent with these findings, both bird density and diversity per unit area was higher in the boundary and untransformed landscape, however, the extent therefore was not considered to be as significant. This indicates that the PV facility matrix is permeable to most species. Regardless, key environmental features, including available habitat and vegetation quality are most likely the overriding factors influencing species' occurrence and their relative density within the development footprint.

There are important ecological implications behind the differences in bird assemblages between the solar facility and the untransformed landscape as these changes were non-random. It appeared that shrubland/woodland species, who were well represented amongst the untransformed landscape, were negatively affected by its development, especially species such as the black-chested prinia and chestnut-vented tit-babbler. Whether this was solely due the absence of shrubs and woody vegetation at the PV facility, is likely to be species specific. Several studies indicate that shrubland species have specific habitat requirements thereby making them specialists with narrow habitat ranges (Schlossberg & King 2008, 2009). Furthermore, shrubland birds have exhibited the tendency to either avoid or experience lower nesting success near edges of habitats or are absent or scarce in smaller habitat patches in general (King et al. 2009). This indicates that even though shrubland birds have been observed in close proximity to the PV facility, it does not necessarily represent an unaffected population. Although none of the shrubland/woodland species observed in the study area were threatened (Appendix A), the further expansion of utility-scale PV facilities might result in cumulative impacts on such bird populations. With the current lack of knowledge regarding the behavioural plasticity and habitat requirements of most species, the effect of these elements is generally difficult to predict at this time (Barrios & Rodríguez 2004; Fox et al. 2006; Madsen & Boertmann 2008). Defining fundamental life-traits in resource exploitation among species, and incorporating adequate baseline and post-construction sampling, might improve the understanding of species–landscape relationships (Lima & Zollner 1996; Fox et al. 2006).

Open country/grassland and generalist species did not appear to be adversely affected by the facility, most likely due to their ability to use both open and shrubland areas (Dean 2000; Hockey et al. 2005). Some of the species were even favoured by the PV facility, such as the Cape sparrow and familiar chat. This suggests that the area supplemented and/or complemented habitat resources for these species. Firstly, the area is dominated by short grassland on which the birds depend (Hockey et al. 2005). Secondly, some of these species are well-adapted to anthropogenic habitat disturbance and modification, with generalists benefiting from water points and built structures. Overall open country and grassland species might benefit from PV developments as the loss of open grassland habitat within the Savanna Biome has become a conservation issue. Bush encroachment has resulted in the general increase in woody vegetation at the expense of grassland and savannas across South Africa and globally, partly due to land-use change and increased carbon-dioxide levels in the atmosphere (Wigley et al. 2009, 2010; O'Connor and Chamane 2012). This has driven the range dynamics of bird species in southern Africa, leaving open country and grassland species more affected than others (Wigley et al. 2009, 2010).

Avian use and behaviour

Opposed to other constructed PV facilities, which have led to severe habitat destruction due to the complete removal of vegetation onsite (Wild Skies Ecological Services 2015), the Jasper PV facility has adopted a less intensive practice. In contrast to results from DeVault et al. (2014), the green zone created through native vegetation regrowth, and possible microclimatic changes from the PV canopies (Armstrong et al. 2014), can maintain habitat resources such as foraging, hunting, and nesting sites. In the United Kingdom, the development of PV facilities has resulted in increasing populations of wildflowers and insects (Peschel 2010; Parker & McQueen 2013). Although no vegetation and invertebrate studies have been conducted at the Jasper PV facility, a variety of species have been observed throughout the study period and may provide a food source for birds in the area. Several bird species were seen to breed at the Jasper PV facility, where most nests were located on the mountings directly underneath the solar panels. This supports the claim that some bird species, including tree-nesting species such as the African red-eyed bulbul, might use the various raised structural components as nesting and roosting sites (Lovich & Ennen 2011; Hernandez et al. 2014). However, as with other solar developments, nests are removed from the infrastructure at the study site in order to manage potential fire hazards. Finally, coinciding with a study by Feltwell (2013), raptors such as the rock kestrel have been observed to scope the corridors among the solar arrays of the Jasper PV facility. This suggests that some birds of prey have the ability to adapt to the presence of its development through the adjustment of their preying strategy. Results from boundary indicate that bird species might be unaffected by their proximity to the Jasper PV facility, where artificial structures such as the evaporation pond provide a drinking point for birds, including those that do not access the facility itself such as the red-billed quelea and white-backed mousebird (*Colius colius*).

Collision mortality

Annual fatality estimates

Upon review of existing literature, the lack of standardisation regarding data collection methods, reporting units, and bias correction at solar facilities provided for sparse and inconsistent avian-fatality data (Table 5; Walston et al. 2015). As a result, it was difficult to provide a meaningful assessment of the overall avian mortality at solar energy developments as it would lead to inaccurate extrapolations to different geographic scales and temporal periods. In relation to other energy sources, current estimates for avian mortality (collision) ranks at 5.18 (0.07) at fossil fuel, 0.416 (0.188) at nuclear, and 0.269 fatalities.GWh^{-1} at wind power facilities (Sovacool 2009). However, the extrapolated fatality estimate of 2.42 fatalities.GWh^{-1} at the study site was most likely overestimated as most fatalities were of unknown causes of death, and multiple feather spots may have resulted from one fatality. Regardless of the current limitations in fatality estimates, results imply that fossil fuels may still be more dangerous to avian wildlife than renewable energy developments.

