ENVIRONMENTAL IMPACT ASSESSMENT PROCESS
FINAL EIA REPORT

PROPOSED POFADDER SOLAR THERMAL PLANT AND ASSOCIATED INFRASTRUCTURE
NORTHERN CAPE

(DEA REF No: 12/12/20/1832)

FINAL SUBMISSION TO DEA
December 2010

Prepared for:
!KaXu CSP South Africa
Lords Office Estates
276 West Avenue
Centurion

!KaXu CSP SOUTH AFRICA

Prepared by:

Savannah Environmental Pty Ltd

UNIT 606, 1410 EGLIN OFFICE PARK
14 EGLIN ROAD, SUNNINGHILL, GAUTENG
PO BOX 148, SUNNINGHILL, 2157
TEL: +27 (0)11 234 6621
FAX: +27 (0)86 684 0547
E-MAIL: INFO@SAVANNAHSA.COM
WWW.SAVANNAHSA.COM

Savannah ENVIRONMENTAL (PTY) LTD

PROJECT DETAILS

DEA Reference No.	:	12/12/20/1832
Title	:	Environmental Impact Assessment Process Final Environmental Impact Assessment Report: Proposed Pofadder Solar Thermal Plant and Associated Infrastructure on a site near Pofadder, Northern Cape
Authors	:	Savannah Environmental (Pty) Ltd Tammy Kruger Karen Jodas
Sub-consultants	:	Tony Barbour Environmental Consulting & Research Outeniqua Geotechnical Services Scherman, Colloty & Associates Agricultural Research Council David Hoare Consulting cc Sustainable Futures ZA Birdlife South Africa McGregor Museum MetroGIS
Client	:	KaXu CSP South Africa (Pty) Ltd
Report Status	:	Final Environmental Impact Assessment Report for submission to the DEA

When used as a reference this report should be cited as: Savannah Environmental (2010) Final Environmental Impact Assessment Report: Proposed Pofadder Solar Thermal Plant and associated infrastructure on a site near Pofadder, Northern Cape Province, for KaXu CSP South Africa (Pty) Ltd.

COPYRIGHT RESERVED
This technical report has been produced by Savannah Environmental (Pty) Ltd for KaXu CSP South Africa (Pty) Ltd. (Pty) Ltd. No part of the report may be copied, reproduced or used in any manner without written permission from KaXu CSP South Africa (Pty) Ltd, or Savannah Environmental (Pty) Ltd.

EXECUTIVE SUMMARY

KaXu CSP South Africa (Pty) Ltd (!KaXu CSP) , an Independent Power Producer, proposes to establish a commercial solar energy facility and associated infrastructure to generate electrical power from solar radiation, a renewable form of energy, on a site near Pofadder. This proposed development is referred to as the **Pofadder Solar Thermal Plant**. The site that has been identified for the establishment of the facility is located approximately 30 km north-east of Pofadder in the Northern Cape on Portion 4 of Scuit-Klip 92 which falls within the Khai Ma Local Municipality.

The proposed facility, which will be primarily contained within this identified farm portion, will have a developmental footprint of approximately 11 km^2. The solar energy facility will have an overall maximum generating capacity of 310 MW and will be comprised of a combination of the following technologies (in any combination):

- **100 MW** to be generated from 80 – 200 loops of parabolic troughs (i.e. to cover a total extent of approximately 200 - 300 ha) with an approximate height of 5 m.
- **50 MW** to be generated from a field of heliostats/mirrors (i.e. approximately 4 000 – 6 000 mirrors each approximately 120 m^2, positioned on 6 m high pedestals) positioned around an approximately 200 m high power tower including the receiver (i.e. to cover a total extent of approximately 300 ha).
- **10 MW** to be generated from several rows of PV panels (i.e. to cover a total extent of approximately 50 ha).

The Renewable Energy Feed-in Tariff Process (criteria not yet finalised by the National Energy Regulator of South Africa), selection process (not finalised by the Department of Energy, together with National Treasury) and the economics of the solar facility will be key in determining the final technology combination and the schedule of implementation for the facility.

The following associated infrastructural requirements will also be established within the developmental footprint of the proposed facility:

- **Power islands** which will include a steam turbine and generator; a generator transformer and a small substation; an auxiliary steam boiler and associated vessels.
- An **overhead power line** feeding into the Eskom electricity network at the Paulputs Transmission Substation.
- An **abstraction point** at the Gariep (Orange) River and an associated water **supply pipeline** to the facility of approximately 30 km in length.
- A **suspension reservoir**.
- A **storage reservoir**.
- Lined **evaporation ponds**.
- **External access road** leading to the site from the R358 which branches off the N14 towards Onseepkans.
- **Internal access road** for construction and maintenance purposes.

» Workshop, office, and storage areas.

The nature and extent of this facility, as well as potential environmental impacts associated with the construction and operation of a facility of this nature are explored in more detail in this Environmental Impact Assessment (EIA) Report which consists of the following chapters:

Chapter 1 provides background to the proposed facility and the environmental impact assessment process.
Chapter 2 provides an overview of the proposed project.
Chapter 3 provides an overview of the Regulatory and Legal Context for electricity generation projects.
Chapter 4 outlines the process which was followed during the EIA Phase, including the consultation program that was undertaken and input received from interested parties and stakeholders.
Chapter 5 describes the existing biophysical and socio-economic environment.
Chapter 6 presents the assessment of environmental impacts associated with the facility and its associated infrastructure.
Chapter 7 presents the conclusions of the EIA process, as well as an impact statement on the proposed project.
Chapter 8 provides a list of references and information sources used in undertaking the studies for this EIA Report.

The Scoping Phase of the EIA process identified potential issues associated with the proposed project, and defined the extent of the studies required within the EIA Phase. The Scoping Phase also identified potentially sensitive areas within the study site which served to inform the placement of the facility through a funnel-down approach.

The EIA Phase addressed those identified potential environmental impacts and benefits (direct, indirect, and cumulative impacts) associated with all phases of the project including design, construction, and operation. The EIA Phase recommends appropriate mitigation measures for potentially significant environmental impacts.

The EIA report aims to provide sufficient information regarding the potential impacts and the acceptability of these impacts in order for the Competent Authority (i.e. the National Department of Environmental Affairs (DEA)) to make an informed decision regarding the proposed project.

The release of a draft EIA Report provided stakeholders with an opportunity to verify that the issues they raised through the EIA process were captured and adequately considered. The final EIA Report incorporates all issues and responses raised during the public review of the draft EIA Report prior to submission to the DEA.

The conclusions and recommendations of this EIA are the result of the assessment of identified impacts by specialists, and the parallel process of public participation. The public consultation process has been extensive and every effort has been made to include

representatives of all stakeholders in the study area.

The most significant environmental impacts associated with the proposed project, as identified through the EIA, include impacts on the water resources (i.e. drainage lines) indentified in the study area and visual impacts on the natural scenic resources of the region and on sensitive receptors (i.e. primarily as a result of the power tower):

» Local site-specific impacts resulting from the physical disturbance/modification to the site
» Impacts on the social environment primarily resulting from the presence of construction workers on-site

The findings of the specialist studies undertaken within this EIA to assess both the benefits and potential negative impacts anticipated resulting from the proposed project conclude that:

» There are **no environmental fatal flaws** that should prevent the proposed solar energy facility and associated infrastructure from proceeding on the identified site, provided that the recommended mitigation and management measures are implemented, and given due consideration during the process of finalising the facility layout.
» The overall **ecological** impacts have been assessed as being of low or medium significance. If mitigation measures are put in place to manage impacts, then most potential impacts can be reduced to having low significance.
» The most significant threat to **avifauna** communities would be from collisions with the overhead power line. The loss of habitat, disturbance, or any interaction with the facility is not anticipated to have a significant negative impact on bird communities in the area.
» Very sparse **heritage resources** were found during the field survey undertaken for the site. From an archaeological perspective the observed heritage resources may be regarded as being of generally low significance.
» With respect to **geology**, the possible presence of shallow, dense residual soil, calcrete, or basement rock may help to reduce the erosion potential but this is difficult to quantify without detailed geotechnical information. However, the direct impacts are likely to be moderate to low and the cumulative significance of all the potential impacts on the geological environment is considered low due to the limited scale of the development and the dearth of development in the immediate surrounding area. With effective implementation of mitigating measures the impacts identified above can be reduced to a low level.
» The anticipated **visual** impact is not considered a fatal flaw considering the low incidence of visual receptors in the region and the contained area of potential visual exposure.
» The development will have both positive and negative **social**

impacts. It will create employment and business opportunities for locals during both the construction and operational phases and represent an investment in clean, renewable energy infrastructure.

» The significance levels of the majority of identified negative impacts can generally be reduced by implementing the recommended mitigation measures. With reference to the information available at this planning approval stage in the project cycle, the **confidence** in the environmental assessment undertaken is regarded as **acceptable**.

TABLE OF CONTENTS

APPENDICES

ABBREVIATIONS AND ACRONYMS

BID	Background Information Document
CaBEERE	Capacity Building in Energy Efficiency and Renewable Energy
CO_2	Carbon dioxide
CSP	Concentrating Solar Power
CPV	Concentrating Photovoltaic Power
DENC	Department of Environment & Nature Conservation
DEA	National Department of Environmental Affairs
DoE	Department of Energy
DM	District Municipality
DWA	Department of Water Affairs
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPC	Engineering, Procurement and Construction
FIT	Feed-in Tariffs
GDP	Gross Domestic Profit
GDPR	Gross Domestic Profit of the Region
GIS	Geographical Information Systems
GG	Government Gazette
GN	Government Notice
GHG	Green House Gases
GWh	Giga Watt Hour
I&AP	Interested and Affected Party
IDP	Integrated Development Plan
IPP	Independent Power Producer
km^2	Square kilometres
km/hr	Kilometres per hour
kV	Kilovolt
LM	Local Municipality
LPG	Liquid Petroleum Gas
LUPO	Rezoning and Subdivision in terms of Land Use Planning Ordinance, Ordinance 15 of 1985
MA	Million years before present
MAR	Mean Annual Rainfall
m^2	Square meters
m/s	Meters per second
MW	Mega Watt
NEMA	National Environmental Management Act (Act No. 107 of 1998)
NERSA	National Energy Regulator of South Africa
NGOs	Non-Governmental Organisations
NT	Not Threatened

NWA	National Water Act (Act No. 36 of 1998)
PES	Present Ecological State
REFIT	Renewable Energy Feed-in Tariffs
SAHRA	South African Heritage Resources Agency
SANBI	South African National Biodiversity Institute
SANRAL	South African National Roads Agency Limited
SDF	Spatial Development Framework
SWMP	Storm Water Management Plan
TPV	Tracking Photovoltaic Power
VAC	Visual Absorption Capacity
VU	Vulnerable

DEFINITIONS AND TERMINOLOGY

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.

Archaeological material: Remains resulting from human activities which are in a state of disuse and are in or on land and which are older than 100 years, including artefacts, human and hominid remains and artificial features and structures.

Clean development mechanism: An arrangement under the Kyoto Protocol allowing industrialised countries with a greenhouse gas reduction commitment (called Annex 1 countries) to invest in projects that reduce emissions in developing countries as an alternative to more expensive emission reductions in their own countries. The most important factor of a Clean Development Mechanism (CDM) project is that it establishes that it would not have occurred without the additional incentive provided by emission reductions credits. The CDM allows net global greenhouse gas emissions to be reduced at a much lower global cost by financing emissions reduction projects in developing countries where costs are lower than in industrialised countries. The CDM is supervised by the CDM Executive Board (CDM EB) and is under the guidance of the Conference of the Parties (COP/MOP) of the United Nations Framework Convention on Climate Change (UNFCCC)

Concentrating solar power: Solar generating facilities use the energy from the sun to generate electricity. Concentrating solar power facilities (CSP) collect the incoming solar radiation and concentrate it (by focusing or combining it) onto a single point, thereby increasing the potential electricity generation.

Concentrating photovoltaic power: Like CSP facilities, concentrating photovoltaic facilities (CPV) operate on the same principle of concentrating the incoming solar radiation. The only different is that in this case photovoltaic panels are used.

Cumulative impacts: Impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities (e.g. discharges of nutrients and heated water to a river that combine to cause algal bloom and subsequent loss of dissolved oxygen that is greater than the additive impacts of each pollutant). Cumulative impacts can occur from the collective impacts of individual minor actions over a period of time and can include both direct and indirect impacts.

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

'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.

Early stone age: A very early period of human development dating between 300 000 and 2.6 million years ago.

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

Environmental impact assessment: Environmental Impact Assessment (EIA), as defined in the NEMA EIA Regulations and in relation to an application to which scoping must be applied, means the process of collecting, organising, analysing, interpreting and communicating information that is relevant to the consideration of that application.

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 plan: An operational plan that organises and co-ordinates mitigation, rehabilitation and monitoring measures in order to guide the implementation of a proposal and its ongoing maintenance after implementation.

Feed-in tariffs: Feed-in Tariffs (FIT) have been set to promote socio-economic and environmentally sustainable growth. They are essentially guaranteed prices for electricity supply as opposed to conventional consumer tariffs. The basic economic principle underpinning the FIT is the establishment of a tariff that covers the cost of generation plus a "reasonable profit" to entice independent power producers to invest in generation projects.

Fossil: Mineralised bones of animals, shellfish, plants and marine animals. A trace fossil is the track or footprint of a fossil animal that is preserved in stone or consolidated sediment.

Heliostat: Movable, flat reflective mirrors which are oriented according to the sun's position in order to capture and reflect the solar radiation.

Heritage: That which is inherited and forms part of the National Estate (Historical places, objects, fossils as defined by the National Heritage Resources Act of 2000).

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

Indirect impacts: Indirect or induced changes that may occur as a result 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 as a result of the activity.

Integrated energy plan: A plan commissioned by the DME in response to the requirements of the National Energy Policy, in order to provide a framework in which specific energy policies, development decisions and energy supply trade-offs can be made on a project-by-project basis. The framework is intended to create a balance between the energy demand and resource availability to provide low cost electricity for social and economic development, while taking into account health, safety and environmental parameters.

Integrated strategic electricity planning: Eskom's planning process which provides strategic projections of supply-side and demand-side options to be implemented to deal with the energy management issues and meet long-term load forecasts.

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 general public.

Kyoto protocol: The Kyoto Protocol calls for developed countries to reduce their green house gas emissions during the commitment period (2008 - 2012) by 5.2% compared to 1990 levels. Developing countries, like South Africa, do not have a limit on their emissions.

Late stone age: In South Africa this time period represents fully modern people who were the ancestors of southern African KhoeKhoen and San groups (40 000 – 300 years ago).

Middle stone age: An early period in human history characterised by the development of early human forms into modern humans capable of abstract though process and cognition 300 000 – 40 000 years ago.

National integrated resource plan: Commissioned by NERSA in response to the National Energy Policy's objective relating to affordable energy services, in order to provide a long-term, cost-effective resource plan for meeting electricity demand, which is consistent with reliable electricity supply and environmental, social and economic policies.

Optics: Mirrors or lenses which are used to concentrate the solar radiation onto a photovoltaic cell.

Parabolic trough: A trough-shaped reflectors which focus the solar radiation onto a receiver at its focal point. It include a receiver tube/heat collection element (i.e. a metal absorber containing the heat transfer fluid surrounded by a glass envelope which absorbs the solar energy received from the parabolic trough), a sun-tracking system (i.e. an electronic control system and associated mechanical drive system used to focus the reflector onto the sun), and support structure (i.e. holds the parabolic trough in accurate alignment with incoming solar radiation while resisting the effects of the wind).

Photovoltaic cell: Semiconductors which absorb solar radiation to produce electricity

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.

Power tower: A power tower forms part of the central receiver type solar electricity generating technology. The purpose of the tower, which may be up to 160 m high, is to

structurally support the receiver. The receiver, consisting of metal tubes which transfer the heat from the solar radiation reflected on it by mirror fields, is used for generating the steam.

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).

Renewable energy feed-in tariff: Renewable Energy Feed-In Tariffs (REFITs) are used to promote renewable energy and have been adopted in over 36 countries worldwide. The establishment of the REFIT in South Africa provides the opportunity for an increased contribution towards the sustained growth of the renewable energy sector, and to promote competitiveness between renewable and conventional energies in the medium and long-term. Under the National Energy Regulator Act (Act No. 40 of 2004), the Electricity Regulation Act (Act No. 4 of 2006), and all subsequent relevant amendment acts, the National Energy Regulator of South Africa (NERSA) has the mandate to determine the prices at and conditions under which electricity must be supplied by licence.

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.

INTRODUCTION CHAPTER 1

!KaXu CSP is proposing the establishment of a commercial solar energy facility on Portion 4 of the Farm Scuit-Klip 92, which lies approximately 30 km north-east of the town of Pofadder in the Northern Cape. Following an extensive site identification process undertaken by !KaXu CSP, a 33 km^2 site which falls within the Khai Ma Local Municipality was identified for consideration within an Environmental Impact Assessment (EIA) process.

A sensitivity analysis was undertaken during the Scoping Phase wherein potentially sensitive areas which should be avoided within the broader 33 km^2 were identified. These sensitive areas included natural drainage lines, areas of increased gradient/slope, and areas containing vegetation of conservation importance. As a result, the southern portion of the triangular shaped site was identified as a preferred area for development of the solar thermal plant, based on the following characteristics:

» ***Relief profile:*** the high relief areas within the north-western and the north-eastern corners of the site should be avoided as the former includes the Konkonsieskop hill and the latter includes the Ysterberg mountain range.
» ***Centre of Endemism****:* the north-western portion of the site falls within the core vegetation type of the Gariep Centre of Floristic Endemism.
» ***Proximity to the grid connection point:*** being in close proximity to the point of connection to the grid will minimise the length of the power line that is required between the proposed facility and the Paulputs Substation. In turn, this would reduce the potential for the linear disturbance associated with the power line including the potential for impacts on avifauna species.

The proposed facility, which will be primarily contained within this identified portion, will have a developmental footprint of approximately 11 km^2. The solar energy facility is proposed to comprise Concentrating Solar Power (CSP) and Concentrating/Tracking Photovoltaic Power (CPV/TPV) components with an overall maximum generating capacity of 310 MW. The facility will be comprised of a combination of the following technologies (in any combination):

» Parabolic troughs (CSP system consisting of several loops of parabolic troughs)
» Power tower plant and associated heliostats (CSP system consisting of a field of heliostats positioned around the power tower)
» Photovoltaic (PV) plant (system consisting of several rows of PV panels)

The Renewable Energy Feed-in Tariff (REFIT) Process (criteria not yet finalised by the National Energy Regulator of South Africa (NERSA)), selection process (not finalised by the Department of Energy, together with National Treasury) and the economics of the

solar facility will be key in determining the final technology combination and the schedule of implementation for the facility.

The following associated infrastructural requirements will also be established, both outside and within the developmental footprint of the proposed facility:

- **Power islands** which will include:
  - A **steam turbine** and **generator** typically housed within a 2-storey building
  - A generator **transformer** and a small **substation** located outside and adjacent to the 2-storey building.
  - An **auxiliary steam boiler** and associated vessels (i.e. fossil fuel boiler/ generator), proposed to be fired by either diesel fuel or liquid petroleum gas (LPG).
- An **overhead power line** feeding into the Eskom electricity network at the Paulputs Substation, which is situated adjacent to the site.
- An **abstraction point** at the Gariep (Orange) River and an associated water **supply pipeline** to the facility of approximately 30 km in length.
- A **suspension reservoir** located approximately 6 km south of the raw water abstraction point (i.e. outside the boundaries of the identified site) to rid the raw water of particles in suspension (silt).
- A **storage reservoir** located within the boundaries of the identified site. The water stored within the reservoir will be used during the steam generation process (boiler makeup), for washing of the heliostats/mirrors, troughs and PV panels, potable water supply and fire protection supply.
- Lined **evaporation ponds** to allow for the evaporation of process waste water not to be re-used within the facility.
- **External access road** leading to the site from the R358 which branches off the N14 towards Onseepkans.
- **Internal access roads** for construction and maintenance purposes.
- Workshop, office, and storage areas.

The nature and extent of this facility, as well as potential environmental impacts associated with the construction of a facility of this nature is assessed in more detail in this final EIA report.

1.1. The Need for the Proposed Project

Countries worldwide are being pressured to increase their share of renewable energy generation due to concerns related to climate change and the on-going, unsustainable exploitation of natural resources such as gas, oil and coal. Grid connected renewable energy is currently the fastest growing sector in the global energy market. Targets for the promotion of renewable energy now exist in more than 58 countries, of which 13 are developing countries. The South African Government has recognised the country's high

level of renewable energy potential and presently has in place targets of 10 000 GWh of renewable energy by 2013 (to be produced mainly from biomass, wind, solar and small-scale hydro). This amounts to approximately 4% (1 667 MW) of the total estimated electricity demand (41 539 MW) by 2013.

To contribute towards this target and towards socio-economic and environmentally sustainable growth, and to stimulate the renewable energy industry in South Africa, the need to establish an appropriate market based mechanism was identified, and Feed-in Tariffs (FIT) have been set. FITs are, in essence, guaranteed prices for electricity supply rather than conventional consumer tariffs. The basic economic principle underpinning the FITs is the establishment of a tariff (price) that covers the cost of generation plus a "reasonable profit" to entice investment. This is quite similar to the concept of cost recovery used in utility rate regulation based on the costs of capital. Feed-in tariffs to promote renewable energy have now been adopted in over 36 countries around the world. The establishment of the South African Renewable Energy Feed-in Tariffs (REFIT) provides the opportunity for an increased contribution towards the sustained growth of the renewable energy sector locally, regionally and internationally. It also serves to promote competitiveness for renewable energy with conventional energies in the medium- and long-term. Under the National Energy Regulator Act, 2004 (Act No. 40 of 2004), the Electricity Regulation Act, 2006 (Act No. 4 of 2006) and all subsequent relevant Amendment Acts, NERSA has the mandate to determine the prices at and conditions under which electricity may be supplied by a generation licence.

Renewable energy is recognised internationally as a major contributor in protecting our climate, nature, and the environment as well as providing a wide range of environmental, economic, and social benefits that will contribute towards long-term global sustainability. It is considered viable that long-term benefits for the community and/or society in general can be realised should this site near Pofadder prove acceptable, from a technical and environmental perspective, for the establishment of a solar energy facility. In addition, the proposed project will aid in achieving the goal of a 30% share of all new power generation being derived from independent power producers (IPPs).

1.2. Project Overview

The proposed site being considered for the development of the Pofadder Solar Thermal Plant falls within the Khai Ma Local Municipality (i.e. that forms part of the Namakwa District Municipality) in the Northern Cape. The site is situated approximately 30 km north-east of Pofadder, on Portion 4 of the Farm Scuit-Klip 92 (refer to Figure 1.1).

The overarching objective for the proposed solar energy facility is to maximise electricity production through exposure to the solar resource, while minimising infrastructure, operational, and maintenance costs, as well as social and environmental impacts. !KaXu CSP undertook an extensive site selection process that identified Portion 4 of Scuit-Klip

92 as a suitable option for development. However, the layout development requires the assessment of environmental and planning issues in detail. As such these issues have been considered within site-specific studies through the EIA process in the Scoping and EIA Phases. During the Scoping Phase, areas of sensitivity within the broader site were identified which ultimately served to inform the general placement of the facility within the broader site (i.e. the southern corner/region). The exact positioning or detailed layout of the facility's components within the boundaries of the broader site and beyond these boundaries (i.e. in terms of the abstraction point; pipeline and de-gritting reservoir) have been developed by taking cognisance of environmental sensitivities and technical constraints identified through the EIA Phase.

This EIA report documents the assessment of environmental impacts that may occur as a result of the establishment of the proposed facility. The scope of the proposed facility, including details of all elements of the project (for the construction, operation, and decommissioning phases) is discussed in more detail in Chapter 2.

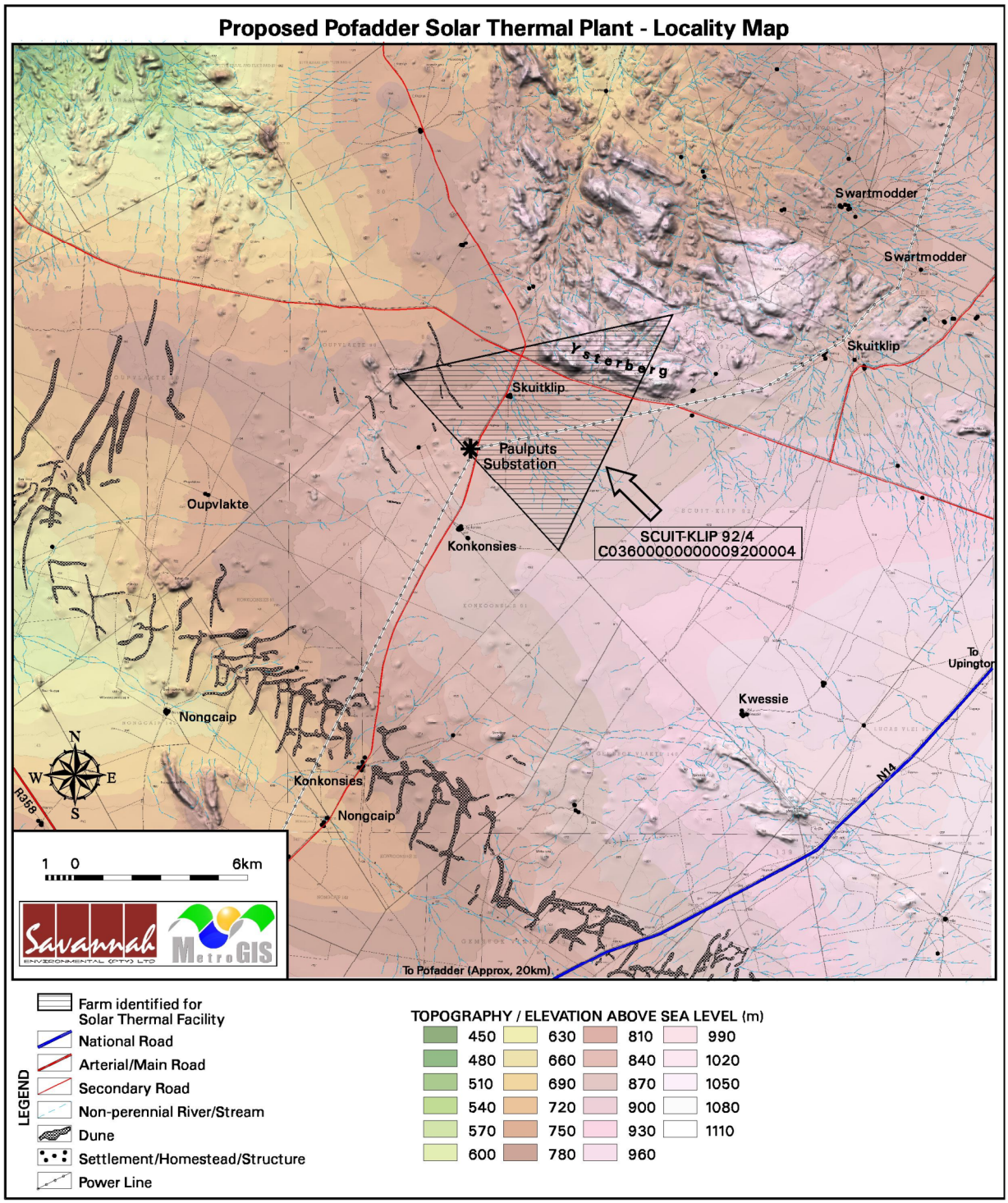


Figure 1.1: Map illustrating Portion 4 of Scuit-Klip 92 identified for the proposed facility

1.3. Requirement for an Environmental Impact Assessment Process

The development of the proposed facility is subject to the requirements of the EIA Regulations published in terms of Section 24(5) of the National Environmental Management Act (NEMA, No 107 of 1998). The EIA Phase, which follows the Scoping Phase, was conducted in accordance with the requirements of these regulations. This

section provides a brief overview of EIA Regulations and their application to this project. !KaXu CSP appointed Savannah Environmental to conduct the independent EIA process for the proposed Pofadder Solar Thermal Plant.

NEMA is the national legislation that provides for the authorisation of certain controlled activities known as 'listed activities'. In terms of Section 24(1) of NEMA, the potential impact on the environment associated with these listed activities must be considered, investigated, assessed and reported on to the competent authority (the decision-maker) charged by NEMA with granting of the relevant environmental authorisation. As this is a proposed electricity generation project (which is considered to be of national importance) the National Department of Environmental Affairs (DEA) is the competent authority for this project. An application for authorisation has been accepted by DEA (under application reference number **12/12/20/1832**). Through the decision-making process, the DEA will be supported by the Northern Cape Department of Environment and Nature Conservation (DENC).

The need to comply with the requirements of the EIA Regulations ensures that decision-makers are provided the opportunity to consider the potential environmental impacts of a project early in the project development process, and assess if environmental impacts can be avoided, minimised or mitigated to acceptable levels. Comprehensive, independent environmental studies are required to be undertaken in accordance with the EIA Regulations to provide the competent authority with sufficient information in order for an informed decision to be made.

An EIA is an effective planning and decision-making tool for the project proponent. It allows for the identification and management of environmental impacts/issues that may occur through the establishment and operation of such a facility. Furthermore, an EIA allows for resolution of the issue(s) reported on in the Scoping and EIA reports as well as dialogue with affected parties.

In terms of sections 24 and 24D of NEMA, as read with Government Notices R385 (Regulations 27 – 36) and R387, a Scoping process and an EIA process are required to be undertaken for this proposed project as it includes the following activities listed in terms of GN R386 and R387 (GG No 28753 of 21 April 2006):

Relevant Notice	Activity	Description of listed activity
Government Notice R387 (21 April 2006)	*1(a)*	*The construction of facilities or infrastructure, including associated structures or infrastructure, for the generation of electricity where (i) the electricity output is 20 megawatts or more; or (ii) the elements of the facility cover a combined area in excess of 1 hectare.*
Government Notice R387 (21	*1(l)*	*The construction of facilities or infrastructure, including associated structures or infrastructure, for the transmission and*

April 2006)		*distribution of above ground electricity with a capacity of 120 kV or more.*
Government Notice R387 (21 April 2006)	*2*	*Any development, activity, including associated structures and infrastructure, where the total area of the developed area is, or is intended to be 20 ha or more.*
Government Notice R386 (21 April 2006)	*1(m)*	*Any purpose in the one in ten year flood line of a river or stream, or within 32 metres from the bank of a river or stream where the flood line is unknown, excluding purposes associated with existing residential use, but including (i) canals; (ii) channels; (iii) bridges; (iv) dams; and (v) weirs.*
Government Notice R386 (21 April 2006)	*7*	*The above ground storage of a dangerous good, including petrol, diesel, liquid petroleum gas or paraffin, in containers with a combined capacity of more than 30 cubic metres but less than 1 000 cubic metres at any one location or site.*
Government Notice R386 (21 April 2006)	*12*	*The transformation or removal of indigenous vegetation of 3 hectares or more or of any size where the transformation or removal would occur within a critically endangered or an endangered ecosystem listed in terms of section 52 of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004).*
Government Notice R386 (21 April 2006)	*13*	*The abstraction of groundwater at a volume where any general authorisation issued in terms of the National Water Act, 1998 (Act No. 36 of 1998) will be exceeded.*
Government Notice R386 (21 April 2006)	*14*	*The construction of masts of any material of type and of any height, including those used for telecommunications broadcasting and radio transmission, but excluding (a) masts of 15m and lower exclusively used by (i) radio amateurs; or (ii) for lightening purposes (b) flagpoles; and (c) lightening conductor poles.*
Government Notice R386 (21 April 2006)	*15*	*The construction of a road that is wider than 4 m or that has a reserve wider than 6 m, excluding roads that fall within the ambit of another listed activity or which are access roads of less than 30 m long.*
Government Notice R386 (21 April 2006)	*16(b)*	*The transformation of undeveloped, vacant or derelict land to residential mixed, retail, commercial, industrial or institutional use where such development does not constitute infill and where the total area to be transformed is bigger than 1 hectare.*

1.4. Objectives of the Environmental Impact Assessment Process

The Scoping Phase refers to the process of **identifying** potential impacts (i.e. positive and negative) associated with the proposed project, and defining the **extent of studies** required within the EIA phase. The Scoping Phase culminated in the identification of a preferred area for development within the broader 33 km^2 site (i.e. the southern corner/portion of the site). The Scoping Phase included input from the project proponent, specialists with experience in the study area as well as

in EIAs for similar projects, as well as a public consultation process with key stakeholders that included both government authorities and interested and affected parties (I&APs).

The EIA Phase focuses on the preferred area for development identified during the Scoping Phase. It addresses identified environmental impacts (direct, indirect, and cumulative as well as positive and negative) associated with all phases of the project including design, construction, operation, and decommissioning. The EIA phase also recommends appropriate mitigation measures for potentially significant environmental impacts. The release of the draft EIA report provided stakeholders with an opportunity to verify that issues they raised through the EIA process have been captured and adequately considered. The final EIA report incorporates all issues and responses raised during the public review of the draft EIA report prior to submission to DEA.

This EIA report consists of the following sections:

Chapter 1: Provides background to the proposed facility and the environmental impact assessment process.
Chapter 2: Provides an overview of the proposed project.
Chapter 3: Provides an overview of the Regulatory and Legal Context for electricity generation projects
Chapter 4: Outlines the process which was followed during the EIA Phase, including the consultation program that was undertaken and input received from interested parties and stakeholders.
Chapter 5: Describes the existing biophysical and socio-economic environment.
Chapter 6: Presents the assessment of environmental impacts associated with the facility, its associated infrastructure.
Chapter 7: Presents the conclusions of the EIA process, as well as an impact statement on the proposed project
Chapter 8: Provides a list of references and information sources used in undertaking the studies for this EIA Report.

1.5. Details of the Environmental Assessment Practitioner and Expertise to conduct the EIA Process

Savannah Environmental was contracted by !KaXu CSP as the independent consultants to undertake an EIA process for the proposed project, as required by the NEMA EIA Regulations. Neither Savannah Environmental, nor any its specialist sub-consultants on this project are subsidiaries of, or are affiliated to !KaXu CSP. Furthermore, Savannah Environmental does not have any interests in secondary developments that may arise out of the authorisation of the proposed project.

Savannah Environmental is a specialist environmental consulting company providing a holistic environmental management service, including environmental assessment and planning to ensure compliance and evaluate the risk of development; and the development and implementation of environmental management tools. Savannah Environmental benefits from the pooled resources, diverse skills and experience in the environmental field held by its team.

