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ENVIRONMENTAL IMPACT ASSESSMENT FOR A PROPOSED 75 MW CONCENTRATING SOLAR THERMAL POWER PLANT AND ASSOCIATED INFRASTRUCTURE IN THE SIYANDA DISTRICT, NORTHERN CAPE

Final Environmental Impact Report
(Revision 01)

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SOLAFRICA
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GLOSSARY OF TERMS

Alternatives:	Different means of meeting the general purpose and requirements of the activity, which may include site or location alternatives; alternatives to the type of activity being undertaken; the design or layout of the activity; the technology to be used in the activity and the operational aspects of the activity.
Aquifer:	A geologic formation of porous rock, often sandstone that stores water, An aquifer may yield significant quantities of water to wells and springs and this water is often utilized as a primary source for municipal, industrial, irrigation and other uses.
Ambient Noise:	**Ambient sound level** or **ambient noise:** means the totally encompassing sound in a given situation at a given time, and usually composed of sound from many sources, both near and far. Note that ambient noise includes the noise from the noise source under investigation. The use of the word *ambient* should however always be clearly defined (compare with *residual noise*).
Cumulative impact:	The impact of an activity that in itself may not be significant but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area.
Do-nothing alternative:	The 'do-nothing' alternative is the option of not undertaking the proposed activity.
Environmental Impact Assessment (EIA)	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 as defined in NEMA.
Hydrology	The science encompassing the behaviour of water as it occurs in the atmosphere, on the surface of the ground, and underground.
Interested and Affected Party (I&AP)	Any person, group of persons or organisation interested in or affected by an activity; and any organ of state that may have jurisdiction over any aspect of the activity.
Plan of Study for Environmental Impact Assessment:	A document which forms part of a scoping report and sets out how an environmental impact assessment must be conducted.
Public Participation Process	A process in which potential interested and affected parties are given an opportunity to comment on, or raise issues relevant to, specific matters.
Red Data	Species listed in terms of the International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species,

Species	and/or in terms of the South African Red Data List. In terms of the South African Red Data List, species are categorised as being extinct, endangered, vulnerable, rare, indeterminate, insufficiently known or not threatened.

ABBREVIATIONS

°C	Degree Celcius
AEWA	Listed under the African-Eurasian Waterbird Agreement
ARC-ISCW	ARC-Institute for Soil, Climate and Water
AERMIC	American Meteorological Society and USEPA Regulatory Model Improvement Committee
ARI	Acute Respiratory Infections
BATNEEC	Best Available Techniques Not Entailing Excessive Costs
BEC	Bathusi Environmental Consultants
CARA	Conservation of Agricultural Resources Act
CDM	Clean Development Mechanism
CEPA	Canadian Environmental Protection Act
CERs	Certified Emissions Reductions
CHE	Christian Higher Education
COPD	Chronic Obstructive Pulmonary Disease
CSIR	Council for Scientific and Industrial Research
CSP	Concentrating Solar Power
DEA	Department of Environmental Affairs
DME	Department of Minerals and Energy
DMR	Department of Minerals and Resources
DNI	Direct Normal Irradiance
DTI	Department of Trade and Industry
EAP	Environmental Assessment Practitioner
EC	European Commision
ECA	Environment Conservation Act
EIA	Environmental Impact Assessment
EMFs	Environmental Management Frameworks
EMP	Environmental Management Plan
ENPAT	Environmental Potential Atlas
ESS	Environmental Scoping Study
EU	European Union
FIT	Feed-in Tariffs
FPAC	Forest Products Association of Canada
FSI	Faunal Specialists Incorporated
GCS	Groundwater Consulting Services (Pty) Ltd
GDACE	Gauteng Department of Agriculture, Conservation and Environment
GHG	Greenhouse Gas
GIS	Geographic Information System
GN	Government Notices
g/kg	Grams per kilogram
GWh	Gigawatt hour
ha	Hectares
HTF	Heat Transfer Fluid
Hu	Hutton
IAP	Indoor Air Pollution
I&APs	Interested and Affected Parties

IDP	Integrated Development Plans
IEM	Integrated Environmental Management
kV	kilo Volt
kW	kilo Watt
kWh/m^2	Kilowatt hour per square meter
LED	Local Economic Development
LIDPs	Local Integrated Development Plans
LPG	Liquid Petroleum Gas
LOWMA	Lower Orange Water Management Area
m^3	Cubic metres
MAR	Mean Annual Rainfall
MJ/m^2	Megajoule per square meter
$\mu g/m^3$	Micrograms per cubic meter
Ms	Mispah
MW	Megawatt
NC DENC	Northern Cape Department of Environment and Nature Conservation
NEMA	National Environmental Management Act
NERSA	National Energy Regulator of South Africa
NGDB	National Groundwater Database
NHRA	National Heritage Resources Act
NNW-SSE	North-North-West to South-South East
NO	Nitrogen Oxide
NO_2	Nitrous Dioxide
NSR	Noise Sensitive Receptors
NT	Near threatened
PBL	Planetary Boundary Layer
PM	Particulate Matter
Ppm	Parts per million
PPP	Public Participation Process
PV	Photovoltaic
R	Rand
Ra	Raptor
REFIT	Renewable Energy Feed-in Tariff
SABS	South Africa Bureau of Standards
SAHRA	South African Heritage Resources Agency
SANBI	South African National Botanical Institute
SANS	South African National Standards
SEGS	Solar Electric Generating Systems
SI	International System of Units
SO_2	Sulphur Dioxide
SPL	Sound Pressure Level
SS	Special regional significance
TDS	Total Dissolved Solids
UK	United Kingdom
UNEP	United Nations Environmental Programme
V	Vulnerable
WHO	World Health Organization
WMA	Water Management Area

WTP	Water Treatment Plant

1 INTRODUCTION

Increasing economic growth and social development within South Africa is placing a growing demand on energy supply. Coupled with the rapid advancement in economic and social development, is the growing awareness of environmental impact, climate change and the need for sustainable development.

Whilst South Africa relies heavily on coal to meet its energy needs, the country is well endowed with renewable energy resources that offer sustainable alternatives to fossil fuels. Renewable energy harnesses naturally occurring non-depletable sources of energy, such as solar, wind, biomass, hydro, tidal, wave, ocean current and geothermal, to produce electricity, gaseous and liquid fuels, heat or a combination of these energy types . The successful use of renewable energy technology in South Africa still requires extensive investigation, however, Concentrating Solar Power (CSP) technologies have been identified as being potentially viable and capable of being employed on a large scale.

1.1 Background

South Africa has a high level of renewable energy potential and to this end the South African Government has set a target 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. The renewable energy is to be utilised for power generation and non-electric technologies such as solar water heating and bio-fuels. This equates to approximately 4% (1 667 MW) of the projected electricity demand for 2013 (41 539 MW)[1].

To contribute towards this target and towards socio-economic and environmentally sustainable growth, and to kick-start and stimulate the renewable energy industry in South Africa, an appropriate market mechanism, the Renewable Energy Feed-in Tariff or REFIT programme, has been proposed by the National Energy Regulator of South Africa (NERSA). The establishment of the REFIT will provide an excellent opportunity for South Africa to increase the deployment of renewable energy in the country and contribute towards the sustained growth of the sector in the country, the region and internationally[2].

Feed-in Tariffs (FIT) are, essentially, guaranteed prices for electricity supply rather than conventional consumer tariffs. The capital costs involved in the development and construction of renewable energy generating facilities far outweighs the incremental costs of typical, fossil-fuel generation plant expansion and continued usage. The basic economic principle underpinning the REFIT is the establishment of a tariff (price) that covers the cost of generation plus a "reasonable return" to encourage developers to invest.

The proposed project involves diversification of electricity production fuel sources, improved efficiency in electricity production, a decrease in the quantity of fossil fuel burned, a decrease in Greenhouse Gas (GHG) emissions and a decrease in a number of other aerial pollutant

[1] Department of Minerals and Energy. 2003. *White Paper on Renewable Energy.*
[2] National Energy Regulator of South Africa. 2009. *South Africa Renewable Energy Feed-in Tariff (REFIT) Regulatory Guidelines.*

emissions. These can all be seen as making a contribution to improving the sustainability of development in South Africa. This is in line with Government's commitment to reduce the country's emissions by 34% by 2020 and 42% by 2025 with financial and technical support from the international community. The project can therefore be seen as making a contribution to improving the sustainability of development in South Africa.

The proposed Solafrica CSP project is likely to qualify for registration as a Clean Development Mechanism (CDM) project as the proposed development will lead to reductions in Greenhouse Gases (GHGs) due to the resultant reduction in electricity that will need to be produced from power plants using non-renewable resources like coal. A CDM is a project-based instrument that allows public or private entities to trade in GHG mitigating activities in developing countries and earn abatement credits called Certified Emissions Reductions (CERs). If the project is formally registered with the Executive Board of the CDM, managed by the United Nations Framework Convention on Climate Change, the reductions in GHGs levels achieved by the project can be registered as Certified Emission Reductions (CERs) allowing Solafrica to sell CERs (the formal name for carbon credits) to buyers who need these credits for compliance purposes in developed countries. In light of the above, Solafrica intends to develop the project as a CDM project and to generate and sell CERs to support the financial viability of the project.

The CDM requirements with regards to the CSP project include the following:

- Requirements defined by the international process include:
  - Projects must result in real, measurable and long-term emission reductions, as certified by a third party agency;
  - Emission reductions must be additional to any that would occur without the project, and
  - Projects must be in line with sustainable development objectives, as defined by the national government. In South Africa this is the Department of Energy which is the relevant national authority for CDM.

1.2 Project Overview

South Africa experiences some of the highest levels of solar radiation in the world. The average daily solar radiation in South Africa varies between 4.5 and 6.5 kWh/m^2 (16 and 23 MJ/m^2)[3], compared to approximately 3.6 kWh/m^2 for parts of the United States and ± 2.5 kWh/m^2 for Europe and the United Kingdom. Figure 1 below illustrates the annual solar radiation (direct and diffuse) for South Africa, which identifies significant solar resource potential for solar water heating applications, solar photovoltaic and solar thermal power generation.

In 2006, Eskom Holdings Limited conducted an Environmental Impact Assessment (EIA) Study for a pilot CSP plant with an installed capacity of approximately 100MWe. Through a

[3] Stassen, G.1996. *Towards a Renewable Energy Strategy for South Africa*, unpublished PhD Thesis, University of Pretoria.

series of feasibility studies and high level assessments undertaken by Eskom - land availability, land use capability, fuel availability and costs, grid connection capacity and strengthening effects, and DNI measurements were considered in the selection of feasible sites. Based on the afore-mentioned considerations the Northern Cape Province ranked as the most favourable area for the establishment of a new CSP plant. Within the Northern Cape Province, the Upington and Groblershoop areas were specifically identified as potential areas for the establishment of the CSP plant – the farms Olyvenhouts Drift, Bokpoort and Tampansrus were selected for further detailed investigation. Subsequent to the Scoping and EIA studies, the farm Olyvenhouts Drift was selected as the preferred site and with consideration of the site specific environmental sensitivities, a preferred location for the plant on the farm was selected. Eskom received authorisation from the Department of Environmental Affairs to construct the CSP plant during 2006.

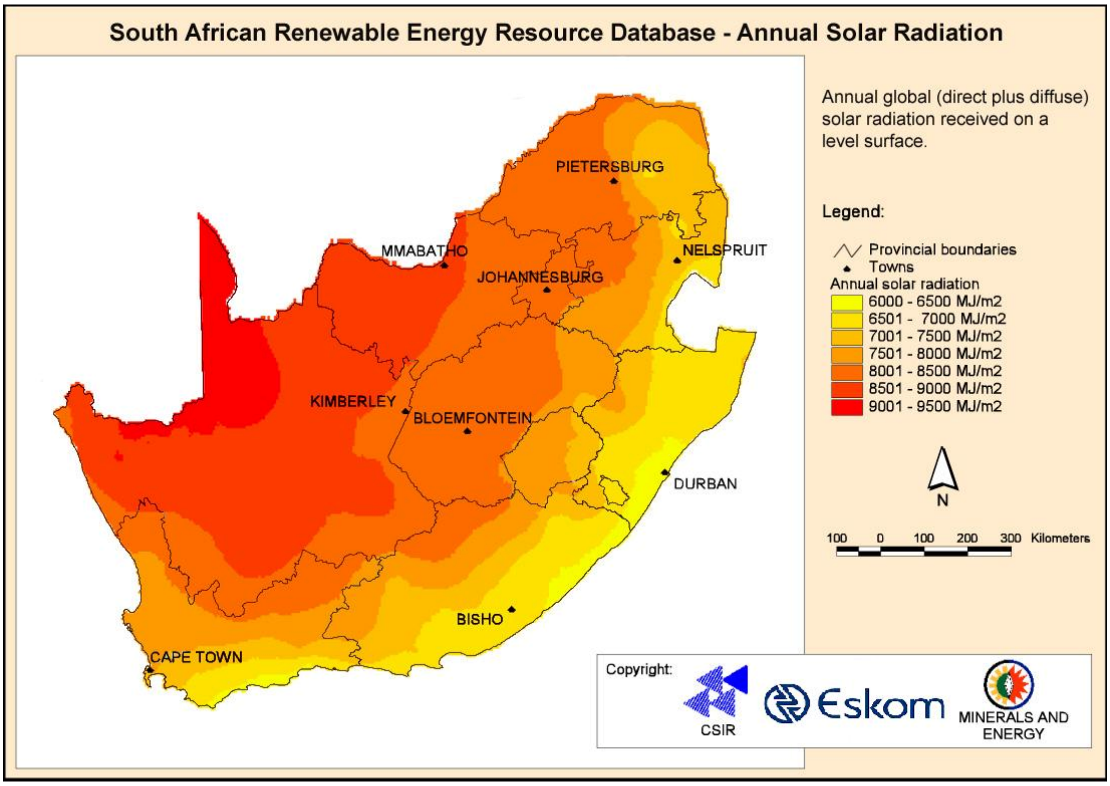


Figure 1: Annual incoming short wave radiation for South Africa (Courtesy: DME, Eskom, CSIR)[4]

Table 1: International solar potential relative to South Africa

Location	Site Latitude	Annual DNI (kWh/m^2)	Relative Solar Resource
South Africa			
Upington, Northern Cape	28°S	2955	100%

[4] Department of Minerals and Energy, Eskom, CSIR. 2001. South African Renewable Energy Resource Database, www.csir.co.za/environmentek/sarerd/contact.html.

Location	Site Latitude	Annual DNI (kWh/m^2)	Relative Solar Resource
United States			
Barstow, California	35°N	2725	92%
Las Vegas, Nevada	36°N	2573	87%
Albuquerque, New Mexico	35°N	2443	83%
International			
Northern Mexico	26 - 30°N	2835	96%
Wadi Rum, Jordan	30°N	2500	85%
Quarzazate, Morocco	31°N	2364	80%
Crete	35°N	2293	78%
Jodhpur, India	26°N	2200	74%
Spain	34°N	2100	71%

Against the backdrop of the above Eskom CSP EIA, Solafrica proposes the construction and operation of a CSP plant associated infrastructure in the Northern Cape Province in the region of two of the alternative sites identified during the Eskom CSP EIA study. The close proximity to the Eskom sites arises from the fact that the selection of feasible sites was guided by similar considerations as mentioned above. The two alternative sites identified by Solafrica were (refer to Figure 2 for the locality map):

- Site 1: Olyvenhouts Drift (15 km west of Upington), and
- Site 2: Bokpoort 390 (northwest of Groblershoop).

The power station is proposed to operate at an installed generation capacity of a maximum 75 MWe. The exact output will depend on the generating technology utilised, the specification of the equipment installed, and the ambient operating conditions. The potential impacts associated with the maximum output of 75 MWe have been evaluated within the environmental studies. The footprint of the proposed CSP plant is conservatively estimated at 350 hectares (ha).

It is preferred that the proposed power plant will utilise a wet cooling method to condense steam, used to drive a turbine, back into water. According to an engineering pre-feasibility study completed by Hatch during July 2010, the plant operation will require approximately 859 000 m^3 of water per year. The environmental impact assessment has been based on this maximum amount of water that may be used and the associated abstraction system. If this volume of water is not available from the water resource, the plant will utilise dry cooling or a wet-dry hybrid system employing both evaporative and dry cooling components. In such cases, the overall impact will be lower in respect of water use and transfer.

Figure 2: Locality map showing the two alternative sites considered for the construction of the CSP plant

1.3 Approach to the EIA Studies

The National Environmental Management Act (NEMA) (No. 107 of 1998) states that the principles of Integrated Environmental Management (IEM) should be adhered to in order to ensure sustainable development. A vital underpinning of the IEM procedure is accountability to the various parties that may be interested in or affected by a proposed development. Public participation is a requirement of the IEM procedure, in terms of the identification of potentially significant environmental impacts during the Scoping phase. The IEM procedure aims to ensure that the environmental consequences of development proposals are understood and adequately considered during all stages of the project cycle, and that negative aspects are resolved or mitigated and positive aspects enhanced.

The NEMA EIA Regulations, which replaced the Environment Conservation Act - ECA EIA Regulations - have been promulgated and came into effect on 3 July 2006. Sections 24 and 24D of NEMA, as per Government Notices (GN) R386 and R387 (April 2006) contain a schedule of activities that are considered likely to have substantial detrimental effects on the environment and which require authorisation from the competent environmental authority.

The nature of the proposed project includes activities listed in these schedules. The primary triggers are (according to GN R386 and R387) included in Table 2.

Table 2: Listed activities according to GN. R386 and R387

GN. R386 – LISTING NOTICE 1	
Activity 1(k)	The construction of facilities or infrastructure, including associated structures or infrastructure, for The bulk transportation of sewage and water, including storm water, in pipelines with - i. An internal diameter of 0,36 metres or more; or ii. A peak throughput of 120 litres per second or more.
Activity 1(m)	The construction of facilities or infrastructure, including associated structures or infrastructure, for 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.
Activity 4	The dredging, excavation, infilling, removal or moving of soil, sand or rock exceeding 5 cubic metres from a river, tidal lagoon, tidal river, lake, in-stream dam, floodplain or wetland.

Activity 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.
Activity 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).
Activity 15	The construction of a road that is wider than 4 meters or that has a reserve wider than 6 meters, excluding roads that fall within the ambit of another listed activity or which are access roads of less than 30 meters long.
GN. R387 – LISTING NOTICE 2	
Activity 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.
Activity 1(l)	The construction of facilities or infrastructure, including associated structures or infrastructure, for the transmission and distribution of above ground electricity with a capacity of 120 kilovolts or more.
Activity 2	Any development activity, including associated structures and infrastructure, where the total area of the developed area is, or is intended to be, 20 hectares or more.

In order to obtain the necessary environmental authorisation from the relevant regulating authority, the undertaking of the appropriate environment assessment process (as prescribed by the EIA Regulations) by an independent Environmental Assessment Practitioner (EAP) was required prior to the commencement of any construction related activities associated with the proposed project.

In terms of Regulation 21 of GN. R 385 (April 2006), should an application for environmental authorisation be required for any activity listed in GN R387 (Listing Notice 2) then the undertaking of an EIA Process is required (Figure 3) – according to the provisions of the EIA Regulations, an *EIA Process* is triggered for the Solafrica CSP project.

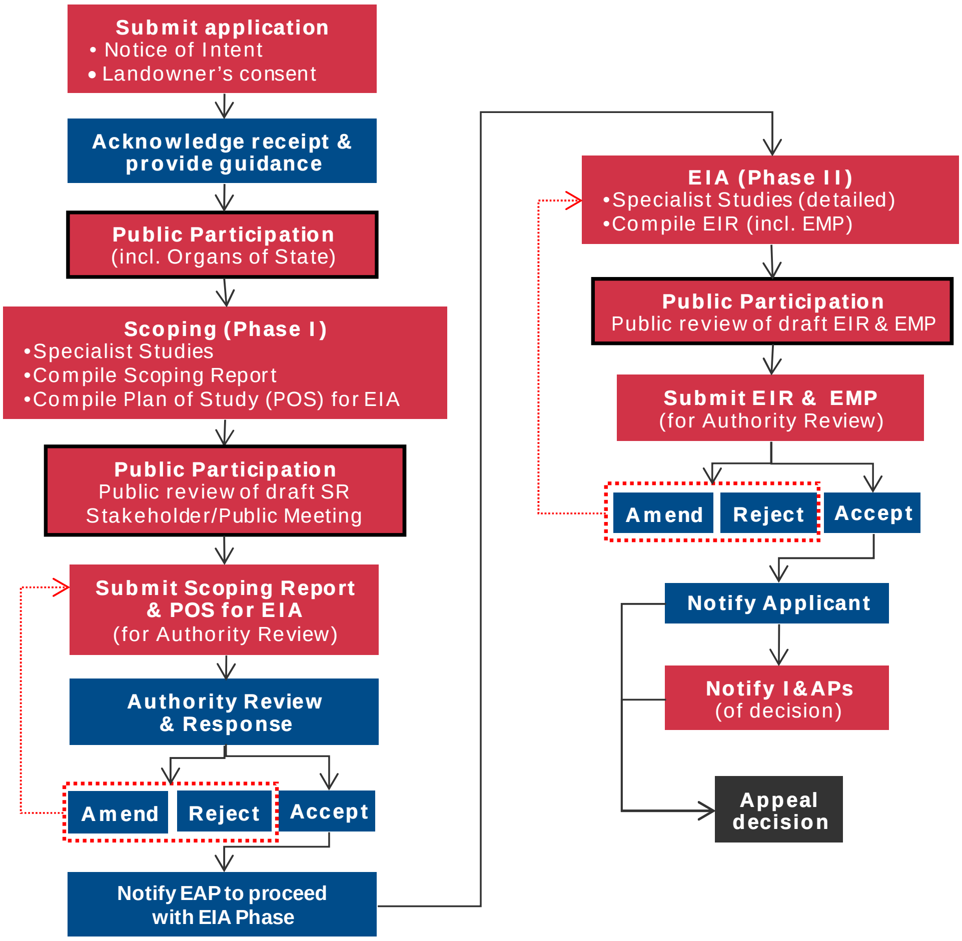


Figure 3: EIA Process flow diagram

The required environmental studies included the undertaking of an Environmental Impact Assessment (EIA) process. This process was undertaken in two phases:

- Phase 1 - Environmental Scoping Study (ESS), and
- Phase 2 - Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP).

1.3.1 Environmental Scoping Study

An application for authorisation in terms of Section 24 of the National Environmental Management Act (Act No. 107 of 1998) for activities listed in Table 2 above was submitted to the Department of Environmental Affairs (previously known as the Department of Environmental Affairs and Tourism or DEAT) during March 2010.

An ESS for the proposed construction and operation of the Solafrica Concentrating Solar Thermal Power Plant was undertaken in accordance with the EIA Regulations published in Government Notice R385. The scope of this phase of the EIA Process included the following:

- A brief project description (including a description of the proposed activity, alternatives considered, plans illustrating the study area, and brief technical details regarding the proposed project);
- A brief description of the pre-conversion environment;
- A description of environmental (biophysical and social) issues identified and potential impacts of the proposed project on these aspects (i.e. how the environment may be affected as a result of the proposed activity);
- A description of the public participation process, including the identification of I&APs, a record of the procedures followed, and the perceptions and views of the I&APs regarding the activity, and
- Conclusions and recommendations regarding the presence of any environmental fatal flaws and recommendations regarding further environmental work required within the EIA phase.

Existing information and input from specialists, the Authorities and I&APs were used to identify and evaluate potential environmental impacts (i.e. social and bio-physical) associated with the proposed Solafrica CSP project. The specialist studies also provided input into the site selection process through which a preferred site was nominated for further assessment in the EIA phase. No fatal flaws associated with the proposed project were identified during the EIA Process.

The Scoping phase of the environmental assessment process provided I&APs with the opportunity to participate in the process and raise issues of concern. The draft Environmental Scoping Report was made available at public places for I&AP review and commenting purposes from 12 May to 8 June 2010. Subsequent to the draft report review period public and focus group meetings with I&APs and Stakeholders were arranged on 17 and 18 June 2010. All the comments, concerns and suggestions received during the Scoping phase Public Participation Process were included in the final Scoping Report, which was submitted to the Department of Environmental Affairs (DEA) on 25 June 2010.

Acceptance of the Environmental Scoping Report and Plan of Study for Environmental Impact Assessment was received from DEA on 16 August 2010 (refer to ***Appendix A***). In terms of this acceptance, an Environmental Impact Assessment was required to be undertaken for the proposed project in accordance with the Plan of Study for EIA. No additional requirements to be addressed during the EIA phase were requested from the DEA.

1.3.2 Authority Consultation

The relevant authorities, that are required to provide input to the proposed project, were consulted from the outset of this study, and were engaged throughout the environmental assessment life-cycle.

The required application form submission process has been completed and the Plan of Study for EIA approved by the DEA. The authority mandated to provide a decision regarding the application for environmental authorisation for the proposed project is the national

Department of Environmental Affairs. The authority consultation process to date has included the following activities:

- Submission of an application for authorisation in terms of the provisions of GN. R385 to R387 of the NEMA to the DEA, together with a *'Declaration of Independence'* from the environmental assessment practitioner;
- Submission to and approval of an Environmental Scoping Report by the DEA, and
- Ad hoc consultation with DEA and Northern Cape Department of Environment and Nature Conservation (NC DENC) if and when required.

1.3.3 Environmental Impact Assessment Study

As part of the overall project planning process, this Environmental Impact Assessment aims to achieve the following:

- To provide an overall assessment of the social and biophysical environments of the affected area by the proposed CSP project;
- To undertake a detailed assessment of the preferred site/s in terms of environmental criteria including the rating of significant impacts;
- To identify and recommend appropriate mitigation measures (to be included in an EMP) for potentially significant environmental impacts; and
- To undertake a fully inclusive public participation process to ensure that I&AP issues and concerns are recorded and commented on and addressed in the EIA process.

1.3.4 Specialist Studies

In undertaking the Environmental Impact Assessment Process, Bohlweki Environmental was assisted by various specialists in order to comprehensively identify both potentially positive and negative environmental impacts (social and biophysical) associated with the Solafrica CSP project, evaluate the significance of the identified impacts, and propose suitable mitigation measures, where required. The environmental specialist team identified and evaluated the potential impacts for the nominated preferred site i.e. the Remainder of the Farm Bokpoort 390. These specialists and their fields of expertise are outlined in Table 3.

Several specialist studies previously conducted for the Eskom CSP EIA[5] during 2006 were consulted and referred to as part of the Solafrica EIA for impacts specifically relating to soils, social and land use, heritage and tourism.

[5] Bohlweki Environmental. 2006. *Environmental Impact Assessment for the establishment of a New Concentrating Solar Power (CSP) plant and associated infrastructure in the Northern Cape Province.*

Table 3: Specialist studies undertaken during the EIA

Specialist Field	Specialist and Organisation
Avifauna Impact Assessment	*Chris van Rooyen* – Chris van Rooyen Consulting
Biodiversity Assessment	*Riaan Robbeson* – Bathusi Environmental Consulting) *Dewald Kamffer* - Faunal Specialists Incorporated
Geohydrology	*Kobus Troskie* - Groundwater Consulting Services
Noise Impacts	*Derek Cosijn* - Jongens Keet and Associates
Visual Impact Assessment	*Dr. Dawie van Vuuren* – MetroGIS
Air Quality Impact Assessment	*Nicola Walton* – Bohlweki-SSI Environmental
Aquatic Impact Assessment	*Mathew Ross* – EnviRoss cc
Heritage†	*Cobus Dreyer*
Social and Land Use Study†	*Dawid de Waal* - Afrosearch
Soils and Agricultural Potential†	*Garry Paterson* - Agricultural Research Council: Institute for Soil, Climate and Water
Tourism†	*Martin Jansen van Vuuren* - Grant Thornton Tourism Hospitality and Leisure
Hydrology†	*Arthur Chapman* - CSIR

* The Aquatic Impact Assessment was undertaken as part of the Water Use Licence Application

† Specialist studies from the EIA study for the Eskom CSP plant

In order to evaluate the significance of the potential impacts related to the proposed CSP project, the following characteristics of each potential impact were identified:

- The *nature*, which shall include a description of what causes the effect, what will be affected and how it will be affected;
- The *extent*, wherein it will be indicated whether the impact will be limited to the immediate areas or site of the development activity (local), limited to the immediate surroundings, sub-regional, regional, and/or national;
- The *duration*, wherein it will be indicated whether the lifetime of the impact will be of a short duration (0-5 years), medium-term (5 – 15 years), long-term (> 15 years) or permanent;
- The *probability*, which shall describe the likelihood of the impact actually occurring, indicated as improbable (low likelihood), probable (distinct possibility), highly probable (most likely) or definite (impact will occur regardless of any preventative measures), and
- The *significance*, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high.

As the Applicant (Solafrica) has the responsibility to avoid or minimise impacts, and plan for the management of such impacts (in terms of the EIA Regulations), the appropriate mitigation of significant impacts identified during the assessment process is required to be addressed as a key outcome of the EIA process – such mitigation is discussed.

1.4 Legal Considerations

A preliminary review of the relevant legislation was undertaken in order to identify any legal issues related to the proposed project. Applicable environmental legislation, which must be considered by Solafrica during the implementation of the proposed project, is summarised in Table 4 below.

Table 4: Summary of applicable environmental legislation

Legislation	Sections	Relates to
The Constitution (Act No 108 of 1996)	Chapter 2	Bill of Rights.
	Section 24	Environmental rights.
	Section 25	Rights in property.
National Environmental Management Act (No 107 of 1998)	Section 2	Defines the strategic environmental management goals and objectives of the government. Applies throughout the Republic to the actions of all organs of state that may significantly affect the environment.
	Section 24(a) &(d) &24(5)	Listed activities and Regulations
	Section 28	The developer has a general duty to care for the environment and to institute such measures as may be needed to demonstrate such care.
National Water Act (No 36 of 1998)	Section 21	The regulation of specific water uses.
National Environmental Management: Air Quality Act (No 39 of 2004)		Regulation of air quality monitoring, management and control.

Legislation	Sections	Relates to
National Environmental Management: Waste Act (No 59 of 2008)		Regulation of the management of waste by providing national norms and standards, specific waste management measures and process(es) for the licensing and control of waste management activities.
National Environmental Management: Biodiversity Act (No 10 of 2004)		The management and conservation of South Africa's biodiversity within the framework of the National Environmental Management Act, 1998. The protection of species and ecosystems that warrant national protection.
Environment Conservation Act (No 73 of 1989)	Section 2	General policy.
	Section 16	Provides for the setting aside of Protected Natural Environments (PNEs). Any construction activities within the PNE require the consent of the PNE management advisory committee and the Premier of the relevant province.
	Sections 19 and 19A	Prevention of littering by employees and subcontractors during construction and the maintenance phases of the proposed project.
The Conservation of Agricultural Resources Act (No 43 of 1983)	Section 6	Implementation of control measures for alien and invasive plant species.
National Heritage Resources Act (No 25 of 1999)		Provides general principles for governing heritage resources management throughout South Africa including national and provincial heritage sites, burial grounds and graves; archaeological and paleontological sites, and public monuments and memorials
Occupational Health and Safety Act (No 85 of 1993)	Section 8	General duties of employers to their employees.

Legislation	Sections	Relates to
	Section 9	General duties of employers and self employed persons to persons other than their employees.
Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act (No 36 of 1947)	Sections 3 to 10	Control of the use of registered pesticides, herbicides (weed killers) and fertilisers. Special precautions must be taken to prevent workers from being exposed to chemical substances in this regard.
Hazardous Substance Act (No 15 of 1973)		Provides for the control of substances which may cause injury or ill-health to or death of human beings by reason of their toxic, corrosive, irritant, strongly sensitizing or flammable nature.
National Forest Act (No 84 of 1998)	Section 15	The protection of certain flora (tree) species.
National Veld and Forest Fire Act (Act 101 of 1998)	Chapter 4	Duty of owners for the preparation and maintenance of firebreaks.
Nature and Environmental Conservation Ordinance (No 19 of 1974)		The preservation and conservation of fauna and flora.
All relevant Municipal bylaws and ordinances		

1.5 Details of the Applicant

Solafrica has been established as a renewable energy project development company, focusing on solar thermal and solar Photovoltaic (PV) technologies. Solafrica was established to participate in the REFIT programme and the broader supportive regulatory regime in South Africa for renewable energy. The current CSP project is the first project under development by Solafrica, but the company intends to develop further projects given the indications of long term support for renewable energy in general and solar energy in particular as evidenced by the Industrial Policy Action Plan of South Africa amongst other policies.

Table 5: Details of the Applicant

Applicant:	Solafrica Thermal Energy Pty Ltd
Contact Person(s):	Marc Immerman or Michael Goldblatt

Telephone Number:	(011) 268 4048 or 082 337 9792
Facsimile Number:	086 601 7002
E-mail address:	marci@lerekometier.com or mike@solafrica.co.za

1.6 Details of the Environmental Assessment Practitioner

Bohlweki-SSI Environmental (Bohlweki-SSI) has been appointed as an EAP by Solafrica, to undertake the appropriate environmental studies for this proposed project. The professional team of Bohlweki-SSI has considerable experience in the environmental management and EIA fields.

Bohlweki-SSI has been involved in and/or managed several of the largest Environmental Impact Assessments undertaken in South Africa to date. A specialist area of focus is on assessment of multi-faceted projects, including the establishment of linear developments (national and provincial roads, and power lines), bulk infrastructure and supply (e.g. wastewater treatment works, pipelines, landfills), electricity generation and transmission, the mining industry, urban, rural and township developments, environmental aspects of Local Integrated Development Plans (LIDPs), as well as general environmental planning, development and management.

The particulars of the EAP are presented in below:

Table 6: Details of the EAP

Consultant:	Bohlweki-SSI Environmental
Contact Persons:	Frank Benedek or Malcolm Roods
Postal Address:	PO Box 867 Gallo Manor 2052
Telephone:	011 798 6430 / 011 798 6442
Facsimile:	011 798 6010
E-mail:	frankb@ssi.co.za / malcolmr@ssi.co.za
Expertise:	Frank Benedek holds a BSc Degree in Geography and Environmental Sciences from the Potchefstroom University for CHE. Prior to joining Bohlweki-SSI Environmental he worked at Marsh (Pty) Ltd as environmental consultant and the Gauteng Department of Agriculture, Conservation and Environment as an Environmental Officer in the Environmental Planning and Impact

	Assessment division. Frank's experience lies in Environmental Impact Assessment and Management, Environmental Management Plans and Environmental Planning. He is currently responsible for facilitating environmental impact assessments principally for property, industrial and agricultural development projects.
	Malcolm Roods is currently employed as a Principal with Bohlweki-SSI Environmental. Malcolm holds a Higher Education Diploma and an Honours degree in Environmental Management (2000)] focusing on EIAs. Before joining SSI Engineers & Environmental Consultants in 2007, he worked at the Gauteng Department of Agriculture, Conservation and Environment (GDACE) for a period of six years, where he was responsible for the management and review of all EIAs and Environmental Management Frameworks (EMFs) falling within the Sedibeng and Ekurhuleni area. He was also responsible for the development and implementation of various environmental polices and guidelines in Gauteng. During his employment at GDACE, he reviewed many EIA applications for residential, commercial, industrial developments, etc and was also responsible for strategic sectoral input for infrastructure developments, which included the telecommunications, rail and roads sectors.

1.7 Structure of this Report

Table 7: Report Structure

Chapter		Content
Chapter 1	*Introduction*	Introduction to project and approach to the Environmental Scoping Study.
Chapter 2	*Project Description*	Provides the technical description of the project as well as a description of the infrastructure.
Chapter 3	*Project Alternatives*	Consideration of alternatives (design/layout, site and do-nothing) for the proposed project.
Chapter 4	*Public Participation Process*	Overview of the public participation process conducted to date.
Chapter 5	*Site Selection and Sensitivity Analysis*	A detailed description of the site selection process and the sensitivity analysis concluded for the preferred site.

Chapter		Content
Chapter 6	*Description of the Study Area*	A description of the biophysical and social environment.
Chapter 7	*Environmental Impact Assessment*	A description of the environmental impacts on the biophysical and social environment.
Chapter 8	*Environmental Impact Statement*	Summary of the key environmental impacts (i.e. social and biophysical) associated with the project.
Chapter 9	*Conclusions and Recommendations*	Conclusions and recommendations of the Environmental Impact Assessment Study.

2 PROJECT DESCRIPTION

The following chapter provides an overview of solar energy as a source for electricity generation and details the CSP technology selected for the project and details regarding plant design.

Solafrica, an independent renewable energy developer, is proposing the development of a Concentrating Solar Thermal Power Plant with a maximum electricity generation capacity of 75 MWe on a portion of the Remainder of the Farm Bokpoort 390, located within the !Kheis Local Municipality jurisdictional boundary approximately 15 km north of the town of Groblershoop (refer to Figure 4). The portion of Bokpoort under investigation as part of the EIA Process measures approximately 6 500 ha however, a conservative development footprint of about 350 ha will be required for the plant facility. The proposed development will further entail the construction of various associated infrastructure required for a functional/operational power plant.

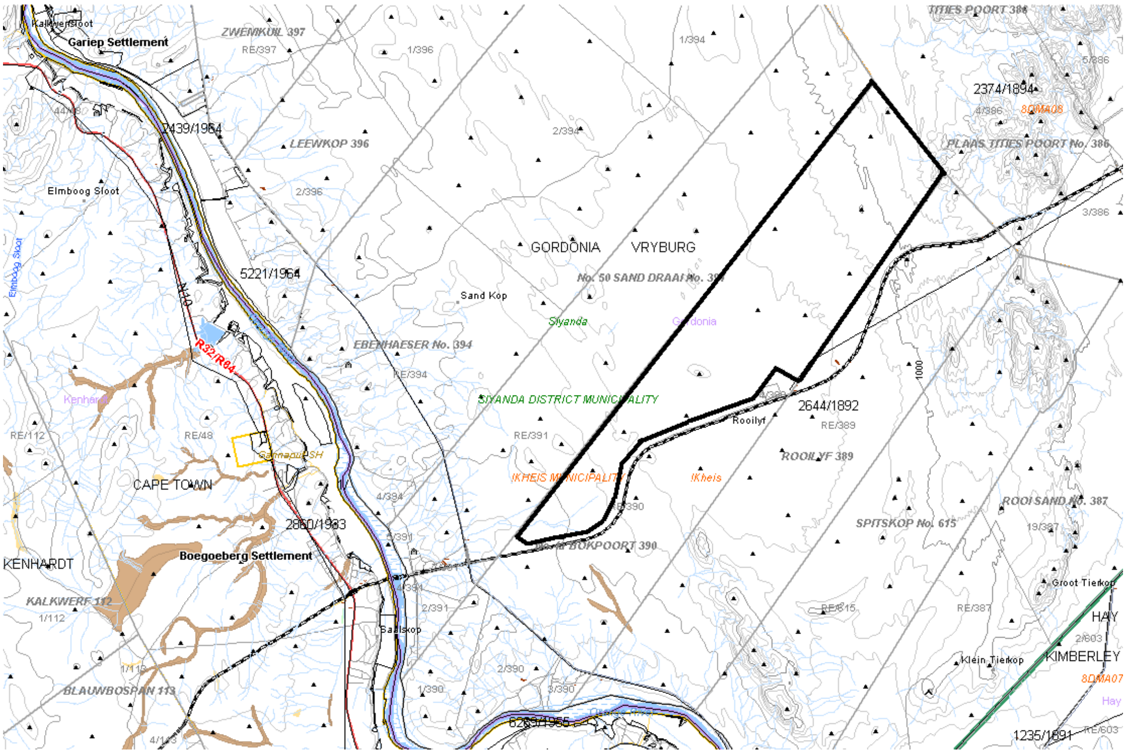


Figure 4: The Remainder of the Farm Bokpoort 390 – preferred development site

2.1 Electricity Generation using Concentrating Solar Power (CSP) Technologies

CSP technologies generate electricity in a similar way to conventional power stations – using steam to drive a turbine. The fundamental principle of Concentrating Solar Power (CSP) technologies is to collect the energy carried by sunrays, allowing a heat transfer fluid (HTF) to absorb the collected energy and then converting the thermal energy into further useful forms such as electricity.

The process of energy conversion in a CSP plant is illustrated in Figure 5. Since a thermal intermediary is always involved, a conventional steam power turbine generator can be coupled for power generation. Energy storage is possible either in thermal form (e.g.: steam, molten salt) or as electrical energy (e.g.: batteries). Losses occur throughout the energy conversion process.

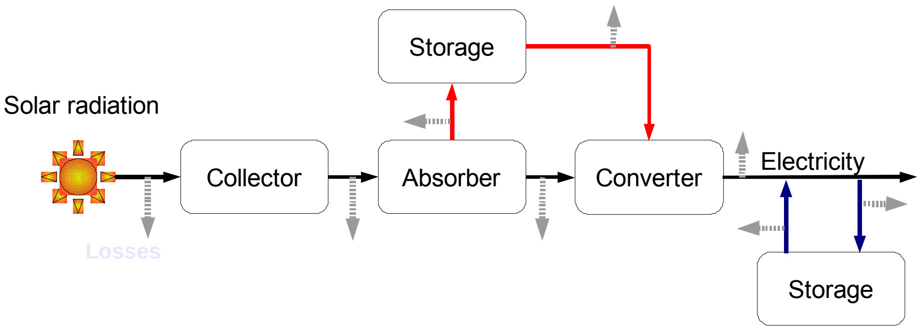


Figure 5: Schematic of the energy conversion in a CSP plant. Storage is optional (Red – thermal energy; Blue – electrical energy, Grey – losses)

2.2 Fundamental Terminology

2.2.1 Insolation, Irradiance and Irradiation

When considering CSP technology, it is important to understand the fundamental terminology.

Insolation is a portmanteau word for *in*cident *so*lar radi*ation*. It is a measure of solar radiation energy received on a given surface during a given time, typically in kWh/m^2/day or kWh/m^2/year.

Sunrays can be scattered by vapour or dust particles in air before reaching the Earth's surface. This is known as the diffuse irradiation. Only the parallel sunrays normal to the receiving surface can be concentrated, and this is the portion known as the Direct Normal Irradiance (DNI), which has the SI unit of W/m^2. In the solar power industry, irradiation with a time duration (typically in the form of Wh/day or kWh/year per unit area) is often used interchangeably with irradiance.

For consistency to international preference, DNI in this document will refer to Direct Normal Irradiation, with the unit of kWh/m^2/day or kWh/m^2/year, similarly with insolation for measuring energy. Figure 6 demonstrates that only parallel beams of sunrays can be concentrated. The diffuse or reflected portion cannot be concentrated.

Due to the directional property of sunrays, concentrating technologies must track the sun's path to receive DNI. Suitable sites are those that receive high levels of DNI, in locations known as the "sun belt", which typically receives more than 1 800 kWh/m^2/year of direct solar irradiation. Other site suitability considerations are water, access, grid access, and surface topography. Upington has one of the higher DNI levels of approximately 2900 kWh/m^2 per year.

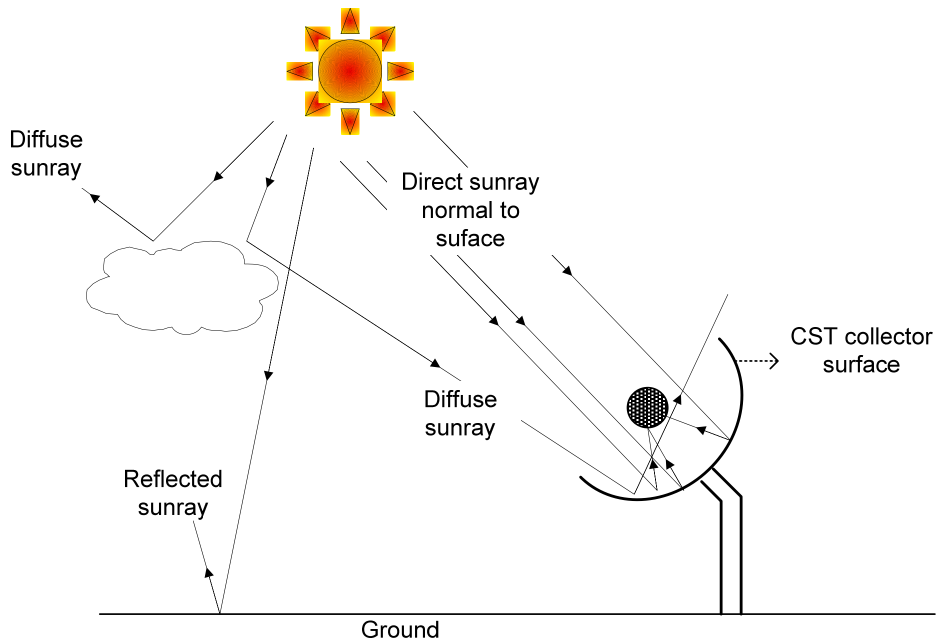


Figure 6: Directional property of sunrays

2.3 Concentrating Solar Power Technology Options

At present there are *four* principal CSP technologies, which are categorised by the method in which the technology focuses the sun's rays and receives the sun's energy. The four technologies are (Figure 7):

- ***Central Receiver/Power Tower*** - Sun-tracking mirrors called heliostats (glass mirrors) are mounted on an axis which reflects the sunlight to a central receiver. The central receiver is situated on the top of a single central tower, or alternatively on a number of smaller central towers. This receiver is a heat exchanger which absorbs the concentrated beam radiation, converts it to heat and transfers the heat to the working fluid (i.e. molten salt or water) which is in turn used to generate steam for conventional power generation.
- ***Parabolic Trough*** - Parabolic trough systems reflects solar radiation to a focal point – linear receiver. An absorber tube located at the focal point transfers solar energy to a working fluid which is used to drive a conventional power cycle.
- ***Parabolic Dish*** - A parabolic dish shaped reflector concentrates sunlight onto a receiver at the focal point of the dish. The concentrated radiation then heats a fluid or gas to approximately 750°C. Electricity is then generated using a Stirling Engine attached to the receiver using heated fluid or gas. The parabolic dishes are designed to track the sun along one axis.
- ***Linear Fresnel Reflector*** - This technology is a line focus system similar to parabolic troughs in which solar radiation is concentrated on an elevated inverted (downward facing) linear receiver/absorber using arrays of flat or slightly curved

mirrors/reflectors. Water flowing through the absorbers/receivers is heated and converted into steam. The steam is used to generate electricity by means of a turbine.

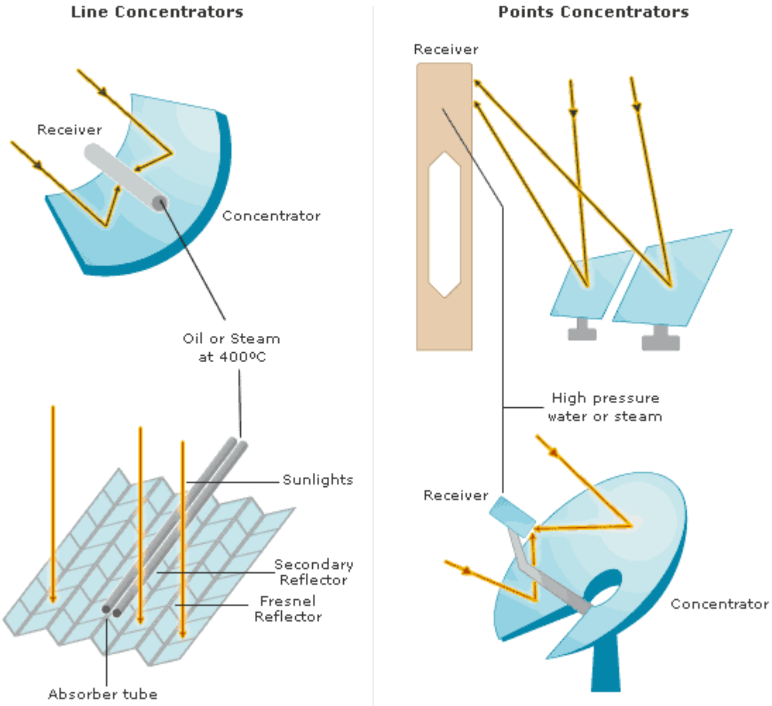


Figure 7: CSP technologies[6]

The primary CSP technologies globally are parabolic trough and central receiver/power tower. Both afore-mentioned technologies were considered by Solafrica during the Scoping phase of the project. The technology selection process was primarily guided by the technical and bankable feasibility of the technologies, and the preferred technologies prescribed by the REFIT Programme – Phase II. Based on the afore-mentioned key considerations Solafrica selected "parabolic trough" as the preferred CSP technology for the project – *refer to Chapter 3 for a description on the technology alternatives considered*.

2.4 The Proposed Concentrating Solar Power (CSP) Plant

2.4.1 Parabolic Trough Plant Operation Explained[7]

In a parabolic trough system the solar field consists of parallel rows of parabolic troughs in a modular configuration (refer to Figure 8, Figure 9 and Figure 10). The parabolic troughs are designed to track the sun directionally from east to west along one axis, predominantly orientated in a north–south direction. As the sun rises, the plant is taken out of it's stow or storage position, which is typically with the troughs positioned vertically, In order to initiate this start up procedure, auxiliary power is required. This is typically drawn off the utility grid into which the solar power plant feeds. If the grid power is not available, a small amount of power is required to run the backup and auxiliary systems. The auxiliary power, whether it be drawn

[6] http://www.abengoasolar.com/corp/web/en/technologies/concentrated_solar_power/what_is_it/index.html
[7] Hatch (2010) – "Functional Specification"

off the grid, or generated by a backup diesel driven generator, for example, is designed to be adequate to support such parasitic loads.

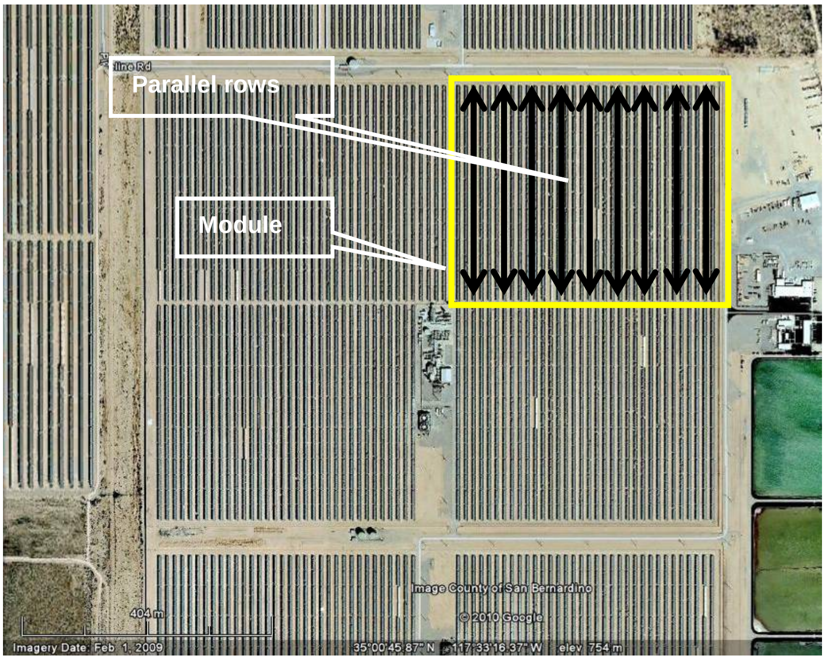


Figure 8: Photographic illustration of a parabolic trough (Source: Google Earth)

Figure 9: Photographic illustration of the Andasol plant in Spain[8]

[8] http://www.renewbl.com/2010/08/31/solar-millenium-sells-stake-in-ibersol-power-plant-to-ferrostaal.html

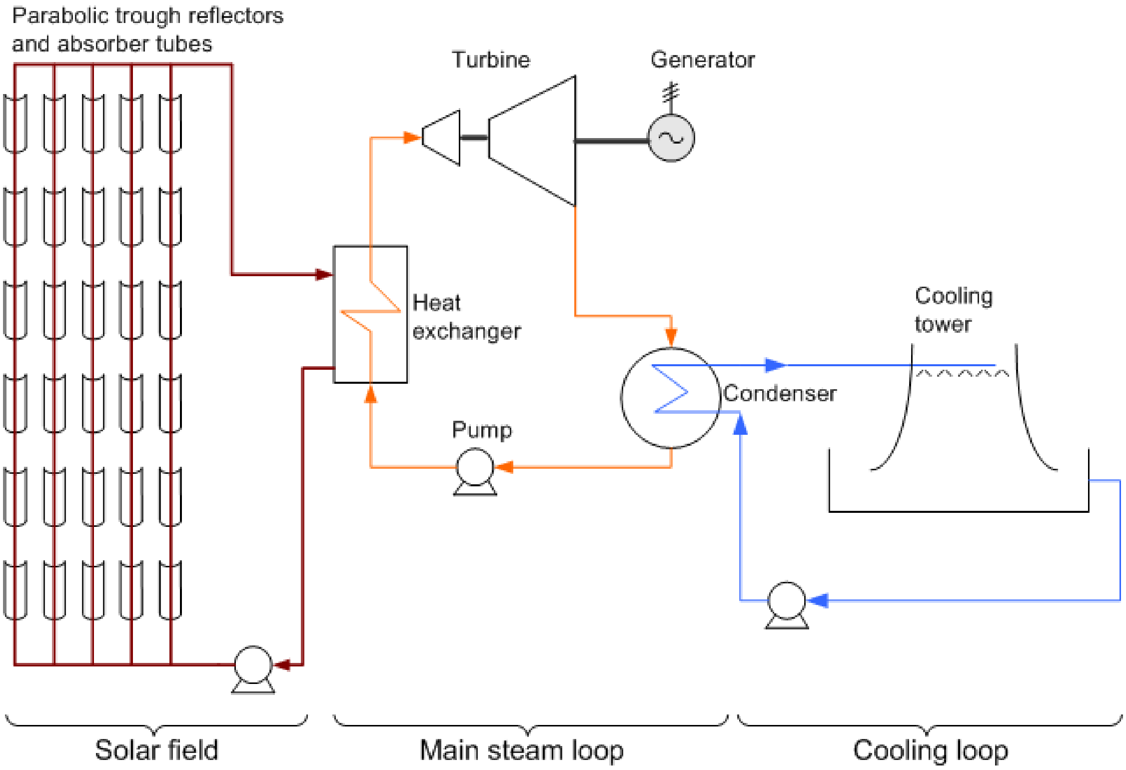


Figure 10: Typical configuration of a parabolic trough CSP plant[9]

Once the mirrors have been taken out of the stow position, automatic tracking of the sun commences (Figure 11). The parabolic trough solar collector is designed to concentrate the sun's rays via parabolic curved solar reflectors onto a thermally efficient linear receiver (Figure 12). The receiver is located in the optical focal line of the collector. The receiver consists of a specially coated absorber tube (Figure 13) embedded in an evacuated glass envelope. A HTF, typically a synthetic thermal oil, is circulated in the absorber tubes.

Figure 11: Mirrors in stow position[10]

[9] http://www.schottsolar.com/global/products/concentrated-solar-power/concentrated-solar-power-plants/
[10] http://www.siemens.com

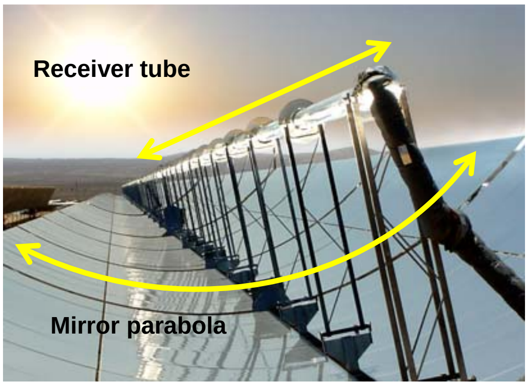


Figure 12: Photographic illustration of a parabolic trough[11]

Figure 13: A receiver tube[12]

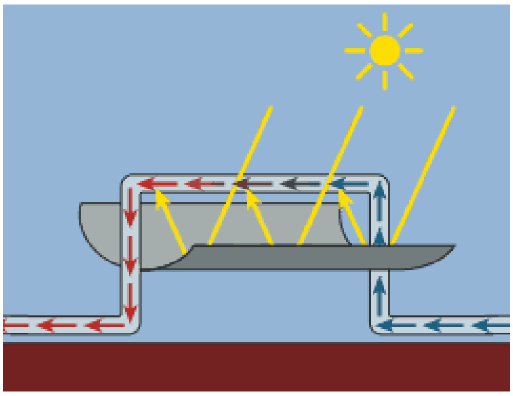


Figure 14: HTF circulation through receiver tube[13]

The HTF is circulated through the solar field using auxiliary power until the solar plant becomes self sustaining, after which the oil circulation is powered by the electricity generated by the solar plant (Figure 14). The HTF is then heated to approximately 400°C by the sun's concentrated rays and subsequently circulated using collector pipes through a series of heat exchangers which imparts the collected solar energy to water circulating through the turbine loop. This happens until the temperature of the water side of the system is heated sufficiently to generate steam. The cooled HTF is subsequently pumped back to the central receiver tubes and the cycle is repeated. The heat transfer (exchange) system is a closed system resulting in the re-use of the HTF. Due to wear and tear, the HTF will require replacement, small volumes are continuously bled off with new fluid being introduced into the system. Spent HTF will be stored in small volumes and periodically removed by a third party services provider for disposal at a registered waste management facility. *The relevance of waste management activities, listed in terms of the National Environmental Management: Waste Act (No 59 of 1998), to the proposed plant is to be determined once detailed engineering design of the CSP plant has been concluded.*

Steam is produced in the heat exchangers which act as a boiler. Thermal energy from the heated HTF is transferred to water with the purpose of generating preheated, evaporated and then superheated water (e.g.: 100 bar in Andasol-1, 50 MWe, Spain). The steam is utilised to turn a conventional steam turbine in the power block to generate kinetic energy which is in turn converted to electrical energy. The system has two steam loop cycles which enables the use of any remaining steam within a secondary turbine and generator system. This will enhance the system and optimise electricity generation.

[11] http://www.schottsolar.com/global/products/concentrated-solar-power/concentrated-solar-power-plants/
[12] TREE (Transfer Renewable Energy & Efficiency) seminar. (2009). Seminar material. March 18-20
[13] http://www.educypedia.be/education/solarenergy.htm

The remaining steam is then transported to a condenser which cools the steam to form water. After being cooled and condensed by a cooling mechanism the water is returned to the heat exchangers. Figure 15 illustrates the working of a condenser.

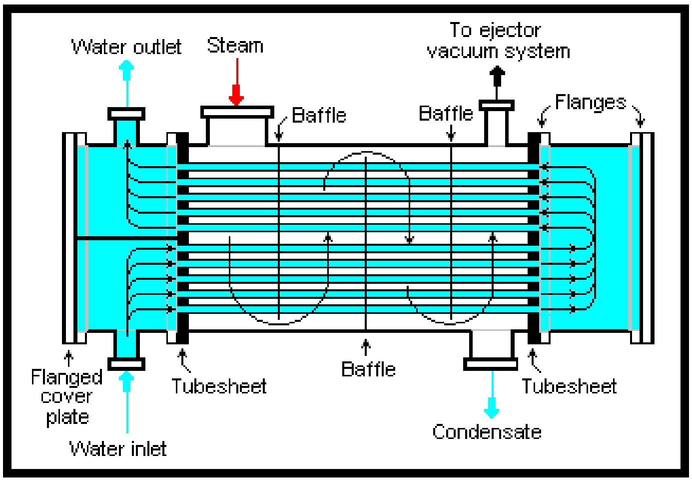


Figure 15: An illustration of a condensor

The main function of the cooling loop is to condense steam and cool water so that it can be re-used in the steam cycle loop. The cooling loop can either use water (wet cooling), air (dry cooling), or both (hybrid) as the cooling medium to the main steam loop. A re-circulating (evaporative) cooling, otherwise known as “wet cooling”, method is proposed for the Solafrica CSP plant - this method of cooling is most common for steam cycle power plants. Furthermore evaporative cooling is the most proven and effective cooling technique, however it uses considerable volumes of water compared to air and hybrid cooling methods. Should the DWA deem that insufficient water is available for evaporative cooling (estimated 859 000 m^3 of water per year), then dry and hybrid cooling methods will be considered for implementation. Dry and hybrid cooling is more costly and less energy efficient than evaporative cooling, hence the preference for evaporative cooling – *refer to Section 3.4.2 for a description of the cooling methods.*

Once the solar field and the steam loop have achieved critical values below which the plant will not operate, the power generation system becomes self sustaining. At this point the plant is still not connected to the external grid. Control of the alternator speed is governed automatically until the output of the alternator coincides with the grid electricity waveform, at which point the solar plant can be switched into the grid. The characteristics of the CSP output power would conform to the national grid codes.

The power plant electrical power output level must achieve a minimum level, typically 20% of the rated output power of the turbine, before it can be switched into the grid. This would normally be determined automatically, with facility for manual intervention.

As the sun arcs across the sky, more solar energy than would be required to run the plant at nameplate capacity is incident on the solar plant. If the plant output is limited by its producer licence, the collection of excess energy is prevented by moving parabolic trough mirrors into stow position until system equilibrium is reached.

As the sun sinks at the end of the day, so the collected energy levels decline. The solar plant can stay connected to the grid until the critical turbine power output level is achieved, at which point the solar plant is disconnected from the grid, either manually of by the automated control system. Once disconnected from the grid, the power block and solar fields are shut down.

The solar plant is also designed to incorporate thermal heat storage facilities. Heat storage allows a CSP plant to produce electricity at night and on overcast days. This allows the use of solar power for baseload generation as well as peak power generation. Additionally, the use of the generator is higher which reduces cost. For thermal storage, heat is transferred to a thermal storage medium in an insulated reservoir during the day, and withdrawn for power generation at night. The likely thermal storage medium to be used would be molten salts. Molten salt is used in solar power tower systems because it is liquid at atmosphere pressure, it provides an efficient, low-cost medium in which to store thermal energy, its operating temperatures are compatible with high-pressure and high-temperature steam turbines, and it is non-flammable and nontoxic.

The mirrors require periodic cleaning, varying typically between fortnightly to weekly, depending on the local conditions which affect the rate of dust deposition on the mirrors. Cleaning of the mirrors is done using dedicated high pressure cleaning equipment, with demineralised water as the cleaning medium. It is crucial that the cleaning water be pure, to avoid abrasion of the front surfaces of the mirrors using the high pressure cleaning equipment. As the plant is shut down at night, the mirror cleaning can be done at night, to maximise plant availability. Alternatively, a loop of the solar field can be moved to the stow position and cleaned, during the day.

Maintenance of the equipment and system comprising the power block would be subject to typical conventional steam turbine maintenance regimes. The downtime required for maintenance of the Power Generating System (GPS) would be similar to that required for conventional fossil fired power stations.

2.4.2 Turbine and Generator

The steam turbine will be a tandem-compound reheat condensing unit with the high-speed/high-pressure section connected by a speed reduction gear to a single-flow-single-casing low pressure reheat section.

A single turbine capable of the mechanical input required for a net generator power output of 75 MW will be included in the Power Block. This configuration will have a length, width, and height of 45m, 25m, and 13m respectively.

The turbine has two rotors (high and low pressure) connected to one another through a speed reduction gear and to the generator rotor with a solid bolted coupling. The steam turbine will be connected to a high-pressure steam inlet (supplying working steam from the steam generator) and a steam outlet (transferring spent steam to the cooling system and heat recovery system for re-heating). The turbine will also be connected, via a common axial shaft, to a single generator to which it supplies the input power that is converted to electricity.

2.4.3 Heat Exchanging and Cooling

The cooling system proposed by Solafrica for the plant will comprise of an evaporative cooling tower of the induced draught type with a multi-cell design (4 cells in total), each cell requiring a heat exchanger (therefore 4 heat exchangers). The cooling tower will comprise of four concurrent flow cells of lineal disposition having a total length, width, and height of 70m, 22m, and 20m respectively.

Three cooling methods will be investigated by Solafrica. The cooling methods are wet, dry and hybrid respectively. Each of the proposed cooling methods will be discussed in more detail in sections 2.4.3.1 to 2.4.3.4.

2.4.3.1 Wet Cooling

The preferred method will utilise an evaporation cooling tower (Figure 16). The cooling tower is a round chimney-like structure with piping surrounding the inner circle. The piping will be filled with the warm water from the condenser. Raw water from the Orange River will then be trickled down the sides of the tower over the piping. The water together with a wind tunnel that is naturally created within the centre of the cooling tower will cool the warm water in the tubing. Trickled water, from the piping, will be captured at the base of the cooling tower and is then pumped back to the top of the tower to repeat the cooling process.

In applying this cooling method the cooling water is cooled by evaporating a percentage of the water to the environment. Due to evaporation, there has to be a make-up water supply to account for the consumed water. The make-up water will be abstracted from the Orange River. *A Water Use License Application in terms of the National Water Act (Act 36 of 1998) for the abstraction of raw water from the Orange River will be submitted to the Department of Water Affairs for review and decision-making purposes – this process is being undertaken by Bohlweki-SSI.*

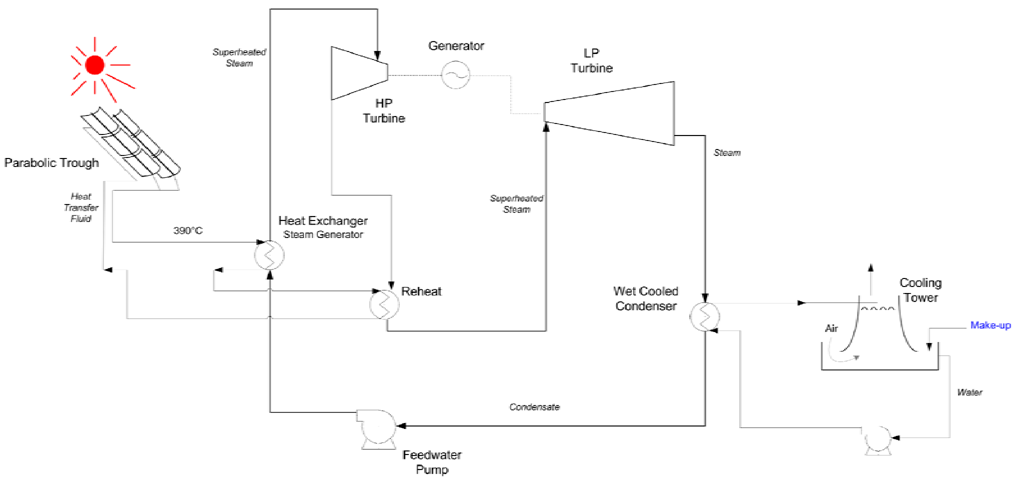


Figure 16: Flow diagram illustrating wet cooling technology[14]

[14] Hatch (2010) – “Water Resource Assessment”

2.4.3.2 Dry Cooling[15]

In a *direct dry cooling system*, steam is condensed directly by air in a heat exchanger and the condensate is pumped to the boiler in a closed loop. Mechanical fans induce air flow for the condensation process, rather than through the updraft induced by cooling towers (Figure 17).

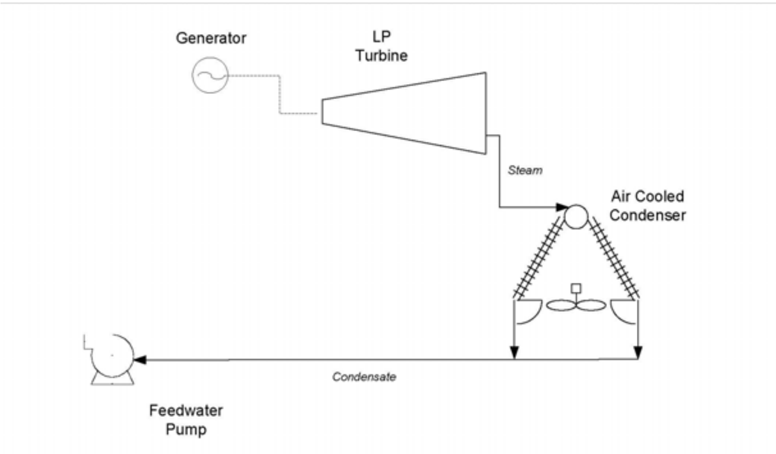


Figure 17: Flow diagram illustrating direct dry cooling technology[16]

An *indirect dry-cooling* system operates similarly to the wet-cooled system, the difference being that the system is closed and heat is dissipated via water-to-air heat exchangers, rather than evaporation of the cooling water. An advantage of indirect dry-cooling is that it consumes very little water as no water is lost via evaporation. The disadvantage is the construction cost of the cooling tower which is not necessary for direct dry-cooling. Comparing this design to a wet cooled plant, has the same advantages and disadvantages as the direct dry cooled design (Figure 18).

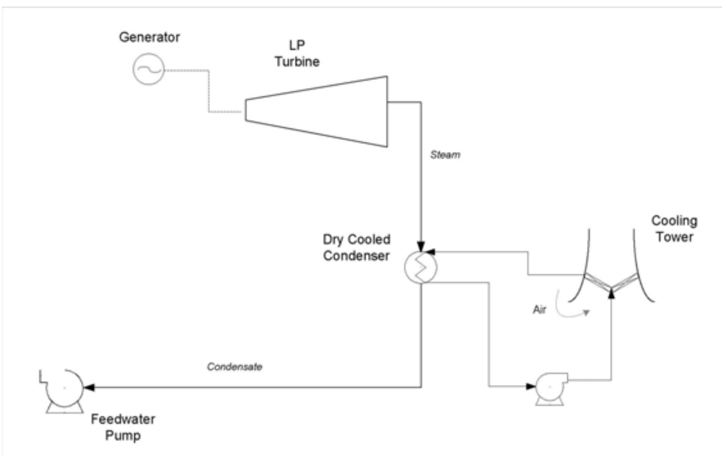


Figure 18: Flow diagram illustrating indirect dry cooling technology[17]

[15] Hatch (2010) – "Water Resource Assessment"
[16] Hatch (2010) – "Water Resource Assessment"
[17] Hatch (2010) – "Water Resource Assessment"

2.4.3.3 Hybrid Cooling[18]

A hybrid cooling system utilises an air cooled condenser in parallel with a wet, mechanical draft cooling tower. On high ambient temperature days, the wet system is placed in service, with a portion of steam being condensed on the wet cooled condenser and the balance condensed in the air cooled condenser (Figure 19).

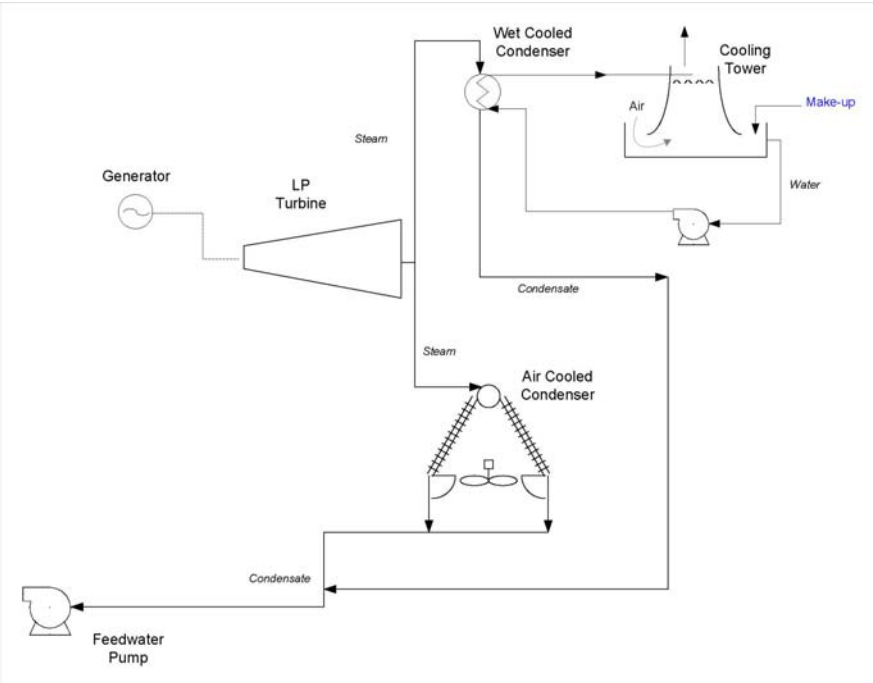


Figure 19: Flow diagram illustrating a hybrid cooling technology[19]

2.4.3.4 Cooling Methods – Advantages and Disadvantages[20]

Refer to Table 8 for an overview of the advantages and disadvantages of wet, dry and hybrid cooling methods employed for CSP plants.