Table 5: Summary of available avian fatality data at utility-scale solar facilities (Walston et al. 2015)

Project name (MW)	Technology	Survey period	Incidental fatalities	Systematic fatalities[a]
96 MW Jasper Solar Farm	PV(Fixed)	09/2015 to 12/2015	1	11
550 MW Desert Sunlight	PV (Fixed)	09/2011 to 03/2014	154	-
550 MW Topaz Solar Farm	PV (Fixed)	01/2013 to 01/2014	19	41
250 MW California Valley Ranch	PV (Fixed)	08/2012 to 08/2013	NA	368[b]
250 MW Mohave Solar	CSP (Trough)	08/2013 to 03/2014	14	-
250 MW Genesis	CSP (Trough)	01/2012 to 05/2014	183	8
377 MW Ivanpah	CSP (Tower)	10/2013 to 03/2014	159	376
10 MW California Solar One	CSP (Tower)	05/1982 to 05/1983	NA	70

[a] Unadjusted fatalities

[b] This value includes fatalities from known and unknown causes at all project elements including background control plots, fence lines, generation tie-line, medium voltage lines, and arrays

Similar to other studies, it is suggested that, in order to fully understand the risk of avian mortality among solar facilities and other sources of electricity generation, fatality estimates need to be calculated through standardised protocols in order to account for potential biases and provide meaningful comparisons through estimates per GWh or MW (Erickson et al. 2005; Sovacool 2009; Waltson 2015). Among solar facilities alone, fatalities per area might be a more meaningful metric, especially for estimating cumulative impacts, since the efficiency of e.g. PV panels are continuing to improve over time (Waltson et al. 2015). Metrics such as fatalities per turbine, transmission line, or solar panels per year as well as studies reporting the number of fatalities assigned to other anthropogenic sources, such as vehicles, buildings and windows, lack comparable information (Sovacool 2009). Similar to wind energy, mortality risk might be influenced by the facility's geographic setting with respect to seasonal differences in avian activity and abundance, bird migration patterns, daytime versus night time, weather patterns, and other variables such as differences in technology and size (Kuvlesky et al. 2007; Arnett et al. 2008; Harvey & Associates 2015). However, with a study period of only three months, such variables could not be investigated.

Causes of death

A comparison between solar facilities indicate that, on average, most known fatality detections were collision-related followed by predation trauma at PV and CSP (trough) facilities and solar-flux exposure at CSP (tower) facilities (Kagan et al. 2014). However, consistent with trends observed in previous monitoring programmes (Kagan et al. 2014; Waltson et al. 2015), the majority of fatalities detected during the study period were inferred from feather spots. Therefore, in the absence of evidence of bodily injuries and/or direct observations of predation or collisions, it was difficult to determine definitive causes of death at the PV facility. Further research is required to develop standardised protocols for feather spot evaluations as such fatalities may indicate lethal or nonlethal panel strikes, or simply direct mammalian or avian predation (Harvey & Associates 2015).

Impact trauma

Similar to results from DeVault et al. (2014), little evidence was found that birds using the PV arrays responded to polarised light pollution. Several design variables at the study site might have affected the illusionary characteristics of the solar arrays, which have been hypothesised to resemble a large body of water. Firstly, the Jasper PV facility implemented a 1.86 m fixed-tilt mounting system with no artificial lighting during the evening, negating the threat of tall obstacles, moving components, light pollution, or simulation of water that might result in fatalities during local movements or migration (Feltwell 2013). Secondly, the structural markings and spatial gaps on the facility's solar panels might be breaking up the reflection of the arrays (Fig. 2a). The placement of white grid lines on solar panels has reduced the attractiveness to aquatic insects, with a loss of only 1.80% in energy-producing surface as a result (Horvath et al. 2010). Although similar research is yet to be conducted on birds, the evidence from this study, and that of window collisions (Klem 1990, 2004, 2006; Loss et al. 2014), suggest that reductions in collision mortality could be achieved by 28 cm-spaced contrasting bands or 10 cm spatial gaps. This is further supported by the lack of visual markers at the Desert Sunlight and CSP facilities, creating large expanses of unobscured reflective panels and mirrors, where most collision mortality among waterbirds have been documented. Such variables may provide a visual cue for birds to differentiate the panels as a solid structure, reducing the risk of collision. If evidence of collision mortality at solar facilities continue to rise, further research into panel design should be undertaken. Modifications of utility-scale wind turbines have seen reductions in avian fatality rates (Orloff & Flannery 1992) and could be expected for improved solar panel designs.

In terms of other infrastructure, the design of the perimeter fence at the study site has resulted in large-bodied birds, such as the Red-crested korhaan, to be entrapped between the ribbon mesh and electric fence. The birds experienced difficulty escaping by flight as the gap was too narrow for their wingspan, with either electrocution or collisions between fencing as a result. This was further supported by the injury of the Orange River francolin at the perimeter fence, where personnel observed the bird stunned after attempting to take flight between the fencing (Appendix D). However, these events are considered to be site-specific as fatalities at other solar facilities, with single-fence designs, were sufficiently low and unrelated to the study site (e.g. Harvey & Associates 2015). In contrast to monitoring programmes at other solar facilities, no fatalities were documented among the power lines, substation, or evaporation pond, most likely due to the relative absence of large-bodied birds that are vulnerable to collision with such infrastructure and/or the short period in which surveys in this study were conducted.