The Savannah Environmental team has considerable experience in environmental assessment and environmental management and have been actively involved in undertaking environmental studies for a wide variety of projects throughout South Africa and neighbouring countries. Strong competencies have been developed in project management of environmental processes, as well as strategic environmental assessment and compliance advice, and the assessment of environmental impacts, the identification of environmental management solutions and mitigation/risk minimising measures.

Savannah Environmental has gained extensive knowledge and experience on potential environmental impacts associated with electricity generation projects through their involvement in related EIA processes. Savannah Environmental has completed the EIA process and received environmental authorisations for:

» The Eskom Wind Energy Facility on the West Coast.
» The Umoya Energy Hopefield Wind Energy Facility in the Western Cape.
» The African Clean Energy Development Cookhouse Wind Energy Facility in the Eastern Cape.

Savannah Environmental is currently undertaking the EIA process and reporting for *inter alia*:

» The Renewable Energy Investments South Africa Kathu Solar Energy Facility in the Northern Cape.
» The VentuSA Energy Sishen Solar Energy Facility in the Northern Cape.
» The Thupela Energy Waterberg Photovoltaic Plant in the Limpopo Province.
» The VentuSA Energy Wag'nbiekiespan Solar Energy Facility in the Free State.
» The Noblesfontein Solar and Wind Energy Facility in the Northern Cape.
» The Moyeng Energy Suurplaat Wind Energy Facility in the Northern Cape.
» The !Khi CSP South Africa Upington Solar Thermal Plant in the Northern Cape.

Savannah Environmental has developed a valuable understanding of impacts associated with the construction and operation of renewable energy facilities. Savannah Environmental has successfully managed and undertaken EIA processes for other power generation projects throughout South Africa. Curricula vitae for the Savannah Environmental project team consultants are included in Appendix A.

In order to adequately identify and assess potential environmental impacts, Savannah Environmental has appointed several specialist consultants to conduct specialist studies, as required. The curricula vitae for the EIA specialist consultants are also included in Appendix A.

OVERVIEW OF THE PROPOSED PROJECT CHAPTER 2

Chapter 2 details the scope of the proposed facility (i.e. construction, operation and decommissioning), and explores alternatives, including the 'do nothing' option. This chapter also explores solar energy as a power generation technology and the need for such a facility in light of the country's energy requirements.

2.1. Consideration of Alternatives

The site for the proposed facility is regarded by !KaXu CSP as preferential based on several site/region specific characteristics. Based on these preferences, no further siting alternatives have been considered in this EIA process.

Climatic conditions

The economic viability of a solar facility is directly dependent on the annual direct solar irradiation values.

Power transmission considerations

The generated electricity will be sold to a single buyer entity (still to be finalised), as part of a power purchase agreement between this entity and !KaXu CSP. Therefore the power will need to be evacuated into the Eskom grid. The site is located right next to the existing Eskom Paulputs Transmission Substation (which has sufficient spare capacity to receive the generated power), thereby providing a direct connection point to the national electricity grid, and eliminating the need for construction of extensive overhead power lines. The power will subsequently be transmitted via an existing 220 kV transmission line from the Paulputs Transmission Substation to the Aggeneys Transmission Substation (a transmission substation located approximately 90 km south-west).

Orography

An area with favourable orography (flat terrain) facilitates the construction and maintenance of the solar facility, and reduces the need for civil/earthworks. For example, parabolic troughs ideally require a level surface preferably with a slope of less than 1%.

Extent of the site

Sufficient open space within an area is a restraining factor (for example a 100 MW parabolic trough system (without storage) requires approximately 200 ha; a 1 MW PV installation (tightly packed flat fixed panel) requires approximately 1 ha, a tracking PV installation of the same size requires roughly 5 ha (5 times) and a 50 MW

heliostat/power tower system requires approximately 300 ha). The infrastructure for this proposed site is estimated to cover a total developmental footprint of 11 km^2.

Proximity to other infrastructure

The site is preferred due to its proximity national/secondary roads (i.e. the N14 and R358).

Water availability

Solar thermal facilities require water as the heat transfer medium for the generation of high temperature steam used to drive a conventional turbine and generator. Water will be extracted from an abstraction point located along the Gariep (Orange) River, the primary water source in the area.

2.1.1 Site-specific / Layout Design Alternatives

The overall aim of the site layout is to maximise electricity production through exposure to the solar resource, while minimising infrastructure, operation, and maintenance costs, and social and environmental impacts. Through the process of determining constraining factors (i.e. technical and environmental), the layout of the facility components within the broader site was planned. In addition, feasible site specific alternative have been provided for the internal access roads and the power line.

Internal access road alternatives

Four alternative routes have been proposed within the development footprint for the internal access road. All four alternatives would branch off the R358 in an easterly direction and would terminate at the power islands (refer to Figure 2.1).

Power line alternatives

Four alternative routes have been proposed within the development footprint for the power line. These power line alternatives would follow similar routes to those alternatives proposed for the internal access road (refer to Figure 2.1).

Water supply pipeline and the location of the abstraction point and raw water reservoirs

Based on an extensive feasibility assessment by !KaXu CSP, only one technically feasible abstraction point was identified at the Gariep (Orange) River A water supply pipeline between this abstraction point and the site is proposed. No other technically feasible alternatives are available.

The proposed abstraction point at the Gariep (Orange) River lies at coordinate 28º 37’ 39.77” S, 19º 30’ 16.89” E. The main considerations included abstraction pool depth consistency throughout the year, access, and limiting alteration to river flow and

flood lines (1:20 and 1:50 year). This is, therefore, the most technically feasible abstraction point, and is considered preferred as the construction of additional embankments in the flow of the river could lead to obstruction and higher water levels upstream.

Abstracted water will be pumped to a settlement reservoir (for de-gritting) located approximately 6 km south of the abstraction point. A second storage reservoir will be located within the boundaries of the identified site. The water supply pipeline route will follow the existing Raap and Skraap (minor road 73), road reserve to the plant.

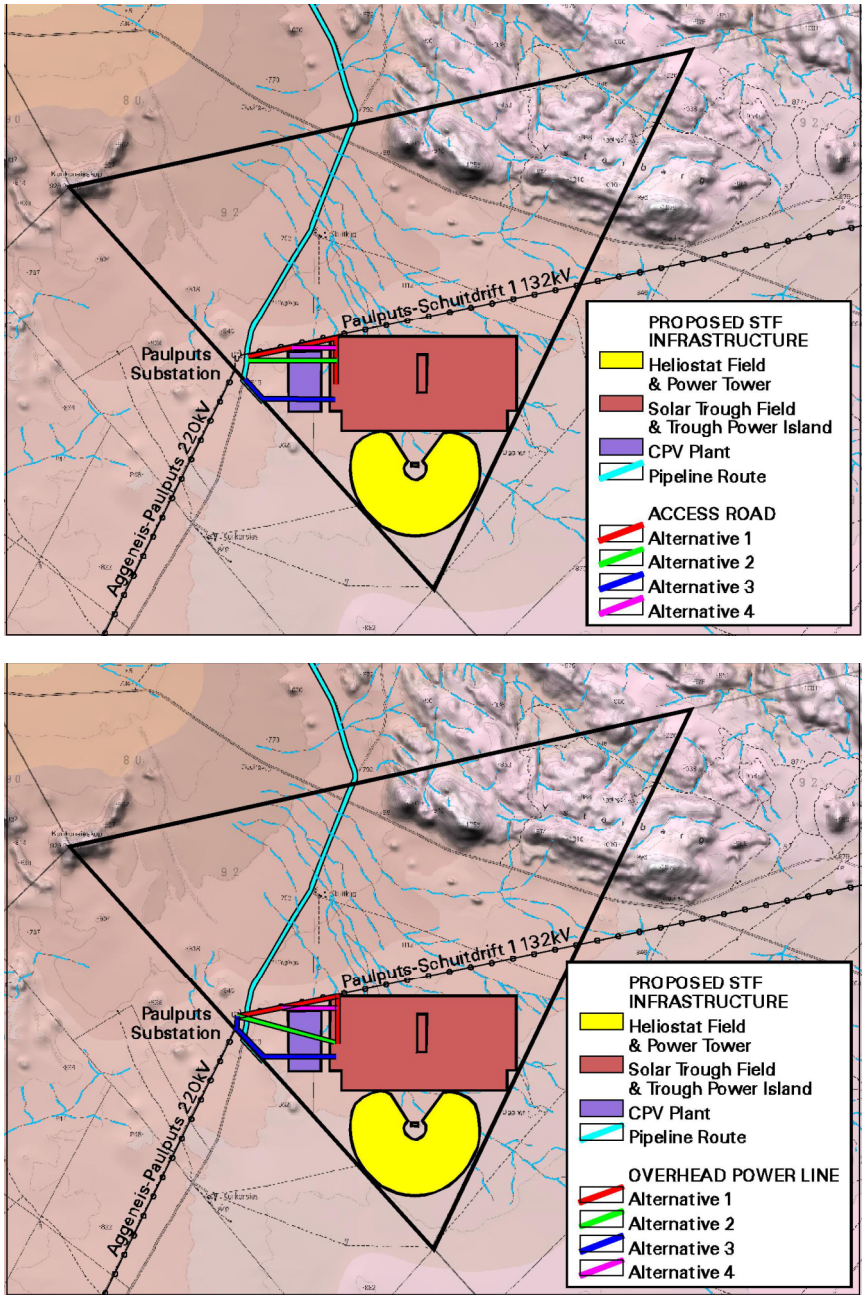


Figure 2.1: Preliminary layouts for the solar infrastructure on the southern corner/region of the site and the road and power line alternatives

2.1.2 The 'do-nothing' Alternative

The 'do-nothing' alternative is the option of not constructing the proposed facility on the identified site near Pofadder.

However, the increasing electricity demand in South Africa is placing ever-increasing pressure on the existing power generation capacity. Therefore additional electricity generation options need to be developed throughout the country. The support for renewable energy policy is guided by a rationale that South Africa has a very attractive range of renewable resources, particularly solar and wind and that renewable applications are in fact the least-cost energy service in many cases - and more so when social and environmental costs are taken into account.

In South Africa the generation of electricity through renewable energy resources offers a range of socio-economic and environmental benefits. These benefits are explored in further detail in the South Africa Renewable Energy Feed-in Tariff (REFIT) Regulatory Guideline published by NERSA (March 2009), and include:

Increased energy security
The current electricity crisis in South Africa highlights the significant role that renewable energy can play in terms of power supplementation. In addition, given that renewables can often be deployed in a decentralised manner close to consumers, they offer the opportunity for improving grid strength and supply quality, while reducing expensive transmission and distribution losses.

Resource saving
Conventional coal fired plants are major consumers of water during their requisite cooling processes. It is estimated that the achievement of the targets in the Renewable Energy White Paper will result in water savings of approximately 16.5 million kilolitres, when compared with wet cooled conventional power stations; this translates into revenue savings of R26.6 million. As an already water-stressed nation, it is critical that South Africa engages in a variety of water conservation measures, particularly due to the detrimental effects of climate change on water availability.

Exploitation of our significant renewable energy resource
At present, valuable national resources including biomass by-products, solar radiation and wind power remain largely unexploited. The use of these energy flows will strengthen energy security through the development of a diverse energy portfolio.

Pollution reduction
The release of by-products from the burning of fossil fuels for electricity generation has a particularly hazardous impact on human health, and contributes to ecosystem degradation.

Climate friendly development

The uptake of renewable energy offers the opportunity to address energy needs in an environmentally responsible manner, contributing to the mitigation of climate change through the reduction of greenhouse gas emissions. South Africa as a nation is estimated to be responsible for 1% of global GHG emissions and is currently ranked 9th worldwide in terms of per capita CO_2 emissions.

Support for international agreements and enhanced status within the international community

The effective deployment of renewable energy provides a tangible means for South Africa to demonstrate its commitment to its international agreements under the Kyoto Protocol, and for cementing its status as a leading player within the international community.

Acceptability to society

Renewable energy offers a number of tangible benefits to society including reduced pollution concerns, improved human and ecosystem health and climate friendly development.

Support to a new industry sector

The development of renewable energy offers the opportunity to establish a new industry within the South African economy. The sale, development, installation, maintenance, and management of renewable energy facilities has the potential for job creation in South Africa.

At present, South Africa is some way off from exploiting the diverse gains from renewable energy and from achieving a considerable market share in the renewable energy industry. South Africa's electricity supply remains heavily dominated by coal based power generation, with the country's significant renewable energy potential largely untapped to date.

Within a policy framework, the development of renewable energy in South Africa is supported by the White Paper on Renewable Energy (November 2003), which has set a target of 10 000 GWh renewable energy contributions to final energy consumption by 2013. The target is to be achieved primarily through the development of wind, biomass, solar and small-scale hydro. DoE's macroeconomic study of renewable energy, developed under the now completed Capacity Building in Energy Efficiency and Renewable Energy (CaBEERE) project, has established that the achievement of this target would provide a number of economic benefits, including increased government revenue amounting to R299 million, increased GDP of up to R1 billion per year and the creation of an estimated 20 500 new jobs. In addition, the development of renewable energy beyond the 10 000 GWh target holds further employment benefits and would maximise the number of jobs created per TWh (South Africa Renewable Energy Feed-in

Tariff (REFIT) Regulatory Guideline published by NERSA (March 2009)). The first and interim IRP was developed in 2009 by the Department of Energy. The initial four years of this plan was promulgated by the Minister of Energy on 31 December 2009, updated on 29 January 2010. The Department of Energy is currently revisiting and revising the IRP, with the IRP2010 (currently in draft and out for comment), expected to be finalised by the end of 2010 or early 2011.

Through research, the viability of a solar energy facility has been established, and !KaXu CSP proposes that up to 310 MW can be generated from the proposed facility near Pofadder. The 'do nothing' alternative will not assist the South African government in reaching their set targets for renewable energy.

This is, therefore, not a preferred alternative and not assessed in further detail.

2.1.3 Technology Alternatives

The economics of a solar energy facility depend on the solar resource at the site. Detailed and reliable information about this resource is vital when considering the installation of such a facility and the type of technology to be installed. Several technologies exist including Concentrating Solar Power (CSP), Concentrating Photovoltaic Power (CPV), and Tracking Photovoltaic Power (TPV). The REFIT rules which have not yet been finalised by NERSA, commercial process facilitated by the Department of Energy on behalf of Treasury, PPA content and the economics of the solar facility will be key in determining the final technology combination for the total facility. The selection of a preferred technology will be made from multifaceted decision-making framework. These include the outcome of the REFIT for solar technologies and the Engineering, Procurement, and Construction (EPC) Partner whom !KaXu CSP selects. However as it stands, the current technology options to be utilised on this site include:

» Parabolic trough systems;
» Heliostats and associated power tower; and
» PV panels.

The details of these technologies are discussed further in Sections 2.3 and 2.4 below.

2.2. Solar Energy as a Power Generation Technology

Solar energy facilities operate by converting solar energy into a useful form (i.e. electricity). The use of solar energy for electricity generation is a non-consumptive use of a natural resource and consumes no fuel for continuing operation. Solar power produces an insignificant quantity of greenhouse gases over its lifecycle as compared to conventional coal-fired power stations. The operational phase of a solar facility does not

produce carbon dioxide, sulfur dioxide, mercury, particulates, or any other type of air pollution, as do fossil fuel power generation technologies.

Environmental pollution and the emission of CO_2 from the combustion of fossil fuels constitute a threat to the environment. The use of fossil fuels is reportedly responsible for approximately 70% of greenhouse gas emissions worldwide. The climate change challenge needs to include a shift in the way that energy is generated and consumed. Worldwide, many solutions and approaches are being developed to reduce emissions. However, it is important to acknowledge that the more cost effective solution in the short-term is not necessarily the least expensive long-term solution. This holds true not only for direct project cost, but also indirect project cost such as impacts on the environment. Renewable energy is considered a 'clean source of energy' with the potential to contribute greatly to a more ecologically, socially and economically sustainable future. The challenge now is ensuring solar energy projects are able to meet all economic, social, and environmental sustainability criteria.

2.3. Details of the functioning of a Solar Thermal Facility

2.3.1 Parabolic Troughs

A trough system is comprised of two component groups, firstly a heat collection system and secondly a conventional generating plant portion (refer to Figure 2.4). The heat collection system is comprised of **parabolic collectors** (i.e. trough-shaped reflectors which focus the solar radiation onto a receiver at its focal point), a **receiver tube/heat collection element** (i.e. a metal absorber containing the heat transfer fluid surrounded by a glass envelope (maintaining a vacuum), which absorbs the solar energy received from the parabolic trough), a **sun-tracking system** (i.e. an electronic control system and associated mechanical drive system used to focus the reflector into the sun), and support structure (i.e. holds the parabolic trough in accurate alignment with incoming solar radiation while resisting the effects of the wind). The collected energy in the heat transfer fluid is used to generate steam through a conventional heat exchanger system that is in turn used for electricity generation in a conventional steam turbine and generator.

Figure 2.4: CSP parabolic troughs (photographs courtesy of Abengoa Solar S.A.)

2.3.2 Heliostats and Power Tower

A power tower system is also comprised of a heat collection system and a conventional generating plant portion (refer to Figure 2.5). The heat collection system consists of **heliostats** (movable, flat reflective mirrors roughly 120 m^2 which are oriented according to the sun's position in order to capture and reflect the solar radiation) onto a **receiver** (consisting of metal tubes which transfer the heat from the solar radiation to water with the purpose of generating steam). The receiver is mounted on a 200 m high **power tower** that provides elevation and structurally supports the receiver. In the generating portion the steam drives a turbine which is connected to a generator (in order to produce electricity, as stated before).

Power tower plants must be large to be economical. The heliostat field and the receiver are sized depending on the needs of the utility, for example, a 50 MW facility will require approximately 300 ha.

In a typical installation, solar energy collection occurs at a rate that exceeds the maximum required to provide steam to the turbine. Consequently, the thermal storage system can be charged at the same time that the plant is producing power at full capacity. The ratio of the thermal power provided by the heliostat field and receiver to

the peak thermal power required by the turbine generator is called the **solar multiple**. A power tower could potentially operate for 40 - 65% of the year (as from such storage, the system could provide energy, even in cloudy conditions or at night) without the need for a back-up fuel source. However, without energy storage, solar technologies are limited to annual capacity factors near 25%. Today, the most used solution is the usage of water/steam or molten salt storage tanks that store the energy to be then distributed when required. Determining the optimum storage size to meet power-dispatch requirements is an important part of the system design process. Storage tanks can be designed with sufficient capacity to power a turbine for up to 6 - 8 hours.

Figure 2.5: CSP power tower (photographs courtesy of Abengoa Solar S.A.)

2.3.3 Functioning of CSP Facilities

The following stages form part of the operating function of the CSP systems.

Stage 1: water is pumped from low to high pressure and steam is extracted from the process and used to pre-heat the water prior to entering the steam generator system (i.e. this increases overall cycle efficiency).

Stage 2: the high pressure working fluid enters the steam generator system where it is then heated by the heat transfer fluid or receiver to become super heated steam.

Stage 3: The super heated steam expands through the high pressure section of the steam turbine turning the generator to produce electricity. This steam is then reheated in a re-heater that is part of the steam generator system and passed onto the low pressure steam turbine. All sections of the steam turbine generator decrease the temperature and pressure of the steam with the low pressure section extracting the last available energy until the steam is operating under vacuum pressure.

Stage 4: the wet steam from the low pressure section of the steam turbine then enters the condenser where it is condensed back into a saturated liquid which is returned to stage 1. The solar field provides the heat input into stage 2 and for the re-heater in stage 3. As the heat transfer fluid or water is circulated through the solar field / power tower receiver, light from the sun reflects off the solar collectors (i.e. parabolic troughs / heliostats) and is concentrated on the heat collection elements located at the focal point of the parabolic troughs / receiver. Fluid flowing through these elements absorbs the heat and provides a high-temperature energy source for the entire cycle.

Low quality waste heat is rejected at Stage 4. As the turbine exhaust is condensed, the heat is transferred to the cooling tower circulating water. The warm cooling tower circulating water carries the heat to the wet, mechanical draft cooling tower where the heat is rejected via evaporation and convection, returning cooled water to the condenser.

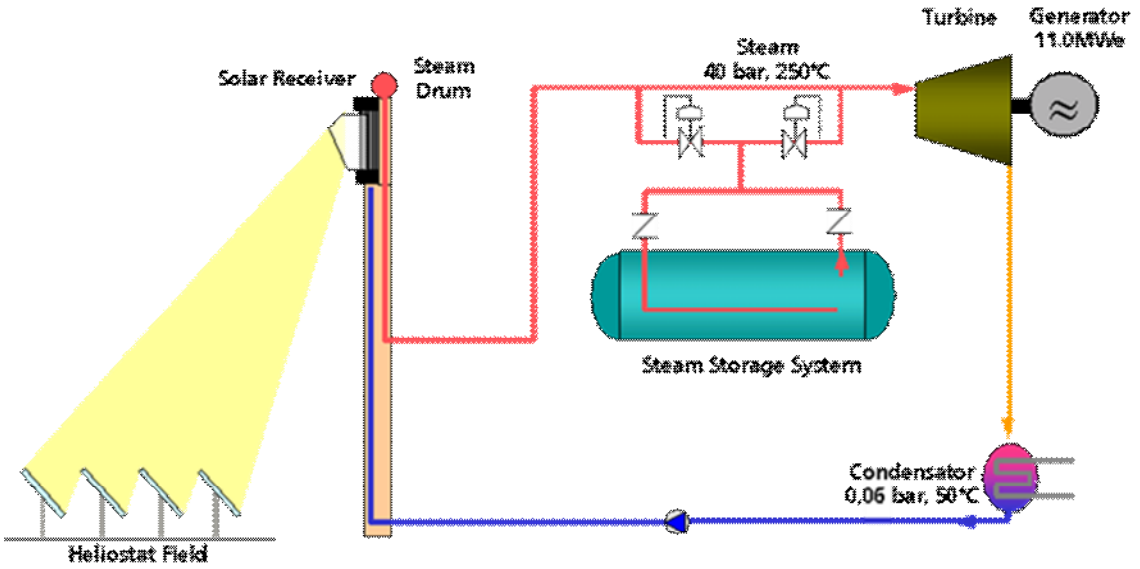


Figure 2.6: Illustration of the power tower operating system (picture courtesy of Abengoa Solar S.A.)

2.4. Details of the functioning of a Photovoltaic Facility

PV facilities use semiconductors which absorb solar energy to produce electricity through the "Photovoltaic Effect." This physical process was discovered in 1839 by Edmund Becquerel who found that certain materials (i.e. silicon) produce electric current when

exposed to light. Sunlight is composed of photons or "packets" of energy and when these photons strike the PV cells, they may be reflected or absorbed, or they may pass right through. When a photon is absorbed, its energy is transferred to an atom of the semiconductor. Thereafter, an electron is able to escape from its normal position associated with that atom to become part of the current in an electrical circuit. Special electrical properties of the solar cell provide the voltage needed to drive the current through an external load (i.e. a light bulb) (refer to Figure 2.5).

The **individual PV cells** are commonly constructed from silicon and are linked together and placed behind a protective glass sheet to operate in unison as a PV panel. A single PV cell is sufficient to power a small device such as an emergency telephone, however to produce 5 MW of power, the proposed plant will require numerous cells arranged in multiples/arrays which will be fixed to **support structures or mounts**. In order to maximise the electricity generated these mounts need to be angled in such a fashion so to receive the maximum amount of solar radiation throughout the year. The preferred angle of the panels (which is dependent on the latitude of the proposed facility) may be adjusted to optimise for summer or winter solar radiation characteristics. This is further optimised through the utilisation of tracking technology, whereby the PV panels are able to 'track' the sun during the day.

The generated power can then be stored or evacuated into a local electricity grid to meet the load requirements. In the case of the latter, the electricity is evacuated to either a substation or a switching station which houses an inverter. The **inverter** serves to convert the electricity, which is produced as direct current by the PV panels, into alternating current which can be used by individuals drawing power from the national electricity grid.

Four primary factors affect the efficiency of a PV cell, these include:

The operational temperature of the PV cell

Higher ambient temperatures reduce the performance of PV panels. For example standard silicon panels lose about 0.5% of efficiency for every 1 degree of temperature increase (calculated by assuming an efficiency at 25°C is 100%), so a 15% efficient panel at 25°C would turn in to a 13.5% panel at PV cells typically get significantly hotter than the ambient temperature (i.e. 25°C hotter under normal conditions).

The intensity of the incoming solar radiation

The PV cell performance is directly proportional to the solar intensity. Therefore the efficiency is affected by the intensity of the sunlight on an optimally oriented panel at the specific location, at the specific time. Clouds cover would cause a significant decrease in efficiency.

The orientation of the panels with respect to the angle of the sun

For best performance, terrestrial PV systems aim to maximise the time they face the sun. Solar trackers aim to achieve this by moving PV panels to follow the sun. The increase can be by as much as 20% in winter and by as much as 50% in summer. Static mounted systems can be optimised by analysis of the sun's path. Panels are often set to latitude tilt, an angle equal to the latitude, but performance can be improved by adjusting the angle for summer or winter. In standard PV applications trackers are used to minimise the angle of incidence between the incoming light and the PV panel. This increases the amount of energy produced from a fixed installed power generating capacity. Various tracker technologies are available and include single axis trackers (i.e. have one degree of freedom that acts as an axis of rotation) or dual Axis trackers (i.e. have two degrees of freedom that act as axes of rotation). Compared to a fixed mount, a single axis tracker increases annual output by approximately 30% and a dual axis tracker by an additional 6%.

The I-V operation point

The power a panel delivers depends on the load it is supplying. Modern PV systems use maximum power point trackers which change the input impedance of the load to match changes in the panels due to sun light changes. This means you have to have the right load resistance so that the panels are outputting maximum power.

2.4.1 Functioning of PV Facilities

PV facilities, unlike CSP, do not require water as the photovoltaic effect does not generate electricity through a conventional steam driven turbine. Instead the electricity that is generated is evacuated directly to the on-site substation through an inverter system. (The inverter system will however require additional cooling in warm climates as experienced in the northern cape.)

2.5. Project Construction Phase

The construction phase is expected to take up to two to three years in total and will entail a series of activities including:

- The **pre-construction phase** will include conducting additional surveys; undertaking site preparation and transporting the required components and equipment to site.
- The **construction phase** will include establishment of internal and external access roads; establishment of construction areas; construction of the power islands; establishment of the solar arrays; establishment of ancillary infrastructure (i.e. power line, pipeline and reservoirs); and connection of the plant substation to the Eskom power grid at the Paulputs Transmission Substation.
- The **post-construction phase** will include site remediation.

The construction phase is expected to create approximately between 400 - 600 employment opportunities, of which approximately 60% would be low skilled positions (i.e. construction labourers, security staff etc) and semi-skilled workers (i.e. drivers, equipment operators etc), and 40% would be available to skilled personnel (i.e. engineers, land surveyors, project managers etc). The majority of the employment opportunities, specifically the skilled and semi-skilled opportunities, are likely to be associated with the contactors appointed to construct the facility and associated infrastructure.

2.5.1 Conduct Surveys

Prior to initiating construction, a number of surveys will be required including, but not limited to, a geotechnical survey, a site survey and confirmation of the micro-siting footprint for the troughs, heliostats, power tower and PV panel, survey of the power island sites, and survey of the power line, water supply and road servitudes.

2.5.2 Establishment of Access Roads to and within the Site

The broader site will be accessed via an existing external access road which traverses the site. Within the site itself, access will be required from this existing secondary road to the individual facility components for construction purposes (and later limited access for maintenance). The amount of earthworks and compaction required in the establishment of the access roads will be established through the detailed geotechnical study to be conducted for the site.

Depending on the technology choices there will be one internal asphalt access road of approximately 6 m wide which provide direct access to the power islands. Between the heliostats/troughs/photovoltaic panels there will be a stabilised gravel track that would be used for maintenance purposes during the operational phase. The final layout of the access roads will be determined following the identification of site related sensitivities.

2.5.3 Undertake Site Preparation

Site preparation activities will include clearance of vegetation for the establishment of internal access roads and at the footprint of each project component. These activities will require the stripping of topsoil which will need to be stockpiled, backfilled and/or spread on site.

2.5.4 Transport of Components and Equipment to Site

The components for the proposed facility will be transported to site in sections by road. Some of the power station components (especially those associated with the power islands) may be defined as abnormal loads in terms of the Road Traffic Act (Act No. 29 of

1989)[1] by virtue of the dimensional limitations (i.e. length and weight). Components of various specialised construction and lifting equipment are required (e.g. for the power tower) and will need to be transported to site. In addition to the specialised lifting equipment/cranes, the 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 establishment of the power islands and power line.

The equipment will be transported to the site using appropriate National, Provincial and local roads, and then the dedicated access/haul road within the site itself.

2.5.5 Establishment of Construction Camps and Laydown Areas

Once the required equipment has been transported to site, a dedicated construction equipment camp will need to be established. The purpose of this camp is to confine activities and storage of equipment to one designated area to limit the potential ecological impacts associated with this phase of the project. The storage of fuel for the on-site construction vehicles and equipment will need to be secured in a temporary bunded facility so to prevent the possibility of leakages and soil contamination. A dedicated area for a batching plant will also need to be established (a batching plant is used to measure the quantities of different materials required to make a correct mix of concrete).

Laydown and storage areas will be required for the typical construction equipment which will be required on site. Hard standing areas will also need to be established for the operation of any cranes to be used on the site.

2.5.6 Assemble and Construct Solar Arrays

The solar array components will be assembled on-site. The solar arrays will comprise the following components:

» Parabolic troughs (~200 ha – 300 ha) per 100 MW;
» Heliostat field and Power Tower (~300 ha) per 50 MW;
» PV panels (~ 50 ha) per 10 MW; and
» Underground cabling.

The parabolic troughs plant will be established as numerous modules (i.e. each of approximately 12.5 m) which will be linked to form a collector of approximately 150 m. A trough loop will consist of 4 collectors in series and arranged such at approximately 300 m in length. A total of 80 - 200 loops will be established which will function as a

[1] A permit will be required for the transportation of these abnormal loads on public roads.

single unit for an output of 100 MW. Each collector module will be supported by pylons mounted on a small concrete foundation. The pylons will lift the troughs off the ground to a height of roughly 5 m.

Each heliostat mirror will be approximately 120 m^2 and will be supported on a 6 m high pedestal which will be supported by a concrete foundation. The heliostat field will be orientated mainly to the southern side of the power tower in order to reflect the sun's rays onto the central receiver. Approximately 4 000 – 6 000 heliostats will be used in a 50 MW plant.

Numerous PV panels will be linked together to form a single operating unit mounted on a sun tracker very similar to the heliostats described above. The PV plant is likely to comprise approximately 400 trackers each rated at about 25 kW The "feet" of the support structure of the PV panels will also be placed on concrete foundations.

2.5.7 Construct Power Islands and Substation

The power islands (with an approximate footprint of 5 ha) and will include the following components:

» The steam turbine generator and the associated heat exchangers;
» A water cooled condenser;
» Feed water pumps;
» Feed water heaters;
» A wet cooling tower; and
» The substation.

The construction of the power islands and substation would require a survey of the site, site clearing and levelling and construction of access road/s (where required), 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.

2.5.8 Establish Water Supply Pipeline and Associated Infrastructure

Ancillary infrastructure includes a water supply pipeline to the facility from the abstraction point at the Gariep (Orange) River[2], a de-gritting and basic filtration facility south of the abstraction point, a water treatment plant and water storage reservoirs on the site, and evaporation ponds (i.e. for wastewater from the generation process). The establishment of these facilities will require the clearing of vegetation and levelling of the development site and the excavation of foundations prior to construction.

[2] A ductile steel pipeline of approximately 30 km in length.

The height difference between the abstraction point and the facility will require the establishment of three pump sets, namely an abstraction pump at the river; a lift pump at the de-gritting reservoir; and a booster pump located a distance of roughly half way to the facility. The pump sets at the abstraction point will be mounted on slides to move them up and down according to the water level of the river. The electrical switch gear will be installed at a point on the embankment above the 1:50 year flood line. The existing embankment is protected against erosion by gabions and stone pitching.

The proposed double lined evaporation ponds are proposed within the development footprint to receive and store the wastewater generated from the electricity generation process as the proposed facility will be operated as a Zero Liquid Effluent Discharge (ZLED) facility.

2.5.9 Connect Substation to Power Grid

A 132 kV distribution line of approximately 2 km will cross the site and will connect to Eskom's existing Paulputs Transmission Substation, which lies immediately to the west of the site. This substation is connected to the national power grid via an existing transmission line to the Aggeneys Transmission Substation.

2.5.10 Undertake Site Remediation

As construction is completed in an area, and as all construction equipment is removed from the site, the site will be rehabilitated where practical and reasonable. On full commissioning of the facility, any access points to the site which are not required during the operation phase will be closed and prepared for rehabilitation. The methodology for site remediation is included in the Draft Environmental Management Plan (EMP). The EMP will provide objectives for returning the site to the pre-establishment conditions and will provide measures to mitigate/manage the potential impacts expected during the construction phase.

2.6. Project Operation Phase

The operations phase is discussed in more detail below.

2.6.1 Solar Array

The parabolic troughs and the heliostat field and power tower combination will receive the heat of the incoming solar radiation during daylight hours. This energy will be used to heat water for the production of steam in order to drive a conventional steam turbine generator.

2.6.2 Power Islands

The power islands will be comprised of a steam turbine and generator (i.e. which will be established and housed within a 2-storey building), a generator transformer, a small substation, an auxiliary steam boiler and associated vessels.

The auxiliary steam boiler will be used to provide process steam to the facility (i.e. to supplement generation). The fuel (i.e. diesel or liquid petroleum gas (LPG)), sizing, and usage characteristics of the boiler will be dependent on the REFIT and the associated economics. The associated fuel will be stored within a secured and bunded area in the vicinity of the power island area.

2.6.3 Water Supply, Use and Treatment

Raw water will be pumped from the abstraction point and will be pumped to the settlement/de-gritting reservoir. Thereafter the water will be pumped to the reservoir within the boundaries of the identified site. The water use of the facility will include (refer to Table 2.1):

» Makeup water for the circulating water system and cooling tower;
» Makeup water for the steam generator;
» Water for mirror washing;
» Service water;
» Potable water; and
» Fire protection water.

Table 2.1: Estimated water consumption for the proposed facility

Description	Approximate Daily Use (m^3/day)
Raw water	6000
Cooling tower	4000
Plant use	1800
Evaporation ponds	200

In order to reduce the overall water consumption and the requisite sizing of the evaporation ponds, service water will first be used as makeup to the cooling tower and circulating water system. Water conditioning chemicals may be fed into the makeup water to minimise corrosion and to inhibit mineral scale formation. The blow down from the circulating water will be continually treated by lime-softening clarification and filtration processes and then delivered to a clear well where the water will be treated by reverse osmosis prior to being used for other plant requirements. Prior to the reverse osmosis process, ion-exchange softeners will be used to remove any dissolved hardness minerals that remain after the clarifier. The discard brine stream from the softeners will be delivered to the evaporation ponds.