Table 8: Advantages and disadvantages of various cooling methods[21]

Type	Advantages	Disadvantages
Wet cooling	• Lowest cost • Low parasitic loads • Small footprint • Best cooling, especially in arid climates	• High water consumption • Water treatment and blowdown disposal required

[18] Hatch (2010) – "Water Resource Assessment"
[19] Hatch (2010) – "Water Resource Assessment"
[20] Hatch (2010) – "Water Resource Assessment"
[21] Renewable Energy Laboratory (NREL) (2009), "Water use in Concentrating Solar Power"

Type	Advantages	Disadvantages
Dry Cooling	• Less water consumption • Less water treatment required • Lower operation and maintenance costs	• More expensive equipment • Higher parasitic loads • Larger footprint • Poorer cooling at high dry-bulb temperatures and turbine derate
Hybrid cooling	• Less water consumption • Potentially less expensive than dry cooling • Maintain good performance during hot weather	• Complication system involving wet and dry cooling • Same disadvantages of wet system, but to lesser degree

2.4.4 Thermal Storage

CSP plants may be designed to accommodate thermal energy storage systems. The systems allow CSP plants to become more dispatchable, meaning that power can be dispatched from the plant outside normal sunny operating conditions. Excess heat collected in the solar field is transferred to the heat exchanger and heats the storage medium (e.g. ceramics, concrete or phase-changing salt mixtures) going from the cold storage tank to the hot storage tank. When required, the heat from the hot storage tank can be transmitted to the HTF and consequently released to the steam cycle allowing the plant to continue producing electricity. The configuration of a parabolic trough CSP plant with storage is shown in Figure 20 as an example.

The proposed Solafrica CSP plant shall be designed for, but not necessarily fitted with on construction, a thermal storage system. The design shall accommodate at least 6 hours of thermal storage.

2.4.5 CSP Plant Typology

The proposed CSP plant will consist of two main functional elements:

- A solar field, and
- A power block.

In addition to the above the plant will comprise of the following major systems:

- Heat transfer system and provision for thermal storage tanks;
- Electrical plant;
- Control and instrumentation system;
- Standby heating system;

- Auxiliary and ancillary systems, and
- Civil works.

Figure 21 illustrates the primary interfaces between the solar field, power block, ancillary and auxiliary systems.

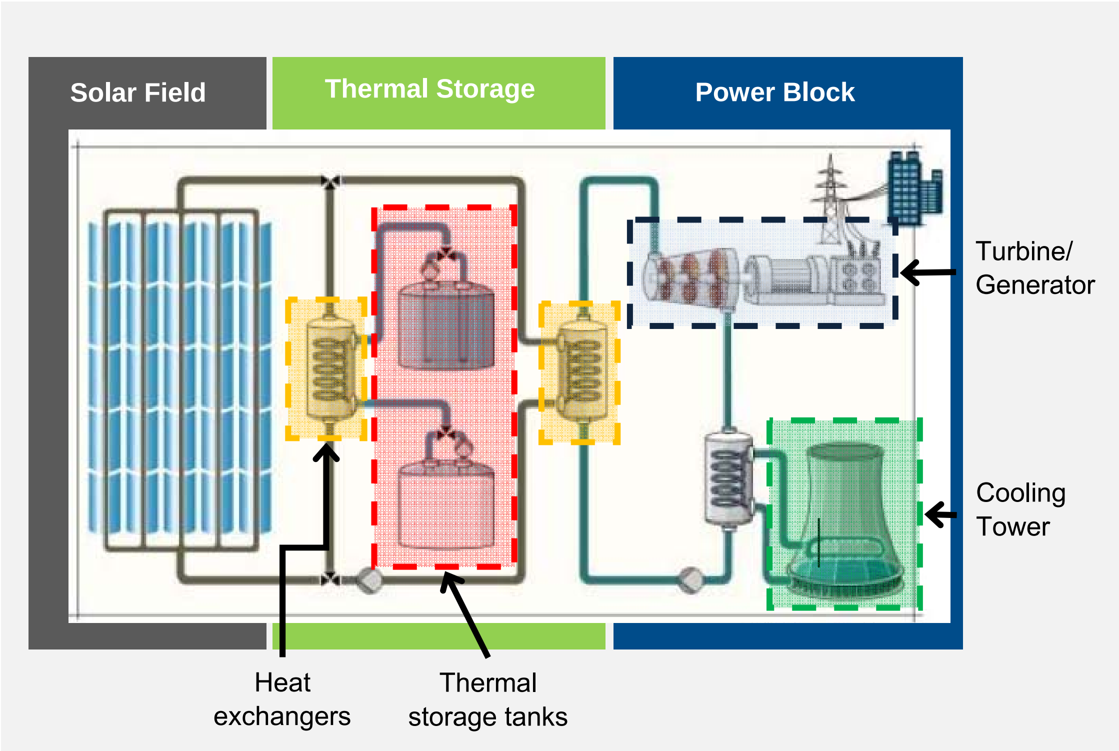


Figure 20: An example of a parabolic trough power plant with thermal storage

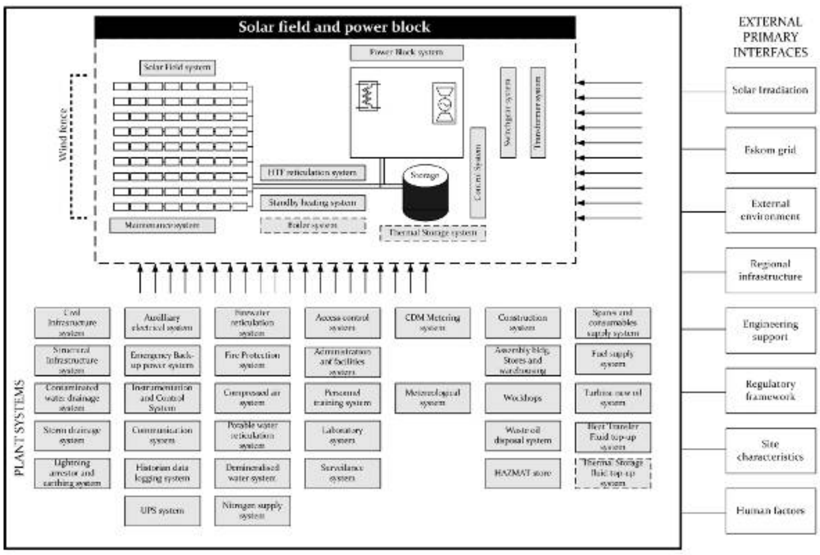


Figure 21: An illustrative plant interface[22]

[22] Power Station Interface Definition (Hatch, 2010).

Figure 22 depicts the conceptual layout plan for the proposed Solafrica CSP plant – the final location of the plant will be determined once a detailed geotechnical assessment of the preferred portion of Bokpoort has been undertaken. A final layout plan indicating the CSP plant will be submitted to the DEA once such details have been finalised.

2.4.6 CSP Plant Interfaces

2.4.6.1 Civil Works and Infrastructure

- **Plant Structures**

The following CSP plant structures are to be constructed on the proposed 350 ha development site:

Steam loops; power generator; reservoir; water treatment plant	Reinforced concrete structures.
Workshop (with over head crane)	Cladded steel structure with a 5 ton over head crane.
Pump-house; stores (equipment, liquids and gases); site ablution facilities.	Masonry structures with timber roof structure.

The SANS 10400:1990 – "*National Building Regulations"* shall apply to the plant.

- **Operations and Administration Block**

An operations and administration block will be constructed on site and will include the following:

- Office block - includes offices, board rooms, kitchen, dinning facilities, first aid room, ablution facilities, etc;
- Temporary staff accommodation;
- Access control building;
- Visitors centre:
- Shade ports;

The administration building, including office, storeroom and ablution facilities with the exception of the shade ports) is to be a two-storey masonry structure (maximum height of 12 m; 3m per floor and 3m pitch height) with a timber roof structure. The shade ports are to be constructed of tubular steel section covered with shade cloth.

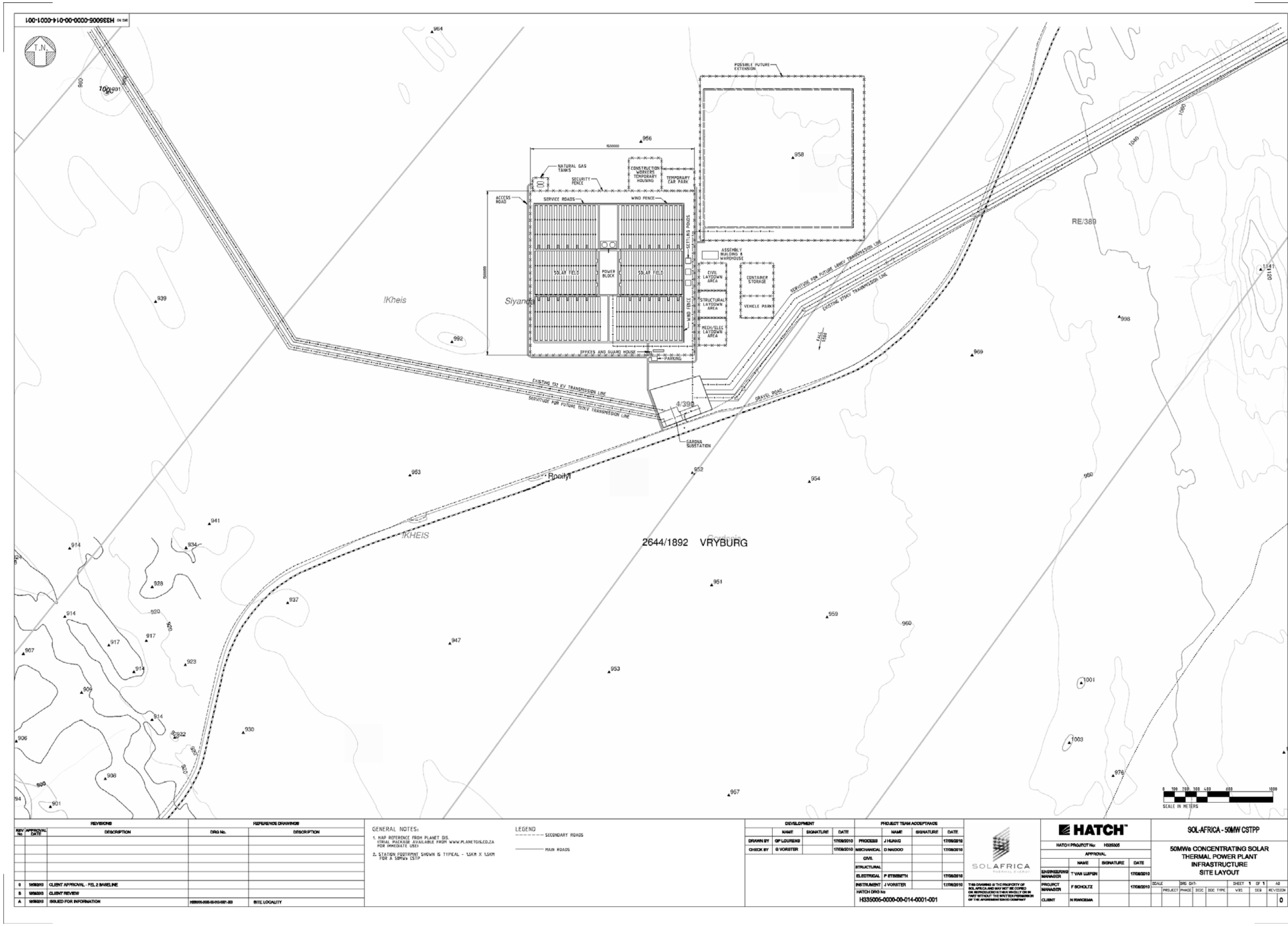


Figure 22: A conceptual layout for the proposed Solafrica CSP plant

2.4.6.2 Vehicle Access / Service Roads

New vehicle access/service roads and upgrades to existing roads (within in the local road network) will be required by Solafrica for the construction and operational phases of the proposed CSP plant in order to allow or improve accessibility to the proposed site. Existing roads (Transnet service and Northern Cape Provincial roads) will be upgraded according to the technical specifications required for heavy hauls/abnormal loads. It is not envisaged that such roads require broadening – the upgrade will likely entail the levelling of sections of these roads.

A new access road is to be constructed connecting the CSP Plant with the Transnet service road across the Farm Bokpoort. In the case of plant location alternatives A, the road will extend 1000 m to the plant, as depicted in Figure 23, having a road width of 8 m. The road will be fully tarred and constructed to meet the required standards for large construction vehicles.

For the case of plant location alternative B, a gravel road of length 3200m and width 8m will be constructed from the Transnet servitude exit from Farm Bokpoort along the farm boundary to a point adjacent to the plant location B. A fully tarred road of length 667m and width 8m will be constructed to connect the gravel road with the plant at location B. The gravel and tar portions of the road will be constructed to meet the required standards for large construction vehicles.

The main access roads and parking areas *on the plant* are to be paved and service roads (on the plant and security road) are to be unpaved.

2.4.6.3 Electricity Supply/Connection Infrastructure

For the plant to supply auxiliary electricity to Eskom’s local electricity distribution network, it is intended by Solafrica to construct a sub-transmission (overhead) powerline, with a nominal voltage of *132 kV*, to allow for connection to Eskom’s Garona substation (located on the Farm Bokpoort). Power generated by the CSP plant’s steam turbine generator will be stepped up by way of on-site transformers from 11-12 kV to 132 kV, to match the rating of the Garona distribution line. The Garona substation forms part of the national transmission network which will enable the supply of electricity to Eskom’s distribution network[23] running from the Garona substation to the Upington region in addition to the transmission network[24] running from Garona substation to the Ferrum substation (near Sishen).

The *132 k*V powerline (height = 25m) requires a 32m wide servitude (or 16m to each side measured from the powerline’s centreline).

[23] Electrical power network where the nominal voltage is equal or less than 132kV.
[24] Electrical power network where the nominal voltage exceeds 132kV.

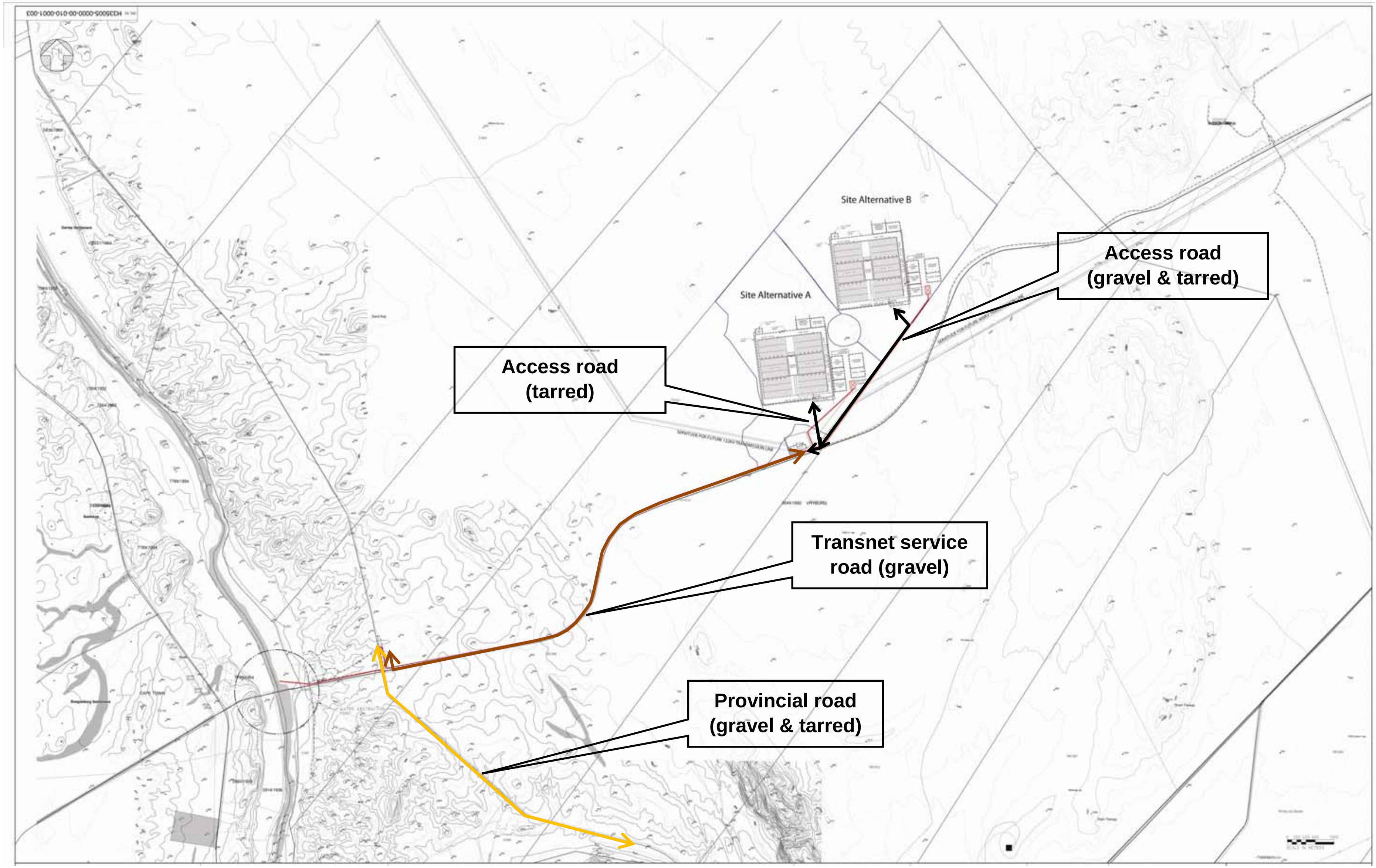


Figure 23: Access roads to the Solafrica CSP plant

The design of overhead power lines shall comply with the requirements of the following:

- SANS 10280:2001 - *"Overhead power lines for conditions prevailing in South Africa"*;
- SANS 10280-1:2008 / NRS 041-1:2008 - *"Overhead power lines for conditions prevailing in South Africa Part 1: Safety"*, and
- Occupational Health and Safety Act – Electrical Machinery Regulations (March 2005).

To allow for connection of the proposed CSP plant to the Garona substation, the substation will require upgrading by the installation of an additional feeder bay including protection equipment which may be deemed necessary by the National Transmission Company[25] or Eskom.

The powerline alignment alternatives for the respective plant location alternatives are illustrated in Figure 24 and Figure 25. It is proposed that a 100 metre corridor be applied to each of the alignment alternative respectively to allow for the maneuverability of the powerline alignment within the proposed corridor should any physical constraints, e.g. geotechnical characteristics, restrict a specific alignment or a portion of an aligment during detailed design. Construction activities associated with the powerline should be confined to the corridor for purposes of restricting the sterilisation of use of land.

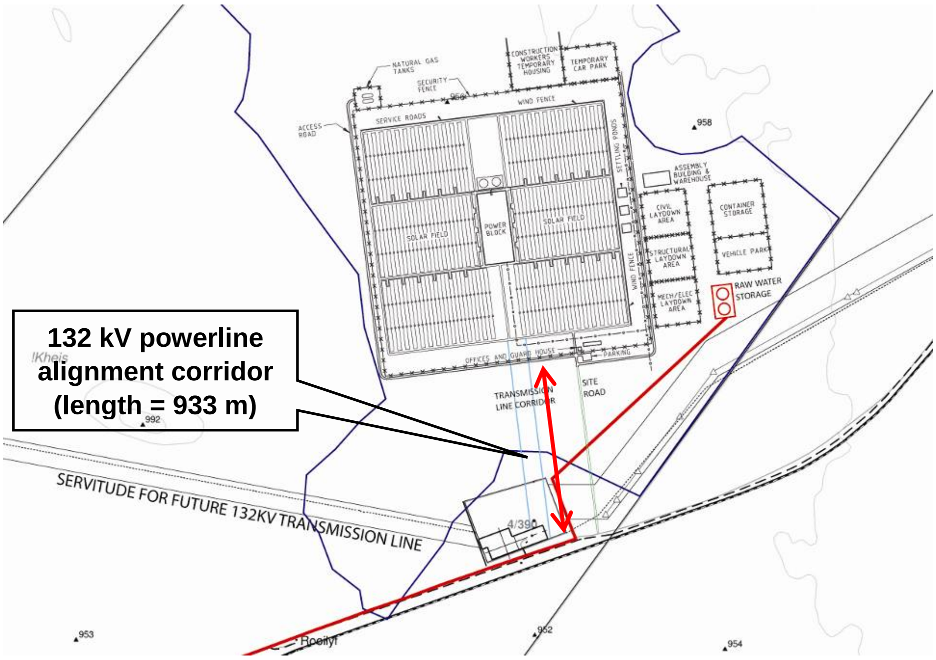


Figure 24: Powerline alignment for plant location alternative A

[25] The South African legal entity licensed to execute the national transmission responsibility. It consists out of a System Operator and a national transmission network service provider.

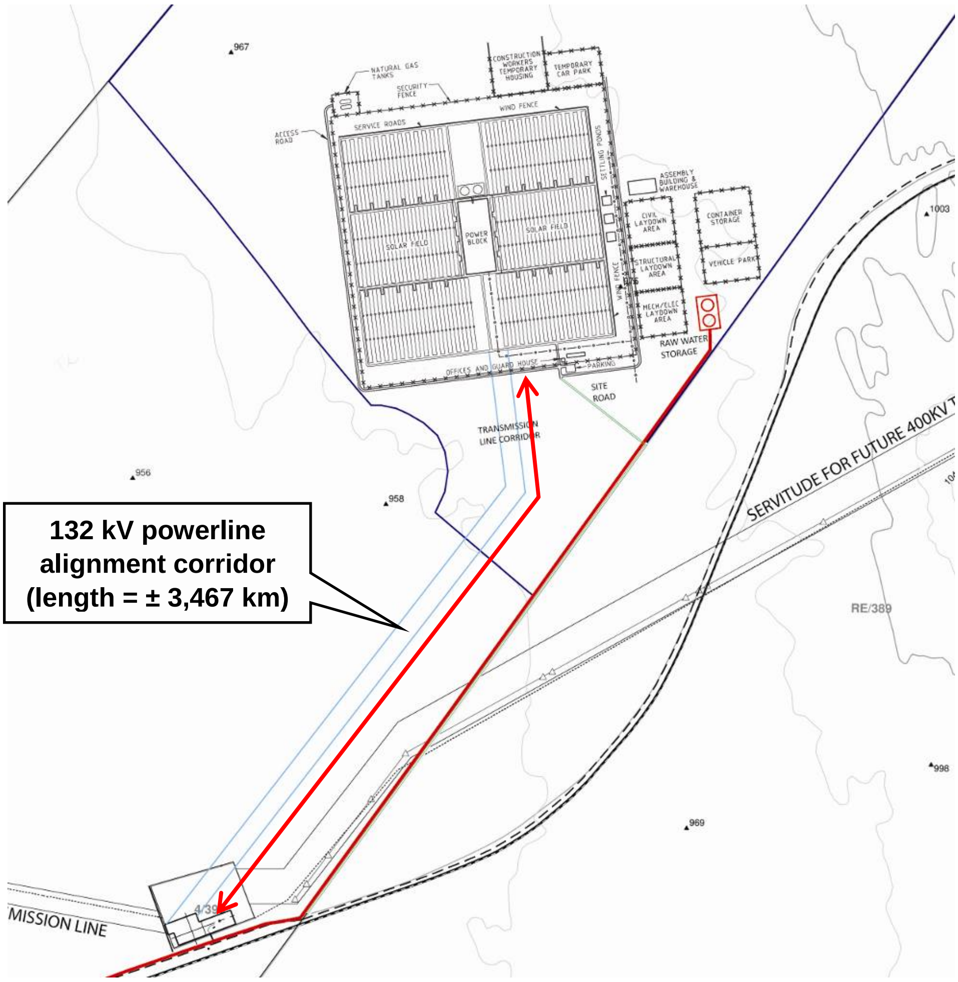


Figure 25: Powerline alignment for plant location alternative B

2.4.6.4 Water Supply and Management[26]

The following key water related facilities and associated infrastructure are required for the proposed CSP plant:

- Raw water storage reservoir/tank;
- Storm water detention basin;
- Firewater tank;
- Evaporation pond (including liner detection system);
- Sewage disposal field and septic tank;
- Water pipelines (including mains), and
- Water pumps.

Water for use during the construction and operation of the plant will be sourced from the Orange River. Raw water from the river will be abstracted using (in-stream) 30kW submersible pumps sited at a pre-determined extraction point located on the banks of the Orange River (abstraction point: *28.786820°S, 21.883255°E*). Once abstracted, raw water is

[26] Water Resource Assessment (Hatch, 2010).

transferred to a settling tank to remove debris and oversized particulates. The settling tank will be constructed outside the 1:100 year floodline of the river to minimise the associated environmental impacts. The water pipeline, connected to the settling tank, will follow the route of the existing *transformed* servitude for the Sishen-Saldanha railway line in a north easterly direction towards the Garona substation. At the Garona substation the pipeline route will deviate slightly to run parallel to the south eastern boundary of the development site to the respective plant location alternatives A or B. The Sishen-Saldanha railway line is owned and operated by Transnet (Transnet servitude Title Deed: T3759/1998) - Solafrica signed an agreement with Transnet during 2010 giving Solafrica the right to use the servitude for the proposed pipeline. The distance from the abstraction point along the Orange River to the plant location alternatives A and B are respectively 20 km and 22,5 km (refer to Figure 28 and Figure 29).

The servitude in addition provides for an access road (existing) to the bank of the watercourse with an existing watercourse crossing for the railroad bridge.

The water main (steel pipeline; 0.25 diameter) will either be installed *above ground* level using support structures along the pipeline alignment or *trenched* depending on the geotechnical conditions along the pipeline alignment. In such instances that the above ground installation alternative is deemed feasible and sections of the pipeline will traverse perennial or non-perennial streams (Figure 27), the support structures will be positioned at strategic locations as to limit the anticipated impacts on such watercourses (Figure 26). Should sections of the pipeline cross a road(s), the pipeline will be sited in pipe trenches in accordance with the *"Standard conditions in connection with the laying of pipes etc. under or along roads"*[27].

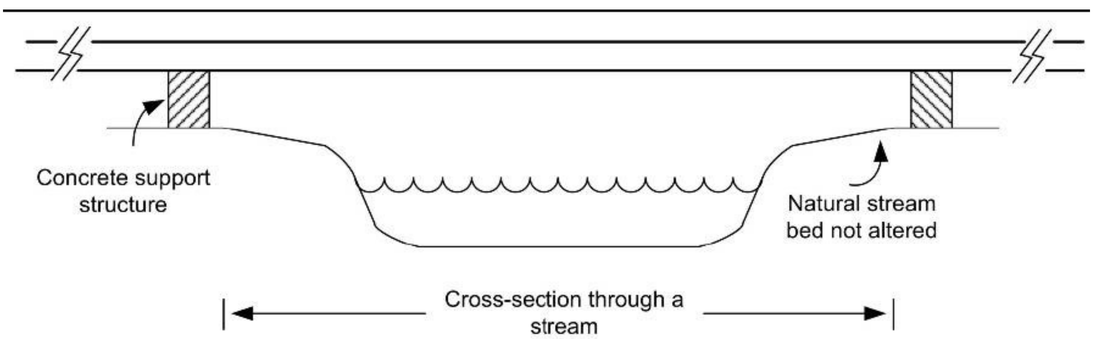


Figure 26: Pipeline support crossing stream

[27] 1.6. Where a water pipe crosses a public road, it must be placed in a sleeve pipe of sufficient diameter over the full statutory width of the road, which sleeve pipe -

1.6.1. Must be laid at a depth of at least one (1) metre below ground level for the full statutory road width, where use i made of an exisitng culvert with an earth floor;

1.6.2. May be placed in a concrete casing on the floor of the culvert, where use is made of an existing culvert with a concrete floor, provided it does not impair the effectiveness of the culvert and provided the sections of the sleeve pipe on either side of the culvert up to the boundaries of the statutory road width are laid at least one (1) metre below ground level, and

1.6.3. Must be laid at right angles across the road at a depth of at least one (1) metre below road level, where no existing culvert is available. In the case of a road with a permanent surface it must preferably be jacked through underneath the roadway so as to avoid the digging of a trench across the roadway

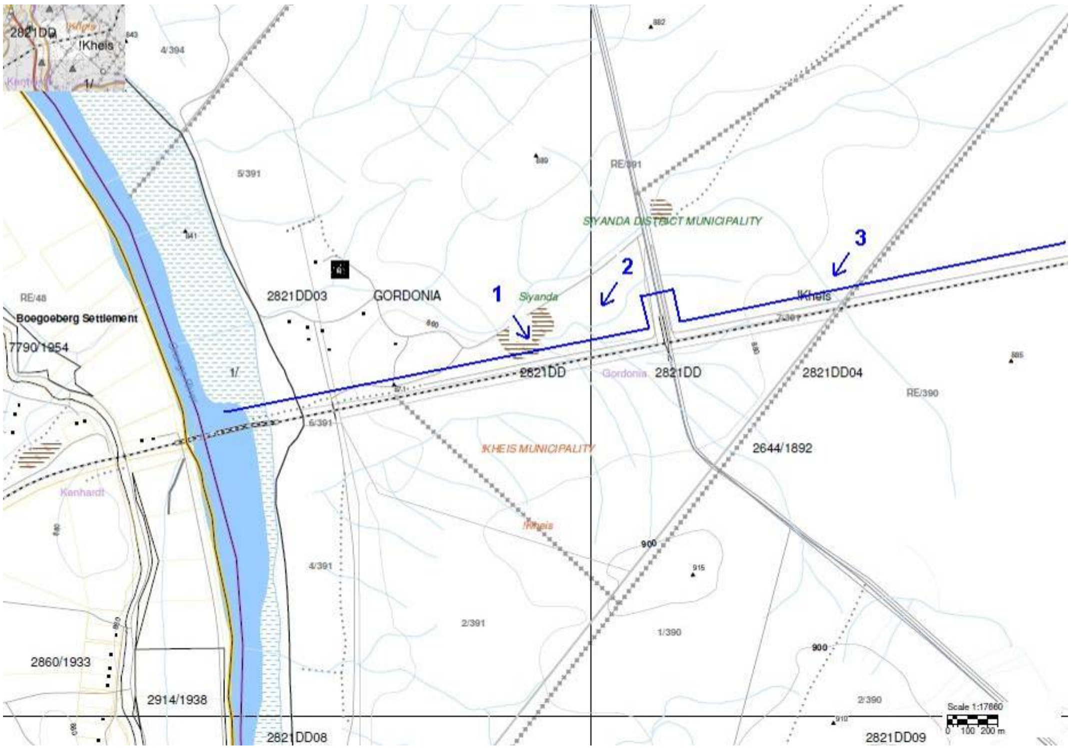


Figure 27: Perennial / non-perennial streams crossings along pipeline alignment

Co-ordinates of Crossings (referenced in Figure 27)	1. 28.783827°S ; 21.897856°E 2. 28.783372°S ; 21.900393°E 3. 28.781389°S ; 21.91217° E

Raw water will be pumped from the Orange River (water resource) to a reservoir/tank for on-site raw water storage purposes. The capacity of the reservoir/tank will allow for a maximum five day (contingency) water supply to the plant in the event of an incident (pump failure, breach of pipeline, routine maintenance etc) prohibiting raw water supply to the plant. The capacity of the reservoir/tank is estimated at 12 000 m^3 for a wet cooled plant.

Abstracted raw water for the provision of potable[28] and demineralised water[29] for plant operational purposes shall be processed and treated at an on site Water Treatment Plant (WTP) – potable water is required for domestic use and as fire water, and demineralised water for the steam cycle, cooling circuit (if closed) and the cleaning of mirrors. For a typical illustration and description of the treatment processes required for potable and demineralised water refer to Figure 30 / Table 9 and Figure 31 / Table 10.

[28] Water of sufficiently high quality for human consumption.
[29] Water of very high quality where the dissolved minerals have been removed.

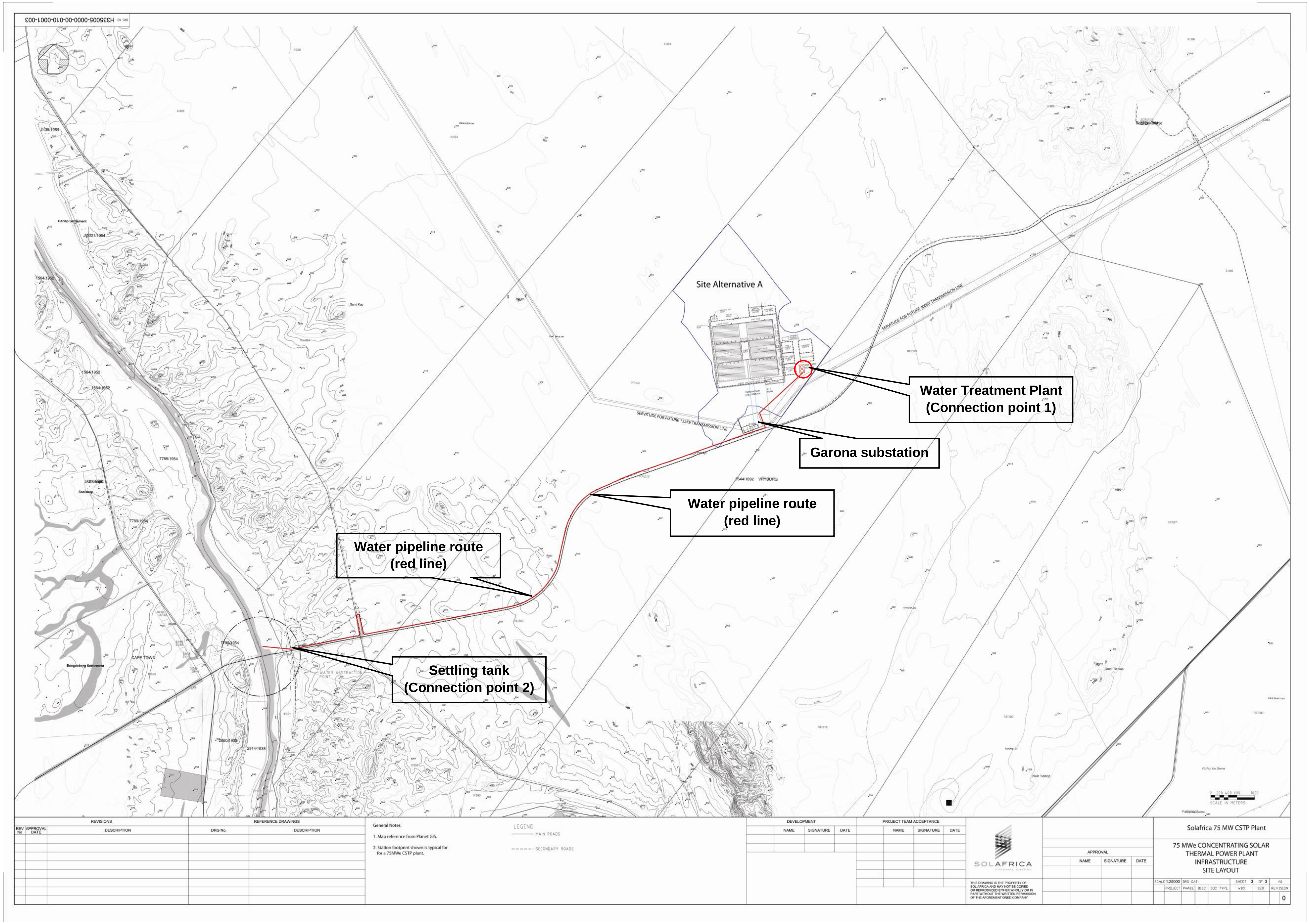


Figure 28: Water main pipeline alignment and pumpstation location – plant location alternative A

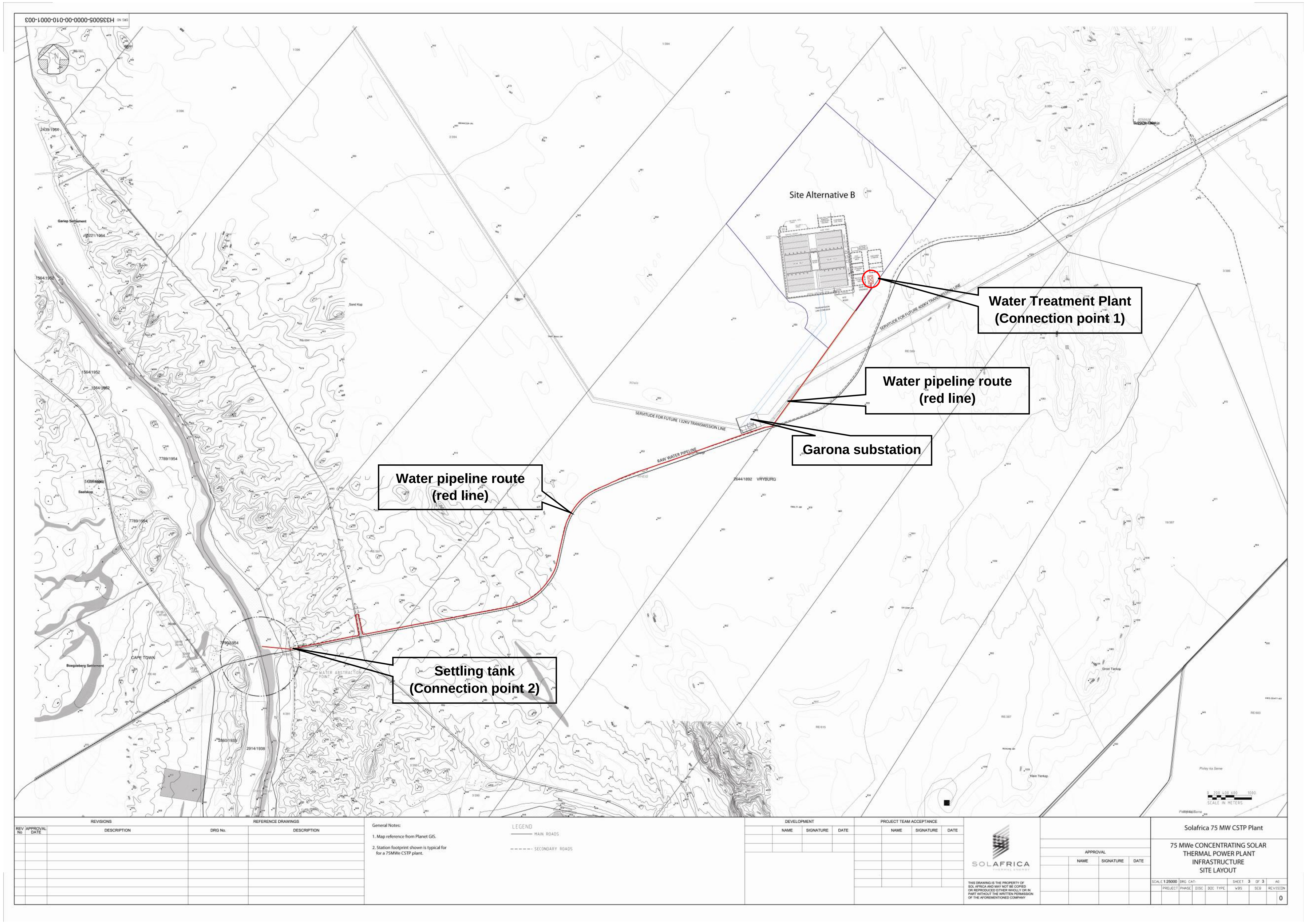


Figure 29: Water main pipeline alignment and pumpstation location – plant location alternative B

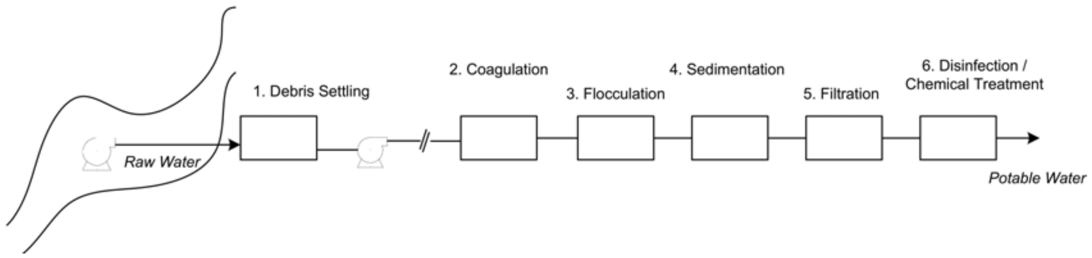


Figure 30: Typical potable water treatment process

Table 9: Description of the potable water treatment process

Process	Purpose
Debris Settling (Step 1)	Settle out twigs, rocks and sand pumped from the river. Chemical agent can be added in this early part of the process to reduce the amount of later disinfectants and is used to control taste and odours, remove colour and control biological growth.
Coagulation (Step 2)	Charged particulates in the water combine with the chemical agent ions, neutralizing the charges. The neutral particulates combine to form larger particles, and finally settle down.
Flocculation (Step 3)	Polymer flocculants are used to bind suspended solid particles.
Sedimentation (Step 4)	A settling tank is used to let the flocculated or coagulated particles to settle out. The sludge must occasionally be removed.
Filtration (Step 5)	Removing solids from the water by passing it through a porous medium. Solids can be removed by backwashing.
Disinfection / Chemical Treatments (Step 6)	To kill unwanted micro organisms in the water.

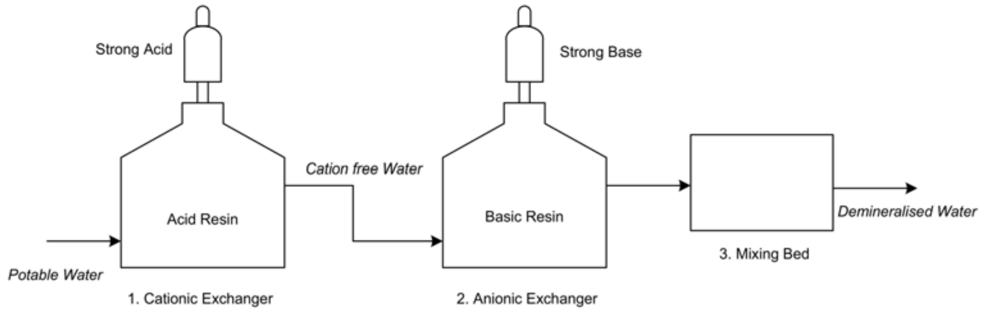


Figure 31: Typical demineralised water treatment process

Table 10: Description of the potable water treatment process

Process	Purpose
Cationic Exchanger (Step 1)	Removes the cationic species (Ca_2^+ and Na^+) and exchanges them into H^+
Anionic Exchanger (Step 2)	Removes all the anionic species (NO_3^{2-}, Cl^-, SiO_2 - and CO_4^{2}-) and exchangers them into OH^-
Mixing Bed (Step 3)	Used to achieve a pH equal to 7 (neutralisation of incoming alkalinity)
Resin Regeneration (Step 4)	• Ion exchange resins need to be regenerated after application. • After regeneration the resins are cleaned with chemical agents.

After treatment potable water will be pumped to an elevated tank for storage and demineralised water to a demineralised water storage tank, or supplied directly to the plant for usage. Fire water shall be supplied from a separate on-site storage facility.

The WTP will be designed accordingly to permit for the re-treatment of waste water or process effluents produced by the plant operations, thus the plant will operate on the principal of “zero discharge”. By adopting this approach, Solafrica will enhance the water usage efficiency of the plant and in so doing, minimise water wastage while promoting the sustainable use of the water resource (Orange River).

A gravity sewerage system is to be installed by Solafrica for the CSP plant. Domestic wastewater (sewerage and greywater from kitchens, showers etc.) will be collected by a sewerage network and treated in a septic/conservancy tank. Resulting sludge collected in the tank over time will periodically be removed by a third party service provider and accordingly disposed of at an appropriate landfill site.

2.4.6.5 Auxiliary Heating System / Boiler

- **Description**

Back-up gas fired heaters are used to maintain the temperature of the HTF above its freezing point of 12°C. Natural-draft burners are used in a wide range of residential and commercial applications, including gas-fired furnaces, water heaters, cooking ranges, and ovens. However, these burners are somewhat unique in industry. Most burners used in industrial combustion applications are forced or mechanical draft, where the combustion air is supplied to the burner with a fan or blower. In natural-draft burners, the combustion air is induced or drawn into the burner via the suction created by the incoming fuel jets and via the buoyancy forces inside the furnace that create an updraft.

Fired heaters are used in the petrochemical and hydrocarbon industries to heat fluids in tubes for further processing. In this type of process, fluids flow through an array of tubes located inside a furnace or heater. The tubes are heated by direct-fired burners. Using tubes to contain the load is somewhat unique compared to the other types of industrial combustion applications.

Process heaters are sometimes referred to as process furnaces or direct-fired heaters. They are heat transfer units designed to heat petroleum products, chemicals, and other liquids and gases flowing through tubes. Typical petroleum fluids include gasoline, naphtha, kerosene, distillate oil, lube oil, gas oil, and light ends. For this plant the heating is done to raise the temperature of the fluid to prevent freezing in the CSP plant.

The primary modes of heat transfer in process heaters are radiation and convection. The initial part of the fluid heating is done in the convection section of the furnace, while the latter heating is done in the radiant section. Each section has a bank of tubes in it through which the fluids flow that is being heated.

- **National Environmental Management: Air Quality Act (Act 39 of 2004)**

Listed activities and associated minimum emission standards have been issued by the DEA on 24 July 2009 (Government Gazette No 32434). As per the listed activities and minimum emission standards, the following activities, where applicable to the proposed project, would require an Atmospheric Emission Licence to operate:

- All liquid fuels combustion installations used primarily for steam raising or electricity generation, with a design capacity of more than 50 MW heat input per unit, based on the lower calorific value of the fuel used;
- Gas combustion used primarily for steam raising or electricity generation, with a design capacity of more than 50 MW heat input per unit, based on the lower calorific value of the fuel used, and

- Petroleum product storage tanks and product transfer facilities, producing more than 100 ton per annum of products; all liquid storage tanks larger than 500 cubic metres cumulative tankage capacity.

In terms of the design capacity (11.5 MW), the proposed boiler would not classify as a listed activity and therefore would not require an Atmospheric Emission Licence to operate. The on-site storage of diesel will also be below the required limit to be classified as a listed activity.

2.4.6.6 Stormwater Management

Stormwater will be collected on-site by a storm water drainage system and temporarily stored in a storm water detention basin before being discharged to the main drainage system. Drainage shall be collected at the lowest point (altitude) of the site.

2.4.6.7 Security

A security fence will be erected along the perimeter of the site with a service road along and perimeter security lighting on the inside of the.

2.4.6.8 Fire protection

Provision shall be made for firebreaks outside the plant perimeter. The firebreak will have a dual purpose:

a) Protecting the plant in the event of a veld fire, and
b) Protecting floral and faunal habitats located outside the plant area in the event of a fire on the CSP plant.

2.4.6.9 Windbreak

A wind fence shall be provided to control the influence of high winds on the solar field.

2.4.6.10 Dangerous Goods Storage

A preliminary investigation was carried out into the sizing of components for the provision of auxiliary power. Boiler capacity (estimated at 11.5 MW) will be included for the *co-firing* of Light Fuel Oil (LFO) [Diesel] or Liquid Petroleum Gas (LPG) and the *heating of the HTF* during start-up and anti-freeze conditions.

Co-firing will take place at times most optimal in supplementing the thermal power of the sun using fuel up to a maximum of the allowable 15% of power generation (as stated in NERSA's REFIT conditions). Additional firing will take place during the 4 months of the winter season to maintain a minimum temperature of the HTF.

Fuel required for both co-firing and heating of the HTF will be transported (either via road/rail) to the plant for on-site storage in 2 x 240 m^3 tanks. Each tank to have a length of 13.1 m and inside diameter of 5.2 m. The storage facility will be connected to the operational plant via a separate utility pipeline(s). The design of the facility will comply with the provisions of SANS 10087 (Rev 4, 2008) – *"The handling, storage and distribution of liquefied petroleum gas in domestic, commercial and industrial installations"*.

In addition to co-firing, LFO shall be required for a generator during the construction phase and a standby generator during the operational phase of the project respectively. The fuel shall be delivered to site by road tanker at appropriate intervals and transferred via an appropriately designed fuel transfer system to an on-site storage tank. It is estimated that the LFO storage capacity for the respective construction and operational phases are 50 m^3 and 12 m^3 respectively. The on-site storage facility shall comply with SANS 10131:2004 – *"Above-ground storage tanks for petroleum products"*.

The following hazardous chemical substances and asphyxiants may in addition to the above, typically be stored on-site:

Table 11: List of hazardous chemical substances and asphyxiants

Description		Storage Capacity
Nitrogen	Used for inertisation purposes (HTF expansion system)	80 m^3
Turbine Oil	-	17.1 m^3
Mirror cleaning chemicals	Mirrors are cleaned with pressurised demineralised water	None
HTF	1 950 000 kg contained within receiver tube system	3.8 m^3
Water treatment chemicals	-	70.2 m^3
Other solvents during maintenance	-	None

The on-site storage facility for the above mentioned hazardous chemicals and asphyxiants shall comply with SANS 10131.

Table 12: Combined storage capacity of dangerous goods (construction and operation)

Phase	Storage Capacity	
Construction	Diesel (generator)	50 m^3
Operation	*Diesel (standby generator)**	*12 m^3*
	LPG / Diesel	480 m^3
	Hazardous chemical substances and asphyxiants	171.1 m^3
Total (storage capacity)		**701.1 m^3**

** - The total storage capacity calculation (701.1.m^3) excludes the capacity required for diesel storage during <u>operational phase</u> as the tank to be used for diesel storage during <u>construction phase</u> may be used for diesel storage during operational phase.*

All storage areas will be designed such to make provision for a bund wall high enough to contain at least 110% and impermeable surfaces to prevent pollution.

3 PROJECT ALTERNATIVES

In terms of the EIA Regulations, Section 29(1)(b) feasible alternatives are required to be considered as part of the environmental investigations. In addition, the obligation that alternatives are investigated is also a requirement of Section 24(4) of the National Environmental Management Act (Act 107 of 1998, 'NEMA') (as amended). An alternative in relation to a proposed activity refers to:

> *"… the different means of meeting the general purpose and requirements of the activity (as defined in Government Notice R385 of the EIA Regulations, 2006), which may include alternatives to:*
>
> *a) The property on which or location where it is proposed to undertake the activity.*
> *b) The type of activity to be undertaken.*
> *c) The design or layout of the activity.*
> *d) The technology to be used in the activity.*
> *e) The operational aspects of the activity."*
>
> \- EIA Regulations, GN R385 (2006) -

During the EIA Process site, technology and development area alternatives were considered. Each of the alternatives are described in further detail in this Chapter.

3.1 No-go Alternative

The 'do-nothing' alternative is the option of not establishing a new CSP plant at any of the alternative sites selected by Solafrica in the Northern Cape Province. This alternative would result in the continuation of the status quo environmental conditions of the sites, consequently no resultant impacts on the site specific and surrounding environmental are likely.

The electricity demand in South Africa is placing increasing pressure on Eskom's existing power generation capacity. South Africa was expected to require additional peaking capacity by 2007, and baseload capacity by 2010, depending on the average growth rate. This has put pressure on the existing installed capacity to be able to meet the energy demands into the future. Although the CSP project will not meet the short term energy demands, the 'do nothing' option will, result in the loss of possible renewable options for the meeting of future electricity demands. This could have long-term implications for socio-economic development in South Africa.

With an increasing demand in energy predicted and growing environmental concerns about fossil fuel based energy systems, the development of large-scale renewable energy supply schemes such as CSP is strategically important for increasing the diversity of domestic energy supplies and avoiding energy imports in the country.

South Africa currently relies almost completely on fossil fuels as a primary energy source (approximately 90%) with coal providing 75% of the fossil fuel based energy supply[30]. Coal combustion in South Africa is the main contributor to carbon dioxide (a GHG) emissions, which has been linked as a primary trigger of climate change.

An emphasis has therefore been placed on securing South Africa's future power supply through the diversification of power generation sources. Furthermore, South Africa would have to invest in a power generation range, and not solely rely on coal-fired power generation, to honour its commitment made under the Copenhagen Accord and to mitigate climate change challenges. Under the Accord, the country committed to reduce its carbon dioxide emissions by 34% below the "business as usual" level by 2020. Research suggests that each square meter of CSP reflector is sufficient in reducing the annual emissions of carbon dioxide by 200 to 300 kilograms (kg), depending on the plant's configuration[31]. Furthermore the carbon dioxide emissions related to the manufacture, installation and servicing over the average 20 year operational lifecycle of a CSP plant are 'paid back' after the initial three to six months of operation.

Without the implementation of this project, the use of renewable options for power supply will be compromised in the future. This has potentially significant negative impacts on environmental and social well-being. Therefore, the no-go option is not considered as a feasible option for this proposed project.

3.2 Site Alternatives

In determining the most appropriate site for the establishment of a new CSP plant, various options were investigated by Eskom during the EIA studies conducted for the pilot CSP plant[32].

This EIA study did not make provision for a new site selection process as the site selection process previously conducted by Eskom was considered to be comprehensive and the criteria mentioned below are still relevant to the Solafrica CSP project.

This site selection process considered the following criteria:

- The availability and accessibility of primary resources required for the operation of the power plant, such as sun (i.e. the required DNI) and water;
- Availability of land to locate the site and associated infrastructure;
- The availability and accessibility of infrastructure for the provision of services, manpower and social structure for the construction and operation of the power plant;

[30] Department of Minerals and Energy (1999) - "*Digest of South African Energy Statistics*"
[31] European Solar Thermal Industry Association *et. al* (2009) – *"Concentrated Solar Thermal Power – Now!"*
[32] Bohlweki Environmental (2006) – "*Environmental Impact Assessment for the establishment of a New Concentrating Solar Power (CSP) plant and associated infrastructure in the Northern Cape Province"*

- The ease of integration of the new power plant into the existing National Transmission network/grid and the environmental impacts associated with this integration; and
- General environmental acceptability in terms of social impacts, water utilisation, general ecology, etc.

Through a series of feasibility and high-level screening studies undertaken by Eskom the Northern Cape Province ranked as the most favourable area for the establishment of a new concentrating solar power plant.

3.2.1 Site Alternatives Identified within the Northern Cape Province for the Establishment of a New Concentrating Solar Power Plant

A strategic analysis was undertaken by Eskom in order to identify feasible alternative sites for the establishment of the proposed new power plant and associated infrastructure within the Northern Cape Province. This analysis considered technical, economic and environmental criteria. From the sensitivity analysis[33] it was concluded that there was the potential to establish a new CSP plant in Upington and Groblershoop areas. In order to ensure the ease of integration of the new power plant into the existing National Transmission network/grid and considering the environmental impacts associated with this integration, it was determined that the most feasible sites would be close to the existing power lines and water resources.

3.2.2 Description of Identified Site Alternatives

The following sections provide a description of the locality of the two alternative sites in relation to the two major towns, namely Upington and Groblershoop (Figure 28). The alternative sites identified as potentially feasible for the establishment of a new Concentrating Solar Power Plant are as follows:

- **Site 1: Farm Olyvenhouts Drift (15 km west of Upington)**

This site is located on the farm Olyvenhouts Drift (Figure 33). There are a few settlements in close proximity to the farm, including Oranjevallei, Klippunt and the small informal settlement of Kalksloot. The road to Lutzputs crosses diagonally over the farm.

The area to the east of the site is municipal property. The majority of farms in the area are currently used for sheep and cattle farming. The Spitskop Nature Reserve is located a few kilometres to the north-west of the site.

[33] Bohlweki Environmental (on behalf of Eskom Holdings Limited). 2006. *Environmental Impact Assessment for the establishment of a New Concentrating Solar Power (CSP) plant and associated infrastructure in the Northern Cape Province.*

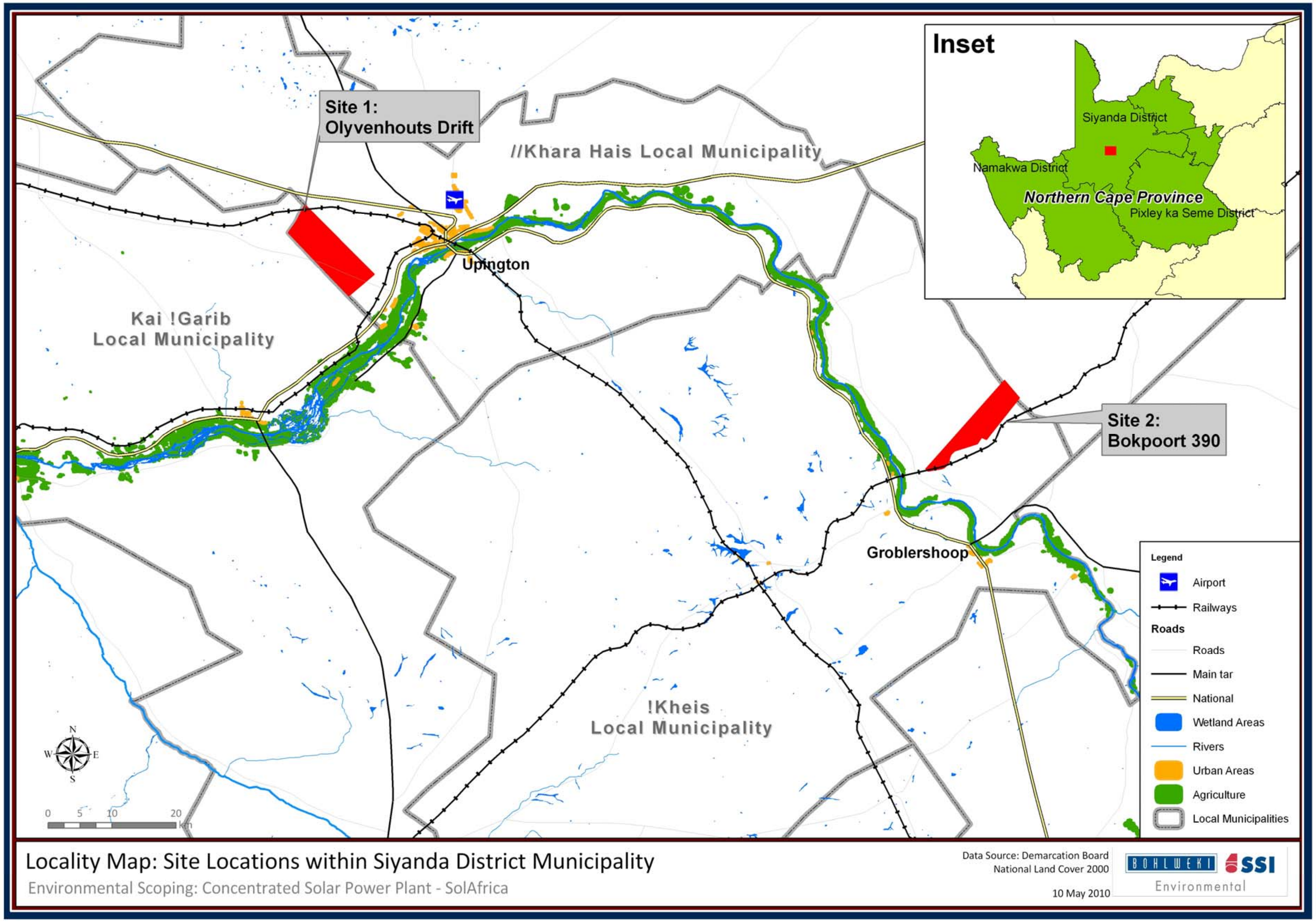


Figure 32: **Location of the site alternatives in relation to each other**

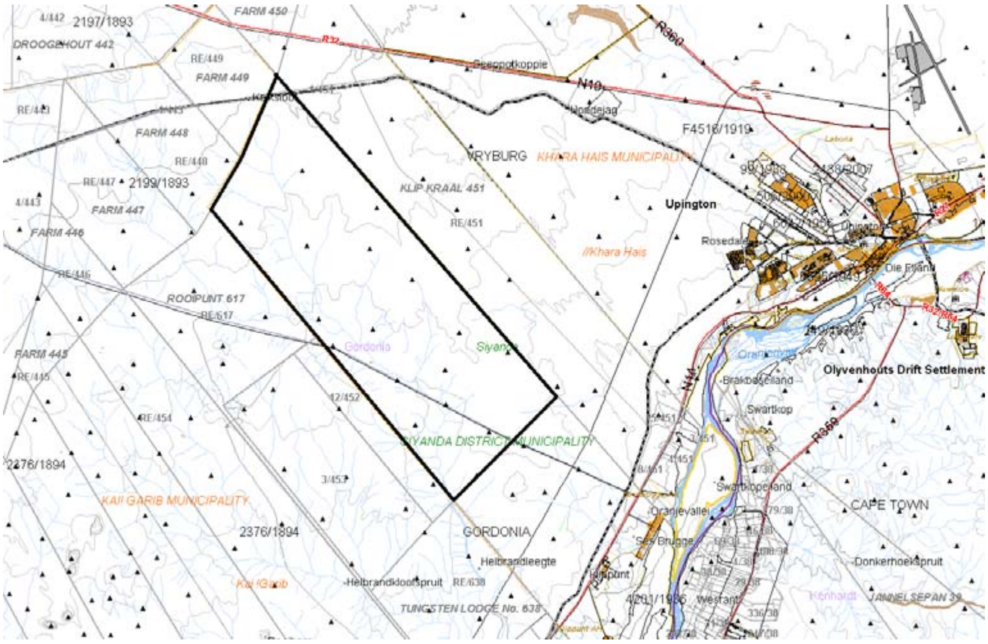


Figure 33: Site 1 - Farm Olyvenhouts Drift (15 km west of Upington)

- **Site 2: Farm Bokpoort 390**

This site is located on the farm Bokpoort 390 (Figure 34). There is some cultivated land and settlements on the south-eastern part of the farm. The Garona substation is located on the eastern part of the farm, and the Sishen-Saldanha railway line is adjacent to the south-eastern part of the farm.

The farm is currently used for farming sheep and cattle. There are a number of game farms to the north of the site.

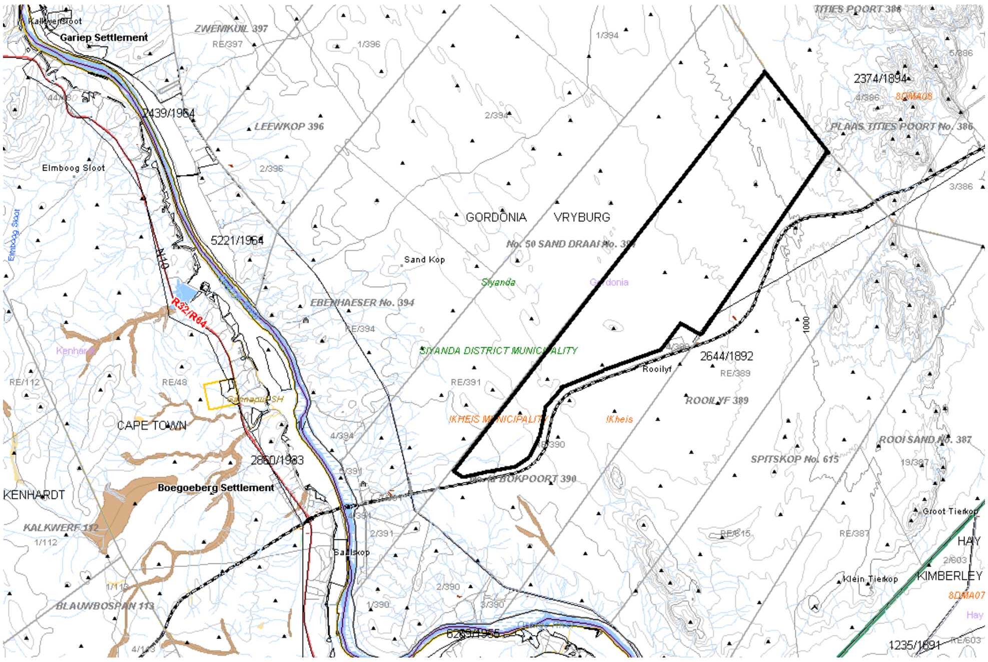


Figure 34: Site 2 - Farm Bokpoort 390

3.3 Plant Location Alternatives

A key aspect in the deployment of a CSP plant is the consideration of the spatial requirements of the plant and the availability of sufficient and suitable area to accommodate the plant development footprint - a conservative plant footprint of 350 ha has been estimated for the Solafrica CSP project. As part of the EIA phase, a qualitative sensitivity analysis was undertaken for the preferred site (i.e. Olyvenhouts Drift or Bokpoort) using various environmental specialists' input. The objective of the analysis was to determine the environmental opportunities and constraints (feasibility limits) associated with the preferred site, thereby providing a synopsis on suitable *development areas* (portions) for the placement of the CSP plant.

Refer to Chapters 5 (Site Selection and Sensitivity Analysis) and 6 (Impact Assessment) for a detailed discussion on plant location alternatives.

3.4 Technology Alternatives

An assessment into the availability of the different renewable energy resources in terms of their abundance and geographic location were conducted through a joint venture with the DME, the CSIR and Eskom. The study led to the compilation of the South African Renewable Energy Resource Database. Using this information, Eskom could identify which renewable energy technology option would represent the most suitable option for which geographic area. The database distinctly concluded that solar technology was the most suitable option in terms of generation resources in the Northern Cape Province.

Solafrica acknowledges that alternative renewable energy technologies such as wind, geothermal, biomass, hydro are available. However, in light of the findings of the above study and with due consideration of the various renewable energy technologies nominated through the REFIT Programme (Phases 1 and 2), the following solar technologies were selected by Solafrica as the technically feasible renewable energy technologies for further consideration during the project:

1. *Parabolic Trough Technology* - Glass mirrors are most commonly shaped into the curved parabolic reflectors (troughs) and are usually designed to track the sun along one axis. Absorber tubes containing heat transfer fluid (HTF) are situated between reflectors. The HTF (i.e. thermal oil) is heated to approximately 390°C in the solar field and then circulated through a series of heat exchangers to produce steam. The steam is converted to electrical energy in the power block, which consists of a conventional steam turbine generator and its associated cooling mechanism.
2. *Central Receiver / Power Tower Technology* - Sun-tracking mirrors called heliostats (glass mirrors) are mounted on an axis which reflects the sunlight to a central receiver. The central receiver is situated on the top of a single central tower, or alternatively on a number of smaller central towers. This receiver is a heat exchanger which absorbs the concentrated beam radiation, converts it to heat and transfers the heat to the working fluid (synthetic oil) which is in turn used to generate steam for conventional power generation.

The above technology options were further evaluated by assessing information compiled from published literature and where possible from demonstration facilities or operational plants. The selected technologies were then screened in terms of technical and economical criteria – refer to Table 13 for a synopsis on the major advantages and disadvantages of the two types of technologies are.

The screening process concluded that parabolic trough technology is the most proven of the two solar technologies. The success of this technology is substantiated by nine large commercial-scale solar power plants currently operational worldwide. The first commercially operable plant has been operational in the California Mojave Desert since 1984 (SEGS I, Andasol etc.). These plants continue to operate daily, ranging in size from 14 to 80 MWe and represent a total of 354 MWe of installed generating capacity.

The bankability of a CSP project is largely driven by the proven commercial deployment of the solar technology considered by renewable energy developers – in the absence of appropriate financial lending from lending institutions, the deployment of renewable energy technologies as proposed by Solafrica would be deemed unfeasible. Based on this premise and considering the proven commercial viability of the parabolic trough technology, the decision made by Solafrica is decisive that parabolic trough technology should be considered for deployment for this project.

A comparative assessment of the environmental impacts associated with the two technology options considered at project inception will therefore not be undertaken as the technology selection process is primarily derived on the basis of bankability.

Table 13: Major advantages and disadvantages of the proposed CSP technologies considered for the project

Concentrating Solar Technology	Application	Advantages	Disadvantages
Parabolic Trough Technology 	• Grid-connected plants; • Mid to high process heat; • Operational solar plant capacity to date: 14-80 MWe; • Total capacity built: >850 MWe, and • Total capacity of projects under planning and construction: 9.5 GWe • 21 Operational plants worldwide.	• Commercially available – over 12 billion kWh of operational experience; • Operating temperature potential up to 500°C (400°C commercially proven); • Commercially proven annual net plant efficiency of 14% (solar radiation to net electric output); • Commercially proven investment and operating costs; • Modularity • Best land-use factor of all solar technologies; • Lowest materials demand, and • Thermal storage capability.	• The use of oil-based heat transfer fluid restricts operating temperatures today to 400°C, resulting in only moderate steam qualities.
Power Tower Technology	• Grid-connected plants; • High temperature process heat, and	• Good mid-term prospects for high conversion efficiencies, operating temperature potential beyond 1,000°C;	• Projected annual performance values, investment and operating costs still to be commercially proven

	• Highest single unit solar capacity to date: 20 MWe. • Total capacity built: ~50 MWe, and • Total capacity of projects under planning and construction: >2.8 GWe	• 565°C proven at 10 MWe scale, and • Thermal storage at high temperatures.	operational.

4 PUBLIC PARTICIPATION PROCESS

Public and Stakeholder participation is a fundamental component of the EIA Process. The inclusion of the views of the affected and interested public aids in ensuring the EIA Process is open, transparent and robust, as well as that the decision making process is equitable and fair. This in turn guides informed choice and better environmental outcomes. It further presents a valuable source of information on key impacts, potential mitigation measures and the identification and selection of feasible alternatives.

The primary aims of the Public Participation Process (PPP) were:

- To inform all I&APs and key stakeholders of the proposed project;
- To initiate meaningful and timeous participation of I&APs;
- To identify issues and concerns of key stakeholders and I&APs with regards to the proposed project (i.e. focus on important issues);
- To promote transparency and an understanding of the proposed project and its potential environmental (social and biophysical) impacts.
- To provide information used for decision-making;
- To provide a structure for liaison and communication with I&APs and key stakeholders;
- To assist in identifying potential environmental (social and biophysical) impacts associated with the proposed project;
- To ensure inclusivity (the needs, interests and values of I&APs must be considered in the decision-making process);
- To focus on issues relevant to the project and issues considered important by I&APs and key stakeholders;
- To provide responses to I&AP queries, and
- To encourage co-regulation, shared responsibility and a sense of ownership.

4.1 Public Participation Process - Scoping Phase

4.1.1 Overview

The PPP as part of the Scoping phase was conducted in terms of the requirements of Regulation 56 of GN. R385, and with due consideration of the Public Participation Guidelines published in the Government Gazette (dated 19 May 2006). The following notification methodology was implemented:

- **Advertising** (30-day notification period) - The project was advertised (Afrikaans) in the *Gemsbok* local newspaper on 02 April 2010;
- **Briefing Paper** - A briefing paper (including a comment sheet) was compiled in English and Afrikaans and distributed to identified Stakeholders and I&APs via post or e-mail.
- **Introductory letter** - An introductory letter was sent to all I&APs and Stakeholders together with the briefing paper and comments sheet;

- **Site Notices** – Site notices were placed in the prescribed format, visible location and size at the entrances to the candidate sites (i.e. Olyvenhouts Drift and Bokpoort);
- **Pamphlets and Notices** – A5/A4 sized paper prints (pamphlets) of the site notice and the registration and comment form were distributed by hand in Klippoort, Upington and Groblershoop. In addition, pamphlets were placed at various amenities located in Upington and Groblershoop (ex. //Khara Hais Municipal Offices, Spar, Discom, Postnet, Post Office, Agrimark, other smaller convenience stores and the Caltex Garage in Groblershoop);
- **Public Review of Draft Environmental Scoping Report** – Stakeholders and I&APs were afforded the opportunity to review the draft Environmental Scoping Report for a 30-day calendar period, from 12 May 2010 to 08 June 2010. The report was made available at the !Kheis / //Khara Hais Municipal Offices, the !Kheis / //Khara Hais Public Libraries and SSI Environmental's website;
- **Focus Group Meetings (key Stakeholders)** – Meetings with representatives of national, provincial and local authorities were held from 17 to 18 June 2010
- **Public Meetings** - In addition to the Focus Group Meeting, public meetings were held in Groblershoop (Groblershoop Stadium Spernham Mariedale Settlement) and Upington (Klippunt Settlement, Upington) on 17 and 18 June 2010 respectively.