Stranding and predation

It is anticipated that a proportion of the unknown fatalities at the study site is the result of predation associated with non-fatal impact trauma with the solar panels, or other causes unrelated to

PV facility. This is supported by the observations of large-bodied birds such as the Orange River francolin colliding with the underside of the SPUs (Appendix D). When flushed, quick navigation through the high-clutter environment of panels resulted in the collision into structural elements of the array, thereby potentially leaving them vulnerable against opportunistic predators. Observations at other solar facilities supports this assertion of non-fatal collisions through evidence of predation mortalities among water-dependent species. The studies report that attempts to land on the solar panels may have either injured or stranded the birds, rendering them unable to escape to safety or easily take-off from land (Kagan et al. 2014). In this situation, although the cause of death is only indirectly related to the presence of the panels, it would still be classified as a solar-related collision.

Monitoring limitations

Similar to the wind industry (Warren-Hicks et al. 2013), challenges to monitoring success included variations in carcass detection by size class and location relative to the SPU. Searcher efficiency indicated that small carcasses would be more difficult to detect than larger-sized carcasses during surveys as well as carcasses located adjacent to the SPUs. This was most likely due to a denser vegetation cover, in comparison to the area under the SPUs, with the orientation of the panels further obscuring ground visibility. The persistence trials confirmed that the rates of carcass removal were greatest in the first week with negligible removal rates surpassing three weeks after placement. Most carcasses were removed within four weeks. Removal rates were higher for small bird carcasses most likely because they are more easily to remove from the development area by scavengers. Scavenger activity appeared not to be affected by the perimeter fence at the study site as terrestrial scavengers such as the yellow mongoose moved effortlessly through the ribbon mesh fence, while larger scavengers dug a swallow hole under the fence as it was not embedded deep into the ground.

This underlines the need for accounting covariates in the searcher efficiency and carcass persistence trials at solar facilities, where results from this study points to shorter intervals in order to maximise the chance of detecting a carcass. There may be limited value in sampling every three weeks or more, therefore, search intervals of no more than two weeks is recommended in post-monitoring research. In order to further improve the probability of carcass detection, protocols should include the placement of feather spots as the probability of detection varied significantly based on findings at the Ivanpah CSP facility (Harvey & Associates 2015). Furthermore, if resources allow, canine searcher efficiency trials should be incorporated in the protocols since have indicated improved detection rates for carcasses and feather spots (Harvey & Associates 2015).

Residency and species composition

Results from the bird community surveys indicated that open country/grassland and generalist species were most abundant within the development footprint and, therefore, used the facility more extensively than others. Although the sample size of fatality detections was too small for conclusive findings, most of the observed fatalities were of species overrepresented at the PV facility such as the fiscal flycatcher and eastern clapper lark. In addition, consistent with results from other solar facilities, resident species and passerines represent most of the avian mortality at the study site (Waltson et al. 2015) as such species were more prevalent within and around the development footprint. Even though water-dependent bird species could potentially occur in the study area (Appendix A), they were underrepresented at the PV facility, with only two flocks of spur-winged goose (*Plectropterus gambensis*) observed to fly-over during the study period. This indicates that, similar to studies in the wind industry, the level of bird use and behaviour of birds at the site could be important factors to consider when assessing potential risk at solar facilities and should be incorporated in future research and monitoring programmes (Erickson et al. 2002; Anderson et al. 2004; Kingsley and Whittam 2007; Kuvlesky et al. 2007).

Conclusion

This study demonstrated that, although some results still remain inconclusive, the concerns regarding the direct impacts of utility-scale PV developments on bird populations and communities are not entirely unfounded. The distribution of birds in the landscape altered in response to changes in the distribution and abundance of habitat resources such as food, water and nesting sites, which altered resource availability patterns that were beneficial to some bird species and detrimental to others. Shrubland/woodland species were threatened by the land-use changes associated with its development, potentially resulting in effective and/or physical habitat loss (Fox et al. 2006). Open country/grassland and generalist species were favoured by its presence with PV developments potentially offsetting some of the widespread loss among these species due to bush encroachment, which has led to increases in shrub-dependent species at the expense of open country and grassland birds. Due to the monitoring limitations, no definitive link with collision impact trauma could be found with solar-related infrastructure at the PV facility. However, finding few carcasses that can be assigned to a conclusive cause of death does not necessarily rule out the possibility of avian mortality. While any bird flying over the solar facility, or using it extensively, is at risk of collision, the extent thereof will most likely depend on biological, topographical, meteorological and technical factors (Bevanger 1994, 1998; Shaw et al. 2010; Lovich & Ennen 2011).

The impact of solar energy development on bird populations must be viewed in the context of climate change in the absence of the solar industry. Continued reliance on fossil-fuel consumption may result in global costs to bird populations that vastly outweigh any effects of the industry. Therefore, the apparent negative impacts of solar PV development should not hamper efforts aimed at reconciling increases in renewable energy generation with wildlife conservation. Similar to other energy sources, the impact of PV facilities on birds is likely to differ on a case-by-case basis (Lovich & Ennen 2011), where solar developments replacing previously degraded lands, such as old landfills or agricultural sites, can play an important role in promoting biodiversity (Peschel 2010; Parker & McQueen 2013). The opposite is generally the case with developments carved out of pristine or near-pristine habitats. Combined with results from other studies (Peschel 2010; Parker & McQueen 2013; DeVault et al. 2014), utility-scale PV facilities can offer opportunities for climate protection that do not conflict with nature conservation. Furthermore, the various forms of PV energy generation such as roof-top structures and other distributed solar sources would have lower impacts while providing the same CO_2 reduction benefits.