Multiple evaporation ponds are proposed within the development footprint to receive and store the wastewater generated from the electricity generation process as the proposed facility will be operated as a ZLED facility. Numerous ponds are proposed in order to allow plant operations to continue in event that a pond needs to be taken out of service for maintenance purposes. The surface area will be sufficient so that the evaporation rate will exceed the blow down rate from the generation process. The depth of the ponds will be selected so that residual solids will not need to be removed during the lifetime of the facility.

2.6.4 Site Operation and Maintenance

It is anticipated that a full-time security, maintenance, and control room staff will be required on site. The proposed facility will employ approximately 60 – 80 fulltime employees over a 30 - 50 year period. Each component within the facility will be operational except under circumstances of mechanical breakdown, unfavourable weather conditions, or maintenance activities.

2.7. Project Decommissioning Phase

The facility is expected to have a lifespan of approximately 30 (with maintenance and refurbishment extendable to 50) and the power plant infrastructure would only be decommissioned once it has reached the end of its economic life. It is most likely that decommissioning activities of the infrastructure of the facility discussed in this EIA would comprise the disassembly and replacement of the individual components with more appropriate technology/infrastructure available at that time.

The following decommissioning activities will form part of the project scope.

2.7.1. Site Preparation

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

2.7.2. Disassemble and Replace Existing Components

The components would be disassembled, and reused and recycled (where possible), or disposed of in accordance with regulatory requirements.

REGULATORY AND LEGAL CONTEXT CHAPTER 3

3.1 Policy and Planning Context for Solar Energy Facility Development in South Africa

The need to expand electricity generation capacity in South Africa is based on **national policy** and informed by on-going strategic planning undertaken by the Department of Energy (DoE), the National Energy Regulator of South Africa (NERSA) and Eskom. The hierarchy of policy and planning documentation that support the development of renewable energy projects such as solar energy facilities is illustrated in Figure 3.1. These policies are discussed in more detail in the following sections, along with the provincial and local policies or plans that have relevance to the proposed solar energy facility's development.

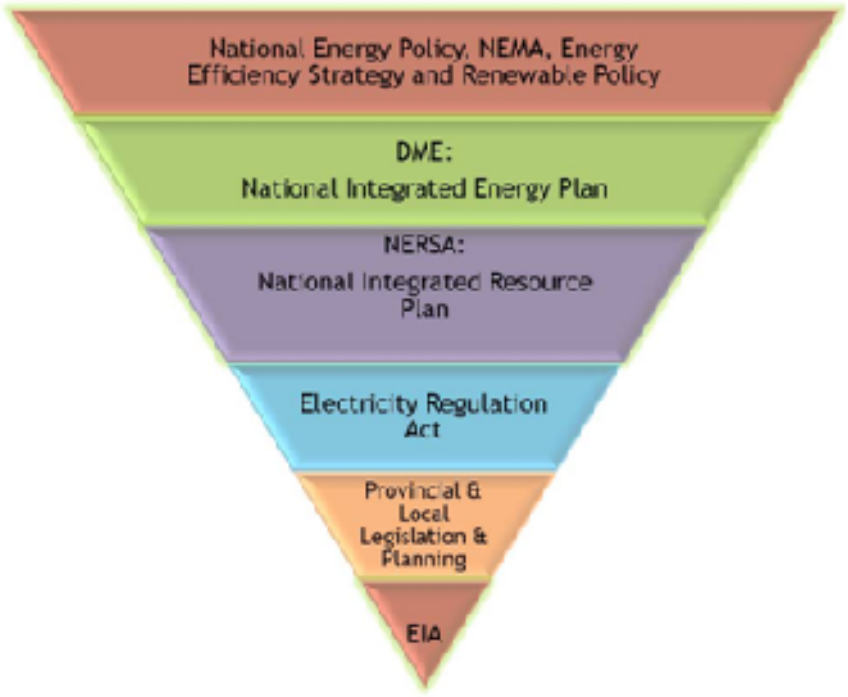


Figure 3.1: Hierarchy of electricity policy and planning documents

3.1.1 White Paper on the Energy Policy of the Republic of South Africa, 1998

Development within the energy sector in South Africa is governed by the White Paper on a National Energy Policy (the National Energy Policy), published by the Department of Minerals and Energy (DME) in 1998. This White Paper identifies key objectives for energy supply within South Africa, such as increasing access to affordable energy services, managing energy-related environmental impacts and securing energy supply through diversity.

Investment in renewable energy initiatives, such as the proposed solar energy facility, is supported by the White Paper on Energy Policy for South Africa. In this regard the document notes that government policy is based on an understanding that renewable energy sources have significant medium - long-term commercial potential and can increasingly contribute towards a long-term sustainable energy future in South Africa. The support for renewable energy policy is guided by a rationale that South Africa has a very attractive range of renewable resources, particularly ***solar*** and wind and that renewable applications are in fact the least cost energy service in many cases; more so when social and environmental costs are taken into account.

3.1.2 Renewable Energy Policy in South Africa, 1998

The White Paper on Renewable Energy (DME, 2003) supplements the Energy Policy, and sets out Government's vision, policy principles, strategic goals, and objectives for promoting and implementing renewable energy in South Africa. The support for the Renewable Energy Policy is guided by a rationale that South Africa has a very attractive range of renewable resources, particularly solar and wind, and that renewable applications are, in fact, the least cost energy service in many cases from a fuel resource perspective (i.e. the cost of fuel in generating electricity from such technology); more so when social and environmental costs are taken into account. Government policy on renewable energy is therefore concerned with meeting economic, technical, and other constraints on the development of the renewable industry.

In order to meet the long-term goal of a sustainable renewable energy industry, the South African Government has set the following 10-year target for renewable energy: "*10 000 GWh (0.8 Mtoe) renewable energy contribution to final energy consumption by 2013 to be produced mainly from biomass, wind, solar and small-scale hydro. The renewable energy is to be utilised for power generation and non-electric technologies such as solar water heating and bio-fuels. This is approximately 4% (1 667 MW) of the estimated electricity demand (41 539 MW) by 2013"* (DME, 2003).

The White Paper on Renewable Energy states "*It is imperative for South Africa to supplement its existing energy supply with renewable energies to combat Global Climate Change which is having profound impacts on our planet*."

3.1.3 Integrated Energy Plan, 2003

In response to the requirements of the National Energy Policy, the DME commissioned the Integrated Energy Plan (IEP) to provide a framework in which specific energy policies, development decisions and energy supply trade-offs can be made on a project-by-project basis. The framework is intended to create a balance between the energy demand and resource availability to provide low cost electricity for social and economic development, while taking into account health, safety, and environmental parameters.

The current IEP recognises that South Africa is likely to be reliant on coal for at least the next 20 years as the predominant source of energy. However, there is potential and a need to diversify energy supply through increased use of natural gas and new and renewable energies.

3.1.4 National Integrated Resource Plan, 2003/2004

In response to the National Energy Policy's objective relating to affordable energy services, NERSA commissioned a National Integrated Resource Plan (NIRP) in order to provide a long-term (from 2003 to 2022), cost-effective resource plan for meeting electricity demand, which is consistent with reliable electricity supply and environmental, social and economic policies. The planning horizon for the study was from 2003 to 2022. The objective of the NIRP is to determine the least-cost supply option for the country, provide information on the opportunities for investment into new power generating projects, and evaluate the security of supply. The long-term electricity planning goal is to ensure sustainable development considering technical constraints, economic constraints, social constraints, and externalities.

Various demand side management and supply-side options are considered in the NIRP process, prior to identifying the least cost supply options for South Africa. The outcome of the process confirmed that coal-fired options are still required over the next 20 years and that additional base load plants will be required from 2010.

The first and interim IRP was developed in 2009 by the Department of Energy. The initial four years of this plan was promulgated by the Minister of Energy on 31 December 2009 and was updated on 29 January 2010. The Department of Energy is currently revisiting and revising the IRP, with the IRP2010 expected to be finalised by the end of 2010.

3.1.5 Electricity Regulation Act, 2006

To contribute towards the renewable energy target set by the Government, socio-economic and environmentally sustainable growth, and kick start and stimulate the renewable energy industry in South Africa, Renewable Energy Feed-in Tariffs (REFIT) have been set by the National Energy Regulator of South Africa (NERSA). REFITs are, in essence, guaranteed prices for electricity supply rather than conventional consumer tariffs. The basic economic principle underpinning the REFITs is the establishment of a tariff (price) that covers the cost of generation plus a "reasonable profit" to induce developers to invest. This is quite similar to the concept of cost recovery used in utility rate regulation based on the costs of capital. Feed-in tariffs to promote renewable energy have now been adopted in over 36 countries around the world. The establishment of the Renewable Energy Feed-In Tariff (REFIT) in South Africa provides the opportunity for an increased contribution towards the sustained growth of the

renewable energy sector in the country, the region and internationally, and promote competitiveness for renewable energy with conventional energies in the medium- and long-term. Under the National Energy Regulator Act, 2004 (Act No 40 of 2004), the Electricity Regulation Act, 2006 (Act No 4 of 2006) and all subsequent relevant Acts of Amendment, NERSA has the mandate to determine the prices at and conditions under which electricity may be supplied by licence to Independent Power Producers (IPPs).

3.2. Regulatory Hierarchy for Energy Generation Projects

The South African energy industry is evolving rapidly, with regular changes to legislation and industry role-players. The regulatory hierarchy for an energy generation project of this nature consists of three tiers of authority who exercise control through both statutory and non-statutory instruments – that is National, Provincial, and Local levels.

At National Level, the main regulatory agencies are:

Department of Energy (formerly DME)	This department is responsible for policy relating to all energy forms, including renewable energy. Solar energy is considered under the White Paper for Renewable Energy and the Department undertakes research in this regard. It is the controlling authority in terms of the Electricity Act (Act No 41 of 1987).
National Energy Regulator of South Africa (NERSA)	This body is responsible for regulating all aspects of the electricity sector, and will ultimately issue licenses for solar energy developments to generate electricity.
Department of Environmental Affairs (DEA)	This Department is responsible for environmental policy and is the controlling authority in terms of NEMA and the EIA Regulations. The DEA is the competent authority for this project, and charged with granting the relevant environmental authorisation.
The South African Heritage Resources Agency (SAHRA)	The National Heritage Resources Act (Act No 25 of 1999) and the associated provincial regulations provides legislative protection for listed or proclaimed sites, such as urban conservation areas, nature reserves and proclaimed scenic routes.
Department of Transport - Civil Aviation Authority (CAA)	This department is responsible for aircraft movements and radar, which are aspects that may influence solar energy development location and planning (i.e. in terms of the power tower).
South African National Roads Agency (SANRAL)	This department is responsible for all National road routes.

At Provincial Level, the main regulatory agencies are:

Provincial Government of the Northern Cape – Department of Environmental and Nature Conservation (DENC)	This Department is responsible for environmental policy and is the Provincial authority in terms of NEMA and the EIA Regulations. The DENC is the commenting authority for this project.
Department of Transport and Public Works	This department is responsible for roads and the granting of exemption permits for the conveyance of abnormal loads on public roads.

At Local Level the local and municipal authorities are the principal regulatory authorities responsible for planning, land use, and the environment. In the Northern Cape, both Municipalities and District Municipalities play a role. The local municipality is the *Khai Ma Local Municipality*, which forms part of the Greater *Namakwa District Municipality*.

- In terms of the Municipal Systems Act (Act No 32 of 2000) it is compulsory for all municipalities to go through an Integrated Development Planning (IDP) process to prepare a five-year strategic development plan for the area under their control.
- Bioregional planning involves the identification of priority areas for conservation and their placement within a planning framework of core, buffer, and transition areas. These could include reference to visual and scenic resources and the identification of areas of special significance, together with visual guidelines for the area covered by these plans.
- By-laws and policies have been formulated by local authorities to protect visual and aesthetic resources relating to urban edge lines, scenic drives, special areas, signage, communication masts, etc.

There are also numerous non-statutory bodies and environmental lobby groups that play a role in various aspects of planning and the environment that will influence solar energy development.

3.3 Legislation and Guidelines that have informed the preparation of this EIA Report

The following legislation and guidelines have informed the scope and content of this final EIA Report:

- National Environmental Management Act (Act No 107 of 1998).
- EIA Regulations, published under Chapter 5 of the NEMA (GN R543, GN R544 and GN R546 in Government Gazette 33306 of 18 June 2010).
- Guidelines published in terms of the NEMA EIA Regulations, in particular:
  - Guideline 3: General Guide to Environmental Impact Assessment Regulations, 2006 (DEAT, June 2006).
  - Guideline 4: Public Participation in support of the Environmental Impact Assessment Regulations, 2006 (DEAT, May 2006).

* Guideline 5: Assessment of alternatives and impacts in support of the Environmental Impact Assessment Regulations, 2006 (DEAT, June 2006).

Acts, standards or guidelines which have informed the project process and the scope of issues assessed within this EIA are summarised in Table 3.1.

Table 3.1: Relevant legislative permitting requirements applicable to the EIA for the Pofadder Solar Thermal Plant

Legislation	Applicable Requirements	Relevant Authority	Compliance requirements
National Legislation			
National Environmental Management Act (Act No 107 of 1998)	» EIA Regulations have been promulgated in terms of Chapter 5. Activities which may not commence without an environmental authorisation are identified within these Regulations. » In terms of S24(1) of NEMA, the potential impact on the environment associated with these listed activities must be considered, investigated, assessed and reported on to the competent authority (the decision-maker) charged by NEMA with granting of the relevant environmental authorisation. » In terms of GNR 387 of 21 April 2006, a scoping and EIA process is required to be undertaken for the proposed project.	» National Department of Environmental Affairs – lead authority » Northern Cape DENC - commenting authority	» This EIA report is to be submitted to the DEA and Provincial Environmental Department in support of the application for authorisation.
National Environmental Management Act (Act No 107 of 1998)	» In terms of the Duty of Care provision in S28(1) 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, stopped or minimised. » In terms of NEMA, it has become the legal duty of a project proponent to consider a project holistically, and to consider the	» Department of Environmental Affairs (as regulator of NEMA)	» While no permitting or licensing requirements arise directly by virtue of the proposed project, this section finds application during the EIA phase and will continue to apply throughout the life cycle of the project.

	cumulative effect of a variety of impacts.		
Environment Conservation Act (Act No 73 of 1989)	» National Noise Control Regulations (GN R154 dated 10 January 1992).	» National Department of Environmental Affairs » Northern Cape DENC - commenting authority » Local Authorities » District & Local Municipality	» There is no requirement for a noise permit in terms of the legislation. Noise impacts may result from specific activities carried out during the construction phase of the project and could present an intrusion impact to the local community. Any such specific activities should be limited to 6:00am to 6:00pm Monday – Saturday (excluding public holidays). Should these specific activities need to be undertaken outside of these times, the surrounding communities will need to be notified and appropriate approval will be obtained from the DEA and the Local Municipality.
National Water Act (Act No 36 of 1998)	» Water uses must be licensed unless such water use falls into one of the categories listed in S22 of the Act or falls under the general authorisation.	» Department of Water Affairs	» The abstraction of water is regarded as a water use (as defined in terms of S21 of the NWA). A water use license is being applied for in parallel with the EIA process.
National Water Act (Act No 36 of 1998)	» In terms of S19, the project proponent must ensure that reasonable measures are	» Department of Water Affairs (as regulator of NWA)	» This section will apply throughout the life cycle of the project.

	taken throughout the life cycle of this project to prevent and remedy the effects of pollution to water resources from occurring, continuing, or recurring.		
Minerals and Petroleum Resources Development Act (Act No 28 of 2002)	» A mining permit or mining right may be required where a mineral in question is to be mined (e.g. materials from a borrow pit) in accordance with the provisions of the Act. » Requirements for Environmental Management Programmes and Environmental Management Plans are set out in S39 of the Act.	» Department of Minerals and Energy	» As no borrow pits are expected to be required for the construction of the facility, no mining permit or right is required to be obtained.
Atmospheric Pollution Prevention Act (Act No 45 of 1965)	» In terms of S27, the Minister may declare certain areas dust control areas. (The project study area has not been declared a dust control area). » Part V of Act regulates pollution generated by vehicle fumes.	» National Department of Environmental Affairs	» Although there is no legal obligation relating to the activities to be undertaken it is suggested that best practice means should be used to prevent dust generation from the roads and excavations during construction.
National Environmental Management: Air Quality Act (Act No 39 of 2004)	» S18, S19, and S20 of the Act allow certain areas to be declared and managed as "priority areas". » Declaration of controlled emitters (Part 3 of Act) and controlled fuels (Part 4 of Act) with relevant emission standards.	» National Department of Environmental Affairs	» While no permitting or licensing requirements arise from this legislation, this act will find application during the operational phase of the project. » The Act provides that an air quality officer may require any person to submit an atmospheric impact report if there is

			reasonable suspicion that the person has failed to comply with the Act.
National Heritage Resources Act (Act No 25 of 1999)	» S38 states that Heritage Impact Assessments are required for certain kinds of development including » The construction of a road, power line, pipeline, canal or other similar linear development or barrier exceeding 300 m in length; » Any development or other activity which will change the character of a site exceeding 5 000 m^2 in extent. » The relevant Heritage Resources Authority must be notified of developments such as linear developments (such as roads and power lines), bridges exceeding 50 m, or any development or other activity which will change the character of a site exceeding 5 000 m^2; or the re-zoning of a site exceeding 10 000 m^2 in extent. This notification must be provided in the early stages of initiating that development, and details regarding the location, nature and extent of the proposed development must be provided. » Stand alone Heritage Impact Assessments are not required where an EIA is carried out as long as the EIA contains an	» South African Heritage Resources Agency (SAHRA) – National heritage sites (grade 1 sites) as well as all historic graves and human remains	» A permit may be required should identified cultural/heritage sites on site be required to be disturbed or destroyed as a result of the proposed development. » S4 of the NHRA provides that within 14 days of receipt of notification the relevant Heritage Resources Authority must notify the proponent to submit an impact assessment report if they believe a heritage resource may be affected.

	adequate Heritage Impact Assessment component that fulfils the provisions of S38. In such cases only those components not addressed by the EIA should be covered by the heritage component.		
Nature Conservation Ordinance (Act 19 of 1974)	» Article 63 prohibits the picking of certain fauna (including cutting, chopping, taking, gathering, uprooting, damaging, or destroying). » Schedule 3 lists endangered flora and Schedule 4 lists protected flora. » Articles 26 to 47 regulate the use of wild animals.	» National Department of Environmental Affairs	» Compliance requirements
National Environmental Management: Biodiversity Act (Act No 10 of 2004)	» In terms of S57, the Minister of Environmental Affairs has published a list of critically endangered, endangered, vulnerable, and protected species in GNR 151 in Government Gazette 29657 of 23 February 2007 and the regulations associated therewith in GNR 152 in GG29657 of 23 February 2007, which came into effect on 1 June 2007. » In terms of GNR 152 of 23 February 2007: Regulations relating to listed threatened and protected species, the relevant specialists must be employed during the EIA phase of the project to incorporate the legal provisions as well as the regulations associated with listed threatened and	» National Department of Environmental Affairs	» As the applicant will not carry on any restricted activity, as is defined in Section 1 of the Act, no permit is required to be obtained in this regard. » Specialist flora and fauna studies are required to be undertaken as part of the EIA process. These studies have been undertaken as part of the previously EIAs undertaken for the power station site. » A permit may be required should any protected plant species on site be disturbed or destroyed because of the proposed

	protected species (GNR 152) into specialist reports in order to identify permitting requirements at an early stage of the EIA phase.		development.
Conservation of Agricultural Resources Act (Act No 43 of 1983)	» Regulation 15 of GNR1048 provides for the declaration of weeds and invader plants, and these are set out in Table 3 of GNR1048. Weeds are described as Category 1 plants, while invader plants are described as Category 2 and Category 3 plants. These regulations provide that Category 1, 2 and 3 plants must not occur on land and that such plants must be controlled by the methods set out in Regulation 15E.	» Department of Agriculture	» While no permitting or licensing requirements arise from this legislation, this Act finds application during the EIA phase and will continue to apply throughout the life cycle of the project. In this regard, soil erosion prevention and soil conservation strategies must be developed and implemented. In addition, a weed control and management plan must be implemented.
National Veld and Forest Fire Act (Act 101 of 1998)	» In terms of Section 21 the applicant would be obliged to burn firebreaks to ensure that should a veldfire occur on the property, that it does not spread to adjoining land. » In terms of section 12 the applicant must ensure that the firebreak is wide and long enough to have a reasonable chance of preventing the fire from spreading, not causing erosion, and is reasonably free of inflammable material. » In terms of section 17, the applicant must have such equipment, protective clothing,	» Department of Water Affairs	» While no permitting or licensing requirements arise from this legislation, this act will find application during the operational phase of the project.

	and trained personnel for extinguishing fires.		
Aviation Act (Act No 74 of 1962) 13th amendment of the Civil Aviation Regulations (CARS) 1997	» Any structure exceeding 45 m above ground level or structures where the top of the structure exceeds 150 m above the mean ground level, the mean ground level considered the lowest point in a 3km radius around such structure. » Structures lower than 45 m, which are considered as a danger to aviation shall be marked as such when specified.	» Civil Aviation Authority	» While no permitting of licence requirements arise from the legislation, this act will find application during the operational phase of the project. Appropriate marking is required to meet the specifications as detailed in the CAR Part 139.01.33.
Hazardous Substances Act (Act No 15 of 1973)	» This Act regulates the control of substances that may cause injury, or ill health, or death because of 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,	» Department of Health	» It is necessary to identify and list all the Group I, II, III and IV hazardous substances that may be on the site and in what operational context they are used, stored or handled. If applicable, a license is required to be obtained from the Department of Health.

	heat or other means, cause extreme risk of injury etc., can be declared to be Group I or Group II hazardous substance; » Group IV: any electronic product; » 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.		
National Road Traffic Act (Act No 93 of 1996)	» 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 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	Provincial Department of Transport (provincial roads) » South African National Roads Agency Limited (national roads)	» 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 22 m. » Depending on the trailer configuration and height when loaded, some of the power station components may not meet specified dimensional limitations (height and width).

	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.		
Development Facilitation Act (Act No 67 of 1995)	» Provides for the overall framework and administrative structures for planning throughout the Republic. » Sections 2- 4 provide general principles for land development and conflict resolution.	» Local Municipality, District Municipality	» The applicant must submit a land development application in the prescribed manner and form as provided for in the Act. A land development applicant who wishes to establish a land development area must comply with procedures set out in the DFA.
Subdivision of Agricultural Land Act (Act No 70 of 1970)	» Details land subdivision requirements and procedures. Applies for subdivision of all agricultural land in the province.	» Local Municipality, District Municipality	» Subdivision will have to be in place prior to any subdivision approval in terms of Section 24 and 17 of LUPO. » Subdivision is required to be undertaken following the issuing of an environmental authorisation for the proposed project.
National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008)	» 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: * Adding other waste management activities to the list;	National Department of Water and Environmental Affairs (hazardous waste and effluent) Provincial Department of Environmental Affairs (general waste)	» As no waste disposal site is to be associated with the proposed project, no waste licence is required in this regard. » Waste handling, storage and disposal during construction and operation is required to be

	* Removing waste management activities from the list; or * Making other changes to the particulars on the list. » In terms of the Regulations published in terms of this Act (GN 718), A Basic Assessment or Environmental Impact Assessment 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.		undertaken in accordance with the requirements of this Act, as detailed in the EMP. Should the waste quantities exceed the thresholds as detailed in the Regulations, a waste licence would be required to be obtained.
Promotion of Access to Information Act (Act No 2 of 2000)	» All requests for access to information held by state or private body are provided for in the Act under S11.	» National Department of Environmental Affairs	» No permitting or licensing requirements.

Promotion of Administrative Justice Act (Act No 3 of 2000)	» In terms of S3 the government is required to act lawfully and take procedurally fair, reasonable and rational decisions. » Interested and affected parties have right to be heard.	» National Department of Environmental Affairs	» No permitting or licensing requirements.
National Forests Act (Act No 84 of 1998)	» In terms of section1 5(1) "no person may cut, disturb, damage or destroy any protected tree or possess, collect, remove, transport, export, purchase, sell donate or in any other manner acquire or dispose of any protected tree or any forest product derived from a protected tree, except under a license granted by the Minister to an (applicant and subject to such period and conditions as stipulated".	» National Department of Environmental Affairs	» A permit would need to be obtained for any protected trees that are affected.

APPROACH TO UNDERTAKING THE EIA PHASE CHAPTER 4

An EIA process refers to the process dictated by the EIA Regulations which involves the identification of and assessment of direct, indirect, and cumulative environmental impacts associated with a proposed project. The EIA process comprises two phases: **Scoping Phase** and **EIA Phase**. The EIA process culminates in the submission of an EIA Report (including an environmental management plan (EMP)) to the competent authority for decision-making. The EIA process is illustrated below:

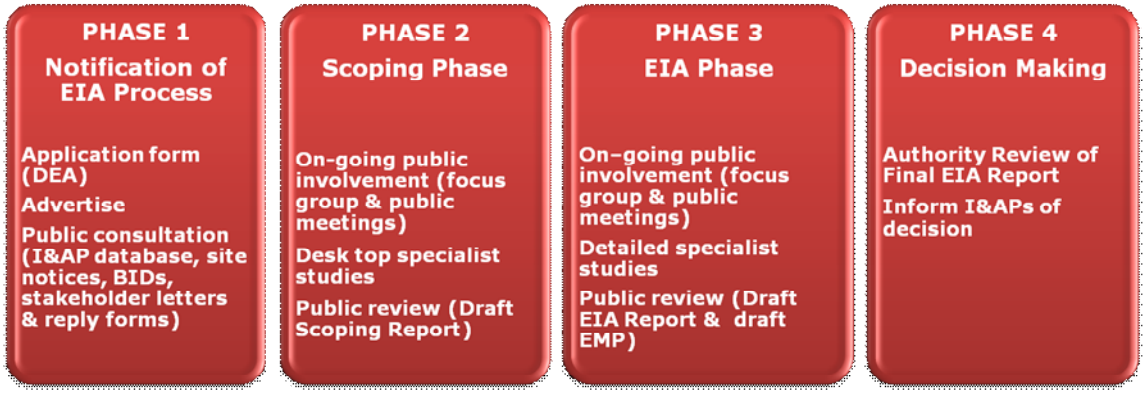


Figure 4.1: Phases within the EIA process

The EIA Phase for the proposed Pofadder Solar Thermal Plant has been undertaken in accordance with the EIA Regulations published in Government Notice 28753 of 21 April 2006, in terms of Section 24(5) of NEMA (Act No. 107 of 1998). The environmental studies for this proposed project were undertaken in two phases, in accordance with the EIA Regulations.

4.1. Phase 1: Scoping Study

The Scoping Phase which was completed in October 2010, provided interested and affected parties (I&APs) with the opportunity to receive information regarding the proposed project, to participate in the process and raise issues or concerns.

The Scoping Report aimed at detailing the nature and extent of the proposed facility, identifying potential issues associated with the proposed project, and defining the extent of studies required within the EIA Phase. This was achieved through an evaluation of the proposed project, involving the project proponent, specialist consultants, and a consultation process with key stakeholders that included both relevant government authorities and I&APs. In accordance with the requirements of the EIA Regulations, feasible project-specific alternatives were identified for consideration within the EIA process.

The draft Scoping Report was made available to the Khai Ma Local Municipality; the Pofadder Public Library and on the Savannah Environmental website for I&AP review and comment. All the comments, concerns, and suggestions received during the Scoping Phase and the review period were included in the final Scoping Report and Plan of Study for EIA. The Scoping Report was submitted to the National Department of Environmental Affairs (DEA) and the Northern Cape Department of Environment and Nature Conservation (DENC) in October 2010. The final Scoping Report, which was submitted to DEA on 04 October 2010, was accepted and in terms of this acceptance, an EIA was required to be undertaken for the proposed project.

4.2. Phase 2: Environmental Impact Assessment

Through the Scoping Study, a number of issues requiring further study for all components of the project were highlighted. These issues have been assessed in detail within the EIA phase of the process.

The EIA Phase aims to achieve the following:

» Provide an overall assessment of the social and biophysical environments affected by the proposed project.
» Assess potentially significant impacts (direct, indirect, and cumulative, where required) associated with the proposed facility.
» Comparatively assess identified site layout alternatives put forward as part of the project.
» Identify and recommend appropriate mitigation measures for potentially significant environmental impacts.
» Undertake a fully inclusive public participation process to ensure that I&AP are afforded the opportunity to participate, and that their issues and concerns are recorded.

The EIA addresses potential environmental impacts and benefits associated with all phases of the project including design, construction, operation, and decommissioning, and aims to provide the environmental authorities with sufficient information to make an informed decision regarding the proposed project.

The EIA process followed for this project is described in detail below.

4.3. Overview of the EIA Phase

The EIA Phase has been undertaken in accordance with the EIA Regulations published in Government Notice 28753 of 21 April 2006, in terms of NEMA. Key tasks undertaken within the EIA phase included:

» Consultation with relevant decision-making and regulating authorities (at National, Provincial and Local levels).
» Undertaking a public participation process throughout the EIA process in accordance with Regulation 56 of Government Notice No R385 of 2006 in order to identify any additional issues and concerns associated with the proposed project.
» Preparation of a Comments and Response Report detailing key issues raised by I&APs as part of the EIA Process (in accordance with Regulation 59 of Government Notice No R385 of 2006).
» Undertaking of independent specialist studies in accordance with Regulation 33 of Government Notice No R385 of 2006.
» Preparation of a draft EIA Report in accordance with the requirements of the Regulation 32 Government Notice No R385 of 2006.

These tasks are discussed in detail below.

4.3.1 Authority Consultation

The National DEA is the competent authority for this application. A record of all authority consultation undertaken prior to the commencement of the EIA Phase is included within the Scoping Report and this EIA report. Consultation with the regulating authorities (i.e. DEA and DENC has continued throughout the EIA process). On-going consultation included the following:

» Submission of a final Scoping Report following a 30-day public review period (and consideration of stakeholder comments received).
» Ad hoc discussions with DEA and DENC, when required, in order to clarify the findings of the Scoping Report and the issues identified for consideration in the EIA process.

The following has been undertaken as part of this EIA process:

» Submission of a final EIA Report following the 30-day public review period.
» A consultation meeting with the DEA and DENC in order to discuss the findings and conclusions of the EIA Report.
» Provision of an opportunity for DEA and DENC representatives to visit and inspect the proposed site, and the study area.
» Consultation with Organs of State that may have jurisdiction over the project, including:
    * Provincial and local government departments (including South African Heritage Resources Agency, Department of Water Affairs, South African National Roads Agency Limited, Department of Agriculture, etc).
    * Government structures (including the Department of Public Works, Roads and Transport, etc).

- Khai Ma Local Municipality and the Namakwa District Municipality.
- Local authorities.
- Conservation authorities.

A record of all authority consultation undertaken prior to the commencement of the EIA Phase is included within the Scoping Report. A record of the consultation throughout the EIA process is included within Appendix B.

4.3.2 Public/stakeholder Involvement and Consultation

The aim of the public participation process was primarily to ensure that:

» Information containing all relevant facts in respect of the proposed project was made available to potential stakeholders and I&APs.
» Participation by potential I&APs was facilitated in such a manner that all potential stakeholders and I&APs were provided with a reasonable opportunity to comment on the proposed project.
» Comment received from stakeholders and I&APs was recorded and incorporated into the EIA process.

Through on-going consultation with key stakeholders and I&APs, issues raised through the Scoping Phase for inclusion within the EIA study were confirmed. All relevant stakeholder and I&AP information has been recorded within a database of affected parties (refer to Appendix C). While I&APs were encouraged to register their interest in the project from the onset of the process, the identification and registration of I&APs has been on-going for the duration of the EIA process, and the project database has been updated on an on-going basis.

In order to accommodate the varying needs of stakeholders and I&APs, as well as ensure the relevant interactions between stakeholders and the EIA specialist team, the following opportunities were provided for I&APs issues to be recorded and verified through the EIA phase, including:

» Focus group meetings (stakeholders invited to attend).
» Public meeting (advertised in the local press).
» Written, faxed or e-mail correspondence.

In addition, a **public meeting** was held in order to provide feedback of the findings of the EIA studies undertaken.

Stakeholders were invited to attend the public meeting held on:

Date: 29 November 2010
Time: 14:00 -16:00
Venue: Khai Ma Municipalities Council Chambers in Pofadder

4.3.3 Identification and Recording of Issues and Concerns

Issues and comments raised by I&APs over the duration of the EIA process have been synthesised into Comments and Response Reports (refer to Appendix D for the Comments and Response Reports compiled thus far during the EIA process).

The Comments and Response Report include responses from members of the EIA project team and/or the project proponent. Where issues are raised that the EIA team considers beyond the scope and purpose of this EIA process, clear reasoning for this view is provided.

4.3.4 Issues raised to date by Stakeholders

At the time of the submission of the final Scoping Report, numerous issues had been raised by stakeholder and I&APs. Comments raised at the public meeting, focus group meetings and faxed or emailed in to the EAP included:

» Community development and employment opportunities;
» Development of renewable energy projects;
» Site selection motivation;
» Project progress;
» The use of water resources; and
» Public participation.

4.3.5 Assessment of Issues Identified through the Scoping Process

Based on the findings of the Scoping Study, the following issues were identified as being of low significance, and therefore not requiring further investigation within the EIA:

Agricultural Potential
Due mainly to the prevailing unfavourable climatic conditions for arable agriculture, as well as the prevalence of soils with limited depth, no further detailed soil investigation was required during the EIA Phase.

Noise
The noise monitoring and modelling results undertaken during the Scoping Phase indicated that noise levels do not exceed specified limits. In addition, due to the lack of

sensitive potential receptors in the area, no further detailed noise emission investigation was required during the EIA Phase.

Issues which require further investigation within the EIA phase, as well as the specialists involved in the assessment of these impacts are indicated in Table 4.1.