4.1.2 Stakeholders

The following stakeholders (government departments, non-governmental organisations etc.) were informed of the proposed development through the Scoping phase Public Participation Process (PPP) and the Water Use License Application PPP:

- National and Provincial Government Representatives:
  - Department of Environmental Affairs (DEA);
  - Department of Water Affairs (DWA);
  - Department of Agriculture;
  - Department of Public Enterprises;
  - Department of Trade and Industry (DTI);
  - Department of Minerals and Resources(DMR);
  - South African Heritage Resources Agency (SAHRA); and
  - Relevant Northern Cape Provincial Authorities (ex. Environment & Conservation, Agriculture).
- Relevant Local and District Municipalities:
  - Siyanda District Municipality;
  - //Khara Hais Local Municipality; and
  - !Kheis Local Municipality.
- Parastatals – Eskom;
- Affected and surrounding landowners;
- Environmental Non-Governmental Organizations (ex. Endangered Wildlife Trust, World Wildlife Fund), and
- Community based organisations.

4.1.3 Stakeholder and I&AP Comments

Issues, concerns and comments (refer to ***Appendix B1***) raised during the Scoping phase PPP were compiled into a Social Issues Trail (refer to ***Appendix B2***) which was submitted with the Environmental Scoping Report.

To follow is a summary of comments received from registered Stakeholders and I&APs during the Scoping phase PPP and the EAP's responses (refer to Table 14).

Table 14: Comments received during the Scoping phase

I&AP/ Stakeholder	Issue/Concern/Comment	Response
Matthys Horak (Air Traffic and Navigation Services)	From the perspective of Air Traffic Management (ATM) Communications, Navigation and Surveillance (CNS) the establishment of a Concentrated Solar Power Plant (CSP) conforming to the specifications provided, and located at the Olyvenhouts Drift and Bokpoort sites will not have a negative operational effect.	Comment noted.
Naas Breytenbach (Sentech Ltd)	Electromagnetic interference to existing radio and TV broadcasting signals. Will government institutions receive preference to supply from the clean energy as part of commitments to Kyoto.	The proposed CSP plant will be designed to comply with the provisions of SANS 61000-6-4:2006 / IEC 61000-6-4:2006 – "*Electromagnetic compatibility (EMC) Part 6-4: Generic standards - Emission standard for industrial environments*". <u>Renewable Energy Targets</u> The South African Government has set a target of 10 000 GWh renewable energy contribution to final energy consumption by 2013. This is to be produced mainly from biomass, wind, solar and small-scale hydro. The renewable energy will principally be utilised for power generation and non-electric technologies such as solar water heating and bio-fuels. This relates to

		approximately 4% (1 667 MW) of the projected electricity demand for 2013 (41 539 MW)[34]. The proposed 75 MWe CSP project will assist the South African Government in meeting these renewable energy targets. <u>Clean Development Mechanism</u> The proposed project involves the diversification of electricity production fuel sources, improved efficiency in electricity production, a decrease in the quantity of fossil fuel burned, a decrease in Greenhouse Gas (GHG) emissions and a decrease in a number of other aerial pollutant emissions. This is in line with Government's commitment to reduce the country's Green House Gas emissions by 34% by 2020 and 42% by 2025. The proposed CSP project is likely to qualify for registration as a Clean Development Mechanism (CDM) project. It is hence Solafrica's intention to register the proposed project as a CDM project with the Executive Board of the CDM, managed by the United Nations Framework Convention on Climate Change (UNFCCC). This will allow Solafrica to register the project's GHG reductions as Certified Emission Reductions (CERs), also known as 'carbon credits'. The CERs can then be sold to potential buyers in developed countries who require these credits for compliance purposes.

[34] Department of Minerals and Energy. 2003. *White Paper on Renewable Energy.*

		The project can therefore be seen as making a contribution to improving the sustainability of development in South Africa.
Irmé van Zyl (Van Zyl Environmental Consultants)	The visual impacts in terms of reflection and the air pollution impact that will be associated with the construction of a solar tower will have a detrimental impact on the visual acceptance of the landscape.	<u>Visual Impact:</u> Solafrica investigated the feasibility of two CSP technologies: parabolic trough and solar tower. Based on the REFIT's qualifying criteria the decision was made that parabolic trough will be the preferred technology to be implemented for the project. A Visual Impact Assessment (VIA) was conducted by MetroGIS based on: • Plant location alternatives selected based on the findings of a preliminary environmental sensitivity analysis, and • The selected CSP technology – parabolic trough. For detailed findings of the VIA refer to ***Appendix H***. <u>Air Quality:</u> a) Construction Phase During the construction phase the only likely impacts on air quality may be from: • The generation of dust, and • The use of a diesel generator(s) on-site for electricity supply purposes. The significance of the impact(s) is considered negligible and can be mitigated accordingly. b) Operational Phase

		The proposed plant's energy output may be supplemented by the inclusion of a 15% contribution (maximum) from the combustion of fossil fuel for co-firing purposes. In such instance the particulate level shall be below the Air Quality Act (Act 29 of 2004) limit of $50mg/Nm^3$. The significance of impacts on air quality during the operational phase of the plant is considered negligible.
Professor RA Hasty (Community Member)	The effect of an energy project as proposed on the environment, wildlife and heritage sites.	Refer to Chapters 5 (*Description of the Receiving Environment)* and 6 (*Impact Assessment*) for details on the findings of the specialist studies.
Johannes Nowalaza (Department of Education)	It is a wise idea to make use of natural resources. It will create temporary and permanent employment opportunities.	The labour force required for the proposed plant is estimated at: • Construction phase: 300–400 workers, and • Operational phase: 40-60 workers with 20 being skilled professionals.
	Training should be provided in solar systems and energy.	Solafrica is currently evaluating various community upliftment programmes / initiatives which will likely involve training, amongst other – relevant stakeholders will be approached once such programmes / initiatives have been finalised.
	Households must be able to save capital.	Comment noted.
JMS Botha (Boegoeberg Water Use Association)	Water must be used in a correct economical and technological way. Water should be re-cycled, purified and re-used.	A Water Treatment Plant (WTP) will be constructed on the CSP plant site for the treatment of raw water for the provision of potable and demineralised water to the plant operations. The WTP will be designed accordingly to permit for the re-treatment of waste water or process effluents produced by the plant operations. The plant will

		therefore operate on the principal of “zero discharge”. This approach will enhance the sustainability of plant operations.
	On site workers should be supplied with potable water and sanitation facilities.	Potable water and sanitation facilities will be provided to contractors and/or employees during both the construction and operational phases of the project.
Abraham Morkel (Louisvale-Weg Up-and-Coming Farmers Association)	Members of the Farmers Association are currently farming (cattle grazing) on the Farm Olyvenhouts Drift and the proposed project may affect the grazing land.	Solafrica considered the following two candidate sites for the proposed CSP development: • Olyvenhouts Drift (Upington), • Bokpoort (Groblershoop). An engineering pre-feasibility study conducted by Hatch Africa Energy included, amongst other, an assessment on the technical feasibility of the above candidate sites - the study was concluded during July 2010. In addition to the afore-mentioned assessment a site selection process based on various environmental specialist disciplines was conducted as part of the EIA Process. Considering both the technical and environmental feasibility of the candidate sites it was concluded that the Bokpoort site is the preferred / nominated site for the for the Solafrica project.
J.G. van Jaarsveld (Vastrap Weaponrange)	Possible electricity supply to the Vastrap weapon range.	Solafrica as an Independent Power Producer will enter into a Power Purchase Agreement with Eskom to supply the national utility with auxiliary electricity generated by the CSP plant. The proposed plant will be connected to Eskom’s Garona substation (located on the Farm Bokpoort) via a 132 kV overhead powerline. The Garona substation

		forms part of the national transmission network which will enable the supply of electricity to: • Eskom's distribution network running from the Garona substation to the Upington region, and • The transmission network running from Garona substation to the Ferrum substation (Limpopo Province).
Ivan Juries (Community Member)	The //Khara Hais Local Municipality has promulgated a municipal by-law regulating developments within the 1:100 year floodline of the Orange River. Consideration must be given to this by-law should any aspect of the proposed project affect the 1:100 year floodline.	Comment noted. Solafrica considered the following two candidate sites for the proposed CSP development: • Olyvenhouts Drift (Upington), • Bokpoort (Groblershoop). An engineering pre-feasibility study conducted by Hatch Africa Energy included, amongst other, an assessment on the technical feasibility of the above candidate sites - the study was concluded during July 2010. In addition to the afore-mentioned assessment a site selection process based on various environmental specialist disciplines was conducted as part of the EIA Process. Considering both the technical and environmental feasibility of the candidate sites it was concluded that the Bokpoort site is the preferred / nominated site for the for the Solafrica project. The Farm Bokpoort falls under the jurisdiction of the !Kheis Local Municipality. The applicant will consider any by-law(s) applicable to the project. The impacts associated with the CSP development on water resources will be assessed and addressed (in detail) as part of the

		Water Use License Application (WULA) Process currently being undertaken.
	Is the site considered by Solafrica for the CSP plant on the site which Eskom is planning to construct a CSP plant?	The Farm Olyvenhouts Drift was a candidate site for the proposed CSP plant development. Eskom obtained approval in 2006 from the DEA for the development of a CSP plant (solar tower) on **a portion** of this particular farm.
	Will the applicant utilise electricity from the municipal grid for purposes of the construction of the plant.	The applicant will either utilise an independent diesel generator or electricity from the local Eskom grid for the provision of construction phase electricity – the outcome will depend on discussions with Eskom.
	Will the plant have any negative human health impacts on Klippunt community members?	The design of the plant will comply with the provisions of the Occupational Health and Safety Act (Act 85 of 1993). It can therefore be concluded that no negative impacts on human health are expected. Furthermore the Olyvenhouts Drift site was eliminated as a candidate site during the site selection process conducted as part of the EIA Process.
	Were the farmers in the area notified of the proposed development?	Landowners, where such contact details were readily available, were notified of the project. Furthermore the relevant Water Use Associations (Boegoeberg, Swartkop and Upington Islands) supplying water to farmers was notified. Local farmers were also consulted during the WULA.
	Should any social investment in the community be considered by the applicant, then direct interaction	Comment noted. The local community will be consulted.

	should be sought with the community to identify the needs of the community. To date, the community has been consulted in English. The preferred language of the overall community is Afrikaans. In future all correspondence to the community should be in Afrikaans. Furthermore the site notice for the project was placed in area considered to be remote. Public participation meetings for the EIA phase should be scheduled for the evenings. Is the Farm Olyvenhouts Drift privately owned land? Feedback on the number of employment opportunities to be created by the CSP development must be given to the community during the EIA phase Public Participation.	 Comments noted. Information regarding the Public Participation Process was communicated in both Afrikaans and English. In terms of the EIA Regulations it is required that a site notice be placed on the site, which the consultant complied with by erecting a notice at the entrance to the Farm Olyvenhouts Drift, across from the access road to the Klippunt/Kalksloot settlements. The land is privately owned. The labour force required for the proposed plant is estimated at: • Construction phase: 300–400 workers, and • Operational phase: 40 workers.
Francina Jobson (Community Member)	The area is known for sand storms. Will the construction and operation of the CSP result in more dust from such storms.	Construction activities will increase dust pollution. This impact will however be temporary and restricted to the construction phase (2-3 years) of the project. Such impacts that may transpire during this phase of the project can be mitigated accordingly by the implementation of an Environmental Management Plan and can therefore be considered as being negligible. Dust is not good for the operations of the CSP plant and the project will also seek dust suppression measures, such as reducing the dust from the adjacent roads. This will therefore tend to reduce overall dust pollution once the project is operational.

Jakobus Blom (!Kheis Local Municipality)	Will the applicant purchase the portion of the Farm Bokpoort should environmental authorisation be granted by the relevant authority.	A conservative 350 hectare portion of land is being considered for the development of the plant. Once environmental authorisation is granted the applicant will enter into a purchase/lease agreement with the owner of the Farm Bokpoort. An application for the subdivision of agricultural land (in terms of Act 70 of 1970) will be submitted to the National Department of Agriculture for approval, should this be required. In addition, an application for the rezoning of the plant site from *"agriculture"* to *"industrial"* (or any equivalent zoning in terms of the relevant town planning scheme/ordinance) will be submitted to the !Kheis Local Municipality for review and approval.
	Has the applicant decided on a plant location alternative?	Yes. Refer to Chapter 5 (*Site Selection and Sensitivity Analysis*) and 7 (*Impact Assessment)* for a detailed assessment of the location alternatives (referred to as development area alternatives in the report) considered during the EIA phase.
	Are there any other companies interested in renewable energy developments in the !Kheis Local Municipality area?	Bohlweki-SSI is aware of multiple projects currently under investigation to determine the feasibility of renewable energy projects in the Siyanda District as this segment of the energy market is emerging rapidly in South Africa
	Has the applicant considered the entire region before the Farm Bokpoort was selected as a site alternative?	Previous investigations undertaken by Eskom Holding Limited in 2006 to assess feasible locations for CSP developments concluded that the Northern Cape Province was the most suitable, specifically Upington

		and Groblershoop. These areas were most suitable based on the high levels of solar radiation recorded which is the primary consideration for such projects. Other considerations included topography, possible water resources, and the availability of land, existing engineering infrastructure and importantly the probability of connecting to the national electricity grid.
Hans Bosman (Community Member)	Will there be less power outages in future if the proposed CSP development is approved and operational? Will this project have an impact on the current electricity tariffs? Will local upcoming farmers benefit from this project in terms of supplying electricity to the farms.	The CSP plant will augment the electricity supply capacity which is likely to result in fewer cases of power outages. The pricing tarrifs for renewable energy under the REFIT Programme have been budgeted in terms of the Eskom's recent multi-year price determination, therefore no impact on current electricity tariffs are forthcoming. Upcoming farmers would not benefit directly from the electricity supply in that direct connection from farms in the area to the plant will not be possible. Solafrica as an Independent Power Producer will enter into a Power Purchase Agreement with Eskom to supply the national utility with auxiliary electricity generated by the CSP plant. The proposed plant will be connected to Eskom's Garona substation (located on the Farm Bokpoort) via a 132 kV overhead powerline. The Garona substation forms part of the national transmission network which will

		enable the supply of electricity to: • Eskom's distribution network running from the Garona substation to the Upington region, and • The transmission network running from Garona substation to the Ferrum substation (Limpopo Province). Various other legislated processes must first be undertaken to obtain the relevant authorisations/approvals applicable to the project prior to the commencement of the project – this typically included amongst other an EIA, WUL and town planning approval. An engineering company has also been appointed by the applicant to undertake the required preliminary and detailed engineering design of the plant. Only once the relevant approvals have been obtained and the engineering design phase concluded can construction of the plant commence. Ground-breaking is scheduled for 2012 however this is only an estimation and dependant on various factors i.e. timeous completion of the engineering design and various regulatory approvals and licensing required.
	Employment opportunities will be welcomed in the area.	As noted above, there will be employment opportunities during construction and operations of the project. As far as possible people from the local area will be employed.
	What is the purpose of registering	By registering as an I&AP such

	as an Interested and Affected Party (I&AP)?	parties will be informed of further meetings, the availability of the project documentation, decisions made by the relevant authorities and any progress related to the project. In addition it provides I&APs with a formal platform to raise any comments and concerns regarding the project.
Willem Engelbrecht (//Khara Hais Local Municipality)	The //Khara Hais Local Municipality had not been informed of the proposed project.	The //Khara Hais Local Municipality was informed on the following occasions: • March 2010 (30-day notification), • May 2010 (public review of the Environmental Scoping Report) and • June 2010 (stakeholder meeting). This included a meeting with the Municipal Manager of the //Khara Hais Local Municipality. A request for a presentation to the Council of the Municipality was also made through the Municipal Manager's office by phone, fax and email. Further to the above, various meetings with other key officials of the municipality have been held – as part of the Water Use Licensing Application Process.
	The site under consideration by the applicant is municipal owned land (the Farm Klipkraal). The KHLM should have been consulted and given consent to the applicant prior to the commencement of the EIA Process.	The candidate site, the Farm Olyvenhouts Drift, is privately owned land and therefore consent from the municipality was not required. The farm directly adjacent to Olyvenhouts Drift (to the east), the Farm Klipkraal is municipal owned land.
Andre Phete (//Khara Hais Local	The //Khara Hais Local Municipality is concerned that consultants do not conduct adequate Public	Consultants are guided by the EIA Regulations which stipulates the minimum requirements for Public

Municipality)	Participation and that regular feedback is not provided to stakeholders. Consultants should contact both the Office of the Speaker and the Municipal Manager's Office as to ensure that relevant local councillors are notified of the project and the relevant information is disseminated to applicable stakeholders whom may assist the consultants with notifying the public.	Participation. The minimum requirements were adhered to and in instances additional measures were taken to inform all parties. This included relevant provincial and local authorities, ward councillors and affected communities. Bohlweki-SSI and the project developers have consulted with both the Office of the Speaker and the Municipal Manager (in person) during the Scoping phase. Furthermore Bohlweki-SSI has adopted the general approach of contacting the Office of the Speaker as a first point of communication with the local authority. This has historically proven to be the best approach. A request for a presentation to the Council of the Municipality was also made through the Municipal Manager's office by phone, fax and email. The ward councillors have been contacted to assist with notifying the affected communities – they included Councillors Klasie and Koloi.
Adv. MEA October (Siyanda District Municipality)	Detailed information on social aspects such as employment opportunities must be reported on to the //Khara Hais Local Municipality.	The labour force required for the proposed plant is estimated at: • Construction phase: 300–400 workers, and • Operational phase: 40 workers.

4.1.4 Registered I&APs

According to Regulation 57 of the GN R385 (April 2006), an Environmental Assessment Practitioner is required to maintain a register which contains the names and contact details of all I&APs who have submitted written comments in respect of the application for environmental authorisation. The following I&APs registered during the Scoping phase PPP (refer to Table 15).

Table 15: List of registered I&APs

Last Name	Initials	Company	Address	City	Telephone No	Postal Code	E-mail Address
Nowalzana	J	Department of Education	65 Omega Street, Paballelo	Upington	054 337 6300 076 101 8829	8801	
Van Niekerk	AN		Klipkoppies	Kenhardt	054 335 1057 082 578 5616	8900	
Morkel	A	Louisvale-Weg Up-and-Coming Farmers Association	7 Honeysuckle Street	Upington	082 820 3759	8801	amorkel@vodamail.co.za
Buys	H	Alstop Supermarket	10 Main Street	Groblershoop	054 833 0393 076 887 8284	8850	alstop@lantic.net
Breytenbach	N	Sentech Ltd	37 Swartmodder Rd	Upington	054 332 6551	8800	breytenn@sentech.co.za
Van Jaarsveld	JJ	Vastrap Weapon Range		Upington	054 756 0001	8800	vastrap@telkomsa.net
Du Plessis	PD	Karsten	Boepersfontein	Blaauwskop	082 491 9300 082 557 9734	8806	pierterdp@karsten.co.za
Botha	JMS	Boegoeberg Water	Saaiskop	Groblershoop	054 841 0002	8850	

		Use Association			082 651 8415		
Hasty	RA			Beaconsfield	083 959 7048	8315	s.chymist@gmail.com
Horak	MC	Air Traffic and Navigations Services Company Ltd		Kempton Park	011 961 0307 079 879 3654	1620	thysh@atns.co.za
Blom	J	!Kheis Local Municipality		Groblershoop	054 833 9500 083 677 0072	8850	jacobusb@kheis.co.za
Bosman	H			Groblershoop	083 691 6506	8850	
Cloete	E	Ward Councillor (!Kheis Local Municipality)		Groblershoop	078 456 4758	8850	
Engelbrecht	W	//Khara Hais Local Municipality		Upington	054 338 7002	8800	manager@kharahais.gov.za
October	M	Siyanda District Municipality		Upington	054 337 9408 082 592 9604	8800	moctober@uposb.ncape.gov.za
Phete	A	Dept. Cooperative Governance, Human Settlement and Traditional Affairs			072 947 0080		aphete@ncpg.gov.za

Jobson	F		54 Ertjie Street Kalksloot	Upington	083 660 4367	8801	
Juries	I		16 Spanspek Street, Kalksloot	Upington	054 338 7078 082 827 9789	8800	admineo@kharahais.gov.za
Van Zyl	I		4 Jan Groentjie Ave, Keidebees	Upington	072 222 6194	8800	ibvanzyl@telkomsa.net

4.2 Public Participation Process - EIA Phase

4.2.1 Review of Draft Environmental Impact Assessment Report

The draft EIR Report was made available for public review from 4 October 2010 to 03 November 2010 (and extended to 12 November 2010) at the following public locations within the study area, which were deemed readily accessible to I&APs:

- !Kheis Public Library (97 Oranje Street, Groblershoop), and
- //Khara Hais Public Library (Market Street, Upington).

In addition, an electronic copy of the draft document (including specialist reports) was obtainable from Bohlweki-SSI Environmental's website (www.bohlweki.co.za).

The availability of the draft EIR was advertised in the *Gemsbok* (local) newspaper. Furthermore Stakeholders and I&APs on the project database within both geographic areas of the site alternatives (i.e. Groblershoop and Upington) were notified of the availability of the report by letter (via facsimile, post or e-mail) a week prior to the commencement of the review period.

Bohlweki-SSI Environmental received <u>four</u> comments/repsonses from I&APs on the draft EIR.

*Refer to **Appendix B3** for copies of the following:*

- *Newspaper advertisement;*
- *Notification letter to Stakeholders/I&APs, and*
- *I&AP comments/responses.*

4.2.2 Public and Focus Group Meetings

Public and Focus Group Meetings were scheduled to coincide with the public review of the draft EIR. The meetings were held on:

- Public Meeting:
  - <u>Date:</u> 12 October 2010;
  - <u>Venue:</u> Orange River Cellars, Groblershoop
- Focus Group Meeting:
  - <u>Date:</u> 13 October 2010
  - <u>Venue:</u> !Kheis Local Municipality offices, 97 Oranje Street, Groblershoop.

Kindly note that meetings with I&APs and Stakeholders were restricted to the geographic area of the nominated site.

Bohlweki-SSI Environmental presented the findings and recommendations of the various specialist studies to attendees at the meetings and provided a platform for I&APs and Stakeholders to engage with the project team.

Stakeholders and I&APs were notified of the Focus Group/Public Meetings using the following methods:

- Advertisment in the *Gemsbok* newspaper;
- Invitation letter sent via e-mail, registered mail and/or fax;
- Telephonic dialogue with key Stakeholders;
- Liaison with the relevant Ward Councillors and Ward Committee Representatives – the Ward Councillors assisted Bohlweki-SSI Environmental by informing the relevant communities.

*Refer to **Appendix B4** for copies of the following PPP documentation:*

- *Newspaper advertisement;*
- *Invitation letter (refer to Appendix B3);*
- *EIA phase presentation;*
- *Attendance registers; and*
- *Minutes of the meetings.*

4.2.3 Social Issues Trail

Issues, comments and concerns raised during the EIA phase PPP has been compiled into a consolidated Social Issues Trail (refer to ***Appendix B5***). The Issues Trail provides a summary of the comments, issues and concerns raised during both the Scoping and EIA phases, and further includes the EAP's responses to Stakeholders and I&APs.

*Refer to **Appendix B6** for a complete register of Stakeholders and I&APs.*

4.2.4 Final Environmental Impact Assessment Report

The final stage in the EIA Process will entail the capturing of responses from I&APs on the draft Environmental Impact Assessment Report in order to refine the report, and ensure that all issues of significance are addressed accordingly. The final report will be submitted to DEA and NC DENC for review, comment and decision-making.

4.2.5 Environmental Authorisation

On receipt of environmental authorisation (positive or negative) for the project, I&APs registered on the project database will be informed of this authorisation and its associated terms and conditions by correspondence.

5 SITE SELECTION AND SENSITIVITY ANALYSIS

5.1 Site Selection

5.1.1 Approach to Site Selection

The Scoping phase of the EIA Process identified the potential positive and negative environmental (biophysical and social) impacts associated with the proposed establishment of a CSP plant and associated infrastructure in the Siyanda District. A number of issues for consideration were identified by the environmental team and/or raised by I&APs during the PPP. This section serves to outline the approach utilised to evaluate the alternative sites and select a preferred site for the establishment of the proposed CSP plant and associated infrastructure.

The potential environmental impacts of the CSP plant and associated infrastructure were considered in the nomination of a preferred site for the construction of the CSP plant, as well as in determining which further studies would be required in the EIA phase.

The Scoping phase evaluated two alternative sites for the proposed Solafrica CSP project:

- Site 1: Farm Olyvenhouts Drift (west of Upington), and
- Site 2: Farm Bokpoort 390 (north west of Groblershoop).

In order to establish the best environmentally and technically practicable site to evaluate in the EIA phase, site specific evaluations were undertaken for each of the alternative sites. The process involved a range of physical, biological, social and technical criteria.

5.1.1.1 Site Evaluation – Field Studies

The two alternative sites were inspected by the specialists in order to:

- Investigate the study area;
- Gather baseline environmental (biophysical and social) information for the sites;
- Assess the status quo conditions, and
- Identify any potential environmental impacts.

5.1.1.2 Specialist Studies

The choice of specialist studies undertaken during the environmental assessment process was influenced by the need to cover all aspects of the environment namely: physical, biological and social. Table 16 outlines the variables or issues that were investigated by 11 specialist studies utilised in determining the preferred site for the CSP plant deployment.

Table 16: Specialist studies and the components investigated during the Environmental Scoping phase

Physical Variables	
Geohydrology	Quantity of waste / overburden
	Leakage potential and liner / decant, seepage
	Toxicity of leakage / seepage
	Infiltration potential (permeability and gradient)
	Mass transport factor of permeability and gradient)
	Depth to groundwater (shallow indicates higher risk)
	Aquifer vulnerability (sole source aquifer indicates high risk)
	Downstream users / receptors (human and aquatic)
Hydrology †	Infiltration rates
	Susceptibility of soil-surface sealing
	Susceptibility of soil to compaction
	Erodibility
	Vulnerability off-site to flooding generated by development
Soils and Agricultural Potential †	Soil types
Biological Variables	
Avi-fauna	Presence of Red Data Bird species
	Habitat uniqueness
	Existing disturbance levels
	Proximity to existing power line infrastructure
	Proximity to existing roads
	Presence of surface water
Biodiversity	Destruction of threatened flora species
	Destruction of protected tree species
	Direct impacts of threatened fauna species
	Direct impact on common fauna species
	Destruction of sensitive / pristine regional habitat types

	Floristic species changes within the development areas
	Faunal interactions with structures, servitudes and personnel
	Impacts on surrounding habitats / species
	Impacts on South Africa's conservation obligations and targets
	Increase in local and regional fragmentation / isolation of habitat
	Increase in environmental degradation
Social Variables	
Visual	Visual exposure of CSP plant components
	Visual exposure to major towns or built up areas
	The length of time or duration the proposed CSP plant would be visible to road users
	Length of visual exposure of the facility from major roads
	Quality of the immediately affected visual environment
	Presence/absence of existing visual clutter
	Level of disturbance of natural vegetation
	Proximity to existing transmission line infrastructure
Tourism[†]	Visual
	Presence of established Tourism Plant
	Traffic
	Potential for future Tourism Development
Heritage[†]	Presence / absence of heritage objects / sites
Noise	The extent to which the existing noise climate is degraded, thereby reducing the impact of the new Plant.
	Potential for impact from CSP plant construction activities.
	Potential for impact from CSP plant construction traffic
	Potential for impact of CSP plant operations on urban areas
	Potential for impact of CSP plant operations on settlement areas.
	Potential for impact of CSP plant operations on farmhouses

	and farm labourer houses	
	Potential for impact of CSP plant operational traffic	
Social Impact Assessment [†]	Population Characteristics	Population Change
		Ethnic and racial distribution
		Relocated populations
		Influx or outflows of temporary workers
		Seasonal residents
	Community and Institutional Structures	Interest group activity
		Size and structure of local government
		Historical experience with change
		Employment/income characteristics
		Employment equity of minority groups
		Enhanced economic inequities
		Local/regional/national linkages
		Industrial/commercial diversity
		Presence of planning and zoning activity
	Conflicts between local residents and newcomers	Presence of an outside agency
		Introduction of new social classes
	Political and Social Resources	Distribution of power and authority
		Identifications of stakeholders
		Interested and affected

		publics
		Leadership capability and characteristics
Technical		
Technical Criteria	Site accessibility - existing roads and their condition	
	Existing electrical infrastructure (i.e. transmission / distribution lines, substation)	
	Planned upgrade to electrical infrastructure (transmission/distribution lines; substation)	
	Accessibility to technical support infrastructure	
	Accessibility to boarding and lodging	
	Water availability	
	Grid accessibility	
	Available grid capacity for connection	
	Geotechnical suitability of the site	
	Geomorphology and land gradient	
	Legal title to land	

† Specialist studies from the EIA study for the Eskom CSP plant

* The Air Quality Impact Assessment was only undertaken for the nominated site and therefore did not form part of the site selection process

5.1.1.3 Site Evaluation

The evaluation and nomination of a potential site for the CSP plant involved an interdisciplinary approach. The approach involved a wide range of specialist studies which examined the feasibility of the candidate sites in terms of various different variables / issues (refer to Table 16 above). Each specialist, upon completion of the Scoping phase evaluation, was required to recommend a preferred site as an outcome – the approach used in evaluating the alternative sites varied from specialist discipline to discipline. Refer to Section 5.2.1 to 5.2.10 for the recommendations of the various specialists regarding site selection.

In order to nominate the preferred site for further assessment in the EIA phase, the identified site alternatives were weighted against one another using a ranking matrix to calculate a comparative score. The following site preference rating scores in Table 17 were applied to each specialist discipline recommendation:

Table 17: Site preference scores

Score	Description
0	Site not developable due to environmental fatal flaw(s)
1	No preference – no distinguishing factor, both candidate sites are suitable for development
2	Candidate site not selected as preferred however developable – no environmental fatal flaws identified disqualifying candidate site
3	Preferred site for CSP development

The site preference results for each site from each specialist study were entered into a matrix and added together. The site with the highest score was then considered the most preferable site.

The standard matrix as described above, gives equal importance to each specialist discipline. Therefore, a weighted matrix was also used. In a weighted matrix each specialist discipline is given a different importance weighting. Input from the project and specialists teams was utilised for the allocation of weightings to the different specialist disciplines. Each member of the project and specialist teams was requested to rank each specialist discipline according to their significance (Table 18):

Table 18: Weighted scores

Score	Description
1	Low significance / standard
2	Medium significance / important
3	High significance / very important

The average weighting for each specialist discipline was calculated and then multiplied by the site preference rating to give a weighted site preference rating for each specialist discipline.

5.1.2 Site Evaluation Findings

5.1.2.1 Soils and Agricultural Potential

The study was conducted at a reconnaissance scale, namely 1:250 000.

It is normal practice that, once a preliminary decision is taken on which of the two sites is the most suitable, a more detailed soil investigation be carried out, at a scale of 1:20 000 or finer, to more accurately characterize the soils in the specific site area and to ensure that the best possible location within the site be chosen, in terms of agricultural potential.

However, it is almost certain that, due to the arid nature of the region and the shallow or sandy nature of the soils, any survey, no matter how detailed, will fail to locate any soils with meaningful arable potential.

The principle finding of the Scoping phase recommended that no detailed assessment was required in this regard for the EIA phase.

From a soils point of view, each site comprises a combination of the following broad groups:

- Deep red sands (A) - land types Ae4, Ae10, Ae108;
- Dune areas (B) - land types Af7, Af8, Ic4; and
- Shallow soils with some rock (C) - land types Ag1, Ic4.

Although substantial variations may occur at the scale of investigation, generally (ranked from preferred to least favourable):

- (C) is preferred for development, since the generally shallow soils are of limited use for any other land use apart from grazing (marked in **green** in Figure 35);
- (A) is not recommended but acceptable for development, although the lack of arable agriculture would make it a possibility (marked in **yellow** in Figure 35); and
- (B) is not preferred for development as a natural ecosystem would be disturbed (marked in **red** in Figure 35).

Olyvenhouts Drift has the largest area of shallow soils available (land type Ag1), as well as an area of deep red soils (land type A108 and A10) when compared to Bokpoort. The recommendation would be that *Olyvenhouts Drift* be considered as the preferred site.

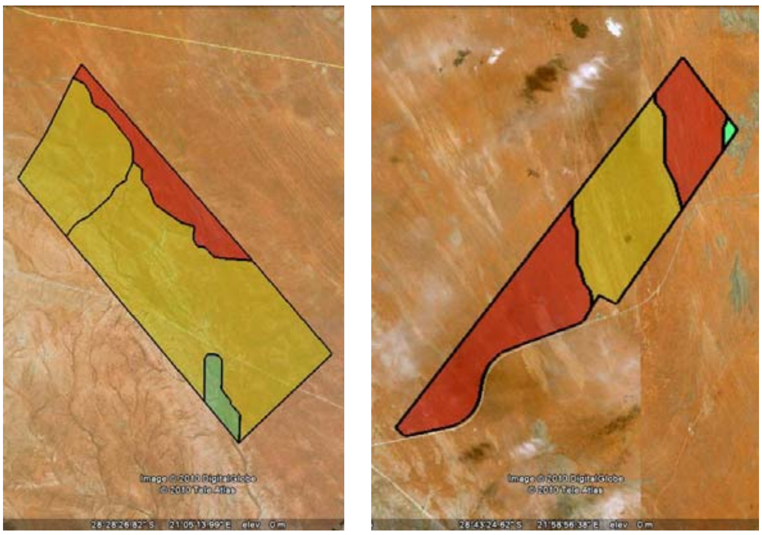


Figure 35: Development preference based on soil type (Olyvenhouts Drift – left; Bokpoort - right)

5.1.2.2 Hydrology

A CSP plant will have a negligible effect on regional water resources because the water requirements of the installation, as a proportion of river flow at Upington, are so small as to be negligible. Such an installation will not affect in any discernable way rainfall or local energy budgets, and will have very little effect, if at all on local infiltration, runoff and streamflows, and neither will they differ markedly between sites. It can be concluded from the above assessment that no further studies need to be undertaken regarding the possible impacts of a CSP plant on the regional or local hydrology.

From a hydrological point of view, there is *no particular advantage for choosing one site above the other*. Rainfall and soil conditions appear very similar for both sites. The differences in expected intensity of rainfalls and infiltration rates at each of the sites are not sufficiently different that a choice based on hydrological response needs to be made. The sites are expected to behave in very similar ways. At none of the sites are there any vulnerable entities downstream which might be affected by any changes.

5.1.2.3 Geohydrology

None of the sites can be regarded as a fatal flaw from a groundwater perspective. *Bokpoort (Site 2)* was however recommended as the preferred site compared to Olyvenhouts Drift (Site 1) due to:

- Water levels being deeper at Site 2 and therefore longer travel times for contaminants.
- Quicker travel time of potential contaminants due to the presence of both alluvial and collegial sand formations on Olyvenhouts Drift; and
- Shallow bedrock conditions present on Bokpoort. This will result in longer travel times of potential pollutants and restrict groundwater flow.

5.1.2.4 Biodiversity

The two sites comprise varying habitat types and characteristics as well as different ecological sensitivities. This is based on habitat attributes and biota that are likely to inhabit these areas. Olyvenhouts Drift comprises relatively extensive areas of riparian habitat in the form of small drainage lines and rivers. The presence of small drainage lines invariably indicates the likelihood of erosion of surface areas, which will be a consideration in the EIA assessment. These areas are regarded to represent the more sensitive areas of this particular site, but the general habitat suggests slightly higher levels of degradation than the Bokpoort site. The Bokpoort site is characterised by the presence of pristine dune habitat and extensive rocky outcrops in the northern sections as well as riparian areas and low outcrops in the south, representing the sensitive areas. This site is regarded slightly higher in ecological sensitivity and quality than the Olyvenhouts Drift site.

Both sites comprise habitat of a moderate sensitivity; these areas are representative of the regional vegetation type and is furthermore adequately represented in the local region. It should however be noted that the general habitat is likely to be inhabited by flora or fauna species of conservation importance, in which case the sensitivity of the particular area will increase significantly and the suitability of the particular site will decrease. The presence of these species has been indicated by previous studies and will ultimately provide guidance for the placement of infrastructure.

Therefore, taking the preliminary status of these sites into consideration, the *Olyvenhouts Drift* site is recommended as the preferred alternative for the proposed development, provided that infrastructure could be placed away from areas of sensitivity.

5.1.2.5 Avi-fauna

A comparative evaluation of the two sites reveals that *Bokpoort* is the preferred site for the CSP development from a bird impact assessment perspective, if only by the slightest of margins. In practical terms there is little to choose between the two sites. Further detail on the impacts of the CSP on avifauna will be explored during the EIA phase once an exact site has been identified.

5.1.2.6 Noise

The following may be concluded from this analysis:

- From a noise perspective, there is very little difference between the impacts on the two alternative sites. However:
  - In general the Upington area (Site 1) would be more suitable due to the developed character of the area and from the perspective that the planned CSP plant can be sited in the central sector of the farm Olyvenhouts Drift where its impact on the surrounding areas will not be significant. However, the current legal title to the land may make such situation difficult.
  - Site 2 (Bokpoort) is more of a “greenfields” site, has a slightly stronger rural character than Olyvenhouts Drift and the introduction of a major industrial noise source into the area is not desirable.
- Therefore, from a noise perspective, it is recommended that *Olyvenhouts Drift* be selected as the more desirable development site.

5.1.2.7 Visual

The landscape analysis indicates a preference for Olyvenhouts Drift should the power tower technology option be selected as the preferred technology. As far as the trough technology is concerned, either of the two sites can be selected. Since the trough technology has been selected either of the two sites could bee seen as equally acceptable.

In this regard it is recommended that the previous EIA for Eskom, in terms of which Olyvenhouts Drift was selected, be considered for determining the preferred site. Based on the fact that authorisation that has been granted to Eskom to establish a CSP plant on

Olyvenhouts Drift, it must be considered that this farm should be the preferred site. This recommendation is made in view of the fact that the landscape is sensitive to industrial sprawl.

5.1.2.8 Heritage

The lithic assemblages found during the whole investigation seem to be in the form of a general distribution of flakes cores. The impact on the cultural heritage remains of the proposed development sites Olyvenhouts Drift and Bokpoort will be of minor significance. The stone flakes are sparsely distributed on the surface with the intensity of the distribution very similar at all the sites. No other cultural, historical or palaeontological components were found during the investigation, nor were there any buildings, graves or burial grounds in the area.

No mitigation measures will be required on any of the sites, however, should any archaeological / heritage sites be exposed during construction, it should immediately be reported to a museum, preferably one at which an archaeologist is available, as well as to the South African Heritage Resources Agency so that an investigation and evaluation of the finds can be made.

The findings of the heritage impact assessment concluded that *no candidate site is preferred* above the other.

5.1.2.9 Social and Land Use

Olyvenhouts Drift emerges as the most preferred site for the power station if social impacts are considered, with Site 2 as second preference. This recommendation is mainly based on the fact that Site 1 is located in the vicinity of Upington, and therefore has greater capacity to absorb and support the influx of workers that will take place during construction and operation of the plant.

From the perspective of land use impacts, on the other hand, Site 2 (Bokpoort) is recommended as the most appropriate site. However, the difference between the two sites in terms of impacts on land use is not of a significant magnitude.

5.1.2.10 Tourism

According to the above description, the *Bokpoort* site is preferred for the location of the CSP plant due to its proximity to the Garona substation and the railway tracks which already acts as a deterrent for the development of tourism.

5.1.3 Summary of Site Evaluation Findings

Refer to Table 19 below for a summary of the specialist recommendations:

Table 19: Recommendation of specialists

Specialist Study	Site 1 (Olyvenhouts Drift)	Site 2 (Bokpoort)
Visual	***Preferred***	-
Noise	***Preferred***	-
Biodiversity	***Preferred***	-
Avifauna	-	***Preferred***
Ground Water	-	***Preferred***
Surface Water	(no preference)	(no preference)
Social & Land Use†	***Preferred***	-
Tourism†	-	***Preferred***
Heritage†	(no preference)	(no preference)
Soils†	***Preferred***	-

† Specialist studies from the EIA study for the Eskom CSP plant

5.1.4 Site Preference Rating

5.1.4.1 Environmental and Social Matrix

Table 20 outlines the un-weighted and weighted ranking scores for the environmental and social criteria. The scores utilised are based on the results of the various specialist studies undertaken during the Scoping phase.

Table 20: Environmental and social matrix

		Unweighted		Weighted	
Criteria	**Weighting**	**Site 1**	**Site 2**	**Site 1**	**Site 2**
Physical					
Soil and Agricultural Potential	1.6	3	2	4.8	3.2
Hydrology (Surface Water)	1.6	1	1	1.6	1.6
Geohydrology (Ground Water)	1.7	2	3	3.4	5.1
Biological					
Biodiversity	2.3	3	2	6.9	4.6

		Unweighted		Weighted	
Criteria	**Weighting**	**Site 1**	**Site 2**	**Site 1**	**Site 2**
Avi-fauna	2.2	2	3	4.4	6.6
Social					
Noise	1.7	3	2	5.1	3.4
Visual	2.4	3	2	7.2	4.8
Heritage	1.7	1	1	1.7	1.7
Social and Land Use	2.6	3	2	7.8	5.2
Tourism	1.8	2	3	3.6	5.4
	Total	**23**	**21**	**46.5**	**41.6**

Site preference scores:

Score	Description
0	Site not developable due to environmental fatal flaw(s)
1	No preference – no distinguishing factor, both candidate sites are suitable for development
2	Candidate site not selected as preferred however developable – no environmental fatal flaws identified disqualifying candidate site
3	Preferred site for CSP development

The above matrix denotes that from an environmental and social perspective, *Site 1 (Olyvenhouts Drift)* is considered to be the preferred site for the development of the CSP plant. It should however be noted that only a 2 point (unweighted) and 4.9 point (weighted) margin respectively, distinguishes the two site alternatives. Considering the marginal qualitative differences between the two candidate sites and that no environmental fatal flaws were identified by the specialist studies undertaken during the Scoping phase, it can be concluded that both candidate sites consist of equally suitable portions of land for development from an environmental (biophysical and social) perspective.

5.1.4.2 Technical and Economic Matrix

In order to provide a holistical approach to the site selection process, the technical and economic criteria which play a role in the selection of a site were also included within the overall evaluation of the candidate sites. The inclusion of the technical and economic criteria in the site selection process stems from the BATNEEC (Best Available Techniques Not

Entailing Excessive Costs) principle. This principle introduces the need for a development to be technically and economically feasible in addition to being environmentally practicable. In this way the site recommended for detailed study within the Environmental Impact Assessment is acceptable from all aspects of the environment, namely natural, social and economic environments, thereby ensuring that the project strives to embrace the principles of sustainable development. The site preference rankings for the technical and economic criteria considered within the Scoping phase are outlined in Table 21.

Table 21: Technical and economic matrix

		Unweighted		Weighted	
Criteria	**Weighting**	**Site 1**	**Site 2**	**Site 1**	**Site 2**
Technical Criteria					
Site accessibility	1	1	1	1	1
Existing electrical infrastructure (transmission/distribution lines; substation)	2	2	3	4	6
Planned upgrade to electrical infrastructure (transmission/distribution lines; substation)	2	1	1	2	2
Accessibility to technical support infrastructure	1	1	1	1	1
Accessibility to board and lodging	1	3	2	3	2
Water supply	3	1	1	3	3
Grid accessibility	3	2	3	6	9
Available grid capacity for connection	3	2	3	6	9
Geotechnical suitability of the site	2	1	1	2	2
Geomorphology and land gradient	2	3	2	6	4
Legal title to land	1	2	3	2	3
Economic Criteria					
Economic	1	2	3	2	3
	Total	**21**	**24**	**38**	**45**

Site preference scores:

Score	Description
0	Site not developable due to environmental fatal flaw(s)
1	No preference – no distinguishing factor, both candidate sites are suitable for development
2	Candidate site not selected as preferred however developable – no environmental fatal flaws identified disqualifying candidate site
3	Preferred site for CSP development

The above matrix denotes that from a technical and economic perspective, Site 2 (Bokpoort) is considered to be the preferred site for the development of the CSP plant by a significant 7 point margin when comparing the calculated individual weighted scores of each of the candidate sites.

5.1.4.3 Conclusion and Recommendation

Both the candidate sites were comparatively evaluated by means of various environmental, social, technical and economic criteria. The purpose of the comparative assessment was to identify a candidate site considered to be suitable for the development based on a high-level appraisal of environmental (biophysical and social) characteristics specific to each of the alternative sites. During this high level assessment, undertaken as part of the Scoping phase, various potential environmental issues unique to each alternative site were identified, however no environmental fatal flaws were flagged, eliminating a candidate site(s) as unsuitable for the proposed development – this is evident from the findings of the high-level assessment and the evaluation results in Section 5.1.4.1. On this basis both candidate sites and or portions thereof, in view of diverse environmental (biophysical and social) considerations are deemed feasible for the deployment of a CSP plant – refer to Figure 36 for an illustration of the development potential of the candidate sites (Olyvenhouts Drift and Bokpoort).

Based on the above premise, technical and economic criteria which are important factors in the selection of feasible sites were considered in the overall evaluation of the candidate sites, with the purpose of providing input to the site selection process. From this evaluation it was evident that from a technical and economic perspective, the Bokpoort site is considered as the preferred site requiring further detailed assessment in the EIA phase of the project.

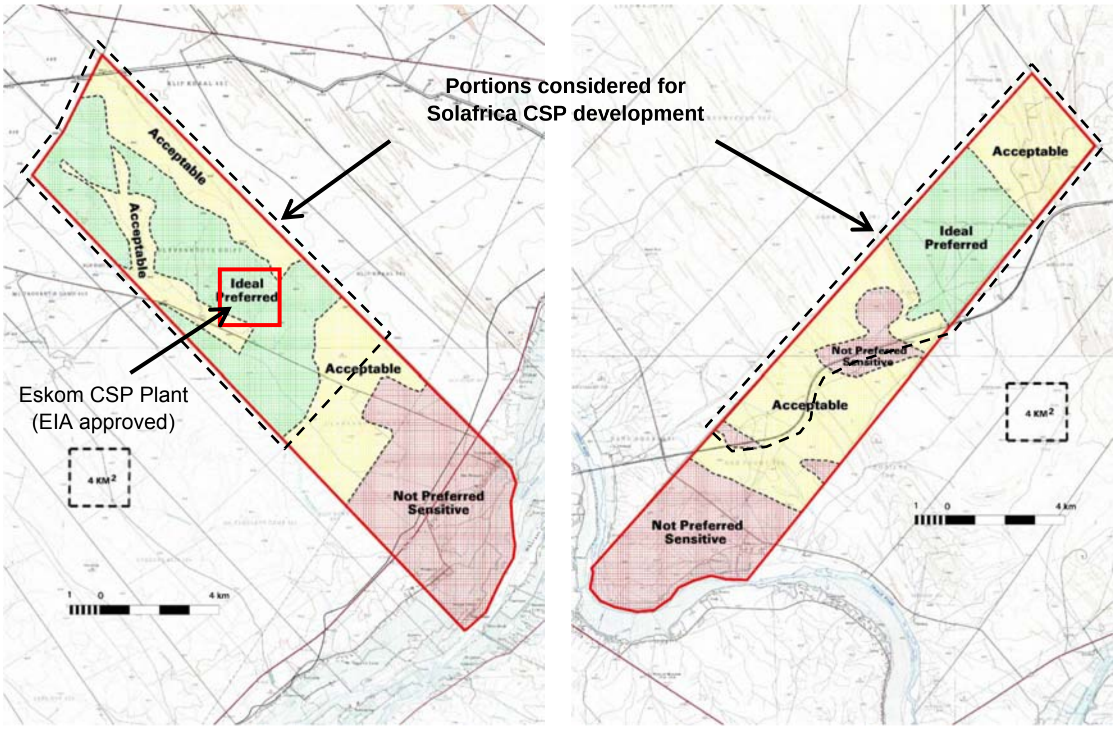


Figure 36: Development potential of the Farms Olyvenhouts Drift and Bokpoort[35]

5.2 Sensitivity Analysis

Following the selection of the preferred development site a qualitative sensitivity mapping exercise was undertaken for the nominated site (Bokpoort). The objective of the exercise was to determine the environmental opportunities and constraints (feasibility limits) associated with the Bokpoort site, thereby providing an illustrative overview of the developable portions suitable for the proposed CSP project.

The environmental sensitivities for each of the specialist studies, with the exception of noise and visual, were mapped according to prescribed groupings. The individual sensitivity maps were subsequently overlaid and utilised to create a composite sensitivity index map and sensitivity zoning map. Based on the outcome of the sensitivity analysis *development area alternatives* were selected on the portions of least environmental sensitivity.

5.2.1 Sensitivity Mapping – Specialist Disciplines

The biophysical and social sensitivities identified by the various specialist studies, with the exception of the noise and visual studies, were mapped. It was required that the Bokpoort site be demarcated into the following categories: *"ideal"* (least sensitive areas), *"acceptable"* (areas with medium or average sensitivity) and *"unacceptable / not ideal"* (i.e. sensitive areas) for each of the following specialist disciplines:

[35] Bohlweki Environmental. 2006. *Environmental Impact Assessment for the establishment of a New Concentrating Solar Power (CSP) plant and associated infrastructure in the Northern Cape Province.*

- Avifauna;
- Biodiversity;
- Surface water;
- Ground water;
- Social;
- Soils / agricultural potential;
- Heritage, and
- Tourism.

The sensitivity maps for each of the above specialists are shown in Figure 37 to Figure 44 respectively.

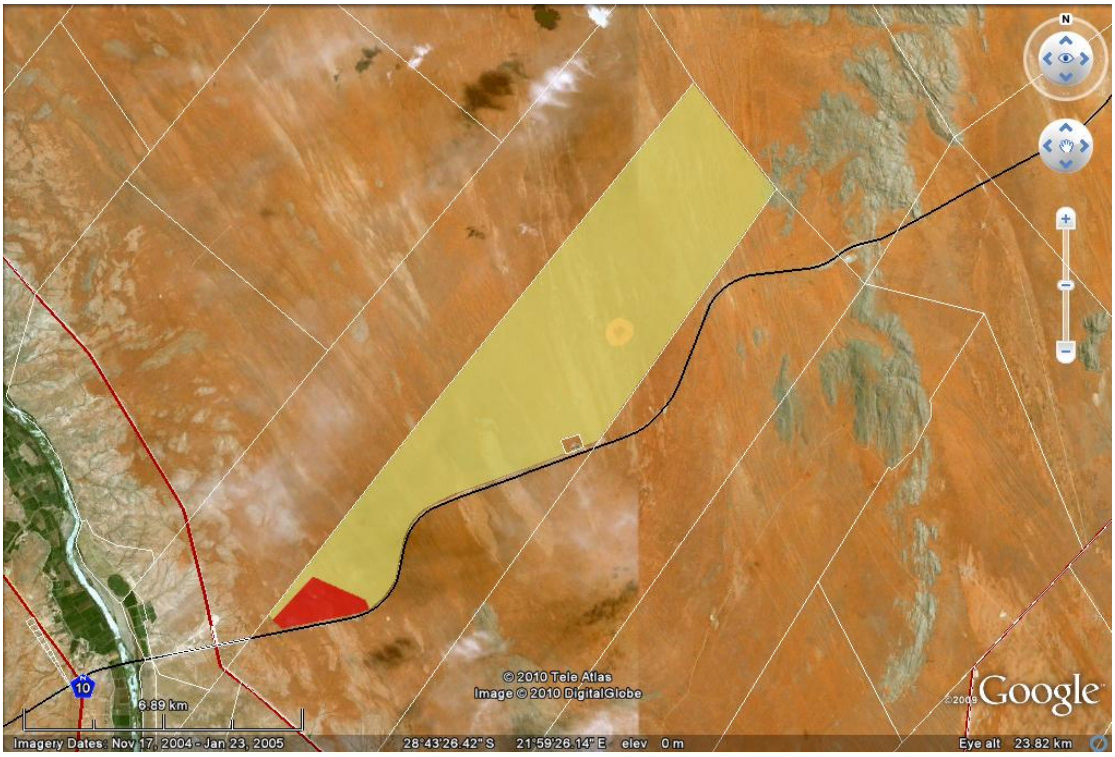


Figure 37: Avifauna sensitivity (yellow – "ideal"; red - "unacceptable")

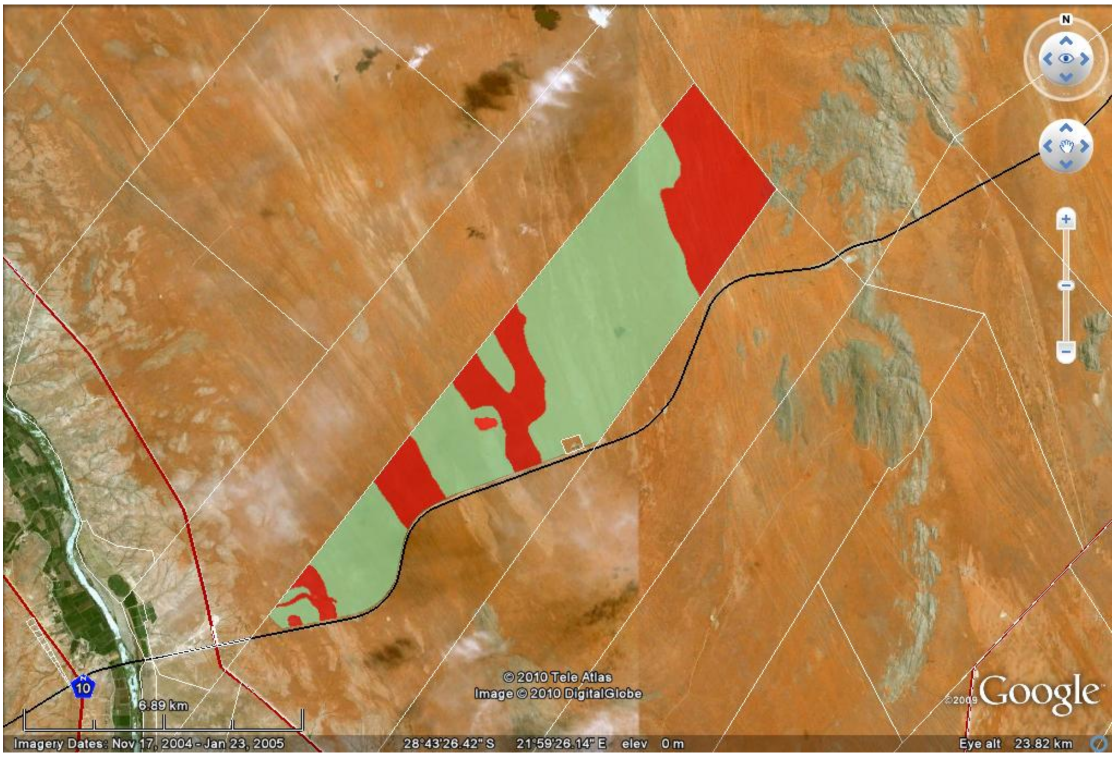


Figure 38: Biodiversity sensitivity (green – "acceptable"; yellow – "ideal"; red – "unacceptable")

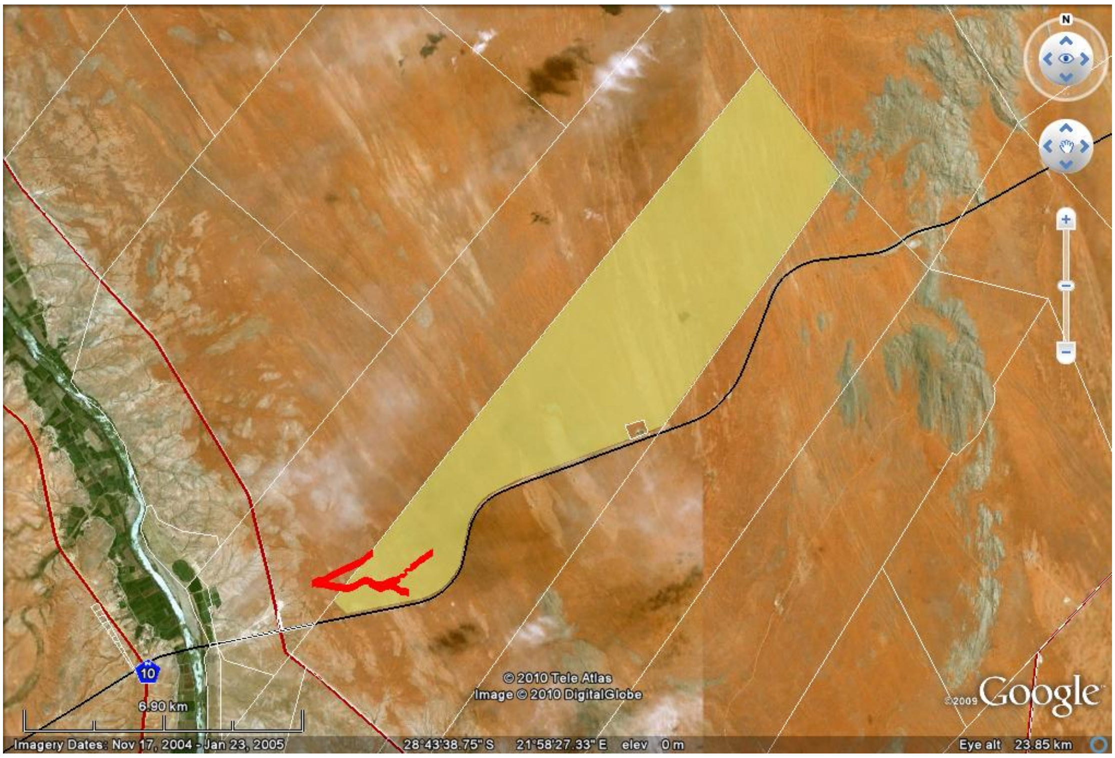


Figure 39: Surface water (yellow – "ideal"; red – "unacceptable")

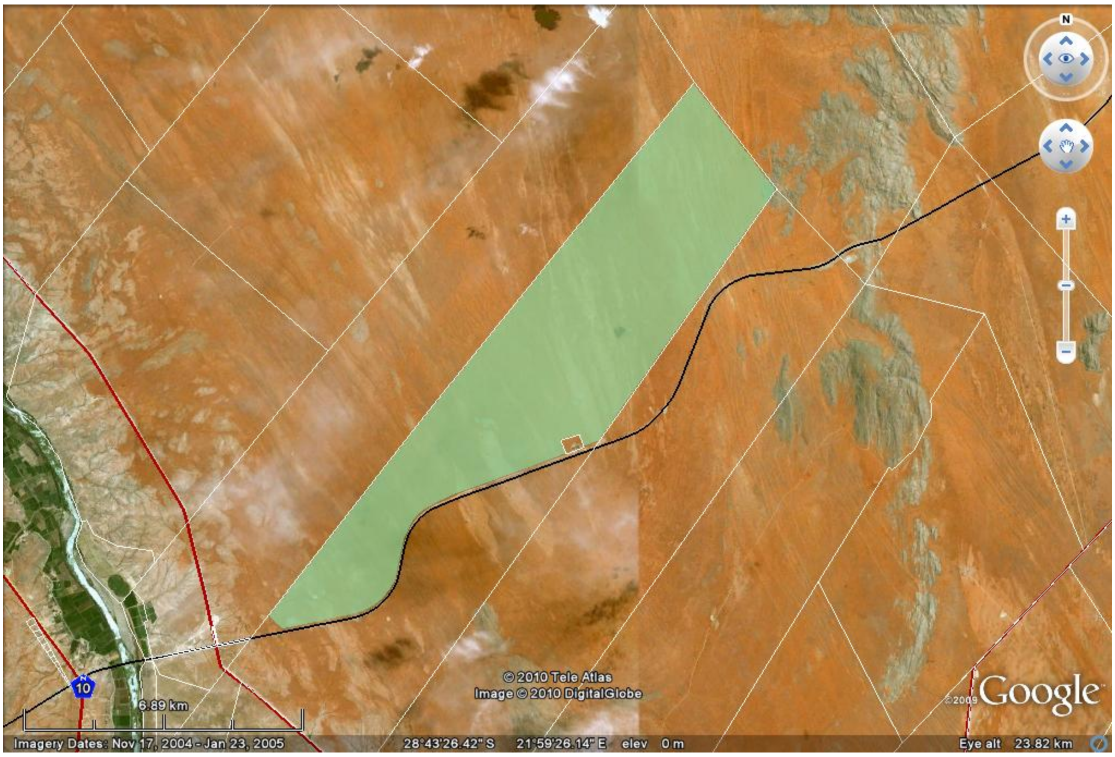


Figure 40: Groundwater sensitivity (green – "acceptable")

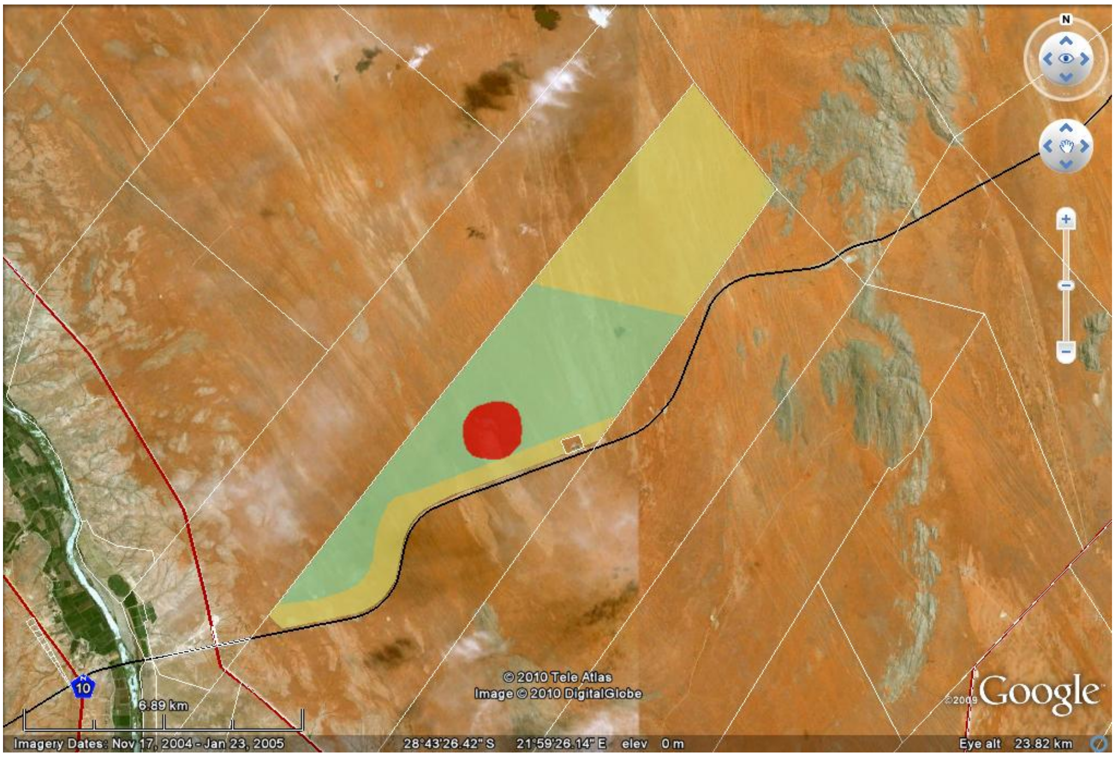


Figure 41: Social sensitivity (green – "acceptable"; yellow – "ideal"; red – "unacceptable")

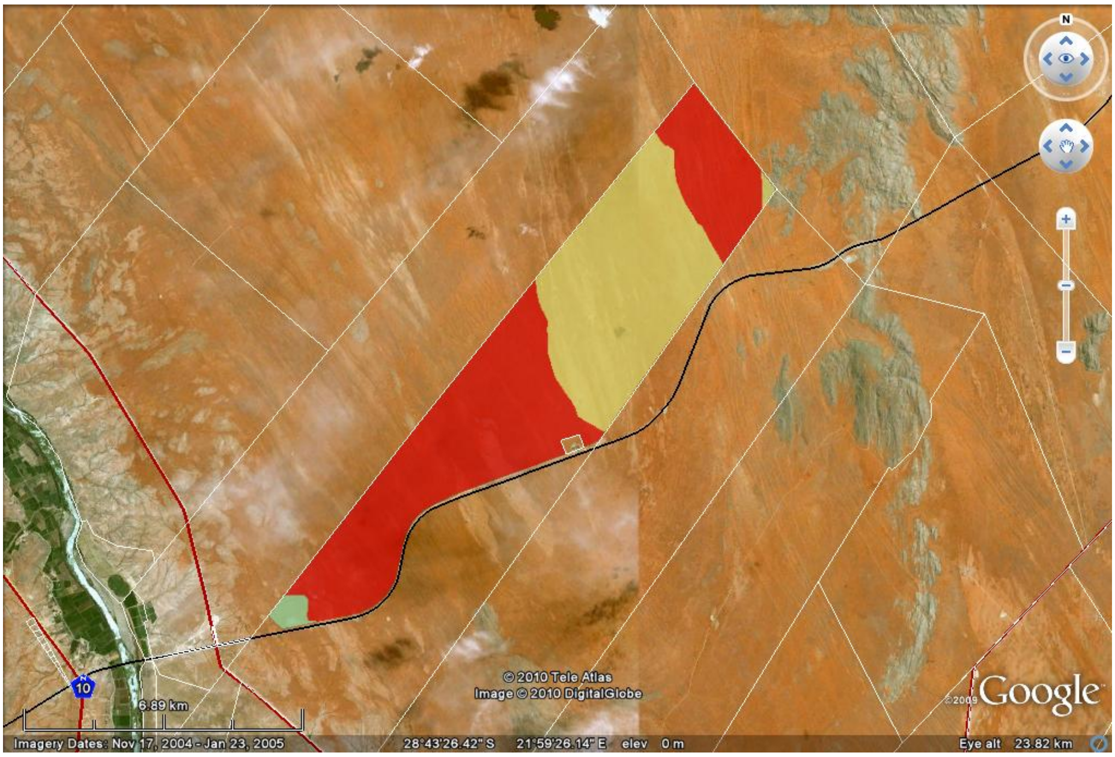


Figure 42: Soil / agricultural potential (green – "acceptable"; yellow – "ideal"; red – "unacceptable")

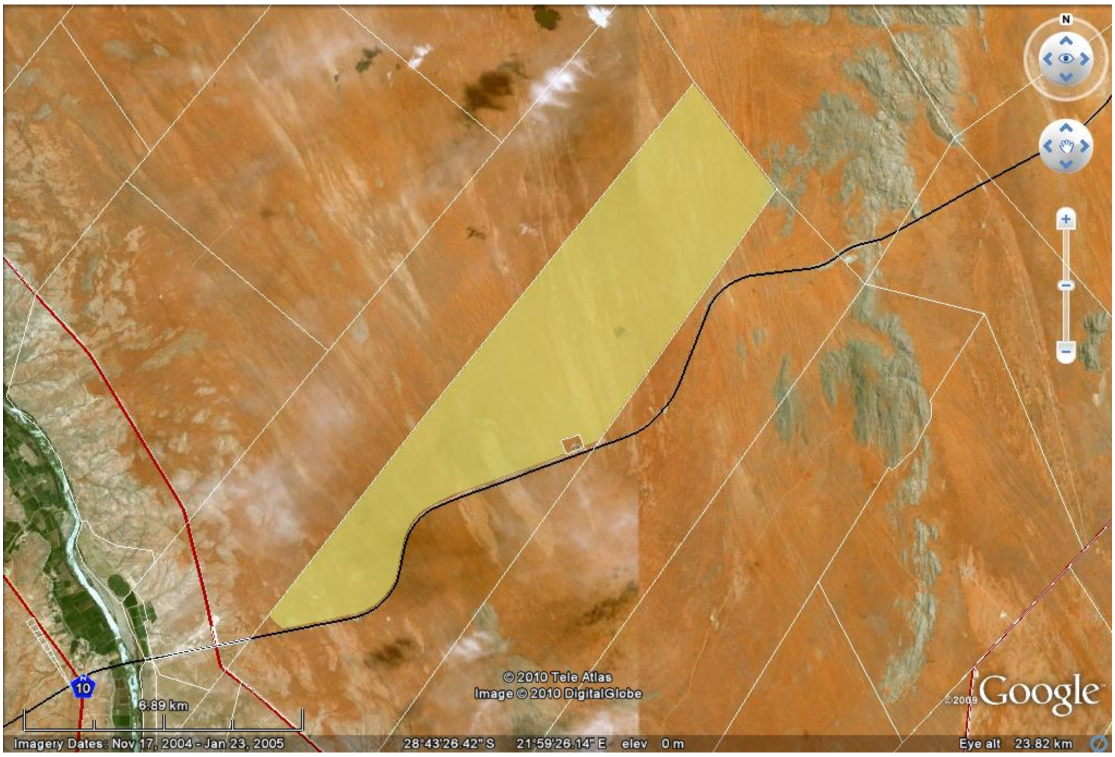


Figure 43: Heritage sensitivity (yellow – "ideal")

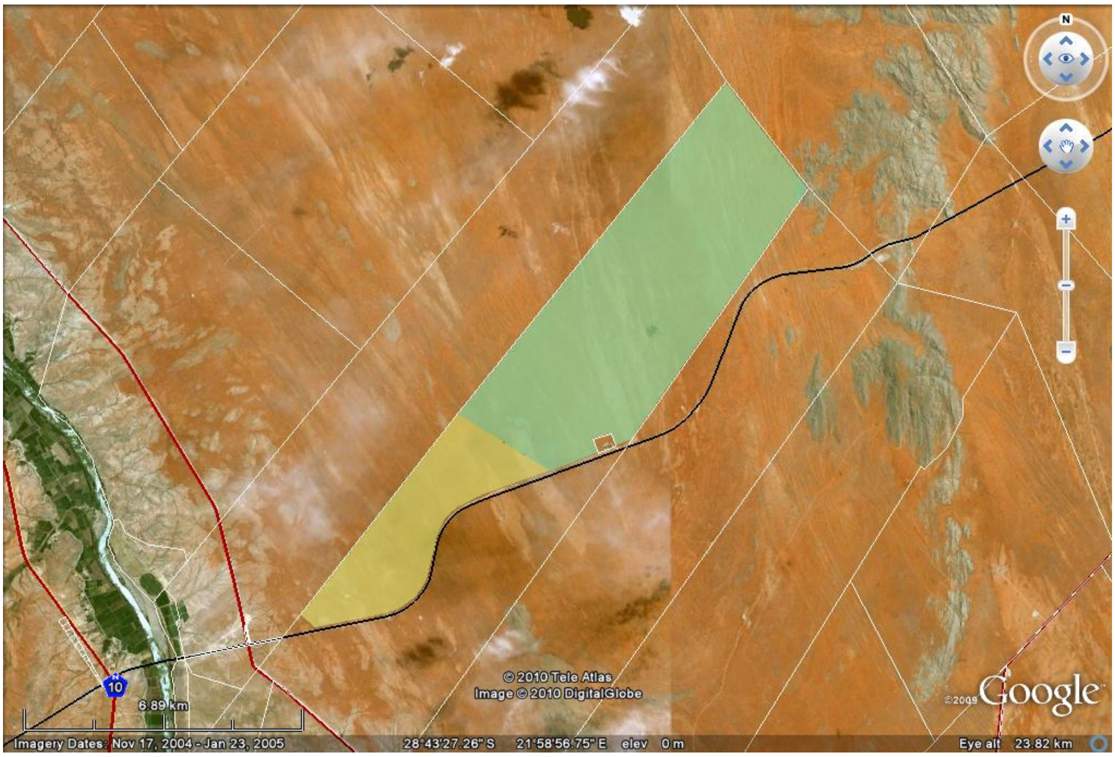


Figure 44: Tourism sensitivity (green – "acceptable"; yellow – "ideal")

5.2.2 Sensitivity Indexing

Each of the above sensitivity maps was then overlaid in order to calculate an overall sensitivity index for the Bokpoort site. The sensitivity index indicates the range of values from lowest suitability (highest sensitivity; sensitivity index value = 11) to ideal/preferred (lowest sensitivity; sensitivity index value = 1).

The sensitivity index map provides an overview of the least sensitive areas (developable areas) and further highlights the sensitive areas that should be avoided – refer to Figure 45.

5.2.3 Sensitivity Zoning

The above sensitivity index map required further improvement to provide a simplified overview of the developable areas of the site by delineating sensitivity zones based on the classification / grouping of the sensitivity indices into the sensitivity categories initially used by the respective specialists – refer to Section 5.2.1 (i.e. ideal, acceptable and unacceptable). The following classification was applied:

Score	Description
Index classes 1 - 4	Ideal/preferred
Index classes 5 - 7	Acceptable
Index classes 8 - 11	Not preferred (sensitive)

Figure 46 indicates the developable areas of the site (dark green) based on the biophysical and social sensitivities.