The results of this study suggests that on-site minimisation measures should be carried out under an adaptive management framework in order to assess their effectiveness before broad-scale applications are used. For the solar industry, the participation in research addressing wildlife impact challenges in the early stages of the energy sector's growth may help avoid situations that the wind industry experienced, in which informative research was delayed or conducted under research designs that did not adequately address the issues at hand (Fox et al. 2006; Stewart 2007; Waltson et al. 2015). Therefore, building upon lessons learned, there is a need for the collation and analysis of data from solar energy facilities across spatial and temporal scales and to produce comparable results from different energy sources. Scientifically rigorous survey, monitoring, assessment, and research designs will fill the gaps regarding the industry, thereby allowing the compilation of appropriate mitigation protocols to alleviate any adverse effects on species of concern and their habitats (Waltson et al. 2015).

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Appendix A: Comprehensive SABAP2 list of bird species that might occur within the study area at the Jasper PV solar facility in the Northern Cape, South Africa. Bird species are defined based on conservation status and endemism in southern Africa and their susceptibility to anthropogenic disturbances (Taylor et al. 2015; SABAP2 2015).

				Susceptibility to		
Common name	Scientific name	Conservation status	Regional endemism	Collision	Electrocution	Disturbance /habitat loss
Black harrier	*Circus maurus*	Endangered	Endemic	-	-	Moderate
Martial eagle	*Polemaetus bellicosus*	Endangered	-	Moderate	High	Moderate
Tawny eagle	*Aquila rapax*	Endangered	-	-	High	Moderate
Black stork	*Ciconia nigra*	Vulnerable	-	High	Moderate	-
White-backed vulture	*Gyps africanus*	Vulnerable	-	High	Moderate	-
Secretarybird	*Sagittarius serpentarius*	Vulnerable	-	High	-	Moderate
Blue crane	*Anthropoides paradiseus*	Near-threatened	Endemic	High	-	Moderate
Kori bustard	*Ardeotis kori*	Near-threatened	-	High	-	Moderate
Greater flamingo	*Phoenicopterus roseus*	Near-threatened	-	High	-	-
Northern black korhaan	*Afrotis afraoides*	-	Endemic	Moderate	-	Moderate
South african shelduck	*Tadorna cana*	-	Endemic	High	-	-
Cape shoveler	*Anas smithii*	-	Endemic	Moderate	-	-
Ant-eating chat	*Myrmecocichla formicivora*	-	Endemic	-	-	Moderate
Fairy flycatcher	*Stenostira scita*	-	Endemic	-	-	Moderate
Fiscal flycatcher	*Sigelus silens*	-	Endemic	-	-	Moderate
Eastern long-billed Lark	*Certhilauda semitorquata*	-	Endemic	-	-	Moderate
Karoo long-billed Lark	*Certhilauda subcoronata*	-	Endemic	-	-	Moderate
White-backed mousebird	*Colius colius*	-	Endemic	-	-	Moderate
Karoo scrub-robin	*Cercotrichas coryphaeus*	-	Endemic	-	-	Moderate
Karoo thrush	*Turdus smithi*	-	Endemic	-	-	Moderate
Rufous-eared warbler	*Malcorus pectoralis*	-	Endemic	-	-	Moderate

Sociable weaver	*Philetairus socius*	-	Endemic	-	-	Moderate
Orange River white-eye	*Zosterops pallidus*	-	Endemic	-	-	Moderate
Orange River francolin	*Scleroptila levaillantoides*	-	Near-endemic	Moderate	-	Moderate
Southern pale chanting goshawk	*Melierax canorus*	-	Near-endemic	-	Moderate	Moderate
Red-crested korhaan	*Lophotis ruficrista*	-	Near-endemic	Moderate	-	Moderate
Southern yellow-billed hornbill	*Tockus leucomelas*	-	Near-endemic	Moderate	-	-
Acacia pied barbet	*Tricholaema leucomelas*	-	Near-endemic	-	-	Moderate
Pririt batis	*Batis pririt*	-	Near-endemic	-	-	Moderate
Bokmakierie	*Telophorus zeylonus*	-	Near-endemic	-	-	Moderate
African red-eyed bulbul	*Pycnonotus nigricans*	-	Near-endemic	-	-	Moderate
Cape bunting	*Emberiza capensis*	-	Near-endemic	-	-	Moderate
Lark-like bunting	*Emberiza impetuani*	-	Near-endemic	-	-	Moderate
White-throated canary	*Crithagra albogularis*	-	Near-endemic	-	-	Moderate
Yellow canary	*Crithagra flaviventris*	-	Near-endemic	-	-	Moderate
Grey-backed cisticola	*Cisticola subruficapilla*	-	Near-endemic	-	-	Moderate
Red-headed finch	*Amadina erythrocephala*	-	Near-endemic	-	-	Moderate
Scaly-feathered finch	*Sporopipes squamifrons*	-	Near-endemic	-	-	Moderate
Chat flycatcher	*Bradornis infuscatus*	-	Near-endemic	-	-	Moderate
Marico flycatcher	*Bradornis mariquensis*	-	Near-endemic	-	-	Moderate
Eastern clapper lark	*Mirafra fasciolata*	-	Near-endemic	-	-	Moderate
Fawn-coloured Lark	*Calendulauda africanoides*	-	Near-endemic	-	-	Moderate
Cape penduline-tit	*Anthoscopus minutus*	-	Near-endemic	-	-	Moderate
Short-toed rock-thrush	*Monticola brevipes*	-	Near-endemic	-	-	Moderate
Kalahari scrub-robin	*Erythropygia paena*	-	Near-endemic	-	-	Moderate
Cape sparrow	*Passer melanurus*	-	Near-endemic	-	-	Moderate
Great sparrow	*Passer motitensis*	-	Near-endemic	-	-	Moderate
Pale-winged starling	*Onychognathus nabouroup*	-	Near-endemic	-	-	Moderate
Dusky sunbird	*Cinnyris fuscus*	-	Near-endemic	-	-	Moderate