Table 4.1: Specialist studies undertaken within the EIA phase

Specialist	Area of Expertise	Refer to Appendix
David Hoare Consulting	Ecology, flora and fauna	Appendix E
Birdlife South Africa	Avifauna	Appendix F
Outeniqua Geotechnical Services	Geology and erosion potential	Appendix G
Scherman, Colloty and Associates	Water resource	Appendix H
McGregor Museum	Heritage	Appendix I
MetroGIS	Visual	Appendix J
Tony Barbour Environmental Consulting	Social	Appendix K

Specialist studies considered direct and indirect environmental impacts associated with the development of all components of the proposed Pofadder Solar Thermal Plant. Issues were assessed in terms of the following criteria:

» The **nature**, a description of what causes the effect, what will be affected, and how it will be affected.
» The **extent**, wherein it is indicated whether the impact will be local (limited to the immediate area or site of development), regional, national or international. A score of between 1 and 5 is assigned as appropriate (with a score of 1 being low and a score of 5 being high).
» The **duration**, wherein it is indicated whether:
  * The lifetime of the impact will be of a very short duration (0 – 1 years) – assigned a score of 1;
  * The lifetime of the impact will be of a short duration (2 - 5 years) - assigned a score of 2;
  * Medium-term (5 – 15 years) – assigned a score of 3;
  * Long term (> 15 years) - assigned a score of 4; and
  * Permanent - assigned a score of 5.
» The **magnitude**, quantified on a scale from 0 - 10, where a score is assigned:
  * 0 is small and will have no effect on the environment;
  * 2 is minor and will not result in an impact on processes;
  * 4 is low and will cause a slight impact on processes;
  * 6 is moderate and will result in processes continuing but in a modified way;
  * 8 is high (processes are altered to the extent that they temporarily cease); and
  * 10 is very high and results in complete destruction of patterns and permanent cessation of processes.

» The **probability of occurrence**, which describes the likelihood of the impact actually occurring. Probability is estimated on a scale, and a score assigned:

  * Assigned a score of 1 – 5, where 1 is very improbable (probably will not happen);
  * Assigned a score of 2 is improbable (some possibility, but low likelihood);
  * Assigned a score of 3 is probable (distinct possibility);
  * Assigned a score of 4 is highly probable (most likely); and
  * Assigned a score of 5 is definite (impact will occur regardless of any prevention measures).

» The **significance**, which is determined through a synthesis of the characteristics described above (refer formula below) and can be assessed as low, medium or high
» The **status**, which is described as either positive, negative or neutral
» The degree to which the impact can be **reversed**
» The degree to which the impact may cause **irreplaceable loss of resources**
» The degree to which the impact can be **mitigated**

The **significance** is determined by combining the criteria in the following formula:

S = (E+D+M) P; where
S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

» **< 30 points:** Low (i.e. where this impact would not have a direct influence on the decision to develop in the area).
» **30-60 points:** Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated).
» **> 60 points:** High (i.e. where the impact must have an influence on the decision process to develop in the area).

As !KaXu CSP has the responsibility to avoid or minimise impacts and plan for their management of the proposed Pofadder Solar Thermal Plant (in terms of the EIA Regulations), the mitigation of significant impacts is discussed. Assessment of impacts with mitigation is made in order to demonstrate the effectiveness of the proposed mitigation measures. A draft EMP is included as Appendix M

4.3.6 Assumptions and Limitations

The following assumptions and limitations are applicable to the studies undertaken within this EIA Phase:

» All information provided by !KaXu CSP and I&APs to the Environmental Team was correct and valid at the time it was provided.
» It is assumed that the development site identified by !KaXu CSP represents a technically suitable site for the establishment of a CSP and CPV facility.
» Studies assume that any potential impacts on the environment associated with the proposed development will be avoided, mitigated, or offset.
» This report and its investigations are project-specific, and consequently the environmental team did not evaluate any other power generation alternatives.

4.3.7 Public Review of draft EIA Report and Public Meeting

The **draft EIA Report** was made available for public review at the following locations from **11 November 2010** to **10 December 2010**:

» Pofadder Public Library
» www.savannahsa.com

In addition **public meeting** was held in order to provide feedback of the findings of the EIA studies undertaken. Stakeholders were invited to attend the public meeting held on:

Date: 29 November 2010
Time: 14:00 -16:00
Venue: Khai Ma Municipalities Council Chambers in Pofadder

All registered I&APs were notified of the availability of the report by letter.

4.3.8 Final EIA Report

The final stage in the EIA Phase entails the capturing of responses from I&APs on the draft EIA Report in order to refine it. It is this final report upon which the decision-making environmental authorities make a decision regarding the proposed project.

DESCRIPTION OF THE AFFECTED ENVIRONMENT CHAPTER 5

This section of the EIA Report provides a description of the environment that may be affected by the proposed Pofadder Solar Thermal Plant. This information is provided in order to assist the reader in understanding the possible effects of the proposed project on the environment. Aspects of the biophysical, social, and economic environment that could directly or indirectly be affected by, or could affect, the proposed development have been described. This information has been sourced from both existing information available for the area as well as collected field data, and aims to provide the context within which this EIA is being conducted. A more detailed description of each aspect of the affected environment is included within the specialist reports contained within Appendices F - L.

5.1 Location of the Study Area

The identified site proposed for the Pofadder Solar Thermal Plant is situated approximately 30 km north-east of Pofadder on a portion of Portion 4 of the Farm Scuit-Klip 92. The study area is relatively isolated and is situated along a minor road that connects the R64 (connecting Onseepkans from the N14 between Pofadder and Kakamas) and the R358 (connecting Pofadder, Onseepkans and Karasburg in Namibia). Most of the site is relatively accessible, with a gravel road traversing part of the site.

The proposed site falls within the Khai Ma Local Municipality which has its administrative centre in Pofadder. This local municipality is one of seven local municipalities that fall within the greater Namakwa District Municipality.

5.2. Biophysical Characteristics of the Study Area and Surrounds

5.2.1 Climatic Conditions

The study area is characterised by an arid climate. The Mean Annual Rainfall (MAR) is approximately 100 mm to 150 mm per year; primarily through summer rainfall, however due to the moderating effect of the Gariep (Orange) River Valley, winter rainfall is able to extend up the valley into the interior. The area also experiences fog up the river valley and high evapotranspiration rates are experienced in summer ranging from 1 400 mm- 1 800 mm. The mean maximum summer temperatures are 38°C while the mean minimum winter temperatures are -1°C.

5.2.2 Topographical Profile

The proposed study site is predominantly located on a series of plains which slope in a north-westerly direction. The site is generally flat to gently undulating and lies at a height of approximately 800 m - 850 m above mean sea level. The study area includes a single hill in the north-western corner (i.e. Konkonsieskop) and a range of steep hills in the north-eastern corner (i.e. Ysterberg) (refer to Figure 5.1).

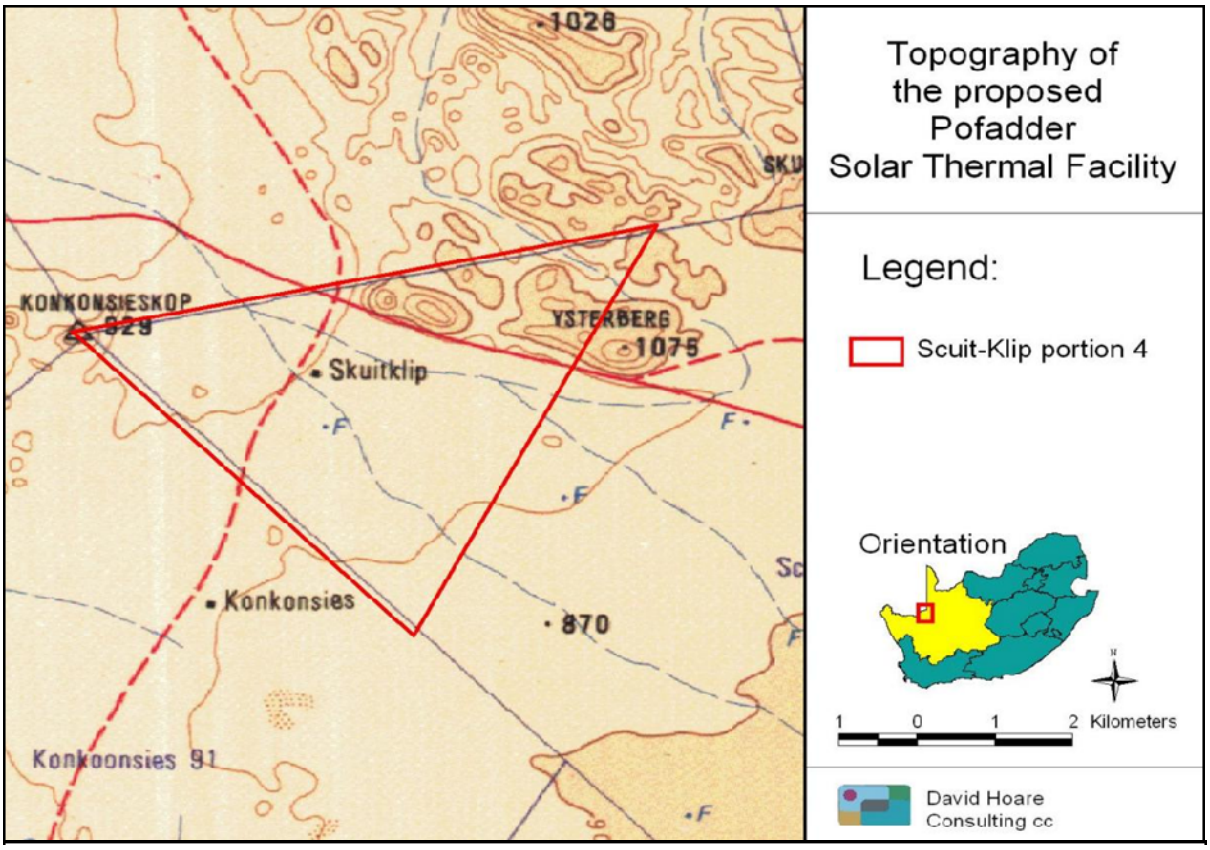


Figure 5.1: Topography of the study area

5.2.3 Geological Profile

The study area is located within the Namaqualand Metamorphic Belt which comprises very old and very highly deformed sedimentary (Khesian Group) and igneous (Namaquan Group) rocks of the Mokolian Erathem (2100 - 1200Ma) that form part of the Southern African Basement Complex rocks. The upland area in the north-eastern portion of the study area is underlain by Koenap Formation meta-pelitic rocks; Polisiehoek gneiss and the Skuitklip granite suite (refer to Figure 5.2). Thick accumulations of transported red sands, scree and gravelly sands are deposited below the western slopes of this upland area. The central, western and southern lowland areas of the study area are dominantly underlain by thick deposits of Quaternary soils of residual and transported origin. The central area is dominated by residual coarse grained, pink feldspathic gravels weathered from the Skuitklip granite suite. The

western-most portion is dominated by red aeolian sands which form lenticular dune cordons. Protruding through this aeolian sand cover is Oupvlakte Formation granulites and Gemsbokvlakte gneiss. These rocks are intensely deformed due to a shear zone that runs along the western boundary of the study area. This shear zone is considered inactive, based on available historic seismic data.

Rocky outcrops are likely to be limited to the north-eastern portion and, to a lesser extent, the western portion of the study area. Talus/scree (gravelly soils transported downslope due to gravity) are expected to exist on slopes in these rocky areas. It is estimated that 20% of the study area has rock outcropping at surface, 10% is underlain by shallow rock, and the remaining 70% has relatively thick soil.

The Erosion Index for South Africa indicates that the site is ranked between 11 and 15 on a scale from 1 (highest potential) to 19 (lowest). This means that the erodibility potential is moderate to low. A wide braided non-perennial stream exists as a feature across the central portion of the study site where thick Quaternary soils occur, and moderate erosion can be expected in this area during heavy downpours (which are generally very rare).

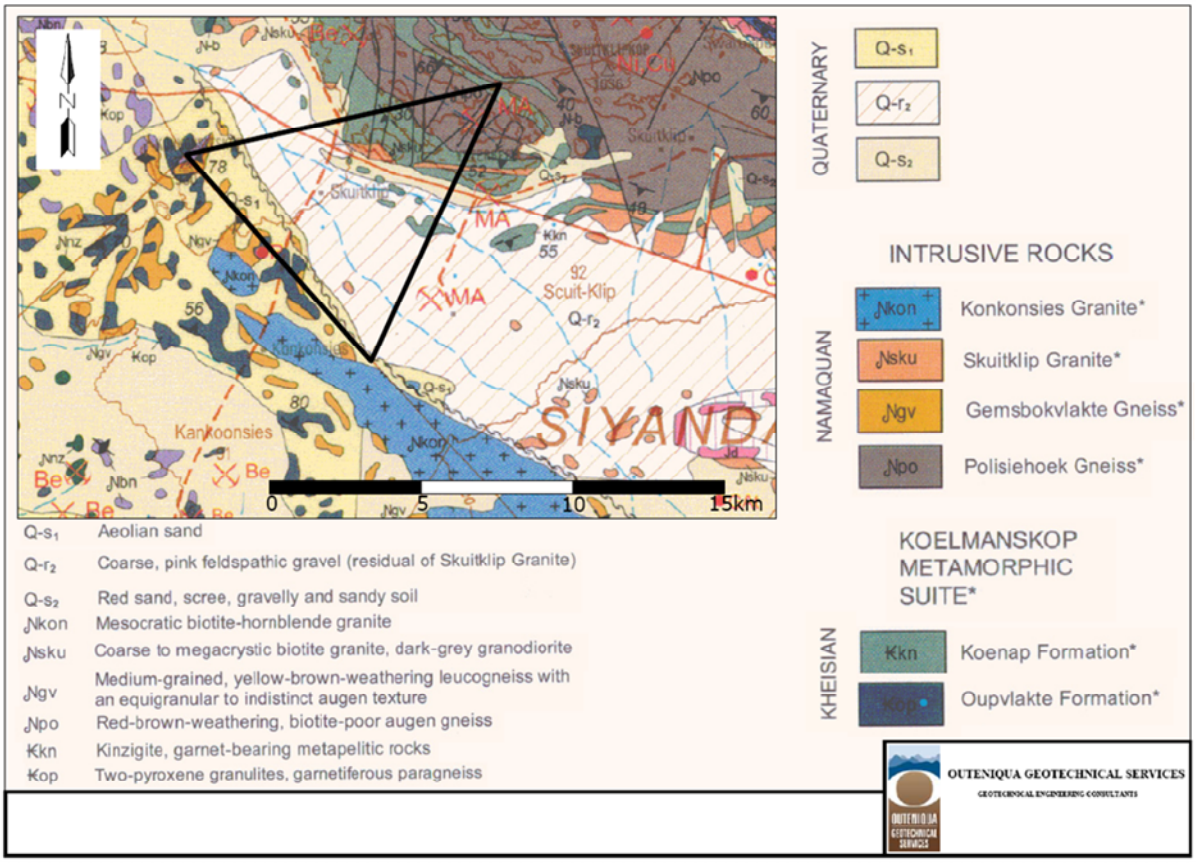


Figure 5.2: Geology of the study area

5.2.4 Hydrological Profile

The study area falls within the Lower Gariep (Orange) River sub-basin, which comprises the Gariep (Orange) River from the confluence with the Vaal River to the Gariep (Orange) River Mouth. The major river systems that contribute to flows in the Gariep (Orange) River include the Ongers River, Sak Rivers, the Kuruman River, Molopo Rivers and the Fish River from Namibia. These rivers drain arid and semi arid areas, which are bordered by the Upper Orange-Senqu and the Vaal sub-basins.

The study site is situated within the D81E quaternary catchment and is dominated by highly ephemeral river systems. Potential runoff from the study area would flow in a north-westerly direction towards the Orange River, while runoff from the elevated areas portions of the Skuitklip ridges would flow in a northerly direction towards the Kaboep River which then flows into the Orange River.

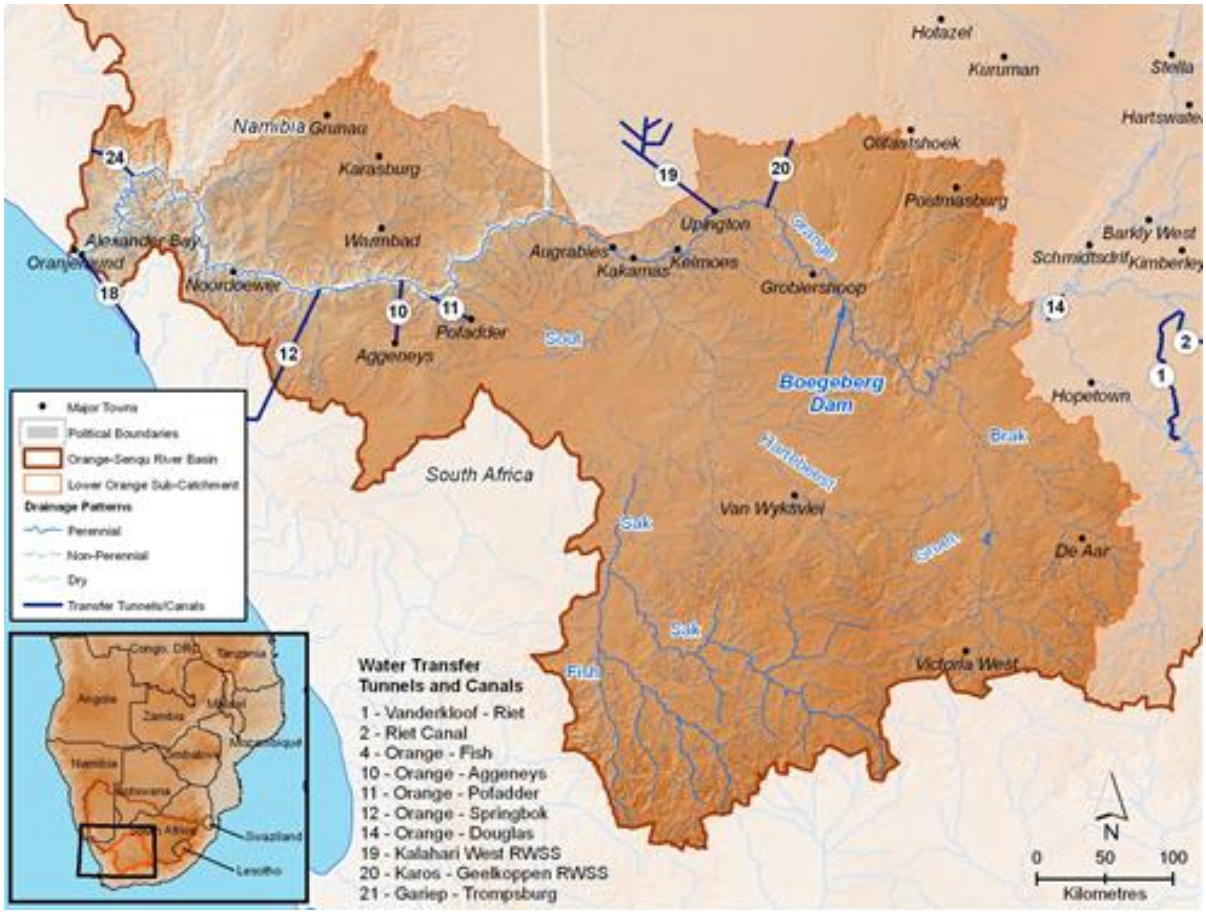


Figure 5.3: Major rivers and transfer schemes in the Lower Orange sub-basin (From Hatfield (2009) after UNDP/GEF 2008, and cited in ORASECOM, 2007)

5.2.5 Ecological Profile

The study area falls within the Karoo Biome and contains two major vegetation types, namely Bushmanland Arid Grassland (i.e. the plains within the study site) and Lower Gariep Broken Veld (i.e. the hills/koppies within the study site), both of which are classified as Least Threatened. Bushmanland Arid Grassland occurs on extensive, relatively flat plains and is sparsely vegetated by tussock grasses as well as abundant displays of annual herbs following heavy rain (refer to Figure 5.4).

This vegetation type contains endemic species belonging to the Griqualand West or Gariep Centres of Endemism. At a national scale this vegetation type has been transformed to a slight degree and approximately 27% is conserved within the Augrabies Falls National Park; it is not therefore considered to be a threatened vegetation type. Lower Gariep Broken Veld consists of sparse vegetation dominated by shrubs, dwarf shrubs, annuals and to a lesser degree by perennial grasses and herbs. This vegetation type contains endemics belonging to the Griqualand West or Gariep Centres of Endemism (refer to Figure 5.5). At a national scale this vegetation type has also been transformed to a slight degree and is also conserved within the Augrabies Falls National Park.

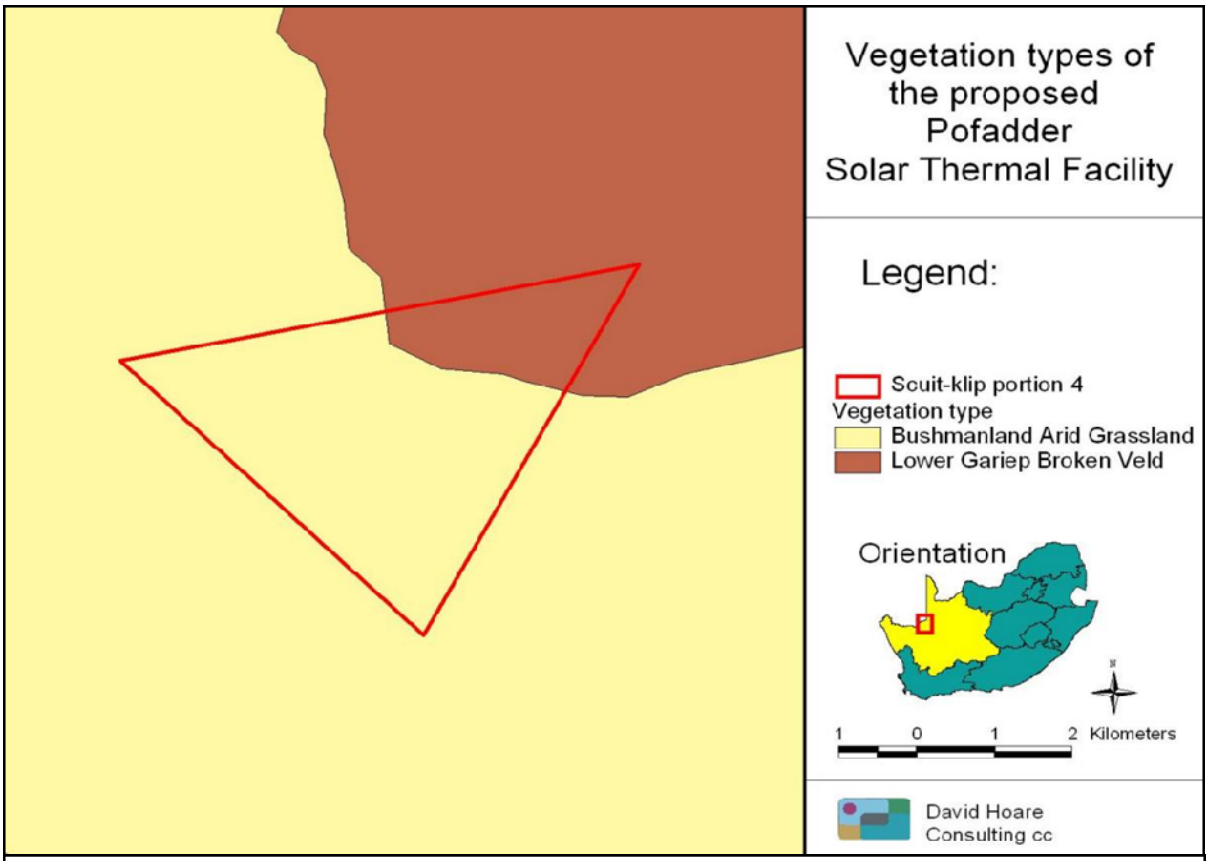


Figure 5.4: Vegetation types within the study area

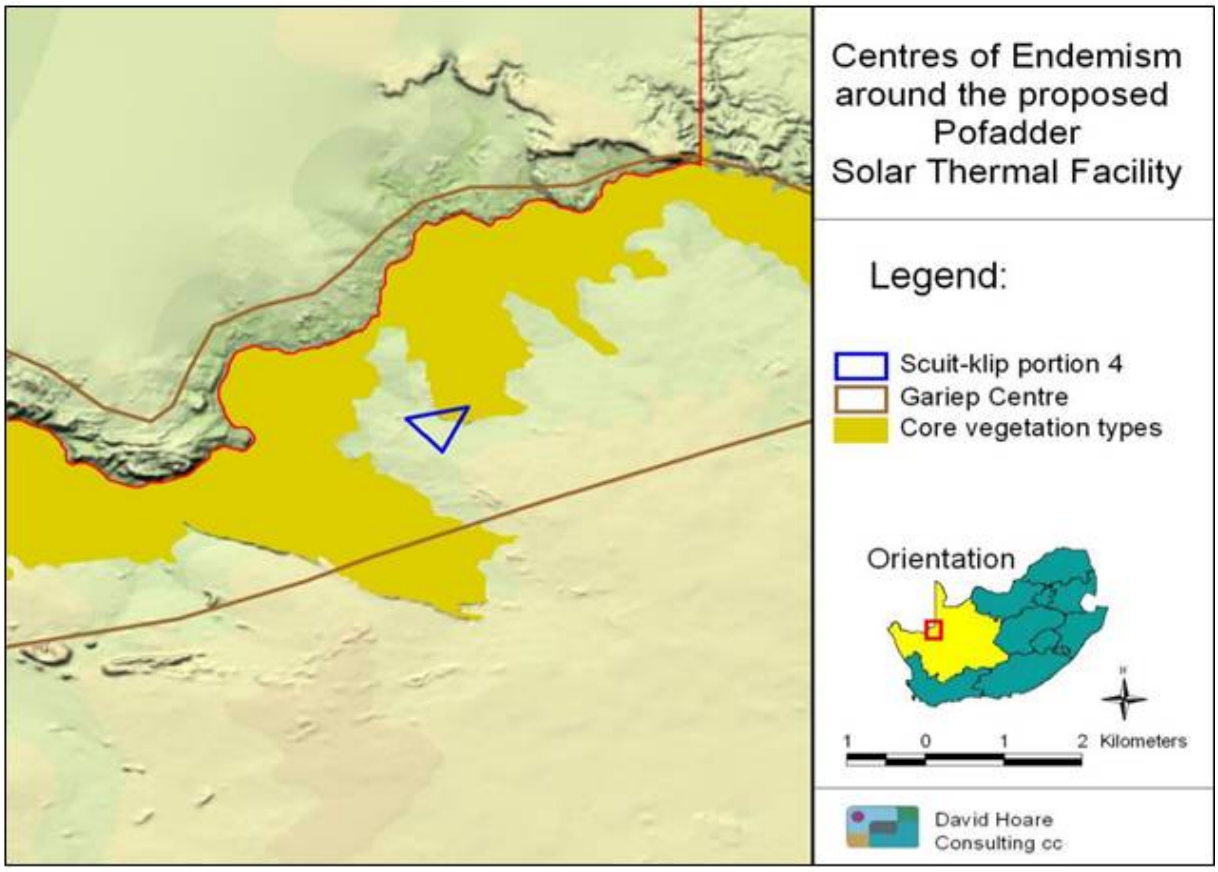


Figure 5.5: Centres of Endemism within the study area

Natural and sensitive habitats on site

The main natural habitats on site are rocky areas, plains, drainage areas, and dunes (Figure 5.6). The rocky areas consist of the large low mountain area in the north-eastern part of the site, a similar but smaller area in the north-western corner and various low koppies scattered around the main rocky areas. The topography in these areas is generally very steep and rocky with very little soil. The plains are relatively flat, but slope towards the drainage lines that traverse the site. There are a few low dune ridges in the western to south-western part of the site.

Sensitive parts of the study area that have high conservation value or that may be sensitive to disturbance include the following:

» Vegetation of conservation importance: this is based primarily on the location of the site within the Gariep Centre of Floristic Endemism.
» Non-perennial watercourses: this represents a number of ecological processes including groundwater dynamics, hydrological processes, nutrient cycling and wildlife dispersal as well as being an important habitat for a number of protected or restricted species.

» Areas classified as mountains, ridges or steep slopes: some of the steeper scarp slopes in the southern portion of the study area are steep enough to be sensitive to erosion and downslope impacts from disturbance or represent links to the mountain chain, an important biogeographical corridor.
» Potential occurrence of populations of red list or protected organisms, including flora and fauna that have been evaluated as having a high chance of occurring within remaining natural habitats within the study area.

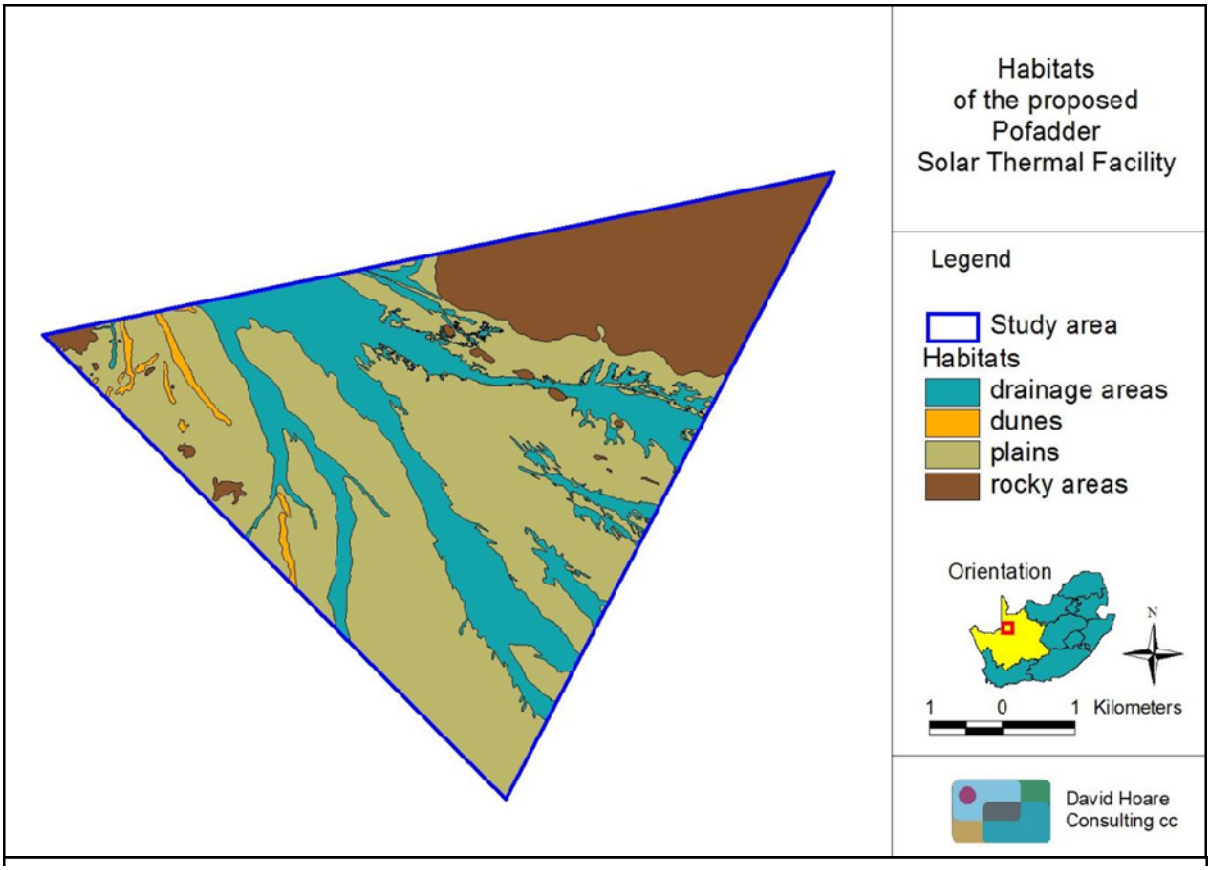


Figure 5.6: Natural habitats within the study area

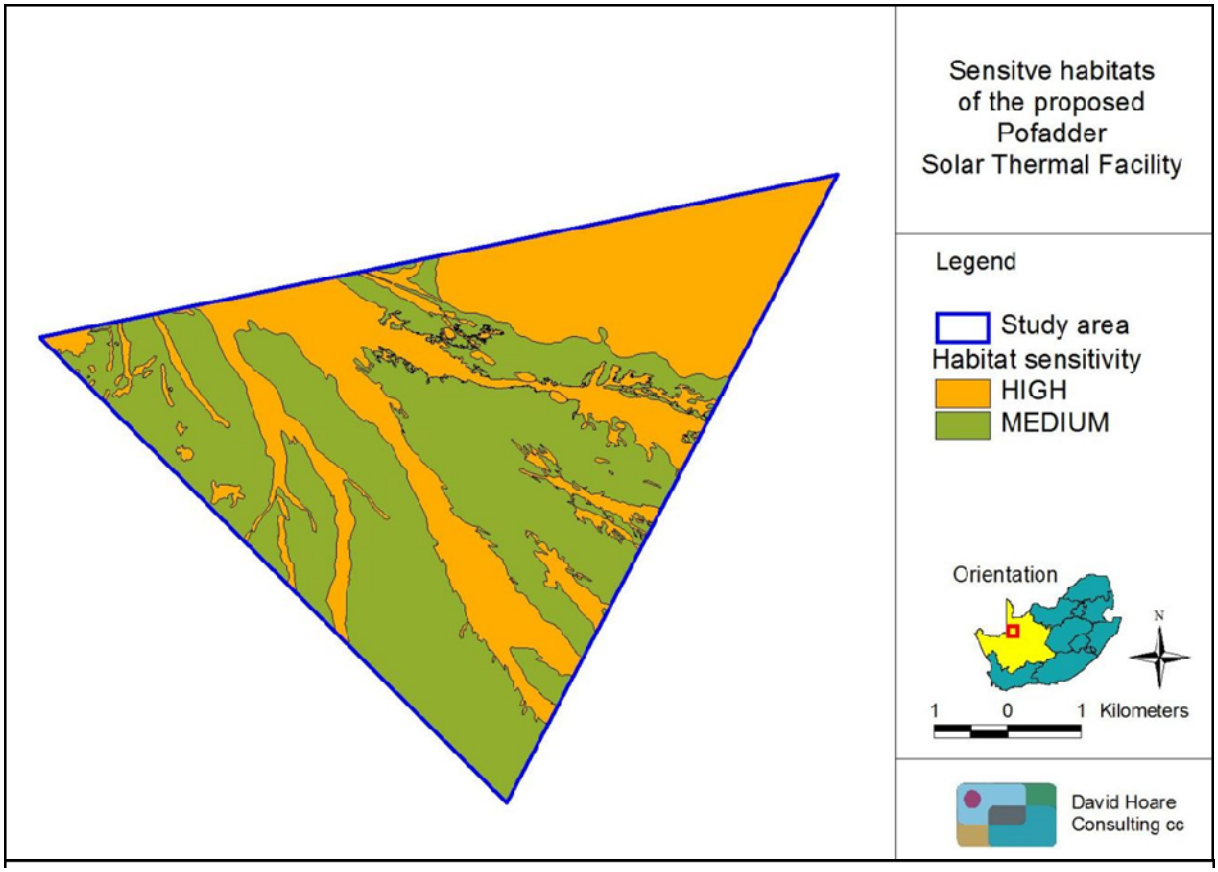


Figure 5.7: Sensitive habitats within the study area

Red Data Species

Ten mammal species of conservation concern could possibly occur within available habitats in the broader study area. This includes one species classified as Endangered (Hartmann's Mountain Zebra), one species classified as Vulnerable (Angolan Wing-gland Bat), four species classified as Near Threatened (Honey Badger, Darling's Horseshoe Bat, Littledale's Whistling Rat and the Dassie Rat), and four species classified as Data Deficient. There is one rare reptile species that has a distribution that includes the study area and which could occur on site (Black Spitting Cobra).