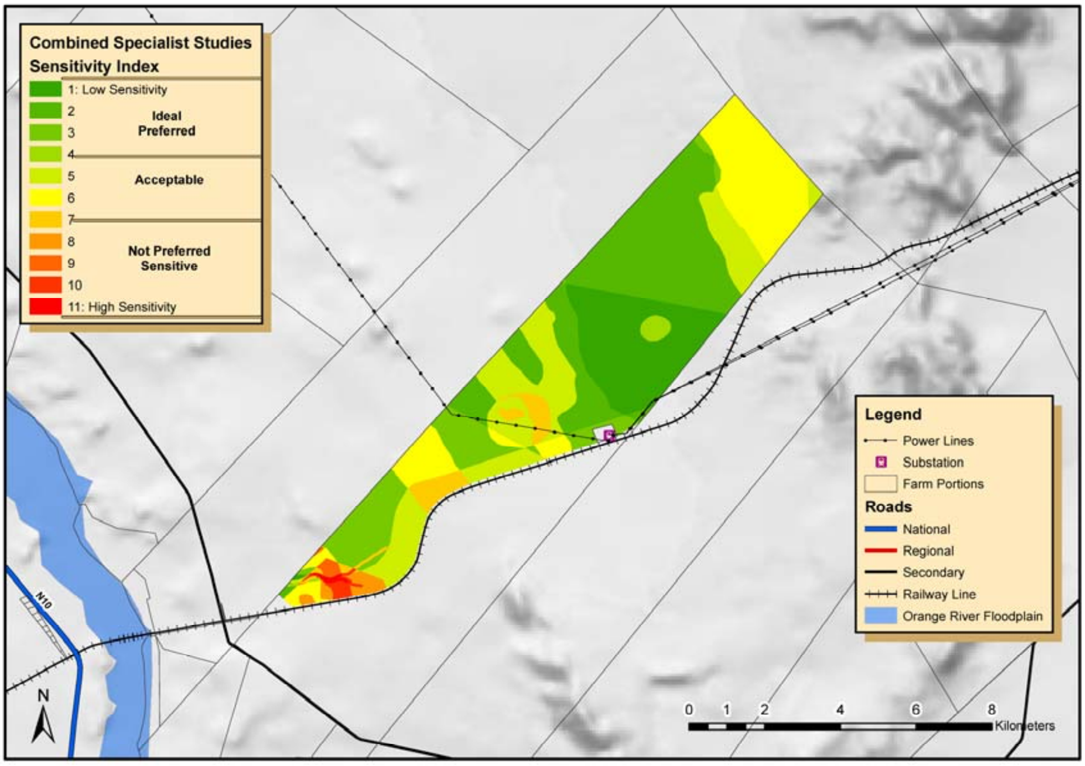


Figure 45: Sensitivity index - Bokpoort

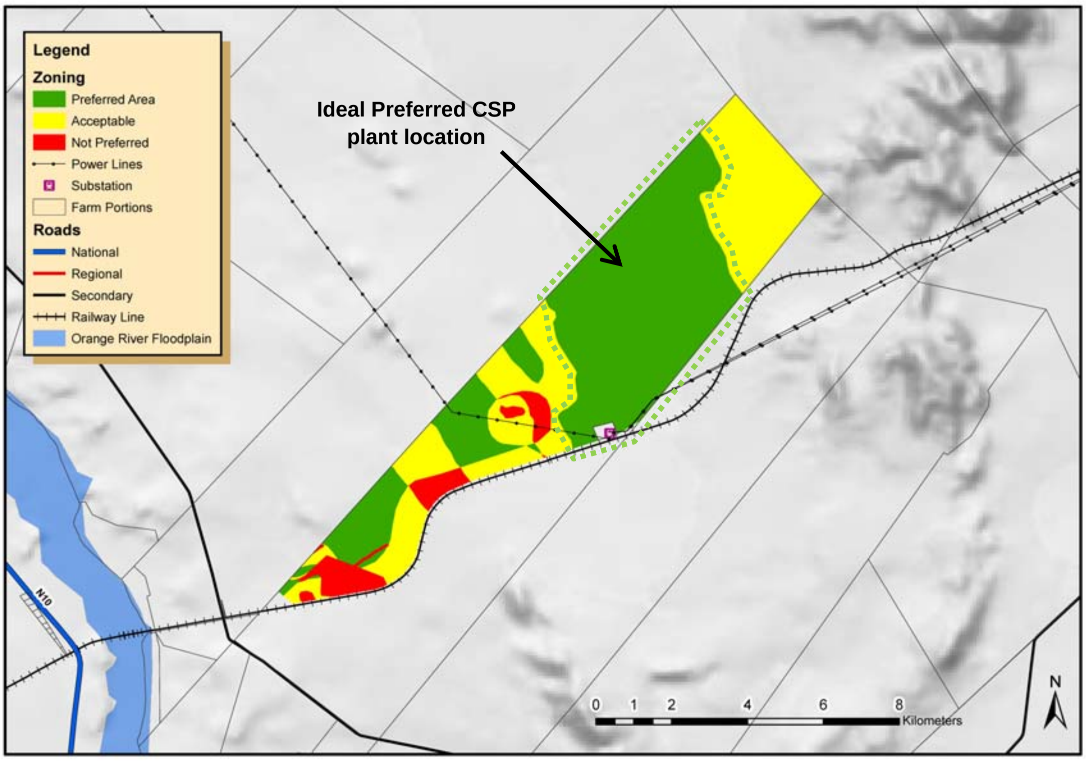


Figure 46: Sensitivity zoning - Bokpoort

5.3 Conclusions

A qualitative mapping exercise was undertaken during the EIA phase of the project with the objective of producing a composite environmental sensitivity map for the Bokpoort site, using the inputs from eight of the ten specialist studies carried out for the Solafrica and Eskom CSP EIA projects – the specialist studies excluded were visual and noise. The composite environmental sensitivity map assisted Bohlweki-SSI in determining the environmental opportunities and constraints (feasibility limits) associated with the Bokpoort site, thereby verifying the "environmentally best practicable" portion(s) / location(s) of the greater Bokpoort site for the deployment of the CSP plant. The sensitivity analysis concluded that a 24km^2 portion north of the Garona substation was suitable for development – refer to Figure 46 above.

Considering the conservative size of the CSP plant required (350 ha) in comparison to the extent of the ideal / preferred portion of Bokpoort, Bohlweki-SSI in conjunction with the project team (consisting of Solafrica and Hatch Energy Africa) decided that this portion of Bokpoort be divided into two equitable alternative development areas (Figure 47) each with a proposed location for the CSP plant (Figure 48), including associated structures or infrastructure .

Refer to Chapter 7 for the environmental impact analysis of the plant location alternatives and the findings of such.

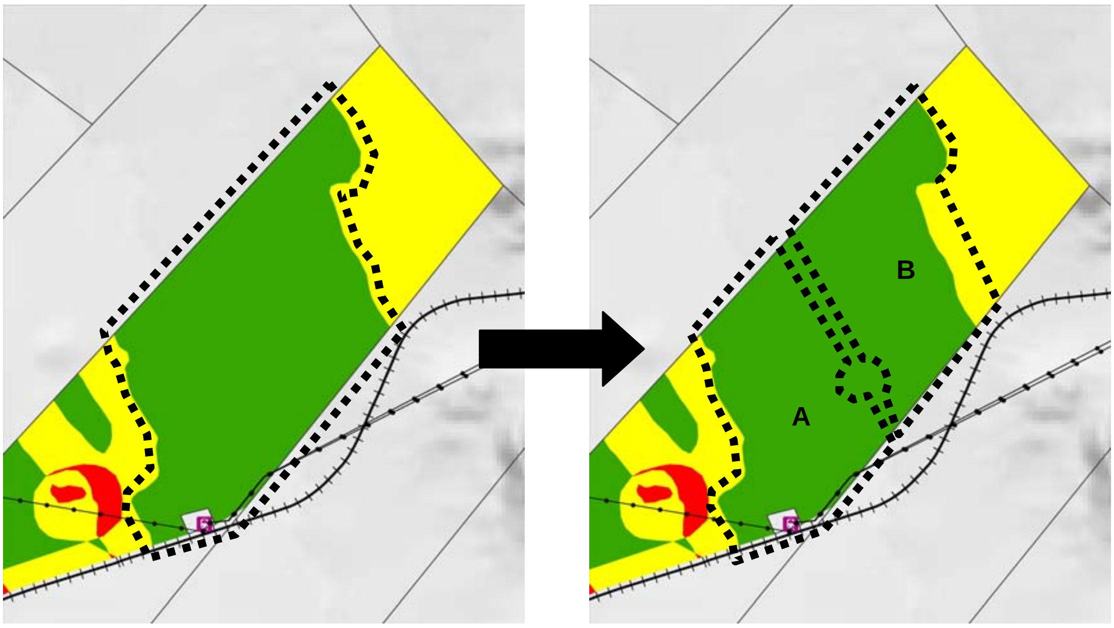


Figure 47: Development area alternatives

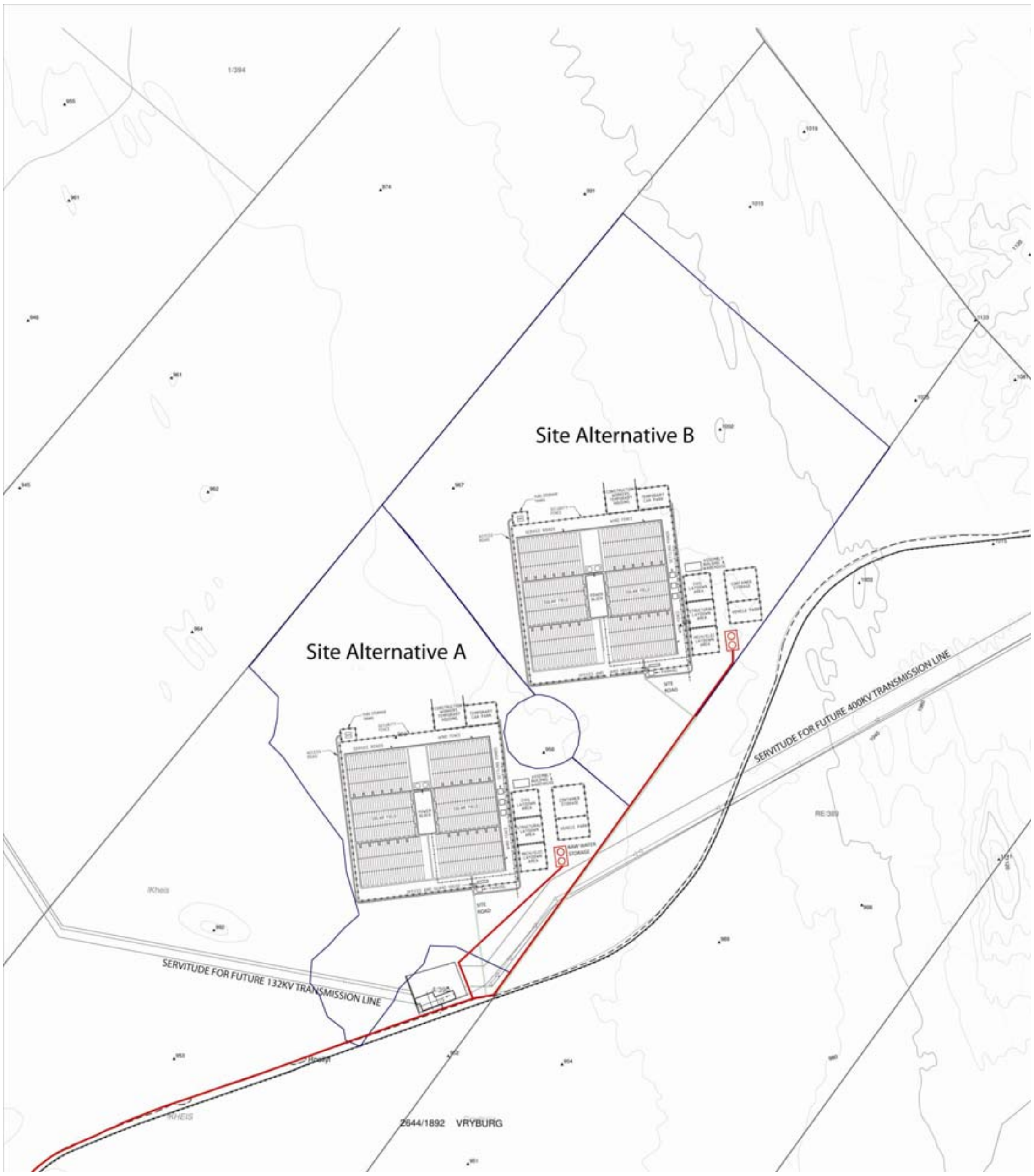


Figure 48: Plant location alternatives considered for the EIA phase

6 DESCRIPTION OF THE RECEIVING ENVIRONMENT

The purpose of this chapter is to provide a comprehensive description of the environmental status quo conditions of the Farm Bokpoort which are likely to be affected by the development of a 75 MWe CSP plant and associated infrastructure. The environment, as referred to in this context, denotes the natural, social (including cultural heritage) and economic attributes of the Farm Bokpoort, including the surrounding areas.

Determining the environmental status quo of the proposed site, this will allow for a baseline against which environmental impacts associated with the plant development can be measured to determine the extent (significance) of the perceived environmental impacts.

Chapter 6 describes the environmental status quo (baseline) in terms of the following:

- Physical environment;
- Biophysical environment, and
- Socio-economic environment.

6.1 Physical Environment

6.1.1 Locality

The study area is situated within the Siyanda District Municipality, in the Northern Cape Province adjacent to the Orange River. The Siyanda District Municipality covers an area of 103 771 square kilometres with its northern borders aligned with Botswana and Namibia. The district is traversed by the Orange River from the east to its west. Along the banks of the Orange River intensive agriculture has developed including vineyards and domestic food farms. Upington town is the main urban area for the region and serves as both an administrative and commercial centre as well as a stopover into the area's hinterland. This region attracts tourists travelling to Namibia and local reserves, such as Witsand (approximately 40km north of Bokpoort) and the Augrabies National Park west of Upington.

The N14 and the N10 are the primary roads in the region and are the main link between the economic centres of Gauteng and Namibia. The population distribution is primarily concentrated in and around the small towns along the Orange River, and specifically in Upington. Other towns/settlements in close proximity to the Farm Bokpoort are, Grootdrink (30km north west), Kalkwerf (17 km north west), Saaiskop (9km west), Groblershoop (15 km south), Wegdraai (9km south west), Stutterheim (16km south east), Skerpioenpunt (20km south east), and Boegoeberg (25km south east) – refer to Figure 49.

Figure 49: Towns/settlements located in close proximity to the Farm Bokpoort

6.1.2 Climate

Refer to *Section 6.1.8* for details on the climatic conditions of the Bokpoort site.

6.1.3 Topography

The study area is generally characterised by Dune Hills (parallel crests) and Lowlands in the northern part and Extremely Irregular Plains in the south, sloping towards the Orange River in a south-eastern direction from a high point of approximately 1,100m in the north to approximately 900m in the south at a general gradient of approximately 1.1%. Part of the Korannaberg foothills is located in the extreme northern section of the study area, comprising a small section of the site, characterized by the presence of boulders, high slopes and mountainous topography.

6.1.4 Geology

The geology of the area is generally characterised by the metamorphosed sediments and volcanics intruded by granites and is known as the Namaqualand Metamorphic Province. The proposed CSP plant site is sited on red brown windblown sands of the Gordonia Formation, Kalahari Group. Dune ridges occur in the northern portions of the site and is characterised by NNW-SSE orientation. Calcrete outcrops occur approximately 2 km west and southwest from the Garona substation (Figure 50). An anticlinal structure (upward pointing fold) causes the Groblersdal formation to be elevated in the area to the east of the site where it forms a range of hills known as the Skurweberge (Figure 50).

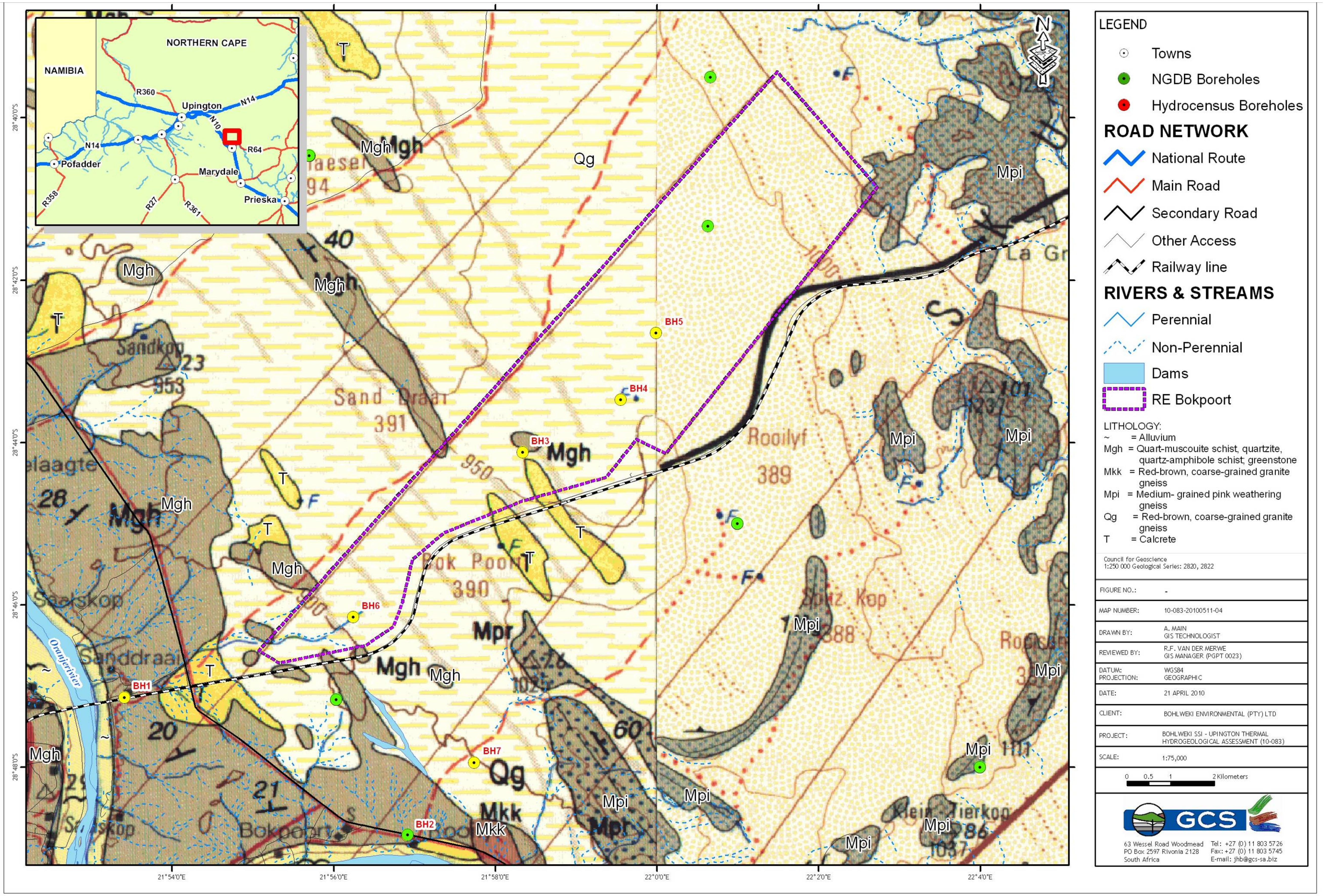


Figure 50: Site geology

In the vicinity of the site, the dip of the bedding is approximately 40 degrees towards the north east indicating that there is an intervening synclinal structure between the site and the Skurweberge anticline to the east.

6.1.5 Soils[36]

The ARC-Institute for Soil, Climate and Water (ARC-ISCW) was requested by Bohlweki-SSI to carry out a desk-top study regarding the soils, and agricultural potential aspects for a proposed CSP plant and associated infrastructure in the Northern Cape Province.

6.1.5.1 Methodology

The databases at ARC-ISCW were used to collate all available information. This was available in ArcGIS.

6.1.5.2 Regional Overview

- **Land types**

The soil information that was used to inform this study forms part of the national 1:250 000 land type survey (Eloff *et. al*, 1986). Each land type is a unique combination of soil pattern, terrain and macroclimate.

The study area comprises a total of three different land types (Figure 51 and Table 22), namely:

Table 22: General description of land types

Red, structureless, high base status soils	Ae4
Red, structureless, high base status soils (with sand dunes)	Af7
Rocky areas with very little soil	Ic4

- **Land Type Characteristics**

The main characteristics of each of the land types occurring (soils, depth, texture and occurrence), as well as agricultural potential[37], are given in Table 23.

[36] Bohlweki Environmental. 2006. *Environmental Impact Assessment for the establishment of a New Concentrating Solar Power (CSP) plant and associated infrastructure in the Northern Cape Province.*
[37] 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.

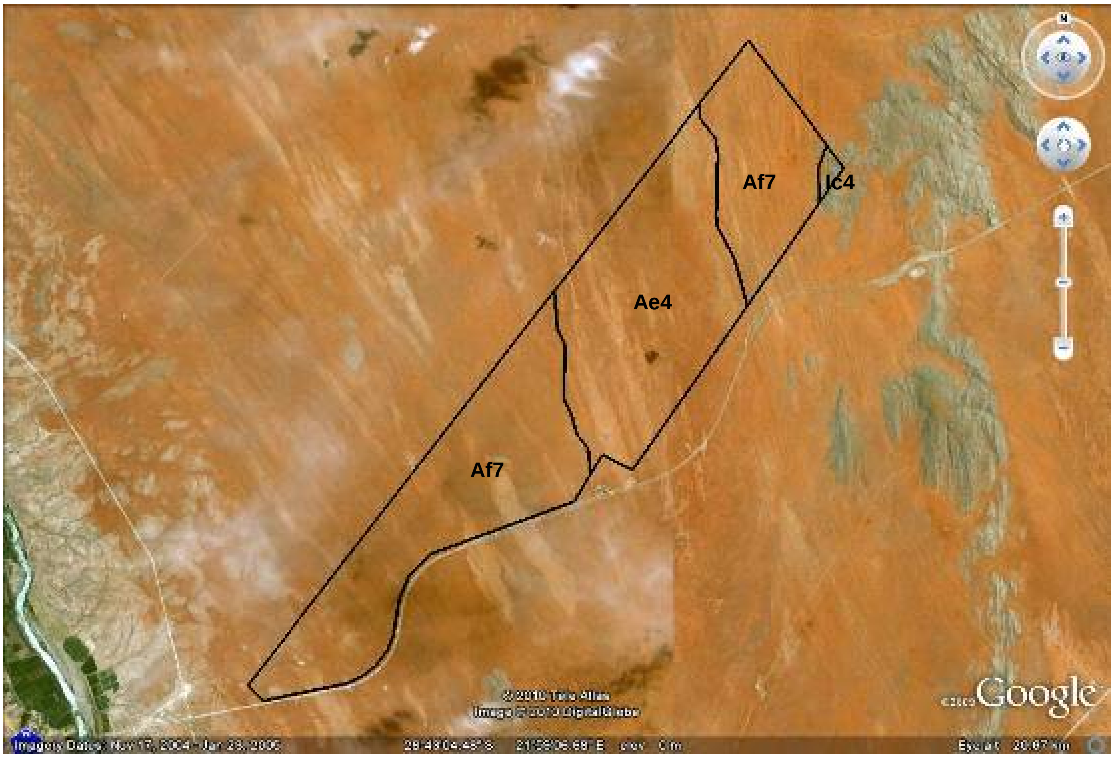


Figure 51: Land types (Bokpoort)

Table 23: Soil properties per land type

Land type	Dominant Soils	Sub-dominant Soils	Slopes	Agricultural Potential (%)
Af7	**Hu30/33/34** (600-1200 mm), Sa, 58%	***Hu30/31*** (>1200 mm), Sa (dunes), 40%	1-2%	H: 0.0 M: 58.0 L: 42.0
Ae4	**Hu33/34** (450-1000 mm), Sa, 42%	***Ms10/22*** (100-250 mm), Sa, 41%	1-2%	H: 0.0 M: 47.0 L: 53.0
Ic4	**Rock, 80%**	***Hu30/Ms10*** (50-250 mm), Sa-LmSa, 11%	4-60%	H: 0.0 M: 8.0 L: 91.0

From the above table and the related map (refer to Figure 51), it can be seen that the soils of the Farm Bokpoort mainly consist of red and yellow sands, mostly of the Hutton (Hu) form, occasionally with dunes, especially at the Bokpoort site. Smaller areas of shallow lithosols of the Mispah (Ms) and Hutton (Hu) forms, along with rock, also occur.

The only areas of high potential land that exist are the alluvial zones close to the Orange River, where irrigation may be practiced.

- **Climate**

In addition to the soil characteristics as outlined above, there are also severe climatic restrictions to agricultural potential. Rainfall is very low, generally between 260 and 340 mm per year, while evaporation is extremely high, due to the high temperatures, which can reach 35 - 40°C in summer. For this reason, even the best soils are unsuited for dryland agriculture under these conditions.

- **Slope**

The dominant slopes occurring in the study area are flat, to gently sloping. Apart from a very small area in the northeast corner of the site (land type Ic4), no areas of steep topography occur.

- **Agricultural Potential**

The general agricultural potential of the soils in each land type is given in the right-hand column of Table 23.

From an agricultural potential assessment, it can be concluded that the only high potential soils in the alluvial zones occur close to the Orange River (Figure 52), with the majority of the remainder comprising low to moderate potential soils, mainly due to the rapid drainage and/or the presence of dunes.

However, it must be borne in mind that these are soil assessments only, and do not take into account any climatic restrictions as outlined above.

Figure 52: Land types (Bokpoort) - with high agricultural potential soils highlighted in yellow

6.1.6 Geohydrology (Groundwater)

Groundwater Consulting Services (Pty) Ltd (GCS) was appointed by Bohlweki-SSI to undertake a geohydrological impact assessment for the proposed CSP plant on the Farm Bokpoort. The aim of this assessment was to assess the baseline groundwater conditions for the local aquifer system and to determine the likely risks to the groundwater environment.

*Refer to **Appendix C** for the Geohydrological Report.*

6.1.6.1 Methodology

The following methodology was used for the geohydrological assessment:

- **Desk Study**

The desk study involved a review of all available geological and hydro-geological literature. This included aerial photography, and topographical, geological and hydro-geological maps. Data was requested from the DWA for existing boreholes and groundwater use in the area.

- **Hydrocensus**

A hydrocensus survey was conducted on the area within a 1km radius surrounding the site. The aim of the survey was to locate and map the groundwater users in the vicinity of the site. Various landowners in the area were consulted to determine the extent of groundwater usage from the boreholes and springs in the vicinity. Groundwater samples were also collected from several of the production boreholes located on surrounding farms.

6.1.6.2 Regional Overview

The proposed CSP site is located in an area of complex pre-Cambrian basement geology, including volcanic, igneous and metamorphic rocks. Groundwater is stored and transmitted mainly via secondary features such as fractures, although some intergranular porosity and permeability is present in certain areas. The solid strata are covered in places by Quaternary unconsolidated to weakly consolidated sediments of the Kalahari Group. To the north of the study area these sediments may yield useful quantities of groundwater. Calcretes and limestones overlie the basement rocks in places, although these are usually of low groundwater potential. Groundwater yields from the basement rocks are generally low, and groundwater quality varies from potable to saline. Naturally high concentrations of nitrate are sometimes found. The depth to groundwater in many areas is frequently in excess of 40 metres.

There is no significant groundwater usage in the study area as most water used is sourced from the Orange River. Groundwater utilisation is of importance across wide areas away from the Orange River in the arid Kalahari region where it is mainly used for rural domestic supplies, stock watering and water supplies to towns. As a result of the low rainfall, recharge of groundwater is limited and only small quantities can be abstracted on a sustainable basis. Artificial recharge of groundwater is practised in some areas where water from small dams is transferred through pipelines into boreholes located in the area of recharge of the main production boreholes.

According the Internal Strategic Perspective for the Lower Orange Water Management Area[38] the aquifer characteristics (borehole yields and storage of groundwater) are typically unfavourable because of the hard geological formation underlying most of the area.

Groundwater constitutes an important source of water for rural water supplies in the Orange River, although it is only a small proportion of the total available water. Much of the groundwater abstracted near the river is actually recharged from the river and could also be accounted for as surface water.

Fractured aquifers are more vulnerable to pollution than aquifers where the storage and transmission of groundwater is primarily intergranular, due to the higher rates of groundwater movement and lower attenuation potential. Once polluted, such aquifers are difficult and expensive to remediate. Soluble pollutants are likely to travel vertically downwards to the water table together with recharging water, and then move with the water in the direction of regional groundwater flow. Recharge mechanisms in this area are not fully understood, but are thought to be episodic, following sporadic heavy rainfall.

The quantity of water to be used for the operation of the proposed CSP plant (i.e. steam generation, cooling, the domestic needs of plant workers, and for the washing of the plant mirrors) is estimated at 859 000 cubic meters per annum for a wet-cooled plant– detailed design specifications regarding water requirements are being developed by the engineering design team. Of these stipulated quantities approximately 100 000 m^3 per annum of water will be required for mirror washing. The mirrors will be cleaned during the night, when non-functional, by a high pressure spray of demineralised water from a vehicle. The water will likely run off the mirrors onto the ground surface below. Some of the wash water might evaporate during spray-washing, although the quantity of water loss through evaporation is more than likely to be insignificant since mirror washing will be undertaken during night time. These water volumes when applied over the estimated plant area (350 ha) may increase the groundwater recharge at the site, raising the local water table and mobilising any contaminants at the site into the groundwater. There is, however, no evidence of current contaminants. As noted below, a suitable protocol for the management of any on-site potential contaminants would mitigate this risk.

The CSP technology (i.e. parabolic trough) considered by Solafrica utilises a HTF for direct steam generation. The HTF may be thermal oil or water. None of the aforementioned fluid will be deliberately discharged to, or be in direct contact with, the surrounding environment, however accidental spills or leakage of the fluid on the ground are possible and if not removed from the contaminated area could likely result in the pollution of the local groundwater resource. A suitable operational protocol to be used in the event of an accidental would mitigate this risk.

[38] Department of Water Affairs and Forestry (DWAF), 2004. Internal Strategic Perspective: Lower Orange Water Management Area. Prepared by PDNA, WRP Consulting Engineers (Pty) Ltd, WMB and Kwezi-V3 on behalf of the Directorate: National Water Resource Planning. DWAF Report No P WMA 14/000/00/0304.

6.1.6.3 Site Specific Findings

- **General Geology and Aquifer Type**

The general geology of the site mainly comprises red-brown, coarse-grained granite gneiss; and quartz-muscouite schists, quartzite, quartz-amphibole schists and greenstones of the Groblershoop formation, Brulpan group. Calcrete is also found especially on the south eastern part of the area.

The hydrogeological map of the area indicates that a fractured aquifer occurs in the area. The yield from the local aquifers range from 0.1 to 0.5 l/s. Data indicates that the area receives a mean annual rainfall 185 mm and the average annual recharge for the area is calculated at 40 million cubic meters per annum over the entire sub-catchment area.

- **Hydrocensus**

The community living in the farms relies mainly on municipal water for domestic water supply. The farms located to the south of Bokpoort uses water from the Orange River. The river water requires treatment before it is ready for domestic use. Groundwater is primarily used by farmers located further away from the river. Groundwater abstracted from surrounding farms is mainly used for domestic purpose and livestock farming (cattle and sheep). Most of the boreholes are equipped with handpumps. The data collected during the survey is presented in Table 24. Refer to Figure 53 for the location of the groundwater and springs.

Water level measurements could not be taken from the farm boreholes, however, the use of wind pumps for groundwater abstraction is indicative that the groundwater level in the area is not very deep. The pH levels ranged from 7.36 to 8.06; and the Total Dissolved Solids (TDS) ranged from 420 to 490 mg/l.

- **National Groundwater Database (NGDB)**

A request was made to the DWA for borehole and groundwater data from the NGDB. The data of six boreholes within a 2 km radius around the boundaries of the Bokpoort farm were obtained from NGDB. The NGDB data indicated that the average water level from the existing boreholes measures 41.88 m below ground level. As it was established during the hydrocensus survey, the boreholes on the surrounding farms are also equipped with wind pumps and are used for stock watering. Although the groundwater resource is generally the sole source of water to the farms, the general use is at a small scale.

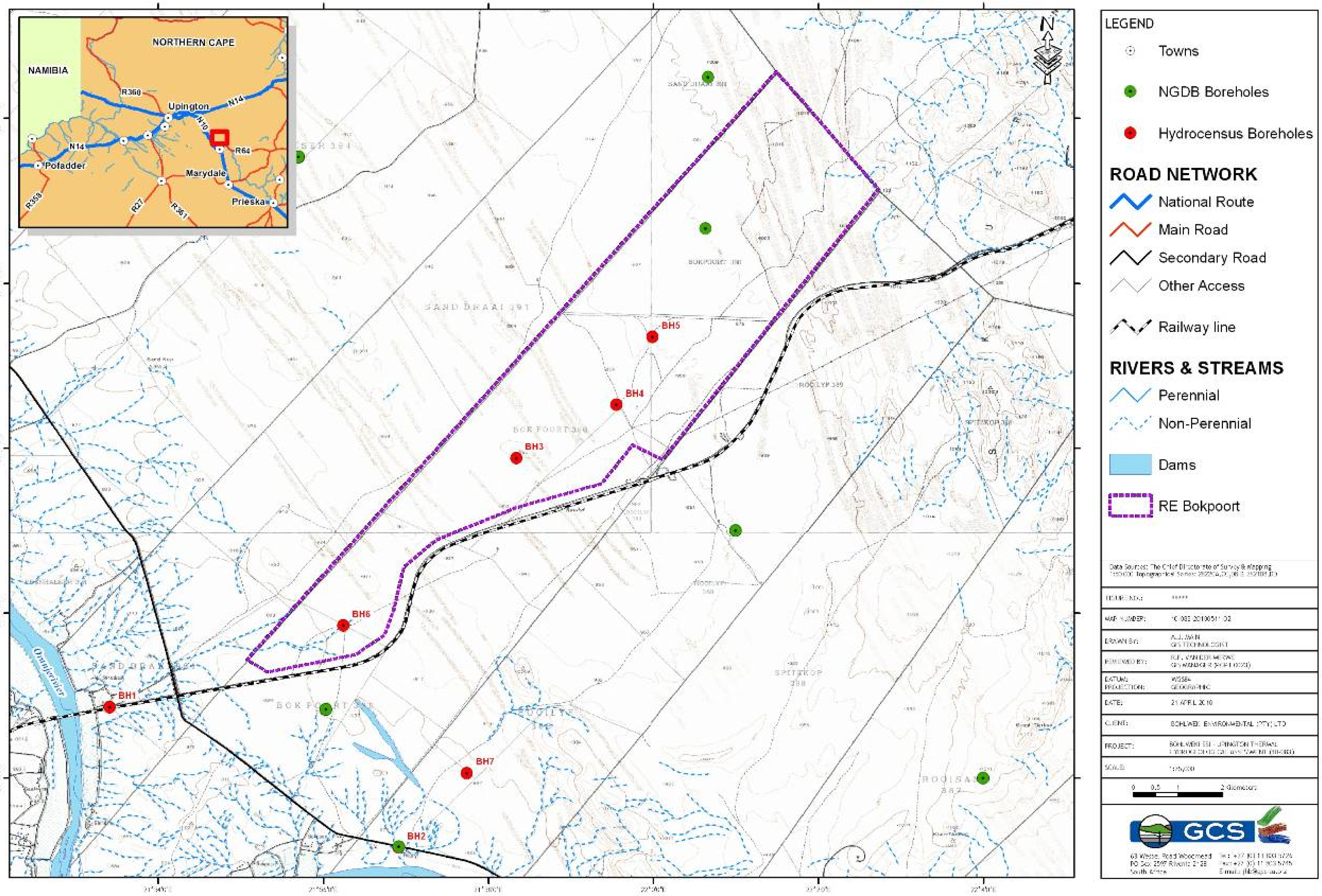


Figure 53: **Boreholes on the Farm Bokpoort and surrounding farms**

Table 24: Data obtained from hydrocensus survey

Site ID	Farm Name	Farm Owner/ Manager	Contact Details	Latitude	Longitude	Equipment	pH	TDS (mg/l)	Use	Comments
BH1		Johannes Fourie	083 785 0626	28.78569	21.89017				Unused	Borehole located next to a farm workers' house. The windpump is broken. The hole is blocked with stones.
BH2	**Rooilyf**	Hennie Jooste	083 388 5314	28.81411	21.94856	Wind pump	8.06	490	Domestic	Borehole located next a farm dwellers village along the Loop 16 gravel road.
BH3	**Bokpoort**	Chris Honiball	082 372 3467	28.73536	21.97234	Submersible pump	7.36	420	Domestic	Borehole located west of the farm house. Water is used in two farm owner's houses and in the farm workers' village.
BH4	**Bokpoort**	Chris Honiball	082 372 3467	28.72458	21.9926	Wind pump			Stock watering	Borehole located on a flat area in the wild game farm.

BH5	**Bokpoort**	Chris Honiball	082 372 3467	28.71084	21.9999	Wind pump			Stock watering	Borehole located on a flat area in a goat and sheep farm. Water is pumped into a concrete tank for stock watering.
BH6	**Bokpoort**	Chris Honiball	082 372 3467	28.7692	21.93741	Wind pump			Stock watering	Borehole located on a flat area in a sheep farm. Water is pumped into two concrete tanks for stock watering.
BH7	**Rooilyf**	Hennie Jooste	083 388 5314	28.79907	21.96237	Wind pump			Stock watering	Borehole located on a sheep farm. Currently unused because there are no sheep in the farm.

Table 25: Hydrochemical analysis results

Sample ID	Sample Date	pH	Cond	Na	K	Mg	Ca	Mn	Fe	Cl	SO4	NO3 as N	NO3	T-Alk	HCO3
HBH2	13/04/2010	7.8	243	259	3.1	82	175	<0.001	0.001	314	266	26	113	501	611
HBH3	13/04/2010	8.1	37.9	28	4	11.9	30	<0.001	<0.001	28	46	0.3	1.4	101	123
HBH5	13/04/2010	7.9	153	104	12.3	68	123	<0.001	<0.001	155	69	22	96	482	588

ID	pH	EC	Na	K	Mg	Ca	Mn	Fe	Cl	SO4	NO3 as N
Class 0 Limits	5 - 9.5	70	100	25	70	80	0.1	0.5	100	200	6
Class 1 Limits	4.5 - 10	150	200	50	100	150	0.4	1	200	400	10
Class 2 Limits	4 - 10.5	370	400	100	200	300	4	5	600	600	20
Class 3 Limits	3 -- 11	520	1000	500	400	>300	10	10	1200	1000	40
Class 4 Limits	3 -- 11	>520	>1000	>500	>400		>10.0	>10.0	>1200	>1000	>40

Quality of Domestic Water Supplies, DWA, Second Edition 1998	
Class 0	**Ideal water quality** - Suitable for lifetime use.
Class 1	**Good water quality** - Suitable for use, rare instances of negative effects.
Class 2	**Marginal water quality** - Conditionally acceptable. Negative effects may occur in some sensitive groups.
Class 3	**Poor water quality** - Unsuitable for use without treatment. Chronic effects may occur.
Class 4	**Dangerous water quality** - Totally unsuitable for use. Acute effects may occur.

South Africa Water Quality Guidelines, Volume 1: Domestic Use, DWA, First Edition 1993 & Second Edition 1996	
NR	**Target water quality range** - No risk.
IR	**Good water quality** - Insignificant risk. Suitable for use, rare instances of negative effects.
LR	**Marginal water quality** - Allowable low risk. Negative effects may occur in some sensitive groups
HR	**Poor water quality** - Unsuitable for use without treatment. Chronic effects may occur.

- **Groundwater quality**

Three groundwater samples were collected from springs in the area and submitted to the M&L Laboratory in Johannesburg for chemical analysis. GCS (Pty) Ltd established a database in AQUABASE (database system for the storage and retrieval of surface water and groundwater related data developed by VSA Earth Resources Consultants (Pty) Ltd) and Microsoft Excel in which data was captured for storage and analysis.

Results of the chemical analysis were compared with the DWA South African Water Quality Guidelines for Domestic Water Use and the SABS Standards. Table 25 below show the analysis results of groundwater samples and the limits from the DWA Guidelines. Values that exceeded the DWA limits are highlighted in colours as assigned to water quality classes by DWA.

Groundwater in the area contains elevated levels of electric conductivity. The dominant cations in two of the sampled boreholes (Borehole 2 and Borehole 5) were sodium and calcium and the dominant anions were chloride and sulphates. Furthermore, high concentrations of nitrates were recorded for these samples Borehole 3 had water of good quality with all the determinants falling in class 0 of the DWA standards. From the chemical analysis if the borehole samples it is concluded that the groundwater in the area is of $Ca/MgHCO_3$ to $CaMg/SO_4$ type.

- **Aquifer classification**

The local aquifers underlying the Bokpoort site are the sole source of potable water for the communities living in the surrounding areas. The use of groundwater resource by the farmers is, however, at a very low scale. The community living in farms located along the Orange River is dependable on water from the Orange River for domestic use.

The local aquifers can be classified as minor, according to Parsons Aquifer Classification system, due to the limited use of groundwater in the area as well as the quality of groundwater obtained from the chemical analysis results.

6.1.7 Surface Water[39]

6.1.7.1 Regional Overview

The !Kheis Local Municipality falls in the Lower Orange Water Management Area (LOWMA[40]) of South Africa. The main water resource of the LOWMA is the Orange River, which is South Africa's biggest and most controlled watercourse. The LOWMA is characterised by an arid

[39] Bohlweki Environmental. 2006. *Environmental Impact Assessment for the establishment of a New Concentrating Solar Power (CSP) plant and associated infrastructure in the Northern Cape Province.*
[40] MS Basson and JD Rossouw. Report number PMWA 14/000/00/0203, Lower Orange Water Management Area: Overview of water resources availability and utilization. Department of Water Affairs and Forestry (DWAF), South Africa, September 2003.

climate, high temperatures and late afternoon summer thunderstorms. The evaporation rate in the LOWMA is estimate at 3000 mm which is higher than the Mean Annual Rainfall (MAR)[41].

The Orange River is the main surface water resource in the Siyanda District and !Kheis Local Municipality providing the necessary resource for the primary economic driver in the area, crop production (i.e. grapes). The river is a perennial river with a varied flow between 50 – 1 800 cubic meters per day depending on the season. The river flow is pre-dominantly controlled at the Bloemhof, Gariep and Van Der Kloof dams all situated upstream of the river (Siyanda District Municipality Integrated Development Plan, 2004). Furthermore the Orange River is regulated by a number of weirs, dams and gauging structures. The function of these structures is to regulate the flow of the river and to provide an efficient volume of water for the irrigation activities situated along the river.

The water quality of the Orange River is categorised as Class C – Moderately Transformed due to existing agricultural activities along the river banks. The major inflow of water feeds from the Vaal River which is known for its high nutrient levels and results in algal blooms from time to time. Slow water flow rates also cause siltation and turbidity of the water which leads to water quality degradation within the river.

The main water users in the LOWMA are the municipalities and the agricultural sector.

6.1.7.2 Surface Water Characteristics of Bokpoort

No area of permanent surface water is present on the site. Evidence of non-perennial drainage lines could be viewed from aerial imagery and visually in the southern part of the proposed site, but these areas are only expected to contain flowing water during periods of exceptional high rainfall.

No significant wetlands, estuaries, Ramsar Sites or major dams are present within the immediate vicinity of the study site. A seasonal pan occurs approximately 3km north of the Garona substation (see Figure 54) – a 200m buffer (no development area) has been demarcated around the pan.

The most significant impact that currently affects the status of smaller riparian systems in the region is the effect of grazing and trampling of cattle in areas where natural habitat are grazed intensively.

[41] Siyanda District Municipality EMF (2008)

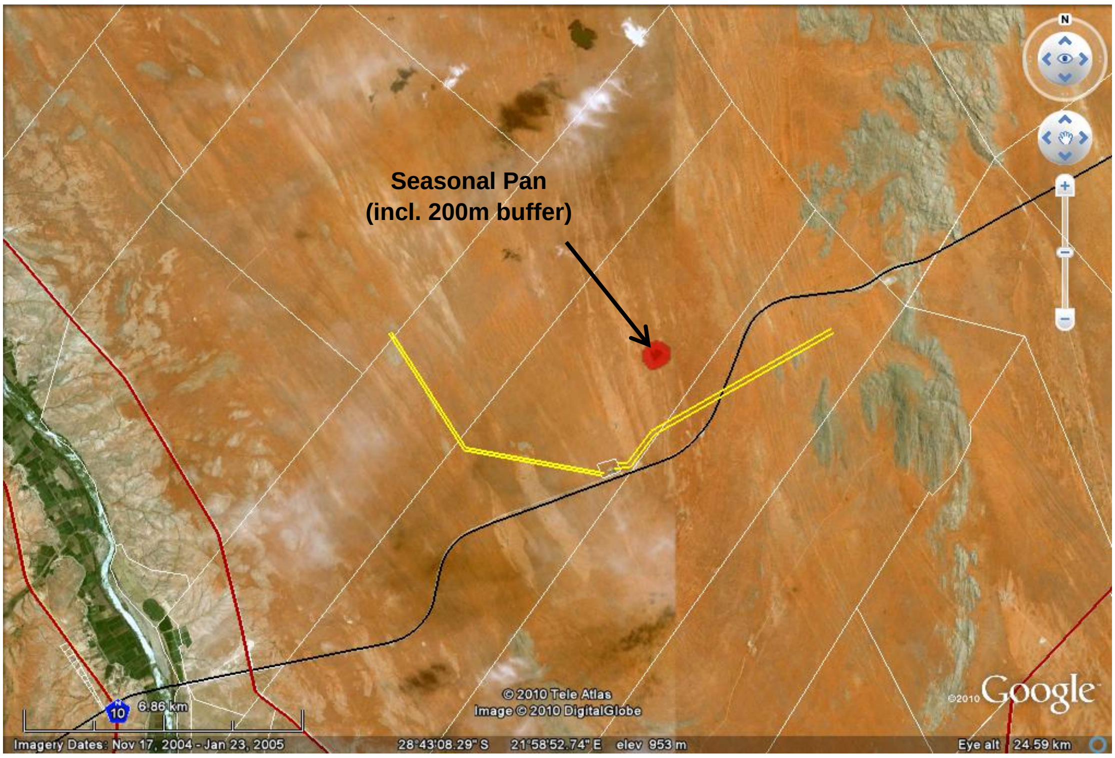


Figure 54: Seasonal pan located north of the Garona substation

6.1.7.3 Assessment Findings

The following aspects were assessed during the hydrological assessment:

- ***Rainfall***: An assessment of local rainfall events, their size, frequency and intensity and likely effects on these as a result of surface energy balance changes. Impacts were assessed using standard methodologies for estimating changes in potential evapo-transpiration and soil and ambient heat fluxes;
- ***Infiltration***: Impacts on soil water infiltration were determined by taking into account the infiltration capacity of soils and any potential changes in rainfall, rainfall interception, as well as changes in evapo-transpiration from areas surrounding the CSP plant;
- ***Surface runoff***: The capacity of the affected ground surfaces to cope with concentrated surface water was assessed in the light of soil infiltration capacity, topography, and soil erosion potential; and
- ***Streamflow***: An assessment of the impacts of the hydrological processes mentioned above on nearby streams. Impacts of streamflow were assessed in terms of total water yield, low flow yields and timing of low flows, as well as on sedimentation. Standard and acceptable hydrological process models were used for this purpose.

- **Assessment of CSP Plant on Regional Hydrology**

Water flowing in rivers in South Africa is precious, particularly in the arid regions such as the Northern Cape. The regional economy depends on the existence of the Orange River, therefore any activity which reduces flow in it is possibly an additional burden to the economy. It is estimated that 859 000 m^3.of water per annum may be required by the CSP for primarily cooling purposes and the cleaning of the plant mirrors – the exact volume of water required for the project will be dependant on the technology selected by Solafrica, and the figure provided should be considered that of a ”worst-case”. On a monthly basis this amount will be less than one five thousandth or 0.0002 of monthly flow in the Orange River at Upington (calculated for DWA measuring station D7H005 at Upington). As a proportion of river flow, this quantity is negligible and it can be concluded that the CSP will have such a small impact on river flow that the issue needs not be considered further.

- **Assessment of CSP Plant on Rainfall**

The question arises whether a facility like the proposed CSP could have an effect on local and regional weather and climate, particularly rainfall, by somehow affecting weather patterns and local energy budgets. To answer this question, regional controls on climate and weather are examined first, followed by the possible effects of the facility on local energy budgets and atmospheric conditions.

The average circulation of the atmosphere over southern Africa is anti-cyclonic and the daily weather is to a large degree controlled by the semi-permanent South Indian Anticyclone. A trough of low pressure across the Northern Cape and Botswana is linked to a tropical low north of Botswana[42]. This system advects moist tropical air from equatorial regions into the sub-continental region from time to time during the summer, when convection can take place and result in rainfall. However, the annual rainfall in the southern Kalahari region is more variable than anywhere else in South Africa[43]. This variability appears to be strongly linked to seasonal and inter-annual meridional (wind circulation in the east-west direction) circulation patterns[44]. Clearly, the controls on rainfall and its variability in the region lie at the much greater scales of continental, oceanic and hemispherical atmospheric circulation.

The net effect of the conversion of sunlight to electrical energy, over the area of the facility, will be a slight cooling of the ground surface and air during the daytime. Although the temperature differences will hardly be discernable, this will result in a small amount of local air subsidence over the facility during the daytime, with associated suppression of evapo-transpiration. The descending air will spread out beyond the field of heliostats/troughs, where, in contact with the hot ground surface, it will soon be heated back to air temperatures normally found close to the ground surface during the day in that region. At night, there will be a net loss of heat energy from a very localised source as power generation and air cooling of the steam cycle continues. The rising column of warmed air will dissipate rapidly in the relatively cooler and moving night air.

By way of example, the quantity of heat loss during this process will be substantially less than a so-called “six-pack” coal fired power station with its chimneys and forced-convection cooling

[42] Preston-Whyte, R.A and Tyson P.D. 1988. *The Atmosphere and Weather of Southern Africa.* Oxford University Press, Cape Town.
[43] Tyson, P.D.1986. *Climatic Change and Variability in South Africa*. Oxford University Press, Cape. Town.
[44] Tyson, P.D.1986. *Climatic Change and Variability in South Africa*. Oxford University Press, Cape. Town.

towers found on the Mpumulanga Highveld. These installations are not known for their weather-altering capabilities. The conclusion to be drawn from the above therefore is that a CSP will have no effect on local weather, particularly rainfall. Neither will the small change in the energy budget over the area of the CSP have any effect, adverse or otherwise.

- **Assessment of CSP Plant on Infiltration**

The aeolian sands that are prevalent at both the sites have high infiltration rates. These sands can have infiltration rates anywhere between 10 $mm.hr^{-1}$ and 250 $mm.hr^{-1}$. The depth of the sand over the underlying calcrete hardpan and its imperviousness would be one local control of infiltration at each site although such data is not available at present.

The installation of a CSP plant would result in some impervious areas of buildings, infrastructure and roads. This would cause local changes to infiltration at the scale of the building, but stormwater drainage will easily disperse this on site because of the high infiltration rates. The heliostats/troughs might cause small-scale ponding under individual structures should there be a very heavy storm, but it is highly unlikely that any such effect would cross site boundaries or have an effect off the site. Possibilities for management of the soil surface under the heliostats/troughs would be to either leave a bare or very short vegetation surface, or lay a surface of stone chips. In either case this would make no difference to the infiltration rate.

There are two other factors of infiltration to consider: 1) disturbance and sealing, and 2) soil crusting. Activities such as vehicular movement between the heliostats/troughs for cleaning purposes might disturb the soil surface. It is well known that agricultural activities result in soil surface sealing, which will lead to reduced infiltration. Further, vehicular activity could lead to compaction, also reducing infiltration. Sands however are particularly resistant to compaction and sealing.

Soil crusting by cyanobacteria is a phenomenon known to occur in the arid Kalahari Basin[45,46]. Biological crusts are advantageous in desert regions to those plants to which they can provide additional nutrients. However, it is not known how this crusting affects infiltration and runoff, if at all. Activity on the soil surface, such as livestock or vehicular traffic, will destroy the crusting, although the crusts can reform fairly rapidly. In the Kalahari Desert in Botswana, the presence of biological crusting is persistent even in areas with livestock movement. Such crusting is not likely to have any effect on infiltration and any of the sites.

- **Assessment of a CSP Plant on Runoff and Streamflow Generation**

Any runoff that can be generated by a soil surface and rainfall is dependent on the intensity and duration of rainfall, combined with the infiltration capacity of the soil. Given that the soils at all sites have high infiltration rates, it is highly unlikely that surface runoff will develop

[45] Dougill, A.J and Thomas, A.D. 2004. *Kalahari sand soils: Spatial heterogeneity, biological soil crusts and land degradation*. Land Degradation and Development 15: 233 – 242. DOI 10.1002/ldr.611.
[46] Berkeley, Thomas, A.D. and Dougill, A.J. 2005. *Cyanobacterial crusts and woody shrub canopies in Kalahari Ranglands*. African Journal of Ecology 43: 137 – 145.

except for long return period heavy rainfalls. The development of a CSP plant is unlikely to change that because most of the site will keep its characteristics of high infiltration rates. If runoff occurs in this arid environment, it occurs as storm flow, which quickly subsides and the stream channel reverts to its normal dry condition. Thus there is also likely to be no effect on streamflow.

Soils are similarly aeolian red sands overlying calcrete hardpans, with some dune features near boundaries of the site. The major advantage of this site is the proximity of Eskom transmission infrastructure, which would reduce some of the development costs. The area is flat, but bounded in the north east by a range of hills and in the south west by a topographic feature. No natural drainage features are evident. Surface runoff appears not to be actively generated on this site either and this is also unlikely to change with the development of a CSP plant on this site.

6.1.8 Air Quality

The Air Quality Unit at SSI Engineers and Environmental Consultants was appointed by Solafrica to undertake an Air Quality Impact Assessment for a proposed 11.5 MW boiler at two likely locations for the CSP plant – refer to Figure 55.

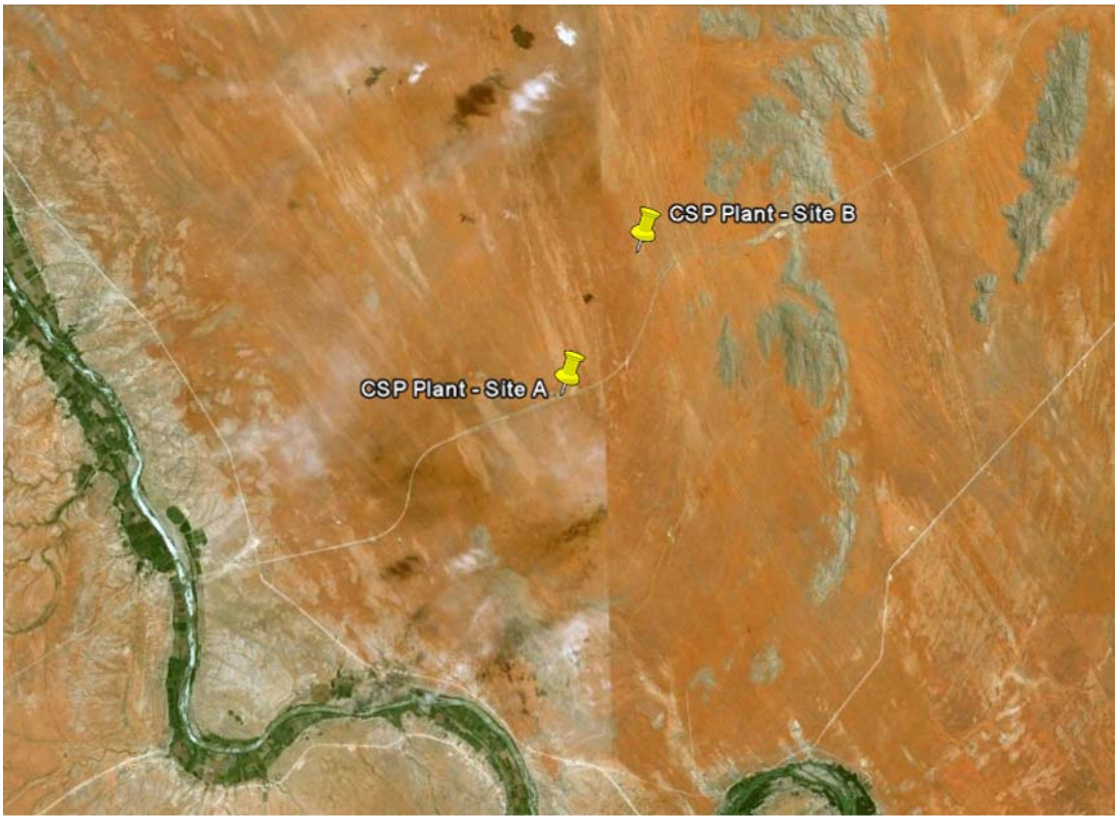


Figure 55: Plant locations assessed during the Air Quality Assessment

As part of the Air Quality Assessment for the proposed boiler, a baseline assessment was undertaken through a review of available meteorological data. The potential impact of emissions from the proposed project on the surrounding environment was evaluated through the compilation of an emissions inventory and subsequent dispersion modelling simulations using the AERMOD dispersion model. Comparison with the South African ambient air quality standards was made to determine compliance in terms of the potential health impacts for humans.

*Refer to **Appendix D** for the Air Quality Impact Assessment Report.*

6.1.8.1 Methodology

An overview of the methodological approach followed during the Air Quality Impact Assessment is outlined in the section which follows.

- **Baseline Assessment**

During the baseline assessment, a qualitative approach was used to assess the baseline conditions in the project area. Modelled meteorological data was obtained for the period January 2005 to December 2009 to determine the atmospheric dispersion potential of the area. Sensitive receptors, such as local communities, in close proximity to the site were identified using available satellite imagery.

- **Air Quality Impact Assessment**

During this phase, an emissions inventory was compiled to estimate emissions from the proposed boiler. Dispersion modelling simulations were undertaken using the AERMOD dispersion model and presented graphically as isopleths plots. Comparison with the National ambient air quality standards was made to determine compliance.

6.1.8.2 Assumptions and Limitations

Due to the unavailability of information required for the modelling studies, the following assumptions were made as part of this assessment:

- Use was made of site-specific modelled meteorological data as hourly surface observations from a nearby meteorological station was not available;
- Emissions were estimated using the USEPA AP-42 emission factors for Fuel Oil Combustion and Liquefied Petroleum Gas Combustion;
- The sulphur content of the diesel fuel was assumed to be 0.55%, as per the South African diesel specification (SABS 342);
- The composition of the LPG fuel was assumed to be 100% propane for the calculation of emission rates. The composition of the LPG to be used at the proposed site is approximately 30% butane and 70% propane;
- All particulate (PM) was modelled in the filterable fraction (PM10 and less);
- The boiler was assumed to operate for a 12 month period - as a maximum emission scenario - based on provided annual diesel and LPG consumption rates. During

normal operating conditions at the proposed site, it is anticipated that the boiler will only be operational for 6 months.

- Emissions from the proposed storage tank were not included in the dispersion simulations. Based on the design parameters provided, the storage tank is not anticipated to be a significant air pollution source and is not classified as a listed activity in terms of the Listed Activities and Associated Minimum Emission Standards (Government Gazette No 32434).

6.1.8.3 Baseline Description of the Area

- **Meso-scale Meteorology**

The nature of local climate will determine what will happen to pollution when it is released into the atmosphere (Tyson and Preston-Whyte, 2000). Pollution levels fluctuate daily and hourly, in response to changes in atmospheric stability and variations in mixing depth. Similarly, atmospheric circulation patterns will have an effect on the rate of transport and dispersion of pollution.

The release of atmospheric pollutants into a large volume of air results in the dilution of those pollutants. This is best achieved during conditions of free convection and when the mixing layer is deep (unstable atmospheric conditions). These conditions occur most frequently in summer during the daytime. This dilution effect can however be inhibited under stable atmospheric conditions in the boundary layer (shallow mixing layer). Most surface pollution is thus trapped under a surface inversion (Tyson and Preston-Whyte, 2000).

Inversion occurs under conditions of stability when a layer of warm air lies directly above a layer of cool air. This layer prevents a pollutant from diffusing freely upward, resulting in an increased pollutant concentration at or close to the earth’s surface. Surface inversions develop under conditions of clear, calm and dry conditions and often occur at night and during winter (Tyson and Preston-Whyte, 2000). Radiative loss during the night results in the development of a cold layer of air close to the earth’s surface. These surface inversions are however, usually destroyed as soon as the sun rises and warm the earth’s surface. With the absence of surface inversions, the pollutants are able to diffuse freely upward; this upward motion may however be prevented by the presence of an elevated inversion (Tyson and Preston-Whyte, 2000).

Elevated inversions occur commonly in high-pressure areas. Sinking air warms adiabatically to temperatures in excess of those in the mixed boundary layer. The interface between the upper, gently subsiding air is marked by an absolutely stable layer or an elevated subsidence inversion. This type of elevated inversion is most common over Southern Africa (Tyson and Preston-Whyte, 2000).

The climate and atmospheric dispersion potential of the interior of South Africa is determined by atmospheric conditions associated with the continental high pressure cell located over the interior. The continental high pressure present over the region in the winter months results in fine conditions with little rainfall and light winds with a northerly flow. Elevated inversions are common in such high pressure areas due to the subsidence of air. This reduces the mixing depth and suppresses the vertical dispersion of pollutants, causing increased pollutant concentrations (Tyson and Preston-Whyte, 2000).

Seasonal variations in the positions of the high pressure cells have an effect on atmospheric conditions over the region. For most of the year the tropical easterlies cause an air flow with a north-easterly to north-westerly component. In the winter months the high pressure cells move northward, displacing the tropical easterlies northward resulting in disruptions to the westerly circulation. The disruptions result in a succession of cold fronts over the area in winter with pronounced variations in wind direction, wind speeds, temperature, humidity, and surface pressure. Airflow ahead of a cold front passing over the area has a strong north-north-westerly to north-easterly component, with stable and generally cloud-free conditions. Once the front has passed, the airflow is reflected as having a dominant southerly component (Tyson and Preston-Whyte, 2000).

Easterly and westerly wave disturbances cause a southerly wind flow and tend to hinder the persistence of inversions by destroying them or increasing their altitude, thereby facilitating the dilution and dispersion of pollutants. Pre-frontal conditions tend to reduce the mixing depth. The potential for the accumulation of pollutants during pre-frontal conditions is therefore enhanced over the plateau (Tyson and Preston-Whyte, 2000).

- **Site-Specific Dispersion Potential**

Given the remote location of the proposed site, local meteorological data required for modelling purposes is not available. Use was therefore made of site-specific modelled MM5 meteorological data for the period January 2005 to December 2009 from Lakes Environmental.

Wind roses comprise of 16 spokes which represent the directions from which winds blew during the period. The colours reflect the different categories of wind speeds. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories.

Based on an evaluation of the meteorological data provided, winds originate predominantly from the north-north-east (10% of the time) and north (9% of the time) (Figure 56). Moderate to fast winds are generally recorded over the monitoring period. Calm wind speeds, which are designated as wind speeds less than 0.5 m/s, occur infrequently (4% of the time).

A diurnal trend in the wind field is recorded at the proposed site (Figure 57). During the day-time (06:00 – 18:00), moderate to fast winds originate predominantly from the westerly and northerly sectors. During the night-time (12:00 – 18:00), winds originate from all sectors with a shift observed to the north-north-east and north-east between 00:00 – 06:00. As would be expected, faster winds are recorded during the day-time period compared to the night-time.

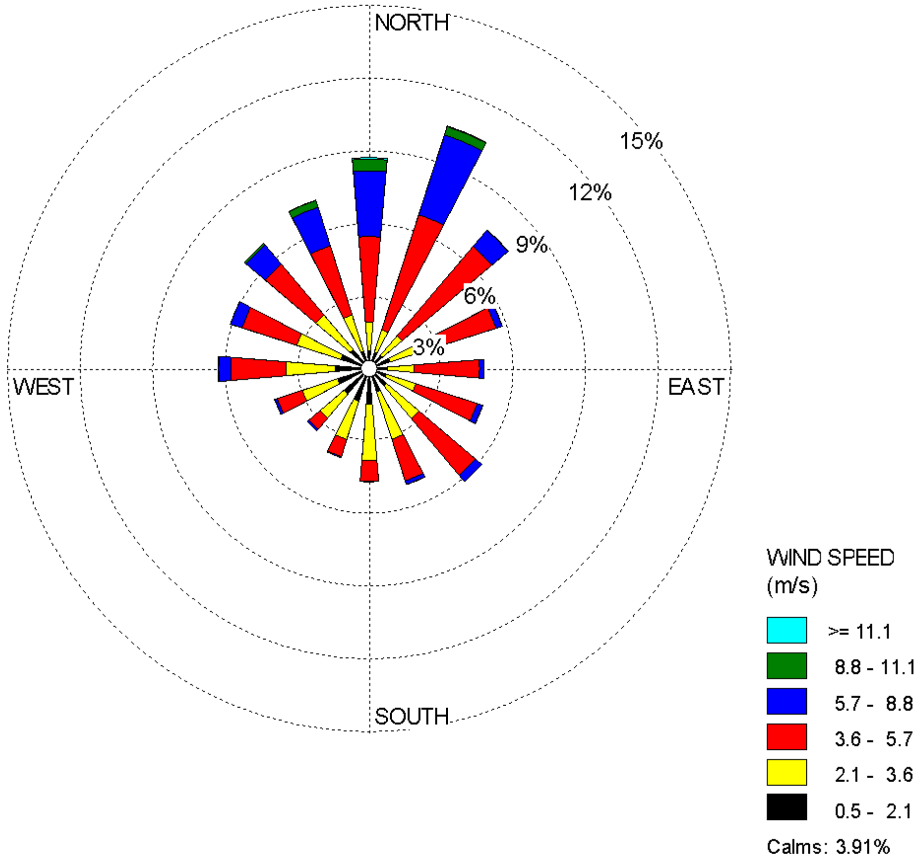
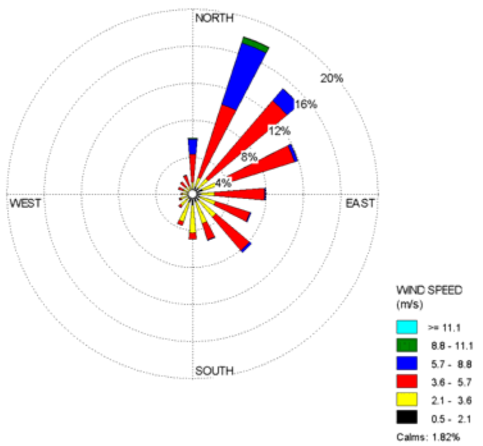
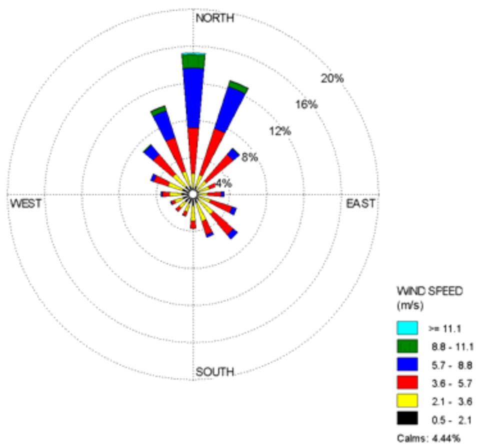


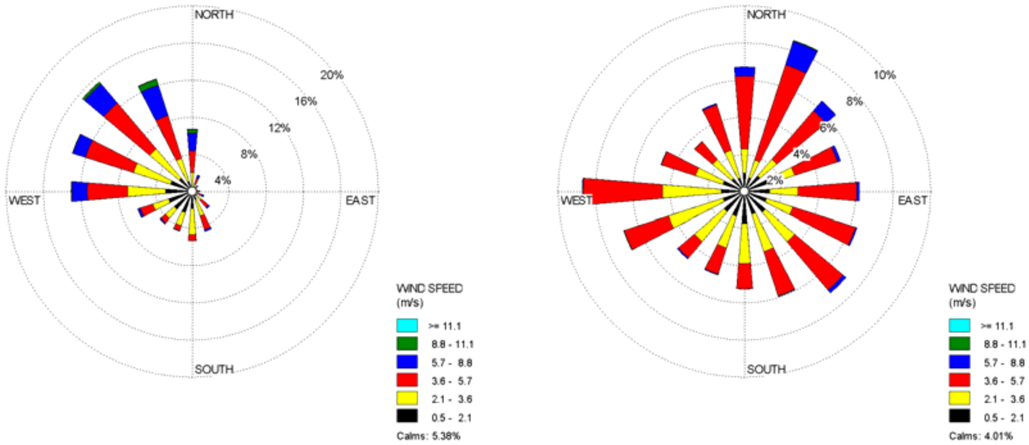
Figure 56: Period wind rose for the proposed site for the period Jan 2005 – Dec 2009



00:00 – 06:00



06:00 – 12:00

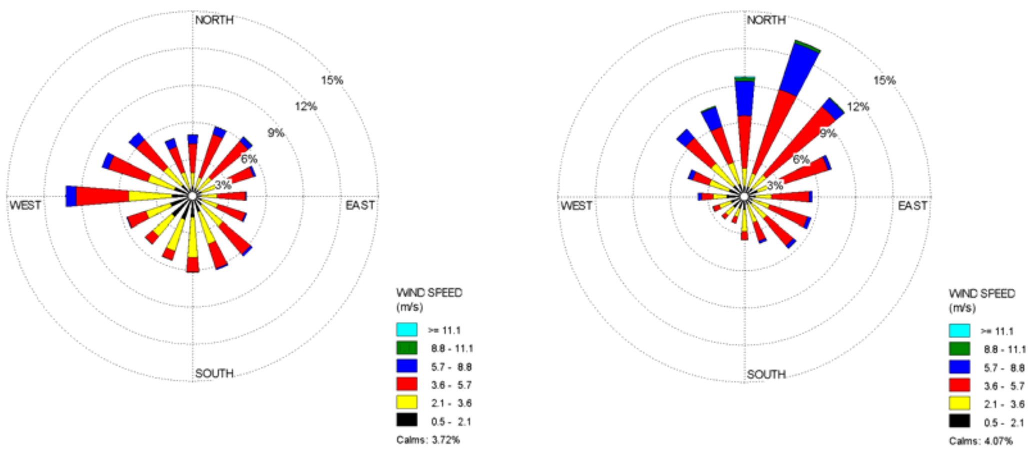


12:00 – 18:00 **12:00 – 18:00**

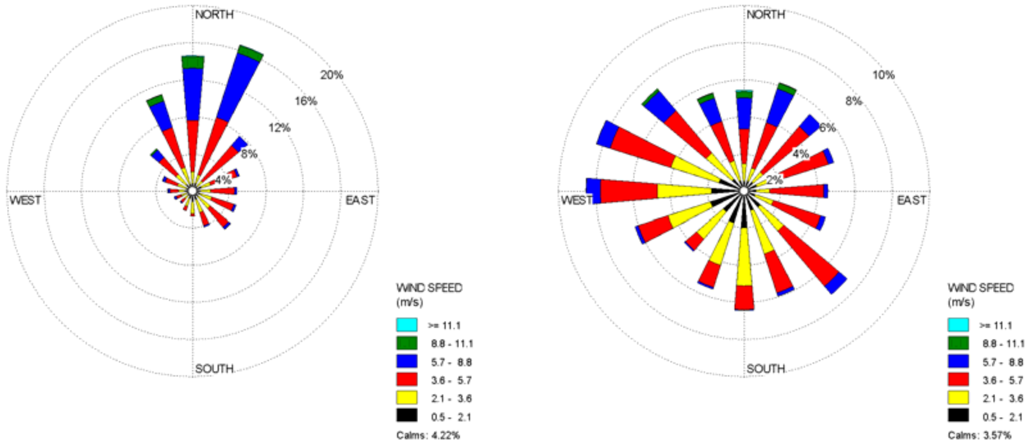
Figure 57: Diurnal wind roses for the proposed site for the period Jan 2005 – Dec 2009

The seasonal variability in the wind field at the proposed site is shown in Figure 58. During the summer months (December, January and February), winds originate predominantly from the west. During autumn (March, April and May), a shift is observed with winds originating predominantly from the north-north-east and north-east. A similar pattern to the autumn months is observed during the winter months (June, July and August). During spring (September, October and November), winds originate from all sectors, with the highest frequency recorded from the westerly sector.