Ashy tit	*Parus cinerascens*	-	Near-endemic	-	-	Moderate
Chestnut-vented tit-babbler	*Parisoma subcaeruleum*	-	Near-endemic	-	-	Moderate
Violet-eared waxbill	*Uraeginthus granatinus*	-	Near-endemic	-	-	Moderate
Mountain wheatear	*Oenanthe monticola*	-	Near-endemic	-	-	Moderate
Shaft-tailed whydah	*Vidua regia*	-	Near-endemic	-	-	Moderate
Burchell's courser	*Cursorius rufus*	-	Near-endemic	-	-	-
Namaqua sandgrouse	*Pterocles namaqua*	-	Near-endemic	-	-	-
Verreaux's eagle	*Aquila verreauxii*	-	-	Moderate	High	Moderate
Egyptian goose	*Alopochen aegyptiacus*	-	-	High	High	-
Spur-winged goose	*Plectropterus gambensis*	-	-	High	Moderate	-
Spotted eagle-owl	*Bubo africanus*	-	-	-	High	Moderate
Helmeted guineafowl	*Numida meleagris*	-	-	Moderate	-	High
Black-headed heron	*Ardea melanocephala*	-	-	Moderate	Moderate	-
Grey heron	*Ardea cinerea*	-	-	Moderate	Moderate	-
Lesser kestrel	*Falco naumanni*	-	-	Moderate	-	Moderate
Steppe buzzard	*Buteo vulpinus*	-	-	-	Moderate	Moderate
Barn owl	*Tyto alba*	-	-	-	Moderate	Moderate
Black-chested snake-eagle	*Circaetus pectoralis*	-	-	-	Moderate	Moderate
White-breasted cormorant	*Phalacrocorax lucidus*	-	-	Moderate	-	-
African black duck	*Anas sparsa*	-	-	Moderate	-	-
Maccoa duck	*Oxyura maccoa*	-	-	Moderate	-	-
White-faced duck	*Dendrocygna viduata*	-	-	Moderate	-	-
Yellow-billed duck	*Anas undulata*	-	-	Moderate	-	-
Grey-headed gull	*Chroicocephalus cirrocephalus*	-	-	Moderate	-	-
Hamerkop	*Scopus umbretta*	-	-	Moderate	-	-
African grey hornbill	*Tockus nasutus*	-	-	Moderate	-	-
African sacred ibis	*Threskionis aethiopicus*	-	-	Moderate	-	-
Glossy ibis	*Plegadis falcinellus*	-	-	Moderate	-	-

Hadeda ibis	*Bostrychia hagedash*	-	-	Moderate	-	-
Greater painted-snipe	*Rostratula benghalensis*	-	-	Moderate	-	-
Southern pochard	*Netta erythrophthalma*	-	-	Moderate	-	-
African spoonbill	*Platalea alba*	-	-	Moderate	-	-
Cape teal	*Anas capensis*	-	-	Moderate	-	-
Red-billed teal	*Anas erythrorhyncha*	-	-	Moderate	-	-
Common ostrich	*Struthio camelus*	-	-	-	-	High
Crested barbet	*Trachyphonus vaillantii*	-	-	-	-	Moderate
Southern red bishop	*Euplectes orix*	-	-	-	-	Moderate
Brubru	*Nilaus afer*	-	-	-	-	Moderate
Cinnamon-breasted bunting	*Emberiza tahapisi*	-	-	-	-	Moderate
Golden-breasted bunting	*Emberiza flaviventris*	-	-	-	-	Moderate
Black-throated canary	*Crithagra atrogularis*	-	-	-	-	Moderate
Familiar chat	*Cercomela familiaris*	-	-	-	-	Moderate
Desert cisticola	*Cisticola aridulus*	-	-	-	-	Moderate
Levaillant's cisticola	*Cisticola tinniens*	-	-	-	-	Moderate
Zitting cisticola	*Cisticola juncidis*	-	-	-	-	Moderate
Long-billed crombec	*Sylvietta rufescens*	-	-	-	-	Moderate
Cape crow	*Corvus capensis*	-	-	-	-	Moderate
Pied crow	*Corvus albus*	-	-	-	-	Moderate
Diderick cuckoo	*Chrysococcyx caprius*	-	-	-	-	Moderate
Laughing dove	*Spilopelia senegalensis*	-	-	-	-	Moderate
Namaqua dove	*Oena capensis*	-	-	-	-	Moderate
Red-eyed dove	*Streptopelia semitorquata*	-	-	-	-	Moderate
Rock dove	*Columba livia*	-	-	-	-	Moderate
Booted eagle	*Hieraaetus pennatus*	-	-	-	-	Moderate
Yellow-bellied eremomela	*Eremomela icteropygialis*	-	-	-	-	Moderate
Common fiscal	*Lanius collaris*	-	-	-	-	Moderate