Of the floral species that are considered to occur within the geographical area under consideration, five species could occur in habitats available in the study site. Two of these are listed as Vulnerable, one as Near Threatened, and two as Declining. One of the Vulnerable species, the Quiver Tree, has a high probability of occurring on site as it normally occurs on rocky slopes and could occur anywhere within Lower Gariep Broken Veld (i.e. the hills within the study area) or in rocky areas in Bushmanland Arid Grassland on site (i.e. on the plains within the study area). The Stone Plant, which is also regarded as Vulnerable, is a habitat specialist, occurring in white translucent quartzite patches. This species has a high probability of occurring on site, if available habitat is present. The Near Threatened Cone Plant is found on inselbergs in Bushmanland in vertical rock crevices. If it occurs on the site, it is most likely to be

found in Lower Gariep Broken Veld. The two Declining species, Camel Thorn and a Hoodia species, both have a high probability of occurring on the site. Camel Thorn in particular is a protected tree species which occurs in deep sandy soils, along drainage lines and sometimes on rocky outcrops.

Areas of Conservation Concern

The study site occurs within the Gariep Centre of Floristic Endemism which is located in the north-western corner of the Northern Cape and adjacent parts of Namibia. There are high levels of succulent diversity and endemism in the Gariep Centre, unparalleled by any other arid region of similar size in the world. In some parts of the Centre, endemism may be as high as 25% of species.

Alien Invasive Species

It is not known to what extent the site contains alien plants. Several invasive species have a distribution centred on arid regions of the country. The shrub, Honey Mesquite, is potentially the most problematic as it invades riverbeds, riverbanks and drainage lines in semi-arid and arid regions. There is therefore the potential for alien plants to spread or invade following disturbance on site.

5.2.6 Agricultural Potential

The study area is underlain by two land types namely, **Ag37** (shallow red soils, high base status) and **Ic136** (mostly rock, little soil) (refer to Figure 5.8).

Table 5.1: Land types occurring (with soils in order of dominance)

Land Type	Dominant soils	Depth (mm)	% Land Type	Characteristics	Agric. Potential (%)
Ag37	Hutton 32/25/42/45 Rock Dundee 10 + Oakleaf 24	200-300 - 500-1000	48% 20% 15%	Red, sandy topsoils on hard rock and calcrete - Red-brown, alluvial soils on calcrete	High:0.0 Mod: 23.0 **Low: 77.0**
Ic136	Rock Mispah 10/20	- 50-150	89% 7%	Grey-brown, sandy/loamy topsoils on hard rock/calcrete	High:0.0 Mod: 3.5 **Low: 96.5**

The study area is comprised of shallow to very shallow soils or surface rock outcrops, and only a very small portion of deep soils. The very low rainfall in the area means that the only means of cultivation would be by irrigation and aerial imagery shows no signs of agricultural infrastructure or of irrigation. The climatic restrictions mean that this part of

the Northern Cape is suited at best for grazing and here the grazing capacity is very low, around 40 - 50 ha/large stock unit.

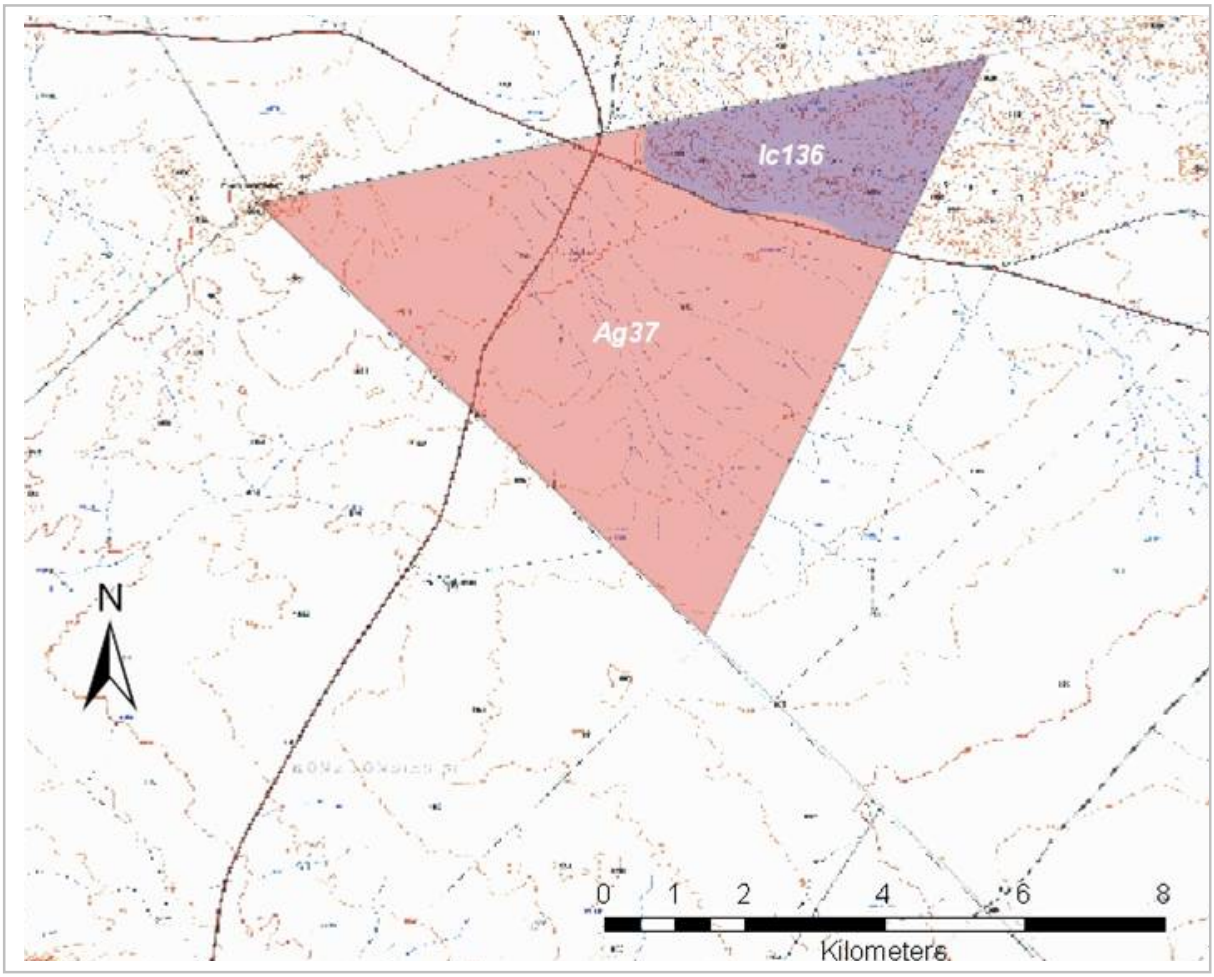


Figure 5.8 Land types within the proposed study area

5.3 Social Characteristics of the Study Area and Surrounds

The proposed project area is located within the Khai Ma Local Municipality within the Northern Cape. This municipality is a category-B municipality[3], which forms part of the greater Namakwa District Municipality (category-C municipality), and is located approximately 614 km west of the provincial capital of Kimberly.

This local municipality is largely rural and agricultural with two urban/semi-urban nodes at Pofadder, the designated administrative centre of the municipality, and Aggeneys. The municipality is approximately 8 332 km² in size (i.e. approximately 7.7% of the Namakwa District Municipality) and is bordered to the north by the Gariep (Orange) River (the border with the Republic of Namibia), by a District Management Area

[3] A category-B municipality is defined as a municipality that shares executive and legislative authority in its area with a category- C municipality within whose area it falls

(NCDMA08, part of the Siyanda District Municipality) to the east, and District Management Area (NCDMA06) to the south, and the Nama Khoi Local Municipality to the west.

5.3.1. Heritage

Colonial Frontier
Conflict at Zwart Modder (the farm adjoining Scuit-Klip) has been recorded, including an isolated grave of a member of the Northern Border Police, which has yet to be relocated. An additional grave is located immediately below the Ysterberg Ridge, located on the Farm Scuit-Klip.

Later Stone Age
Dunn (1872) refers to a place at Schuit Klip (i.e. Scuit-Klip) where water collected following rains and was still available after a year of no rain in the vicinity. At such times competition between groups over resources and stress within an already marginalised hunter-gatherer society, must have intensified.

Pleistocene: Middle and Earlier Stone Age
No substantial sites have been found previously in the survey area. Only very sparse localised scatters of stone tools have been seen in places, with limited traces in the hills or at the bases of hills. There is a roadside grave along one of the access roads in the vicinity; however the area has not been investigated in its entirety.

5.3.2 Social Characteristics[4] of Northern Cape Province

The proposed facility is located in the Northern Cape Province, which is the largest province in South Africa and covers an area of 361,830 $km^{2,}$ and constitutes approximately 30% of South Africa. The Province is divided into five district municipalities (DM), namely, Frances Baard, Karoo, Namakwa, Siyanda, and Kgalagadi DM, twenty-six Category B municipalities and five district management areas.

Population Demographics
Despite having the largest surface area, the Northern Cape has the smallest population (822 727 or 1.8% of the population) of South Africa. The population has declined by 2.1% from 1996 (840 321) to 2001 (822 727), resulting in a decrease in the population density, of an already sparsely populated Province, from 2.32 to 2.27 persons per km^2. Of the five districts, Frances Baard has the largest population of 303 239. The other districts and their respective populations are Siyanda (209 889), Karoo (164 607), Kgalagadi (36 881) and Namakwa (108 111). The population within the Northern Cape can be classified as a young population with 57.7% of the population being younger than

[4] The demographic data used in this chapter is largely based on the 2001 Census.

30 years old. The female proportion makes up approximately 51.2% of the total with males making up the remaining 48.8%.

Education

In terms of education levels, 15.1% of the population has received no formal education, while 71.3% have primary or secondary education. Those with a higher educational qualification accounted for 3.7% of the population.

Economy

The Northern Cape Province has the third highest per capita income of all nine provinces, however, income distribution is extremely skewed, with a high percentage of the population living in extreme poverty. The Northern Cape's share of the country's Gross Domestic Product (GDP) in 2002 was 2%, the lowest contribution of the nine provinces. However, although the Northern Cape Province has the smallest economy of the nine provinces, Gross Domestic Product of the Region (GDPR) per capita is higher than the national average. In terms of economic activities, the economy of Northern Cape is heavily dependent on the primary sectors of the economy, which in 2002 made up 31.0% of GDPR. The largest sector is mining which has declined in contribution to the GDPR from 25.8% in 1996 to 23.7% in 2002. Agriculture, on the other hand, increased in its contribution from 6.2% to 7.3%.

Employment

Of the economically active population in the Northern Cape, 55.5% were employed while 26.1% could not find employment. Significant for this province, however, is that a third of the total population is younger than 15 years old and approximately 45% of the potential labour force is younger than 30 years.

5.3.3 Khai Ma Local Municipality

The proposed site falls within the Khai Ma Local Municipality within the greater Namakwa District Municipality.

Population Demographics

The population the Khai Ma Municipality is estimated at 12 571 and makes up approximately 10% of the total population of the greater Namakwa District Municipality. The main towns of Pofadder and Aggenys account for approximately 64% of the total population, while the remainder of the population is made up of small farming communities. The average population density within the Municipality is very low and is estimated at approximately 1 - 3 people/km^2. The average population growth is estimated at approximately 1%.

Education

Approximately 6.4% of the population has no formal education, while approximately 24% have less than a Grade 7 (i.e. a third of people in this municipality have less than a Grade 7 which is regarded as the minimum education level required for functional literacy and numeracy). Only 14.6% of the population had a Grade 12 (Matric) qualification, while less than 4% had a tertiary qualification.

Employment

Approximately 53% of the population between the economically active age group of 15 - 65 was employed in the formal sector. The agricultural sector provided approximately 18% of the formal employment, followed by the Community services, mining and quarrying sectors, which employed between 5% and 4% of the employed population in the area respectively. The majority of the remainder of employment is characterised as 'undetermined' (i.e. approximately 62%).

5.3.4 Khai Ma Local Municipality – Ward 1

Ward 1 is one of 4 administrative wards that make up the Khai Ma Local Municipality. This ward constitutes approximately 22.5% of the total area with the largest town being Pofadder with a population of approximately 2 935.

Education

Approximately 36.7% of the population aged 15 and older is estimated to be functionally illiterate. Approximately 50% of the population have less than a Grade 7 education whilst 37% have a Grade 12 qualification and just over 3% a tertiary qualification.

Employment

In 2001 approximately 55.4% of the population was employed while the unemployment rate was relatively low at approximately 11%. The largest employer is the agricultural sector which provides approximately 62% of the formal employment in the area. This sector is followed by the wholesale and retail trade sector that employs approximately 9% of the employed population and the community and social Services sector, providing approximately 9%. The other significant formal employment sectors are the construction sector and private households sector which provides approximately 6.5% and 5.2% respectively with the remainder "undefined".

The vast majority of households (i.e. approximately 96%) live on less than the minimum subsistence level (i.e. R1 600 per month). Approximately 4% of household heads were earning an income clustered in the R800 - R3200 per month range.

5.4. Site Specific Land-Use

Portion 4 of the Farm Scuit-Klip, which is owned by a single land owner, will be affected by the establishment of the proposed facility (i.e. the solar array, power island, evaporation ponds, water storage reservoir). This farm portion is currently used for low density sheep farming.

The ancillary infrastructure outside of the site will be located as follows:

» Water abstraction from the Gariep (Orange) River will be at the farm Raap en Skraap located approximately 30 km north of the site (refer to Figure 5.9 and 5.10). The land use of the site is currently intensive commercial agricultural.
» The reservoir/de-gritting dam and the booster pump fall on the farm Styr-Kraal 81 (i.e. 9 km away from the abstraction point). The current land use of this farm is low density agricultural.

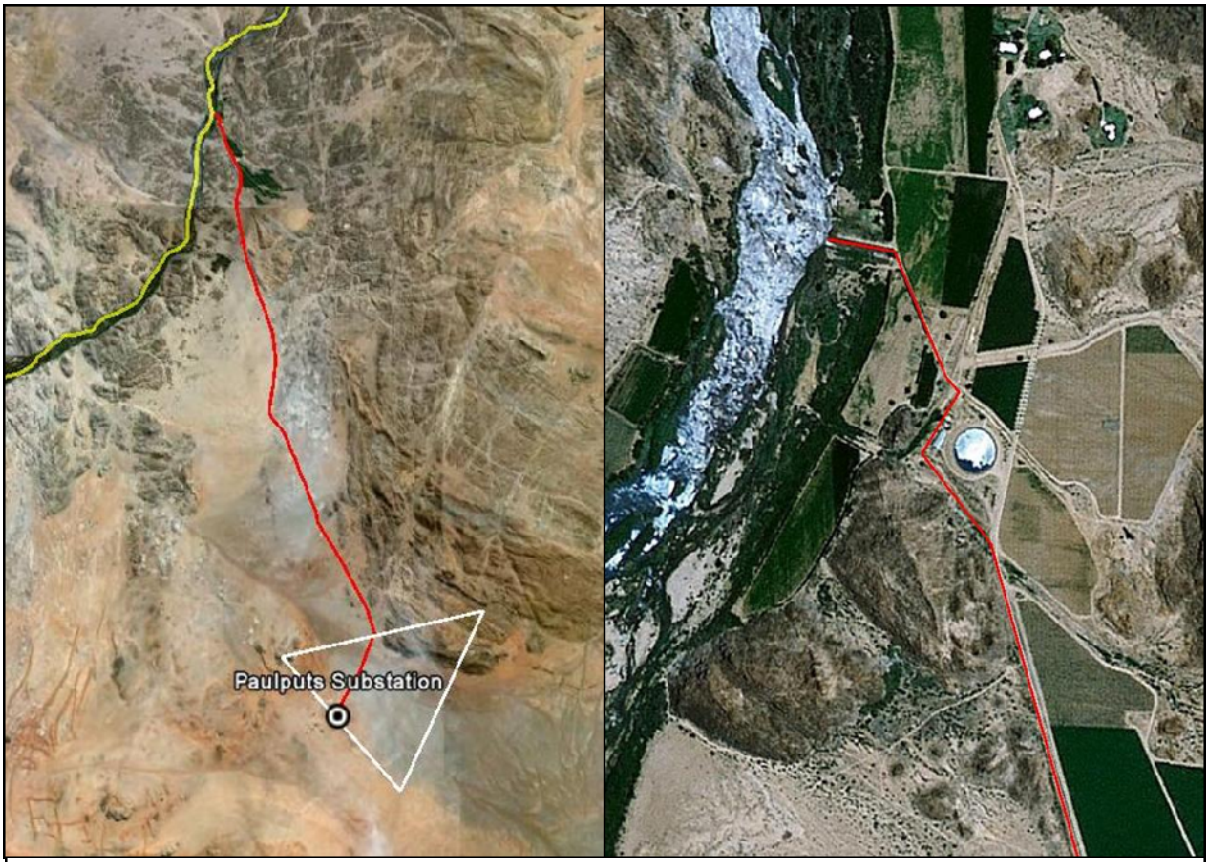


Figure 5.9: Pipeline route and abstraction point at Raap en Skraap (David Hoare Consulting cc, 2010)

Figure 5.10: Man-made channel and upstream berm at the existing site of abstraction at Raap en Skraap.

ASSESSMENT OF IMPACTS: CHAPTER 6
SOLAR THERMAL PLANT & ASSOCIATED INFRASTRUCTURE

The generation of electricity from the proposed Pofadder Solar Thermal Plant will be achieved through the following solar technologies (in any combination):

» **100 MW** to be generated from 80 – 200 loops of parabolic troughs (i.e. to cover a total extent of approximately 200 - 300 ha) with an approximate height of 5 m
» **50 MW** to be generated from a field of heliostats/mirrors (i.e. approximately 4 000 – 6 000 mirrors each approximately 120 m^2, positioned on 6 m high pedestals) positioned around an approximately 200 m high power tower including the receiver (i.e. to cover a total extent of approximately 300 ha)
» **10 MW** to be generated from several rows of PV panels (i.e. to cover a total extent of approximately 50 ha)

In conjunction with the abovementioned solar components, the following associated infrastructural requirements will also be established:

» **Power islands** which will include a steam turbine and generator (i.e. typically housed within a 2-storey building); a generator transformer and a small substation (i.e. located outside and adjacent to the 2-storey building); an auxiliary steam boiler and associated vessels (i.e. fossil fuel boiler/ generator), proposed to be fired by either diesel fuel or liquid petroleum gas (LPG).
» An **overhead power line** feeding into the Eskom electricity network at the Paulputs Transmission Substation, which is situated adjacent to the site.
» An **abstraction point** at the Gariep (Orange) River and an associated water **supply pipeline** to the facility of approximately 30 km in length.
» A **suspension reservoir** located approximately 6 km south of the raw water abstraction point (i.e. outside the boundaries of the identified site) to rid the raw water of particles in suspension (silt).
» A **storage reservoir** located within the boundaries of the identified site. The water stored within the reservoir will be used during the steam generation process (boiler makeup), for washing of the heliostats/mirrors, troughs and PV panels, potable water supply and fire protection supply.
» Lined **evaporation ponds** to allow for the evaporation of process waste water not to be re-used within the facility.
» **External access road** leading to the site from the R358 which branches off the N14 towards Onseepkans.
» **Internal access roads** for construction and maintenance purposes.
» Workshop, office and storage areas.

The establishment of a solar energy facility project is comprised of several phases, including pre-construction, construction, operation, and decommissioning. The **construction activities** involved for the proposed Pofadder Solar Thermal Plant project will include the following:

» Conduct pre-construction surveys;
» Establishment of access roads;
» Undertaking site preparation (i.e. including clearance of vegetation; and stripping of topsoil);
» Transportation of solar components and equipment to site;
» Establishment of construction camps; laydown and hard standing areas (i.e. including storage facilities; batching facilities);
» Assemble and construct solar arrays;
» Construct power island and substation;
» Establish abstraction point; pipeline; storage/treatment facilities and evaporation ponds;
» Connection of the on-site substation to the Eskom grid; and
» Undertake site remediation.

The **operational activities** will include the following:

» The operation of the solar field (parabolic troughs, heliostats and associated power tower, and the PV panels);
» The operation of the power island;
» The abstraction, treatment; pumping and storage of water for use in the CSP system; and
» Site operation and maintenance.

The **decommissioning activities** will include the following:

» Removal of project infrastructure; and
» Site rehabilitation.

The construction and decommissioning activities have the potential to impact on the receiving environment in terms of habitat destruction, disturbance, and alteration; impacts on biodiversity; threatened fauna and flora species; protected tree species and ecological processes; soil degradation; erosion; and increased erosion potential; impacts on heritage sites; impacts on water resources and impacts on the visual aesthetics.

Environmental issues specific to the operation phase of a solar thermal plant include, amongst others visual impacts through the visual dominance of the power tower within the landscape; avian mortality through collisions/electrocutions with the power line; and water quality and quantity related issues.

These and other environmental issues were originally identified through a scoping evaluation of the proposed solar thermal plant. Potentially significant impacts have now been assessed during this EIA Phase. This EIA process has involved key input from specialist consultants, the project developer, and from key stakeholders and interested and affected parties. The significance of impacts associated with a facility of this nature is always project specific, and therefore impacts may vary significantly between facilities.

This chapter serves to assess the identified potentially significant environmental impacts associated with the development of the proposed facility, and to make recommendations for the management of these impacts for inclusion in the draft EMP (refer to Appendix M).

6.1 Methodology for the Assessment of Potentially Significant Impacts associated with the proposed Pofadder Solar Thermal Plant

In order to assess the potential impacts associated with the proposed facility, it was necessary to understand the extent of the affected area. This affected area includes the area infrastructure (i.e. solar fields; power islands; abstraction point; water storage/treatment reservoirs) and linear infrastructure (i.e. the internal and external access roads; the water supply pipeline and the power line).

A broader site of 33 km^2 was originally identified by the project developer for the purposed of establishing the proposed facility, originally anticipated to cover an extent of approximately 11 km^2. During the Scoping Phase assessment a preferred portion within the southern tip of the triangular shaped farm portion was identified based on reduced environmental sensitivities, in comparison to the remainder of the site. This smaller portion is likely to suffer disturbance, particularly during the construction phase, as the establishment and operation of a solar thermal plant generally results in whole-scale disturbance to significant portions of the affected site where infrastructure is located.

From the results of the facility layout determination, it is apparent that the effective utilised area within the identified farm portion is approximately 11 km^2 in extent. This amounts to approximately 25% of the total 33 km^2 originally earmarked for development, and is illustrated in Figure 6.1.

Permanently affected areas within and beyond the farm boundaries are summarised as follows.

Permanent Component –Within the facility	**Approximate extent (in ha)**
Parabolic troughs	500
Heliostats & power tower	300
PV panels	50
Power island	10
Internal access roads [5]	1
Water storage reservoir	0.5
Workshop and storage areas	1.5
TOTAL (ha)	**~ 850** (of a total area of 3 300 ha) **~ 25% of site**

Permanent Component –Outside the facility	**Approximate extent (in ha)**
Water supply pipeline[6]	9
De-gritting reservoir	0.5
Abstraction point[7]	0.1
TOTAL (ha)	**~10**

Temporarily affected areas within the identified farm portion comprise laydown areas for construction equipment, construction camps, temporary storage areas, and a batching plant area are summarised as follows:

Facility Component -Temporary	**Approximate area/extent (in ha)**
Laydown areas	1
Construction camps	0.5
Temporary storage areas	1
Batching plant	0.1
TOTAL	**2.6** (of a total area of 3 300 ha) **= 0.08% of site**

[5] Assuming a maximum length of 2 km and a width of 6 m (0.006 km)
[6] Assuming a length of 30 km and a servitude of 3 m (0.003 km)
[7] Assuming dimensions of 50 m x 20 m

In order to assess the potential impacts that could occur, a site layout was produced, which is illustrated below in Figure 6.1.

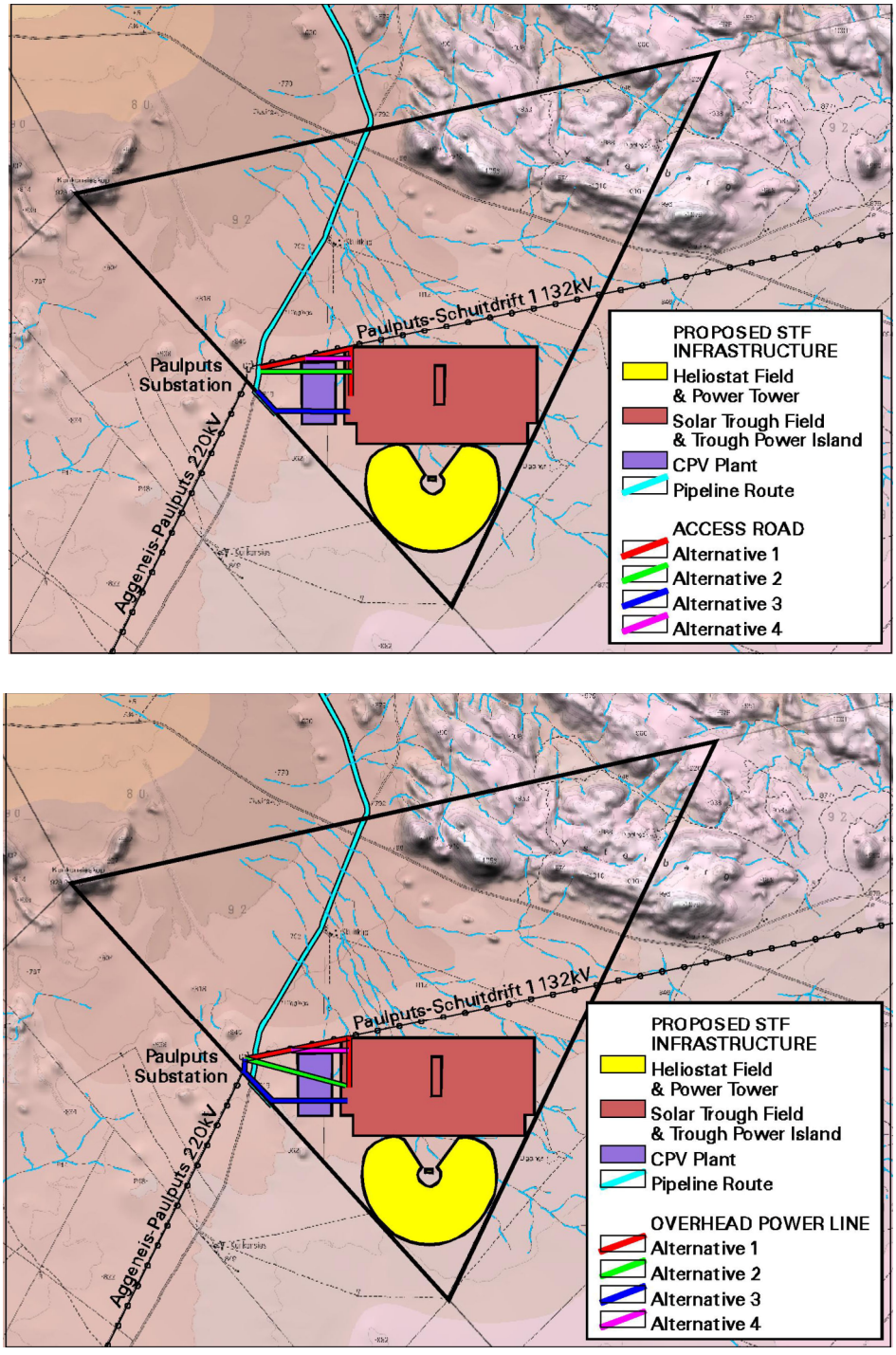


Figure 6.1: Layout map illustrating the provisional layout including the components within the preferred portion as well as the alternative routings for the power line and external access road (to be discussed in Chapter 7)

6.2 Assessment of the Potential Impacts associated with the Construction and Operation of the Proposed Pofadder Solar Thermal Plant on the Identified Site in the Northern Cape

The sections which follow provide a summary of the findings of the assessment undertaken for potential impacts associated with the construction and operation of the proposed solar thermal plant on the identified site. Issues were assessed in terms of the criteria detailed in Chapter 4. The nature of the potential impact is discussed; the significance is calculated with and without the implementation of mitigation measures. Recommendations are made regarding mitigation and management measures for potentially significant impacts and the possibility of residual and cumulative impacts are noted.

6.2.1 Potential Impacts on Ecology

It was concluded that no mammal, reptile, or amphibian species of conservation concern that could occur in available habitats in the study area were present in the proposed development footprint. However, should any individuals occur they are likely to move away during construction and return to nearby natural habitats during operation. It is therefore unlikely that construction of the solar plant will have a significant impact on fauna.

Impacts on vegetation may be both direct and indirect, with direct impacts occurring mostly during the construction phase, and indirect impacts during the operational phase. Clearing activities during the construction phase will lead to direct loss of vegetation which will in turn lead to localised or more extensive reduction in the overall extent of vegetation.

Plant species are especially vulnerable to infrastructure development because they cannot move out of the path of the construction activities. They are also affected by overall loss of habitat. There may be a number of plant species that occur within this area for which there are no records. Populations of Vulnerable *Aloe dichotoma* (i.e. Kokerboom), which were found on site, and are likely to be impacted. None of the other species occur, or are likely to occur, where the proposed infrastructure is planned.

Certain tree species are protected under the National Forests Act (Act No 84 of 1998)[8]. There are protected tree species that have a geographical distribution across the study area, including: Camel Thorn, Grey Camel Thorn, Sheppard's Tree, and Cape Ebony. However, only Shepherd's Tree was actually found on site. This was recorded in the hills

[8] In terms of section 5(1) "no person may cut, disturb, damage or destroy any protected tree or possess, collect, remove, transport, export, purchase, sell donate or in any other manner acquire or dispose of any protected tree or any forest product derived from a protected tree, except under a license granted by the Minister to an (applicant and subject to such period and conditions as may be stipulated".

in the northern part of the site, which will not be affected by the proposed project. Impacts on protected trees will therefore not occur and are scored as zero for infrastructure components. The impact is not evaluated further.

According to the National Water Act (Act No 36 of 1998), the non-perennial drainage lines and watercourses on-site are classified as wetlands or water resources. These drain towards the north-west, are very shallow, and anastamose to a significant degree. The general topography is so shallow that much of the site probably forms part of a general drainage basin. Construction may lead to some direct or indirect loss of or damage to some of these areas or changes to the catchment of these areas. This may affect the hydrology of the landscape.

The health of the ecosystem may also be affected through the establishment and spread of alien invasive species due to disturbance activities in the construction phase. Potential weeds with a distribution centred on arid regions of the country include Prickly saltwort, Lindley's saltbush, Prickly pear, Walking stick cholla, Honey mesquite, Velvet mesquite, Old man saltbush, and Tree tobacco. The shrub, Honey mesquite, is potentially the most problematic as it invades riverbeds, riverbanks and drainage lines in semi-arid and arid regions. There is therefore the potential for alien plants to spread or invade following disturbance on site.

Impact table summarising the significance of impacts on ecology during the construction and operation phases (with and without mitigation) (not including the water supply pipeline)

Nature: Impacts on indigenous natural vegetation The vegetation types on site are Bushmanland Arid Grassland and Lower Gariep Broken Veld, both of which are classified as Least Threatened. The total footprint of the infrastructure (i.e. solar arrays, power islands, ancillary infrastructure, power line, and internal access roads) is insignificant compared to the overall extent of these two vegetation types. Impacts are therefore relevant only at a local scale and will be scored relative to the study area.		
	Without mitigation	***With mitigation***
Extent	Local (1) - Local and surroundings (2)	Local (1) - Local and surroundings (2)
Duration	Medium-term (3) - Permanent (5)	Permanent (5)
Magnitude	Low (4) - Moderate (6)	Low (2) - Moderate (5)
Probability	Definite (5)	Definite (5)
Significance	**Medium (35 - 60)**	**Low (20) - Medium (45 - 55)**
Status (positive or negative)	Negative	
Reversibility	Not reversible	
Irreplaceable loss of resources	Yes	

Can impacts be mitigated	To some extent
Mitigation: Avoid unnecessary impacts on natural vegetation surrounding infrastructure. Impacts should be contained, as much as possible, within the footprint of the construction site.	
Cumulative impacts: Soil erosion, alien invasions may lead to additional loss of habitat that will exacerbate this impact.	
Residual impacts: Some loss of this vegetation type will occur, but this is insignificant relative to the total extent of the vegetation type.	

Nature: Impacts on threatened plant species

Plant species are especially vulnerable to infrastructure development because they cannot move out of the path of the construction activities, but are also affected by overall loss of habitat. One Vulnerable species, (i.e. Kokerboom), was found on site during the field survey and it is likely that there will be impacts on these tree populations.

No individuals of this species were recorded along the route of the proposed power lines or access road alternatives and therefore the impact is scored as zero.

	Without mitigation	***With mitigation***
Extent	Local (1) - Local & surroundings (2)	Local (1) - Local & surroundings (2)
Duration	Medium-term (3) - Permanent (5)	Medium-term (3) - Permanent (5)
Magnitude	Minor (2)	Minor (1)
Probability	Definite (5)	Definite (5)
Significance	**Medium (40)**	**Medium (35)**
Status (positive or negative)	Negative	
Reversibility	Not reversible	
Irreplaceable loss of resource	Yes	
Can impacts be mitigated	Yes	
Mitigation: The affected plants should be rescued and planted at a suitable locality adjacent to the infrastructure where they will not be disturbed further		
Cumulative impacts: The potential loss of habitat, soil erosion, and alien invasions may lead to additional impacts that will exacerbate the impact on the Kokerboom species.		
Residual impacts: No likely residual impacts are expected.		