Based on the prevailing meteorological conditions for the area, emissions released from the proposed site will be transported predominantly in a south-south-westerly and southerly direction from the proposed site. The prevalence of moderate to fast winds will transport emissions several kilometres from the proposed site.



Summer **Autumn**



Winter **Spring**

Figure 58: Seasonal wind roses for the proposed site for the period Jan 2005 – Dec 2009

6.1.8.4 Atmospheric Stability

Atmospheric stability is commonly categorised into six stability classes (Table 26). The atmospheric boundary layer is usually unstable during the day due to turbulence caused by the sun's heating effect on the earth's surface. The depth of this mixing layer depends mainly on the amount of solar radiation, increasing in size gradually from sunrise to reach a maximum at about 5 to 6 hours after sunrise. The degree of thermal turbulence is increased on clear warm days with light winds. During the night-time a stable layer, with limited vertical mixing, exists. During windy and/or cloudy conditions, the atmosphere is normally neutral.

Table 26: Atmospheric stability classes

A	Very unstable	calm wind, clear skies, hot daytime conditions
B	Moderately unstable	clear skies, daytime conditions
C	Unstable	moderate wind, slightly overcast daytime conditions
D	Neutral	high winds or cloudy days and nights
E	Stable	moderate wind, slightly overcast night-time conditions
F	Very stable	low winds, clear skies, cold night-time conditions

In general, the proposed site experiences neutral (Class D) to stable (Class E) atmospheric conditions (Figure 59). This is expected given the predominance of a high-pressure anticyclone over South Africa which produces stable, clear conditions.

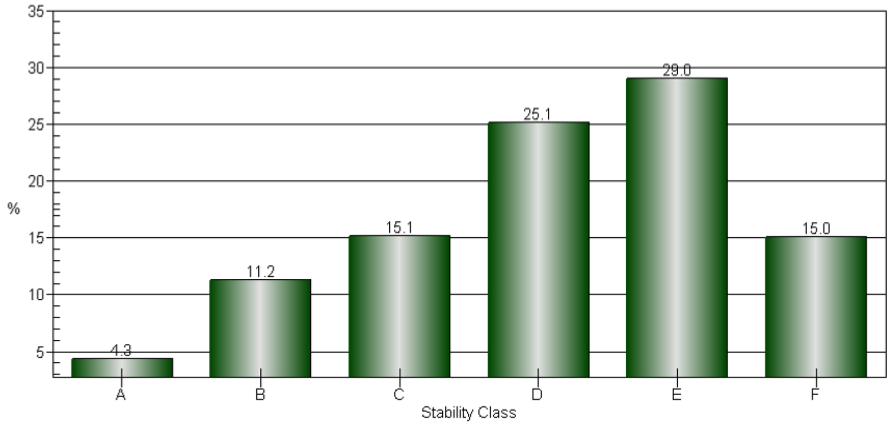


Figure 59: Stability class frequency distribution for the proposed site for the period Jan 2005 – Dec 2009

6.1.8.5 Temperature and Humidity

Temperature affects the formation, action, and interactions of pollutants in various ways (Kupchella and Hyland, 1993). Chemical reaction rates tend to increase with temperature and the warmer the air, the more water it can hold and hence the higher the humidity. When relative humidity exceeds 70%, light scattering by suspended particles begins to increase, as a function of increased water uptake by the particles (CEPA/FPAC Working Group, 1999). This results in decreased visibility due to the resultant haze. Many pollutants may also dissolve in water to form acids. Temperature also provides an indication of the rate of development and dissipation of the mixing layer.

Average monthly temperature and humidity at the proposed site for the period 2005 – 2009 is given in Figure 60. Daily average summer temperatures range between ~24 °C and ~26 °C while winter temperatures range between ~11 °C and ~13 °C. Relative humidity peaks during the winter months.

Figure 60: Average monthly temperature and humidity for the proposed site for the period 2005 – 2009

6.1.8.6 Health Risk Evaluation Criteria

South African ambient air quality standards have been issued by the Department of Environmental Affairs and will be used as a basis for comparison for this assessment. However, reference will be made to international guidelines to ensure complete compliance. The pollutants assessed during the current investigation included the criteria pollutants: inhalable particulate matter (PM), sulphur dioxide (SO_2) and nitrogen dioxide (NO_2).

- **Particulate Matter**

Particulate matter is the collective name for fine solid or liquid particles added to the atmosphere by processes at the earth's surface. PM includes dust, smoke, soot, pollen and soil particles (Kemp, 1998). PM has been linked to a range of serious respiratory and cardiovascular health problems. The key effects associated with exposure to ambient particulate matter include: premature mortality, aggravation of respiratory and cardiovascular disease, aggravated asthma, acute respiratory symptoms, chronic bronchitis, decreased lung function, and an increased risk of myocardial infarction (USEPA, 1996).

PM represents a broad class of chemically and physically diverse substances. Particles can be described by size, formation mechanism, origin, chemical composition, atmospheric behaviour and method of measurement. The concentration of particles in the air varies across space and time, and is related to the source of the particles and the transformations that occur in the atmosphere (USEPA, 1996).

PM can be principally characterised as discrete particles spanning several orders of magnitude in size, with inhalable particles falling into the following general size fractions (USEPA, 1996):

- PM10 (generally defined as all particles equal to and less than 10 microns in aerodynamic diameter; particles larger than this are not generally deposited in the lung);
- PM2.5, also known as fine fraction particles (generally defined as those particles with an aerodynamic diameter of 2.5 microns or less)
- PM10-2.5, also known as coarse fraction particles (generally defined as those particles with an aerodynamic diameter greater than 2.5 microns, but equal to or less than a nominal 10 microns); and
- Ultra fine particles generally defined as those less than 0.1 microns.

Fine and coarse particles are distinct in terms of the emission sources, formation processes, chemical composition, atmospheric residence times, transport distances and other parameters. Fine particles are directly emitted from combustion sources and are also formed secondarily from gaseous precursors such as sulphur dioxide, nitrogen oxides, or organic compounds. Fine particles are generally composed of sulphate, nitrate, chloride and ammonium compounds, organic and elemental carbon, and metals.

Table 34 outlines the various international health risk criteria used for the assessment of inhalable particulate matter (PM10). Guidelines and standards are provided for a 24-hour exposure and annual average exposure period respectively.

Table 27: Ambient air quality guidelines and standards for particulate matter

Origin	24-Hour Exposure (µg/m³)	Annual Average Exposure (µg/m³)	Number of exceedance allowed per year
South Africa(1)	120	50	4 daily exceedance
World Bank(6)	500	100	NA
EU(3)	50	30 20(2)	25 daily exceedance By 2010 only 7 daily exceedance
USEPA(4)	150	50(5)	1 daily exceedance
UK(6)	50	40	35 daily exceedance
WHO(7) (8) (9)	50	20	NA

Notes:

(1) Standard laid out in the National Environment Management: Air Quality Act. No 39 of 2004.

(2) Compliance by 1 January 2010.

(3) World Bank Air Quality Standards summary obtainable at URL http://www.worldbank.org/html/fpd/em/power/standards/airqstd.stm#paq.

(4) European Union Air Quality Standards summary obtainable at URL http://europa.eu.int/smartapi/cgi/sga_doc?smartapi!celexplus!prod!DocNumber&lg=en&type_doc=Directive&an_doc=1999&nu_doc=30.

(5) United States Environmental Protection Agencies National Air quality Standards obtainable at URL http://www.epa.gov/air/criteria.html

(6) To attain this standard, the 3-year average of the weighted annual mean PM_{10} concentration at each monitor within an area must not exceed 50 ug/m^3.

(7) United Kingdom Air Quality Standards and objectives obtainable at URL http://www.airquality.co.uk/archive/standards.php

(8) WHO = World Health Organisation.

(9) Guidance on the concentrations at which increasing, and specified mortality responses due to PM are expected based on current scientific insights (WHO, 2005).

(10) Air quality guideline.

- **Oxides of Nitrogen**

Air quality guidelines and standards issued by most other countries and organisations tend to be given exclusively for NO_2 concentrations as NO_2 is the most important species from a human health point of view. International and South African standards for NO_2 are presented in Table 28.

Table 28: Ambient air quality guidelines and standards for nitrogen dioxide

Averaging Period	South Africa		WHO		EC		Australia	
	$\mu g/m^3$	ppm	$\mu g/m^3$	ppm	$\mu g/m^3$	ppm	$\mu g/m^3$	ppm
Annual Ave	40	0.021	40	0.021	40$^{(2)}$	0.021$^{(2)}$	57$^{(4)}$	0.03$^{(4)}$
Max. 1-hr	200	0.10	200	0.10	200$^{(3)}$	0.10$^{(3)}$	240$^{(5)}$	0.12$^{(5)}$

Notes:

(1) Annual arithmetic mean.

(2) Annual limit value for the protection of human health, to be complied with by 1 January 2010.

(3) Averaging times represent 98th percentile of averaging periods; calculated from mean values per hour or per period of less than an hour taken through out year; not to be exceeded more than 8 times per year. This limit is to be complied with by 1 January 2010.

(4) Standard set in June 1998. Goal within 10 years given as being no exceedances.

(5) Standard set in June 1998. Goal within 10 years given as maximum allowable exceedances of 1 day a year.

NO is one of the primary pollutants emitted by aircraft and motor vehicle exhausts. As discussed previously, NO_2 is formed through oxidation of these oxides once released in the air. NO_2 is an irritating gas that is absorbed into the mucous membrane of the respiratory tract. The most adverse health effect occurs at the junction of the conducting airway and the gas exchange region of the lungs. The upper airways are less affected because NO_2 is not very soluble in aqueous surfaces. Exposure to NO_2 is linked with increased susceptibility to respiratory infection, increased airway resistance in asthmatics and decreased pulmonary function.

Available data from animal toxicology experiments indicate that acute exposure to NO_2 concentrations of less than 1 880 $\mu g/m^3$ (1 ppm) rarely produces observable effects (WHO, 2000). Normal healthy humans, exposed at rest or with light exercise for less than two hours to concentrations above 4 700 $\mu g/m^3$ (2.5 ppm), experience pronounced decreases in pulmonary function; generally, normal subjects are not affected by concentrations less than 1 880 $\mu g/m^3$ (1.0 ppm). One study showed that the lung function of subjects with chronic obstructive pulmonary disease is slightly affected by a 3.75-hour exposure to 560 µg/m3 (0.3 ppm) (WHO, 2000).

Asthmatics are likely to be the most sensitive subjects, although uncertainties exist in the health database. The lowest concentration causing effects on pulmonary function was reported from two laboratories that exposed mild asthmatics for 30 to 110 minutes to 565 µg/m3 (0.3 ppm) NO_2 during intermittent exercise. However, neither of these laboratories was able to replicate these responses with a larger group of asthmatic subjects. NO_2 increases bronchial reactivity, as measured by the response of normal and asthmatic subjects following exposure to pharmacological bronchoconstrictor agents, even at levels that do not affect pulmonary function directly in the absence of a bronchoconstrictor. Some, but not all, studies show increased responsiveness to bronchoconstrictors at NO_2 levels as low as 376-565 $\mu g/m^3$ (0.2 to 0.3 ppm); in other studies, higher levels had no such effect. Because the actual mechanisms of effect are not fully defined and NO_2 studies with allergen challenges showed no effects at the lowest concentration tested (188 $\mu g/m^3$; 0.1 ppm), full evaluation of the health consequences of the increased responsiveness to bronchoconstrictors is not yet possible.

Studies with animals have clearly shown that several weeks to months of exposure to NO_2 concentrations of less than 1 880 µg/ m^3 (1ppm) causes a range of effects, primarily in the lung, but also in other organs such as the spleen and liver, and in blood. Both reversible and irreversible lung effects have been observed. Structural changes range from a change in cell type in the tracheobronchial and pulmonary regions (at a lowest reported level of 640 µg/m^3), to emphysema-like effects. Biochemical changes often reflect cellular alterations, with the lowest effective NO_2 concentrations in several studies ranging from 380-750µg/m^3. NO_2 levels of about 940 µg/m^3 (0.5 ppm) also increase susceptibility to bacterial and viral infection of the lung. Children of between 5 to12 years old are estimated to have a 20% increased risk for respiratory symptoms and disease for each increase of 28 µg/m^3 NO_2 (2-week average), where the weekly average concentrations are in the range of 15-128 µg/m^3 or possibly higher. However, the observed effects cannot clearly be attributed to either the repeated short-term high-level peak, or to long-term exposures in the range of the stated weekly averages (or possibly both). The results of outdoor studies consistently indicate that children with long-term ambient NO_2 exposures exhibit increased respiratory symptoms that are of longer duration, and show a decrease in lung function.

- **Sulphur Dioxide**

SO_2 is an irritant that is absorbed in the nose and aqueous surfaces of the upper respiratory tract, and is associated with reduced lung function and increased risk of mortality and morbidity. Adverse health effects of SO_2 include coughing, phlegm, chest discomfort and bronchitis.

Short-period exposures (less than 24 hours): Most information on the acute effects of SO_2 comes from controlled chamber experiments on volunteers exposed to SO_2 for periods ranging from a few minutes up to one hour (WHO, 2000). Acute responses occur within the first few minutes after commencement of inhalation. Further exposure does not increase effects. Effects include reductions in the mean forced expiratory volume over one second (FEV1), increases in specific airway resistance, and symptoms such as wheezing or shortness of breath. These effects are enhanced by exercise that increases the volume of air inspired, as it allows SO_2 to penetrate further into the respiratory tract. A wide range of sensitivity has been demonstrated, both among normal subjects and among those with asthma. People with asthma are the most sensitive group in the community. Continuous exposure-response relationships, without any clearly defined threshold, are evident.

Sub-chronic exposure over a 24-hour period: Information on the effects of exposure averaged over a 24-hour period is derived mainly from epidemiological studies in which the effects of SO_2, suspended particulate matter and other associated pollutants are considered. Exacerbation of symptoms among panels of selected sensitive patients seems to arise in a consistent manner when the concentration of SO_2 exceeds 250 µg/m^3 in the presence of suspended particulate matter. Several more recent studies in Europe have involved mixed industrial and vehicular emissions now common in ambient air. At low levels of exposure (mean annual levels below 50 μg/m^3; daily levels usually not exceeding 125 μg/m^3) effects on mortality (total, cardiovascular and respiratory) and on hospital emergency admissions for total respiratory causes and chronic obstructive pulmonary disease (COPD), have been consistently demonstrated. These results have been shown, in some instances, to persist when black smoke and suspended particulate matter levels were controlled for, while in others no attempts have been made to separate the pollutant effects. In these studies no obvious threshold levels for SO_2 has been identified.

Long-term exposure: Earlier assessments, using data from the coal-burning era in Europe judged the lowest-observed-adverse-effect level of SO_2 to be at an annual average of 100 μg/m^3, when present with suspended particulate matter. More recent studies related to industrial sources of SO_2, or to the changed urban mixture of air pollutants, have shown adverse effects below this level. There is, however, some difficulty in finding this value.

Based upon controlled studies with asthmatics exposed to SO_2 for short periods, the WHO (WHO, 2000) recommends that a value of 500 μg/m^3 (0.175 ppm) should not be exceeded over averaging periods of 10 minutes. Because exposure to sharp peaks depends on the nature of local sources, no single factor can be applied to estimate corresponding guideline values over longer periods, such as an hour. Day-to-day changes in mortality, morbidity, or lung function related to 24-hour average concentrations of SO_2 are necessarily based on epidemiological studies, in which people are in general exposed to a mixture of pollutants; and guideline values for SO_2 have previously been linked with corresponding values for suspended particulate matter. This approach led to a previous guideline 24-hour average value of 125 μg/m^3 (0.04 ppm) for SO_2, after applying an uncertainty factor of two to the lowest-observed-adverse-effect level. In more recent studies, adverse effects with significant public health importance have been observed at much lower levels of exposure. However, there is still a large uncertainty with this and hence no concrete basis for numerical changes of the 1987-guideline values for SO_2.

The EC's air quality criteria represent standards to be achieved by the year 2005, and would supersede the EU standards. The ambient air quality standards of the USEPA are based on clinical and epidemiological evidence. These standards were established by determining concentrations with the lowest-observed-adverse effect, adjusted by an arbitrary margin of safety factor to allow for uncertainties in extrapolating from animals to humans and from small groups of humans to larger populations. The standards of the USEPA also reflect the technological feasibility of attainment.

Ambient air quality guidelines and standards issued for various countries and organisations for SO_2 are given in Table 29.

Table 29: Ambient air quality guidelines and standards for sulphur dioxide

Country	Annual Average (µg/m³)	Maximum 24-hour Ave (µg/m³)	Maximum 1-hour Ave (µg/m³)	<1-hour Maximum (µg/m³)
RSA	50	125	350	500 (10 min average)
WHO	50[1] 10-30[2]	125[1]	-	500[1] (10 min average)
EC	20[3]	125[4]	350[5]	
UK	20[6]	125[7]	350[8]	266[9] (15 min mean)
World Bank	50[10]	125[10]	-	-
USEPA	80	365	-	-
Australia	53[11]	209[12]	520[13]	-

Notes:

(1) Air quality guidelines (issued by the WHO for Europe) for the protection of human health (WHO, 2000).

(2) Represents the critical level for ecotoxic effects (issued by the WHO for Europe); a range is given to account for different sensitivities of vegetation types.

(3) Limit value to protect ecosystems. Applicable two years from entry into force of the Air Quality Framework Directive 96/62/EC.

(4) Limit to protect health, to be complied with by 1 January 2005. (Not to be exceeded more than 3 times per calendar year.)

(5) Limit to protect health, to be complied with by 1 January 2005. (Not to be exceeded more than 4 times per calendar year.)

(6) Given as annual and winter (1 Oct to 31 March) mean, to be complied with by 31 December 2000.

(7) 24-hour mean, not to be exceeded more than 24 times a year. Compliance required by 31 December 2004.

(8) 1-hour mean, not to be exceeded more than 24 times a year. Compliance required by 31 December 2004

(9) 15-minute mean, not to be exceeded more than 35 times a year. Compliance required by 31 December 2005.

(10) Ambient air concentration permissible at property boundary.

(11) Standard set in June 1998 as 0.02 ppm. Goal within 10 years is to have no exceedances.

(12) Standard set in June 1998 as 0.08 ppm. Goal within 10 years is to have maximum allowable exceedances of 1 day per year.

(13) Standard set in June 1998 as 0.20 ppm. Goal within 10 years is to have maximum allowable exceedances of 1 day per year.

(14) 90% of hourly observation to be less than 300 µg/m³

- **Identified Sensitive Receptors**

A sensitive receptor for the purposes of the current investigation is defined as a person or place where involuntary exposure to pollutants released by the proposed project could take place. Receptors surrounding the proposed sites (Sites A and B) were identified from satellite images of the area (Table 30). The residential areas of Groblershoop, Sutterheim and Wegdraai are the closest residential areas to the proposed sites. The town of Upington is located approximately 80 km to the west-north-west of the proposed sites. A neighbouring farmhouse is located in close proximity (approximately 2 km) to the proposed sites.

Table 30: Identified receptors surrounding the proposed site (as determined from Site A)

Receptor	Distance (km)	Direction from Site
Wegdraai	~ 17 km	SW
Groblershoop	~ 18 km	S
Stutterheim	~ 19 km	S
Boegoberg	~ 24 km	SSE
Upington	~ 80 km	WNW

- **Existing Sources of Air Pollution**

Based on satellite imagery and a site description of the area, the following surrounding sources of air pollution have been identified in the area:

- Agriculture;
- Domestic fuel burning; and
- Veld fires.

A qualitative discussion of each identified sources is provided in the subsections below. The aim is to highlight the potential contribution of surrounding sources to the overall ambient air quality situation in the area. These sources have not been quantified as part of this assessment.

<u>Agriculture</u>

Agricultural activity can be considered a significant contributor to particulate emissions, although tilling, harvesting and other activities associated with field preparation are seasonally based.

The main focus internationally with respect to emissions generated due to agricultural activity is related to animal husbandry, with special reference to malodours generated as a result of the feeding and cleaning of animal. The types of livestock assessed included pigs, sheep, goats and chickens. Emissions assessed include ammonia and hydrogen sulphide (USEPA, 1996).

Little information is available with respect to the emissions generated due to the growing of crops. The activities responsible for the release of particulates and gases to atmosphere would however include:

- Particulate emissions generated due to wind erosion from exposed areas;
- Particulate emissions generated due to the mechanical action of equipment used for tilling and harvesting operations;
- Vehicle entrained dust on paved and unpaved road surfaces;
- Gaseous and particulate emissions due to fertilizer treatment; and
- Gaseous emissions due to the application of herbicides and pesticides.

Land-use along the Orange River is predominantly agricultural with crops such as grapes and raisins grown in the flood plains of the Orange River. Agricultural activities along the Orange River would likely contribute to the ambient particulate and gaseous pollutant concentrations in the area.

Domestic Fuel Burning

Due to the close proximity of residential developments it is anticipated that low income households in the area are likely to use coal and wood for space heating and/ or cooking purpose. Exposure to indoor air pollution (IAP) from the combustion of solid fuels is an important cause of morbidity and mortality in developing countries. Biomass and coal smoke contain a large number of pollutants and known health hazards, including particulate matter, carbon monoxide, nitrogen dioxide, sulphur oxides (mainly from coal), formaldehyde, and polycyclic organic matter, including carcinogens such as benzo[a]pyrene (Ezzati and Kammen, 2002).

Exposure to indoor air pollution (IAP) from the combustion of solid fuels has been implicated, with varying degrees of evidence, as a causal agent of several diseases in developing countries, including acute respiratory infections (ARI) and otitis media (middle ear infection), chronic obstructive pulmonary disease (COPD), lung cancer (from coal smoke), asthma, cancer of the nasopharynx and larynx, tuberculosis, perinatal conditions and low birth weight, and diseases of the eye such as cataract and blindness (Ezzati and Kammen, 2002).

Monitoring of pollution and personal exposures in biomass-burning households has shown concentrations are many times higher than those in industrialized countries. The latest International Ambient Air Quality Standards, for instance, required the daily average concentration of PM10 to be < 180 μg/m^3 (annual average < 60 μg/m^3). In contrast, a typical 24-hr average concentration of PM10 in homes using bio fuels may range from 200 to 5 000 μg/m^3 or more throughout the year, depending on the type of fuel, stove, and housing. Concentration levels, of course, depend on where and when monitoring takes place, because significant temporal and spatial variations may occur within a house. Field measurements, for example, recorded peak concentrations of > 50 000 µg/m^3 in the immediate vicinity of the fire, with concentrations falling significantly with increasing distance from the fire. Overall, it has been estimated that approximately 80% of total global exposure to airborne particulate matter occurs indoors in developing nations. Levels of CO and other pollutants also often exceed international guidelines (Ezzati and Kammen, 2002).

Given the remote location of the area, the burning of domestic fuels such as coal, wood and paraffin for heating and cooking purposes is likely to occur in surrounding residential areas such as Wegdraai, Groblershoop, Stutterheim and Boegoberg.

Veld Fires

A veld fire is a large-scale natural combustion process that consumes various ages, sizes, and types of flora growing outdoors in a geographical area. Consequently, veld fires are potential sources of large amounts of air pollutants that should be considered when attempting to relate emissions to air quality. The size and intensity, even the occurrence, of a veld fires depend directly on such variables as meteorological conditions, the species of vegetation involved and their moisture content, and the weight of consumable fuel per hectare (available fuel loading).

Once a fire begins, the dry combustible material is consumed first. If the energy released is large and of sufficient duration, the drying of green, live material occurs, with subsequent burning of this material as well. Under suitable environmental and fuel conditions, this process may initiate a chain reaction that results in a widespread conflagration. It has been hypothesized, but not proven, that the nature and amounts of air pollutant emissions are directly related to the intensity and direction (relative to the wind) of the veld fire, and are indirectly related to the rate at which the fire spreads. The factors that affect the rate of spread are (1) weather (wind velocity, ambient temperature, relative humidity); (2) fuels (fuel type, fuel bed array, moisture content, fuel size); and (3) topography (slope and profile). However, logistical problems (such as size of the burning area) and difficulties in safely situating personnel and equipment close to the fire have prevented the collection of any reliable emissions data on actual veld fires, so that it is not possible to verify or disprove the hypothesis.

The major pollutants from veld burning are particulate matter, carbon monoxide, and volatile organics. Nitrogen oxides are emitted at rates of from 1 to 4 g/kg burned, depending on combustion temperatures. Emissions of sulphur oxides are negligible (USEPA, 1996). A study of biomass burning in the African savannah estimated that the annual flux of particulate carbon into the atmosphere is estimated to be of the order of 8 Tg C, which rivals particulate carbon emissions from anthropogenic activities in temperate regions (Cachier *et al*, 1995).

6.1.8.7 Impact Assessment

This section outlines the potential ambient air quality impacts associated with the proposed CSP plant. A detailed emissions inventory was compiled as part of this assessment to determine emissions released from the proposed boiler. Dispersion modelling simulations were undertaken using the AERMOD dispersion model and presented graphically as isopleths plots.

- **Construction Phase**

During the construction assessment phase it is expected that the main sources of impact will result due to the construction of new infrastructure associated with the proposed plant. These predicted impacts cannot be directly quantified, primarily due to the lack of detailed information related to scheduling and positioning of construction related activities. Instead a qualitative description of the impacts will be provided. This will involve the identification of possible sources of emissions and the provision of details related to their impacts.

Construction is commonly of a temporary nature with a definite beginning and end. Construction usually consists of a series of different operations, each with its own duration and potential for dust generation. Dust emission will vary from day to day depending on the phase of construction, the level of activity, and the prevailing meteorological conditions (USEPA, 1996).

The following possible sources of fugitive dust have been identified as activities which could potentially generate dust during construction operations at the site:

- Vehicle activities associated with the transport of equipment to the site;
- Preparation of the surface areas which will be required prior to the set up of new infrastructure; and
- The removal of construction equipment from site after the set up of new infrastructure.

- **Operational Phase**

<u>Model Overview</u>

AERMOD, a state-of-the-art Planetary Boundary Layer (PBL) air dispersion model, was developed by the American Meteorological Society and USEPA Regulatory Model Improvement Committee (AERMIC). AERMOD utilizes a similar input and output structure to ISCST3 and shares many of the same features, as well as offering additional features. AERMOD fully incorporates the PRIME building downwash algorithms, advanced depositional parameters, local terrain effects, and advanced meteorological turbulence calculations.

The AERMOD atmospheric dispersion modelling system is an integrated system that includes three modules:

- A steady-state dispersion model designed for short-range (up to 50 km) dispersion of air pollutant emissions from stationary industrial sources;
- A meteorological data pre-processor (AERMET) for surface meteorological data, upper air soundings, and optionally, data from on-site instrument towers. It then calculates atmospheric parameters needed by the dispersion model, such as atmospheric turbulence characteristics, mixing heights, friction velocity, Monin-Obukov length and surface heat flux; and
- A terrain pre-processor (AERMAP) which provides a physical relationship between terrain features and the behaviour of air pollution plumes. It generates location and height data for each receptor location. It also provides information that allows the dispersion model to simulate the effects of air flowing over hills or splitting to flow around hills.

Model Requirements

Given the remote location of the proposed site, local meteorological data is not available. Use was therefore made of site-specific modelled meteorological data (MM5) for the period January 2005 to December 2009 and includes hourly observations of wind speed, wind direction, temperature and humidity. Source and emission parameters for the model are given in the section below.

- **Emissions Inventory**

Sources of emissions identified as occurring due to the proposed project and which need to be addressed from an air quality perspective are summarized as follows:

Proposed Boiler

Source parameters and fuel consumption values for the proposed boiler were provided by Hatch for the purpose of this assessment (Table 31). It is proposed that either diesel or LPG will be used to fuel the boiler. The boiler will operate for a total of 6 months per year. Emission rates for the proposed boiler were calculated using the USEPA AP-42 emission factors for Fuel Oil Combustion and LPG Combustion (Table 32).

Table 31: Source parameters for the Proposed Boiler

Site	Latitude (°S)	Longitude (°E)	Stack height (m)	Stack diameter (m)	Exit velocity (m/s)	Temp (° C)
Site A	28° 44' 22.28"	21° 59' 51.00"	30	1.5	6	180
Site B	28° 42' 04.73"	22° 01' 16.65"	30	1.5	6	180

Table 32: Emission rates for the Proposed Boiler

Fuel Type	Fuel Usage (m^3/yr)	Emission rate (g/s)		
		PM10	SO_2	NO_2
Diesel	3100	0.024	0.838	0.236
LPG	2900	0.002	0.001	0.143

- **Impact Assessment**

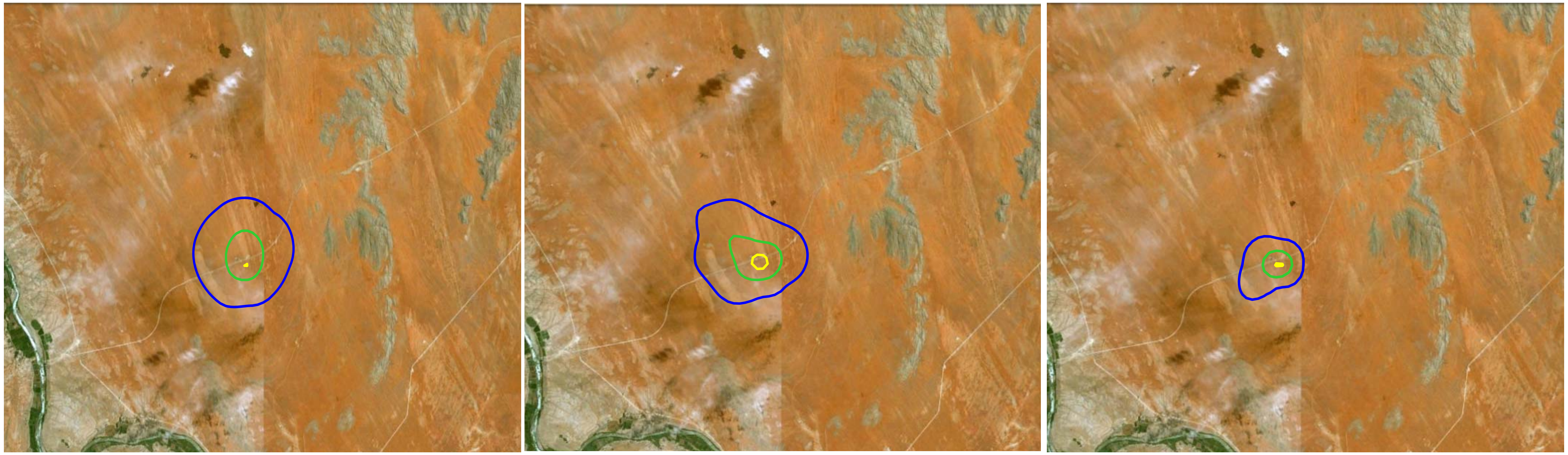
Dispersion modelling simulations were undertaken to determine the potential air quality impacts associated with emissions from the proposed boiler. Dispersion modelling simulations were undertaken for each proposed site (Site A and Site B). Results are presented graphically as isopleth plots in the figures below. Isopleth plots reflect gridded contours which represent zones of impact at various distances from the contributing sources. The patterns generated by the contours are representative of the maximum predicted ground level concentrations for the averaging period being represented. Maximum hourly, daily and annual average concentrations for PM10, SO_2 and NO_2 are represented in Figure 61 to Figure 62.

<u>Proposed Site A</u>

Predicted maximum hourly, daily and annual average concentrations due to emissions from the proposed boiler are low and fall well below the National standards for all modelled pollutants (Figure 61). The neighbouring farmhouse will not be influenced by elevated pollutant concentrations due to emissions from the boiler. Although higher concentrations are predicted when using diesel as compared to LPG, concentrations remain very low.

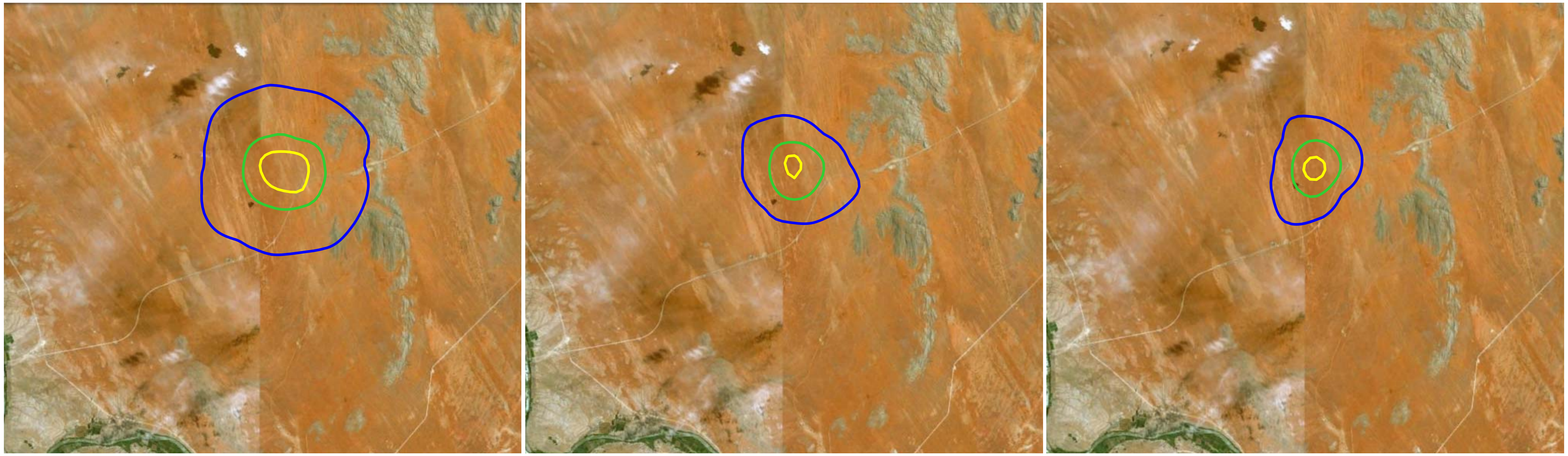
<u>Proposed Site B</u>

As observed at the proposed Site A, maximum hourly, daily and annual average concentrations are low and fall well below the National standards for all modelled pollutants at proposed Site B (Figure 62). The neighbouring farmhouse will not be influenced by elevated pollutant concentrations due to emissions from the boiler.



Hourly				Daily				Annual			
Diesel											
PM	0.060	0.108	0.156	PM	0.014	0.029	0.043	PM	0.002	0.005	0.007
SO_2	2.094	3.771	5.447	SO_2	0.503	1.006	1.508	SO_2	0.084	0.168	0.251
NO_2	0.590	1.062	1.534	NO_2	0.142	0.283	0.425	NO_2	0.024	0.047	0.071
LPG											
PM	0.005	0.009	0.013	PM	0.001	0.002	0.004	PM	0.0002	0.0004	0.006
SO_2	0.003	0.005	0.007	SO_2	0.0006	0.001	0.002	SO_2	0.0001	0.0002	0.0003
NO_2	0.358	0.644	0.930	NO_2	0.086	0.172	0.257	NO_2	0.014	0.029	0.043

Figure 61: Hourly, daily and annual average predicted ground level concentrations (μg/m3) from the proposed boiler at Site A



Hourly				Daily				Annual			
Diesel											
PM	0.048	0.077	0.106	PM	0.014	0.029	0.043	PM	0.001	0.003	0.004
SO_2	1.676	2.682	3.687	SO_2	0.503	1.006	1.508	SO_2	0.050	0.102	0.151
NO_2	0.472	0.755	1.038	NO_2	0.1412	0.283	0.425	NO_2	0.014	0.028	0.042
LPG											
PM	0.004	0.006	0.009	PM	0.001	0.002	0.004	PM	0.0001	0.0002	0.0004
SO_2	0.002	0.003	0.004	SO_2	0.0006	0.001	0.002	SO_2	0.00006	0.0001	0.0002
NO_2	0.286	0.458	0.629	NO_2	0.086	0.172	0.257	NO_2	0.009	0.017	0.026

Figure 62: Hourly, daily and annual average predicted ground level concentrations (µg/m3) from the proposed boiler at Site B

- **Decommissioning Phase**

The decommissioning phase is associated with activities related to the demolition of infrastructure and the rehabilitation of disturbed areas. The following activities are associated with the decommissioning phase (USEPA, 1996):

- Existing structures demolished, rubble removed and the area levelled;
- Remaining exposed excavated areas filled and levelled;
- Topsoil replaced; and
- Land and permanent waste piles prepared for re-vegetation.

Possible sources of fugitive dust emission during the closure and post-closure phase include:

- Smoothing of areas by bulldozer;
- Grading of sites;
- Transport and dumping of material for void filling;
- Infrastructure demolition;
- Infrastructure rubble piles;
- Transport and dumping of building rubble;
- Transport and dumping of topsoil; and
- Preparation of soil for re-vegetation – ploughing and addition of fertiliser, compost etc.

Exposed soil is often prone to erosion by water. The erodability of soil depends on the amount of rainfall and its intensity, soil type and structure, slope of the terrain and the amount of vegetation cover (Brady, 1974). Re-vegetation of exposed areas for long-term dust and water erosion control is commonly used and is the most cost-effective option. Plant roots bind the soil, and vegetation cover breaks the impact of falling raindrops, thus preventing wind and water erosion. Plants used for re-vegetation should be indigenous to the area, hardy, fast-growing, nitrogen-fixing, provide high plant cover, be adapted to growing on exposed and disturbed soil (pioneer plants) and should easily be propagated by seed or cuttings.

6.1.8.8 Conclusion

Predicted maximum hourly, daily and annual average concentrations due to emissions from the proposed boiler are low and fall well below the National standards for all modelled pollutants. The neighbouring farmhouse will not be influenced by elevated pollutant concentrations due to emissions from the boiler. Although higher concentrations are predicted when using diesel as compared to LPG, concentrations remain very low.

6.2 Biophysical Environment

6.2.9 Terrestrial Biodiversity

Bathusi Environmental Consultants (BEC) has been appointed as independent ecological specialists to conduct a strategic biodiversity scoping evaluation of the biological environment that will be affected by the proposed development. Dewald Kamffer (Faunal Specialists Incorporated, FSI) conducted the faunal assessment; Riaan Robbeson (BEC) conducted the floristic assessment, provided the ecological interpretation and compiled the ecological sensitivity analysis.

*Refer to **Appendix E** for the Biodiversity Assessment Report.*

6.2.9.1 Methodology

While a proper knowledge of the biodiversity of the region is not negotiable to the ultimate success of this project, an attempt was made to remove any subjective opinions that might be held on any part of the study area as far as possible. Inherent characteristics of a project of this nature implies that no method will be foolproof, mainly as a result of shortcomings in available databases and lack of site specific detail that could be obtained from limited detailed site investigations conducted over a short period of time. It is an unfortunate fact that inherent sensitivities within certain areas are likely to exist that could not be captured or illustrated during the process. This is a shortcoming of every scientific study that has ever been conducted; it simply is not possible to know everything or to consider aspects to a level of molecular detail. However, the approach followed in this study is considered effective in presenting objective comments on the comparison of biodiversity sensitivity of parts in the study area.

In order to present an objective opinion of the biodiversity sensitivity of the study area and how this relates to the suitability/ unsuitability of any area within the site in terms of the proposed development, all opinions and statements presented in this document are based on the following aspects, namely:

- A desk-top study of all available biological and biophysical data;
- Augmentation of existing knowledge by means of site specific and detailed field surveys;
- Specialist interpretation of available data, or known sensitivities of certain regional attributes;
- A GIS analysis, mapping and description of results obtained from the process, and
- An objective impact assessment process, estimating potential impacts on biological and biophysical attributes.

- **Background Information**

The overall goal of this section of the biodiversity investigation is to establish a reference point for the biophysical and biological sensitivities of the study area by means of the Ecosystem Approach or Landscape Ecology. The Ecosystem Approach is advocated by the Convention on Biological Diversity. It recognizes that people and biodiversity are part of the broader ecosystems on which they depend, and that it should thus be assessed in an integrated way. Principles of the Ecosystem Approach include the following:

- The objectives of ecosystem management are a matter of societal choice;
- Ecosystem managers should consider the effects of their activities on adjacent and other systems;
- Conservation of ecosystem structure and functioning, to maintain ecosystem services, should be a priority target;
- Ecosystems must be managed within the limits of their functioning;
- The approach must be undertaken at appropriate spatial and temporal scales;
- Objectives for ecosystem management should be set for the long-term;
- Management must recognise that change is inevitable;
- The approach should seek an appropriate balance between, and integration of, conservation and use of biodiversity;
- All forms of relevant information should be considered; and
- All relevant sectors of society and scientific disciplines should be involved.

For the purpose of this particular study a local scale was selected as suitable in terms of the size of the study area. The approach of Landscape Ecology includes the assessment of biophysical and societal causes, consequences of landscape heterogeneity and factors that causes disturbance to these attributes. In layman's terms it implies that if sensitive habitat types/ ecosystems (frequently associated with biodiversity elements of high sensitivity or conservation importance) are protected, species that are highly sensitive to changes in the environment will ultimately be protected. Species conservation is therefore largely replaced by the concept of habitat conservation. This approach is regarded effective since the protection of sensitive ecosystems will ultimately filter down to species level.

It is inevitable that the Landscape Ecology Approach will not function effectively in all cases since extremely localised and small areas of sensitivity do occur scattered in the study area, which can not always be captured on available databases or might have been missed during the site investigations. In addition to the compilation of basic species lists and the identification and description of localised ecological habitat it was also regarded important to identify areas of sensitivity on a local scale and, where possible, communities or species that are considered sensitive in terms of impacts that are likely to result from the proposed development.

This investigation therefore aims to:

- Determine the biological sensitivity of the receiving natural environment as it relates to the construction and operation of the plant and associated infrastructure in a natural environment;
- Highlight the known level of biodiversity;
- Highlight flora and fauna species of conservation importance that are likely to occur within the study area;
- Estimate the level of potential impacts of the construction and operation of proposed power generation structures on the biological resources of the study area, and

- Apply the Precautionary Principal throughout the assessment[47].

- **Assessment of Biophysical Attributes**

Data Selection Process

Available databases of biophysical attributes are implemented to identify regional areas of importance as it relates to biodiversity. Biophysical attributes that are known to be associated with biodiversity aspects of importance, conservation potential or natural status of the environment were implemented to compile the ecological sensitivity analysis of the study area. These attributes include the following:

- Areas of known biological importance (ENPAT);
- Areas of surface water (ENPAT);
- Degradation classes (ENPAT Land Cover Classes);
- Regional vegetation types (VEGMAP);
- Land cover categories (ENPAT), and
- Ridges and outcrops.

The first step in assessing the biophysical aspects of importance is the delineation of natural habitat, or the exclusion of transformed or degraded habitat. Areas that are transformed as a result of human activities, including agriculture, mining, urban development, etc, constitute parts of the study area where no natural habitat remains and where natural biodiversity is entirely compromised, to the extent that any recovery to a previous, pristine status is regarded impossible. These areas are generally suitable for the purpose of construction and development since impacts on important/ sensitive biological resources are regarded unlikely. Ultimately, areas that are characterised by high levels of transformation or degradation or which are characterised by low occurrences of biophysical aspects or biodiversity importance, will be considered more suitable for the proposed development, compared to areas constituting large tracts of untransformed and sensitive habitat types.

Secondly, sensitivity values are ascribed to biophysical attributes based on how these contribute to biological diversity or sensitivity. Ultimately all the information is compiled to present a holistic picture of the areas where biophysical aspects of importance occur, presenting a map that depicts regional biodiversity sensitivities based on biophysical attributes.

Biophysical Sensitivities - GIS Analysis

This method is believed to present a holistic overview of the biophysical sensitivity of the area, based on available data as well as the specialist's interpretation of the sensitivity of aspects that are contained in the databases. In specific cases an adjustment of sensitivity of certain areas were made based on information that was obtained from field surveys as well as information that was presented from landowners and interested parties.

[47] (www.pprinciple.net/the_precautionary_principle.html).

The GIS analysis of data was compiled in following stages, namely:

- As a first approximation an assessment was compiled during which available databases were assessed for suitability of use in this particular project. Every attempt was made to utilise the most recent available data; databases were replaced as newer information became available even during late stages of the assessment. Each database was separated into different aspects in terms of how it affects biodiversity sensitivity on a local and regional scale:

    - A biodiversity sensitivity category was ascribed to respective biophysical attributes. For example, the 'Land Cover' database was separated into respective classes in the manner in which it affects the local and regional biodiversity sensitivity, i.e. classes such as 'Agricultural', 'Urban Developments' and 'Degradation' was grouped and ascribed a LOW value;
    - Care was taken to avoid duplication between the various databases, for instance, aspects such as 'Woodland' and 'Grassland' was omitted from the 'Land Cover' database as these classes are adequately represented by the VEGMAP database;
    - Care was also taken of existing gaps of information in available databases, for example; while the ENPAT database of rivers does reflect larger rivers on a national scale, additional data is available in other databases that are not necessarily captured in the ENPAT database;
    - Where a single database contains different classes of sensitivity, these databases were split in the respective classes for layering;
    - Available databases were subsequently integrated in order to determine the maximum sensitivity of a particular parcel of land; and
    - The resultant map provided a basic assessment of the potential biophysical sensitivity on a local and regional scale.

6.2.9.2 Flora

- **Regional Diversity**

The Northern Cape Province is characterised by five biomes. Table 33 presents the area coverage and proportion of each biome within the Northern Cape Province.

Table 33: Extent of biomes within the Northern Cape Province

Biome	Area	Percentage
Fynbos	663,527 ha	1.83%
Grassland	123,837 ha	0.34%
Nama Karoo	19,593,363 ha	54.05%

Savanna	10,686,003 ha	29.48%
Succulent Karoo	5,182,370 ha	14.30%

The proposed site is mainly located within the Savanna Biome, with a small southern portion situated within the Nama Karoo Biome. The Savanna Biome is known to support more than 5,700 plant species, exceeded only by the Fynbos Ecoregion in species richness. The study sites are located within the Kalahari variation of the Savanna Biome, which although referred to as a desert, is not a true desert as it does not approximate the extreme aridity of a true desert. This area is densely covered by grasses, shrubs and trees.

The Nama Karoo Biome, the second largest biome in Southern Africa, is characterised by plains of dwarf shrubs and grasses, dotted with characteristic koppies. It is essentially a grassy, dwarf shrubland; the ration of grasses to shrubs increase progressively, until the Nama Karoo merges with the Grassland Biome. The species richness of this region is not particularly rich; only 2 147 species, of which 386 (18%) are endemic and 67 are threatened, occur.

The SANBI database indicates the presence of approximately 5 315 plant species within this province, with only 91 species within the ¼ degree grids in which the study sites are located (2821DB, DD, 2822CA). This low diversity reflects the poor floristic knowledge of the region. The species diversity comprises a diversity of growth forms, dominated by herbs (32 species, 35.2%), dwarf shrubs (24 species, 26.4%) and grasses (18 species, 19.8%). Trees and tall shrubs comprise a relatively low part of the total, reflecting on the open savanna / shrubland physiognomy of the region.

- **Diversity – Survey Results**

The species list that was compiled during the site investigation is considered moderately comprehensive. A total of 112 plant species were identified during the site investigations. The regional setting dictates the physiognomic dominance of the herbaceous component with 47 forb species (41.96%) and 24 grass species (21.43%). Trees and shrubs occur extensively throughout most of the study area (26 species 28.58%).

Taking the setting of the study area into consideration, the species composition of untransformed vegetation types is regarded representative of the regional vegetation. A total of 35 plant families are represented in the study area, dominated by Poaceae (grass family, 24 species, 21.43%), Fabaceae (16 species, 14.29%) and Asteraceae (daisy family, 12 species, 10.71%).

- **Floristic Habitat Types**

In spite of a relative homogenous appearance to much of the regional habitat, with the exception of extensive mountain ranges, a relatively obvious physiognomic variability is noted in the study area with plains alternating with parallel dunes and mountain foothills in the northern parts. It is highly likely that various smaller phytosociological differences are present within each of the identified habitat types, but for the purpose of this assessment, the observed ecological units are considered similar in major phytosociological, physiognomic and biophysical attributes. Many plant species occur across all of the habitat types, but many of the differences between units are ascribed purely on the basis of terrain morphology, soil characteristics or changes in the dominance and structure of the plant species. Surface water and rainfall in this part of the Kalahari is scarce and, together with substrate, is a major driving force of vegetation development.

Results of the photo analysis and site investigations revealed the presence of the following habitat types (Figure 63):

- Calcareous Low Shrub Plains;
- Open Shrub Duneveld;
- Open Shrub Plains;
- Quartzitic Low Shrub Plains;
- Rocky Outcrops/ Foothills;
- Transformed Areas; and
- Riparian Habitat.

The extent and coverage of habitat types within the study area is presented in Table 34.

Table 34: Extent of habitat types within the study area

Habitat Type	Extent (ha)	Percentage
Calcareous Low Shrub Plains	905.73 ha	18.94%
Open Shrub Duneveld	1,538.11 ha	32.16%
Open Shrub Plains	2,168.18 ha	45.33%
Quartzitic Low Shrub Plains	71.87 ha	1.50%
Riparian Habitat	16.54 ha	0.35%
Rocky Outcrops/ Foothills	75.88 ha	1.59%
Transformed Areas	6.67 ha	0.14%

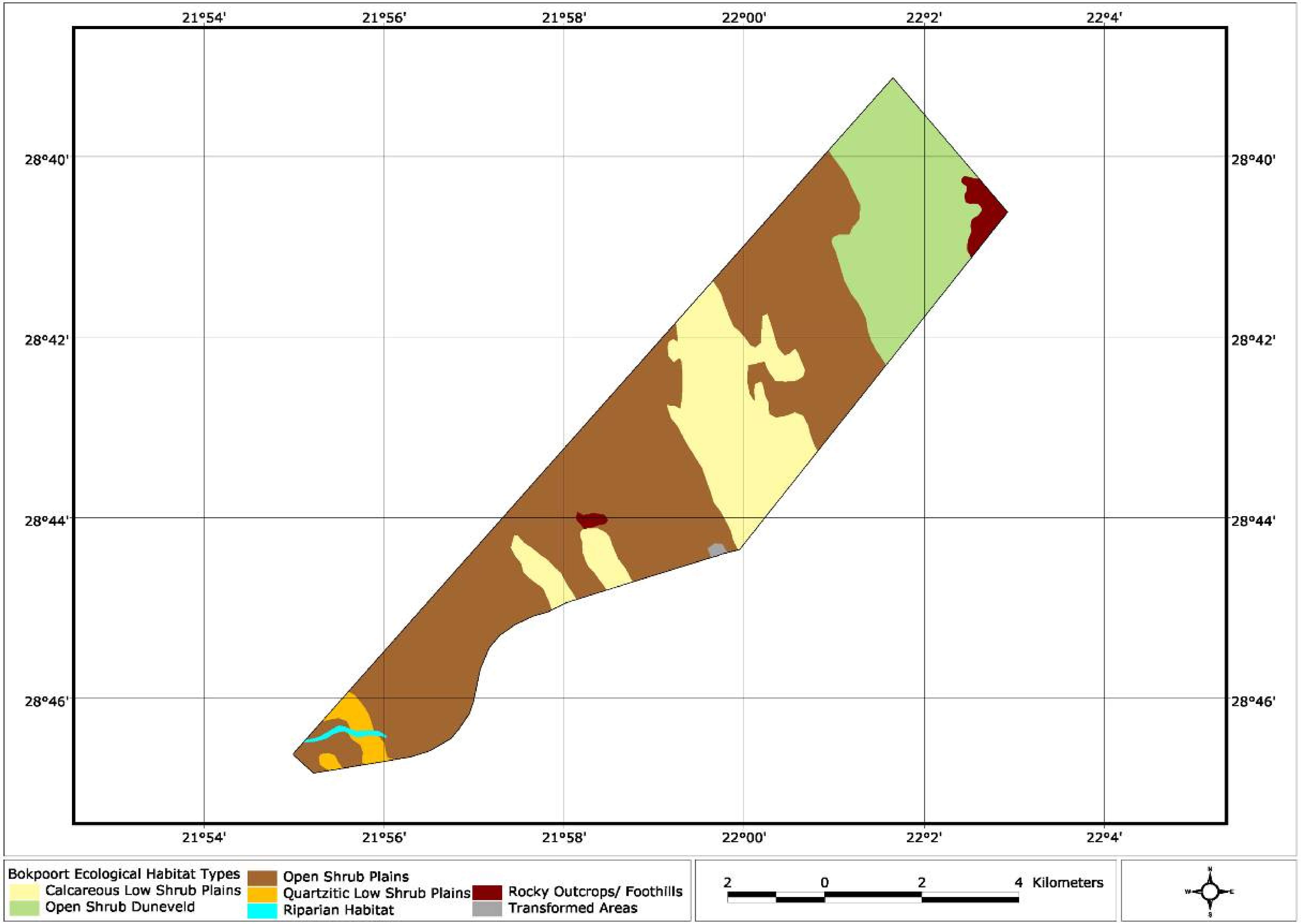


Figure 63: Ecological habitat types

Calcareous Low Shrub Plains

This unit comprises approximately 905.73 ha (18.94%) of the study area. The topography of these areas are characterised by relative flat or slightly undulating plains where the substrate comprises whitish calcareous and compact sandy soils (grey to brown, not red). The vegetation is characterised by low shrubs and grasses; tall shrubs and trees are generally absent from this unit, or occur at extremely low intervals. Prominent species include the grasses *Enneapogon desvauxii*, *Eragrostis obtusa*, *Eragrostis truncata*, *Fingerhuthia africana*, *Stipagrostis ciliata*, the shrub *Salsola etoshensis* and the forbs *Pentzia calcarea*, *Eriocephalus spinescens*, *Monechma genistifolium* subsp. *australe*, *Geigeria* species. The shrubs *Rhigozum trichotomum* and *Lycium horridum* were observed in this unit.

The status of these areas appears to be relatively degraded due to high grazing pressure and a moderate status is therefore ascribed.

Open Shrub Duneveld

This unit comprises approximately 1 538.11 ha (32.16%) of the study area. The major physiognomic attribute of this unit is the presence of low dunes with characteristic crests, slopes and streets. Each of these units could be described as a variation of this unit on the basis of distinctive habitat attributes and species composition, but for the purpose of this investigation, they are considered holistically as they always occur in association with each other.

The physiognomy conforms to an open tree savanna. Dominant species include the tree *Acacia mellifera* and the grass *Schmidtia kalahariensis*. Other prominent woody species are *Acacia haematoxylon*, *Parkinsonia africana*, *Rhigozum trichotomum*, *Boscia albitrunca* and *Acacia erioloba* and occasionally *Lycium bosciifolium*. Besides *Schmidtia kalahariensis*, the grass layer is characterised by *Eragrostis lehmanniana*, *Centropodia glauca*, *Stipagrostis amabilis*, *Brachiaria glomerata*, *Stipagrostis obtusa* and *S. ciliata*. Herbs that are found in this unit include *Hermannia tomentosa*, *Hermbstaedtia fleckii*, *Requienia sphaerosperma*, *Dicoma capensis*, *Momordica balsamina* and the climber *Pergularia daemia*.

The presence of the grass species *Schmidtia kalihariensis* is generally accepted as an indicator of high utilisation pressure. This habitat type is representative of the Gordonia Duneveld vegetation type (Mucina & Rutherford, 2006) and is in a relative good condition. A moderate status and moderate-high sensitivity is therefore ascribed to this unit due to the association with dune habitat.

Open Shrub Plains

This habitat type comprises the largest part of the study area, approximately 2,168.18 ha (45.33%). Biophysical attributes include open plains (flat or slightly undulating) with high shrubs and scattered trees on deep sandy, red soils or gravel plains and a well-developed herbaceous layer.

The species diversity is relative low; only 24 species were observed during the survey period. Prominent tall woody species in this undulating landscape are *Acacia erioloba*, *A. mellifera*, *Parkinsonia africana*, *Grewia flava* and *Boscia albitrunca*. Low shrubs include *Lebeckia linearifolia*, *Lycium bosciifolium*, *Rhigozum trichotomum* and *Salsola etoshensis*. Conspicuous grass species include *Schmidtia kalahariensis*, *Eragrostis lehmanniana* and *Stipagrostis ciliata*. Prominent forb species include *Monechma genistifolium* subsp. *genistifolium* and *Indigofera* species.

This habitat type is representative of the regional vegetation type Kalahari Karroid Shrubland (Mucina & Rutherford, 2006), which typically forms bands alternating with bands of Gordonia Duneveld. A moderate floristic status is ascribed to this unit.

Quartzitic Low Shrub Plains

This fairly unique habitat is situated in the southern part of the study area, comprising a small portion of the study area (71.87 ha, 1.50%) that is situated on plains of quartzitic stones where soils are shallow and stony. The vegetation of these areas conforms to a more succulent nature, with various succulents occurring exclusively in this habitat type. Although not noted during the survey period, the succulent *Hoodia* species, also occurs in this unit. Other succulents include *Aloe claviflora*, *Kleinia longiflora*, *Cadaba aphylla*, *Anacampseros ustilata*, *A. albidiflora* and *Euphorbia* species. Prominent grasses include *Enneapogon desvauxii*, *Eragrostis* species, *Fingerhuthia africana* and *Stipagrostis obtusa*. Woody species are generally absent with only the low shrub *Salsola etoshensis* occurring regularly.

This habitat type is not representative of the regional vegetation type and therefore represents an atypical and important variation. A high floristic status and sensitivity is therefore ascribed.

Riparian Habitat

This habitat type is situated in the southern part of the study area, comprising approximately 16.5 ha (0.35%) of the study area. It conforms to drainage lines which are mostly non-functional during most parts of the year; only flowing for short periods after significant rains has fallen. The vegetation is dominated by a prominent tree layer, consisting of *Acacia mellifera*, *Ziziphus mucronata*, *Boscia albitrunca* and the invasive species *Prosopis glandulosa*. The herbaceous layer is poorly developed with only the graminoids *Eragrostis porosa*, *Enneapogon scoparius*, *Setaria verticillata* and Cenchrus *ciliaris* occurring at relative high densities. The forb component comprises the weedy species *Pentarrhinum insipidum*, *Berkheya* species, *Flaveria* bidentis and *Kyphocarpa angustifolia*.

In spite of a poor floristic status, a high sensitivity is ascribed due to the association with riparian conditions. This habitat also frequently occurs in close vicinity to the Quartzitic Low Shrub Plains habitat type.

Rocky Outcrops/ Foothills

This habitat type occurs in the far northern section of the study area, comprising approximately 75.88 ha (1.59%) of the study area. The major physiognomic characteristic of this unit is the prevalence of rocks/ boulders, rendering the appearance of the unit extremely rugged. This unit probably forms part of the southern outliers of the Langeberg Mountain group. Soils in this unit are characteristically shallow and poor in nutrients. All other habitat types had little or nor rock cover and deeper soils. The species composition compares well to the Koranna-Langeberg Mountain Bushveld described by Mucina and Rutherford (2006). The physiognomy is an open tall shrubveld; a prominent herbaceous stratum with interspersed tall shrubs, bushes and low trees is observed.

This unit was found to be in an extremely pristine condition and, due to the association with high slopes, are generally regarded as sensitive.

A moderate species diversity was noted (27 species) with a relative equal distribution of herbs, grasses and shrubs. The shrubs *Croton gratissimus* and *Searsia burchelli* appears prominently in this unit. Prominent grasses include *Cymbopogon pospischilii*, *Aristida* species, *Digitaria eriantha*, *Enneapogon scoparius*, *Cenchrus ciliaris* and *Stipagrostis ciliata*. Prominent forbs include Asparagus species, *Geigeria* species, *Indigofera* species and *Thesium* species.

Transformed Areas

No natural vegetation remains in this area, and a low floristic status is ascribed.

- **Flora Species of Conservation Importance**

PRECIS data from SANBI indicate no Red Data flora species present within the quarter degree grids in which the study area is situated. However, the following species of conservation importance are known to occur in the region, or was observed in the study area (Table 35).

Table 35: Conservation important flora species for the region

Species	Family	Threat status
***Acacia erioloba*†**	**Fabaceae**	**Protected Tree (National Forest Act, 1998)**
***Acacia haematoxylon*†**	**Fabaceae**	**Kalahari Endemic**
Anthephora argentea*	**Poaceae**	**Regionally important (VEGMAP)**
***Boscia albitrunca*†**	**Capparaceae**	**Protected Tree (National Forest Act, 1998)**
Cucumis heptadactylus	Cucurbitaceae	SA Endemic
Digitaria polyphylla	Poaceae	Regionally important (VEGMAP)
Dinebra retroflexa	Poaceae	Regionally important (VEGMAP)
Dinteranthus pole-evansii	Mesembryanthemaceae	Regionally important

Species	Family	Threat status
		(VEGMAP)
Haworthia venosa subsp. tessellata	Asphodelaceae	SA Endemic
Helichrysum arenicola*	**Asteraceae**	**Regionally important (VEGMAP)**
Heliophila remotiflora	Brassicaceae	SA Endemic
Hyobanche sanguinea	Orobanchaceae	SA Endemic
Justicia puberula	Acanthaceae	SA Endemic, Regionally important (VEGMAP)
Justicia thymifolia	Acanthaceae	SA Endemic
Kohautia ramosissima	Rubiaceae	Regionally important (VEGMAP)
Larryleachia dinteri	Apocynaceae	Regionally important (VEGMAP)
Larryleachia marlothii	Apocynaceae	Regionally important (VEGMAP)
Lotononis oligocephala	Fabaceae	Regionally important (VEGMAP)
Megaloprotrachne albescens*	**Poaceae**	**Regionally important (VEGMAP)**
Nemesia maxii	Scrophulariaceae	Regionally important (VEGMAP)
Neuradopsis austro-africana*	**Neuradaceae**	**Regionally important (VEGMAP)**
Pharnaceum viride	Molluginaceae	SA Endemic
Ruschia kenhardtensis	Aizoaceae	Regionally important (VEGMAP)
Senecio intricatus	Asteraceae	SA Endemic
Stipagrostis amabilis ✝	**Poaceae**	**Kalahari endemic**
Tridentea dwequensis	Asclepiadaceae	Regionally important (VEGMAP)
Zygophyllum lichtensteinianum	Zygophyllaceae	SA Endemic

*** -** Species indicated in **black bold** are regarded likely inhabitants of the study area, taking cognisance of the habitat available.
[+] - Species in **red bold** were observed in the study area.

- **Alien and Invasive Species**

Invading alien organisms pose the second largest threat to biodiversity after direct habitat destruction (UNEP, 2002). Invasive species are a threat to indigenous species through the following mechanisms:

- Displacement by direct competition;
- Reduction of structural diversity;
- Disruption of the prevailing vegetation dynamics;
- Impacts on fire regimes due to increases in biomass;
- Alteration of local hydrology; and
- Modification of nutrient cycling (Van Wilgen and Van Wyk, 1999).

CARA (2001) makes provision for four groups of problem plants:

- Declared weeds (Category 1 plants) – alien species prohibited on any land or water surface in South Africa; must be controlled or eradicated where possible;
- Declared invaders (Category 2 plants, commercial and utility plants) – alien species allowed only in demarcated areas providing there is a permit and that steps are taken to prevent their spread;
- Declared invaders (Category 3 plants, ornamentals) – alien species that may no longer be planted; existing plants may remain provided that all reasonable steps are taken to prevent their spread; prohibited within the floodline of watercourses and wetlands; and
- Declared indicators of bush encroachment – indigenous species that under certain circumstances e.g. overgrazing may cause bush densification.

The following species occur in the study area:

Table 36: Declared invasive and exotic flora species for the study area

Species	Threat Status
Prosopis glandulosa	Category 2 Invader
Rhigozum trichotomum	Declared indicator of encroachment
Acacia mellifera	Declared indicator of encroachment

- **Floristic Sensitivity**

Floristic sensitivity estimations are presented in Table 37 and illustrated in Figure 64.

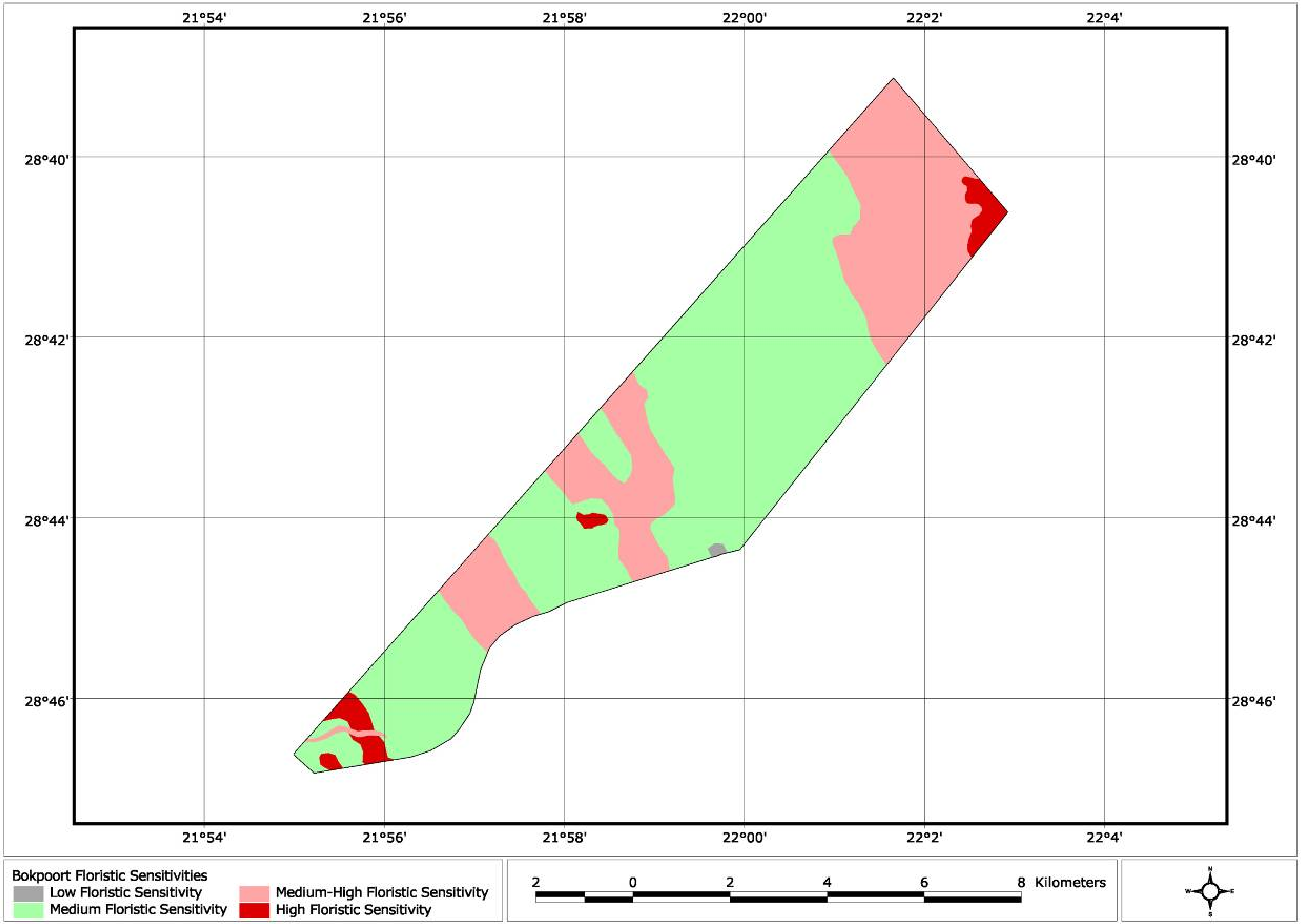


Figure 64: Floristic sensitivities of habitat types within the study area

Table 37: Floristic sensitivity for the respective habitat types

	Criteria	Sensitivity Class
Community	Calcareous Low Shrub Plains	Medium
	Open Shrub Duneveld	Medium-High
	Open Shrub Plains	Medium
	Quartzitic Low Shrub Plains	High
	Riparian Habitat	Medium-High
	Rocky Outcrops/ Foothills	High
	Transformed Areas	Low

6.2.9.3 Fauna

- **General Diversity**

Invertebrates

The invertebrates observed in the study area during the field investigation attested to a healthy, functioning ecosystem on the microhabitat as well as source-sink population dynamics scales. A total of 12 butterflies were observed in the study area; most of these species are common and widespread; if not in Southern Africa then in the drier western regions of the subcontinent.

It is highly likely that many other species will complement the observed assemblage of butterflies should the study be repeated in early summer (the only flight time of some Lepidoptera groups, notably Lycaenidae). The drier western regions of South Africa have significantly fewer butterflies than the wetter east; consequently the number of species observed during the field survey (given timing of the survey as well geographic location of the study area) confirms the untransformed and un-fragmented nature of the study area.

Herpetofauna

During the field study, the presence of eight reptiles was confirmed to occur in the study area by means of observation techniques as well as by the landowner. Species confirmed by the landowner included well-known species such as Cape Cobra and Puff Adder; these species are easily identifiable and changes of erroneous identification are unlikely. No frogs were observed during the field investigation and is regarded to reflect the combination of the dry nature of the habitat (there are far fewer species in the Northern Cape than for instance in KZN) and the timing of the field investigation (if the study is repeated after the first spring rains it is expected that at least a couple of species would prove to reside in the study area).

Mammals

A total of 25 mammals were confirmed in the study area during the field investigation. Various of the species were confirmed as residents of the study area by the landowner. It must be noted that many of the ungulate species listed for the proposed development site are a direct result of the hunting-related activities of the farm on which the study area is located; they cannot be considered free-roaming and are fenced in for hunting purposes.

Listed species that should not be considered free-roaming include Njala, Red Hartebeest, Blue Wildebeest, Waterbuck, Gemsbok and Springbok.

During the small mammal trapping (using baited small mammal live traps), the Red Data species *Tatera leucogaster* (DD), Bushveld Gerbil, was confirmed in the Open Shrub Duneveld of the study area. The species is relatively widespread in the region of the study area and sandy soils of the subcontinent.

The study area proved to have a significant number of carnivores including Bat-eared Fox, Cape Fox, Slender Mongoose, Yellow Mongoose, Suricate, Caracal, Striped Polecat and Black-backed Jackal. This is testament to the diversity and functionality of the ecosystem of which the study areas forms part of.

- **Red Data Fauna Assessment**

As a result of restrictions with regards to database availability only specific faunal groups are used during the red data aspect of this faunal assessment. Data on the Q-degree level is available for the following faunal groups:

- Invertebrates: Butterflies (South African Butterfly Conservation Assessment – http://sabca.adu.org.za);
- Amphibians: Frogs (Atlas and Red Data Book of the South Africa, Lesotho and Swaziland);
- Reptiles: Snakes and other Reptiles (South African Reptile Conservation Assessment - http://sarca.adu.org.za), and
- Mammals: Terrestrial Mammals (Red Data Book of the Mammals of South Africa: A Conservation Assessment).

Red Data fauna species known to be present in the quarter degree grids 2821DB, 2821DD and 2822CA in the above-mentioned databases were considered potential inhabitants of the study area. Additionally, species observed in the study sites during the field investigation were added to the list of species considered relevant to the study area. The likelihood of each species' presence in the study areas were estimated based on known ecological requirements of species; these requirements were compared to the ecological conditions found in the study area and surrounding faunal habitat.

- Linda's Hairtail is the only potential Red Data butterfly inhabitant of the study area. It is known from "only a few localities in Arid Savanna near Witsand, Northern Cape, near the Langeberge." There is no data on the larval host of this butterfly, but it is thought to potentially be Acacia erioloba. The species cannot be discounted as a potential inhabitant of the study area and is deemed to have at least a moderate likelihood of occurring in the study area;
- The Giant Bullfrog, *Pyxicephalus adspersus* (NT), is widespread in South Africa and is known from all nine provinces as well as Swaziland and Lesotho. It is known from the Savanna and Nama-Karoo biomes and is a potential inhabitant of the study area (it has been observed in the very dry Central Kalahari Game Reserve in Botswana – pers. obs.) and is considered to have a moderate-high probability of occurring in the study area;
- No Red Data reptiles are known from the quarter degree grids of the study area, and
- Two Red Data mammals were confirmed to occur in the study area: Bushveld Gerbil (DD) and Honey Badger (NT).