Spotted flycatcher	*Muscicapa striata*	-	-	-	-	Moderate
Gabar goshawk	*Micronisus gabar*	-	-	-	-	Moderate
African hoopoe	*Upupa africana*	-	-	-	-	Moderate
Greater kestrel	*Falco rupicoloides*	-	-	-	-	Moderate
Rock kestrel	*Falco rupicolus*	-	-	-	-	Moderate
Black-shouldered kite	*Elanus axillaris*	-	-	-	-	Moderate
Red-capped lark	*Calandrella cinerea*	-	-	-	-	Moderate
Sabota lark	*Calendulauda sabota*	-	-	-	-	Moderate
Spike-heeled lark	*Chersomanes albofasciata*	-	-	-	-	Moderate
Banded martin	*Riparia cincta*	-	-	-	-	Moderate
Brown-throated martin	*Riparia paludicola*	-	-	-	-	Moderate
Rock martin	*Ptyonoprogne fuligula*	-	-	-	-	Moderate
Southern masked-weaver	*Ploceus velatus*	-	-	-	-	Moderate
Red-faced mousebird	*Urocolius indicus*	-	-	-	-	Moderate
Neddicky	*Cisticola fulvicapilla*	-	-	-	-	Moderate
European nightjar	*Caprimulgus europaeus*	-	-	-	-	Moderate
Rufous-cheeked nightjar	*Caprimulgus rufigena*	-	-	-	-	Moderate
Speckled pigeon	*Columba guinea*	-	-	-	-	Moderate
African pipit	*Anthus cinnamomeus*	-	-	-	-	Moderate
Buffy pipit	*Anthus vaalensis*	-	-	-	-	Moderate
Black-chested prinia	*Prinia flavicans*	-	-	-	-	Moderate
African quailfinch	*Ortygospiza atricollis*	-	-	-	-	Moderate
Red-billed quelea	*Quelea quelea*	-	-	-	-	Moderate
Cape robin-chat	*Cossypha caffra*	-	-	-	-	Moderate
Purple roller	*Coracias naevius*	-	-	-	-	Moderate
Crimson-breasted shrike	*Laniarius atrococcineus*	-	-	-	-	Moderate
Lesser grey shrike	*Lanius minor*	-	-	-	-	Moderate
Red-backed shrike	*Lanius collurio*	-	-	-	-	Moderate

House sparrow	*Passer domesticus*	-	-	-	-	Moderate
Southern grey-headed sparrow	*Passer diffusus*	-	-	-	-	Moderate
White-browed sparrow-weaver	*Plocepasser mahali*	-	-	-	-	Moderate
Cape glossy starling	*Lamprotornis nitens*	-	-	-	-	Moderate
Wattled starling	*Creatophora cinerea*	-	-	-	-	Moderate
African stonechat	*Saxicola torquatus*	-	-	-	-	Moderate
Marico sunbird	*Cinnyris mariquensis*	-	-	-	-	Moderate
Barn swallow	*Hirundo rustica*	-	-	-	-	Moderate
Greater striped swallow	*Hirundo cucullata*	-	-	-	-	Moderate
White-throated Swallow	*Hirundo albigularis*	-	-	-	-	Moderate
Brown-crowned tchagra	*Tchagra australis*	-	-	-	-	Moderate
Groundscraper thrush	*Psophocichla litsitsirupa*	-	-	-	-	Moderate
Cape turtle-dove	*Streptopelia capicola*	-	-	-	-	Moderate
Cape wagtail	*Motacilla capensis*	-	-	-	-	Moderate
Willow warbler	*Phylloscopus trochilus*	-	-	-	-	Moderate
Common waxbill	*Estrilda astrild*	-	-	-	-	Moderate
Capped wheatear	*Oenanthe pileata*	-	-	-	-	Moderate
Pin-tailed whydah	*Vidua macroura*	-	-	-	-	Moderate
Pied avocet	*Recurvirostra avosetta*	-	-	-	-	-
European bee-eater	*Merops apiaster*	-	-	-	-	-
Red-knobbed coot	*Fulica cristata*	-	-	-	-	-
Reed cormorant	*Microcarbo africanus*	-	-	-	-	-
Double-banded courser	*Rhinoptilus africanus*	-	-	-	-	-
African darter	*Anhinga rufa*	-	-	-	-	-
Cattle egret	*Bubulcus ibis*	-	-	-	-	-
Great egret	*Ardea alba*	-	-	-	-	-
Little egret	*Egretta garzetta*	-	-	-	-	-
Yellow-billed egret	*Egretta intermedia*	-	-	-	-	-