Nature: Impacts on ecology associated with drainage lines

Construction activities (i.e. for the solar array, ancillary infrastructure, power islands, internal access road, and power line) may affect the hydrology of the landscape. Stormwater and runoff water must be controlled and managed to avoid impacts on watercourses. A permit from the Department of Water Affairs (DWA) is required if there are expected to be any impacts on any wetland or water resources.

	Without mitigation	***With mitigation***
Extent	Local (1) - Local & Surroundings (2)	Local (1) - Local & Surroundings (2)
Duration	Medium (3) - Permanent (5)	Medium (3) - Permanent (5)
Magnitude	Moderate (5) - High (7)	Low (3) – Moderate (5)
Probability	Improbable (2) - Definite (5)	Improbable (2) - Definite (5)
Significance	**Low (14) - Medium (50 - 60)**	**Low (12) - Medium (45 - 55)**
Status (positive or negative)	Negative	
Reversibility	Reversible with effective rehabilitation	
Irreplaceable loss of resource	Yes	
Can impacts be mitigated	To some degree	

Mitigation:

Control stormwater and runoff water.

Obtain a permit from Department of Water Affairs, where necessary, should any wetland or water resource be impacted.

Cumulative impacts:

Soil erosion, alien invasions may all lead to additional impacts on watercourses that will exacerbate the impact on the drainage lines.

Residual impacts:

Despite proposed mitigation measures, it is expected that this impact will still occur to some degree.

Nature: Impacts of the establishment and spread of alien invasive species

The site is not known to harbour alien plants in significant numbers. There is therefore a weak potential for alien trees to spread or become established following disturbance on site. The presence of a diffuse disturbance over a wide area could, however, lead to the spread of species that are present in the area. Watercourses are especially vulnerable to such impacts.

	Without mitigation	***With mitigation***
Extent	Site & surroundings (2)	Site & surroundings (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Moderate (6)	Low (3)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (33)**	**Low (18)**
Status (positive or	Negative	

negative)	
Reversibility	Reversible
Irreplaceable loss of resources	Yes
Can impacts be mitigated	To a degree
Mitigation: Keep disturbance of indigenous vegetation to a minimum. Rehabilitate disturbed areas as quickly as possible following completion of construction activities in an area. Do not translocate soil stockpiles from areas with alien plants. Control any alien plants immediately to avoid establishment of a soil seed bank that would take decades to remove. Establish an ongoing monitoring programme to detect and quantify any aliens that may become established.	
Cumulative impacts: Soil erosion, habitat loss, damage to wetlands and increased frequency of veld fires may all lead to additional impacts that will exacerbate the impact for the spread of alien invasive species.	
Residual impacts: Residual impacts will probably be very low if control measures are effectively applied.	

Impact table summarising the significance of impacts on ecology during the construction and operation phases for the water supply pipeline (with and without mitigation)

Nature: Loss of habitat within indigenous natural vegetation types The vegetation types on site and surrounding areas are Bushmanland Arid Grassland and Lower Gariep Broken Veld, both of which are classified as Least Threatened. The total footprint of the water pipeline is insignificant compared to the overall extent of these two vegetation types. Impacts are therefore relevant only at a local scale and will be scored relative to the study area. In addition, the water pipeline follows an existing road from the site to the Gariep (Orange) River. There are, therefore, not expected to be significant impacts on surrounding natural habitat due to construction of the pipeline.		
	Without mitigation	***With mitigation***
Extent	Local (1)	Local (1)
Duration	Short-term (2)	Short-term (2)
Magnitude	Minor (2)	Minor (2)
Probability	Highly probable (4)	Probable (3)
Significance	**Low (20)**	**Low (15)**
Status (positive or negative)	Negative	
Reversibility	Not reversible	
Irreplaceable loss of resources	Yes	
Can impacts be mitigated	To a small extent	

Mitigation: Avoid unnecessary impacts on natural vegetation surrounding infrastructure. Keep the pipeline as close as possible to the existing road. Impacts should be contained, as much as possible, within the footprint of the construction site. Rehabilitate disturbed areas quickly after construction.	
Cumulative impacts: Soil erosion, alien invasions may lead to additional loss of habitat that will exacerbate this impact.	
Residual impacts: Some loss of this vegetation type will occur, but this is insignificant relative to the total extent of the vegetation type.	

Nature: Damage to watercourses There are various minor watercourses that will be affected by the proposed construction of the pipeline (between the site of the plant and the Gariep (Orange) River). Along its entire length the pipeline will be located next to an existing structure. At the slopes overlooking the Gariep (Orange) River, the habitat is disturbed.	
	Without mitigation
Extent	Local (1)
Duration	Short-term (2)
Magnitude	Minor (2)
Probability	Improbable (3)
Significance	**Low (15)**
Status (positive or negative)	Negative
Reversibility	Reversible with effective rehabilitation
Irreplaceable loss of resources	Yes
Can impacts be mitigated	To some degree
Mitigation: Cross wetlands or drainage lines perpendicularly. Avoid unnecessary impacts on natural vegetation. Impacts should be contained, as much as possible, within the footprint of the proposed watercourse crossing. Obtain a permit from Department of Water Affairs to impact on any wetland or water resource. Rehabilitate any disturbed areas immediately to stabilise landscapes Proper culvert and bridge structures are required for permanent roads.	
Cumulative impacts: No cumulative impacts are expected.	
Residual impacts: Despite proposed mitigation measures, it is expected that this impact will still occur to some degree.	

Nature: Establishment and spread of declared weeds and alien invader plants The site is not known to harbour alien plants in significant numbers. There is therefore a weak potential for alien trees to spread or become established following disturbance on site. The presence of a diffuse disturbance over a wide area could, however, lead to the spread of species that are present in the area. Watercourses are especially vulnerable to such impacts.		
	Without mitigation	***With mitigation***
Extent	Site & surroundings (2)	Site & surroundings (2)
Duration	Long-term (4)	Short-term (4)
Magnitude	Moderate (6)	Low (3)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (33)**	**Low (18)**
Status (positive or negative)	Negative	
Reversibility	Reversible	
Irreplaceable loss of resources	Yes	
Can impacts be mitigated	To some degree	
Mitigation: Keep disturbance of indigenous vegetation to a minimum. Rehabilitate disturbed areas as quickly as possible following completion of construction activities in an area. Do not translocate soil stockpiles from areas with alien plants. Control any alien plants immediately to avoid establishment of a soil seed bank that would take decades to remove. Establish an ongoing monitoring programme to detect and quantify any aliens that may become established.		
Cumulative impacts: Soil erosion, habitat loss, damage to wetlands and increased frequency of veld fires may all lead to additional impacts that will exacerbate this impact.		
Residual impacts: Will probably be very low if control measures are effectively applied.		

Implications for Project Implementation

» The development footprint will not affect any botanical "no go" habitats or areas.
» The overall impacts of the proposed project have been assessed as being of low or medium significance. If mitigation measures are put in place to manage impacts, then most potential impacts can be reduced to having low to medium significance.
» No mammal, reptile, or amphibian species of conservation concern that could occur within available habitats are in the study area, and therefore the site is not considered sensitive in terms of faunal impacts (i.e. excluding avifauna).
» A "Search and Rescue" Plan for the individual Quiver Tree should take place prior to construction.
» A permit would need to be obtained for any protected trees that are affected.

» A permit is required from (DWA) if there are expected impacts on any water resources (i.e. the drainage lines).
» An on-going monitoring programme should be implemented to detect and quantify any aliens that may become established and provide information for the management of aliens.

6.2.2 Potential Impacts on Avifauna

On-site bird communities are not expected to be negatively impacted through habitat loss, disturbance, or through interaction with the solar facility.

Impact tables summarising the significance of impacts on avifauna (with and without mitigation)

Nature: Disturbance and habitat loss
Solar energy facilities often cover a sizeable land area, in this case 11km^2. A certain amount of habitat will be lost during the establishment of the solar farm and the associated infrastructure (including the clearing of land for access roads and the powerline).

The on-site habitat was severely degraded with a corresponding low diversity and density of bird species. Furthermore the amount of habitat that would be lost (i.e. 11 km^2) would be insignificant in the context of availability of similar habitat in the area that the study site is found.

	Without mitigation	***With mitigation***
Extent	Local (1)	Local (1)
Duration	Long term (4)	Long term (4)
Magnitude	Minor (2)	Small (0)
Probability	Highly probable (4)	Highly probable (4)
Significance	**Low (28)**	**Low (20)**
Status (positive or negative)	Negative	
Reversibility	Possible	
Irreplaceable loss of resources	None	
Can impacts be mitigated	Yes	

Mitigation:
Development in the north-eastern area of the site should be minimised.
The minimum amount of vegetation on site should be cleared.
The diversity and abundance of bird species was far greater in the drainage channels as opposed to the open plains. Where possible as much of this habitat should be kept intact.
If possible the servitude of the power line exiting the site should follow existing roads where possible and should not cut across habitat.
Concerning the four alternative access roads and the amount of habitat loss, there is a minimal amount of difference in terms of impact on bird communities and therefore it is recommended that Alternative A, the shorter route, be preferred.

All construction and maintenance activities must be undertaken in accordance with Eskom Transmission's Environmental Best Practise Standards. All construction activities and access roads should be restricted as much as possible.

Cumulative impacts:

The quality (degraded) as well as the amount of habitat (11 km^2) that would be lost in the context of the amount of similar habitat in the region means that the cumulative habitat would be negligible.

Residual impacts:

No residual impacts are expected.

Nature: Impact on local bird community due to collision with the facility

There are two types of collision events that may occur, namely collisions with the PV panels, heliostats, parabolic troughs, and power tower and collisions with the power line.

The impact of collisions with the solar arrays is likely to be minimal. However, in South Africa, bird collisions with power lines are a major form of unnatural mortality amongst several threatened species as well as other species (Jenkins, Smallie, and Diamond 2010). Unfortunately, the majority of species that are susceptible to collision tend to be long lived, slow reproducing species such as bustards, cranes, korhaaans, and different species of waterbird. All of these species utilise waterways as flyways and the proximity of the Gariep (Orange) River exacerbates the likelihood of interaction with power lines. Due to the slow reproductive nature of the species most likely to be collision suspects, long-term mortalities caused by collisions with power lines could have a high likelihood on future population's abilities to be able to sustain themselves.

	Without mitigation	***With mitigation***
Extent	Local (1)	Local (1)
Duration	Long term (4)	Long term (4)
Magnitude	Low (4)	Low (4)
Probability	Improbable (4)	Improbable (2)
Significance	**Medium (36)**	**Low (10)**
Status	Negative	
Reversibility	Possible	
Irreplaceable loss of resources	None	
Can impacts be mitigated	Yes	

Mitigation:

An appropriate bird deterrent device is placed at locations around the facility to lessen this impact, where required. Additional mitigation options considered included reviewing the placement of proposed new lines, or else fitting the earth wire with a type of marker where necessary as opposed to the conductors).

The line should be kept as low as possible taking into account engineering and legal requirements.

The span lengths should be kept as short as possible taking into account engineering and legal requirements.

Placement of a sufficiently large form of marker which will increase the visibility of the wire

where necessary. There remains considerable uncertainty about the best performing marking device.
The marker should be placed with sufficient regularity where deemed necessary.

Cumulative impacts:
There are existing power lines in the area as well as on the site. The length of the proposed power line is 2 km and it is unlikely that this will add significantly to the cumulative impact of power lines collisions in the region.

Residual impacts:
No residual impacts are expected.

Nature: Impact on local bird communities due to electrocution events
The design has allowed for a 132 kV power line feeding into the existing Eskom Paulputs Transmission Substation, which lies immediately to the west of the site. Electrocution events refer to scenarios whereby a bird perches on an electrical structure and causes an electrical short circuit by bridging the gap between live components and or live and earthed components. The larger transmission lines from 220kV to 765kV upwards are not a threat to large raptors and other birds which are vulnerable to electrocution and in a number of cases have proved to be beneficial by providing roosting and nesting sites.

	Without mitigation	***With mitigation***
Extent	Local (1)	Local (1)
Duration	Long term (4)	Long term (4)
Magnitude	Moderate (6)	Minor (2)
Probability	Distinct possibility (4)	Improbable (2)
Significance	**Medium (44)**	**Low (14)**
Status	Negative	
Reversibility	Possible	
Irreplaceable loss of resources	None	
Can impacts be mitigated	Yes	

Mitigation:
!KaXu CSP indicated that it is planned to utilise the mono pole bird friendly structure which will significantly minimise the number of electrocutions on the power lines.

Cumulative impacts:
There are a number of power lines near Pofadder as well as throughout the Northern Cape. The length of the proposed power line is 2km; it is unlikely that this will add significantly to the cumulative impact of electrocution events in the region.

Residual impacts:
No residual impacts are expected.

Nature: Impact of bird pollution on the power line
A streamer is when a bird defecates and releases a stream of faeces which creates an air gap intrusion between the conductor and the earthed structure. The fault appears to flash across the air gap (i.e. between the live conductor and the tower steelwork which is earthed) and does not follow an insulator creepage as observed on pollution faults. Species which create streamers

large enough to create this type of situation are typically large species such as vultures, raptors, and herons.		
	Without mitigation	***With mitigation***
Extent	Local (1)	Local (1)
Duration	Long term (4)	Long term (4)
Magnitude	Moderate (6)	Moderate (4)
Probability	Highly probable (4)	Improbable (2)
Significance	**Medium (44)**	**Low (18)**
Status	Negative	
Reversibility	Yes	
Irreplaceable loss of resources	None	
Can impacts be mitigated	Yes	
Mitigation: !KaXu CSP has indicated that it intends to utilise the Eskom mono pole bird-friendly structure similar to the design already found on site. The design of the tower needs to incorporate perch deterrents in the area directly above the insulator strings to ensure that bird species are not given the opportunity to defecate on the string.		
Cumulative impacts: N/A		
Residual impacts: N/A		

Nature: Species capable of nesting on the infrastructure Certain structures have proven to be beneficial to certain raptors by providing roosting and nesting sites in areas where natural alternatives are scarce. In the case of the proposed facility, there are two areas of concern namely of species nesting on transmission tower structures and then nesting on the solar infrastructure itself. This is especially true in the Northern Cape where there is a lack of suitable sites. Species, such as Martial Eagle, are known to be restricted by suitable nesting opportunities and are known to utilise tower structures.		
	Without mitigation	***With mitigation***
Extent	Local (1)	Local (1)
Duration	Long term (4)	Long term (4)
Magnitude	Minor (2)	Small (0)
Probability	Definite (5)	Probable (3)
Significance	**Medium (35)**	**Low (15)**
Status	Negative	
Reversibility	Yes	
Irreplaceable loss of resources	None	
Can impacts be mitigated	Yes	
Mitigation: A procedure for the removal of nests must be written into the operating manual for the facility.		

The project proponent will be required to apply to the Northern Cape Provincial Department for a permit in order to relocate the nests of Sociable Weavers and White Browed Sparrow Weavers, where necessary.
Cumulative impacts: N/A
Residual impacts: N/A

Implications for Project Implementation

» The most significant threat to bird communities would be from collisions with the overhead powerline. However, it should be noted that due to the relatively short length of the proposed power line, this impact will be minimal.
» The site is not located in an area of high bird traffic (i.e. near riverbeds, wetlands, or valleys etc). Therefore, the loss of habitat, disturbance, or any interaction with the facility is unlikely to negatively affect bird communities in the area.
» Provided the recommended mitigation measures are employed, the construction and operation of the facility is unlikely to negatively affect local bird communities or Species of Special Concern occurring in the region.

6.2.3 Potential Impacts on Geology, Soils and Erosion Potential

The proposed construction activities will include excavation, loosening, displacement and/or burial of soil, stockpiling, mixing, wetting, filling and compaction of soil and soil pollution with chemicals (i.e. fuel, oil and cement). These activities may negatively affect the soil profile, contributing to soil degradation and possibly accelerated erosion[9]. These activities could also cause negative indirect impacts such as increased siltation in other areas away from the site causing negative impact on water sources and agriculture with potential socio-economic repercussions.

Impact tables summarising the significance of impacts on geology, soil, and erosion potential (with and without mitigation)

Nature: Soil/rock degradation through the removal of soil/rock; site clearing; soil mixing; cut-and-fill operations; soil compaction; stockpiling; and dumping of soil The proposed activities may affect soil forming processes and/or local geology. However, these impacts are unlikely to be significant as site clearing; soil mixing; cut-and-fill operations; soil compaction; stockpiling; and dumping of soil will be limited to the construction phase. Furthermore, the majority of the proposed structures will not involve excavations deeper than 1 – 2 m.		
	Without mitigation	***With mitigation***
Extent	Local (1)	Local (1)

[9] The Erosion Index for South Africa indicates that the area where the site is located has a moderate to low susceptibility to erosion, primarily due to the very dry climate.

Duration	Medium term (3) - Permanent (5)	Very short term (1) - Medium term (3)
Magnitude	Low (4) – Moderate (6)	Minor (2) – Low (4)
Probability	Definite (4)	Definite (4)
Significance	**Moderate (32 - 44)**	**Low (24) – Moderate (32)**
Status (positive or negative)	Negative	
Reversibility	Partially reversible	
Irreplaceable loss of resources	Yes, but low	
Can impacts be mitigated	Yes, to a certain extent	
Mitigation: Topsoil can be replaced over foundations, where practical. Keep to existing roads/tracks, where practical, to minimise impact on undisturbed ground. Plan access roads and platforms in order to minimise impact on drainage lines. Minimise size of disturbance areas and restrict construction activity within these areas. Plan soil embankments with max slope of 1:2 to allow for rehabilitation and or use erosion control measures where necessary. Restrict temporary stockpiles to certain areas. No permanent dumping on site other than approved filling operations. Rehabilitate soil and vegetation in areas of activity.		
Cumulative impacts: The cumulative impact of topsoil removal and burial is considered low due to the limited extent of the activity and the dearth of development in the area. The cumulative impact of site clearing, soil mixing, etc. is considered low due to the limited extent of the activity and the relative lack of development in the area. The cumulative impact of stockpiling or dumping from all development in the area is considered low if mitigating measures are adopted.		
Residual impacts: Residual impacts are expected to be minor due to the slow regeneration of topsoil.		

Nature: Soil degradation through down-slope deposition Down-slope deposition may affect soil forming processes and siltation of watercourses and dams. The increased siltation downstream may have a knock-on potential socio-economic impact resulting from the degradation of agricultural land.		
	Without mitigation	***With mitigation***
Extent	Local (1)	Local (1)
Duration	Permanent (5)	Permanent (5)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (4)	Probable (3)
Significance	**Moderate (48)**	**Low (30)**
Status	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources	Yes	

Can impacts be mitigated	Yes, to a certain degree
Mitigation: Minimise aerial extent of construction disturbance areas. Minimise uncontrolled surface run-off or the discharge of construction water. Install anti-erosion measures such as silt fences in disturbance areas.	
Cumulative impacts: The cumulative impact of siltation from all development in the area is considered low if mitigating measures are applied diligently.	
Residual impacts: Minor residual impacts are expected in terms of localised movement of soil across the site.	

Nature: Soil degradation through pollution, salinisation, acidification or water-logging of natural soil

Soil pollution etc which may affect soil forming processes, is expected to occur during the construction phase, predominantly because of the presence of vehicles and construction equipment.

	Without mitigation	***With mitigation***
Extent	Local (1)	Local (1)
Duration	Medium term (3)	Short term (2)
Magnitude	Low (4)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Low (24)**	**Low (21)**
Status (positive or negative)	Negative	Negative
Reversibility	Irreversible	Reversible
Irreplaceable loss of resources	Yes	Yes, minor
Can impacts be mitigated	Yes	

Mitigation:

Minimise disturbance areas.
Maintain good housekeeping practices in terms of spills remediation.
Implementation of a storm water management plan.
Chemicals, fuel, and cement only to be used in approved areas.
Rehabilitate soil and vegetation after construction.
Spoil from excavations must not be haphazardly dumped on site. Spoil material should be removed from site.

Cumulative impacts:

Cumulative impact of soil pollution from all development in the area is considered low if mitigating measures are applied diligently.

Residual impacts:

Minor negative residual impacts are expected due to the slow regeneration of vegetation and soil.

Nature: Soil erosion due to construction activities		
Soil erosion concerns will be greatest along drainage lines where run-off is concentrated and hydraulic energy is potentially high. Areas where loose, unconsolidated sandy soils of low plasticity (i.e. Quaternary sandy soils) occur also tend to be more susceptible to erosion following heavy downpours, and this includes most of the proposed site. Localised occurrences of hard, resistant bedrock or calcrete duricrust will tend to limit erosion. In addition to this, areas where vegetation is limited or has been disturbed or damaged due to construction activity will be also more susceptible to erosion following heavy downpours.		
	Without mitigation	***With mitigation***
Extent	Local (1)	Local (1)
Duration	Medium term (3)	Very short term (1)
Magnitude	Moderate (6)	Low (4)
Probability	Highly probable (4)	Probable (3)
Significance	**Moderate (40)**	**Low (18)**
Status (positive or negative)	Negative	
Reversibility	Irreversible	
Irreplaceable loss of resources	Yes	
Can impacts be mitigated	Yes	
Mitigation: Minimise aerial extent of construction/disturbance areas. Minimise activity in high erosion-sensitive areas. Implement effective erosion control measures. Stage construction in phases, where practical, to minimise exposed ground. Keep to existing roads, where practical, to minimise impact on undisturbed ground. Ensure stable slopes of stockpiles/excavations to minimise slumping.		
Cumulative impacts: The cumulative impact of soil erosion from all development in the area is considered low if mitigating measures are adhered to.		
Residual impacts: The residual impacts are expected to be minor due to the localised movement of sediment and the slow regeneration of soil processes.		

Implications for Project Implementation

» The natural drainage lines/watercourses on the site are regarded as highly sensitive as they comprise fine-grained alluvial and aeolian soils which are sensitive in terms of erodibility potential. Some infrastructure and roads are sited near or across these drainage lines. Special engineering designs such as culverts, river training, etc. may need to be considered to minimise impact on these watercourses and to prevent obstructions in the site drainage. These are regarded as no-go areas without the implementation of mitigation measures.
» Areas underlain by Quaternary sands on the site are regarded as moderately sensitive as erosion of loosened, exposed sand is likely to occur during heavy

downpours or due to concentrated discharge of construction water. The presence of shallow calcrete or bedrock will have limiting effect. Normal mitigating measures apply to these areas.

» Areas underlain by calcrete and basement rocks are regarded as having a low sensitivity as these may help to reduce the erosion potential. However this is difficult to quantify without detailed geotechnical information.

» The direct impacts are likely to be moderate to low and the cumulative significance of all the potential impacts on the geological environment is considered low due to the limited scale of the development and the rarity of development in the immediate surrounding area. With effective implementation of mitigating measures the impacts identified above can be reduced to a low level.

6.2.4 Potential Impacts on Water Resources

From a habitat and ecosystem point of view, the dry river beds and associated riparian systems in the study area would be rated as sensitive to development, particularly the mainstem systems, which flow from the northern boundary of the site.

The riparian vegetation structure and plant species diversity was found in a degraded state due to the lack of large natural surface flows and the high degree of grazing and other anthropogenic impacts. Therefore the site selected for the development footprint would have a limited impact on the structure and functioning of the riparian zones, both locally and within the region.

Nature: Loss of riparian systems The physical removal of the narrow strips of woody riparian zones, being replaced by hard engineered surfaces. This biological impact would however be localised, as a large portion of the remaining farm would remain intact. The overall structure and diversity of these zones was also found to be undefined and low respectively.		
	Without mitigation	***With mitigation***
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Low (24)**	**Low (24)**
Status (positive or negative)	Negative	
Reversibility	Yes	
Irreplaceable loss of resources	No	
Can impacts be mitigated	Yes	
Mitigation: The most significant form of mitigation would be to select a development area, which contained no drainage lines. However due to the nature of the site, this was not possible, thus an area		

with the least number of riparian systems was earmarked, i.e. the southern portion of the site. This area is also a significant distance from the main drainage systems, and is thus unlikely to be flooded or in itself pose a risk to the aquatic systems should there be any major spills (coolants).
Cumulative impacts:
No cumulative impacts are expected.
Residual impacts:
Possible impact on the remaining catchment due to changes in run-off characteristics in the development site.

Nature: Impact on dry riverbeds and localised drainage systems

The physical removal of narrow strips of woody riparian zones being replaced by hard engineered surfaces could alter the hydrological nature of the area, by increasing the surface run-off velocities, while reducing the potential for any run-off to infiltrate the soils. This impact would however be localised, as a large portion of the remaining farm and the catchment would remain intact.

	Without mitigation	***With mitigation***
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Low (24)**	**Low (24)**
Status (positive or negative)	Negative	
Reversibility	Yes	
Irreplaceable loss of resources	No	
Can impacts be mitigated	Yes	

Mitigation:

The most significant form of mitigation would be to select a development area which contained no drainage lines. However due to the nature of the site, this was not possible, thus an area with the least number of riparian systems was earmarked, i.e. the southern portion of the site. Any stormwater within the site will 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, trap sediments, and reduce flow velocities.

Cumulative impacts:

The increase in surface run-off velocities and the reduction in the potential for groundwater infiltration are unlikely to occur, considering that the site is not near the main drainage channel, and the annual rainfall figures are low.

Residual impacts:

Diversion of run-off away from downstream systems is unlikely to occur as the site is not near the main drainage channel and the annual rainfall figures are low.

Nature: Impact on riparian systems through the possible increase in surface water runoff on riparian form and function

Due to the distance between the site and the Gariep (Orange) River (i.e. approximately 30 km), there is a limited risk of any direct impact on the river. The sandy, porous nature of the soil at this locality and the absence of streams or even major drainage lines, indicates that apart from the possible pollution of groundwater, the risk of contaminated run-off from the solar facility reaching the river itself is remote.

	Without mitigation	***With mitigation***
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (2)	Low (2)
Probability	Definite (5)	Probable (3)
Significance	**Medium (35)**	**Low (19)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources	No	No
Can impacts be mitigated	Yes	

Mitigation:

Any stormwater 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, trap sediments, and reduce flow velocities (e.g. water used when washing the mirrors).

The project should also try capture and recycle any form of run-off created by the daily operations. This would minimise the amount of water required by the project, but also serve to limit the downstream impacts on the riparian systems through an increase in run-off, a situation that these riparian systems are currently unaccustomed too.

Cumulative impacts:

Downstream alteration of hydrological regimes due to the increased run-off from the area.

Residual impacts:

Possible impact on the remaining catchment due to changes in run-off characteristics in the development site.

Nature: Increase in sedimentation and erosion within the development footprint

There is a risk of elevated sediment input into the Gariep (Orange) River during the establishment of the water abstraction facilities on the banks and floodplains of the river. However, the abstraction facilities already in place at Raap en Skraap will be used with minor modifications, meaning that the risk of sediment input due to infrastructural changes at the abstraction point will be minimal. Sediment-laden runoff from the proposed site of the solar power facility reaching the river is unlikely due to the distance between the site and the river.

	Without mitigation	***With mitigation***
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (1)	Low (1)
Probability	Probable (3)	Probable (3)

Significance	**Low (18)**	**Low (18)**
Status (positive or negative)	Negative	
Reversibility	Yes	
Irreplaceable loss of resources	No	
Can impacts be mitigated	Yes	
Mitigation: Any stormwater within the site will 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, trap sediments, and reduce flow velocities (e.g. water used when washing the mirrors).		
Cumulative impacts: Downstream erosion and sedimentation of the downstream wetland / dam area and canal system of the Raap en Skraap / Onseepkans agricultural operations. During flood events, the unstable banks (eroded areas) and sediment bars (sedimentation downstream) already deposited downstream will then be washed into the river.		
Residual impacts: During flood events, the unstable banks (eroded areas) and sediment bars (sedimentation downstream) deposited downstream could be washed into the river.		

Nature: Physical disturbance by the supporting infrastructure (pump stations) on the riparian environment
Poor planning and design of abstraction infrastructure and new flood protection measures on the floodplain may result in bank erosion or slumping to occur during river flooding events. However, abstraction modification will be minor, thereby negating the potential impact of this activity. The proposed pipeline route will have limited to no impact on the functioning of any riparian systems.

	Without mitigation	***With mitigation***
Extent	Local (Low 1)	Local (Low 1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (3)	Low (3)
Probability	Probable (3)	Probable (3)
Significance	**Low (24)**	**Low (24)**
Status (positive or negative)	Negative	
Reversibility	Medium	
Irreplaceable loss of resources	No	
Can impacts be mitigated	Yes	
Mitigation: The placement of pump inlets and the supporting infrastructure to prevent the potential for scour / erosion and downstream sedimentation of the river. The developer will also make use of the pumping systems already in place at Raap en Skraap, and the Department of Water Affairs research station.		

Cumulative impacts: Additional downstream erosion and sedimentation of the Gariep (Orange) River from the potential impacts along the pipeline.
Residual impacts: Residual impacts are expected in terms of interruption in surface water flows by the roads and pipelines.

Implications for Project Implementation

» With suitable mitigation and implementation of the proposed layout, the development should have limited impact on the overall status of the riparian systems within the region.
» Impacts on the Gariep (Orange) River system due to water abstraction, and site-specific impacts on in-stream biota are difficult to quantify due to the number of unknowns and the highly regulated nature of the system. The desktop assessment of the potential impacts of the proposed facility on the fish biota of Gariep (Orange) River also did not reveal any significant impacts on the fish fauna and associated aquatic habitats, provided the appropriate mitigation measures are implemented.
» All impacts, apart from the moderate impact of water abstraction from the Gariep (Orange) River, that were assessed as being of moderate significance can readily be reduced to a low significance rating through the implementation of appropriate mitigation measures.
» The moderate impact of water abstraction from the Gariep (Orange) River cannot be mitigated.
» Although the volume does not seem to be prohibitive, water use can be reduced by implementing alternative operational processes, e.g. dry cooling, as suggested by the Department of Water Affairs. This impact may represent a significant financial implication to the development, as tariffs proposed under the REFIT only cater for wet cooling currently.

6.2.5 Assessment of Potential Impacts on Heritage Sites

The terrain close to hills or rocky features, particularly sandy spots near sheltering rocks, may tend to have traces of pre-colonial Stone Age occupation/activity (such a site was previously documented on the adjoining farm Zwart Modder). While open plains have been found to have sparsely scattered artefacts (such as at Konkonsies near the Paulputs Substation), these areas are expected to be less significant for the proposed study site. As an exception, rocky outcrops which may have provided depressions for water collection may prove to be more significant. Such places often attracted people in the past with traces of this including artificial grinding grooves in the bedrock and ample evidence of stone artefacts and pottery (i.e. at Schuitdrift South). The name Scuit-Klip may refer to such a locale on this property, though not necessarily in that portion selected for the present project. The sand dunes in the north-western region of the study site may also have been a focus for past human occupation. Colonial era sites or

features within the study area include the known road-side grave below Ysterberg, a presently unknown grave of a member of the Northern Border Police (near Zwart Modder), and a farm cemetery and homestead/kraal ruins at the old Skuit-Klip farm between the study area and Zwart Modder. Strauss and Esterhuizen family graves in the cemetery date between 1914 and 1974.

Impact tables summarising the significance of impacts on heritage resources (with and without mitigation)

Nature: Impacts on heritage resources

Acts or activities resulting in disturbance of surfaces and/or sub-surfaces containing artefacts (causes) resulting in the destruction, damage, excavation, alteration, removal or collection from its original position (consequences), of any archaeological material or object (what affected).

These potential impacts would tend to be direct, once-off events occurring during the initial construction period. In the long term, the proximity of operations in a given area could result in secondary indirect impacts resulting from the movement of people or vehicles in the immediate or surrounding vicinity. Certain activities would generally have a lower impact than others (i.e. power lines tend to be less destructive on Stone Age sites than access roads).

	Without mitigation	***With mitigation***
Extent	Local (1)	Local (1)
Duration	Permanent (5)	Short (1)
Magnitude	High (8)	Low (4)
Probability	Improbable (2)	Improbable (1)
Significance	Low (**28**)	Low (**6**)
Status	Negative	Negative
Reversibility	No	No
Irreplaceable loss of resources	Yes, where present – but occurrence is extremely low density and of low significance.	
Can impacts be mitigated	Yes – but not considered necessary.	

Mitigation:

Artefact densities are close to zero over the development footprint and along the pipeline route. So much so that mitigation measures are not considered necessary in most instances unlike biological processes, heritage destruction generally has a once-off permanent impact and in view of this the figures given in the "Without mitigation" column err on the side of caution. Even so, the criteria for significance indicated in this matrix give a Low significance weighting (<30 points). Mitigation measures are not considered necessary.

Cumulative impacts:

Where any archaeological contexts occur the impacts are once-off permanent destructive events.

Residual impacts:

No residual impacts are expected.

Implications for Project Implementation

» Very sparse heritage traces were found on the site and from an archaeological perspective the observed heritage resources may be regarded as being of generally low significance.
» In the event of archaeological materials being present such activity would alter or destroy their context (even if the artefacts themselves are not destroyed, which is also obviously possible).
» In the event that such resources are found, they are likely to be of a nature that potential impacts could be mitigated by documentation and/or salvage following approval and permitting by the South African Heritage Resources Agency and, in the case of any built environment features, by Ngwao Boš wa ya Kapa Bokone (the Northern Cape Heritage Authority).

6.2.6 Potential Visual Impacts

Potential visual impacts associated with the construction phase
The construction phase will last for approximately 2 – 3 years; however this is dependent on several external factors. During this time construction related traffic (i.e. in terms of traffic and construction workers) will frequent the area and may cause a visual nuisance to other road users and landowners in the area.

Potential visual impacts associated with the operational phase
During the operational phase, the facility (i.e. primarily the power tower) will be visible. Other ancillary infrastructure (i.e. the 2 story generator buildings, the substation, the settlement and storage reservoirs, the blow down pond, the internal roads, the office and the workshop) will generally be overshadowed by the much taller power tower). The results of the viewshed analyses in Figure 6.2 show the potential visual exposure of the facility. This figure illustrates the core area (primary visual catchment) of potentially uninterrupted exposure of the facility as contained within a 16 km buffer zone. It is envisaged that the proposed facility (i.e. the 200m high power tower) would be easily and comfortably visible, especially within a 16 km radius of the site and the power tower in particular, would constitute a high visual prominence, potentially resulting in a high visual impact. It should be noted, however that the nature of the impact is subjective. This means that some visual receptors may consider the visual impact to be positive rather than negative, depending on their frame of reference and their intention for visiting the area (for example if they are in the region with the purpose of visiting the facility, they might see the visual prominence as a positive thing).

The majority of potentially uninterrupted exposure will occur with the 0 – 4 km zone which equates to a short distance view where the solar facility (i.e. primarily the power tower) would dominate the frame of vision and constitute a very high visual prominence (refer to Figure 6.3). Visibility beyond the 16 km mark equates to a long distance

exposure where the power tower would still be visible, though not as easily recognisable, and this zone would constitute a medium visual prominence.