Table 38: Red Data fauna probabilities for the study area

Biological Name	English Name	Status	Probability
Lepidoptera			
Anthene lindae	Linda's Hairtail	Vulnerable	Moderate
Amphibians			
Pyxicephalus adspersus	Giant Bullfrog	Near Threatened	Moderate-High
Mammals			
Atelerix frontalis	South African Hedgehog	Near Threatened	High
Crocidura cyanea	Reddish-grey Musk Shrew	Data Deficient	Moderate
Elephantulus intufi	Bushveld Elephant-shrew	Data Deficient	High
Equus zebra hartmannae	Hartmann's Mountain Zebra	Endangered	Low
Mellivora capensis	Honey Badger	Near Threatened	Confirmed
Myosorex varius	Forest Shrew	Data Deficient	Low
Paratomys littledalei	Littledale's Whistling Rat	Near Threatened	Moderate-Low
Petromys typicus	Dassie Rat	Near Threatened	Moderate-Low
Rhinolophus darlingi	Darling's Horseshoe Bat	Near Threatened	Moderate-Low

Biological Name	English Name	Status	Probability
Rhinolophus denti	Dent's Horseshoe Bat	Near Threatened	Moderate
Tatera leucogaster	Bushveld Gerbil	Data Deficient	Confirmed

- **Faunal Habitat Sensitivities**

The close relationship between vegetation units and specific faunal composition has been noted in several scientific studies. For the purpose of this investigation the floristic units identified in the floristic assessment are considered representative of the faunal habitat types. For a description of the habitat structure and physiognomy, the reader is therefore referred to Section 8 of this document.

Faunal habitat sensitivities are subjectively estimated based on the following criteria:

- Habitat status;
- Connectivity;
- Observed species composition & RD Probabilities, and
- Functionality.

The faunal sensitivities are presented in Table 39 and Figure 65.

Table 39: Faunal habitat sensitivities for the study area

	Criteria	Sensitivity Class
Community	Calcareous Low Shrub Plains	Medium
	Open Shrub Duneveld	Medium
	Open Shrub Plains	Medium-Low
	Quartzitic Low Shrub Plains	Medium-High
	Riparian Habitat	High
	Rocky Outcrops/ Foothills	High
	Transformed Areas	Low

Habitat types that exhibit high faunal sensitivities frequently exhibit habitat characteristics that are associated with wetlands, pristine terrestrial habitat and the presence of Red Data species in these areas are generally confirmed or a high likelihood is ascribed to the potential presence of such species.

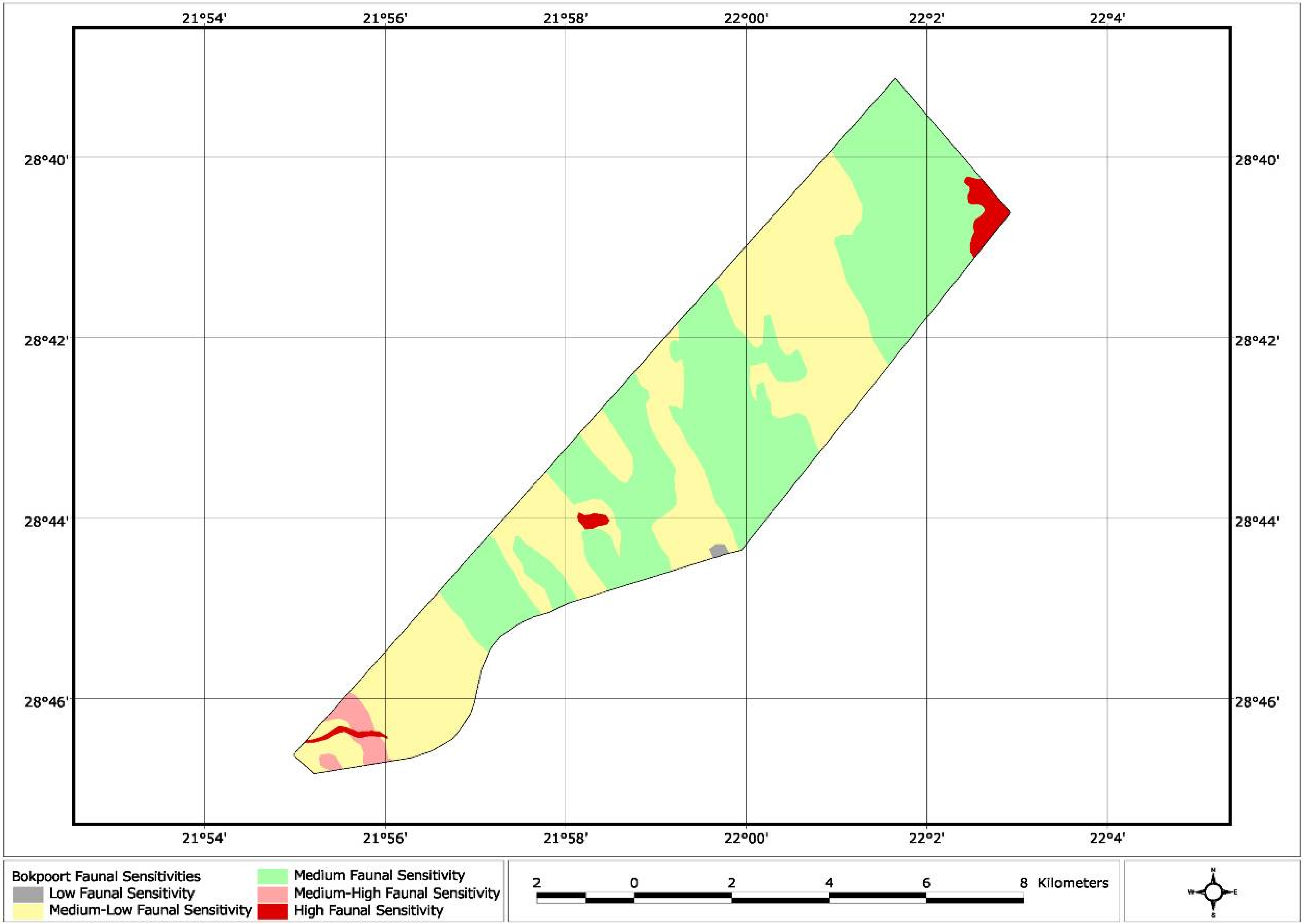


Figure 65: Faunal sensitivity of the study area

- **Discussion - Fauna**

The study area includes diverse, unfragmented faunal habitats that are natural and untransformed in nature and represent well-functioning ecosystems that are also well-connected to adjacent regions of large, natural faunal habitat characteristic of the Savanna and Nama-Karoo of the Northern Cape Province in South Africa. This is reflected in the species richness and – diversity of the animals confirmed for the study area (by personal observation and confirmation of the landowner), including five red data species (two mammals and three birds).

However, the faunal habitats of the study area represent regional vegetation communities that are largely untransformed and not considered to be under threat. The Bushmanland Arid Grassland (99.4% remaining), Gordonia Duneveld (99.8% remaining), Kalahari Karroid Shrubland (99.2% remaining) and Koranna-Langeberg Mountain Bushveld (99.9% remaining) are all listed as Least Threatened (VEGMAP, 2006). The study area investigated does not represent a significant portion of the remaining untransformed areas of any of these regional vegetation communities; indeed the larger region in which the study area is located remains largely natural and well-connected. It can be reasoned that the proposed project and associated impacts are unlikely to influence any animal species, assemblage or community significantly based on above-mentioned facts.

The relative sensitivities of the faunal habitats are based on the potential impacts of the proposed project on the faunal communities of these habitats relative to each other. For instance, it is estimated that the impacts of the proposed project are more likely to be significant with regards to the faunal assemblages limited to the riparian and ridge (rocky outcrops) habitat found in the study area than those of the Open Shrub Plains and Open Shrub Duneveld. Riparian and ridge faunal assemblages (mostly of invertebrates, birds, reptiles and frogs) are intrinsically limited in space and are therefore naturally vulnerable to habitat degradation and transformation processes. With regards to mammals, one of the most important impacts (albeit an indirect impact potentially associated with the proposed project) is the increase in road traffic volumes and associated road kills.

These habitat types are often associated with environmental features that are also generally regarded as sensitive, such as riparian zones aquatic regions and rocky outcrops.

6.2.9.4 Ecological Interpretation

Respective results of the floristic and faunal sensitivity analysis are combined to present an overview of the ecological sensitivity of the study area.

In order to present the reader with an indication of the ecological sensitivity of the respective communities, the highest sensitivity for each ecological unit is selected as being representative of the ecological sensitivity of the specific ecological unit. Results are determined in Table 40 and visually presented in Figure 66.

Table 40: Ecological sensitivity of the study area

	Criteria	Floristic	Faunal	Ecological
Community	**Calcareous Low Shrub Plains**	Medium	Medium	Medium
	Open Shrub Duneveld	Medium-High	Medium	Medium-High
	Open Shrub Plains	Medium	Medium-Low	Medium
	Quartzitic Low Shrub Plains	High	Medium-High	High
	Riparian Habitat	Medium-High	High	High
	Rocky Outcrops/ Foothills	High	High	High
	Transformed Areas	Low	Low	Low

The extent of respective sensitivity classes are presented in Table 41.

Table 41: Extent of ecological habitat sensitivities within the study area

Sensitivity Class	Extent	Percentage
Low ecological sensitivity	6.67 ha	0.14%
Medium ecological sensitivity	3073.9 ha	64.27%
Medium-High ecological sensitivity	1538.11 ha	32.16%
High ecological sensitivity	164.29 ha	3.43%

Combined results from the floristic and faunal sensitivity analysis indicate the high sensitivity of the areas associated with wetland regimes and rocky outcrops. The status of these areas is moderately pristine and are therefore considered suitable habitat for a variety of Red Listed flora and fauna species. These areas are relative small, comprising small portions of the study area. A medium-high ecological sensitivity is exhibited by the natural duneveld of the study area, particularly as a result of the likely presence of several Red Data species and the high suitability of these areas for Red Data species.

The largest extent of the study area exhibit low and medium sensitivity ecological attributes and the proposed activity is not expected to result in significant impacts in these areas.

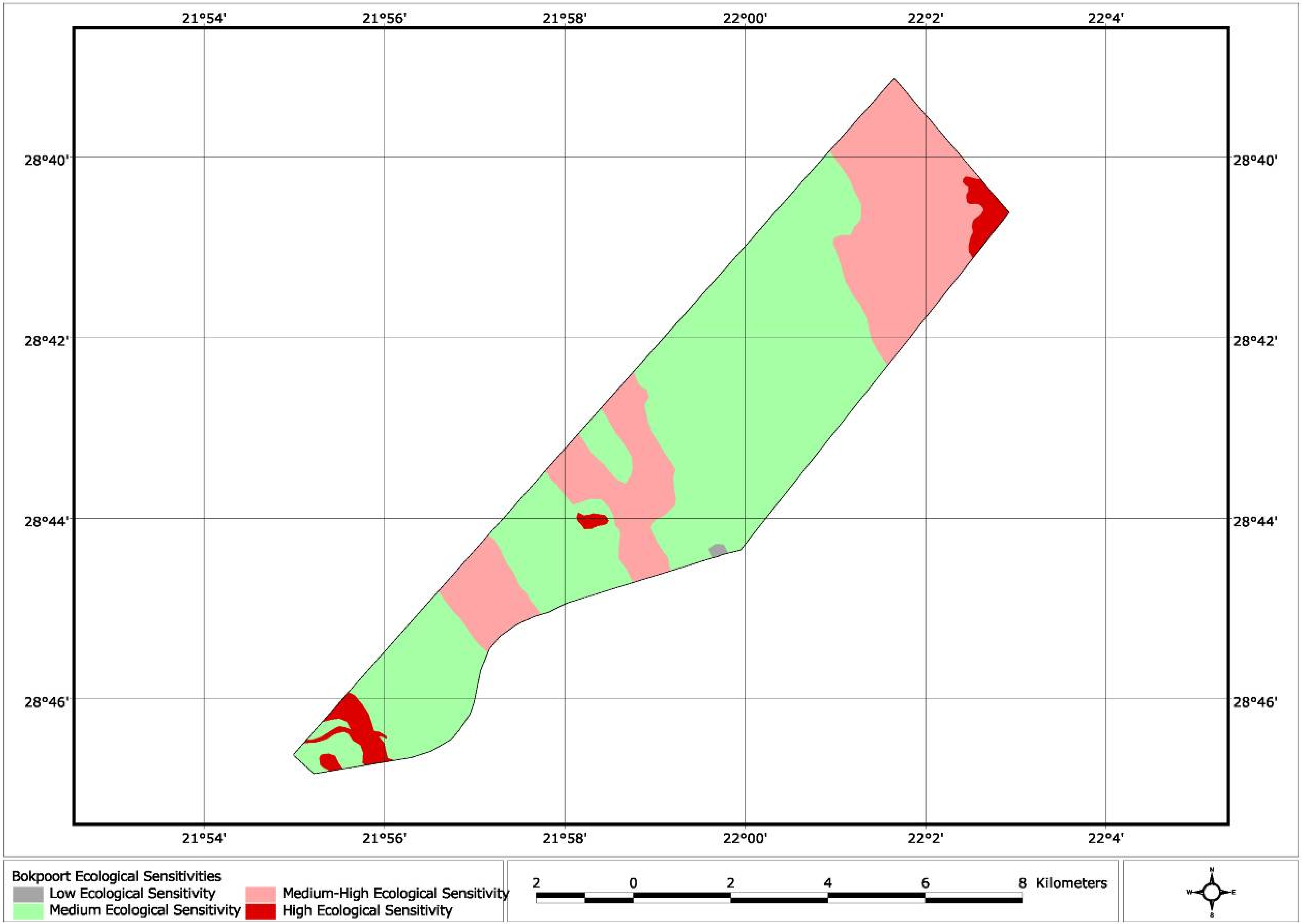


Figure 66: Ecological sensitivity of the study area

6.2.10 Avifauna

An Avifaunal Impact Assessment was undertaken and compiled by Chris van Rooyen of Chris van Rooyen Consulting

*Refer to **Appendix F** for the Avifauna Report.*

6.2.10.1 Review of Potential Avifaunal Issues

The solar thermal power industry is growing rapidly with 1.2GW under construction as of April 2009 and another 13.9GW announced globally through 2014. Spain is the epicentre of solar thermal power development with 22 projects for 1,037 MW under construction, all of which are projected to come online by the end of 2010. In the United States, 5,600 MW of solar thermal power projects have been announced. In developing countries, three World Bank projects for integrated solar thermal/combined-cycle gas-turbine power plants in Egypt, Mexico, and Morocco have been approved (Wikipedia, accessed 28 April 2010).

Despite the growing popularity of solar power, an extensive review of the available literature on the internet relating to avifaunal interactions at solar energy power plants revealed very little. Possible reasons for this include the following:

- Little knowledge exists relatively few plants have been constructed to date; currently there are only twenty operational solar thermal power stations in the world (Wikipedia, accessed 28 April 2010), and
- It may be that the impacts of solar power plants of this type on avifauna are in fact minimal, therefore the lack of available literature on the subject.

Only one paper entitled “Avian mortality at a solar energy power plant” (McCrary, McKernan, Schreiber, Wagner & Sciarrotta 1986) dedicated to the impacts of solar energy plants on birds was found. This describes the results of monitoring at the experimental Solar One solar power plant in southern California (now de-commissioned), which is a 10 megawatt, central receiver solar power plant consisting of a 32 ha field of 1818, 6.9m x 6.9m mirrors (heliostats) which concentrates sunlight on a centrally located, tower-mounted boiler, 86m in height. The key findings are summarized below:

- Forty visits (one week apart) to the facility over a two year period revealed 70 bird carcasses involving 26 species. It was estimated that between 10 and 30% of carcasses were removed by scavengers in between visits, so the actual figure may have been slightly higher. It is important to note that extensive agricultural lands and evaporation ponds were situated adjacent to the facility, which probably resulted in a higher abundance of many bird species than would otherwise have been the case.
- Fifty seven (81%) of these birds died through collision with infrastructure, mostly (>75%) the heliostats. Species killed in this manner included waterbirds, small raptors, gulls, doves, sparrows and warblers.

- Thirteen (19%) of the birds died through burning in the standby points. Species killed in this manner were mostly swallows and swifts.

The following potential avifaunal issues have been identified with regard to CSP plants, based on international experience and the author's knowledge of bird behaviour of species occurring at the site of the proposed CSP plant:

6.2.10.2 Issues Relating to the CSP Plant

- **Collision with trough mirrors**

Reflective surfaces are particularly prone to collisions in the same way as household windows. Monitoring at Solar One revealed that 81% of mortalities were through collision, mostly (>75%) with heliostats.

- **Burning when in vicinity of receiver tube of trough mirrors**

The receiver tubes located at the focal point of the trough mirror will glow white hot when the plant is operational which might potentially result in birds in the vicinity being burnt – however one would question why birds would fly close enough to this structure to be burnt. It is more likely that the heat given off would become uncomfortable and would deter the birds long before they get close enough to be burnt.

- **Loss of habitat**

The CSP will take up an area of approximately 350 ha. This is obviously habitat that was previously available to the birds in the area. In this Northern Cape landscape where habitat is so uniform and largely untransformed this is not anticipated to be a significant impact.

- **Nesting of Sociable Weavers on the plant infrastructure**

Experience in this arid region has shown that Sociable Weavers are quick to nest on any manmade infrastructure. It is hoped that the constant movement of the trough mirrors and the regular cleaning and maintenance activities will prevent this from becoming an issue – but close monitoring will still be required.

It is however, important to stress at this stage that most of the above impacts will probably only become significant when large numbers of birds are in the vicinity of the CSP plant for some or other reason. For example if one swallow was burnt in a focal point this would hardly be considered significant. However, if a large flock of swallows congregated for some reason – perhaps due to a nearby roost site – a large number of birds could be burnt and the impacts significance would be greatly amplified. For this reason, the more sensitive species in terms of the above impacts are likely to be the gregarious, flocking species e.g. sandgrouse flocking near a water point.

6.2.10.3 Issues Relating to Associated Plant Infrastructure

It is possible that the impacts of the associated infrastructure such as overhead powerlines on birds may actually outweigh the impacts of the CSP plant itself, depending on the length of new infrastructure that needs to be constructed. In evaluating the two alternative sites during the scoping phase, the proximity of each site to existing power line infrastructure was given considerable weight. The closer the final site is to the existing network, the shorter the new power line will need to be.
The following potential impacts have been identified:

- **Collision with associated power line infrastructure**

This is not a new impact and has been well documented – this author has extensive experience assessing and mitigating for collision of birds with overhead cables.

- **Electrocution on associated power line infrastructure**

The new power line is likely to be 132 kV in size and the most likely pylon structure would then be the steel monopole. Electrocution on this structure is unlikely to be an issue for any species with the possible exception of vultures.

- **Nesting on associated power line infrastructure**

Species such as crows, Sociable Weavers, and various raptors may take advantage of the nesting substrate that power line provides, particularly in this largely treeless landscape. The extent to which this occurs will depend on the exact pylon structure that is used.

6.2.10.4 Issues or Factors That May Attract Birds to the Vicinity of the CSP

In this relatively uniform landscape, large congregations of birds are unlikely unless a strong attractant exists, particularly surface water.

- **Birds attracted to surface water**

In arid landscapes, any source of water is hugely important for all animals including birds. If the CSP plant operations involves any open water sources such as evaporation ponds, or is located near any surface water, this will attract more birds into the immediate area thus heightening the risk of the above impacts occurring. At this stage it is unclear whether these ponds would be needed for the CSP. McCrary et al (1986) found a number of water birds (teal, grebes, coots) that had collided with heliostats at Solar One and this is almost certainly related to the presence of large (53 ha) evaporation ponds nearby. This is supported by the fact that 45% of all species recorded in 150 ha around Solar One, were only recorded at the ponds. The importance of the evaporation ponds at Solar One to birds is further illustrated by the fact that 107 bird species were recorded in the vicinity of Solar One, whilst the avian community in similar habitat elsewhere is usually less than 20 species. It is clear then that the presence of open water (including seasonal waterbodies such as pans which are present on Bokpoort) close to the CSP plant could drastically alter the potential for avifaunal impacts. Open water at Bokpoort may attract many species, including storks, raptors and sandgrouse.

- **Birds mistakenly attracted to trough mirrors**

In arid regions the daily activity schedule of many animals and birds revolves around securing their required daily intake of water. For example, sandgrouse fly in flocks to water sources during mid to late morning, and many raptors descend to open water to bath and drink. There is a possibility that birds such as these may mistake the heliostats for water sources when flying high above and descend to investigate. In the case of the sandgrouse, they would typically circle several times once they have located a water sources, before descending. If the heliostats are mistaken for water, these birds could then be circling in the region of the focal points, in the case of a tower plant, and may well be burnt to death – however, this would not apply to the trough plant under consideration as there would be no focal points outside of the parabolic troughs.

6.2.10.5 Limitations

The following are some issues relating to the limitations of this study and the confidence with which this report is submitted:

- In assessing the impacts of the associated infrastructure such as the new power line, an extensive body of published literature is available, and the author has 13 years experience in dealing with this type of impact. However, with regard to the impacts of the CSP plant itself, this is largely new territory – quite possibly the case for all consultants on this project. With the exception of the one paper already cited, very little information on avifaunal impacts at solar plants could be found. The level of confidence with which the various impacts are assessed is therefore relatively low. However it must also be stated that many of the impacts discussed above cannot readily be mitigated in any case or practical mitigation measures will only become apparent in the course of post-construction monitoring of the facility. Ideally, if the CSP plant is built, regular monitoring by a suitably experienced ornithologist should take place in order to gather data on avifaunal impacts. This data would make assessment of future solar plants much more accurate;
- Unfortunately, neither of the two Southern African Bird Atlas Projects (Harrison et al 1997; http://sabap2.adu.org.za) covered this area very well at all as can be seen from the number of cards for each square. This results in a very low confidence in the report rates of the various species in the study area. Since no other reliable source of data for abundance of species exists, a comparison of abundance of species between the two sites was not possible;
- The site visits involved physically examining only a limited proportion of the farm. Factors relating to avifaunal impacts may vary considerably within the site, especially rainfall, as this is a rain driven ecosystem with conditions varying dramatically depending on the level of rainfall – which introduces a level of uncertainty. However,

this was countered to some extent by the availability of satellite images from Google Earth indicating the presence of landscape features such as drainage lines and seasonal pans, as well as the author's extensive experience of erratic conditions in the Kalahari;

- It is clear that the presence of open water near the facility could greatly aggravate the impact on avifauna as it could potentially change the abundance and diversity of bird life in the vicinity. At this stage of the project, the proponent has not yet finalized this level of detail, making it difficult to make accurate assessments. However, seasonal waterbodies and drainage areas were identified from Google Earth satellite images, and
- Likewise, the exact position and nature of the associated infrastructure such as pipelines, power lines and roads cannot be finalized until an exact site is chosen, and the proponent reach this level of detail in their planning. Since this infrastructure could potentially have a greater impact on avifauna than the CSP itself, these details will have to be finalized and the impacts thereof assessed more thoroughly at a later stage.

6.2.10.6 Avifauna in the Study Area

- **Criteria for the identification of priority species**

The following criteria were applied to identify key bird taxa that might potentially be affected by the CSP plant:

- Nationally threatened species, i.e. species listed in the Red Data book of birds of South Africa, Lesotho and Swaziland (Barnes 2000);
- Taxa listed under provisions of relevant legislation that provide protection for particular categories of taxa whether threatened or not. This includes international treaties. From an international perspective, the Convention on Biological Diversity (1992) is applicable, of which South Africa is a signatory. The overall objective of the Convention is the "…conservation of biological diversity and the sustainable use of its components and the fair and equitable sharing of the benefits…". Another international convention which is applicable is the Convention on the Conservation of Migratory Species of Wild Animals (http://www.unep-aewa.org). This Convention, commonly referred to as the Bonn Convention, (after the German city where it was concluded in 1979), came into force in 1983. The goal of the Convention is to provide conservation for migratory terrestrial, marine and avian species over the whole of their range. This is very important, because failure to conserve these species at any particular stage of their life cycle could adversely affect any conservation efforts elsewhere. The fundamental principle of the Bonn Convention therefore, is that the Parties of the Bonn Convention acknowledge the importance of migratory species being conserved and of Range States agreeing to take action to this end whenever possible and appropriate, paying special attention to migratory species, the conservation status of which is unfavourable, and taking individually or in co-operation appropriate and necessary steps to conserve such species and their

habitat. Parties acknowledge the need to take action to avoid any migratory species becoming endangered. Agreements are the primary tools for the implementation of the main goal of the Bonn Convention. Moreover, they are more specific than the Convention itself, involve more deliberately the Range States of the species to be conserved, and are easier to put into practice than the whole Bonn Convention. One such agreement is the African-Eurasian Waterbird Agreement, (AEWA) is an international agreement aiming at the conservation of migratory waterbirds;

- Taxa naturally occurring at low densities because of their ecological function high in the trophic order. This primarily relates to taxa like raptors that are top-order predators;
- Taxa that have special cultural significance, and
- Any other taxa that regulatory authorities require to be considered for a particular site such as species not included in the categories above but for which the site is especially significant e.g. Kalahari and Karoo near-endemics.

- **Habitat**

The Northern Cape region is one of the most arid in southern Africa. In examining the region as a whole in terms of avifauna, it is important to relate the avifauna to the biomes and vegetation types present in the area. Harrison et al (1997) in “The Atlas of Southern African Birds” provide a description of the various vegetation types represented in the region and the associated bird species. It is widely accepted that vegetation structure, rather than the actual plant species, influences bird species distribution and abundance (in Harrison et al 1997). Therefore, this vegetation description focuses on factors which are relevant to bird distribution and is not a complete account of plant species.

The table below indicates the vegetation types (Harrison et al 19997) in the quarter degree grid cells (the equivalent of 1:50 000 map units) which overlaps with the boundaries of the study site at Bokpoort.

Table 42: Vegetation types in the study area (Harrison et al 1997)

Biome	Vegetation type	2822CA	2821DD	2821DB
Nama karoo	Nama karoo	-	99	67
Woodland	Southern Kalahari	100	1	33

The Nama karoo biome comprises mainly low shrubs and grasses, trees such as Acacia karoo and exotic species such as *Prosopis glandulosa* are restricted to watercourses. Compared to “Succulent Karoo”, “Nama Karoo” has a much higher proportion of grass and tree cover. The term “karoo” (used loosely to mean both “Nama” and “Succulent Karoo”) supports a particularly high diversity of species endemic or near-endemic to southern Africa. Avifauna characteristically comprises ground dwelling species of open habitats. The tree lined watercourses allow penetration of several species typical of arid woodland such as the Kori Bustard, Martial Eagle and Tawny Eagle; the latter two species probably also benefited from the nesting substrate offered by transmission lines. Several species are almost entirely confined to the “Nama Karoo” such as the Red Lark, Sclater’s Lark, Karoo Korhaan and Ludwig’s Bustard.

The Woodland biome covers much of the northern and eastern parts of the country and is defined as having a distinct grassy under story and a woody upper story of trees and shrubs. Tree cover can range from sparse such as in the southern Kalahari, to almost closed. The more arid woodland types such as the Kalahari vegetation types are typically fine leaved and dominated by acacias and typically occur on nutrient rich, often alluvial soils in the western regions. Central Kalahari is characterized by sparse to dense shrubland on deep Kalahari soils, grass cover is variable and dependant on rainfall. Southern Kalahari consists of open shrubland on deep Kalahari sands and again, grass cover is variable and dependant on rainfall.

Avifauna of the Kalahari vegetation types is characteristic, with many species that occur in the moister woodlands avoiding the Kalahari, probably due to the absence of surface water. At the same time there are no species truly endemic to the Kalahari, most of them also spread to other woodland types. Two species which have their ranges centred on the Kalahari however, are the Fawn-coloured Lark (*Calendulauda africanoides)* and Kalahari Scrub - Ro in *Cercotrichas paena*, representing possibly the closest to endemic species of the Kalahari.

Although much of the distribution and location of bird species within the study area can be explained by vegetation as discussed briefly above, it is necessary to look more closely at the habitats available to birds, namely the micro-habitats, in order to determine where the relevant species will most likely occur within the study area. These micro-habitats do not always correspond to vegetation types and are determined by a combination of vegetation type, topography, land use, food sources and other intrinsic factors.

Investigation of this study area revealed the following critically important bird micro-habitats:

<u>Ephemeral drainage lines</u>

The southern part of the study area contains several ephemeral drainage lines which drain into the Orange River, These watercourses usually hold water briefly after good rains. The drainage lines are important for Kori Bustard, as they are inclined to forage in them, attracted by the shade of the Acacia trees that grow on these river courses. These channels are also important micro-habitat for Secretarybirds that sometimes breed on small Acacia trees in the river courses. After good rains, the standing water in the river bed may attract various Red Data species, including Black Stork as well as large raptors such as White-backed Vulture, Lappet-faced Vulture, Tawny Eagle and Martial Eagle that visit these pools to drink and bath. Namaqua Sandgrouse is also attracted to all standing water. Apart from Red Data species, many non-threatened species also make use of the drainage lines for the same reason, including waterbirds covered by international treaties.

Pans

The study area contains seasonal pans which hold water for a while after rainfall and this dynamic makes them a significant attraction to birds at those times, in much the same manner as the ephemeral drainage lines (see preceding paragraph).

Priority species

The table below shows the list of priority species, using the criteria stated above that have been recorded in the quarter degree grid cells overlapping with the study area. The following acronyms are used to indicate the potential use of the habitat by a species.

- Woodland (southern Kalahari) = SK;
- Nama Karoo = NK;
- Ephemeral drainage lines = ED, and
- Pans = P

The following acronyms are used to indicate conservation significance:

- V = Vulnerable (Barnes 2000);
- NT = Near threatened (Barnes 2000);
- AEWA = Listed under the African-Eurasian Waterbird Agreement;
- Ra = Raptor, and
- SS = Special regional significance.

Table 43: Priority species identified in the study area

Species	Scientific name	Conservation Status	Habitat
Grey Heron	*Ardea cinerea*	AEWA	**ED, P**
Black-headed Heron	*Ardea melanocephala*	AEWA	**ED, P**
Goliath Heron	*Ardea goliath*	AEWA	**ED, P**
Cattle Egret	*Bubulcus ibis*	AEWA	**ED, P**
African Sacred Ibis	*Threskiornis aethiopicus*	AEWA	**ED, P**
Egyptian Goose	*Alopochen aegyptiacus*	AEWA	**ED, P**
Black-shouldered Kite	*Elanus caeruleus*	Ra	**SK**
Booted Eagle	*Aquila pennatus*	Ra	**NK, SK, ED, P**

Species	Scientific name	Conservation Status	Habitat
African Fish-Eagle	*Haliaeetus vocifer*	Ra	**ED, P**
Southern Pale Chanting Goshawk	*Melierax canorus*	Ra	**NK, SK, ED, P**
Secretarybird	*Sagittarius serpentarius*	Ra, NT	
Red-knobbed Coot	*Fulica cristata*	AEWA	**ED, P**
Kori Bustard	*Ardeotis kori*	V	**NK, SK, ED**
Ludwig’s Bustard	*Neotis ludwigii*	V	**NK, ED**
Lappet-faced Vulture	*Torgos tracheliotus*	Ra, V	**SK, ED, P**
Three-banded Plover	*Charadrius tricollaris*	AEWA	**ED, P**
Crowned Lapwing	*Vanellus coronatus*	AEWA	**NK, SK**
Wood Sandpiper	*Tringa glareola*	AEWA	**ED, P**
Pied Avocet	*Recurvirostra avosetta*	AEWA	**ED, P**
Black-winged Stilt	*Himantopus himantopus*	AEWA	**ED, P**
Namaqua Sandgrouse	*Pterocles namaqua*	SS	**NK, SK, ED, P**
Fawn-coloured Lark	*Calendulauda africanoides*	SS	**SK**
Sociable Weaver	*Philetairus socius*	SS	**SK**
Martial Eagle	*Polemaetus bellicosus*	Ra, V	**SK, NK, ED, P**
Lanner Falcon	*Falco biarmicus*	Ra, NT	**NK, SK, ED, P**
Black Stork	*Ciconia nigra*	V	**ED, P**
Verreaux's Eagle	*Aquila verreauxii*	Ra	**NK, ED, P**
Abdims’ Stork	*Ciconia abdimii*	NT	**NK, SK, ED, P**
Jackal Buzzard	*Buteo rufofuscus*	Ra	**NK, SK, ED, P**
Sociable Weaver	*Philetairus socius*	Ss	**SK**
Kalahari Scrub-Robin	*Cercotrichas coryphoeus*	Ss	**SK**
Barn Owl	*Tyto alba*	Ra	**NK, SK**

Species	Scientific name	Conservation Status	Habitat
Spotted Eagle-Owl	*Bubo africanus*	Ra	**NK, SK**
Pearl-spotted Owl	***Glaucidium perlatum***	**Ra**	**SK**

6.2.10.7 Site Specific Impacts Associated with the CSP Plant

- **Collision with trough mirrors**

This is likely to impact on birds, but the extent to which it will occur is unknown at this stage. The impact on bird populations worldwide through them colliding with windows of buildings has been well documented (see www.flap.org). At Solar One, 81% of bird mortalities were through collision with structures, with >75% of these collisions having occurred with the heliostat mirrors themselves (McCrary et al 1986).

- **Burning when in vicinity of receiver tube of trough mirrors**

It seems unlikely to be a significant impact as birds would presumably be repelled by the heat before they get within burning range. Research at Solar One did not detect any mortalities through this mechanism (McCrary et al 1986).

- **Loss of habitat**

Approximately four square kilometres will be taken up by the CSP plant in total. The vegetation in this area will be partially cleared. Construction activities on site will flatten and impact on certain areas of vegetation even if it is not cleared. It should be noted that the heliostats might also create new habitat for birds. Cape Sparrows (*Passer melanurus*) might build nests on them, and (possibly) Sociable Weavers. The latter species commonly nests on electricity structures, including the Ferrum – Garona 275 kV line that runs through Bokpoort (*pers. obs.*). It cannot be stated with certainty if the species will be attracted to the heliostats, but the possibility cannot be excluded. It is unlikely that the larger species mentioned in this paragraph will be significantly adversely affected by the construction of the plant from a habitat destruction perspective. Due to the mobility of the larger species, they could conceivably move out of the immediate area and forage elsewhere in similar habitat. The species that are most likely to be affected by the loss of habitat are the smaller species that are currently resident in that 2.5km^2 of vegetation.

6.2.10.8 Site Specific Impacts Associated with CSP Plant Infrastructure - Powerlines

- **Collision with power lines**

Collision of large terrestrial birds with overhead power lines is likely to occur and is anticipated to be the most significant threat posed by associated infrastructure. Species most likely to be affected are bustards, korhaans and other large terrestrial species. The significance of this impact depends on the length of new line to be built (Van Rooyen 2004).

- **Electrocution of birds on pylons**

The extent and likelihood of this potential impact will depend entirely upon the exact pylon structure for the new line – which has not yet been decided. Electrocution risk is determined by the phase-phase and phase-earth clearances on a pole structure which differ greatly between different structures (Van Rooyen 2004). Again, if the structure used is dangerous to birds, the significance of this impact will vary with the length of the line.

- **Nesting of birds on pylons**

The additional nesting substrate offered by the electricity line could be viewed as a positive impact on avifauna (particularly large raptors and Sociable Weavers), but may impact negatively on the quality of electrical supply by causing electrical faults. In the case of Sociable Weaver nests, the nest material may pose problems to the pylons structural integrity through added weight, and there is an increased fire risk due to the fuel load of these massive nests.

- **Habitat destruction**

The habitat construction caused by the construction of the electricity line is likely to occur, as the servitude needs to be cleared of vegetation that could potentially interfere with the quality of supply. This is particularly the case with large trees, which may have to be removed. If large trees are removed, it will impact on potential nesting substrate for birds, including large raptors and Sociable Weavers.

6.2.10.9 Site Specific Impacts Associated with CSP Plant Infrastructure - Roads

- **Disturbance of avifauna**

This may occur to some extent, especially during the construction phase. There is already a gravel district road through the farm and it is therefore unlikely that extensive new roads would be required, but this will depend on the exact site of the CSP within the farm, which is not known at this stage.

- **Habitat destruction**

The road construction will have some impact on avifaunal habitat, but as discussed elsewhere it is unlikely that the larger species mentioned in this paragraph will be significantly adversely affected by the construction of the plant and associated infrastructure from a habitat destruction perspective. Due to the mobility of the larger species, they could conceivably move out of the immediate area and forage elsewhere in similar habitat. The species that are most likely to be affected by the loss of habitat are the smaller species with smaller home ranges, e.g. Kalahari Scrub-Robin.

6.2.11 Aquatic Biodiversity

Bohlweki-SSI Environmental appointed EnviRoss CC to undertake an aquatic biomonitoring and impact assessment survey of the water abstraction point along a section of the Orange River. The aim of the survey was to ascertain the present ecological state (PES) of the river and the potential aquatic ecological impacts that would emanate from a development of this nature at the proposed abstraction point. This was ascertained during a field survey undertaken in June 2010.

*Refer to **Appendix F** for the Aquatic Assessment Report.*

6.2.11.1 Methodology

Standard, DWAF-endorsed bio-monitoring protocols and methodologies were followed for the aquatic survey for all of the sites that are based on the nationally-implemented River Health Programme. The outline of the ecological indicators that were utilised in order to ascertain the ecological integrity of the various study sites are outlined in Table 44.

Table 44: Various components of the ecological indicators selected for characterisation of the aquatic and associated riparian site

Ecological indicators	Measurable ecological components.
Stressor indicators	*In situ* water quality
Habitat indicators	General habitat assessment; Index of Habitat Integrity (IHI); Integrated Habitat Assessment System (IHAS)
Response indicators	Aquatic macro-invertebrates (SASS v5); Ichthyofauna

- **Habitat characterisation**

The assessment of the physical habitat characteristics of an aquatic system that are available for inhabitation by aquatic fauna plays an important role in determining whether a particular site is inhabitable or not. This is an important aspect to consider when interpreting the biological data that are gathered at each study site. An example of this aspect is that a system with good water quality and poor habitat availability will show poor aquatic faunal inhabitation, whereas a system with good water quality and good habitat availability will show a diverse aquatic faunal species community structure. Therefore, habitat evaluations are as important in interpreting aquatic ecological integrity of a site as the determination of the water quality.

In river systems with variable-use catchment areas, the use of the Integrated Habitat Assessment System (IHAS) is regarded as being an important habitat evaluating tool. The IHAS is aimed at determining the instream habitat integrity for suitability for aquatic macro-invertebrate inhabitation (coupled to SASS5 data). A reason why the IHAS tool (together with the SASS5 protocols) are regarded a being reliable aquatic ecological integrity indicators is that aquatic macro-invertebrates are highly mobile within a system as the majority of the taxa have adult terrestrial life-stages capable of flight. Therefore, periodically impacted stretches of river systems are rapidly recolonised when the negative impact disappears.

The IHAS methodology recognises three major biotopes within aquatic systems. These include:

- Stones (including stones in current, stones out of current and bedrock);
- Gravel, sand & mud (both in current and out of current); and
- Vegetation (including aquatic, emergent and marginal, both in current and out of current).

The IHAS evaluates the quality and quantity of these three major biotopes and this is expressed as a percentage score per site. It is further split into Sampling habitat (constituting 55% of the total IHAS score rating) and Stream condition (constituting 45% of the total IHAS rating).

The use of the IHI (Index of Habitat Integrity) is a generalised habitat evaluation tool that is modified slightly to make it more applicable to the various study sites as many aspects of the IHI are undeterminable due to unknown factors that fall outside of the scope of the survey. Only applicable aspects of the IHI will therefore be reported on.

- **Vegetation and general riparian area**

The abstraction site was inspected on foot for a distance both upstream and downstream of the actual study site. General readily-observable indicators of ecological integrity were noted. This was aimed at evaluating potential soil erosion, refuse dumping within the riparian zones, encroachment of exotic vegetation, etc.

- **Water quality**

The *in situ* water quality of all of the aquatic biomonitoring sites were taken using a Hanna model 9828 multiparameter water quality meter. These data are important to the interpretation of the biological data that are gathered during the sampling at the various sites. The parameters that were recorded were: dissolved oxygen (%), Oxygen content (mg/ℓ), pH, TDS (ppm), electro-conductivity (EC) (µS/cm) and temperature (°C).

- **Site categorisation and classification**

The ecological state of a stretch of a river is compared to a reference state, which is regarded as the ideal ecological state of a river within a similar river reach as the study site. The ecological state model allows for the classification of the system according to various combinations of index scores (Dallas, 2007). To ensure applicability, a reference state model was created that takes into account the natural variations that river reaches within similar geographical area are subjected to. The reference state model most applicable to the rivers of the Nama Karoo Lower Ecoregion is presented in Table 45.

Table 45: Eco-classification model for determining the Present Ecological State for Nama Karoo Lower rivers, based on SASS5 and ASPT* scores (adapted from Dallas, 2007)

SASS5 Score	ASPT	Description	Class
>108	>6.0	**Excellent/Unimpaired.** Community structures and functionality comparable to the best situation that can be expected. This is the optimum community structure for stream size and habitat quality.	A
101-108	5.6-6.0	**Very Good/Minimally impaired.** Largely natural with few modifications. A small change in community structure may have taken place, but ecosystem functionality remains essentially unchanged.	B
76-100	5.4-5.5	**Good/Moderately impaired.** Community structure and function less than the reference condition. Community composition lower than expected due to loss of some sensitive taxa. Basic ecosystem functionality remains predominantly unchanged.	C
33-75	4.7-5.3	**Fair/Largely impaired.** Fewer taxa presented than expected due to loss of sensitive species. This is indicative of a loss of basic ecosystem functionality.	D
<33	<4.7	**Poor/Seriously impaired.** Few aquatic taxa are present due to loss of most of the sensitive species. This is indicative of an extensive loss of basic ecosystem functionality.	E/F

*ASPT = Average Score per Taxon.

- **Biological Sampling**

Aquatic macro-invertebrate sampling

Benthic macro-invertebrate communities of the selected sites were investigated according to the South African Scoring System, version 5 (SASS5) approach (Dickens & Graham, 2001). This method is based on the British Biological Monitoring Working Party (BMWP) method and has been adapted for South African conditions by Dr. F. M. Chutter (Thirion et al., 1995). The SASS5 method is a rapid, simple and cost effective method, which has progressed through four different upgrades/versions.

Ichthyofauna

The assessment of fish community structures is often a useful tool in ascertaining the ecological integrity of a river system as fish represent a different trophic level to aquatic macro-invertebrates and, whereas aquatic macro-invertebrates are indicators of short term stressors, fish are indicators of more long term impacts on a system. The fish community structure is, however, very often governed by factors other than local habitat integrity and water quality. The presence or absence of fish in a river reach is largely determined by natural cyclic seasonal factors, often leading to the absence of fish at a site during the winter season. Other reasons for poor fish species representation at a particular site is the lack of accessibility to the specific reaches due to instream migratory barriers. Whereas aquatic macro-invertebrates are capable of overcoming many of these barriers due to morphological adaptations, fish often cannot and are consequently excluded from colonising a river reach upstream of a migratory barrier. These barriers are often in the form of low-level bridges, gauging and other weir structures, dam walls, culverts, etc. Rivers and streams that have highly urbanised catchment areas (especially) are well-known to suffer greatly from this impact. Therefore, the absence of fish species within certain study sites is not necessarily an indication of poor localised habitat or water quality, but may be due to migratory barriers that are often located relatively far downstream of the study site. A desktop survey of both upstream and downstream habitat through review of topographical maps, aerial photographs and available GIS data was undertaken prior to undertaking the field survey in order to pinpoint the closest major migratory barriers relevant to the project.

Fish were sampled throughout the study area to determine the fish community structures within the river reach associated with the various proposed development areas. Fish were surveyed with the use of electro-narcosis and cast-netting as sampling techniques. Electronarcosis makes use of an electric current that is passed through the water that induces a temporary narcotic and paralysed state in the fish. The fish can then be netted using hand-held nets and placed into a bucket away from the electrical current. The different species are then identified and measured, to later be released back into the system. This collection method is regarded as the most effective collection technique for riverine habitat where the physical habitat and hydrology allows for it where the water does not exceed wading depth. Deeper and faster-flowing waters were sampled using cast-netting.

6.2.11.2 Site Specific Findings

Site description

A high-level railway bridge is site in close proximity to the proosed abstraction site. The bridge pillars / supporting structures are mainly placed on islands occurring within the river channel. The macro-channel incorporates a series of islands within the area of the proposed site, therefore increasing the habitat diversity at the site. This site is in addition not impacted by extrinsic sources.

The surrounding area is dominated by agriculture, which relies on the river for irrigation water. This bridge therefore has a minimal impact on the river system at present.

Habitat characterisation

- Integrated Habitat Assessment System (IHAS)

Habitat integrity and water quality forms the basis for aquatic faunal inhabitation. Assessing the habitat integrity therefore forms the basis for accurate data interpretation following the biological sampling of a system. The Instream Habitat Assessment System (Version 2) (IHAS) (McMillan, 1998) is a habitat evaluation tool used in conjunction with the SASS5 methodology. Table 46 presents the results from the IHAS application at all of the biomonitoring sites.

The IHAS score is presented as a percentage – with 100% representing ideal habitat quality. It is therefore thought that a score of above 65% indicates good habitat quality (green); 55-64% indicates adequate habitat quality (blue). A score of less than 55% indicates poor habitat quality (red) and is regarded as being a limiting factor to aquatic macro-invertebrate inhabitation. A score of above 65% represents a biomonitoring site that has adequate representation of all the major biotopes, whereas a score of between 55 and 65% is indicative of a sampling site that lacks adequate representation of certain biotopes or biotopes of poor quality. A score of less than 55% is indicative of the complete lack of certain biotopes or biotopes of critically modified or transformed biotopes.

Table 46: Results from the IHAS survey conducted at each site

IHAS			Description
Sampling habitat (55)	Stream condition (45)	Total (%)	
57	24	81	**Good**

The abstraction site was dominated by deep, slow-flowing water, with the substrate being dominated by sand and mud. Furthermore white waters were obsereved at a section of the site which greatly improved the instream habitat integrity. The IHAS score indicated 'good' habitat quality (Table 46).

The full details for the IHAS score sheets are presented in ***Appendix F***.

- Index of Habitat Integrity (IHI)

Another procedure for assessing habitat integrity is the Index of Habitat Integrity (IHI). This tool was developed as a rapid habitat assessment tool that evaluates the general and readily-observable perceived impacts on a specific river segment in the field. This index takes riparian habitat as well as instream aquatic habitat into consideration. Table 47 presents the results from the application of the IHI to all of the sites surveyed.

Table 47: Results of the IHI after application at each survey site

Instream habitat quality (Impact score out of 25)		
Primary		
Criteria	**Weight**	**Score**
Water abstraction	14%	5
Flow modification	13%	5
Bed modification	13%	5
Channel modification	13%	6
Water quality	14%	2
Inundation	10%	1
Sub Total:	**77%**	**12.64**
Secondary		
Exotic macrophytes	9%	2
Exotic fauna	8%	5
Solid waste disposal	6%	2
Sub Total (75):	**23%**	**2.8**
Instream habitat integrity (%):	**100%**	**85**
Instream habitat integrity class:		**B**

Riparian zone habitat integrity (Impact score out of 25)		
Indigenous vegetation removal	13%	8
Exotic vegetation encroachment	12%	2
Bank erosion	14%	2
Channel modification	12%	2
Water abstraction	13%	5
Vegetation inundation	11%	1
Flow modification	12%	5
Water quality	13%	2
Total:	**100%**	**13.68**
Riparian habitat integrity score (%):		**86.32**
Riparian habitat integrity class:		**B**
Total integrity score (%):		**85**
Total integrity class:		**B**

From Table 47, the results of the IHI indicate that the proposed abstraction site presently do not suffer from habitat modification and degraded habitat quality due to anthropogenically-induced features. The site is largely representative of unimpacted habitat. The vastness of the river channel at the site contributes greatly to the significance of any impacts.

The IHI results do not concur entirely with the results of the IHAS due to the measurable impacts that each index represents – the IHAS focuses primarily on aquatic sampling habitat, whereas the IHI incorporates terrestrial riparian habitat as well and the extrinsic impacts on a system. Various priority weights are also designated in different impact areas that differ between the various indices and therefore the average values after application of all of the indices are ultimately regarded as the most accurate reflection of habitat integrity.

- Aquatic macro-invertebrate sampling

The results of the SASS5 (biological sampling) are presented in conjunction with the IHAS (habitat integrity) scores in Table 48. The instream habitat diversity was good at the proposed site and therefore the SASS5 scores were expected to be relatively good. Habitat quality at the the abstraction site can therefore not be regarded as a limiting factor to macro-invertebrate inhabitation.

Table 48: Results from the SASS5 sampling

SASS				IHAS Score
SASS score	No of Taxa	ASPT	Class	
116	21	5.5	A	83
48	11	4.4	D	51
85	16	5.3	C	81

The results from the SASS5 survey at the abstraction site showed that the aquatic macro-invertebrate community structures were representative of largely natural conditions. The ASPT score indicated that the site supported a community of organisms that are less tolerant to pollution.

- Ichthyofauna

A desktop review pertaining to distribution and habitat preference of fish species indicated that the proposed site has historical records of supporting various fish species (Kleynhans, 2007). This was cross-referenced to the available habitat units present at the site.

Table 49: Fish species expected to inhabit the river reach associated with the proposed development area

Species	Common name	FROC Sites
		140F5 Bokpoort
Austroglanis sclateri	Rock catfish	-
Barbus anoplus	Chubbyhead barb	-
Barbus paludinosus	Straightfin barb	2
Barbus trimaculatus	Threespot barb	-
Labeobarbus aeneus	Smallmouth yellowfish	2
Labeobarbus kimberleyensis	Largemouth yellowfish	-
Cyprinus carpio	Common carp	-
Clarias gariepinus	Sharptooth catfish	-
Labeo capensis	Orange River labeo	2

Species	Common name	FROC Sites 140F5 Bokpoort
Labeo umbratus	Moggel	-
Pseudocrenilabrus philander	Southern mouthbrooder	2
Tilapia sparrmanii	Banded tilapia	-

Table 49 presents the fish species that would potentially occur within the river reach associated with the survey area. These species have all been sampled at a reference site located downstream and upstream of the survey area (Kleynhans, 2007) at a site known as 140F5). These reference sites are known as FROC (Frequency of Occurrence) sites – refer to ***Appendix F*** for the FROC site locality map.

Species abundance and richness / diversity is rated as low at the proposed abstraction point. The greatest threat to the fish abundance and diversity of species from a development of this nature is the creation of migratory barriers when weirs are constructed for water abstraction points.

6.3 Social-Economic Environment

6.3.1 Social Assessment[48]

As part of the EIA Process for the proposed Eskom CSP EIA, a Social Impact Assessment (SIA) was contracted. The study was undertaken during 2006 by Afrosearch – a social consultancy firm based in Pretoria with extensive experience in the fields of sustainable development, public participation and impact assessment.

6.3.1.1 Definition of a Social Impact Assessment

This section provides a brief overview of the methodology employed for the Social Impact Assessment. According to the International Association for Impact Assessment (IAIA), "impact assessment, simply defined, is the process of identifying the future consequences of a current or proposed action"[49]. A social impact assessment (SIA) is therefore the process of assessing or estimating, in advance, the social consequences or changes that are likely to emanate from a proposed development. Significance is attributed to these consequences or changes, against the background of social impact variables.

[48] Bohlweki Environmental. 2006. *Environmental Impact Assessment for the establishment of a New Concentrating Solar Power (CSP) plant and associated infrastructure in the Northern Cape Province.*
[49] IAIA (2001), available on-line.

Two internationally widely applied definitions that are in line with, but expand upon the IAIA definition will be used to guide the present study. In this regard, Social Impact Assessment is defined as:

- *"A process aimed at identifying the future consequences for human populations of any public or private action that alters the way in which people live, work, play, relate to one another, organise to meet their needs, and generally cope as members of society".* [50]
- *"(An investigation into) the potential change in the activity, interaction and/or sentiment of the community, as it responds to the impacts resulting from the alteration in the surrounding social and biophysical environment" (Adapted from Burdge[51]).*

A SIA therefore attempts to predict the probable impacts of a development on individuals and communities and how one should deal with this change. The anticipated impacts that the development could have on the social environment are identified and listed, and issues that have to be addressed during future processes and studies, are highlighted. This enables the project proponent and community to jointly deal with possible negative changes in a pro-active and participative manner, and to determine which aspects need to be mitigated.

6.3.1.2 Purpose

The purpose of this report[52] is to provide an overview of the social assessment and indicate mitigation measures where relevant. Mitigation measures and recommendations on how to address these anticipated social impacts are provided. The report therefore aims to assist the project proponent, consultants and communities to identify issues that have to be considered during the construction and operational phases of the proposed project.

6.3.1.3 Scope

The social assessment reported in this chapter is partly focused on the impacts that the project is expected to have on the local social environment, where the latter is defined as the area delimited by the boundaries of the local municipality in which the development site is situated, the !Kheis Local Municipality. However, the assessment also takes a broader view by recognising the long-term, indirect social impacts that the power station is likely to have at a regional and even national scale. These large-scale social impacts mainly derive from the fact that, by constructing and operating the plant, South Africa stands to gain considerable experience and expertise in terms of the utilisation of solar power. Hence, the project represents a significant step towards reduced reliance on non-renewable energy sources – a step that has far-reaching implications in terms of environmental sustainability.

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[50] Becker, H. (1997) Social Impact Assessment: Method and Experience in Europe, North America and the Developing World. University College of London.
[51] Burdge, R.J. (2004). A community guide to social impact assessment. Middleton: Social Ecology Press.
[52] The findings, conclusions and recommendations contained in the report are based on the information supplied to the consultants.

6.3.1.4 Methodology

- **Data Gathering**

The assessment process was informed by the social characteristics of the area. As part of the data gathering process information was extracted from the relevant Integrated Development Plans (IDP), Stats South Africa as well as the specialist reports.

- **Site Visit**

The social consultants undertook a site visit to familiarise themselves with the study area and to observe the local social dynamics, as well as the general characteristics of the area.

- **Consultation**

Information was sourced from the consultation processes implemented as part of the environmental assessment process for the project

6.3.1.5 Overview

The study area is situated within the Siyanda District Municipality (DC8) which is one of the five District Municipalities located in the Northern Cape Province. Siyanda District Municipality (DC8) is situated to the north of the province and covers an area of 103 771 square kilometres with its borders aligned with Botswana and Namibia. This district municipality consists of six Local Municipalities.

The farm Bokpoort falls under the jurisdiction of the !Kheis Local Municipality and is located approximately 10km to the north west of Groblershoop in Ward 1. The proposed site is further sited within Ward 1 covering an area of 1040 square kilometres. The map below indicates the location of the Bokpoort site in relation to the wards and the boundaries of the local municipality within which it occurs. Furthermore the map indicates the location of the preferred site in relation to the candidate site Olyvenhouts Drift which was considered by Solafrica during the Scoping phase of the project.

The information in the subsequent sections have been extracted from the Social Scoping Assessment conducted by Afrosearch for the Eskom CSP project[53] as well as the Siyanda District Integrated Development Plan[54] and the !Kheis Integrated Development Plan[55].

[53] Bohlweki Environmental (on behalf of Eskom Holdings Limited). 2006. *Environmental Impact Assessment for the establishment of a New Concentrating Solar Power (CSP) plant and associated infrastructure in the Northern Cape Province.*
[54] Siyanda District Municipality. 2007. *Integrated Development Plan 2007/2008 – 2011/12.*
[55] !Kheis Local Municipality. 2005. *Integrated Development Plan.*

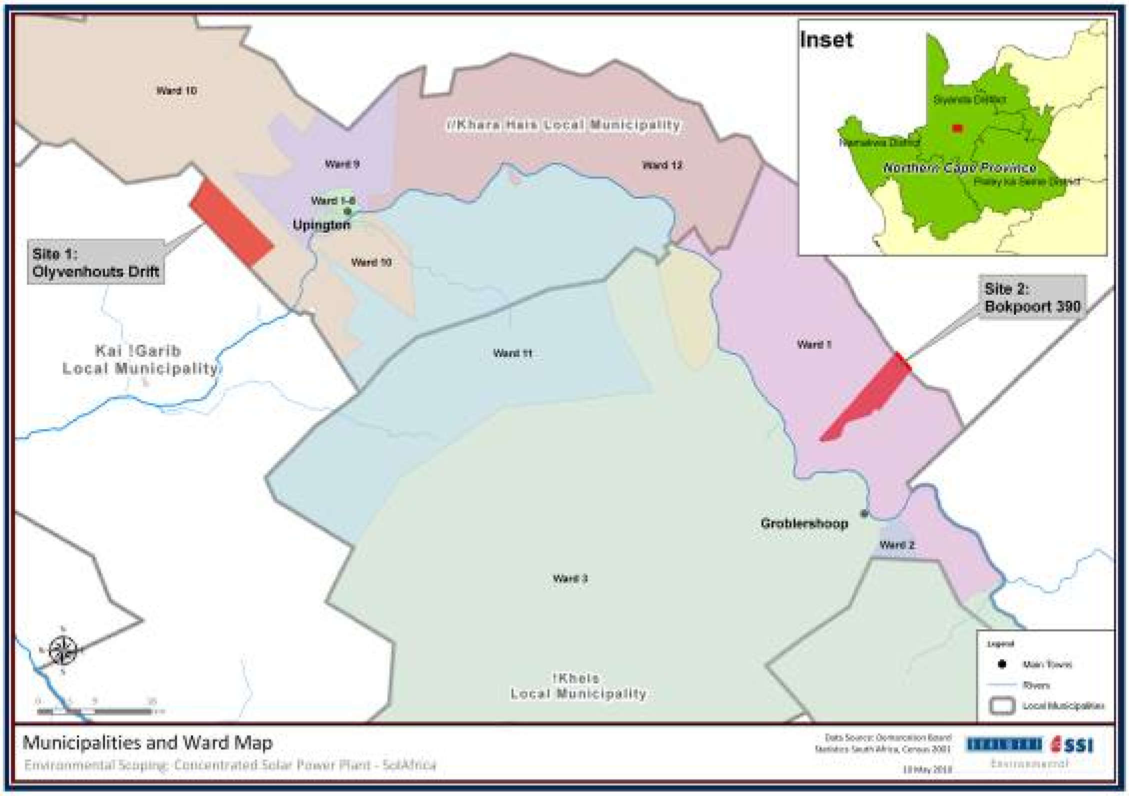

Figure 67: Jurisdictional map of the study area

- **Demographics**

The following paragraphs present an overview of the population density and composition, the age and gender distribution and the education levels of the populations residing in the !Kheis Local Municipality within the Siyanda District Municipality.

<u>Population</u>

The Northern Cape covers and area of 363 000 square kilometres with a population of approximately 823 000 (according to Census 2001 data) and a population density of just over 2 people per square kilometre. In 2001 just over 50% of that population consisted of Coloured individuals and a further 35% consisted of Africans.

According to the 2001 Census data, the total population of the Siyanda District Municipality is approximately 202 000, which may be equated to approximately a quarter of the total population for the Northern Cape Province. Correspondingly the racial distribution of the population is similar to that of the Northern Cape, with 64% Coloured and 24% African people, while the population density is exactly the same at 2 people per square kilometre.

The estimated population of !Kheis Local Municipality in 2001 was 16 027 people with the major ethnic group being Coloured, representing 86% of the entire !Kheis Local Municipality population followed by White (9.3%), Black (4.6%) and Indian/Asian (0.04%).

Table 50: Population of the !Kheis Local Municipality

Ethnic Group	!Kheis Local Municipality
African	743
Coloured	13784
White	1494
Indian/Asian	6
Total	**16027**

Age and Gender Distribution

The Northern Cape as a whole in 2001 had an approximately equal distribution of females and males with there being marginally more females than males. The highest population density for the Northern Cape fell into the age group 15 to 34 for females and males, more specifically 35% of the total male population and 34% of the total female population.

Similarly in the Siyanda District Municipality, the male and female population were largely equal in 2001 with there being about 5000 more females. Just over a third of the male and female population in Siyanda was observed to fall between 15 and 34 years of age. Of interest in relation to the given project may be the distribution of individuals between the ages of 15 and 64 as the sector of the population that is of the age to enter, act within or just be leaving the employment arena. In Siyanda 31% of the males and 33% of the females fell between the ages of 15 and 64.

Within the !Kheis Local Municipality, the sex structure is almost equal with 51% (8133) of the total population being female and the male population constitutes the remaining 49% (7894).

Approximately a third of the population in !Kheis Local Municipality is under the age of 15 (35%). This holds particular implications for future development planning as this section of the population will become economically active within the next 5 to 10 years. Within the local municipality, 27% of the population were aged between 35 to 64 years. Ward 1 within the !Kheis Local Municipality imitates the district age and sex distributions with up to a third of the female and male population falling into the 15 to 34 year age group. Correspondingly Groblershoop's population was made up of 34% 15 to 34 year olds followed by a fifth of the population aged between 35 and 64 and a further fifth aged between 5 to 14.

Education

In the Northern Cape as a whole, 30% of the population over 20 years of age (in 2001) have been educated up to a secondary level but have not obtained a Grade 12. In this population, 21% have some primary school education and 18% have no education.

The education level of over 20 year olds in Siyanda District Municipality in 2001 showed the majority of the population having done secondary schooling (30%) followed by 24% having done some primary school and 17% not having any form of formal education.

Within !Kheis Local Municipality there were fewer individuals over 20 years of age that have a secondary school education (23%) and the majority have some primary school education (30%). Approximately a fifth of the population did not have any education. Ward 1 within !Kheis Local Municipality had even lower levels of education amongst its population aged over 20, with a third having some primary education and 28% having no education. This can be compared to Groblershoop, where 28% of the population over 20 have had some primary education followed by 24% with a secondary education and 22% with no education at all.

- **Employment**

In the Northern Cape the total labour force was estimated to consist of approximately 313 000 or 38% of the total population with an aggregate of a third of the total labour force being unemployed in 2001.

Siyanda Local Municipality had a total labour force of roughly 83 000 of which 27% were unemployed.

The unemployment rate within the !Kheis Local Municipality stands at 20%. Ward 1 within !Kheis Local Municipality boasts half the rate of unemployment with 10% of the labour force without work. In contrast to this, Groblershoop has a 29% unemployment rate.

- **Sectoral employment**

The largest source of employment within Siyanda District Municipality in 2001 was agriculture with 42% of the employed labour force working within this sector. This is followed by community, social and personal employment occupying 14% of the employed labour force.

Agriculture remains the main source of employment for the labour force in !Kheis Local Municipality with up to 60% of the employed labour force engaged in such. Similarly within Ward 1 of !Kheis Local Municipality a large majority of 67% of the labour force is employed or is working within the agricultural industry while 8% of the labour force is working from private households. This differs significantly in Groblershoop as 24% of the employed labour force of 393 people works in wholesale and retail, followed by 18% in the agriculture sector and 17% working from private households.

- **Income**

Poverty appears to be a widespread problem in the Siyanda District Municipality with up to 60% of the total population not earning a monthly income in 2001. In addition this does not seem to be a stable figure, as this percentage has increased from 51% in 1996. Of those earning a salary a further 17% of the total population in the Siyanda District Municipality only earned between R400 and R800 a month.

This situation was reflected in the same way in !Kheis Local Municipality were the circumstances appear just as severe and two thirds of the population went without a monthly income along with 19% earning between R400 and R800 a month. Similarly just over half of the total population in Ward 1 within !Kheis did not earn a monthly income followed by 24% earning between R400 and R800 per month. Although the situation appears to be most severe in Groblershoop where up to 65% of the population did not earn a monthly income followed by 15% earning between R400 and R800 a month and 10% earning up to R400 a month.

- **Housing**

In the Siyanda District Municipality as well as the relevant Local Municipalities, the large majority of dwellings remained formal. This was also carried over to the wards with Ward 1 in !Kheis Local Municipality, which consisted of around 1 200 households. Of these, 78% lived in formal residences. The large majority of households within Groblershoop were also formal households. The majority of households in Siyanda have a size of 2 people per household with the average household consisting of 4 rooms. Within the !Kheis Local Municipality the average household was smaller, being made up of 2 rooms.

- **Services**

<u>Transport</u>

The main mode of transport for individuals living within the Siyanda District Municipality was by foot in 2001 with 62% of the individual needing to travel to work or school walking. This was followed by 10% being passengers in cars. In Groblershoop, 7636 members of the population travel to work or school every day. Of those people 69% walk, a further 8% were car passengers and 6% drive cars. This is particularly noteworthy for the potential labour force that may be used for the site, for some of them may be drawn from the closest town, namely Groblershoop but may have no means of getting to work outside of the town. Travel by foot holds as the prevailing means of transport for !Kheis Local Municipality and Ward 1 (60% of those going to work or school).

<u>Water and Sanitation</u>

Access to water within the Siyanda District Municipality was mainly via water inside the dwelling (36% of dwellings) or in the yard (44% of households) while a remaining majority of households obtained water from a community stand or a river/stream. While the relevant Local Municipality showing similar statistics, Ward 1 within !Kheis Local Municipality indicates that 37% of its households accessed water from their yards, while a further fifth accessed it in their dwellings and a fifth at the community stand. In Groblershoop, close to a half of the households got water from their yards and a further 21% had access to water in their dwelling and 14% obtained water from a community stand.

Within the Siyanda District Municipality, up to 58% of the total households had flush toilets, while 13% of households had no means of sanitation. In !Kheis Local Municipality, the majority (34%) of household have flush toilets, while 33% of households with no means to sanitation. However, the figures for Ward 1 differ notably from !Kheis Local Municipality's figures as a whole: a preponderance of 42% of the households not having any means to sanitation, while 31% the households have flush toilets.

- **Land Use Profile**

The area is predominantly agricultural. The main farming endeavour is sultana grapes. The vineyards are planted along both banks of the Orange River and are generally contained to an area close to the river (500 m to 1000 m). Other significant land uses in the area are:

- Residential:
  - The town of Groblershoop is located approximately 9 km south-east of the eastern boundary of the farm Bokpoort;
  - The urban settlement (township) of Wegdraai, which is located on the western side of the Orange River on the farm Boegoeberg 48;
  - Numerous farmhouses and farm labourer houses on the northern and southern banks of the Orange River. These are residences related mainly to the sultana grape farms;
  - The main farmhouse on Bokpoort is situated on a hill in the central portion of the farm; and
  - The main farmhouse on the farm La Gratitude is situated 5200 m east of the north-eastern corner boundary of Bokpoort.
- Educational: there is a school in Groblershoop and several farm schools in the area;
- Recreational: there is a golf course on the western side of Groblershoop; and
- Industrial: Eskom's Garona substation is located on the eastern boundary of Bokpoort 1800 m north-east of the Rooilyf siding on the Saldanha-Sishen railway line.

6.3.1.6 Assessment Findings

For the purposes of the assessment, the sphere of influence of the proposed power plant was subdivided into three parts: a macrosystem, a mesosystem and a microsystem. This classification was borrowed from the theory of human ecology (Bronfenbrenner, 1979), and is described more fully below:

Macrosystem	Social impacts pertaining to the *macrosystem* derive from the fact that the plant will boost the development of solar power technology. Thus, in the long run, it will help to reduce South Africa's dependence on non-renewable energy sources. It will therefore bring about significant environmental benefits – which, in turn, will have social repercussions in the form of an enhancement of human well-being. The proposed power

	plant will also have macroeconomic benefits by helping to meet South Africa's electricity demand.
Mesosystem	Social impacts pertaining to the *mesosystem* are those extending through all or part of the local municipality's area of jurisdiction. These impacts derive from the effects of the project on employment rates, demand for infrastructure and the like.
Microsystem	Impacts at the level of the *microsystem* are those brought about by the physical presence of plant and ancillary infrastructure, and are confined to the areas occupied by or directly adjacent to this infrastructure. Possible repercussions of the project at this level include changes in an area's sense of place, as well as potential impacts on health and safety. Impacts on land use (with a possible concomitant loss of productive assets) also sort under the category of micro-level impacts.

The potential impacts of the project on land use and on the social environment are graphically depicted in the figure below. These impacts are described in greater detail in the following sections.

- **Macro-level Impacts**

The project is likely to have significant long-term, indirect social impacts that may extend to a regional and even national scale. These large-scale social impacts derive from the experience in the utilisation of solar power that will be gained by constructing and operating the plant. This experience may be employed in the future construction of other, similar plants in South Africa. In addition, the project will impact on Eskom's capacity to supply electricity. Solafrica has indicated to potential technology vendors a strong intention for the use of local labour in construction- and preparation- related activities.

One of the most advantageous features of the proposed plant is its ability to potentially store thermal energy, which can then be used to generate electricity for a number of hours in the absence of sunlight. It can therefore be used to supplement electricity supply during peak demand hours effectively becoming baseload supply.

The social impacts derived from the environmental and economic benefits of increased reliance on solar power are discussed in greater detail below.

<u>Social Impacts Derived from Environmental Benefits of Solar Power</u>

A report by Greenpeace entitled Solar Thermal Power 2020 - Exploiting the Heat from the Sun to Combat Climate Change contains the following statement in its introductory section:

"The benefits of solar power are compelling: environmental protection, economic growth, job creation, diversity of fuel supply and rapid deployment, as well as the global potential for technology transfer and innovation. On climate change, a solid international consensus now

clearly states that business-as-usual is not an option and the world must move swiftly towards a clean energy economy. Solar thermal power is a prime choice in developing an affordable, feasible, global energy source that is able to substitute for fossil fuels in the sunbelts around the world." (Greenpeace, 2003, p. 2)

One of the major benefits of solar thermal power is that it has little environmental impact, with none of the polluting emissions or safety concerns associated with conventional electricity generation technologies. Estimates indicate that each square metre of CSP solar field surface is sufficient to avoid the annual emission of 200kg of carbon dioxide. Increased reliance on solar power can therefore help to slow the pace of global climate change.

Social Impacts Derived from Economic Benefits of Solar Power

Although the proposed plant could help to meet evening peak loads in South Africa, it will not bring about a reduction in energy prices over the short term. Indications are that CSP will cost more than Eskom's current price of coal power for the foreseeable future (SABRE-Gen, 2005).

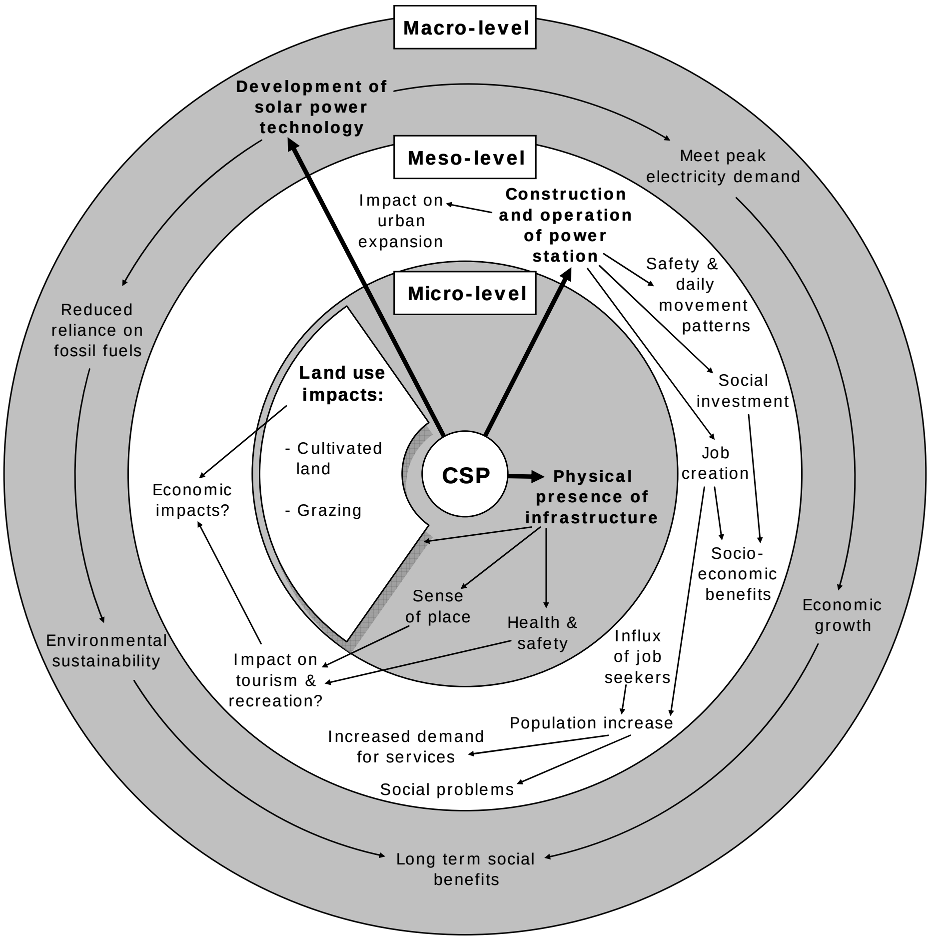

Figure 68: Overview of social and land use impacts

Over the longer term, with increasing shortages in fossil fuels, the economic benefits of solar power are likely to become more apparent. The cost of solar thermal power is already falling at a steady place. Experience from the Solar Electric Generating Systems (SEGS) in California shows that impressive cost reductions have already been achieved, with generation costs ranging today between 10 and 13 US cents/kWh. As more experience is gained in the utilisation of CSP technology, still greater cost-effectiveness is likely to be achieved (SABRE-Gen, 2005).