Black-necked grebe	*Podiceps nigricollis*	-	-	-	-	-
Great crested grebe	*Podiceps cristatus*	-	-	-	-	-
Little grebe	*Tachybaptus ruficollis*	-	-	-	-	-
Common greenshank	*Tringa nebularia*	-	-	-	-	-
Blacksmith lapwing	*Vanellus armatus*	-	-	-	-	-
Crowned lapwing	*Vanellus coronatus*	-	-	-	-	-
Common moorhen	*Gallinula chloropus*	-	-	-	-	-
Kittlitz's plover	*Charadrius pecuarius*	-	-	-	-	-
Three-banded plover	*Charadrius tricollaris*	-	-	-	-	-
Ruff	*Philomachus pugnax*	-	-	-	-	-
Marsh sandpiper	*Tringa stagnatilis*	-	-	-	-	-
Black-winged stilt	*Himantopus himantopus*	-	-	-	-	-
Little stint	*Calidris minuta*	-	-	-	-	-
Alpine swift	*Tachymarptis melba*	-	-	-	-	-
Common swift	*Apus apus*	-	-	-	-	-
Little swift	*Apus affinis*	-	-	-	-	-
White-rumped swift	*Apus caffer*	-	-	-	-	-
Whiskered tern	*Chlidonias hybrida*	-	-	-	-	-
White-winged tern	*Chlidonias leucopterus*	-	-	-	-	-
Spotted Thick-knee	*Burhinus capensis*	-	-	-	-	-

Appendix B: List of bird species used in the searcher efficiency and carcass persistence trials at the Jasper PV solar facility in the Northern Cape, South Africa.

Searcher efficiency trials			
Size class	Common name	Scientific name	Number
Small (<100 g)	Fawn-coloured lark	*Calendulauda africanoides*	3
	Namaqua dove	*Oena capensis*	5
	Lark-like bunting	*Emberiza impetuani*	2
	Southern red bishop[1]	*Euplectes orix*	4
	White-browed sparrow-weaver	*Plocepasser mahali*	1
	Yellow canary[2]	*Crithagra flaviventris*	1
Medium (100-1000 g)	Blacksmith lapwing	*Vanellus armatus*	2
	Crowned lapwing	*Vanellus coronatus*	1
	Feral pigeon	*Columba livia domestica*	3
	Green pigeon	*Treron calvus*	4
Large (>1000 g)	Hadeda ibis	*Bostrychia hagedash*	4
		Total	30

Carcass persistence trials			
Size class	Common name	Scientific name	Number
Small (<100 g)	Common quail	*Coturnix coturnix*	12
	Fawn-coloured lark	*Calendulauda africanoides*	3
	House sparrow	*Passer domesticus*	5
	Namaqua dove	*Oena capensis*	5
	Southern red bishop[1]	*Afrotis afraoides*	4
	Yellow canary[2]	*Crithagra flaviventris*	1
Medium (100-1000 g)	Blacksmith lapwing	*Vanellus armatus*	2
	Crowned lapwing	*Vanellus coronatus*	1
	Feral pigeon	*Columba livia domestica*	2
	Green pigeon	*Treron calvus*	5
Large (>1000 g)	Hadeda ibis	*Bostrychia hagedash*	5
		Total	45

[1] Southern red bishop: one colourful male and 3 females/ plain males
[2] Yellow canary: one colourful male

Appendix C: Comprehensive list of bird species observed within and around the Jasper PV solar facility in the Northern Cape, South Africa. Bird species are defined based on their preferred habitat (Hockey et al. 2005).

Common name	Scientific name	Preferred habitat					
		Open grassland	Shrubland	Woodland[1]	Rocky outcrops	Open water bodies	Man-made habitats[2]
Cape penduline-tit	*Anthoscopus minutus*		×				
African red-eyed bulbul	*Pycnonotus nigricans*		×			×	
European bee-eater	*Merops apiaster*		×				×
Kalahari scrub-robin	*Cercotrichas paena*		×				×
Red-billed quelea	*Quelea quelea*		×				×
Namaqua dove	*Oena capensis*		×				×
Cape bunting	*Emberiza capensis*		×		×		×
Rock martin	*Ptyonoprogne fuligula*				×		×
White-backed mousebird	*Colius colius*			×		×	×
Familiar chat	*Cercomela familiaris*			×	×		×
Southern pale chanting goshawk	*Melierax canorus*			×	×		
Fawn-coloured lark	*Calendulauda africanoides*		×	×			
Grey-backed cisticola	*Cisticola subruficapilla*		×	×			
Violet-eared waxbill	*Uraeginthus granatinus*		×	×			
Red-backed shrike	*Lanius collurio*		×	×			
Karoo scrub-robin	*Cercotrichas coryphoeus*		×	×			
Red-crested korhaan	*Lophotis ruficrista*		×	×			
Chestnut-vented tit-babbler	*Parisoma subcaeruleum*		×	×			
Black-chested prinia	*Prinia flavicans*		×	×			×
Neddicky	*Cisticola fulvicapilla*		×	×			×
Yellow-bellied eremomela	*Eremomela icteropygialis*		×	×			×
Pied crow	*Corvus albus*		×	×			×
Scaly-feathered finch	*Sporopipes squamifrons*		×	×			×