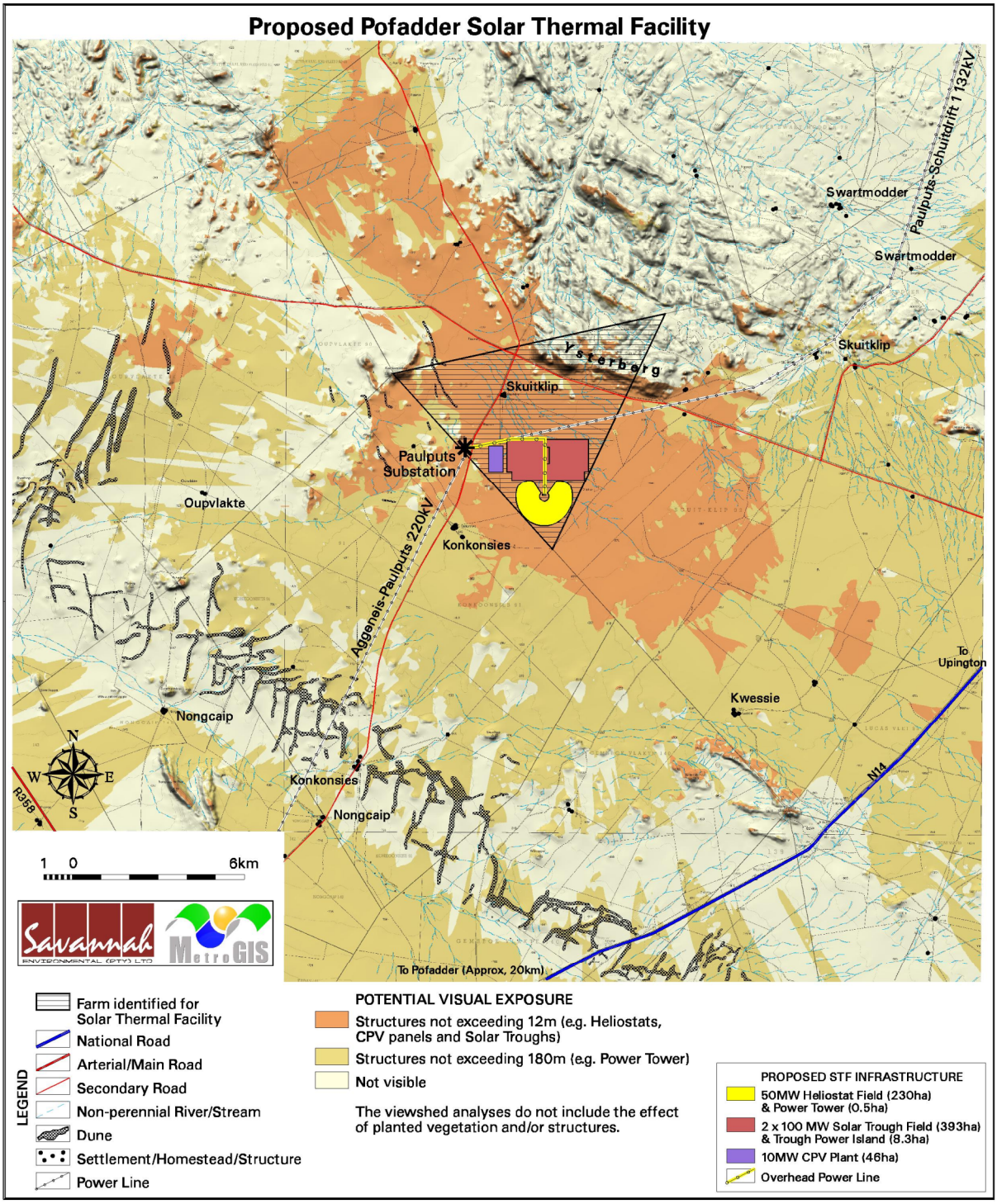


Figure 6.2: Theoretical potential visual exposure of the solar plant.

The pink shading in Figure 6.2 indicates areas from where whole or parts of a single structure not exceeding 12 m could potentially be visible and the yellow shading indicate areas where ***only*** the power tower or a section thereof could be visible[10]

Two categories were identified as having differing observer incidences and/or perceptions the first is that of relatively low viewer incidence, but potential negative perception[11]. This includes the homesteads / settlements within the study area (i.e. Konkonsies, Kwessie, Nongcaip, and Skuitklip). Observers residing in these areas are accustomed to the wide natural expanses and vistas afforded by this rural region. Developments of the scale of the power tower may constitute a negative visual impact. Viewers from Konkonsies could be exposed to an accumulative impact, as the Paulputs Transmission Substation and the Aggeneys-Paulputs 220 kV power line already constitute visual intrusion.

The second category comprises corridors along the main roads in the area (i.e. including a 200 m buffer zone along the national, arterial, and secondary roads) which are expected to support a higher frequency of observers. Of significance is that the N14 and R358 are utilised as tourist access routes within the region, giving access to visitors to the Green Kalahari, Namaqualand, and Namibia (via Onseepkans). Views from the southern parts of these corridors are considered more significant, since the facilities will be viewed against the backdrop of the Ysterberg topography.

» **Within 4 km**, users of the secondary roads in close proximity of the facility would be exposed to a **very high** potential visual impact as a result of the power tower and the other primary infrastructure (i.e. the heliostats, the PV panels and the troughs) as well as the on-site ancillary infrastructure. This includes those sections of secondary road passing through the site in the north and in the west. It should be noted, however, that these secondary roads do not carry high volumes of motorists.

» **Between 4 km – 8 km** these secondary roads will potentially experience **high** visual impact for short sections, dropping to a **moderate** impact.

» **Beyond 8 km**, primary infrastructure (i.e. including the power tower, the heliostats, the troughs, and the PV panels) may be visible for these stretches, as may some secondary infrastructure. A section of the N14 national road which lies between 8 km and 16 km of the site will be exposed to views of the power tower, and thus experience **moderate** visual impact, if any. It is not anticipated that the other

[10] The potential visual exposure as illustrated is a theoretical representation of where visual receptors would be able to see the facility from. This does not take into consideration local factors such as vegetation, orientation of structures and localised topographical features.

[11] No complaints pertaining to potential visual impact of the construction and operation of the proposed solar facility, as far as the author is aware, were received from individual landowners in the study area during the public participation process or otherwise.

primary infrastructure or on-site ancillary infrastructure will be visible from this distance. A section of the R358 lies more that 16 km from the facility, and will thus be potentially exposed to only **low** to **very low** visual impact.

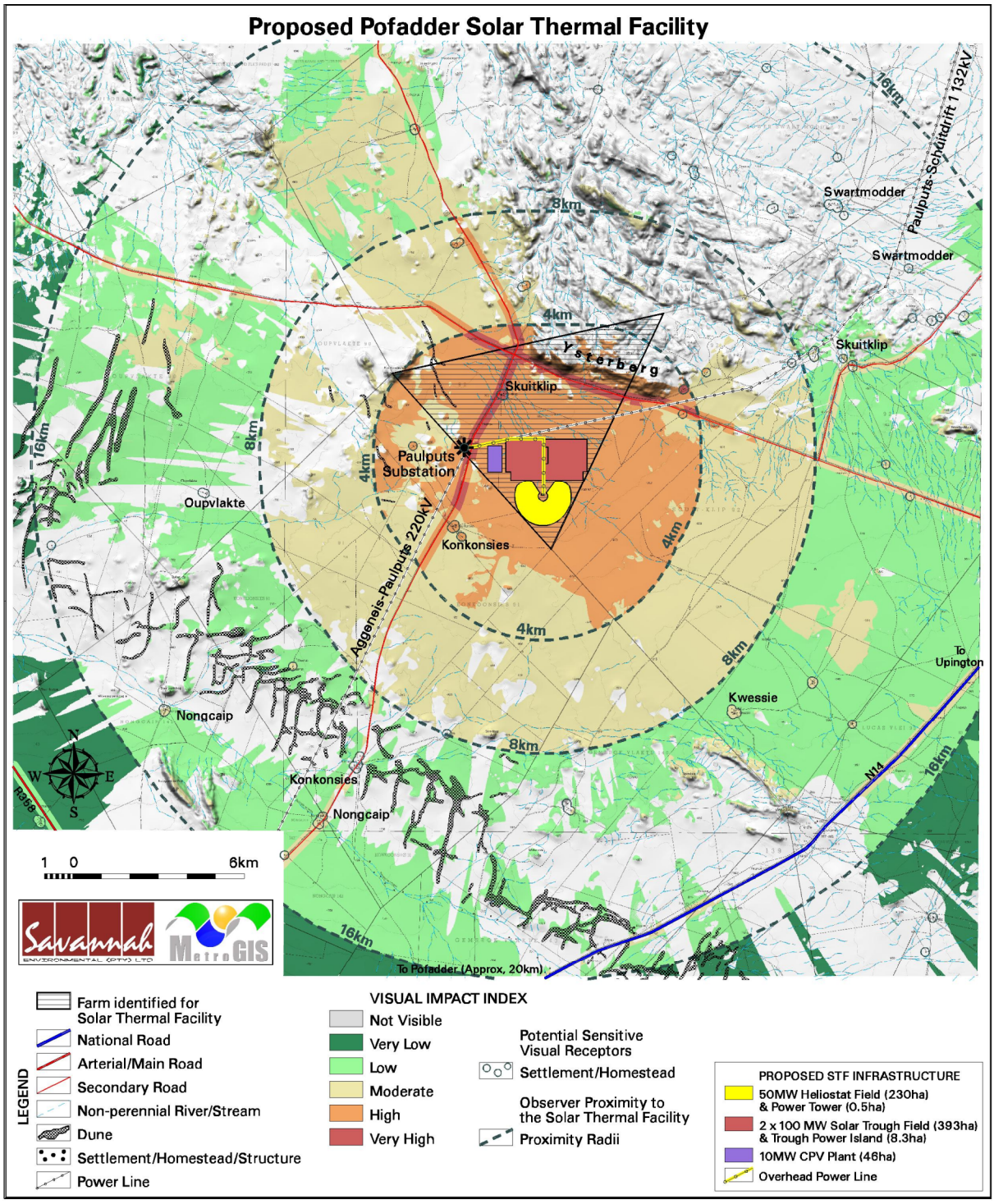


Figure 6.3: Visual impact index of the proposed solar facility

Photo simulations

Photo simulations were undertaken to illustrate the potential visual impact of the facility the receiving environment. The simulation was undertaken from three viewpoints which are described below (refer to Figures 6.4 – 6.):

Viewpoint 1 (long distance view) - is located at the junction of the N14 and the road that links this with Onseepkans, which runs through the north-eastern tip of the proposed development site. This view is indicative of a long range view that residents and commuters travelling along the N14 from Lutzburg to Pofadder, as well as those travelling north-west along the secondary road towards Onseepkans, will see of the facility. The viewing direction is west north-westerly and only the power tower will be visible in the distance.

Viewpoint 2 (medium distance view) - is located on a secondary road to the north of the proposed facility, leading to Styr-kraal. This position lies approximately 7 km from (at the closest point) the plant and is indicative of what will be seen by residents and commuters moving from Styr-kraal towards the facility as well as potential guests making use of the facilities at the Keboes Fruit Farms Guest House. The viewing direction is south south-easterly and the power tower will be clearly visible in the landscape. Portions of the solar trough field, heliostat field as well as the troughs may also be visible from this distance

Viewpoint 3 (close distance view) - is located on the 4 way intersection of the road running from the N14 to Onseepkans, the northern access point to the facility and the road that leads to the Keboes Fruit Farms Guest House. This view is from the northern boundary of the proposed development site, lies approximately 3 km away from the closest plant infrastructure, and is indicative of what will be seen from close range. The viewing direction is south south-easterly and large portions of the solar trough field, heliostat field as well as the power tower will be visible in the landscape.

Figure 6.4: Post construction overview from Viewpoint 1

Figure 6.5: Post construction overview from Viewpoint 2

Figure 6.6 Post construction overview from Viewpoint 3

Impact table summarising the significance of visual impacts (with and without mitigation)

Nature: Visual impact on users of secondary roads in close proximity to the facility Potential visual impact on the secondary roads in close proximity (i.e. within 8 km) to the proposed solar facility is expected to be **high**.	
	Without mitigation
Extent	Local (4)
Duration	Long term (4)
Magnitude	High (10)
Probability	High (4)
Significance	**High (72)**
Status (positive or negative)	Negative
Reversibility	Recoverable
Irreplaceable loss of resources	No
Can impacts be mitigated during the operational phase	No
Mitigation: Decommissioning: removal of the solar facility structures and ancillary infrastructure after 30 years (not considered in above "after mitigation" assessments).	
Cumulative impacts: The development of the primary and ancillary infrastructure over 2 to 3 years may create the impression of a cumulative visual impact on uninformed observers (i.e. observers who are not aware of the total extent of the facility).	
Residual impacts: None, the visual impact will be removed after decommissioning.	

Nature: Visual impact on residents of towns, settlements, and homesteads in close proximity to the proposed facility The visual impact of the proposed solar facility on homesteads and settlements is found to be high for those within 8 km of the facility.	
	Without mitigation
Extent	Local (4)
Duration	Long term (4)
Magnitude	High (8)
Probability	High (4)
Significance	**High (64)**
Status (positive or negative)	Negative
Reversibility	Recoverable
Irreplaceable loss of resources	No
Can impacts be mitigated during operational phase	No

Mitigation: Decommissioning: removal of the solar facility structures and ancillary infrastructure after 30 years (not considered in above "after mitigation" assessments).
Cumulative impacts: The development of the primary and ancillary infrastructure over 2 to 3 years may create the impression of a cumulative visual impact on uninformed observers (i.e. observers who are not aware of the total extent of the facility).
Residual impacts: None. The visual impact will be removed after decommissioning.

Nature: Visual impact on residents of towns, settlements, and homesteads within the region

The visual impact of the proposed solar facility on users of the national, arterial, and secondary roads, as well as residents of settlements and homesteads which lie beyond 8 km of the site is found to be **moderate**. Of significance is that the N14 and R358 are recognised tourist access routes within the region, giving access to visitors to the Green Kalahari, Namaqualand, and Namibia (via Onseepkans).

	Without mitigation
Extent	Regional (3)
Duration	Long term (4)
Magnitude	Moderate (6)
Probability	High (4)
Significance	**Moderate (52)**
Status (positive or negative)	Negative
Reversibility	Recoverable
Irreplaceable loss of resources	No
Can impacts be mitigated during operational phase	No

Mitigation: Decommissioning: removal of the solar facility structures and ancillary infrastructure after 30 years (not considered in above "after mitigation" assessments).
Cumulative impacts: The development of the primary and ancillary infrastructure over 2 to 3 years may create the impression of a cumulative visual impact on uninformed observers (i.e. observers who are not aware of the total extent of the facility).
Residual impacts: None. The visual impact will be removed after decommissioning.

Nature: Potential visual impact of on-site ancillary infrastructure on visual receptors in close proximity of the solar facility

The on-site ancillary infrastructure proposed for the solar facility includes the following:

» Steam turbine & generator housed within a 2 storey building,
» Generator transformer and a small substation,
» Energy storage plant and vessels,
» 132 kV power line,
» Evaporation ponds,
» An access road and
» Workshop, office, and storage areas.

Although no dedicated viewshed has been generated for the above infrastructure, it is all located within the development site. It is thus anticipated that the area of potential visual exposure will lie within that of the primary infrastructure (i.e. specifically the power tower, heliostats, PV panels, and troughs). The potential visual impact of this on-site ancillary infrastructure is expected to be **medium** in close proximity (i.e. within 4km) of the proposed facility.

	Without Mitigation
Extent	Local (4)
Duration	Long term (4)
Magnitude	High (8)
Probability	Probable (3)
Significance	**Medium** (**48**)
Status (positive or negative)	Negative
Reversibility	Recoverable
Irreplaceable loss of resources?	No
Can impacts be mitigated during operational phase?	Yes

Mitigation:

Decommissioning: removal of the solar facility structures and ancillary infrastructure after 30 years (not considered in above "after mitigation" assessments).

Cumulative impacts:

The development of the primary and ancillary infrastructure over 2 to 3 years may create the impression of a cumulative visual impact on uninformed observers (i.e. observers who are not aware of the total extent of the facility).

Residual impacts:

None. The visual impact will be removed after decommissioning.

Nature: Potential visual impact of lighting on visual receptors in close proximity of the solar facility

Although these are not densely populated areas, the light trespass, glare (i.e. aircraft warning lights mounted on top of the power tower), and sky glow from the security and after-hours operational lighting will have some significance. Furthermore, the sense of place and rural ambiance of the local area increases its sensitivity to such lighting intrusions, and will create a cumulative impact with the existing lighting on the Paulputs Substation.

The anticipated affected of lighting is expected to be moderate, and may be mitigated to low.

	Without Mitigation	***After Mitigation***
Extent	Local (4)	Local (4)
Duration	Long term (4)	Long term (4)
Magnitude	Medium (6)	Low (4)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (42)**	**Low (24)**
Status (positive or negative)	Negative	
Reversibility	Recoverable	
Irreplaceable loss of resources?	No	
Can impacts be mitigated during operational phase?	Yes	

Mitigation:

Decommissioning: removal of the solar facility structures and ancillary infrastructure after 30 years (not considered in above "after mitigation" assessments).

Cumulative impacts:

The development of the primary and ancillary infrastructure over 2 to 3 years may create the impression of a cumulative visual impact on uninformed observers (i.e. observers who are not aware of the total extent of the facility).

Residual impacts:

None. The visual impact will be removed after decommissioning.

Implications for Project Implementation

» The natural and relatively unspoiled rural views surrounding the site will be impacted upon, primarily by the power tower, for the entire operational lifespan of the facility.
» The primary visual impact, namely the appearance of the facility (specifically the power tower), is not possible to mitigate. The largest structure, being the power tower, will be impossible to hide.
» The visual impact of the power line is not possible to mitigate, but it is anticipated that this impact will be somewhat absorbed by the existing power line infrastructure.
» Considering the topography of the land and the VAC of the vegetation, very little can be done to mitigate the visual impacts caused by these structures. Furthermore, the functional design of these structures and the dimensions of the facility cannot be changed in order to reduce visual impacts. Therefore, the potential for mitigation is low.

» The potential visual impact on users of national, arterial, and secondary roads in close proximity of the facility will be of high significance, as will the potential visual impact on residents of settlements and homesteads in close proximity to the proposed facility.
» Within the region, the anticipated visual impact on users of major roads and residents of settlements and homesteads will be moderate.
» In terms of the on-site ancillary infrastructure, the potential visual impact is expected to be medium, but much of this will be overshadowed by the much taller power tower as well as the heliostats, PV panels and troughs.
» This anticipated visual impact is not, however, considered a fatal flaw from a visual perspective, considering the low incidence of visual receptors in the region and the contained area of potential visual exposure.

6.2.7 Potential Social Impacts

The key social issues associated with the **construction phase** include the following potential **positive** impacts:

» Creation of employment, business opportunities, and the opportunity for skills development and on-site training

The key social issues associated with the **construction phase** also include the following potential **negative** impacts:

» Impacts associated with the presence of construction workers on site
» Increased risk of theft, and damage to farm infrastructure associated with presence of construction workers on the site
» Increased risk of veld fires associated with construction related activities
» Threat to safety and security of farmers associated with the presence of construction workers in the area
» Impact of heavy vehicles, including damage to roads, safety, noise and dust

The key social issues affecting the **operational phase** include the following potential **positive** impacts:

» Creation of employment and business opportunities, and opportunities for skills development and training
» The promotion of clean energy as an alternative energy source and establishment of Cleaner Development Mechanism (CDM) project

The key social issues affecting the **operational phase** include the following potential **negative** impacts:

» The visual impacts and associated impact on sense of place (refer to the assessment of the visual impacts)
» Impact on scarce water resources (refer to the assessment of the impact on water resources)

Impact tables summarising the significance of social impacts associated with the construction phase (with and without mitigation measures)

Nature: Employment, business opportunities, and skills development

The construction phase is expected to create approximately 400 - 600 employment opportunities where approximately 60% will be low skilled positions (i.e. construction labourers, security staff etc) and semi-skilled workers (i.e. drivers, equipment operators etc) and 40% will be available to skilled personnel (i.e. engineers, land surveyors, project managers etc).

In terms of business opportunities for local companies, expenditure during the construction phase will create business opportunities for the regional and local economy. However, given the technical nature of the project and high import content associated with solar energy facilities opportunities for the local Pofadder economy and the towns of Keimoes and Kakamas are likely to be limited.

The potential opportunities for the local service sector would be linked to accommodation, catering, cleaning, transport and security, etc associated with the construction workers on the site. The majority of the construction workers will be accommodated in the nearest local towns, with Pofadder likely to be the most convenient due to its proximity to the site. This will create opportunities for local hotels, B&Bs, guest farms and people who want to rent out their houses. In addition, a proportion of the total wage bill earned by construction workers over the 2 – 3 year construction phase is also likely to be spent in the regional and local economy. The injection of income into the area in the form of rental for accommodation and wages will create opportunities for local businesses in local larger towns in the Northern Cape, specifically Pofadder. The benefits to the local economy will however be confined to the construction period.

In terms of training, the contractors are likely to provide on-site training and skills development opportunities. However, the majority of benefits are likely to accrue to personnel employed by the relevant contractors. The potential for meaningful skills development and training for members from the local communities are likely to be limited.

	Without Enhancement	***With Enhancement***
Extent	Local – Regional (2)	Local – Regional (4)
Duration	Short term (2)	Short term (2)
Magnitude	Low (4)	Moderate (6)
Probability	Highly probable (4)	Highly probable (4)
Significance	**Medium (32)**	**Medium (48)**
Status (positive or negative)	Positive	
Reversibility	N/A	
Irreplaceable loss of resources	N/A	

Can impacts be enhanced	Yes
Enhancement: Where reasonable and practical, the EPC contractor should appoint local contractors, especially for semi and low-skilled job categories. However, due to the low skills levels in the area, the majority of skilled posts are likely to be filled by people from outside the area. Prior to the construction phase the existence of a skills database for the area should be determined and if such as database exists it should be made available to the contractors appointed for the construction phase. Where applicable and feasible, training and skills development programmes for locals should be initiated prior to the initiation of the construction phase. The local municipality, in conjunction with the local Chamber of Commerce and representatives from the local hospitality industry, should identify strategies aimed at maximising the potential benefits associated with the project.	
Cumulative impacts: Opportunity to up-grade and improve skills levels in the area. However, due to relatively small number of local employment opportunities this benefit is likely to be limited.	
Residual impacts: The improved pool of skills and experience in the local area is likely to be a residual impact. However, due to relatively small number of local employment opportunities this benefit is likely to be limited.	

Nature: Theft, and damage to farm infrastructure

The presence of construction workers on-site increases the potential risk of theft. The movement of construction workers on and off the site also poses a potential threat to farm infrastructure, such as fences and gates, which may be damaged. Stock and game losses may also result from gates being left open and/or fences being damaged. !KaXu CSP and/or the EPC contractor will have the necessary management and control procedures in place for this.

	Without mitigation	***With mitigation***
Extent	Local (4)	Local (2)
Duration	Short term (2)	Short term (2)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Medium (36)**	**Low (24)**
Status (positive or negative)	Negative	
Reversibility	Yes	
Irreplaceable loss of resources	No	
Can impacts be mitigated	Yes	

Mitigation:

Contractors should be held liable for damage to farm infrastructure that can be linked to construction workers (i.e. for all externally affected farm portions).

The EMP must outline procedures for managing and storing waste on site, specifically plastic

waste that poses a threat to livestock if ingested. Contractors should ensure that all workers are informed of the conditions contained on the Code of Conduct, specifically trespassing on adjacent farms. The housing of construction workers on the site should be limited to essential and security personnel.
Cumulative impacts: No cumulative impacts are expected.
Residual impacts: Refer to cumulative impacts.

Nature: Potential impacts associated with the presence of construction workers

The manner in which construction workers conduct themselves can affect the local community. In this regard the most significant negative impact is associated with the disruption of existing family structures and social networks. This risk is linked to the potential behaviour of male construction workers, including:

- An increase in alcohol and drug use
- An increase in crime levels
- The loss of girlfriends and or wives to construction workers
- An increase in teenage and unwanted pregnancies
- An increase in prostitution
- An increase in sexually transmitted diseases (STDs)
- Given the relatively large labour force of 400 – 600 during the construction phase, the potential risk to local family structures and social networks is regarded as high.
- This risk is heightened by the relatively low-income and education levels in the town and surrounding area.

	Without mitigation	***With mitigation***
Extent	Local (4)	Local (3)
Duration	Short term (2) - Long term (5) (i.e. individuals affected by STDs etc)	Short term (2) - Long term (5) (i.e. individuals affected by STDs)
Magnitude	Moderate (6) - Very high (10) (i.e. for specific individuals affected by STDs etc)	Moderate (4) - Very high (10) (i.e. for specific individuals affected by STDs etc)
Probability	Probable (3)	Probable (3)
Significance	**Moderate (36 - 57)**	**Low (27) – Moderate (51)**
Status (positive or negative)	Negative	
Reversibility	No in the case of HIV and AIDS	
Irreplaceable loss of resources	Yes, if people contract HIV/AIDS as human capital plays a critical role in communities that rely on farming for their livelihoods	
Can impacts be mitigated	Yes, to some degree, however, the risk cannot be eliminated	

Mitigation:

Where reasonable and practical, the EPC contractor should appoint local contractors, especially

for semi and low-skilled job categories as this could reduce the potential impact on local family and social networks.
A code of good conduct should be developed for the construction phase which should identify what types of behaviour and activities by construction workers are not permitted.
An HIV/AIDS awareness programme should be implemented for all construction workers at the outset of the construction phase.
The movement of construction workers on and off the site should be closely managed and monitored by the contractors and the contractors should be responsible for making the necessary arrangements for transporting workers to and from site on a daily basis.
Construction workers, with the exception of essential and security personnel, should not be permitted to overnight on the site.

Cumulative impacts:
Impacts on family and community relations may, in some cases, persist for a long period. Also in cases where unplanned / unwanted pregnancies occur, or members of the community are infected by an STD, specifically HIV and or AIDS, the impacts may be permanent and have long term to permanent cumulative impacts on the affected individuals and/or their families and the community.

Residual impacts:
As per the above cumulative impacts.

Nature: Increased risk of accidental fires
The presence of construction workers and construction-related activities on the site poses an increased risk of grass fires that in turn pose a threat to the livestock, wildlife, and farmsteads in the area. In the process, farm infrastructure may also be damaged or destroyed and human lives threatened. The potential risk of grass fires is heightened by windy conditions in the area, specifically during the dry, winter months. The majority of farms in the area farm sheep and their livelihoods are dependent on grazing availability. Therefore any loss of grazing due to a fire would therefore impact negatively on the affected farmers livelihoods. The risk of fire related damage is exacerbated by the distance to fire-fighting vehicles located in the nearest towns of Pofadder.

	Without mitigation	***With mitigation***
Extent	Local (4)	Local (2)
Duration	Short term (2)	Short term (2)
Magnitude	High (8)	Moderate (6)
Probability	Probable (3)	Probable (3)
Significance	**Medium (42)**	**Low (30)**
Status (positive or negative)	Negative	
Reversibility	Yes	
Irreplaceable loss of resources	No	
Can impacts be mitigated	Yes	

Mitigation:
Contractor to ensure that open fires on the site for cooking or heating are not allowed except in designated areas.

Contractor to ensure that construction related activities that pose a potential fire risk such as welding are properly managed and are confined to areas where the risk of fires has been reduced. Special care should be taken during the high risk dry, windy winter months. Contractor to provide adequate fire fighting equipment on-site. Contractor to provide fire-fighting training to selected construction staff.
Cumulative impacts: No cumulative impacts are expected.
Residual impacts: Refer to cumulative impacts.

Nature: Impact of construction vehicles

The site is traversed by the R358 (a secondary road to Onseepkans), which links up with the N14. Within the site itself, access to the individual components of the facility will be required from the R358.

The movement of heavy construction vehicles during the construction phase will damage roads and create noise, dust, and safety impacts for other road users. The potential damage to the heavy equipment can result in a number of potential negative impacts, including increased wear on vehicles owned by local farmers, impact on ease of access (e.g. time delays, detours) to stock posts, between neighbors and members of the farming community, as well as access to local towns (services, retail, socialising). However, the current road use frequency is low and therefore the significance of this impact is low.

	Without mitigation	***With mitigation***
Extent	Local (3)	Local (2)
Duration	Short term (2)	Short term (2)
Magnitude	Low (4)	Minor (2)
Probability	Probable (3)	Probable (3)
Significance	**Low (27)**	**Low (18)**
Status (positive or negative)	Negative	
Reversibility	Yes	
Irreplaceable loss of resources	No	
Can impacts be mitigated	Yes	

Mitigation:

The contractor must ensure that damage caused to roads by the construction related activities, including heavy vehicles, is repaired before the completion of the construction phase.
The costs associated with repairs must be borne by the contractor.
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 sand and building materials are fitted with tarpaulins or covers when required by climatic conditions.
All vehicles must be road-worthy and drivers must be qualified, made aware of the potential road safety issues, and need for strict speed limits.

Cumulative impacts: If road damage is not repaired then this will affect the farming activities in the area and result in higher maintenance costs for vehicles of local farmers and other road users. The costs will be borne by road users who were no responsible for the damage.
Residual impacts: Refer to cumulative impacts.

Impact tables summarising the significance of social impacts associated with the operation phase (with and without mitigation measures)

Nature: Creation of employment and business opportunities

The operation phase will employ approximately 60 - 80 full time employees over a 30 - 50 year period. Approximately 3 - 6% of the posts will be managerial, 12 - 18% engineers, 35 - 40% technicians and 40 - 50% craftsmen. The proposed facility will therefore create potential employment opportunities in the Northern Cape Province and the local municipality. However, given that the solar energy sector in South Africa is relatively new it may be necessary to import the required operational and maintenance skills from other parts of South Africa or even overseas. However, it will be possible to increase the local skills levels through the implementation of training programmes to local contractors contracted by the turnkey EPC contractor as applicable. Following construction, these skills will be available to following solar projects hence supporting the strategic goals of promoting local employment and skills development contained in the Namakwa District Integrated Development Plan.

Given the location of the proposed facility the majority of permanent staff is likely to reside in the town of Pofadder. In terms of accommodation options, a percentage of the permanent employees may purchase houses in one of these towns, while others may decide to rent. Both options would represent a positive economic benefit for the region. In addition, a percentage of the monthly wage bill earned by permanent staff would be spent in the regional and local economy, which will benefit local businesses in these towns. The benefits to the local economy will extend over the operational lifespan.

The local hospitality industry in Pofadder is also likely to benefit from the operational phase. These benefits are associated with site visits by company staff members and other professionals (engineers, technicians etc) who are involved in the company and the project but who are not linked to the day-to-day operations.

	Without Enhancement	***With Enhancement***
Extent	Local and Regional (2)	Local and Regional (3)
Duration	Long term (4)	Long term (4)
Magnitude	Low (4)	Moderate (6)
Probability	Probable (3)	Probable (3)
Significance	**Moderate (30)**	**Moderate (39)**
Status (positive or negative)	Positive	
Reversibility	N/A	
Irreplaceable loss of resources	No	

Can impacts be enhanced	Yes
Enhancement: The enhancement/mitigation measures listed in for the construction phase apply. The turnkey EPC contractor should consider training programmes to local contractors that have been contracted that will increase local skills levels.	
Cumulative impacts: Cumulative impacts include creation of permanent employment, skills, and development opportunities for members from the local community and creation of additional business and economic opportunities in the area.	
Residual impacts: See cumulative impacts.	

Nature: Potential impact on local tourism

Sustainable utilisation of the natural resource base on which agriculture depends is critical in the Northern Cape with its fragile eco-systems and vulnerability to climatic variation. Therefore caution must be taken to ensure that the development of large renewable energy projects, such as the proposed solar energy facility, do not affect the tourism potential of the province. However, the proposed facility is not likely to impact on the tourism sector in the area or the province. In some instances the plant may also attract tourists to the area as has happened in other countries where such facilities have been constructed. However, the significance of this potential benefit is also rated as low positive.

	Without Enhancement	***With Enhancement***
Extent	Local (2)	Local (3)
Duration	Long term (4)	Long term (4)
Magnitude	Low (2)	Low (2)
Probability	Probable (3)	Probable (3)
Significance	**Low (24)**	**Low (27)**
Status (positive or negative)	Both	
Reversibility	Yes	
Irreplaceable loss of resources	No	
Can impacts be Mitigated	Yes	

Enhancement:

In terms of mitigating the visual impacts, it is virtually impossible to hide the facility. The impact on the sense of place of the area cannot therefore be effectively mitigated.

The local municipality and local tourism representatives should identify strategies aimed at maximising the potential benefits associated with the project.

In order to maximise the benefits of an information board for the benefit of the broader community, it is recommended that the information be presented in the three languages of the Northern Cape Province, namely Afrikaans, English and Setswana.

Cumulative impacts:

Cumulative impacts include potential benefit for tourism in the Kai !Gariep Municipality.

Residual impacts:
See cumulative impacts.

Nature: Promotion of clean, renewable energy		
South Africa currently relies on coal-powered energy to meet more than 90% of its energy needs. The establishment of a clean, renewable energy facility will therefore reduce, albeit minimally, South Africa's reliance on coal-generated energy and the generation of carbon emissions into the atmosphere. The overall contribution to South Africa's total energy requirements of the proposed solar thermal plant is relatively small. However, the 310 MW produced will offset the total carbon emissions associated with energy generation in South Africa. Given South Africa's reliance on Eskom as a power utility, the benefits associated with an IPP based on renewable energy are regarded as significant.		
	Without Enhancement	***With Enhancement***
Extent	Local, Regional and National (4)	Local, Regional and National (4)
Duration	Long term (4)	Long term (4)
Magnitude	High (8)	Very High (10)
Probability	Highly Probable (4)	Highly Probable (4)
Significance	**High (64)**	**High (72)**
Status (positive or negative)	Positive	
Reversibility	Yes	
Irreplaceable loss of resources	No	
Can impacts be mitigated	Yes	
Enhancement:		
Use the project to promote and increase the contribution of renewable energy to the national energy supply. Maximise the public's exposure to the project via an extensive communication programme.		
Cumulative impacts:		
Cumulative impacts include the reduction of carbon emissions via the use of renewable energy and associated benefits in terms of global warming and climate change.		
Residual impacts:		
See cumulative impacts.		