Based on the foregoing discussion, it is clear that increased reliance on solar power will have significant environmental and economic benefits over the long term. Both these effects will translate into social impacts in the form of increased human well-being and prosperity.

- **Meso-level Impacts**

Job Creation

Construction activities will create a number of temporary employment opportunities. The magnitude of this impact will depend on the number of construction workers to be employed, either by Solafrica itself or by contractors. Sourcing of construction workers from the local labour pool is likely to be limited to unskilled workers due to the highly technical nature of the work to be undertaken. This could have some economic benefits for surrounding communities, although only of a temporary nature.

The construction process is expected to last approximately 2 years*. At its peak, it will involve some 300 - 400 construction workers*. In total, between 1000 and 1500 jobs* will be created during the construction phase. It is the intention of Solafrica to use employment-intensive construction methods instead of traditional machine-intensive alternatives. Such methods increase the number of unskilled labourers under employ as well as introducing additional requirements for training and skills development.

In addition to creating job opportunities for construction workers, the project may also offer other sources of temporary employment. Indirect employment creation in the informal sector may also occur, for instance in terms of food stalls for the convenience of construction workers.

The operational phase of the power plant will result in the creation of approximately 60 employment opportunities*. Of these, approximately 20 will be unskilled jobs, 20 moderately-skilled jobs, and 20 highly skilled jobs.

Whether the benefits of these employment opportunities will accrue to surrounding communities will depend on whether those positions will be filled by local residents. This will, in turn, depend on whether the necessary skills are available in surrounding communities. It is the intention of Solafrica to fill as great a proportion as possible of employment positions with local residents.

It is the intention of Solafrica to also involve the local community directly with the project by including between 10% - 20% of local or regional ownership in the project through a Broad Based Black Economic Empowerment programme.

** The above figures are estimations.*

Influx of Job Seekers

As news regarding the proposed project spreads, expectations regarding possible employment opportunities may take root. Consequently, the area surrounding the site may experience an influx of job seekers. The magnitude of this impact will depend on the severity of unemployment in surrounding areas. As previously mentioned the unemployment rate within the !Kheis Local Municipalities stands at 20%. Furthermore, poverty is a widespread problem in the !Kheis Local Municipality.

Given these figures, it is likely that a large enough number of job seekers will flock into the area to having a fairly significant population impact on the immediate social environment. This population increase will impact on the local municipality in terms of additional demand for services and infrastructure.

This impact is listed below as a construction-related impact. However, it is possible that the impact may commence prior to construction, and may continue after construction has been completed. Contact between newcomers and locals could also create various social problems.

Increased Demand for Services

As was indicated above, the construction workforce will consist of between 1000 and 1500 workers, of which an undetermined percentage will be locals. Workers sourced from elsewhere would have to be housed reasonably close to the construction site or in a temporary construction village. It is highly likely that not all workers would be housed in a construction village, but some will reside in available lodgings in residential areas close to the site. The temporary construction village will mean that there will be very limited requirement on the local municipality to provide additional road or water and sanitation infrastructure as this will be provided by the Project. In particular, Solafrica intends to upgrade and maintain the main access road to the site during construction and project operations.

As previously mentioned, news of the project may bring about an influx of job seekers. The project is therefore expected to have a two-fold impact on the size of the local population. This increase is expected to impact on the local municipality in various ways. For example, some additional demand for schooling and health care facilities may be created. Meeting these demands will imply very limited capital expenditure on the part of the municipality but may have some implications for operating expenditure. The municipality's IDP planning process may have to be adapted to take into account the population increase. The municipality will also potentially benefit from increased rates income due to the fact that the project will rezone the land on which it is situated from an agricultural to industrial land-use.

Social Problems Arising from Population Increase

A large percentage of the construction workforce will have to be housed reasonably close to, or on, the construction site. It is possible that conflict might arise between the newcomers and local residents. One possible reason for such conflict would be the perception among locals that the outsiders are taking up jobs that could have gone to unemployed members of the local community. An influx of unemployed job seekers could add to the potential for conflict. An influx of construction workers and job seekers might be accompanied by an increase in crime. Even if particular instances of crime are not as a result of the newcomers, they may still be attributed to them by local communities.

Another possibility is that a population influx will contribute to alcoholism, drug abuse and the spread of sexually transmitted diseases in the local population. Alcoholism is already a problem in many parts of the region, and this situation could be aggravated through the population influx brought about by the project.

Social Investment Initiatives by Solafrica

The project will offer socio-economic benefits in the form of employment creation. These benefits may be augmented by social investment activities initiated by Solafrica. Two factors will play a key role in determining the effectiveness of such initiatives: whether they actually meet the needs of local communities, and whether they are adequately coordinated with other, existing development initiatives in the area. Such coordination will be essential to avoid unnecessary overlap and fragmentation of efforts. It is therefore recommended that social investment initiatives be planned in close collaboration with local community structures as well as with representatives of the local municipality that are involved with Local Economic Development (LED).

Impacts of Construction and Operation on Safety and Daily Movement Patterns

The construction and operation of the power plant is likely to result in an increase in traffic volumes. This could lead to damage of local roads and increased speeding through residential areas, thereby impacting on the safety and daily movement patterns of residents in surrounding communities.

The magnitude of this impact will also depend on current traffic volumes and on the increase in traffic volumes that will be associated with construction and operation activities.

- **Micro-level Impacts**

This sub-section deals with impacts that might be brought about by the physical presence of plant and ancillary infrastructure. It is foreseen that the extent of these impacts would be limited to the areas occupied by or directly adjacent to these structures, and would therefore be felt by landowners and residents in the immediate vicinity of the power plant.

Hazards Imposed by the Power Plant

A great advantage of a CSP plant is that it does not produce any significant atmospheric emissions. The concerns regarding air quality and health impacts that would be associated with a coal-fired power plant are therefore absent in this study. It is possible that the plant might still impact on the safety of surrounding communities by giving rise to an increase in traffic volumes – especially during its construction phase.

Thoroughness demands that other possible impacts of this novel technology on the safety and well-being of communities and individuals be considered. One such potential impact relates to the possibility that glare or reflection from the mirrors might interfere with aviation. In this regards, Solafrica has submitted an application to the Civil Aviation Authority to ensure thorough consideration of any potential impacts of the project. Initial indications are that, due to the parabolic shape of the mirrors focusing all the solar radiation on a fixed receiver tube, there is very little glare arising from the project. Solafrica is also conducting an on-going risk review and hazardous operations study that will be integrated into the plant design.

Effect on Sense of Place

Even if the CSP plant does not pose any hazard whatsoever, it would still impinge on the lives of surrounding communities by having a significant visual impact. Bokpoort in particular in sparsely populated with little expected impact. It is possible that the plant will have an impact on the surrounding area by altering its sense of place – a term used to denote the personal emotions and memories that persons or communities associate with a landscape, as well as the sense of connectedness that they feel towards it (Snyder, Williams & Peterson).

- **Potential Impacts on Land Use**

Various aspects of the proposed project might impact upon land use. These will include:

- The power plant itself, which will occupy an area of approximately 350 ha. This area will be unavailable for other land uses during the project's construction and operational phases;
- Infrastructure for extracting water from the river (which would be necessary if water for the power plant is not sourced from the local municipality). Since virtually all of the land adjoining the river is under cultivation (especially within Site 1), some of this land might have to be acquired to accommodate water extraction infrastructure
- A pipeline for transporting water to the power plant. If the pipeline is placed underground, its impact on land use would be limited to the construction phase;
- Transmission lines linking the power plant to the grid. During construction of the transmission lines, the land within the servitude would be lost to grazing as well as to cultivation and human habitation. During operation, the use of this land for grazing could be resumed, as livestock could move between the pylons. Using this land for cultivation might pose a larger problem, however, as pylons might interfere with

irrigation. The land within the servitude would also be unavailable for human habitation; and

- Access roads. If it is necessary to construct new roads to provide access to the power plant, the land occupied by these roads would be unavailable to other uses during construction and operation.

The potential impacts are strongly mitigated by the following site characteristics:

With respect to the water extraction and transport infrastructure, an existing Transnet servitude is to be used which will remove the need to acquire or disturb additional land.

As the site has an Eskom substation adjacent to it any transmission lines will be over a very limited length and impose minimal disruption or sterilisation of use of land.

The project will upgrade and maintain the existing Gariep Road which will be only temporarily unavailable and which would thereafter improve road access for local residents.

<u>Impacts on Cultivated Land</u>

The most likely impacts on cultivated land would arise from infrastructure for water extraction and from the pipeline used to transport water to the plant. Transmission lines and access roads could also impinge on cultivated land, depending on the route along which these are aligned. As noted above, these impacts are, however, likely to be minimal.

<u>Impact on Grazing Land</u>

The most likely impacts on grazing land would arise from the power plant itself. Impacts as a result of the pipeline and power lines would most likely be limited to the construction phase. Access roads may also impinge on grazing land.

6.3.2 Cultural / Heritage Resources[56]

The National Heritage Resources Act (No 25 of 1999) presents guidelines as to the areas of heritage that need to be addressed in Heritage Impact Assessments or as the heritage components of Environmental Impact Assessments. Mr Cobus Dreyer was appointed to undertake the Heritage Impact Assessment for the Solafrica CSP plant project.

6.3.2.1 Scope of work

According to the guidelines the areas of heritage that need to be addressed in a Heritage Impact Assessment include:

- Cultural landscapes;

[56] Bohlweki Environmental. 2006. *Environmental Impact Assessment for the establishment of a New Concentrating Solar Power (CSP) plant and associated infrastructure in the Northern Cape Province.*

- Palaeontology;
- Archaeology;
- Built environments;
- Graves and burial grounds;
- Places and objects of historical significance, and
- Intangible aspects of heritage such as visual impacts, place and tradition.

This study evaluated the potential effects that the proposed CSP plant development would have on heritage resources at the preferred development site by obtaining knowledge of the background history of the area, the state of existing information, as well as a physical site survey.

The context of the affected areas was assessed in terms of its landscape qualities. Built structures, human made landscapes were recorded and assessed for significance in terms of the protections and provisions of the National Heritage Resources Act.

6.3.2.2 Methodology

The area was examined for possible archaeological and historical material and to establish the potential impact on any cultural material that might be found. The study was undertaken during 2006 in terms of the National Heritage Resources Act (NHRA) (Act 25 of 1999), as part of the EIA undertaken for the Eskom CSP project. The site investigation was undertaken from 13 to 16 February 2006.

6.3.2.3 Regional Context

The !Kheis Municipal Area was initially inhabited by the Khoi-San people. The San, who lived a nomadic life, migrated through the area. The Korannas (Khoi group) arrived in the area during the 18th century. They were widely spread over the “Benede Oranje” area and consisted of various tribes, each with its own captain (leader). The groups who lived in the !Kheis area, was under leadership of Captain Willem Bostander and Klaas Springbok. Many of their descendants still live in the area today. Other Khoi-groups, such as the Griekwas, also migrated through the area and intermarried with the Korannas. Later Coloured stock farmers, as well as white hunters and farmers arrived.

6.3.2.4 Site Specific Findings

The investigation at Bokpoort produced a small collection of stone flakes (Figure 69) mainly towards the power line. The material used was also meta-quartzite and chalcedony from the local lithic sources.

Figure 69: Stone flakes from Bokpoort (site 2) made out of Chalcedony, banded ironstone and meta-quartzite (Pocket knife = 83 mm)

The lithic assemblages found during the whole investigation seem to be in the form of a general distribution of flakes cores. The impact on the cultural heritage remains located on the Farm Bokpoort will be of minor significance.

The stone flakes are sparsely distributed on the surface with the intensity of the distribution the same at both sites.

No other cultural, historical or palaeontological components were found during the investigation, nor were there any buildings, graves or burial grounds in the area.

6.3.3 Tourism[57]

The tourism Impact Assessment was undertaken and compiled by Zengeziwe Msimang in her capacity as a consultant for Grant Thornton Tourism Hospitality and Leisure during 2006 as a specialist component to the Eskom CSP EIA project.

Tourism has been prioritised by government as a key development sector and plays a large role in the creation of jobs in the South African economy. In 2004 over 6.7 million tourists visited South Africa contributing 93.6 billion to the domestic economy. As the fastest growing industry in the country that is estimated to employ over 3% of South Africa's work force, the impact of the CSP plant on tourism is of vital importance.

[57] Bohlweki Environmental. 2006. *Environmental Impact Assessment for the establishment of a New Concentrating Solar Power (CSP) plant and associated infrastructure in the Northern Cape Province.*

6.3.3.1 Methodology

- A detailed assessment of all existing and potential tourism products that may be affected by the CSP project. This included interviews with product owners/operators, an assessment of the current tourism business demand and operations (current revenue, rates, patronage levels, occupancy, etc) as well as a testing of their views on the potential impact of the CSP on their businesses. The assessment has identified which areas and what types of tourism businesses will be most and least affected;
- An assessment of the future tourism appeal and/or prospects for the tourism assessment area through the interviews with the product owners/operators as well as interviews with relevant tourism organisations (public and private sector), and
- Through interviews with local estate agents, an assessment of the current land/property prices (average values for all types of land/properties as well as values for land/properties with a tourism appeal) in the region and their opinion with regard to the impact of the transmission line and/or substation on land values.

Through reference to previous research (conducted by Grant Thornton and others), the current and projected future average demand for tourism products in the tourism assessment area was determined.

6.3.3.2 Regional Overview – Northern Cape Province

- **Foreign Tourism in the Northern Cape**

According to the 2004 SA Tourism survey there were a total of 6 677 839 foreign visitors to South Africa in 2004.The provinces that receive the highest number of visitors were Gauteng, the Western Cape, KwaZulu Natal and Mpumalanga. The Northern Cape received 2.6 percent of all foreign visitors in 2004, which is marginally down from 2.7 percent in 2003 but up from the 2.2 percent in 2002. This is the lowest visitation level of any province and represents 173 623 visitors out of a total of 6.6 million visitors nationally.

The Northern Cape also had the least number of bednights in the country. There were a total of 57 577 400 bednights in the year 2004 of which the Northern Cape received 1% equating to a total of 575 774 bednights.

- **Origin of Foreign Tourists to the Northern Cape**

In 2004, Namibia accounted for 28% of foreign visitors to the Northern Cape. This was followed by Germany with 6.4%, the Netherlands with 6% and Zambia with 4.7%. France contributed 4.6%, of foreign visitors to the Northern Cape.

- **Foreign Visitor Spend in the Northern Cape**

Foreign visitors to South Africa spent a total of R43 billion in 2004. The highest amount spent was in Gauteng (R13 billion) followed by the Western Cape (8.9 billion). For the Northern

Cape Province, which is historically the province with the lowest tourism figures, direct foreign spending dropped from R1.2 billion in 2003 to R0.8 billion in 2004. This represents 2,2% of the total foreign tourist spending in South Africa. The amount is also the lowest foreign spending in a province. French, UK and Namibian foreign tourist are the largest contributors of foreign spending in the Northern Cape at 16% each.

- **Domestic Tourism in the Northern Cape**

As with foreign tourism, the Northern Cape, at only 828 851 trips in 2003 receives the lowest number of domestic tourists of any province in South Africa. This represents approximately 1,6% of the total domestic market. KwaZulu Natal generated the highest number of domestic trips in the country with 13.2 billion trips.

- **Average Length of Stay and Purpose of Visit**

The average length of stay of domestic visitors to the Northern Cape varies according to the purpose of their visit. The average length of stay of the holiday visitor to the Northern Cape is 6 days. When visiting friends and relatives the average length of stay in the province is 7 days. People who travel to the Northern Cape for business purposes tend to stay an average of 5 days. The main purpose of visit of domestic tourists to the Northern Cape is to visit friends and relatives (VFR) (65%), followed by holiday trips (19%). Business visits accounted for 12% of all total visits.

- **Domestic Visitor Spend in the Northern Cape**

Domestic tourists in the Northern Cape spent a total of R800 million in 2003. Holiday visitors contributed the largest portion of spending followed by “VFR” and business travellers. 19% of domestic tourists to the Northern Cape visit the province for holiday purposes but generate 44% of the receipts for the province.

6.3.3.3 Findings

The tourism sector in the !Kheis Municipality has not yet reached its full potential. Currently the Boegoeberg Dam is the most popular tourism attraction in the area. The facility is especially popular for fishing and water sport enthusiasts. Other popular attractions include:

- Ezelsklaauw;
- Centenary Monument;
- Oranjerivier Wine Cellars; and
- Water turbine at Winstead Farm.

The farm Bokpoort has no established tourism facility in its vicinity. There are no guesthouses in the area and the proximity of the Garona substation and the railway tracks would already act as a deterrent for the development of tourism in close proximity to the area due to the perception of high noise levels. The presence of the CSP plant on this site would result in an increase of business tourism in the area, which would have a positive impact on Groblershoop.

All of the land surrounding the substation is privately owned and is currently being used for farming purposes. There is one major Arab-owned game farm in the area that is currently operational. The presence of the plant would act as a deterrent for guests who stay at the game farm for an African gaming experience due to the potential visibility of the plant from the game farm. The value of the land in the area is currently approximately R450 per hectare. The farm is situated in the vicinity of the plant, less than 10 km from the main N14 route. The plant would stimulate the growth of tourism accommodation in the Groblershoop area where there is currently no accommodation. However as with the Olyvenhouts Drift site, the building of the plant would most likely result in the development of a minor tourist industry to cater to the tourists who are interested in solar energy. The business tourists would more than likely use the facilities in the larger towns and commute.

The potential visual impact of the plant is low. According to the visual assessment, the existence of infrastructure in the area would result in the plant adding to the already existing visual clutter and thus having a low visual impact. In addition the presence of a smaller population means that there would be less people to actually see the plant at this site. Traffic to the area, which is currently very limited, would be increased particularly during the construction phase

6.3.4 Conservation Areas

The Northern Cape has extensive areas under management by Nature Conservation. Some of the key conservation areas in the area include:

- Augrabies Falls National Park;
- Kgalagadi Transfrontier Park;
- Witsand Nature Reserve; and
- Numerous private game farms and nature reserves.

None of the areas currently registered as conservation areas are impacted on by the proposed site. According to the Environmental Potential Atlas (ENPAT)[58] this area has a high scenic value (4 out of 5), a high environmental resources index and low population pressure. It is therefore, listed as one of the areas in South Africa with the highest environmental resources conservation requirements and falls within the highest category for environmentally sustainable tourism and/or ecotourism development.

6.3.5 Noise

As part of the EIA, a Noise Impact Assessment has been undertaken by Jongens Keet Associates (JKA). The study was undertaken by Mr Derek Cosijn and Dr Erica Cosijn. Two

[58] Van Riet, W., P. Claassen, J. van Rensburg, T. Viljoen & L. du Plessis. 1997. *Environmental Potential Atlas for South Africa*. J.L. van Schaik. Pretoria.

development area alternatives were identified for the Bokpoort site (preferred site) during the EIA phase by means of a sensitivity analysis. This section documents the findings of the EIA phase investigation.

*Refer to **Appendix H** for the Noise Impact Report.*

6.3.5.1 Location and Extent of the Study Area

Two candidate sites, namely the Development Area A and Development Area B sites have been evaluated on the farm Bokpoort 390 - Figure 70. The core study area at each of the two alternative sites was that within the area of influence of the noise generated by the operations at the respective CSP plant and appurtenant works. Essentially the whole area of the farm Bokpoort and an area within at least 4 kilometres of the Bokpoort farm boundaries have been evaluated. Where necessary however, and particularly in regard to the CSP-generated traffic impact, a wider area of influence has been considered.

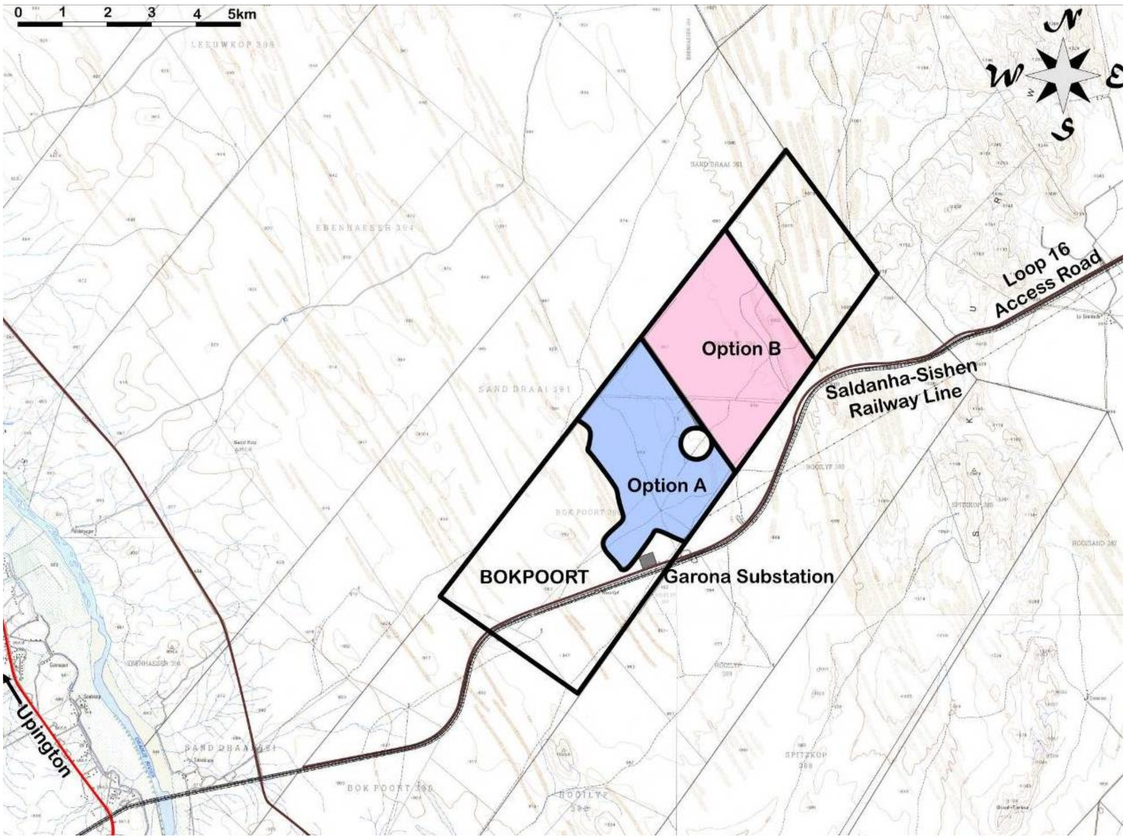

Figure 70: The development areas investigated during the Noise Impact Assessment

6.3.5.2 Scope and Limitations

Although much of the technical details of the planned CSP plant have already been determined, the specific noise characteristics of the various component plant machinery and equipment to be installed have not. Conservative (worst-case scenario) predictions based on equipment baseline noise levels of typical plant that will be installed have therefore been made.

Since the water supply to the CSP plant is still under investigation, the impact of the aspect has not been addressed in this study.

6.3.5.3 Methodology

- **General**

The general procedure used to determine the noise impact was guided by the requirements of the Code of Practice SANS 10328:2008: Methods for Environmental Noise Impact Assessments. The level of investigation was the equivalent of an EIA. A comprehensive assessment of all noise impact descriptors (standards) has been undertaken. The noise impact criteria used specifically take into account those as specified in the South African National Standard SANS 10103:2008, The Measurement and Rating of Environmental Noise with Respect to Annoyance and Speech Communication as well as those in the National Noise Control Regulations. The investigation comprised the following:

- Determination of the existing situation (prior to the planned development);
- Determination of the situation during and after development;
- Assessment of the change in noise climate and impact;
- Determination of the significance of impact;
- Comparison of alternative sites, and
- Identification of mitigation measures.

- **Determination of Existing Conditions**

This phase comprised the following:

- The relevant technical details of the planned CSP plant, the existing traffic patterns and the existing and planned land use in the study area were reviewed in order to establish a comprehensive understanding of all aspects of the project that will influence the future noise climate in the two respective study areas;
- Using these data, the limits of the study area for each alternative development area were determined and the potential noise sensitive areas, other major noise sources and potential problems in these areas were identified;
- Applicable noise standards were established. The National Noise Control Regulations and the SANS 10103:2008 standards were applied;
- The existing noise climate of the study area was determined by means of a field inspection and a noise measurement survey. The measurement survey appropriately covered the whole extent of the study area, focussing specifically on the identified noise sensitive/problem areas. Measurements from the earlier survey in 2006 as well as recent measurements taken in April 2010 have been summarised in this report. Measurements were taken at 10 monitoring sites in the study area. The daytime conditions were measured at all sites. Night-time conditions were only measured at a

few locations. The sound pressure level (SPL) (noise) measurements were taken in accordance with the requirements of the Code of Practice SANS 10103. Type 1 Integrating Sound Level meters were used for the noise measurements. All measurements were taken under dry weather and normal traffic (that is mid-week/school term) conditions;

- On the general field inspection and at the same time as each individual measurement was being taken, the qualitative nature of the noise climate in the area of the measurement site was assessed and recorded. This comprised an appraisal of the general prevailing acoustic conditions based on the subjective response to the sounds as perceived by the listener (i.e. auditory observation by the surveyor), as well as identifying those noise incidents, which influenced the noise meter readings during that measurement period. This procedure is essential in order to ensure that that there is a human correlation between the noise as perceived by the human ear and that, which is measured by the meter, as well as to establish any anomalies in the general ambient noise conditions, and
- The existing noise climates along the main roads as related to the current traffic volumes and patterns were established. These traffic noise levels were calculated using the South African National Standard SANS 10210 Calculating and Predicting Road Traffic Noise for Route. The latest traffic was used as the baseline reference. The calculated 24-hour period noise indicators, as well as those for the daytime period and night-time period provided the main data for the impact assessment. The measured data provided a field check of the acoustic conditions.

- **Assessment of Planning/Design Phase and Construction Phase Impacts**

Aspects of the pre-design field surveys and construction activities that potentially will have a noise impact were identified and, where appropriate, mitigation measures have been recommended.

- **Assessment of Operational Phase Impacts**

The main focus of the operational phase assessment was to establish the nature, magnitude and extent of the potential change in noise climate in the study area directly related to and within the area of influence of each of the two alternative development sites. The likely noise that will be generated by the CSP plant operations was established and this was used to determine a footprint of impact.

- **Determination of Significance of Impact**

The significance of impact was the assessed by means of the methodology provided by Bohlweki-SSI.

6.3.5.4 Regional Overview

- **Topography**

The main topographical feature in the area is the Orange River, which flows in a south-east to north-west direction through the study area. The river is the southern boundary of the farm Bokpoort. The terrain is relatively flat across the farm. The land falls gently towards the Orange River. The Skurweberg and Prynnsberg lie to the north-east of the farm Bokpoort. There is also a range of low hills to the east of the farm.

- **Land Use**

The area is predominantly agricultural. The main farming endeavour is sultana grapes. The vineyards are planted along both banks of the Orange River and are generally contained to an area close to the river (500m to 1 000m). Other significant land uses in the area are:

- Residential.
  - The town of Groblershoop is located approximately 9 km south-east of the eastern boundary of the farm Bokpoort;
  - The urban settlement (township) of Wegdraai, which is located on the western side of the Orange River on the farm Boegoeberg 48;
  - Numerous farmhouses and farm labourer houses on the northern and southern banks of the Orange River. These are residences related mainly to the sultana grape farms;
  - The main farmhouse on Bokpoort is situated on a hill in the central portion of the farm, and
  - The main farmhouse on the farm La Gratitude is situated 5 200 metres east of the north-eastern corner boundary of Bokpoort.
- Educational. There is a school in Groblershoop and several farm schools in the area;
- Recreational. There is a golf course on the western side of Groblershoop, and
- Industrial. Eskom's Garona substation is located on the eastern boundary of Bokpoort 1800 metres north-east of the Rooilyf siding on the Saldanha-Sishen railway line.

- **Roads**

There are a number of major roads and relevant secondary roads servicing the area:

- National Road N10, which links Upington and Groblershoop, is aligned in a north-west to south-east direction through the south-western sector of the study area. The road essentially follows the course of the Orange River along its southern bank;
- National Road N8 /Road R64, which links Groblershoop to Griekwastad, is aligned in a north-south direction through the south-eastern sector of the study area;

- "Gariep" Road (MR874) along the northern bank of the Orange River, which links from Road R64 (near Groblershoop) to National Road N14 (near Upington). The road is aligned through the southern sector of the farm Bokpoort;
- "Opwag" Road (MR873) serving the farms on the southern bank of the Orange River. It links from Road R64 (near Groblershoop) to National Road N10 (10-kilometres west of Groblershoop), and
- "Loop 16 Access Road". This is the service road for the Saldanha-Sishen railway line, which is aligned in a south-north direction from the Gariep Road through Bokpoort.

- **Railway Lines**

The Saldanha-Sishen railway line is aligned in a north-east to south-west direction through the central sector of the farm Bokpoort. There is a cross-over siding (Rooilyf Siding) for the ore trains in the central sector of Bokpoort (Loop 16). There are 3 trains per day on this line (data obtained from Transnet Freight Rail).

- **Factors of Acoustical Significance**

The relatively flat topographical features in the Bokpoort CSP study area provide little acoustic shielding between the possible development sites and the adjacent noise sensitive areas. Noise will tend to be channelled along the shallow drainage valleys in the area. The hills to the north-east and east of the farm will shield noise sensitive receptors to the east of these features.

The main meteorological aspect that will affect the transmission (propagation) of the noise is the wind. The wind can result in periodic enhancement downwind or reduction upwind of noise levels. Analysis of the wind records for the area indicates that the main prevailing winds blow from the northeast (48% of the time) and the northwest (21%). Approximately 6,7% still periods are experienced annually.

- **Noise Sensitive Receptors**

The noise sensitive receptors (NSR) in the area are identified in Figure 71. Residential, educational and recreational land uses are considered to be NSRs.

For this study, the position of houses/dwellings on the farms was taken off 1:50 000 topographical cadastral maps and verified as far as possible using Google Earth. Even though the latest editions of the maps were used, the relevant maps are up to 28 years out of date and there may be new dwellings and/or some of the existing shown buildings may be derelict. During the field survey for the noise measurement survey, such aspects were noted where possible. The following 1:50 000 topographical cadastral maps were used:

- SOUTH AFRICA 1:50 000 Sheet 2821DB, GROOTDRINK Second Edition 1991;
- SOUTH AFRICA 1:50 000 Sheet 2821DD, GROBLERSHOOP Second Edition 1991, and

- SOUTH AFRICA 1:50 000 Sheet 2822CA, TITIESPOORT Second Edition 1982.

6.3.5.5 Site Specific Findings

- **Noise Sources**

The main noise sources presently affecting the study area and the additional sources that will affect the area once the CSP plant is commissioned are:

- Road traffic. Mainly from the traffic on National Road N10 and National Road N8 (Road R64), and to a lesser extent from the traffic on the secondary roads along the northern and southern banks of the Orange River;
- Railway traffic on the Saldanha-Sishen line through the central sector of the farm Bokpoort;
- Garona substation;
- Noise from general farming operations;
- Fans from refrigeration units at various wineries, and
- Planned CSP plant (future).

- **Noise Sensitive Receptors**

The noise sensitive sites/areas in the study area that are potentially affected by the development of the CSP plant on this site are the urban areas, settlements and farm residences, schools and recreational areas are shown in Figure 71. There is only one farmhouse that lies within 2 km of the candidate development sites.

- **The Residual (existing) Noise Climate**

The determination of the residual (existing) noise climate in the study area is based on the measurements and observations made in the area, and where relevant also from the calculation of the noise from the traffic on the main roads.
The areas on the farm Bokpoort that are remote from the main roads and other farms along the banks of the Orange River are extremely quiet and are typical of a rural/agricultural noise environment. The noise levels in Groblershoop and at the settlement of Wegdraai are typical of urban areas. The noise climates in areas close to National Road N10 and National Road N8/Road R64 are degraded. There is a noise nuisance factor in areas close to the Saldanha-Sishen railway line when trains pass.

- **The Predicted Noise Climate (Pre-construction Phase)**

Activities during the planning and design phase that normally have possible noise impact implications are those related to field surveys (such seismic testing and geological test borehole drilling for large building foundations). As these activities are usually of short duration and take place during the day, they are unlikely to cause any noise disturbance or nuisance in adjacent areas.

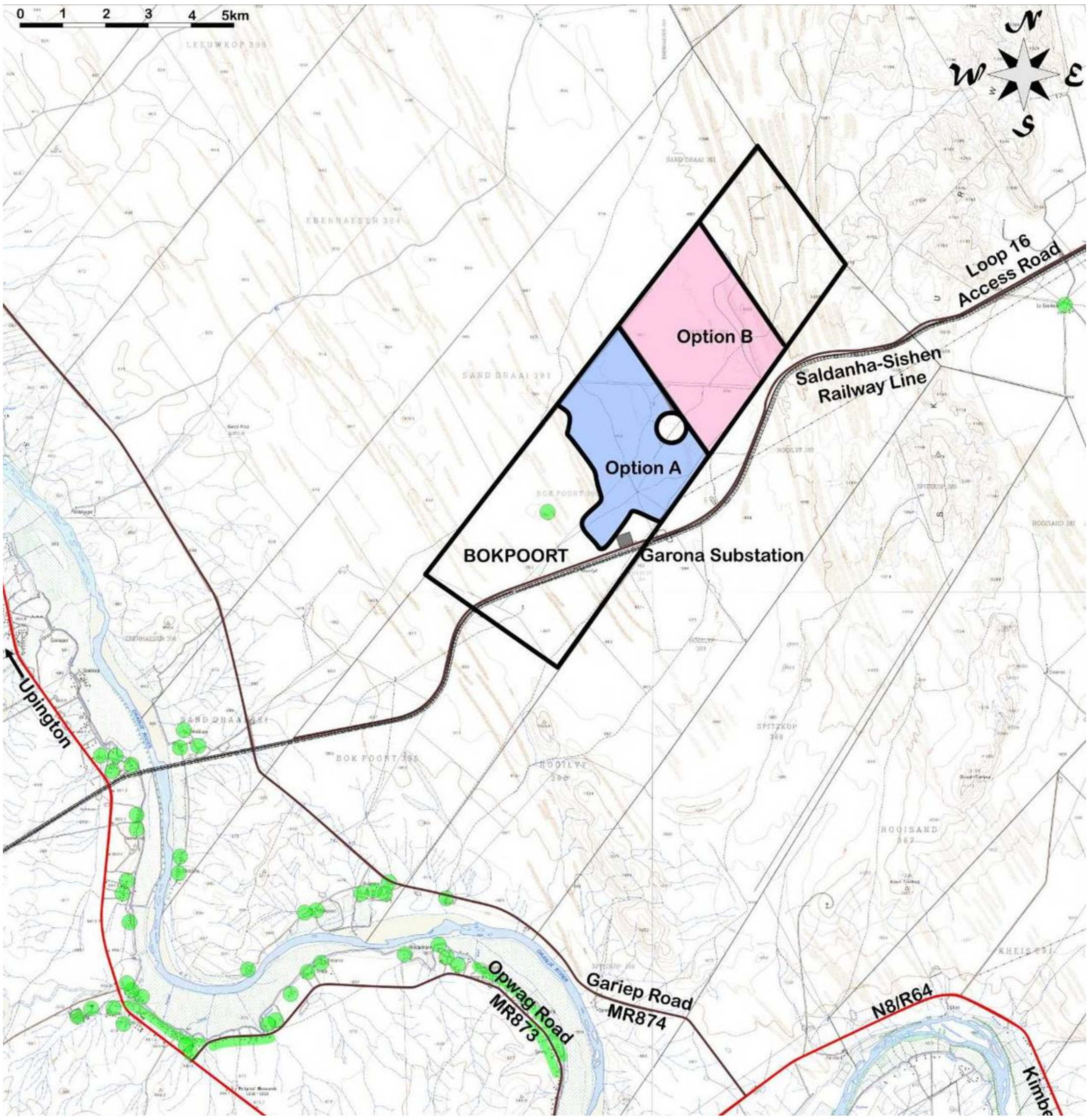

Figure 71: Noise sensitive receptors

- **The Predicted Noise Climate (Construction Phase)**

Construction will likely be carried out during the daytime only (07h00 to 18h00 or 20h00). It should however be noted that certain activities may occasionally extend into the late evening period, while others such as de-watering operations may need to take place over a 24-hour period. It is estimated that the development of the project will take place over a period of 3 years. A large construction camp will need to be established.

The nature of the noise impact from the construction sites is likely to be as follows:

- Source noise levels from many of the construction activities will be high. Noise levels from all work areas will vary constantly and in many instances significantly over short periods during any day working period;

- Exact daytime period and night-time period continuous equivalent sound pressure levels are not possible to calculate with certainty at this stage as the final construction site layout, work programme, work modus operandi and type of equipment have not been finalised. Ideally the daytime outdoor ambient noise levels should not exceed 45dBA for rural residential areas (as specified in SANS 10103). For the ambient conditions, there will be no noise disturbance further than 800 m from the construction activity. Working on a worst case scenario basis, it is estimated that the short term maximum noise levels from general construction operations should not exceed 62dBA at a distance of 1500 metres from the activity site;
- Slightly higher ambient noise levels than those normally considered as reasonable are acceptable during the construction period provided that the very noisy construction activities are limited to the daytime and that the contractor takes reasonable measures to limit noise from the work site;
- There are however unlikely to be noise disturbance and noise nuisance effects, as the nearest noise sensitive sites are approximately 2 000 metres from the construction site, and
- For all construction work, the construction workers working with or in close proximity to equipment will be exposed to high levels of noise.

As there is only one noise sensitive receptor (landowner dwelling) approximately 2 000m to the south-west of the Development Area A, it is considered that there will be very little noise impact during the construction phase. Furthermore the relocation of the landowner is impending prior to commencement of the construction phase of the plant. A land purchase agreement between Solafrica and Mr C Honiball has been enacted.

- **The Predicted Noise Climate (Operational Phase)**

With the construction of the CSP plant the noise climate close to this facility will alter. During power generation the main noise sources at the CSP plant will be the cooling fans (at the powerblock), the pumps and the power generating unit. The noise from the cooling fans will be the loudest . It is predicted that the noise from the CSP plant could be the following at the given offsets from the plant (see Table 51, Figure 72 and Figure 73):

Table 51: Offsets from the plant and associated noise levels

Offset from the Plant	Noise Level (dBA)
1 000m	52.5
2 000m	44.7
3 000m	39.6
4 000m	35.7
5 000m	32.6

Assuming daytime operations, noise sensitive sites (in a rural setting) closer than 1950 metres away from the plant power block will lie within the 45dBA noise contour and will be impacted by the noise from the plant. If, for any reason, night-time operations are allowed then noise sensitive sites within 4 200 metres of the plant power block will be impacted. The CSP plant power block should be built at an offset of at least 2 000 metres from the nearest noise sensitive receptors.

It should be noted that the exact position and layout of the CSP plant have not yet been finalized. There are several alternative candidate sites for the power block at both the Development Area A and Development Area B sites. It was thus necessary in the analysis to consider all possibilities, and an outer envelope of the worst case scenario power block development points were used as a potential noise source point. A maximum offset of 500 metres from (and inside) the Bokpoort farm property boundary was used to develop this envelope's location (locus). The noise contours shown in Figure 72 and Figure 73 do not represent a specific location of the main source of noise (i.e. the power block) but rather indicate the maximum extent of the area contained within a specific contour representing all the alternative locations.

An auxiliary heating system for the heat transfer fluid will be installed. It is intended that an LPG (Liquid Petroleum Gas) fired heater will be used to maintain the temperature of the heating fluid above 12^{0}C. This will be a continuous operation for as long as is required during the down-period (night-time) of the CSP plant. As this will be mainly a night-time operation, the maximum noise level of 35dBA cannot be exceeded (SANS 10103 night-time standard for rural areas). The 35dBA contour will not extend beyond the boundary of the farm Bokpoort, provided that this noise source lies within the outer boundary of the potential site for the power block as indicated in Figure 72 and Figure 73.

The alternative of a generator-based system was also investigated. The generator system is significantly louder than the LPG system.

A further source of noise is that related to the washing of the reflective troughs. A truck mounted high pressure washing system will be used. This operation will in all likelihood be undertaken at night. While the trucks are spraying the reflective troughs, maximum noise levels from the compressors are not expected to exceed 33dBA at 1 000 metres.

- **CSP Plant Generated Traffic**

The total volume of traffic generated by the CSP plant will be very small in comparison to the total volume of traffic on the adjacent main roads. It is estimated that there could be of the order of 60 vehicle trips (two-way) per day generated by the CSP plant. Although this is a relatively large increase in traffic on Loop 16 Access Road and the Gariep Road, these increased volumes will only cause an increase of 6.3dBA and 3.7dBA respectively on these roads. The resultant ambient noise levels are too low to cause any significant noise impact. On National Road N8 and National Road N10 the traffic noise increase from the CSP plant generated traffic is negligible. The Opwag Road will hardly be affected.

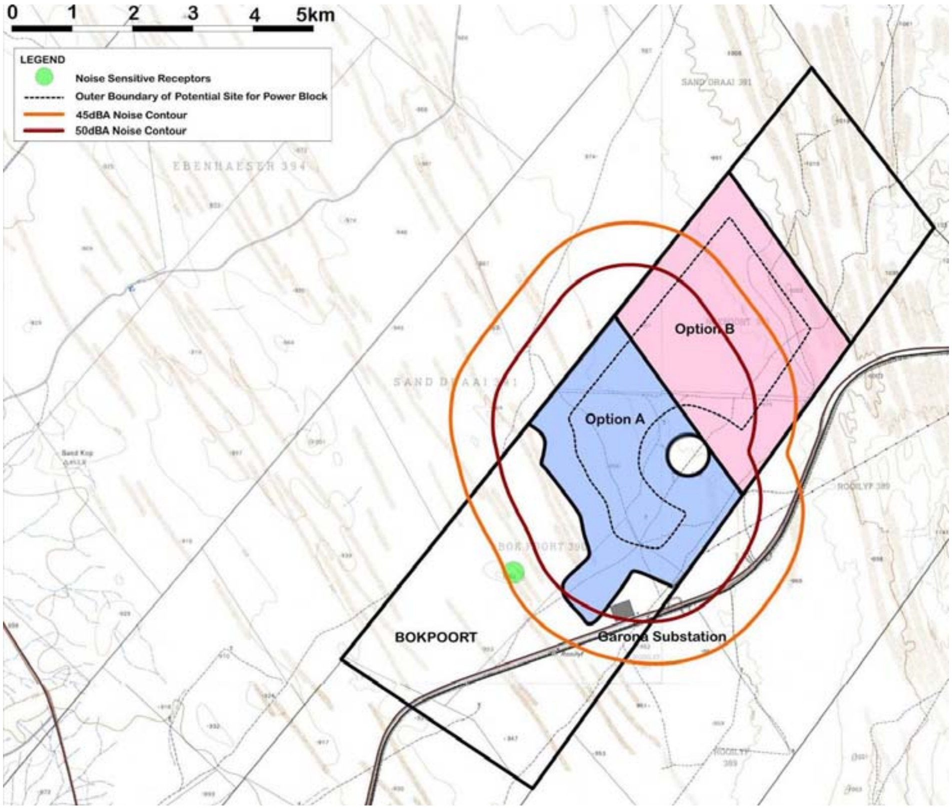

Figure 72: Noise profile of Development Area A

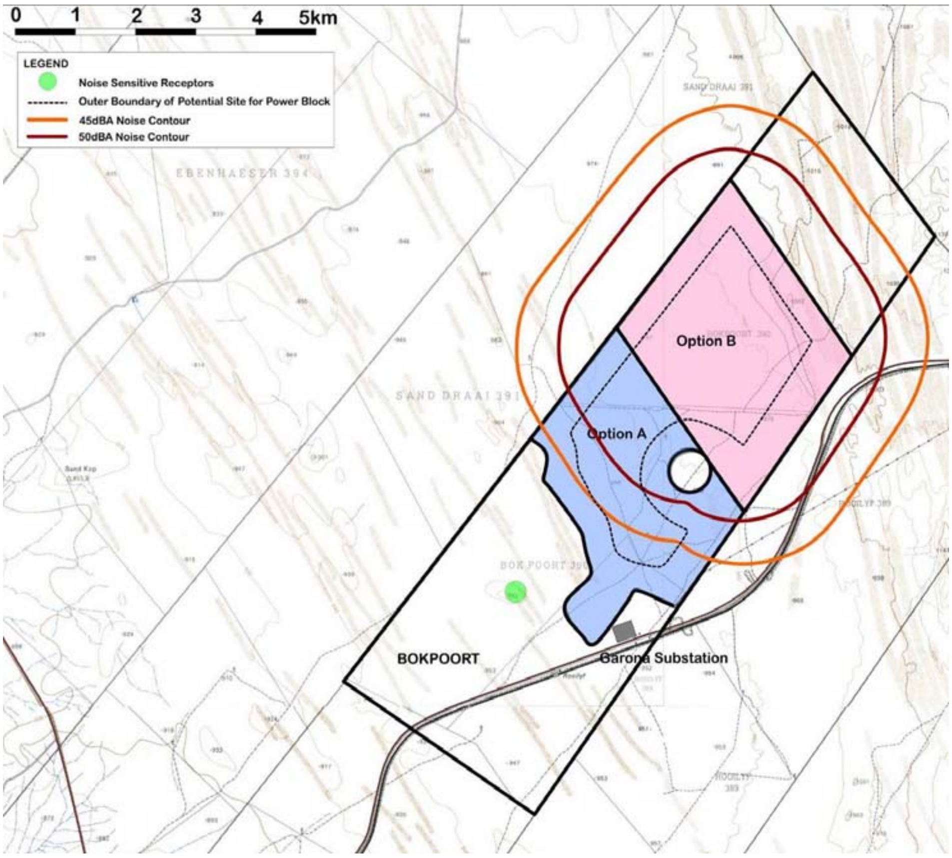

Figure 73: Noise profile of Development Area B

6.3.5.6 Conclusions and Recommendations

The following can be concluded from the Noise Impact Assessment:

- The existing typical residual noise climate throughout the study area is typical of a rural/agricultural environment as defined in SANS 10103:2008, that is, areas where ambient noise levels generally do not exceed 45dBA during the day and generally do not exceed 35dBA during the night-time;
- The noise climates near to the main roads are degraded as they are adversely affected by traffic noise;
- The areas alongside the railway line are significantly affected by noise with the passing of each train;
- The Garona substation (Eskom) is an existing source of noise on Farm Bokpoort. There will only be minimal cumulative noise effects between the substation and either of the two development areas;
- Daytime operations: The areas of noise impact from power generation activities from either alternative CSP plant sites will extend onto the adjacent farms of Rooilyf 389 and Sand Draai 391. There are no noise sensitive receptors in these areas;
- Night-time operation: There will be no impact from the auxiliary heating system (LPG fired)
- The only noise sensitive receptor in the potential area of influence of the two development areas is the farmhouse on Farm Bokpoort (the Honniball residence), and
- *Although the two development areas that were analyzed are very similar in character and the identified impacts are of the same order, it should be noted that the farmhouse on Bokpoort will be affected worst if Option A is used for the development of the CSP plant. Note however that, although Option A is slightly less desirable as a development site for the CSP plant than Option B, this does not imply that Option A is not a viable site. Both sites are acceptable from a noise perspective.*
- There are mitigation measures that can be introduced to prevent or reduce the noise impacts.

The following is recommended:

- *From a noise perspective, it is recommended that Option B site be selected as the more desirable development site. It should, however, be noted that although Option A is not preferred, it is still a viable option;*
- As the areas of potential noise impact extend onto adjacent farms, the related implications will need to be discussed with the relevant farm owners;
- The National Noise Control Regulations and SANS 10103:2008 should be used as the main guidelines for addressing the potential noise impact on this project;
- The noise mitigation measures will need to be designed and/or checked by an acoustical engineer in order to optimise the design parameters and ensure that the cost/benefit of the measure is optimised;

- Once the layout of infrastructure at the proposed CSP plant is finalised and the actual noise profile of plant and equipment is known, the position of the noise contours should be checked, and
- At commissioning of the CSP plant, the noise footprint of each discrete element should be established by measurement in accordance with the relevant standards, namely SANS ISO 8297:1994 and SANS 10103. The character of the noise (qualitative aspect) should also be checked to ascertain whether there is any nuisance factor associated with the operations.

6.3.6 Visual

The Visual Impact Assessment (VIA) was undertaken and compiled by Dawie van Vuuren from MetroGIS (Pty) Ltd by quantifying and visually representing information related to parameters such as visibility, proximity and visual absorption capacity, measured against the visual quality of the landscape.

Refer to ***Appendix I*** *for the Visual Impact Report.*

6.3.6.1 Description of the proposed CSP technology

Of the various types of solar power technology, parabolic trough technology has been selected to establish a 75 MWe Concentrating Solar Thermal Power plant on the farm Bokpoort. An area of 2.5km^2 will be cleared to establish the plant, which will consist of the following main components:

- Solar collector assembly – 6m in height;
- Heat exchanger vessel – 20m in height;
- Cooling towers – 15m in height, and
- Generator – 6m in height.

Other associated infrastructure includes the following:

- Auxiliary power plant;
- Sub-transmission power line, and
- Water pipeline.

The purpose of the auxiliary power plant is to maintain the required temperature levels of the oil that is heated during the day, to prevent crystallisation of the oil during cold nights. The power plant consists of a boiler and emissions stack, and is fuelled by either diesel or gas technology.

Since the final location of the plant is yet to be determined, information with regard to associated infrastructure has not been finalised and is therefore not included in the analysis part of this document. Reference will however be made in as far as issues that may be identified.

6.3.6.2 Landscape Character and Visual Resources

Visual quality is evaluated by identifying the vividness, intactness and unity present in the study area. Vividness is the visual power of landscape components as they combine in distinctive visual patterns that may last in a viewer's memory. Intactness is the visual integrity of the natural and man-built landscape and its freedom from encroaching elements. Unity is the visual coherence and compositional harmony of the landscape considered as a whole.

The landscape in the study area is uniquely characterised by open plains and mountain ridges within a semi-arid region. Shrubland and thickets with occasional views of the Orange River and high mountain ridges in the distance dominate views of the landscape from various vantage points.

Land use in the study area is associated with development in the Orange rive floodplain. The river banks are almost fully transformed by agricultural activities which are primarily vineyard and associated land uses. Small towns occur intermittently along the N10 national road between Groblershoop and Upington. Farmsteads occur in a distinct linear pattern alongside the Orange River. In contrast with the Orange River corridor, the rest of the study area is sparsely populated and natural vegetation is fairly intact.

The quiet and peaceful sense of place is brought about by views of the landscape as described above. Tourists are attracted by the Orange River Wine Route along the N10 between Groblershoop and Upington, as well as other tourist destinations such as the Augrabies National Park.

The unique combination of visual resources such as plains, mountain ridges and the Orange River valley creates a landscape which reflects a high visual coherence and compositional harmony, which is largely free of encroaching elements, and leaves a lasting impression of distinctive visual patterns as is demonstrated in the photographs in Figure 74. Such landscapes are sensitive to the introduction of industrial type activities, such as a CSP plant which will be in contrast with the surrounding environment.

Figure 74: Land use, topography and vegetation depicting the landscape quality. Looking towards Bokpoort from two different locations

6.3.6.3 Sensitive Viewer Locations and Viewer Perceptions

Sensitive viewer locations include places of residence, work, leisure (including tourism), and travelling routes. As described above, the area is sparsely populated, with the highest concentration of people along the Orange River floodplain. Incidentally the main routes in the area follow the alignment of the river, with the result that virtually all of the potential sensitive viewer locations occur in a corridor south and west of Bokpoort (refer to the map in Figure 76). Of concern, however, is the location of the farm owner's residence approximately 2km from the plant site. This location will be exposed to all components of the plant at relative close proximity.

Viewer perceptions could not be established, except for a few conversations with residents in the area during the site visit. Due to relative long distances from the site (15km and further), it is expected that the local community will not express negative perceptions of the CSP. A land purchase agreement between Solafrica and Mr C Honiball has been enacted – the landowner has articulated that the family will be relocating prior to the construction of the proposed plant.

More information concerning viewer perception should be obtained upon further public participation.

Figure 75: View of the farm owner's residence, as seen from the CSP site

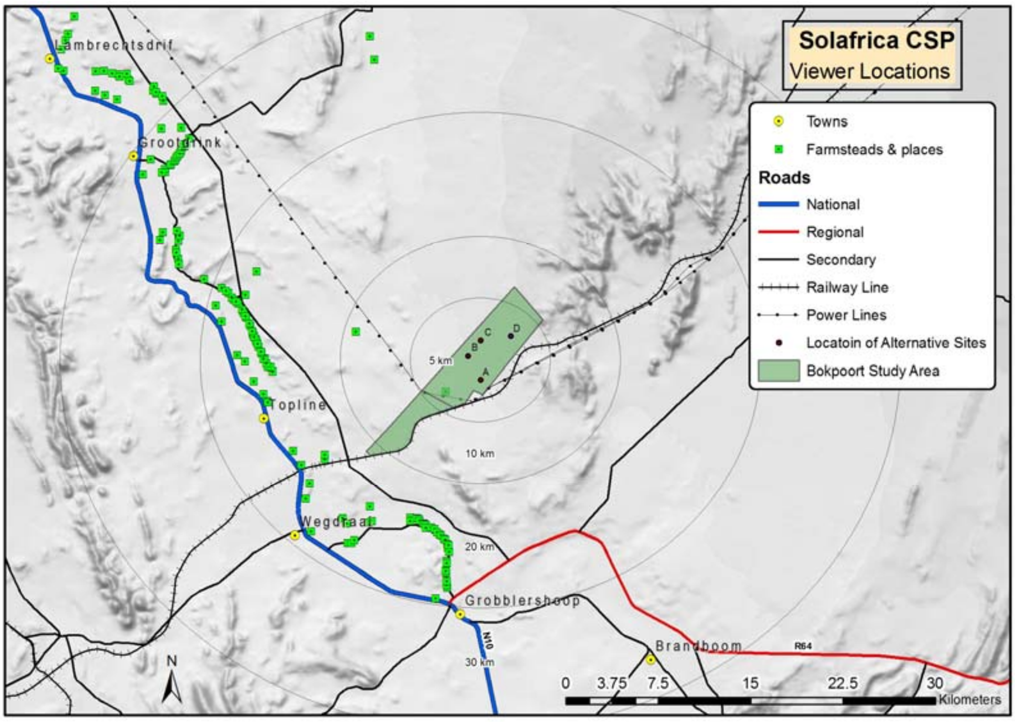

Figure 76: Location of roads, towns and farmsteads in relation to the CSP site

6.3.6.4 Approach, Methodology and VIA tools

Visual impact assessment is an iterative process of data collection, analysis and representation to describe the quality of the landscape before development and possible visual impacts after development. Visual impacts are however difficult to determine and the findings can never be exact, as these are perceived differently by people, and as a person's view is affected by other environmental factors. Nevertheless, a particular methodology is followed that has stood the test of time and is supported by others (Berry and Martin, 2003. Oberholzer, 2005).

The methodology entails the analysis and description of the following:

- Visual Exposure;
- Proximity;
- Sensitive Receptors & Viewer Incidence;
- Visual Absorption Capacity;
- Visual Impact Sensitivity, and
- Quantified Visual Impact.

- **Visual Impact Assessment Resources**

The tools and techniques that are used in this study, are aimed at quantifying the visual impact indicators as much as possible, and include the following:

- Geographic Information System technology (using ArcGIS software). GIS operations include:
  - Data Capturing & Processing;
  - Digital Terrain Modelling (DTM);
  - Spatial Analysis (line of sight & distance buffering), and
  - Mapping.
- Satellite Imagery / Aerial photography available on Google Earth;
- Site visits;
- Photographs;
- Project meetings & discussions, and
- Layout of mining components and processing plant infrastructure.

The DTM is used primarily for generating the viewshed analyses of the various project components but the results of the viewshed process can be used as components in other analyses that generate new and valuable data. The accuracy of the DTM is therefore of considerable importance to any visual impact assessment. The DTM was generated from the standard 20m contours available from the Directorate Surveys and Mapping.

6.3.6.5 Visual Impact Assessment

The visual impact assessment (VIA) is undertaken in a series of analyses taking into account the main factors that determine visual impact, i.e. proximity, visibility and the visual absorption capacity of the landscape. For the purpose of the VIA four main components of the CSP plant have been selected as major sources of visual impacts by virtue of their highly reflective properties and size (footprint and height above ground level). These are listed in Table 52 below.

Table 52: List of component used for viewshed analysis

Component	Length (m)	Width (m)	Height (m)
Solar collector assembly	2500	2500	6
Heat exchanger vessel	5	4	20
Cooling towers			15
Boiler stack	0.5	0.5	30

- **Proximity Analysis**

In addition to the viewshed analyses as described above, a proximity analysis is required to incorporate the effect of reduced visibility over distance. The degree to which an object fills a person's central field of vision determines the visual impact it might cause, and this in turn is determined by distance. The central field of vision for most people covers an angle of between 50° to 60°. Within this angle, both eyes observe an object simultaneously. This creates a central field of greater magnitude than that is possible by each eye separately. Within this field images are sharp, depth perception occurs and colour discrimination is possible (Figure 77).

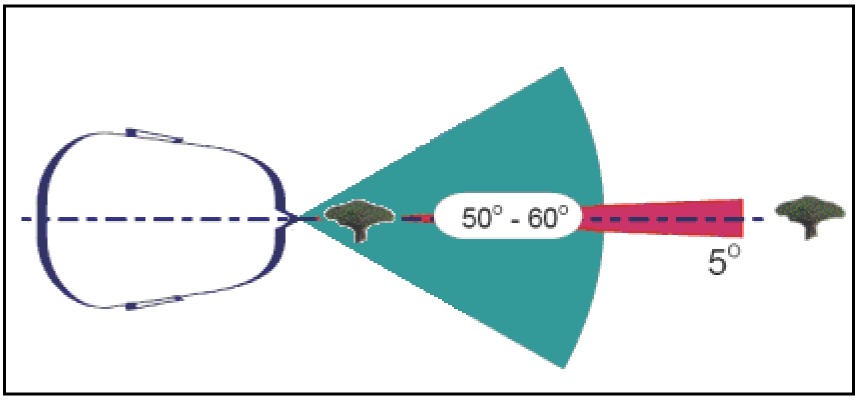

Figure 77: Illustration of a person's central field of vision and the relation between distance from an object and visual impact

The visual impact of any development will vary according to the proportion in which a particular sight of it affects the central field of vision. This in turn is determined by the distance from an object. Objects which take up less that 5% of the central field of vision are usually insignificant in most landscapes (Berry and Martin, 2003).

The degree to which visual impact might be reduced over distance is illustrated by the graph in below (Figure 78). Expressed as a hyperbolic function, more than 50% of the degree of impact is reduced over a relative short distance from the immediate proximity of an object (Table 53).

Table 53: Reduced visibility classified in terms of proximity zones

Proximity Zone (m)	Proximity Impact	%
2500	Very High	100
5000	High	50
10000	Moderate	25
20000	Low	13
Further than 20km	Insignificant	6

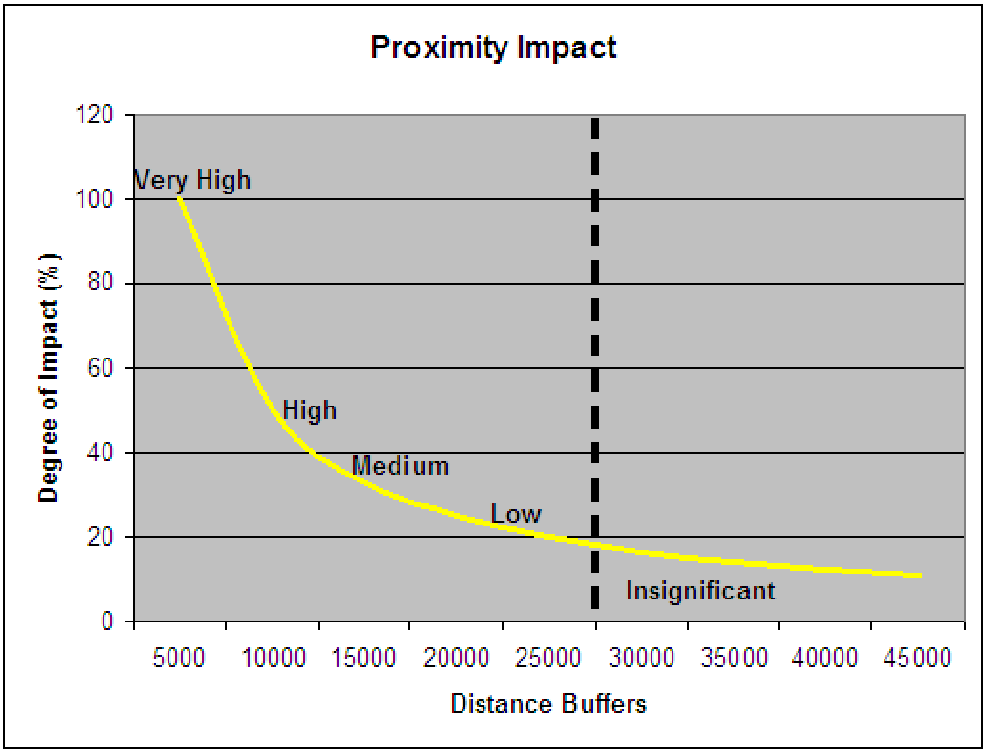

Figure 78. Graph illustrating reduced visibility over distance. (Source: MetroGIS)

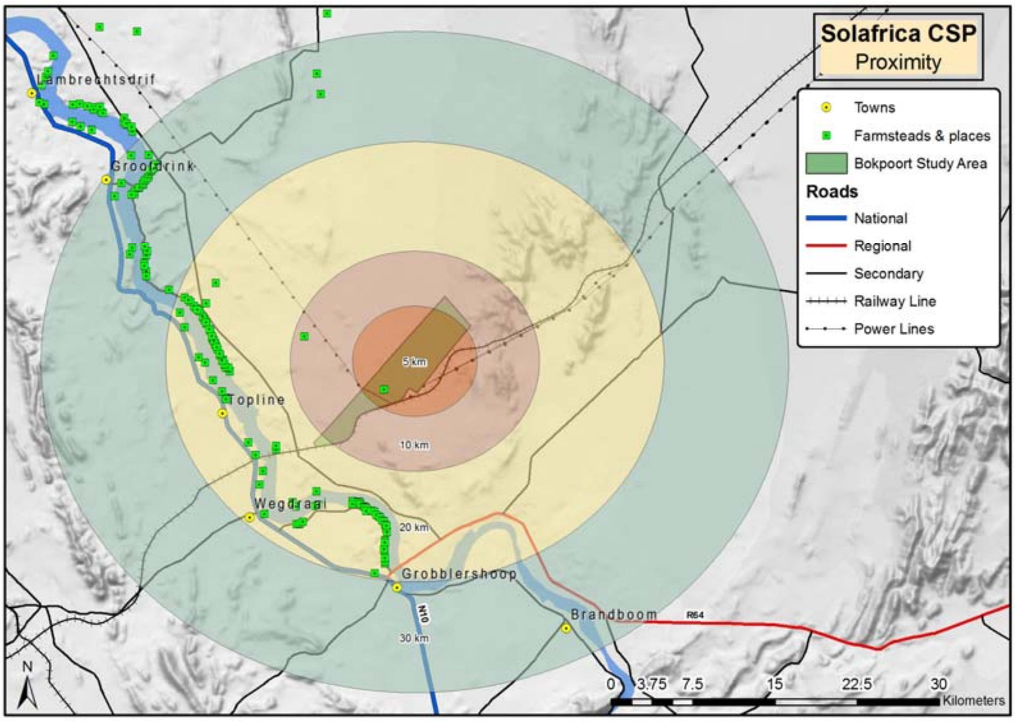

Figure 79: Proximity zones around the CSP site

Possible sensitive viewer locations within the visual catchment of the CSP have been captured from available aerial photography (Google Earth). Notably very few occur within 10 km from the site (refer to the map in Figure 79 above).

It can be concluded that visual impact will vary from low to very high, depending on the position of the viewer, and the distance to the CSP site. Most of the viewer locations are situated further than 10km from the site. Exposure to the CSP from this distance will be minimal, and since other objects such as buildings will occasionally appear in the foreground of a person's view, the impact of the CSP will be moderate to low. In this context the effect of the topography should also be considered, which is further explained under Visual Exposure and Visual Absorption Capacity below.

- **Visual Exposure**

Visual exposure is a function of visibility (line of sight) and the appearance of objects in a particular sight. It answers the question "is it visible?" GIS techniques (viewshed analysis) are used to calculate a surface area from a digital terrain model (DTM), which is an area with the likelihood that a specified object may be visible. Typically, a flat landscape with grass and shrubs will give rise to a high degree of exposure, as opposed to hilly terrain with high trees or dense bush which may effectively screen a development from being visible. Surface features, such as trees or buildings are not incorporated into the model, since the data does not exist and cannot be created due to high costs and time involved. This is not deemed necessary, because of the vast open space characterising the terrain and minimal effect of surface features to obscure visibility.
By incorporating the effect of distance (proximity), the analysis is further enhanced to determine the level of exposure, thereby answering the question "how much of it can it be seen?"

The results of the integrated viewshed and proximity analyses are displayed in a series of maps in Figure 80 to Figure 83. It is evident from these maps that there is little differentiation between the four alternative sites in terms of the spatial pattern of visual exposure, and that the height of structures determine the extent of visual catchment. Large scale visibility is confined to the immediate surroundings of the CSP site, stretching some 10km in a northern and southern direction. Visibility to the north and to the south is capped by the appearance of hills and mountains. The effect of the low lying Orange River valley is clearly noticeable. Being close to the river, most of the sensitive viewer locations are clear of the area of visibility. As the height of components increases, however, the areas of visibility encroach on the N10 road and the residential areas along the road.

<u>Viewshed Analysis for the Collector Assembly</u>

The collector assembly will stand at a maximum height of 6m, and will cover most of the 2.5 km² on site. There is very little exposure to the east and the west, due to the nature of the topography. It is evident from the map that, in terms of viewer locations, the collector assembly will not be visible from any of the four site options.

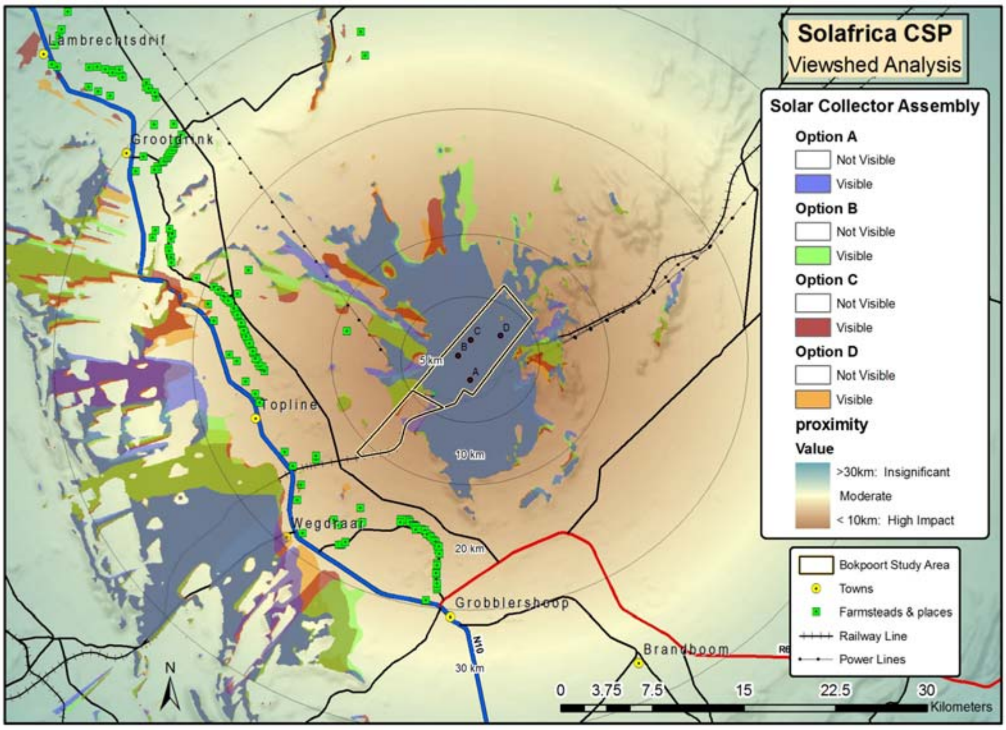

Figure 80: Area of possible exposure to the Collector Assembly

Viewshed Analysis for Heat Exchange Tower

The heat exchange tower is the second tallest structure at 20m above ground. It is a single structure with the highest possibility of large scale exposure beyond 10km. The location of the tower at site option C and D shows a higher degree of exposure to residents and travellers. This exposure is only expected at distances close to 20km and visual impact is expected to be moderate.

This viewshed analysis is the only factor according to which a distinct difference between the three site options is noticed. By virtue of this Option C can be ruled out as an alternative (Figure 81).

Viewshed Analysis for the Cooling Towers

The cooling tower is the third tallest structure at 15m above the ground. The pattern of visibility for this feature shows is similar to the heat exchange tower, as described above (Figure 82).