Black-throated canary	*Crithagra atrogularis*		×	×			×
Yellow canary	*Crithagra flaviventris*		×	×			×
Bokmakierie	*Telophorus zeylonus*		×	×			×
Buffy pipit	*Anthus vaalensis*	×					×
Northern black korhaan	*Afrotis afraoides*	×					×
Black-headed heron	*Ardea melanocephala*	×				×	
Cape wagtail	*Motacilla capensis*	×				×	×
Southern red bishop	*Euplectes orix*	×				×	×
Eastern Clapper Lark	*Mirafra fasciolata*	×	×				
Spike-heeled Lark	*Chersomanes albofasciata*	×	×				
Spur-winged goose	*Plectropterus gambensis*	×	×			×	×
Spotted thick-knee	*Burhinus capensis*	×	×			×	×
Desert cisticola	*Cisticola aridulus*	×	×				
Greater-striped swallow	*Hirundo cucullata*	×	×				×
Plain-backed pipit	*Anthus leucophrys*	×	×				×
Ant-eating chat	*Myrmecocichla formicivora*	×	×				
Helmeted guineafowl	*Numida meleagris*	×	×				
House sparrow	*Passer domesticus*	×	×				×
Orange River francolin	*Scleroptila levaillantoides*	×	×				
Namaqua sandgrouse	*Pterocles namaqua*	×	×				
Rock kestrel	*Falco rupicolus*	×	×		×		×
Alpine swift	*Tachymarptis melba*	×	×	×	×		
Little swift	*Apus affinis*	×	×	×	×		×
White-rumped swift	*Apus caffer*	×	×	×			
Crowned lapwing	*Vanellus coronatus*	×	×	×			×
Laughing dove	*Streptopelia senegalensis*	×	×	×			×
Cape turtle dove	*Streptopelia capicola*	×	×	×			×
Burchell's Courser	*Cursorius rufus*	×	×	×			×
Chat flycatcher	*Bradornis infuscatus*	×	×	×			
Fiscal flycatcher	*Sigelus silens*	×	×	×			

Cape sparrow	*Passer melanurus*	×	×	×			×
Common fiscal	*Lanius collaris*	×	×	×			×
Barn swallow	*Hirundo rustica*	×	×	×		×	×

[1] Open to dense woodland (including drainage lines)
[2] Urban areas, gardens, parks, golf courses, and croplands

Appendix D: List of fatal and non-fatal detections of bird species recorded during the avian mortality surveys at the Japer PV solar facility in the Northern Cape, South Africa.

Date	Common name	Scientific name	Survey type[1]	Location	Condition of bird/carcass[2]	Suspected cause	Level of certainty[3]
14/09/2015	Fiscal flycatcher	*Sigelus silens*	Clearance	Under solar panel	Feather spot	Unknown	NA
15/09/2015	African red-eyed bulbul	*Pycnonotus nigricans*	Clearance	Perimeter fence	Carcass	Unknown	NA
15/09/2015	Orange river francolin	*Scleroptila levaillantoides*	Clearance	Under solar panel	Feather spot	Unknown	NA
22/09/2015	Orange river francolin	*Scleroptila levaillantoides*	Systematic	Under solar panel	Feather spot	Unknown	NA
24/09/2015	Fiscal flycatcher	*Sigelus silens*	Systematic	Under solar panel	Feather spot	Unknown	NA
25/09/2015	Orange river francolin	*Scleroptila levaillantoides*	Systematic	Under solar panel	Feather spot	Unknown	NA
19/10/2016	Eastern clapper lark	*Mirafra apiata*	Systematic	Under solar panel	Feather spot	Unknown	NA
02/11/2015	Speckled pigeon	*Columba guinea*	Systematic	Under solar panel	Feather spot	Unknown	NA
26/11/2015	Fiscal flycatcher	*Sigelus silens*	Systematic	Under solar panel	Feather spot	Unknown	NA
28/11/2015	Orange river francolin	*Scleroptila levaillantoides*	Systematic	Under solar panel	Feather spot	Unknown	NA
14/09/2015	Orange river francolin	*Scleroptila levaillantoides*	Systematic	Under solar panel	Uninjured	Non-fatal collision	Observed
14/09/2015	Orange river francolin	*Scleroptila levaillantoides*	Systematic	Under solar panel	Uninjured	Non-fatal collision	Observed
14/10/2015	Orange river francolin	*Scleroptila levaillantoides*	Systematic	Under solar panel	Uninjured	Non-fatal collision	Observed
14/10/2015	Orange river francolin	*Scleroptila levaillantoides*	Systematic	Under solar panel	Uninjured	Non-fatal collision	Observed
02/10/2015	Orange river francolin	*Scleroptila levaillantoides*	Systematic	Perimeter fence	Feather spot	Entrapment	Valid
09/10/2015	Red-crested korhaan	*Lophotis ruficrista*	Systematic	Perimeter fence	Uninjured	Entrapment	Observed
12/11/2015	Red-crested korhaan	*Lophotis ruficrista*	Systematic	Perimeter fence	Uninjured	Entrapment	Observed
30/11/2015	Red-crested korhaan	*Lophotis ruficrista*	Systematic	Perimeter fence	Uninjured	Entrapment	Observed

14/10/2015	Crowned lapwing	*Vanellus coronatus*	Incidental	Main road	Carcass	Vehicle strike	Valid

[1] Clearance - avian fatalities detected and removed from the study site prior to the scheduled surveys that will not be included in the fatality estimates, systematic surveys - avian fatalities detected that will be included in the fatality estimates, incidental - avian fatalities detected outside the scheduled surveys that will not be included in the fatality estimates.

[2] African red-eyed bulbul: fresh (within a week old, with soft flesh remains and fresh feathers); crowned lapwing: recent (within two months old, with dried flesh remains and numerous feathers still present); other: > 10 feathers of any type concentrated in an area less than 3 m^2

[3] Observed - 100%, valid - >90% certainty; probable - >50% certainty; possible - <50%, but > 0% certainty; not applicable - 0% certainty or unknown