Implications for Project Implementation

» The landowner who stands to be directly affected by the proposed facility supports the project.
» The negative impacts associated with the proposed facility can be mitigated while the positive impacts can be enhanced with appropriate mitigation/enhancement measures.

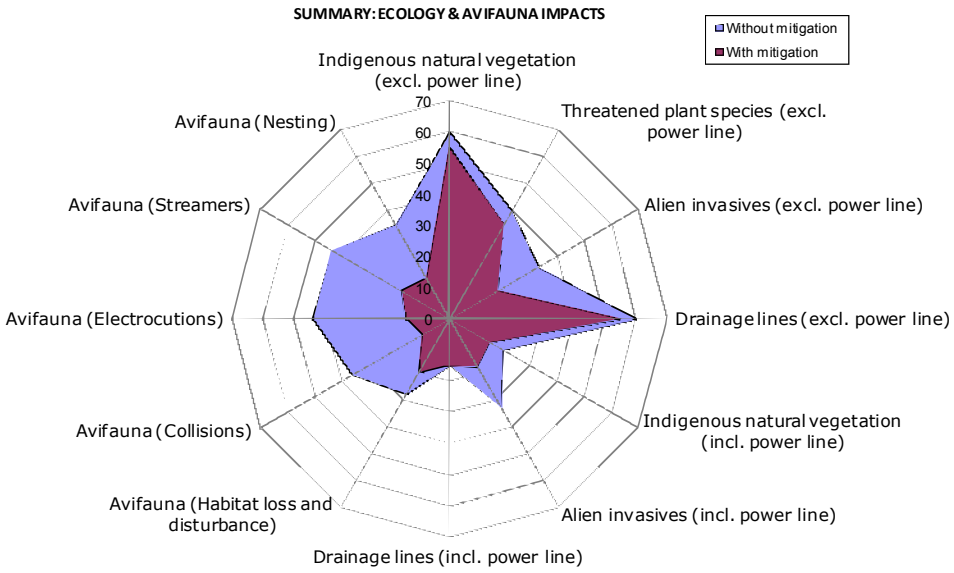
6.3 Summary of Impacts

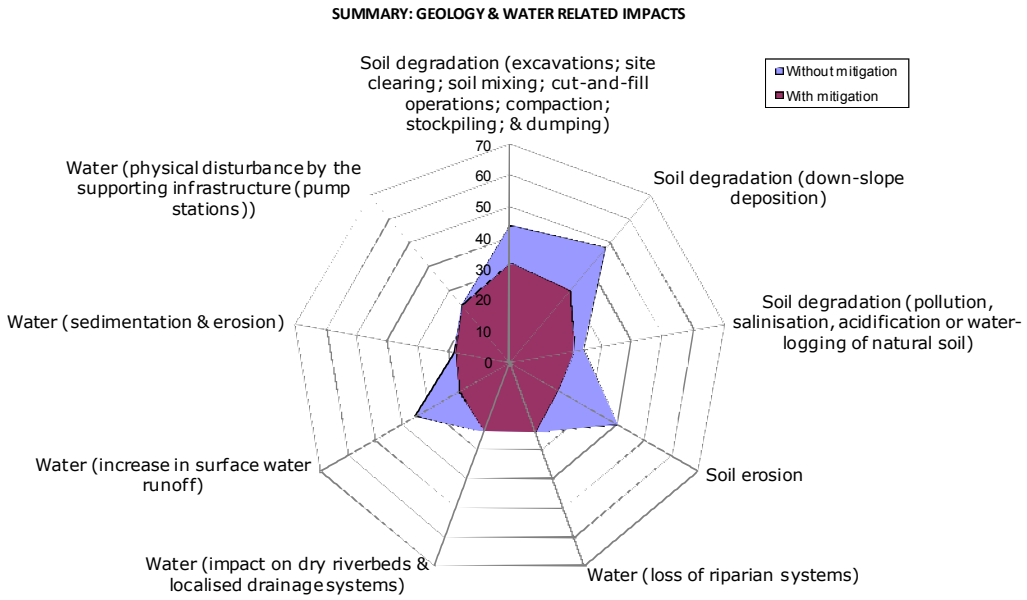
As a summary of the potential impacts identified and assessed through the EIA process, the following provide a diagrammatic representation of the significance ratings for the potential impacts.

As indicated in Chapter 3, the significance weightings for potential impact have been rated as follows:

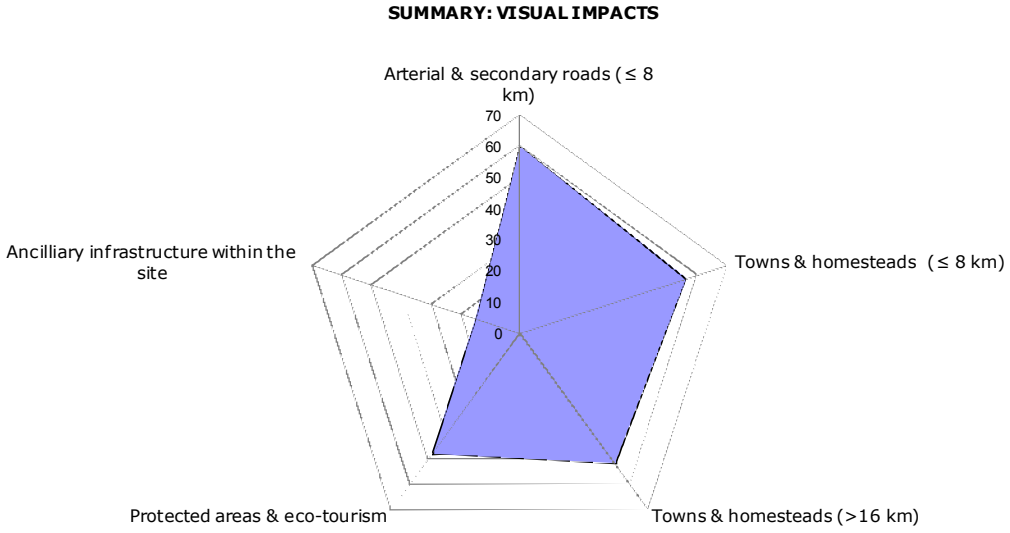
- **< 30 points:** Low (i.e. where this impact would not have a direct influence on the decision to develop in the area)
- **30-60 points:** Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated)
- **> 60 points:** High (i.e. where the impact must have an influence on the decision process to develop in the area)

These ratings are illustrated on the axis of the graph. Impact ratings without mitigation are indicated in blue, and impact ratings with mitigation are indicated in purple.



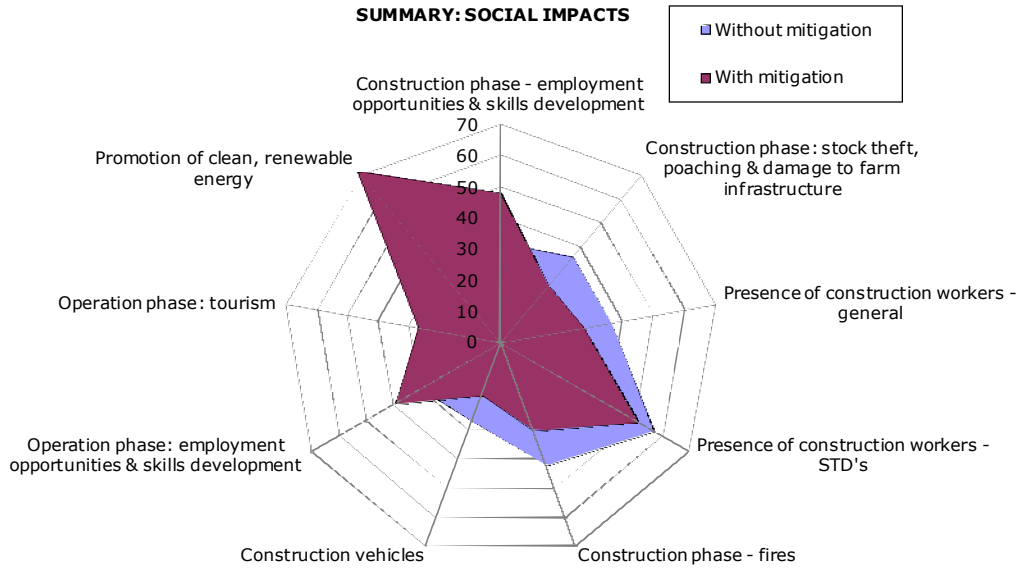


Biophysical impacts in terms of the biophysical receiving environment (i.e. ecology, geology, avifauna, and water resources) are primarily of low to moderate significance without mitigation. With the implementation of mitigation measures, the impacts can be reduced.



The potential *visual impact* on users of national, arterial, and secondary roads in close proximity of the solar facility (power tower structure) will be of high significance, as will the potential visual impact on residents of settlements and homesteads in close proximity to the proposed facility. Within the region, the anticipated visual impact on users of major roads and residents of settlements and homesteads will be moderate. In terms of the on-site ancillary infrastructure, the potential visual impact is expected to be

medium, but much of this will be overshadowed by the much taller power tower as well as the heliostats, PV panels and troughs. This anticipated visual impact is not, however, considered a fatal flaw from a visual perspective, considering the low incidence of visual receptors in the region and the contained area of potential visual exposure.



The development will create employment and business opportunities for locals during both the construction and operational phase of the project. The proposed development also represents an investment in clean, renewable energy infrastructure, which, given the challenges created by climate change, represents a positive social benefit for society as a whole. However, the visual impacts associated with facility will affect the areas rural sense of place and landscape character. This impact will be for the entire operational lifespan (approximately 30 years) of the facility. However, these impacts are not considered to represent a fatal flaw.

6.4. Assessment of Potential Cumulative Impacts Associated with the proposed Pofadder Solar Thermal Plant

A cumulative impact, in relation to an activity, refers to 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 undertaking in the area[12]. The cumulative impacts associated with the proposed solar thermal plant primarily refer to those impacts associated with visual and water related impacts.

With respect to **ecology**, the loss of habitat within indigenous natural vegetation types may be exacerbated by soil erosion and alien invasions. Soil erosion, habitat loss,

[12] Definition as provided by DEA in the EIA Regulations.

damage to wetlands and increased frequency of veld fires may lead to additional impacts that will exacerbate the establishment and spread of declared weeds and alien invader plants.

With respect to **avifauna**, the amount of habitat (11 km^2) that would be lost in the context of the amount of similar habitat in the region means that the cumulative habitat would be negligible. With respect to the power line, there are existing power lines in the area as well as on the site, however, the length of the proposed line is 2 km and it is unlikely that this will add significantly to the cumulative impact of powerlines collisions in the region.

With respect to **geology**, the cumulative significance of all the potential impacts on the geological environment is considered low due to the limited scale of the development and the dearth of development in the immediate surrounding area.

With respect to **water resources**, cumulative impacts may occur in terms of:

» Increase in surface water run-off velocities and the reduction in the potential for groundwater infiltration – this is unlikely to occur, considering that the site is not near the main drainage channel and the annual rainfall figures are low.
» Downstream erosion and sedimentation of the downstream wetland / dam area and canal system of the Raap en Skraap / Onseepkans agricultural operations.
» Elevation of the river banks, embankment construction and earthmoving activities in the floodplain of the Gariep (Orange) River. Further manipulation will exacerbate these impacts, but to a limited degree with a localised impact, particularly due to the limited nature of abstraction modifications.
» Man-induced erosion and sedimentation in this area from intensive farming activities along the Gariep (Orange) River is expected to be unnaturally high. Additional impacts from the site are expected to be negligible.
» The widespread use of chemicals in farming activities (fertilizers, insecticides, herbicides, etc.) means that any chemical pollution from the solar thermal facility will have a marked cumulative impact on aquatic biota. This impact is not expected to be high, however, due to the non-polluting nature of the activity.
» Water abstraction in the Lower Gariep (Orange) River is already considered as high and will be exacerbated by the abstractions for this project. The water use required by this project is relatively small in a regional context.

With respect to **visual impacts**, viewers from Konkonsies could be exposed to a cumulative impact, as the Paulputs Substation and the Aggeneys-Paulputs power line already constitute visual intrusion.

With respect to social impacts, the cumulative impacts associated with large, renewable energy facilities, such as the proposed facility are largely linked to the impact on sense

of place and visual impacts. At the time of undertaking the EIA process there was no indication that additional solar energy facilities were being planned in the area. The current cumulative impact is therefore regarded to be low.

Cumulative effects have been considered within the detailed specialist studies, where applicable and are low (refer to Appendices F – L).

6.5. Nomination of Preferred Alternatives

Four site specific alternatives, in terms of the power line and the internal access road were assessed through this EIA Phase. With respect to the access road, all four alternatives would branch off the R358 in an easterly direction and would terminate at the power islands (refer to Figure 2.1). With respect to the power line, the alternatives would follow similar routes to those alternatives proposed for the access road (refer to Figure 2.1).

Table 6.1: Summary of the specialist preferences in terms of the power line route alternatives and internal access road alternatives

	Power line / access road	**Notes**
Ecology	No distinct preference Route alternatives 1 and 4 next to the existing power line considered the preferred alternatives.	All four alternatives cross the same dune and one ephemeral drainage area. The impacts of all roads are therefore almost identical. However, alternatives 1 and 4 are situated next to an existing power line, which consolidates impacts on the landscape, and alternatives 3 is near the terminal end of the dune, which reduces the potential for fragmenting this feature. Therefore, alternatives 1, 3 or 4 are marginally preferred over alternative 2. The consolidation of linear infrastructure, i.e. route alternatives 1 and 4 next to the existing power line are considered the best alternatives.
Avifauna	No distinct preference	There is no significant difference the four alternatives.
Geology	No distinct preference Route alternative 1 considered preferred	All the alternatives cross areas of high erosion sensitivity (i.e. drainage lines) and therefore the only variable is the size or extent of the disturbance area. The most suitable proposed power line would be one that runs along the preferred access road to minimise impact on undisturbed ground.
Water	No preference	None of the proposed alternatives will affect the aquatic or riparian environment.
Heritage	No preference	
Social	Alternative 1	The findings of the SIA support the preferred route (route alternatives 1 or 4), which follows an existing

		Eskom power line route.
Visual	Alternative 1	In both instances (i.e. for both the access road and the overhead power line) the preferred alternative would be Alternative 1. These alternatives both follow the Paulputs-Schuitdrift 1 132kV power line, thereby consolidating the existing linear infrastructure within the region.

There is no distinct preference in terms of the proposed power line corridor and the internal access road. However, Alternative 1 is considered to be the preferred route for both linear routes, as this alignment follows an existing power line, which would allow for the consolidation of impacts.

CONCLUSIONS AND RECOMMENDATIONS CHAPTER 7

KaXu CSP South Africa (Pty) Ltd (!KaXu CSP), is proposing the establishment of a commercial solar energy facility and associated infrastructure on Portion 4 of the Farm Skuit-Klip 92 near Pofadder in the Northern Cape.

A study area of approximately 33 km^2 was originally considered as the larger study area for the construction of the proposed facility. Following the Scoping Phase, a preferred area for the development footprint (of approximately 11 km^2) located in the southern portion of the broader triangular shaped site, was identified. This portion is preferred based on site sensitivities such as the relief profile; the location of the Gariep Centre of Floristic Endemism in the north-western portion of the site; and proximity to the grid connection point.

The primary components of the project (i.e. areas of activity) include the following:

» The developmental footprint **within** the identified southern portion including the solar collector fields; water storage reservoirs; evaporation ponds; a portion of the water pipeline; the overhead power line; the power islands; internal access roads; workshops; offices; and storage areas.
» The developmental footprint **outside** of the identified southern portion including an abstraction point at the Gariep (Orange) River; a suspension reservoir; and the underground water supply pipeline to the facility.

The EIA for the proposed facility has been undertaken in accordance with the EIA Regulations published in Government Notice 28753 of 21 April 2006, in terms of Section 24(5) of the National Environmental Management Act (NEMA; Act No 107 of 1998). The EIA Phase aimed to achieve the following:

» Provide an overall assessment of the potential social and biophysical impacts that may occur because of the establishment of the proposed facility.
» Assess potentially significant impacts (direct, indirect, and cumulative, where required) associated with the proposed facility.
» Comparatively assess identified alternatives put forward as part of the project.
» Nominate preferred power line and access route corridors for consideration by the decision-making authorities.
» Identify and recommend appropriate mitigation measures for potentially significant environmental impacts.
» Undertake a fully inclusive public involvement process to ensure that I&APs are afforded the opportunity to participate, and that their issues and concerns are recorded.

The conclusions and recommendations of this EIA are the result of the assessment of identified impacts by specialists, and the parallel process of public participation. The public consultation process has been extensive and every effort has been made to include representatives of all stakeholders in the study area.

7.1 Correspondence received during the review of the Draft EIA Report

During the review period of the draft EIA Report comment was received from SAHRA regarding the need for palaeontology study to be carried out (refer to Appendix B). Therefore based on the advice of a qualified palaeontologist a brief desk-top was commissioned (refer to Appendix J). This study reported that the fossil record from Bushmanland deposits is very poor with respect to finds of fossil bones of vertebrates. Furthermore, the status of the potential impact for palaeontology is not neutral or negligible and in light of the low fossil potential, monitoring of bulk earth works by a specialist is not justified.

Furthermore, comments were received from DEA's Biodiversity Planning Department on 26 November 2010 (refer to Appendix B1). These comments were based on the Draft Scoping Report which was finalised on 11 November 2010 with the acceptance of scoping from DEA. Therefore the majority of the comments have *already* been sufficiently addressed as part of the Draft EIA Report and are briefly elaborate on below:

1. *Identification of TOPS species, as well as provincially protected species need to be made* - reference has been made with respect to protected tree species and red date species in the Ecology Study (refer to Appendix E).
2. *Identification of protected tree species on terms of the National Forest Act (Act No. 84 of 1998*) – reference has been made with respect to protected tree species in the Ecology Study (refer to Appendix E).
3. *The ORASECOM study for the Orange River* - extensive comments have been made in the Water Resources Study (refer to Appendix H), regarding the Reserve and the ORASECOM study. Brief mention has been made in the same report of the estuarine reserve requirement. References to the impacts related to abstraction from the Orange River are included in this report, as well as the seasonality issues for the Reserve.
4. *The impact of water acquisition from the Orange River* – this has been addressed in the Water Resources Study (refer to Appendix H).
5. *The impact of the proposed power line and associated infrastructure* – the potential impacts of the power line and the associated infrastructure has been evaluated in the Ecology Study (refer to Appendix E).
6. *Evaluation of the site in terms of the Protected Areas Expansion Strategy* -
7. *Evaluation of options by the relevant specialists* – the project alternatives in terms of the power line and internal access road alignment were assessed by the specialists.

8. *In terms of the conservation targets for this project area, consideration of an offset arrangement* – no offset arrangement was considered as part of the project scope.
9. *The inclusion of the Department of Water Affairs as a commenting authority* – the Department of Water Affairs was liaised with on several occasions (refer to Appendix D).
10. *Mitigation measures of importance, that should be included in the EMP such as:*
    - » *Measures to avoid soil erosion during construction* – this has been addressed in the draft EMP (refer to Appendix N).
    - » *Mitigation for impacts on avifauna* - this has been addressed in the draft EMP (refer to Appendix N).
    - » *Delineation of wetlands / watercourses* - this has been addressed in the draft EMP (refer to Appendix N).
    - » *Removal of natural vegetation should be in accordance to the National Environmental Management: Biodiversity Act and National Forest Act* - this has been addressed in the draft EMP (refer to Appendix N).
    - » *Removal of alien invasive species in accordance with the Conservation of Agricultural Resources Act (Act 43 of 1983)* - this has been addressed in the draft EMP (refer to Appendix N).
    - » *Mitigation measures should be provided for the threatened reptiles, birds, and mammals that inhabit that ecosystem* - this has been addressed in the draft EMP (refer to Appendix N).

7.2. Evaluation of the Proposed Project

The preceding chapters of this report together with the specialist studies contained within Appendices F - L provide a detailed assessment of the environmental impacts on the social and biophysical environment that may result from the proposed project. This chapter concludes the final EIA Report by providing a summary of the conclusions of the assessment of the proposed site for the solar energy facility and the associated infrastructure. In so doing, it draws on the information gathered as part of the EIA process and the knowledge gained by the environmental consultants during the course of the EIA and presents an informed opinion of the environmental impacts associated with the proposed project.

» The overall impact on the **ecology** is likely to be of a **low - moderate significance** prior to mitigation. This could be reduced to **low significance** following the implementation of mitigation measures. Higher ecological sensitivity within the greater site can be attributed to the drainage lines, steep slopes, mountains and ridges, and floristic elements from the Gariep Centre of Floristic Endemism consisting of the low mountains and hills.

» The overall impact on **avifauna** is likely to be of a **low - moderate significance**. The most significant threat to bird communities would be from collisions with the

overhead power line. However, since only 2 km of power line will be installed, this impact will be **minimal**. The site is not located in an area of high bird traffic (i.e. near riverbeds, wetlands or valleys); therefore the loss of habitat, disturbance, or any interaction with the facility is unlikely to have any significant negative impact on bird communities in the area.

» The overall impact on the **geology, soils, and erosion potential** is likely to be of **moderate - low** significance in terms of direct impacts. The possible presence of shallow, dense residual soil, calcrete, or basement rock may help to reduce the erosion potential, but this is difficult to quantify without detailed geotechnical information. The cumulative significance of all the potential impacts on the geological environment is considered **low** due to the limited scale of the development and the dearth of development in the immediate surrounding area. With effective implementation of mitigating measures the impacts identified above can be reduced to a low level.

» The overall impact on the **water resources** is likely to be of a **moderate** significance. This could readily be reduced to **low significance** by appropriate mitigation, apart from the moderate impact of water abstraction from the Gariep (Orange) River. The overall 1100 ha, 310 MW facility will have an approximate water requirement of 2.5 million m^3 per annum, assuming wet cooling, which is not regarded as prohibitive. The water consumption could be reduced through the implementation of alternative operational processes. However, these alternatives would have financial as well as efficiency implications on the overall development, and are not considered further as current proposed tariff's under the REFIT do not cater for such and in light of the water resource required not being seen as a limiting factor at this time.

» The overall impact on the **heritage resources** is likely to be of a **low significance**. Very sparse heritage traces were found during a field survey. From an archaeological perspective the observed heritage resources either fall well outside of the proposed development footprint or are of low significance.

» The potential **visual impact** of the power tower on users of national, arterial, and secondary roads in close proximity of the solar facility will be of **high significance**, as will the potential visual impact on residents of settlements and homesteads in close proximity to the proposed facility. Within the region, the anticipated visual impact on users of major roads and residents of settlements and homesteads will be **moderate**. In terms of the on-site ancillary infrastructure, the potential visual impact is expected to be **moderate**, but much of this will be overshadowed by the much taller power tower. This anticipated visual impact is not, however, considered a fatal flaw from a visual perspective, considering the low incidence of visual receptors in the region and the contained area of potential visual exposure.

» The overall **social** impact is likely to be of a **moderate significance** in terms of positive impacts, and a **low – high significance** in terms of the negative impacts. The development will create employment and business opportunities for locals during both the construction and operational phase of the project and represents an investment in clean, renewable energy infrastructure.

No environmental fatal flaws were identified with the establishment of the proposed Pofadder Solar Thermal Plant. However a number of issues requiring mitigation have been highlighted. Environmental specifications for the management of potential impacts are detailed within the draft EMP included within Appendix M.

The most significant environmental impacts associated with the proposed project, as identified through the EIA, include:

Local site-specific impacts

Local site-specific impacts because of physical disturbance/modification to the site with the establishment of the facility that may occur during the construction phase will include:

» Impacts on biodiversity which includes any impacts on protected or sensitive species and on overall species richness;
» Impacts on sensitive habitats (i.e. drainage lines, hills and slopes) that leads to direct or indirect loss of such habitat; and
» Soil erosion induced or increased by human activity is termed 'accelerated erosion' and is an integral element of global soil degradation.

These impacts will be primarily limited to the preferred developmental area located within the south-eastern region of the broader site which was identified during the Scoping Phase.

Impacts on Water Resources

From a habitat and ecosystem point of view, all the dry river beds and the associated riparian systems would be rated as extremely sensitive to development. The following impacts may occur through the establishment of the proposed facility:

» Impacts on the Gariep (Orange) River system due to water abstraction, and site-specific impacts on in-stream biota.
» Impacts on the Gariep (Orange) River system due to water abstraction, and site-specific impacts on in-stream biota are difficult to quantify due to the number of unknowns and the highly regulated nature of the system. Releases from Vanderkloof Dam would affect the site, although release patterns are re-evaluated every year to provide for irrigators and is therefore well known.
» Impacts on the drainage lines may lead to direct or indirect loss of such habitat.

» Inadequate erosion control or containment of sediment-laden runoff during site clearing and construction activities for infrastructure at both the abstraction points (e.g. pipelines and reservoirs) and at the solar plant site
» A possible impact on the development of the Pofadder Solar Thermal Plant is in terms of the quantity of water required for operation of the facility.
» Poor planning and design of new abstraction infrastructure and new flood protection measures on the floodplain, resulting in bank erosion or slumping to occur during river flooding events.

Visual impacts

The construction and operation of the proposed facility will have a visual impact on the natural scenic resources of this region.

The facility (specifically the power tower) would be exposed to a large geographical area due to the relatively flat topography. This is particularly relevant to the south, north-west, and east. Visibility is limited from the north and north-east, where the topography of the Ysterberg provides visual screening. It is anticipated that the power tower, as well as the smaller infrastructure (i.e. the heliostats, the PV panels, the parabolic troughs and the larger buildings) will be visible from the area immediate surrounding the facility and that the power tower will be visible from the Paulputs Transmission Substation to the immediate area west of the proposed plant. The power tower may be visible from sections of the N14 and R358 as well as from relatively continuous stretches of the secondary roads traversing the study area. It is further envisaged that the power tower would be visible within a 16 km radius of the site and would constitute a high visual prominence, potentially resulting in a high visual impact.

There are not many recommendations as to the mitigation of the visual impact of the power tower as no amount of vegetation screening or landscaping would be able to hide structures of these dimensions. It is, however, recommended that the ancillary infrastructure be properly planned with due cognisance of the topography, that all disturbed areas be appropriately rehabilitated.

The facility further has a novel and futuristic design that invokes a curiosity factor not generally present with other conventional power generating plants. The advantage being that the solar facility can become an attraction or a landmark within the region that people would actually want to come and see. As it is impossible to hide the facility, the only option would be to promote it.

7.3. Overall Conclusion (Impact Statement)

Internationally there is increasing pressure on countries to increase their share of renewable energy generation due to concerns such as climate change and exploitation of resources. The South African Government has set a 10-year cumulative target for

renewable energy of 10 000 GWh renewable energy contribution to final energy consumption by 2013, to be produced mainly from biomass, wind, solar and small-scale hydro. This amounts to approximately 4% (1 667 MW) of the total estimated electricity demand (41 539 MW) by 2013. The draft Integrated Resource Plan (IRP) 2010, has set a requirement of 600MW of CSP plant to be introduced.

The viability of establishing a solar power plant with a maximum total generating capacity of 310 MW on a site near Pofadder has been established by !KaXu CSP. The positive implications of establishing a solar energy facility on the identified site within the Northern Cape include:

» The project would assist the South African government in reaching their set targets for renewable energy.
» The potential to harness and utilise solar energy resources.
» The National electricity grid in the Northern Cape would benefit from the additional generated power.
» Promotion of clean, renewable energy in South Africa.
» Positive impacts on the tourism economy of the area.
» Creation of local employment, business opportunities and skills development for the area.

The findings of the specialist studies undertaken within this EIA to assess both the benefits and potential negative impacts anticipated from the proposed project conclude that:

» There are **no environmental fatal flaws** that should prevent the proposed solar energy facility and associated infrastructure from proceeding on the identified site, provided that the recommended mitigation and management measures are implemented, and given due consideration during the process of finalising the facility layout.
» The overall **ecological** impacts have been assessed as being of low or medium significance. If mitigation measures are put in place to manage impacts, then most potential impacts can be reduced to having low to moderate significance.
» The most significant threat to **avifauna** would be from collisions with the overhead power line. The loss of habitat, disturbance, or any interaction with the facility is not anticipated to have a significant negative impact on bird communities in the area.
» Very sparse **heritage resources** were found during the field survey undertaken for the site. From an archaeological perspective the observed heritage resources may be regarded as being of generally low significance.
» With respect to **geology**, the possible presence of shallow, dense residual soil, calcrete, or basement rock may help to reduce the erosion potential but this is difficult to quantify without detailed geotechnical information. However, the direct impacts are likely to be moderate to low and the cumulative significance of all the

potential impacts on the geological environment is considered low due to the limited scale of the development and the dearth of development in the immediate surrounding area. With effective implementation of mitigating measures the impacts identified above can be reduced to a low level.

» The anticipated **visual** impact is not considered a fatal flaw considering the low incidence of visual receptors in the region and the contained area of potential visual exposure.
» The development will have both positive and negative **social** impacts. It will create employment and business opportunities for locals during both the construction and operational phases and represent an investment in clean, renewable energy infrastructure.

The significance levels of the majority of identified negative impacts can generally be reduced by implementing the recommended mitigation measures. With reference to the information available at this planning approval stage in the project cycle, the **confidence** in the environmental assessment undertaken is regarded as **acceptable**.

The proposed power line and internal access road alternative are all considered acceptable from an environmental perspective, with **Alternative 1** being preferred for both due to the potential for consolidation of linear impacts.

7.4. Overall Recommendation

Based on the nature and extent of the proposed project, the local level of disturbance predicted as a result of the construction and operation of the facility and associated infrastructure, the findings of the EIA, and the understanding of the significance level of potential environmental impacts, it is the opinion of the EIA project team that the application for the proposed Pofadder Solar Thermal Plant can be mitigated to an acceptable level.

The following conditions would be required to be included within an authorisation issued for the project:

» As far as possible, any component of the facility which could potentially affect sensitive areas (i.e. primary drainage lines) should be shifted in order to avoid these areas of high sensitivity (i.e. best practice is impact avoidance). Where this is not possible, alternative mitigation measures as detailed in this report must be implemented.
» Disturbed areas should be rehabilitated as quickly as possible and an on-going monitoring programme should be established to detect, quantify, and manage any alien species.
» During construction, unnecessary disturbance to habitats should be strictly controlled and the footprint of the impact should be kept to a minimum.

- All *practical* mitigation measures detailed within this report and the specialist reports contained within Appendices F to K are implemented.
- The EMP as contained within Appendix M of this report should form part of the contract with the EPC Contractor appointed to construct the proposed solar energy facility, and will be used to ensure compliance with environmental specifications and management measures. The implementation of this EMP for all life cycle phases of the proposed project is considered key in achieving the appropriate environmental management standards as detailed in this project.
- A comprehensive stormwater management plan should be compiled for the developmental footprint prior to construction.
- Applications for all other relevant and required permits required to be obtained by !KaXu CSP must be submitted to the relevant regulating authorities. This includes permits for the transporting of all components (abnormal loads) to site, disturbance to heritage sites, disturbance of protected vegetation, and disturbance to any drainage lines or riparian vegetation.

REFERENCES CHAPTER 8

ARC-ISCW, 2004. Overview of the status of the agricultural natural resources of South Africa (First Edition). ARC-Institute for Soil, Climate and Water, Pretoria

Beaumont, P. B., Smith, A.B., and Vogel, J.C. 1995. Before the Einiqua: the archaeology of the frontier zone. In A. B. Smith (ed.). Einiqualand: studies of the Orange River frontier, Cape Town: UCT Press.

Demarcation Board www.demarcation.org.za (Census 2001 data)

Eloff, J.F., Bennie, A.T.P., Dietrichsen, J.A.V. and Geers, B.C., 1983. Land types of the map 2820 Upington. Field information. *Mem. Nat. Agric. Res. S. Afr.* No. 3. ARC-Institute for Soil, Climate and Water, Pretoria.

Fairbanks, D.H.K., Thompson, M.W., Vink, D.E., Newby, T.S., Van Den Berg, H.M and Everhard, D.A. 2000. The South African Land-Cover Characteristics Database: a synopsis of the landscape. *S.Afr.J.Science* 96: 69-82.

Geological Survey, 1988. 1:250 000 scale geological map 2820 Upington. Department of Mineral and Energy Affairs, Pretoria.

Jenkins, A J, J J Smallie, and M Diamond. "Avian collisions with power lines: a global review of causes and mitigation with a Sout

Kai !Garib Municipality Integrated Development Plan (IDP) (2009)

Koch, F.G.L. and Kotze, A.V., 1986. Climate data. In: Land types of the maps SE27/20 Witdraai, 2720 Noenieput, 2722 Kuruman, 2724 Christiana, 2820 Upington, 2822 Postmasburg. *Mem. Agric. nat. Res. S. Afr*. No. 3. Department of Agriculture and Water Supply, Pretoria.

MacVicar, C.N., de Villiers, J.M., Loxton, R.F, Verster, E., Lambrechts, J.J.N., Merryweather, F.R., le Roux, J., van Rooyen, T.H. and Harmse, H.J. von M., 1977. Soil classification. A binomial system for South Africa. ARC-Institute for Soil, Climate and Water, Pretoria.

Morris, D. and Beaumont, P.B. 1991. !Nawabdanas: archaeological sites at Renosterkop, Kakamas District, Northern Cape. South African Archaeological Bulletin 46:115-124.

ORASECOM (2007). Orange Senqu River Commission Integrated Water Resources Management Plan. Accessed 24 March 2010. http://www.orasecom.org/publications/iwrm+plan.aspx

Mucina, L., Rutherford, M.C. and Powrie, L.W. (eds) 2005. Vegetation map of South Africa, Lesotho and Swaziland, 1:1 000 000 scale sheet maps. South African National Biodiversity Institute, Pretoria.

Mucina, L., Rutherford, M.C., Palmer, A.R., Milton, S.J., Scott, L., Van Der Merwe, B., Hoare, D.B., Bezuidnehout, H., Vlok, J.H.J., Euston-Brown, D.I.W., Powrie, L.W. and DoldOLD, A.P. 2006. *Nama-Karoo Biome.* In: Mucina, L. and Rutherford, M.C. (eds.) The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.

Parsons, I. 2003. Lithic Expressions of Later Stone Age Lifeways in the Northern Cape *South African Archaeological Bulletin* 58:33-37.

Soil Classification Working Group, 1991. Soil classification. A taxonomic system for South Africa. ARC-Institute for Soil, Climate and Water, Pretoria.

South African National Biodiversity website (www.sanbi.org).

StatsSA Community Survey, 2007.

Van Wyk and Smith 2001 2001. Regions of floristic endemism in Southern Africa. Umdaus press, Hatfield.