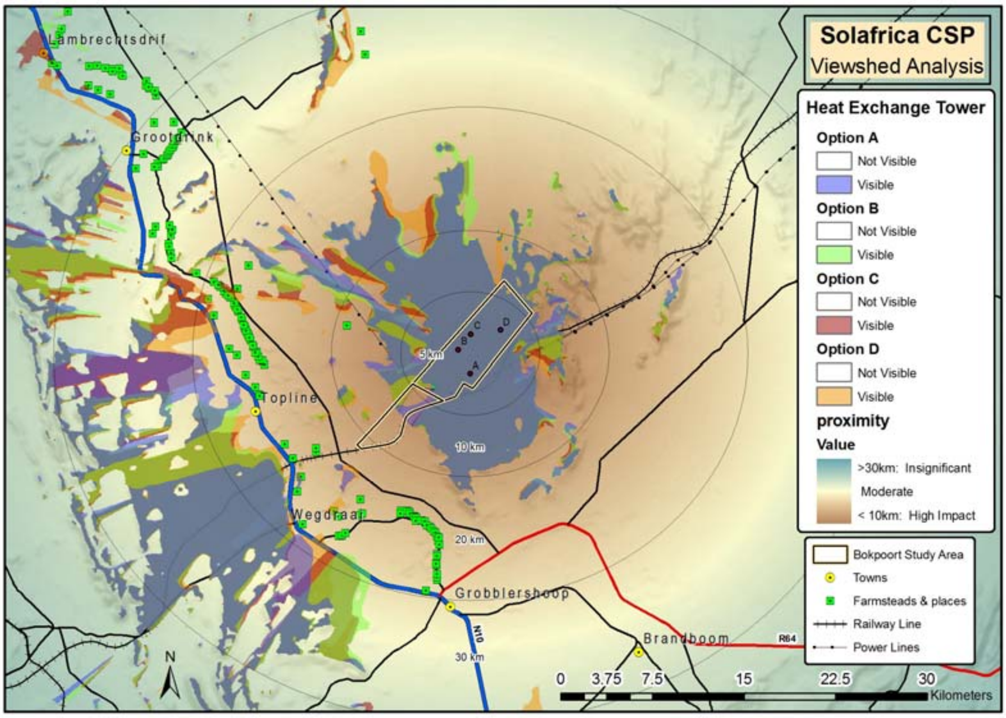

Figure 81: Area of possible exposure to the Heat Exchange Tower

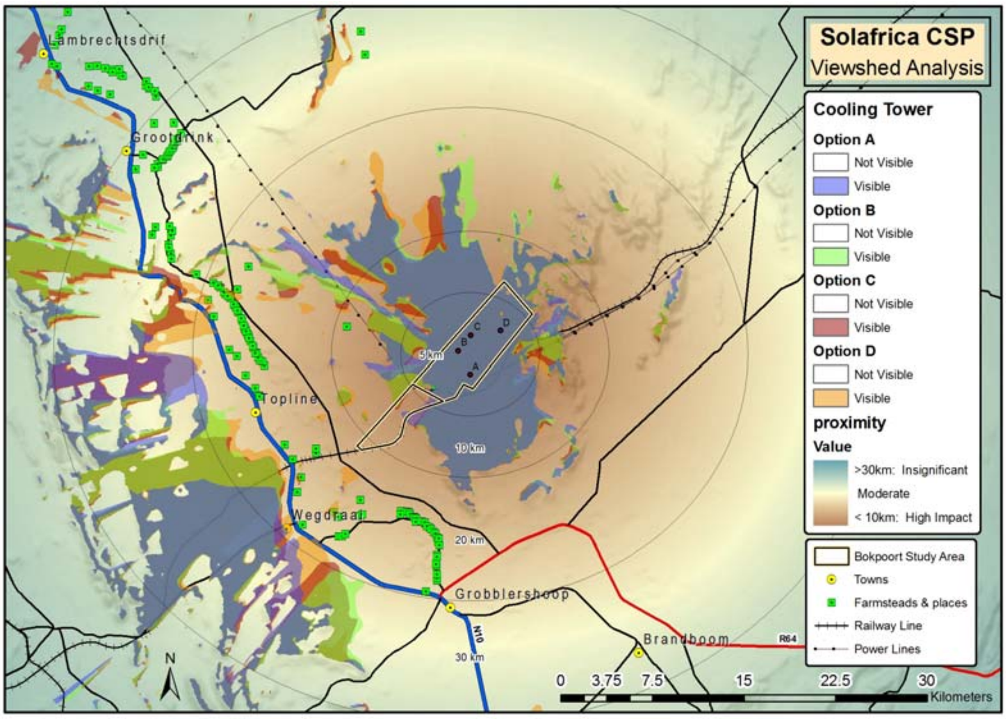

Figure 82: Area of possible exposure to the Cooling Tower

Viewshed Analysis for the Boiler Stack

The boiler stack is the tallest structure at 30m above ground. Evidently the area of visibility is the largest of all components and includes the N10 national road. At a distance of 15 – 25km from the CSP site the boiler stack (with a diameter of 0.5m) will hardly be noticeable, especially since it will be viewed against the backdrop of high mountains to the north-east (Figure 83).

Of concern, however, is the possibility that emissions from the stack, when operated during daytime, may be visible. When operated during night time emissions will be trapped in the cold air of temperature inversions occurring over the low lying river valley, especially during winter. This may be noticeable by sensitive receptors who are accustomed to the unpolluted clean air of this region.

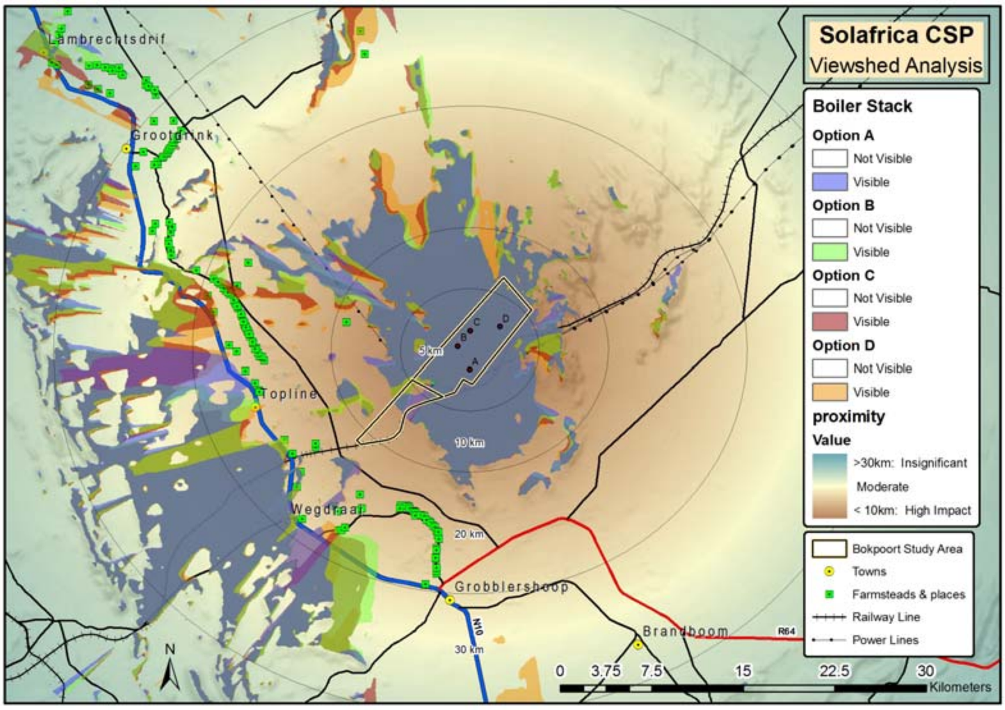

Figure 83: Area of possible exposure to the Boiler Stack

- **Visual Absorption Capacity**

Visual Absorption Capacity (VAC) of the terrain refers to its ability to absorb new elements (development), without any loss of its visual integrity. It indicates if given types of changes are feasible within the area, in terms of its configuration, covering, natural illumination and visibility.

The configuration and covering of the CSP entails a high density development of trough mirrors, towers, generator, buildings, fences and lighting on an area of 2.5km². Given the landscape character of fairly undeveloped land, it is highly improbable that this type of development will be absorbed into the environment without loss of its visual integrity.

As described, the topography around the proposed site offers excellent screening capabilities. The site is flanked by a ridge of high ground to the west and high mountainous terrain to the east. To a large extend these features obscure visibility beyond its topographical setting. With most of the viewer locations situated at lower altitudes, this type of terrain also provides a background which extends higher than the normal horizon. This provides some degree of visual absorption for tall structures such as the heat exchange tower and the boiler stack, as long as it does not extend above the horizon (vertical intrusion).

The effect of the topography is further illustrated by the cross section in Figure 84 and a shaded relief map in Figure 85, which clearly shows high ground to the south and the north of the optional sites for the CSP.

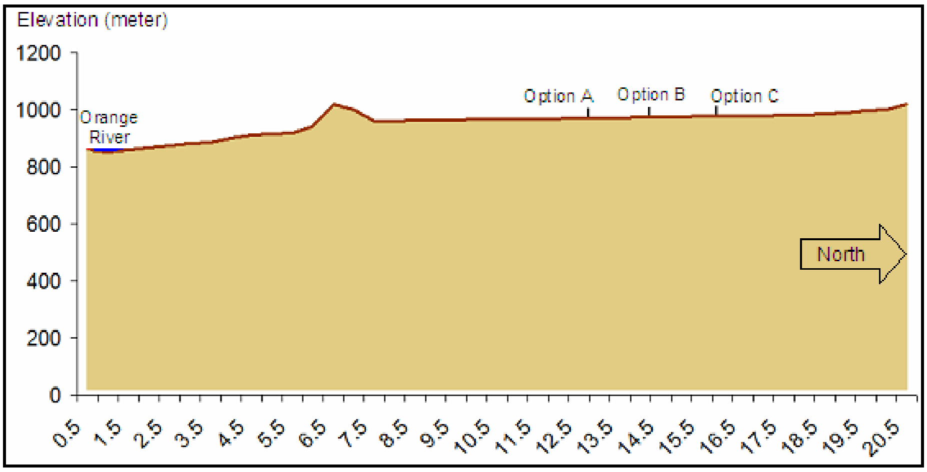

Figure 84: Cross section from north to south, illustrating the location of the CSP in relation to the Orange River basin where most of the viewer locations occur

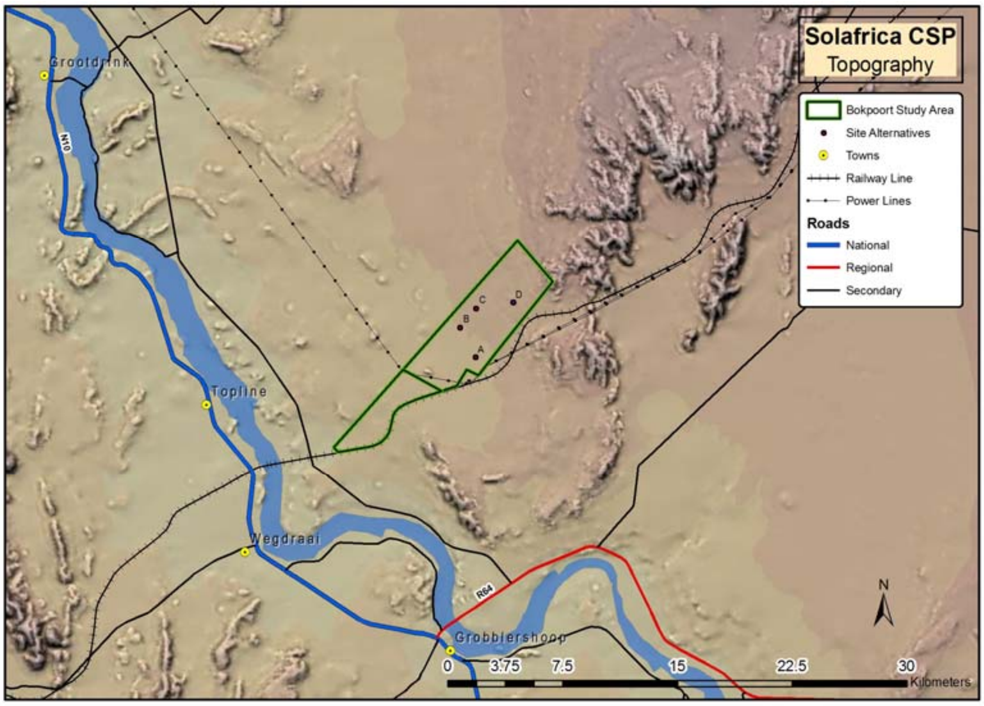

Figure 85: Shaded relief map depicting the topography around the CSP site

6.3.6.6 Preferred Site Selection

Four alternative locations have been indicated as options for the development of the CSP. These options are close to each other on fairly homogenous terrain. This results in the same pattern of visual exposure, as is evident from the viewshed analysis above.

Option A is regarded as the preferred site, since it presents the least possible visual exposure in comparison with the other options. Option B may also be considered as an alternative, bearing similar visibility patterns as Option A.

6.3.6.7 Issues Relating to Visual Impact

The proposed CSP has an inherent visual character with a particular visual impact when exposed. The above analysis, however, indicates a very low probability of exposure because of its location between ridges. Whereas little mitigation measures can be introduced to reduce any possible visual impact, it is important to highlight issues that are regarded as possible nuisance factors. These may create negative perceptions in respect of the CSP in general.

Apart from visual impact, the creation of dust and light pollution is regarded as nuisance factors which are described as follows:

Dust

Dust from construction of the CSP over a period of two years, mainly because of heavy vehicles travelling dirt roads towards the site, has the potential to impact air quality and create a nuisance to other road users in the area. The duration of this impact is regarded as short and could be mitigated by limiting the number of daily trips and avoiding vehicles to approach or depart in short succession of each other.

Lighting

All lighting, especially industrial lighting can have an impact on night time visual conditions. Structures and ground surfaces that are highly illuminated can be clearly visible for long distances, especially on clear nights. The amount of lighting sources is primarily cumulative, with each brightly-lit structure affecting night sky visibility (Sevier County Economic Development Department, 2007).

With regard to the CSP plant, lighting is mainly required for security and limited 24-hour operation purposes. The location of the CSP plant and the surrounding areas is sparsely populated and virtually no viewers occurring in a radius of 10 km. The effects of security and after-hours operational lighting (flood lights), in terms of light trespass and glare, are therefore not significant due to the absence of sensitive visual receptors. This should however not distract from the careful planning and sensitive placement of light fixtures for the facility, designed to contain rather than spread the light. It is still necessary to be pro-active in the mitigation of potential lighting impacts on future developments in the region.

Boiler Stack

Although it is unlikely that the boiler stack in itself will be highly visible, there is some concern with regard to emissions. Depending on the type of fuel that will be used, emissions may cause secondary impacts by virtue of air pollution. Being a rural area far from pollution sources, the study area enjoys clean air which is significant in terms of the sense of place. Being close to a river valley polluted air may be trapped under conditions of temperature inversion. When noticeable and in contrast with the current conditions, this may have an adverse effect impacting on the sense of place. Based on a preliminary investigation the use of LPG has been reiterated - the resultant visual impacts from emissions therefore will be insignificant. Should a further detailed investigation deem the use of LPG as unfeasible then diesel will be used. The impacts of diesel emissions will then be assessed and presented to the DEA.

6.3.6.8 Conclusion

The selection of Bokpoort for the development of a CSP plant is in many aspects ideal. Being close to an existing transmission line and substation, little additional infrastructure which may create cumulative visual impacts is required.

The selected trough technology in itself is highly visible when exposed, but due to the terrain the CSP site is unlikely to be visible from a wide area. The viewshed analysis indicates that most of the CSP components will not be visible from existing viewer loctions, and that only tall structures (20-30 m) might be visible from exposed locations. Its remote location also puts the facility out of range of prominent views, since most viewer locations occur beyond 10 km from the site.

It is concluded that visual impacts, where it may occur, will be moderate to low. Furthermore, the CSP plant can potentially become a tourist attraction and it is advised that the whole development be planned with this in mind.

7 IMPACT ASSESSMENT

7.1 Introduction

As part of the overall project planning process, this Environmental Impact Assessment aims to achieve the following:

- To provide an overall assessment of the social and biophysical environments of the area affected by the proposed establishment of a CSP plant and associated infrastructure;
- To undertake a detailed assessment of the farm Bokpoort in terms of environmental criteria;
- To identify and recommend appropriate mitigation measures for potentially significant environmental impacts, and
- To undertake a fully inclusive public participation process to ensure that I&AP issues and concerns are recorded.

In undertaking the EIA, Bohlweki-SSI were assisted by a number of specialists in order to comprehensively identify both potentially positive and negative environmental impacts (social and biophysical) associated with the project, evaluate the significance of the identified impacts, and propose appropriate mitigation measures, where required. The environmental team identified and evaluated the potential impacts for the nominated preferred site i.e. farm Bokpoort. These specialists and their fields of expertise are outlined in Table 54.

Table 54: Specialist studies undertaken during the EIA

Specialist Field	Specialist and Organisation
Avifauna Impact Assessment	*Chris van Rooyen* – Chris van Rooyen Consulting
Biodiversity Assessment	*Riaan Robbeson* – Bathusi Environmental Consulting) *Dewald Kamffer* - (Faunal Specialists Incorporated)
Geohydrology	*Kobus Troskie* - Groundwater Consulting Services
Noise Impacts	*Derek Cosijn* - Jongens Keet and Associates
Visual Impact Assessment	*Dr. Dawie van Vuuren* - MetroGIS
Air Quality Impact Assessment	*Nicola Walton* – Bohlweki-SSI Environmental
Aquatic Impact Assessment★	*Mathew Ross* – EnviRoss cc
Heritage†	*Cobus Dreyer*
Social and Land Use Study†	*Dawid de Waal* - Afrosearch
Soils and Agricultural Potential†	*Garry Paterson* - Agricultural Research Council: Institute for Soil, Climate and Water

Tourism†	*Martin Jansen van Vuuren* - Grant Thornton Tourism Hospitality and Leisure
Hydrology	*Arthur Chapman* - CSIR

* The Aquatic Impact Assessment was undertaken as part of the Water Use Licence Application

† Specialist studies from the EIA study for the Eskom CSP plant

As Solafrica has the responsibility to avoid or minimise impacts and plan for the management of impacts (in terms of the EIA Regulations), the mitigation of significant impacts was discussed and conclusions and recommendations regarding the preferred sites were drawn.

The significance of potential environmental impacts has been determined through a description of impacts identified during the study, the methodology for rating the impacts as well as a comparative assessment of the proposed plant location alternatives identified. The assessed impacts were originally identified in the Scoping Report. It is acknowledged that assigning significance is a subjective process used to determine environmental impacts associated with development activities. Recognising this, the inputs of the various specialist studies as well as feedback from I&APs and Stakeholders have served to provide a guideline in an attempt to provide an objective assessment of impacts.

7.2 Assumptions and Limitations

The assumptions and limitations on which this study has been based include:

- Assumptions:
  - All information provided by Solafrica, the engineering team, I&APs and Stakeholders to the Bohlweki-SSI were correct and valid at the time it was provided. The consultants and specialist investigators do not accept any responsibility in the event that additional information comes to light at a later stage of the process;
  - The nominated preferred site identified in the Environmental Scoping Study is environmentally, socially, technically and economically viable;
  - All data from unpublished research is valid and accurate, and
  - It is not always possible to involve all interested and affected parties individually. Every effort was, however, made to involve as many broad based representatives of the stakeholders in the nominated area. The assumption has, therefore, been made that those representatives with whom there has been consultation, are acting on behalf of the parties which they represent.

- Limitations:
  - This report and its investigations are project-specific, and consequently the environmental team did not evaluate any other power source alternatives.

7.3 Impact Assessment – Abstraction Point

7.3.1 Methodology

The Aquatic Impact Assessment was undertaken as part of the Water Use Licence - *the impact assessment methodology used by the aquatic specialist is different to the methodology used for the EIA.*

The significance rating (SP) is calculated by the following formula:

SP = Consequence X Probability (P)

where

Consequence = (S + D + I + E) – R

S = Spatial extent
D = Duration
I = Intensity
E = Effects on important ecosystems
R = Reversibility

Table 55: Rating scores for the various factors used for calculating the significance rating of a particular impact

S		D		I		E		R		P	
Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score
Site specific	1	Short (0-15yrs)	1	Low	1	None	1	Irreversible	0	Improbable	1

S		D		I		E		R		P	
Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score
Local	2	Medium (2-15yrs)	2	Medium	3	Negligible	2	Largely irreversible	1	Possible	2
Regional	3	Long (16-30yrs)	3	High	5	Insignificant	3	Somewhat reversible	2	More than likely	3
National	4	Discontinuous	4			Significant	4	Largely reversible	3	Highly probable	4
International	5	Permanent	5			Vast	5	Totally reversible	4	Definite	5

Confidence limits:

The impact ratings are all defined in terms of confidence limits. A High impact rating with a High degree of confidence is considered to have the greatest significance. A High impact rating with a Low confidence rating therefore has a limited significance. It should be noted that a Low degree of confidence could either be attributed to a lack of sufficient data that would allow for accurate measurement of the potential impact, or that the impact falls outside the scope of the survey. This is indicated where applicable.

7.3.2 Impact Ratings of the Proposed Water Abstraction Point

SP Rating	
Low	0-33
Medium	34-74
High	75-100

Table 56: Consolidated impact ratings table for the *Construction Phase*

Potential Environmental Impact	Project activity or issue	Environmental significance *before* mitigation								Environmental significance *after* mitigation							
		S	D	I	E	R	P	Conf	SP	S	D	I	E	R	P	Conf	SP
Riparian Vegetation Impacts	Clearing of riparian vegetation, due to preconstruction activities, leading to habitat loss and potential soil erosion aggravation.	2	1	5	4	2	4	High	**40**	1	1	3	3	3	2	High	**10**
Soil erosion	Soil stripping, soil compaction and vegetation removal will increase rates of erosion and entry of sediment into the general aquatic ecosystem.	2	2	3	3	3	4	High	**28**	1	1	1	2	3	2	High	**4**
Soil erosion	Erosion of stockpiled topsoil & disturbance of soils due to vegetation stripping leading to erosion and habitat smothering.	2	2	3	3	3	4	High	**28**	1	1	1	2	3	2	High	**4**
Habitat destruction	Vegetation removal, soil stripping and dumping leading to habitat loss.	1	4	3	3	3	3	High	**24**	1	1	1	1	4	1	High	**0**
Impacts on aquatic fauna	Direct impacts due to instream destruction for weir construction.	2	5	3	4	1	4	High	**52**	2	5	3	3	1	4	High	**48**

Table 57: Consolidated impact ratings table for the *Operational Phase*

Potential Environmental Impact	Project activity or issue	Environmental significance *before* mitigation								Environmental significance *after* mitigation							
		S	D	I	E	R	P	Conf	SP	S	D	I	E	R	P	Conf	SP
Biodiversity impacts	Exotic vegetation encroachment following soil disturbances.	2	2	1	2	3	3	High	**12**	1	1	1	1	4	1	High	**0**
Biodiversity impacts	Change in hydrological regime due to weir construction leading to modification of aquatic community structures.	3	5	5	4	3	4	High	**64**	1	1	1	2	4	2	High	**2**
Biodiversity impacts	Construction of abstraction weirs that will create a migratory barrier and affect fish community structures.	3	5	5	4	3	4	High	**64**	1	1	1	2	4	2	High	**2**
Soil erosion	Resulting from runoff through poor stormwater drainage management.	2	4	3	3	3	3	High	**36**	1	1	1	2	4	1	High	**1**

7.3.3 Description of Impacts – Construction Phase

7.3.3.1 Riparian Vegetation Impacts

The destruction of areas of riparian vegetation and habitat is inevitable due to the nature of the proposed development that requires vegetation stripping to allow for the establishment of infrastructure. This impact has a duration considered to be permanent. The spatial extent and the effects that it will have on important ecosystems are all dependent, however, on the specific methods employed during the construction phases. Careful planning and restrictions on construction footprint areas will abate negative ecological impacts.

The riparian habitat is dominated by deep sands. This means that any infrastructure development would require deep excavations in order to located stable foundation material (this is an assumption and was not subject to any engineering or geotechnical scrutiny). If this is the case, it will necessitate heavy machinery to be active for longer periods and over a greater footprint within this area, thereby increasing the overall ecological impact. The loose soils are all alluvial in nature and therefore compaction of these soils will alter the dynamics of the riverbanks, potentially influencing erosion features within other areas.

Indiscriminent dumping of excess building material and unnecessary soil and vegetation stripping will also lead to associated habitat destruction. The soils within these areas are highly dispersive, and therefore any disturbances will aggravate soil erosion. This impact can easily be mitigated thorugh the implementation of an EMP as well as general education of construction crews and management.

7.3.3.2 Soil Erosion

Soil erosion of riverbanks following construction activities is a leading cause of habitat destruction that can be easily avoided through careful planning and ecologically-sensitive construction methods. The normally-steep gradient of riverbanks coupled to the scouring effects of the flowing water within the channel means that any disturbances of the riparian soils and vegetation stripping will inevitably lead to soil erosion with the consequence of siltation and smothering of the aquatic habitat. This is an impact that, if left unabated, is ongoing and has an exponential effect as it worsens. It is, however, easily mitigated if planned for and implemented as part of the construction process.

Largescale excavation within riparian areas as well as within the watercourse will lead to erosion if not mitigated and managed on site both before and during the construction process. Follow-up surveys are then also recommended to identify any potential and emerging erosion concerns.

7.3.3.3 Impacts on Aquatic Fauna

The localised associated aquatic habitat is not regarded as an important area for fish or aquatic macro-invertebrate conservation as it does not offer the diversity of habitat required to support a diversity of species. The concerns associated with the proposed development within this area are the disturbance of the sediments during the construction phase, which will lead to siltation and smothering of the aquatic habitat downstream, as well as the potential formation of a migratory barrier through the construction of a weir. These features could significantly alter the dynamics of the system. If a weir is to be constructed that could potentially inhibit migratory behaviour of aquatic organisms, then provision should be made for a fishway, which should be incorporated into the design of the weir.

7.3.3.4 Compaction of Soils

The compaction of soils within the riparian zones will inhibit the natural succession and regeneration of the vegetation layers within these areas. Compaction of soils will also influence the hydrology of the system, potentially creating emerging erosion problems elsewhere. By restricting vehicular access to only designated roadways, this impact can be negated.

7.3.4 Description of Impacts – Operational Phase

The management phase of the proposed development should include follow-up surveys of both the aquatic and riparian habitats to determine the extent of functionality of the mitigation measures provided for during the construction phases of the bridge construction.

7.3.4.1 Biodiversity Impacts

The potential for exotic vegetation encroachment within the riparian zones following the site disturbances through the construction activities is high and therefore mitigation measures should be implemented to manage any recruitment by such species. This will ensure protection of the riparian zones and the retention of natural biodiversity features. Encroachment of exotic vegetation will negatively affect avifaunal diversity within the area as well as leading to aggravated erosion of the riverbanks. This is therefore an important aspect that requires active management. Follow-up surveys should be conducted in order to identify potential development of these impacts to the biodiversity.

The aridity of the surrounding region means that a large seedbank for exotic species is not present within the area. The riparian areas do, however, offer ideal habitat for aggressively-growing exotic species, which will quickly out-compete and displace indigenous species.

7.3.4.2 Soil Erosion

Stormwater management from the increased road surface will require particular attention. The increased surface area of impermeable surfaces will lead to the increased runoff potential of stormwaters that will lead to increased soil erosion of riverbanks if no measures to abate it are implemented. Careful planning by engineers and careful attention to design specifications of stormwater outfalls by construction crews are vital features to successfully mitigate this aspect. It is also recommended that this feature be assessed through follow-up surveys following completion of the construction phase in order to allow for the early identification of any potential development of soil erosion through poor stormwater management.

7.3.5 Mitigation Measures

The following mitigation measures have been proposed by the aquatic specialist for development activities at the abstraction point:

- Any development of infrastructure within the watercourse that could potentially block up and downstream migratory activity of fish and other aquatic biota should incorporate a fishway. The input of a suitably qualified fish ecologist should be sought when the weirs are designed and constructed;
- Particular attention must be paid to controlling soil erosion as siltation will impact on sensitive aquatic habitats downstream of the site;
- Adequate stormwater management must be provided that won't aggravate the erosion of the river banks;
- An Environmental Conservation Officer (ECO) should be present to facilitate watercourse and riparian habitat rehabilitation efforts;
- The ECO should be educated in general river rehabilitation measures and how to identify emerging and potential problems;
- The footprint of the development during the construction phase should be retained as small as possible by construction vehicles being limited to designated roadways only. Destruction of the riparian habitat through the unnecessary clearing of vegetation should be avoided;
- Dumping of any excess rubble, building material or refuse must be prohibited within the riparian habitat. Dumping of materials should only take place at designated and properly managed areas;
- Adequate toilet facilities must be provided for all construction crews to negate informal ablutions taking place within riparian zones;
- Fires within the riparian zones should be prohibited;
- Fishing and hunting of local fauna should be prohibited;
- Exotic vegetation identified presently at the site should be managed;
- Follow-up surveys are recommended to potentially identify emerging impacts following post-construction within both the aquatic and riparian areas. This is important so as to implement any further mitigatory measures required for emerging problems (e.g. soil erosion forming through poor stormwater management feature design, recruitment of exotic vegetation, formation of instream migratory barriers, etc). The appointed ECO should be well-versed in identifying potential emerging environmental concerns.

7.4 Impact Assessment – Plant Location Alternatives (including Roads, Powerline and Pipeline)

7.4.6 Methodology

The evaluation of impacts is conducted in terms of the criteria detailed in Table 58 to Table 62. The various environmental impacts and benefits of this project will be discussed in terms of the status, extent, duration, probability, and intensity of the impact.

- The *nature*, which shall include a description of what causes the effect, what will be affected and how it will be affected;
- The *extent*, wherein it will be indicated whether the impact will be limited to the site of the development activity specifically, limited to the immediate surroundings (local),regional, and/or national;
- The *duration*, wherein it will be indicated whether the lifetime of the impact will be of a short duration (0-5 years), medium-term (5 – 15 years), long-term (> 15 years) or permanent, and
- The *probability*, which shall describe the likelihood of the impact actually occurring, indicated as improbable (low likelihood), probable (distinct possibility), highly probable (most likely) or definite (impact will occur regardless of any preventative measures).

Finally an impact magnitude and *significance* rating is applied to rate each identified impact in terms of its overall magnitude and significance (Table 63).

In order to adequately assess and evaluate the impacts and benefits associated with the project it is necessary to develop a methodology that would scientifically achieve this and to reduce the subjectivity involved in making such evaluations. For informed decision making it is necessary to assess all legal requirements and clearly defined criteria in order to accurately determine the significance of the predicted impact or benefit on the surrounding natural and social environment.

7.4.6.1 Impact Status

The nature or status of the impact is determined by the conditions of the environment prior to construction and operation. A discussion on the nature of the impact will include a description of what causes the effect, what will be affected and how it will be affected. The nature of the impact can be described as negative, positive or neutral.

Table 58: Status of impacts

Rating	Description	Quantitative Rating
Positive	A benefit to the receiving environment.	+

Neutral	No cost or benefit to the receiving environment.	N
Negative	A cost to the receiving environment.	-

7.4.6.2 Spatial Scale

The spatial scale defines physical extent of the impact.

Table 59: Extent of impacts

Rating	Description	Quantitative Rating
None	No impact	0
Low	Site Specific; Occurs within the site boundary.	1
Medium	Local; Extends beyond the site boundary; Affects the immediate surrounding environment (i.e. up to 5km from Project Site boundary).	2
High	Regional; Extends far beyond the site boundary; Widespread effect (i.e. 5km and more from Project Site boundary).	3
Very High	National and/or international; Extends far beyond the site boundary; Widespread effect.	4

7.4.6.3 Temporal Scale

The temporal scale defines the significance of the impact at various time scales, as an indication of the duration of the impact.

Table 60: Duration of impacts

Rating	Description	Quantitative Rating
None	No impact	0
Low	Short term; Quickly reversible; 0 – 5years.	1
Medium	Medium term; Reversible over time; 5 – 15 years.	2

High	Long term; Approximate lifespan of the project: 16 -30 years.	3
Very High	Permanent; over 30 years and resulting in a permanent and lasting change that will remain.	4

7.4.6.4 Probability Scale

The risk or likelihood of all impacts taking place as a result of project actions differs. There is no doubt that some impacts would occur if the road goes ahead, but certain other (usually secondary) impacts are not as likely, and may or may not result from the road. Although these impacts may be severe, the likelihood of them occurring may affect their overall significance and will be taken into account.

Table 61: Probability of impacts

Rating	Description	Quantitative Rating
None	No impact	0
Improbable	Possibility of the impact materialising is negligible; Chance of occurrence <10%.	1
Probable	Possibility that the impact will materialise is likely; Chance of occurrence 10 – 49.9%.	2
Highly Probable	It is expected that the impact will occur; Chance of occurrence 50 – 90%.	3
Definite	Impact will occur regardless of any prevention measures; Chance of occurrence >90%.	4

7.4.6.5 Severity/Beneficial Rating Scale

The severity scale is used in order to scientifically evaluate how severe negative impacts would be, or how beneficial positive impacts would be on a particular affected system or a particular affected party. It is a methodology that attempts to remove any value judgements from the assessment, although it relies on the professional judgement of the specialist.

Table 62: Severity of impacts

Rating	Description	Quantitative Rating
None	No impact	0
Negligible / Minor	The system(s) or party(ies) is marginally affected by the proposed development.	1
Average	Medium or short term impacts on the affected system(s) or party(ies). Mitigation is very easy, cheap, less time consuming or not necessary. For example, a temporary fluctuation in the water table due to water abstraction.	2
Severe	Medium to long term impacts on the affected system(s) or party (ies) that could be mitigated. For example constructing a narrow road through vegetation with a low conservation value.	3
Very Severe	An irreversible and permanent change to the affected system(s) or party(ies) which cannot be mitigated. For example, the permanent change to topography resulting from a quarry.	4

7.4.6.6 Significance Scale

The environmental significance scale is an attempt to evaluate the importance of a particular impact. This evaluation needs to be undertaken in the relevant context, as an impact can either be ecological or social, or both. The evaluation of the significance of an impact relies heavily on the values of the person making the judgement. For this reason, impacts of especially a social nature need to reflect the values of the affected society.

The impact magnitude and significance rating is utilised to rate each identified impact in terms of its overall magnitude and significance. The impact is rated in terms of the following criteria:

Table 63: Impact ratings table

Impact	Rating	Description	Quantitative Rating
Positive	**High**	Of the highest positive order possible within the bounds of impacts that could occur.	**+ 12 – 16**

	Medium	Impact is real, but not substantial in relation to other impacts that might take effect within the bounds of those that could occur. Other means of achieving this benefit are approximately equal in time, cost and effort.	**+ 6 – 11**
	Low	Impacts is of a low order and therefore likely to have a limited effect. Alternative means of achieving this benefit are likely to be easier, cheaper, more effective and less time-consuming.	**+ 1 – 5**
No Impact	**No Impact**	Zero impact.	**0**
Negative	**Low**	Impact is of a low order and therefore likely to have little real effect. In the case of adverse impacts, mitigation is either easily achieved or little will be required, or both. Social, cultural, and economic activities of communities can continue unchanged.	**- 1 – 5**
	Medium	Impact is real, but not substantial in relation to other impacts that might take effect within the bounds of those that could occur. In the case of adverse impacts, mitigation is both feasible and fairly possible. Social cultural and economic activities of communities are changed but can be continued (albeit in a different form). Modification of the project design or alternative action may be required.	**- 6 – 11**
	High	Of the highest order possible within the bounds of impacts that could occur. In the case of adverse impacts, there is no possible mitigation that could offset the impact, or mitigation is difficult, expensive, time-consuming or a combination of these. Social, cultural and economic activities of communities are disrupted to such an extent that these come to a halt.	**- 12 - 16**

Impact assessment for each individual phase of the project, namely the construction and operational phases, is indicated. No closure phase for the proposed development is expected. The table summarises the identified / expected impacts of a proposed activity during each project phase both before and after the proposed mitigations measures.

7.4.7 Impact Ratings of CSP Plant Location Alternatives (including Roads, Powerline and Pipeline)

Table 64: Consolidated impact ratings table for the *Construction Phase*

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
Physical Environment														
Soils	Plant (footprint)	Potential loss of soil types of high agricultural potential	-	1	1	4	4	**-10**	-	1	1	4	4	**-10**
	Road (Garona substation to plant)	Potential loss of soil types of high agricultural potential	-	1	1	3	2	**-7**	-	1	1	1	1	**-4**
	Powerline (Garona substation to plant)	Potential loss of soil types of high agricultural potential	-	1	1	3	2	**-7**	-	1	1	1	1	**-4**
	Pipeline (sections 1 & 2)	Potential loss of soil types of high agricultural potential	-	1	1	3	2	**-7**	-	1	1	1	1	**-4**
	Sub-total (sum)							**-31**						**-22**
Groundwater	All (plant, powerline,	Quantity of waste / overburden	-	1	1	2	2	**-6**	-	1	1	2	2	**-6**

			Alternative A						Alternative B					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Status	Extent	Duration	Probability	Intensity	Significance
	pipeline, road)	Leakage potential and liner / decant, seepage	-	1	1	2	2	-6	-	1	1	2	2	-6
		Toxicity of leakage / seepage	-	2	1	3	3	-9	-	2	1	3	3	-9
		Infiltration potential (permeability and gradient)	-	2	1	1	1	-5	-	2	1	1	1	-5
		Mass transport factor of permeability and gradient	-	2	2	1	1	-6	-	2	2	1	1	-6
		Depth to groundwater (shallow indicates higher risk)	-	2	1	2	2	-7	-	2	1	2	2	-7
		Aquifer vulnerability (sole source aquifer indicates high risk)	-	2	3	2	1	-8	-	2	3	2	1	-8
		Downstream users / receptors (human and aquatic)	-	1	1	2	2	-6	-	1	1	2	2	-6
	Sub-total (sum)							-53						-53
Surface water	All	Potential impact on infiltration	-	1	1	2	2	-6	-	1	1	2	2	-6
		Potential impact on surface water run-off	-	1	1	1	2	-5	-	1	1	1	2	-5

			Alternative A						Alternative B					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Status	Extent	Duration	Probability	Intensity	Significance
		Increased erodibility	-	1	1	2	2	-6	-	1	1	2	2	-6
		Impact on regional and local water resources	-	1	1	1	0	-3	-	1	1	1	0	-3
	Sub-total (sum)							-20						-20
Air Quality		Potential human health risk resulting from increased figutive dust emissions	N	0	0	0	0	0	N	0	0	0	0	0
	Sub-total (sum)							0						0
Biological Environment														
Avifauna	Plant	Disturbance of avifauna	-	1	1	3	1	-6	-	1	1	3	1	-6
		Destruction of faunal habitat	-	1	1	3	3	-8	-	1	1	3	3	-8
		Impact on RD bird species	-	1	1	1	2	-5	-	1	1	1	2	-5
	Powerline (Garona substation to plant)	Disturbance of avifauna	-	1	1	3	1	-6	-	1	1	3	2	-7
		Destruction of faunal habitat	-	1	1	3	1	-6	-	1	1	3	2	-7
		Impact on RD bird species	-	1	1	1	1	-4	-	1	1	1	2	-5

			Alternative A						Alternative B					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Status	Extent	Duration	Probability	Intensity	Significance
	Road (Garona substation to plant)	Disturbance of avifauna	-	1	1	3	1	-6	-	1	1	3	2	-7
		Destruction of faunal habitat	-	1	1	3	1	-6	-	1	1	3	2	-7
		Impact on RD bird species	-	1	1	1	1	-4	-	1	1	1	2	-5
	Pipeline (Section 1 and 2)	Disturbance of avifauna	-	1	1	3	1	-6	-	1	1	3	2	-7
		Destruction of faunal habitat	-	1	1	1	1	-4	-	1	1	1	2	-5
		Impact on RD bird species	-	1	1	1	1	-4	-	1	1	1	2	-5
	Sub-total (sum)							-65						-74
Biodiversity	Plant	**Open Shrub Plains**												
		Direct impacts on Red Data flora	-	4	4	1	3	-12	-	4	4	1	3	-12
		Direct impacts on Red Data fauna	-	4	4	1	3	-12	-	4	4	1	3	-12
		Destruction of sensitive / pristine regional habitat types	-	2	4	1	2	-9	-	2	4	1	2	-9
		Direct impact on common fauna species	-	2	3	2	1	-8	-	2	3	2	1	-8
		Species changes	-	2	3	2	2	-9	-	2	3	2	2	-9

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		Faunal interactions with structures, servitudes and personnel	-	1	3	3	2	**-9**	-	1	3	3	2	**-9**
		Impacts on surrounding habitats	-	1	3	3	2	**-9**	-	1	3	3	2	**-9**
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	2	**-11**	-	2	4	3	2	**-11**
		Increase in environmental degradation	-	2	3	1	2	**-8**	-	2	3	1	2	**-8**
		Sub-total (sum)						**-87**						**-87**
		Calcareous Low Shrub Plains												
		Direct impacts on Red Data flora	-	4	4	1	3	**-12**	-	4	4	1	3	**-12**
		Direct impacts on Red Data fauna	-	4	4	1	3	**-12**	-	4	4	1	3	**-12**
		Destruction of sensitive / pristine regional habitat types	-	3	4	2	2	**-11**	-	3	4	2	2	**-11**
		Direct impact on common fauna species	-	2	3	2	2	**-9**	-	2	3	2	2	**-9**
		Species changes	-	2	3	2	2	**-9**	-	2	3	2	2	**-9**

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		Faunal interactions with structures, servitudes and personnel	-	1	3	3	2	**-9**	-	1	3	3	2	**-9**
		Impacts on surrounding habitats	-	1	3	3	2	**-9**	-	1	3	3	2	**-9**
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	2	**-11**	-	2	4	3	2	**-11**
		Increase in environmental degradation	-	2	3	1	2	**-8**	-	2	3	1	2	**-8**
		Sub-total (sum)						**-90**						**-90**
		Open Shrub Duneveld												
		Direct impacts on Red Data flora	**N**	0	0	0	0	**0**	-	4	4	3	3	**-14**
		Direct impacts on Red Data fauna	**N**	0	0	0	0	**0**	-	4	4	3	3	**-14**
		Destruction of sensitive / pristine regional habitat types	**N**	0	0	0	0	**0**	-	3	4	3	3	**-13**
		Direct impact on common fauna species	**N**	0	0	0	0	**0**	-	2	3	2	2	**-9**
		Species changes	**N**	0	0	0	0	**0**	-	2	3	3	2	**-10**

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		Faunal interactions with structures, servitudes and personnel	**N**	0	0	0	0	**0**	-	1	3	2	3	**-9**
		Impacts on surrounding habitats	**N**	0	0	0	0	**0**	-	1	3	2	3	**-9**
		Increase in local and regional fragmentation / isolation of habitat	**N**	0	0	0	0	**0**	-	3	4	2	2	**-11**
		Increase in environmental degradation	**N**	0	0	0	0	**0**	-	2	3	2	1	**-8**
		Sub-total (sum)						**0**						**-97**
	Road (Garona substation to plant)	**Open Shrub Plains**												
		Direct impacts on Red Data flora	**N**	0	0	0	0	**0**	-	4	4	1	3	**-12**
		Direct impacts on Red Data fauna	**N**	0	0	0	0	**0**	-	4	4	1	3	**-12**
		Destruction of sensitive / pristine regional habitat types	**N**	0	0	0	0	**0**	-	2	4	1	2	**-9**
		Direct impact on common fauna species	**N**	0	0	0	0	**0**	-	2	3	2	1	**-8**
		Species changes	**N**	0	0	0	0	**0**	-	2	3	2	2	**-9**

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		Faunal interactions with structures, servitudes and personnel	**N**	0	0	0	0	**0**	-	1	3	3	2	**-9**
		Impacts on surrounding habitats	**N**	0	0	0	0	**0**	-	1	3	3	2	**-9**
		Increase in local and regional fragmentation / isolation of habitat	**N**	0	0	0	0	**0**	-	2	4	3	2	**-11**
		Increase in environmental degradation	**N**	0	0	0	0	**0**	-	2	3	1	2	**-8**
		Sub-total (sum)						**0**						**-87**
		Calcareous Low Shrub Plains												
		Direct impacts on Red Data flora	-	4	4	1	3	**-12**	-	4	4	1	3	**-12**
		Direct impacts on Red Data fauna	-	4	4	1	3	**-12**	-	4	4	1	3	**-12**
		Destruction of sensitive / pristine regional habitat types	-	3	4	2	2	**-11**	-	3	4	2	2	**-11**
		Direct impact on common fauna species	-	2	3	2	2	**-9**	-	2	3	2	2	**-9**
		Species changes	-	2	3	2	2	**-9**	-	2	3	2	2	**-9**

			Alternative A						Alternative B					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Status	Extent	Duration	Probability	Intensity	Significance
		Faunal interactions with structures, servitudes and personnel	-	1	3	3	2	-9	-	1	3	3	2	-9
		Impacts on surrounding habitats	-	1	3	3	2	-9	-	1	3	3	2	-9
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	2	-11	-	2	4	3	2	-11
		Increase in environmental degradation	-	2	3	1	2	-8	-	2	3	1	2	-8
		Sub-total (sum)						-90						-90
	Powerline	**Open Shrub Plains**												
		Direct impacts on Red Data flora	-	4	4	1	3	-12	-	4	4	1	3	-12
		Direct impacts on Red Data fauna	-	4	4	1	3	-12	-	4	4	1	3	-12
		Destruction of sensitive / pristine regional habitat types	-	2	4	1	2	-9	-	2	4	1	2	-9
		Direct impact on common fauna species	-	2	3	2	1	-8	-	2	3	2	1	-8
		Species changes	-	2	3	2	2	-9	-	2	3	2	2	-9

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		Faunal interactions with structures, servitudes and personnel	-	1	3	3	2	**-9**	-	1	3	3	2	**-9**
		Impacts on surrounding habitats	-	1	3	3	2	**-9**	-	1	3	3	2	**-9**
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	2	**-11**	-	2	4	3	2	**-11**
		Increase in environmental degradation	-	2	3	1	2	**-8**	-	2	3	1	2	**-8**
		Sub-total (sum)						-87						-87
		Calcareous Low Shrub Plains												
		Direct impacts on Red Data flora	-	4	4	1	3	**-12**	-	4	4	1	3	**-12**
		Direct impacts on Red Data fauna	-	4	4	1	3	**-12**	-	4	4	1	3	**-12**
		Destruction of sensitive / pristine regional habitat types	-	3	4	2	2	**-11**	-	3	4	2	2	**-11**
		Direct impact on common fauna species	-	2	3	2	2	**-9**	-	2	3	2	2	**-9**
		Species changes	-	2	3	2	2	**-9**	-	2	3	2	2	**-9**

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		Faunal interactions with structures, servitudes and personnel	-	1	3	3	2	**-9**	-	1	3	3	2	**-9**
		Impacts on surrounding habitats	-	1	3	3	2	**-9**	-	1	3	3	2	**-9**
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	2	**-11**	-	2	4	3	2	**-11**
		Increase in environmental degradation	-	2	3	1	2	**-8**	-	2	3	1	2	**-8**
		Sub-total (sum)						**-90**						**-90**
	Pipeline - Section 1 (pipeline from settling tank to Garona substation)	No impacts expected for the section of the pipeline located within the Transnet service road servitude	**N**	0	0	0	0	**0**	**N**	0	0	0	0	**0**
	Pipeline - Section 2 (pipeline from Garona substation to Water Treatment Works)	**Open Shrub Plains**												
		Direct impacts on Red Data flora	**N**	0	0	0	0	**0**	-	4	4	1	3	**-12**
		Direct impacts on Red Data fauna	**N**	0	0	0	0	**0**	-	4	4	1	3	**-12**
		Destruction of sensitive / pristine regional habitat types	**N**	0	0	0	0	**0**	-	2	4	1	2	**-9**

			Alternative A						Alternative B					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Status	Extent	Duration	Probability	Intensity	Significance
		Direct impact on common fauna species	N	0	0	0	0	0	-	2	3	2	1	-8
		Species changes	N	0	0	0	0	0	-	2	3	2	2	-9
		Faunal interactions with structures, servitudes and personnel	N	0	0	0	0	0	-	1	3	3	2	-9
		Impacts on surrounding habitats	N	0	0	0	0	0	-	1	3	3	2	-9
		Increase in local and regional fragmentation / isolation of habitat	N	0	0	0	0	0	-	2	4	3	2	-11
		Increase in environmental degradation	N	0	0	0	0	0	-	2	3	1	2	-8
		Sub-total (sum)						**0**						**-87**
		Calcareous Low Shrub Plains												
		Direct impacts on Red Data flora	-	4	4	1	3	-12	-	4	4	1	3	-12
		Direct impacts on Red Data fauna	-	4	4	1	3	-12	-	4	4	1	3	-12
		Destruction of sensitive / pristine regional habitat types	-	3	4	2	2	-11	-	3	4	2	2	-11

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		Direct impact on common fauna species	-	2	3	2	2	**-9**	-	2	3	2	2	**-9**
		Species changes	-	2	3	2	2	**-9**	-	2	3	2	2	**-9**
		Faunal interactions with structures, servitudes and personnel	-	1	3	3	2	**-9**	-	1	3	3	2	**-9**
		Impacts on surrounding habitats	-	1	3	3	2	**-9**	-	1	3	3	2	**-9**
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	2	**-11**	-	2	4	3	2	**-11**
		Increase in environmental degradation	-	2	3	1	2	**-8**	-	2	3	1	2	**-8**
		Sub-total (sum)						**-90**						**-90**
Social Environment														
Noise	All	Extent to which the existing noise climate is degraded	-	1	1	1	2	**-5**	-	1	1	2	3	**-7**
		Impact from CSP plant construction activities	-	1	1	3	1	**-6**	-	1	1	3	1	**-6**
		Impact from CSP plant construction	-	1	1	3	2	**-7**	-	1	1	3	2	**-7**

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		traffic												
		Impact from CSP plant construction on farmhouses	-	1	1	1	1	**-4**	-	1	1	1	1	**-4**
		Impact from CSP plant construction on neighbouring farms	-	1	1	2	2	**-6**	-	1	1	2	3	**-7**
	Sub-total (sum)							**-28**						**-31**
Tourism	All	Visual impact on established tourism products and potential tourists	-	1	1	1	1	**-4**	-	1	1	1	1	**-4**
		Impact on present tourism establishments in the area	+	2	1	3	3	**9**	+	2	1	3	3	**9**
		Impact of CSP plant on local traffic	-	1	1	1	1	**-4**	-	1	1	1	1	**-4**
		Impact of CSP plant on the growth of tourism in the area	**N**	0	0	0	0	**0**	**N**	0	0	0	0	**0**
	Sub-total (sum)							**1**						**1**
Heritage	All	Potential impact on heritage and cultural resources	**N**	0	0	0	0	**0**	**N**	0	0	0	0	**0**

			Alternative A						Alternative B					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Status	Extent	Duration	Probability	Intensity	Significance
	Sub-total (sum)							0						0
Social and Land Use	All	Job creation	+	1	1	4	4	10	+	1	1	4	4	10
		Influx of job seekers	+	1	1	3	3	8	+	1	1	3	3	8
		Increased demand for services	-	1	1	4	3	-9	-	1	1	4	3	-9
		Social problems arising from population increase	-	1	2	3	2	-8	-	1	2	3	2	-8
		Impacts of construction and operation on safety and daily movement patterns	-	1	1	3	3	-8	-	1	1	3	3	-8
		Impact on cultivated land	N	0	0	0	0	0	N	0	0	0	0	0
	Plant	Impact on grazing land	-	1	1	3	3	-8	-	1	1	3	3	-8
	Road (Garona substation to plant)	Impact on grazing land	-	1	1	3	1	-6	-	1	1	3	2	-7
	Powerline (Garona substation to plant)	Impact on grazing land	-	1	1	3	1	-6	-	1	1	3	2	-7
	Pipeline (sections 1	Impact on grazing land	-	1	1	3	1	-6	-	1	1	3	2	-7

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
	& 2)													
	Sub-total (sum)							**-33**						**-36**
Visual	Plant	Visual exposure of CSP plant components	-	3	1	1	1	**-6**	-	3	1	2	2	**-8**
		The length of time or duration the proposed CSP plant would be visible to road users	-	3	1	1	1	**-6**	-	3	1	1	1	**-6**
		Length of visual exposure of the facility from major roads	-	3	1	1	1	**-6**	-	3	1	1	1	**-6**
	All	Absence of existing visual clutter	-	1	0	1	1	**-3**	-	1	0	2	3	**-6**
		Level of disturbance of natural vegetation	-	1	1	3	2	**-7**	-	1	1	3	3	**-8**
	Sub-total (sum)							**-28**						**-34**

Table 65: Consolidated impact ratings table for the *Operational Phase*

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
Physical Environment														
Soils	Plant (footprint)	Potential loss of soil types of high agricultural potential	-	1	3	0	0	**-4**	-	1	3	0	0	**-4**
	Road (Garona substation to plant)	Potential loss of soil types of high agricultural potential	-	1	3	0	0	**-4**	-	1	3	0	0	**-4**
	Powerline (Garona substation to plant)	Potential loss of soil types of high agricultural potential	-	1	3	0	0	**-4**	-	1	3	0	0	**-4**
	Pipeline (sections 1 & 2)	Potential loss of soil types of high agricultural potential	-	1	3	0	0	**-4**	-	1	3	0	0	**-4**
	Sub-total (sum)							**-16**						**-16**
Groundwater	All	Quantity of waste / overburden	-	1	1	2	2	**-6**	-	1	1	2	2	**-6**
		Leakage potential and liner / decant, seepage	-	1	3	1	3	**-8**	-	1	3	1	3	**-8**

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		Toxicity of leakage / seepage	-	2	3	1	3	**-9**	-	2	3	1	3	**-9**
		Infiltration potential (permeability and gradient)	-	2	3	1	3	**-9**	-	2	3	1	3	**-9**
		Mass transport factor of permeability and gradient	-	2	3	1	1	**-7**	-	2	3	1	1	**-7**
		Depth to groundwater (shallow indicates higher risk)	-	2	3	1	2	**-8**	-	2	3	1	2	**-8**
		Aquifer vulnerability (sole source aquifer indicates high risk)	-	2	3	1	3	**-9**	-	2	3	1	3	**-9**
		Downstream users / receptors (human and aquatic)	-	1	3	1	3	**-8**	-	1	3	1	3	**-8**
	Sub-total (sum)							**-64**						**-64**
Surface water	All	Potential impact on infiltration	-	1	1	2	2	**-6**	-	1	1	2	2	**-6**
		Potential impact on surface water run-off	-	1	1	1	2	**-5**	-	1	1	1	2	**-5**
		Increased erodibility	-	1	1	2	2	**-6**	-	1	1	2	2	**-6**

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		Impact on regional and local water resources	-	1	1	1	0	**-3**	-	1	1	1	0	**-3**
	Sub-total (sum)							**-20**						**-20**
Air Quality		Potential human health risk resulting from increased figutive dust emissions	**N**	0	0	0	0	**0**	**N**	0	0	0	0	**0**
	Sub-total (sum)							**0**						**0**
Biological Environment														
Avifauna	Plant	Impact on RD bird species	-	1	3	2	2	**-8**	-	1	3	2	2	**-8**
		Collision of birds with trough mirrors	-	1	3	1	4	**-9**	-	1	3	1	4	**-9**
		Burning when in vicinity of focal points	-	1	3	1	4	**-9**	-	1	3	1	4	**-9**
		Nesting	-	1	3	2	3	**-9**	-	1	3	2	3	**-9**
	Powerline (Garona substation to plant)	Collision of birds with powerlines	-	1	3	2	2	**-8**	-	1	3	3	3	**-10**
		Electrocution of birds on pylons	**N**	1	3	Don't kno	Don't kno	**0**	**N**	1	3	Don't kno	Don't kno	**0**

			Alternative A						Alternative B					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Status	Extent	Duration	Probability	Intensity	Significance
						w	w					w	w	
		Nesting of birds on pylons	N	1	3	Don't know	Don't know	0	N	1	3	Don't know	Don't know	0
	Road (Garona substation to plant)	Disturbance of avifauna	-	1	3	3	1	-8	-	1	3	3	3	-10
	Sub-total (sum)							**-51**						**-55**
Biodiversity	Plant	**Open Shrub Plains**												
		Direct impacts on Red Data flora	-	4	4	1	1	**-10**	-	4	4	1	1	**-10**
		Direct impacts on Red Data fauna	-	4	4	1	1	**-10**	-	4	4	1	1	**-10**
		Destruction of sensitive / pristine regional habitat types	-	2	4	1	1	**-8**	-	2	4	1	1	**-8**
		Direct impact on common fauna species	-	2	3	1	0	**-6**	-	2	3	1	0	**-6**
		Species changes	-	2	3	2	1	**-8**	-	2	3	2	1	**-8**

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		Faunal interactions with structures, servitudes and personnel	-	1	3	1	1	**-6**	-	1	3	1	1	**-6**
		Impacts on surrounding habitats	-	1	3	3	1	**-8**	-	1	3	3	1	**-8**
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	1	**-10**	-	2	4	3	1	**-10**
		Increase in environmental degradation	-	2	3	0	1	**-6**	-	2	3	0	1	**-6**
		Sub-total (sum)						-72						-72
		Calcareous Low Shrub Plains												
		Direct impacts on Red Data flora	-	4	4	1	1	**-10**	-	4	4	1	1	**-10**
		Direct impacts on Red Data fauna	-	4	4	1	1	**-10**	-	4	4	1	1	**-10**
		Destruction of sensitive / pristine regional habitat types	-	2	4	1	1	**-8**	-	2	4	1	1	**-8**
		Direct impact on common fauna species	-	2	3	1	0	**-6**	-	2	3	1	0	**-6**
		Species changes	-	2	3	2	1	**-8**	-	2	3	2	1	**-8**

			Alternative A						Alternative B					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Status	Extent	Duration	Probability	Intensity	Significance
		Faunal interactions with structures, servitudes and personnel	-	1	3	1	1	-6	-	1	3	1	1	-6
		Impacts on surrounding habitats	-	1	3	3	1	-8	-	1	3	3	1	-8
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	1	-10	-	2	4	3	1	-10
		Increase in environmental degradation	-	2	3	0	1	-6	-	2	3	0	1	-6
		Sub-total (sum)						-72						-72
		Open Shrub Duneveld												
		Direct impacts on Red Data flora	N	0	0	0	0	0	-	4	4	1	1	-10
		Direct impacts on Red Data fauna	N	0	0	0	0	0	-	4	4	1	1	-10
		Destruction of sensitive / pristine regional habitat types	N	0	0	0	0	0	-	3	4	1	1	-9
		Direct impact on common fauna species	N	0	0	0	0	0	-	2	3	1	0	-6
		Species changes	N	0	0	0	0	0	-	2	3	2	1	-8

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		Faunal interactions with structures, servitudes and personnel	**N**	0	0	0	0	**0**	-	1	3	1	1	**-6**
		Impacts on surrounding habitats	**N**	0	0	0	0	**0**	-	1	3	3	1	**-8**
		Increase in local and regional fragmentation / isolation of habitat	**N**	0	0	0	0	**0**	-	3	4	3	1	**-11**
		Increase in environmental degradation	**N**	0	0	0	0	**0**	-	2	3	0	1	**-6**
		Sub-total (sum)						**0**						**-74**
	Road (Garona substation to plant)	**Open Shrub Plains**												
		Direct impacts on Red Data flora	**N**	0	0	0	0	**0**	-	4	4	1	1	**-10**
		Direct impacts on Red Data fauna	**N**	0	0	0	0	**0**	-	4	4	1	1	**-10**
		Destruction of sensitive / pristine regional habitat types	**N**	0	0	0	0	**0**	-	2	4	1	1	**-8**
		Direct impact on common fauna species	**N**	0	0	0	0	**0**	-	2	3	1	0	**-6**
		Species changes	**N**	0	0	0	0	**0**	-	2	3	2	1	**-8**

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		Faunal interactions with structures, servitudes and personnel	**N**	0	0	0	0	**0**	-	1	3	1	1	**-6**
		Impacts on surrounding habitats	**N**	0	0	0	0	**0**	-	1	3	3	1	**-8**
		Increase in local and regional fragmentation / isolation of habitat	**N**	0	0	0	0	**0**	-	2	4	3	1	**-10**
		Increase in environmental degradation	**N**	0	0	0	0	**0**	-	2	3	0	1	**-6**
		Sub-total (sum)						**0**						**-72**
		Calcareous Low Shrub Plains												
		Direct impacts on Red Data flora	-	4	4	1	1	**-10**	-	4	4	1	1	**-10**
		Direct impacts on Red Data fauna	-	4	4	1	1	**-10**	-	4	4	1	1	**-10**
		Destruction of sensitive / pristine regional habitat types	-	2	4	1	1	**-8**	-	2	4	1	1	**-8**
		Direct impact on common fauna species	-	2	3	1	0	**-6**	-	2	3	1	0	**-6**
		Species changes	-	2	3	2	1	**-8**	-	2	3	2	1	**-8**

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		Faunal interactions with structures, servitudes and personnel	-	1	3	1	1	**-6**	-	1	3	1	1	**-6**
		Impacts on surrounding habitats	-	1	3	3	1	**-8**	-	1	3	3	1	**-8**
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	1	**-10**	-	2	4	3	1	**-10**
		Increase in environmental degradation	-	2	3	0	1	**-6**	-	2	3	0	1	**-6**
		Sub-total (sum)						**-72**						**-72**
	Powerline	**Open Shrub Plains**												
		Direct impacts on Red Data flora	-	4	4	1	1	**-10**	-	4	4	1	1	**-10**
		Direct impacts on Red Data fauna	-	4	4	1	1	**-10**	-	4	4	1	1	**-10**
		Destruction of sensitive / pristine regional habitat types	-	2	4	1	1	**-8**	-	2	4	1	1	**-8**
		Direct impact on common fauna species	-	2	3	1	0	**-6**	-	2	3	1	0	**-6**
		Species changes	-	2	3	2	1	**-8**	-	2	3	2	1	**-8**

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		Faunal interactions with structures, servitudes and personnel	-	1	3	1	1	**-6**	-	1	3	1	1	**-6**
		Impacts on surrounding habitats	-	1	3	3	1	**-8**	-	1	3	3	1	**-8**
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	1	**-10**	-	2	4	3	1	**-10**
		Increase in environmental degradation	-	2	3	0	1	**-6**	-	2	3	0	1	**-6**
		Sub-total (sum)						**-72**						**-72**
		Calcareous Low Shrub Plains												
		Direct impacts on Red Data flora	-	4	4	1	1	**-10**	-	4	4	1	1	**-10**
		Direct impacts on Red Data fauna	-	4	4	1	1	**-10**	-	4	4	1	1	**-10**
		Destruction of sensitive / pristine regional habitat types	-	2	4	1	1	**-8**	-	2	4	1	1	**-8**
		Direct impact on common fauna species	-	2	3	1	0	**-6**	-	2	3	1	0	**-6**
		Species changes	-	2	3	2	1	**-8**	-	2	3	2	1	**-8**

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		Faunal interactions with structures, servitudes and personnel	-	1	3	1	1	**-6**	-	1	3	1	1	**-6**
		Impacts on surrounding habitats	-	1	3	3	1	**-8**	-	1	3	3	1	**-8**
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	1	**-10**	-	2	4	3	1	**-10**
		Increase in environmental degradation	-	2	3	0	1	**-6**	-	2	3	0	1	**-6**
		Sub-total (sum)						-72						-72
	Pipeline - Section 1 (pipeline from settling tank to Garona substation)	No impacts expected for the section of the pipeline located within the Transnet service road servitude	**N**	0	0	0	0	**0**	**N**	0	0	0	0	**0**
	Pipeline - Section 2 (pipeline from Garona substation to Water Treatment Works)	**Open Shrub Plains**												
		Direct impacts on Red Data flora	**N**	0	0	0	0	**0**	-	4	4	1	1	**-10**
		Direct impacts on Red Data fauna	**N**	0	0	0	0	**0**	-	4	4	1	1	**-10**
		Destruction of sensitive / pristine regional habitat types	**N**	0	0	0	0	**0**	-	2	4	1	1	**-8**

			Alternative A						Alternative B					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Status	Extent	Duration	Probability	Intensity	Significance
		Direct impact on common fauna species	N	0	0	0	0	0	-	2	3	1	0	-6
		Species changes	N	0	0	0	0	0	-	2	3	2	1	-8
		Faunal interactions with structures, servitudes and personnel	N	0	0	0	0	0	-	1	3	1	1	-6
		Impacts on surrounding habitats	N	0	0	0	0	0	-	1	3	3	1	-8
		Increase in local and regional fragmentation / isolation of habitat	N	0	0	0	0	0	-	2	4	3	1	-10
		Increase in environmental degradation	N	0	0	0	0	0	-	2	3	0	1	-6
		Sub-total (sum)						**0**						**-72**
		Calcareous Low Shrub Plains												
		Direct impacts on Red Data flora	-	4	4	1	1	-10	-	4	4	1	1	-10
		Direct impacts on Red Data fauna	-	4	4	1	1	-10	-	4	4	1	1	-10
		Destruction of sensitive / pristine regional habitat types	-	2	4	1	1	-8	-	2	4	1	1	-8

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		Direct impact on common fauna species	-	2	3	1	0	**-6**	-	2	3	1	0	**-6**
		Species changes	-	2	3	2	1	**-8**	-	2	3	2	1	**-8**
		Faunal interactions with structures, servitudes and personnel	-	1	3	1	1	**-6**	-	1	3	1	1	**-6**
		Impacts on surrounding habitats	-	1	3	3	1	**-8**	-	1	3	3	1	**-8**
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	1	**-10**	-	2	4	3	1	**-10**
		Increase in environmental degradation	-	2	3	0	1	**-6**	-	2	3	0	1	**-6**
		Sub-total (sum)						**-72**						**-72**
Social Environment														
Noise	Plant	Extent to which the existing noise climate is degraded (reducing the impact of the new Plant)	-	1	3	2	2	**-8**	-	1	3	3	3	**-10**
		Impact from CSP Plant operations on urban areas	**N**	0	0	0	0	**0**	**N**	0	0	0	0	**0**

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		Impact from CSP Plant operations on settlements	-	1	3	1	1	**-6**	-	1	3	1	1	**-6**
		Impact from CSP Plant operations on farmhouses	-	1	3	1	2	**-7**	-	1	3	1	2	**-7**
		Impact from CSP Plant operational traffic	-	1	3	1	0	**-5**	-	1	3	1	0	**-5**
		Impact from CSP Plant on neighbouring farms	-	1	3	2	3	**-9**	-	1	3	2	3	**-9**
		Extent to which the existing noise climate is degraded (reducing the impact of the new Plant)	-	1	3	2	2	**-8**	-	1	3	3	3	**-10**
	Sub-total (sum)							**-35**						**-37**
Tourism	Plant	Visual impact on established tourism products and potential tourists	-	2	1	1	1	**-5**	-	2	1	1	1	**-5**
		Impact on present tourism establishments in the area	+	2	3	2	1	**8**	+	2	3	2	1	**8**
		Impact of CSP plant on local traffic	-	2	1	1	1	**-5**	-	2	1	1	1	**-5**

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		Impact of CSP plant on the growth of tourism in the area	**N**	0	0	0	0	**0**	**N**	0	0	0	0	**0**
	Sub-total (sum)							**-2**						**-2**
Heritage	All	Potential impact on heritage and cultural resources	**N**	0	0	0	0	**0**	**N**	0	0	0	0	**0**
	Sub-total ((sum)							**0**						**0**
Social and Land Use	All	Social impacts derived from environmental benefits of solar power	**+**	4	3	3	4	**14**	**+**	4	3	3	4	**14**
		Social impacts derived from economic benefits of solar power	**+**	4	3	3	4	**14**	**+**	4	3	3	4	**14**
		Job creation	**+**	1	3	4	3	**11**	**+**	1	3	4	3	**11**
		Increased demand for services	**-**	1	2	4	2	**-9**	**-**	1	2	4	2	**-9**
		Social investment initiatives by Solafrica	**+**	1	3	3	2	**9**	**+**	1	3	3	2	**9**
		Impacts of construction and operation on safety and daily movement patterns:	**-**	1	3	3	1	**-8**	**-**	1	3	3	1	**-8**

			Alternative A						Alternative B					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		Hazards imposed by the power station	-	1	3	1	2	**-7**	-	1	3	1	2	**-7**
		Effect on sense of place	-	3	3	2	3	**-11**	-	3	3	2	3	**-11**
	Plant	Impact on grazing land	-	1	3	0	0	**-4**	-	1	3	0	0	**-4**
	Road (Garona substation to plant)	Impact on grazing land	-	1	3	0	0	**-4**	-	1	3	0	0	**-4**
	Powerline (Garona substation to plant)	Impact on grazing land	-	1	3	0	0	**-4**	-	1	3	0	0	**-4**
	Pipeline (sections 1 & 2)	Impact on grazing land	-	1	3	0	0	**-4**	-	1	3	0	0	**-4**
	Sub-total (sum)							**-3**						**-3**
Visual	Plant	Visual exposure of CSP plant components	-	3	3	1	1	**-8**	-	3	3	2	3	**-11**
		The length of time or duration the proposed CSP plant would be visible to road users	-	3	3	1	1	**-8**	-	3	3	2	3	**-11**
		Length of visual exposure of the facility from major roads	-	3	3	1	1	**-8**	-	3	3	2	3	**-11**

			Alternative A						Alternative B					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Status	Extent	Duration	Probability	Intensity	Significance
	All	Absence of existing visual clutter	-	1	0	1	1	-3	-	1	0	2	3	-6
	Powerline (Garona substation to plant)	Distance from existing transmission line infrastructure	-	1	0	2	1	-4	-	1	0	2	3	-6
	Sub-total (sum)							-31						-45

7.4.8 Preferred alternative

The following summary of impact significance and mitigation potential has been included in order to obtain an overview of the severity of impacts for each alternative based on a quantitative calculation.

Table 66: Summary of impact significance for alternatives considered

	Sub-Total			
	Alternative A	Alternative B	Alternative A	Alternative B
Specialist	**Construction Phase**		**Operational Phase**	
Surface Water	-20	-20	-20	-20
Groundwater	-53	-53	-64	-64
Soils	-31	-22	-84	-84
Air Quality	0	0	0	0
Biodiversity	-534	-805	-432	-650
Avifauna	-65	-74	-51	-55
Noise	-28	-31	-35	-37
Tourism	1	1	-2	-2
Heritage	0	0	0	0
Social and Land Use	-33	-36	-3	-3
Visual	-28	-34	-31	-45
Total	**-791**	**-1074**	**-722**	**-960**

As reflected in Table 66, there is a clear indication that the impact significance varies between the two plant location alternatives (during both the construction and operational phases of the proposed development).

It is noteworthy to mention that all the alternatives considered indicate equivalent impact significance ratings for positive impacts which are principally related to socio-economic impacts.

It is evident from the impact significance summary (above) that the impacts associated with the development of ***Alternative A*** is considered to be of lowest severity compared to ***Alternative B***. The reason plant location alternative B scored higher on severity is primarily due to the additional area/footprint likely to be affected by infrastructure associated with this plant location alternative and its corresponding environmental impacts (refer to Table 67).

Table 67: Extent of area likely to be affected by plant location alternatives

	Alternative A			Alternative B		
	Length (m)	Width (m)	Area (ha)	Length (m)	Width (m)	Area (ha)
Plant footprint			**350**			**350**
Water pipeline*	1,600	3	**0.48**	3,900	3	**1.17**
Powerline Line	900	100	**9**	3,467	100	**34.67**
Road**	1000	8	**0.8**	3,800	8	**3.04**
		Total area	**360.28**			**388.88**

** -Only section of water pipeline outside the Transnet servitude.*
*** - Excluding existing Transnet Service road and Provincial road.*

Therefore for purpose of the EIA Process, ***Alternative A*** is considered to be the *'preferred' location alternative*.

7.4.9 Impact Ratings of CSP Plant Development After Mitigation – Plant Location A

To follow is an impact analysis of ***Alternative A*** (preferred) considering various measures to mitigate each of the impacts associated with this alternative. Table 68 and Table 69 indicates the degree of mitigation of each of the impacts identified during the EIA phase.

Table 68: Consolidated impact ratings table for the *Construction Phase* (after mitigation)

			Alternative A (before mitigation)							Alternative B (after mitigation)					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Mitigation	Status	Extent	Duration	Probability	Intensity	Significance
Physical Environment															
Soils	Plant (footprint)	Potential loss of soil types of high agricultural potential	-	1	1	4	4	**-10**	1. No soil stripping must take place on areas within the site that the contractor does not require for construction works or areas of retained vegetation. 2. Subsoil and overburden should, in all construction and lay down areas, be stockpiled separately to be returned for backfilling in the correct soil horizon order. 3. Should any topsoil become polluted the contractor must remove the polluted soil to the full depth of pollution and replace it at his own expense with approved topsoil which should be at least equal to Department of Agriculture approved topsoil specifications. 4. Construction vehicles must only be allowed to utilise existing tracks or pre-planned access routes. 5. Stockpiles should be kept clear of weeds and alien vegetation growth by regular weeding.	-	1	1	2	2	**-6**
	Road (Garona substation to plant)	Potential loss of soil types of high agricultural potential	-	1	1	3	2	**-7**		-	1	1	2	1	**-5**
	Powerline (Garona substation to plant)	Potential loss of soil types of high agricultural potential	-	1	1	3	2	**-7**		-	1	1	2	1	**-5**
	Pipeline (sections 1 & 2)	Potential loss of soil types of high agricultural potential	-	1	1	3	2	**-7**		-	1	1	2	1	**-5**
	Sub-total (sum)							**-31**							**-21**
Groundwater	All	Quantity of waste / overburden	-	1	1	2	2	**-6**	1. Controlled use and or storage of materials, fuels and chemicals which could potentially leak into the ground. 2. All storage tanks containing hazardous materials must be placed in bunded containment areas with sealed surfaces. The bund walls must be high enough to contain 110% of the total volume of the	-	1	1	1	1	-4
		Leakage potential and liner / decant, seepage	-	1	1	2	2	**-6**		-	1	1	1	1	-4
		Toxicity of leakage / seepage	-	2	1	3	3	**-9**		-	2	1	1	1	-5

			Alternative A (before mitigation)							Alternative B (after mitigation)					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Mitigation	Status	Extent	Duration	Probability	Intensity	Significance
		Infiltration potential (permeability and gradient)	-	2	1	1	1	-5	stored hazardous material. 3. The ELO should be responsible for ensuring that potentially harmful materials are properly stored in a dry, secure environment, with concrete or sealed flooring and a means of preventing unauthorised entry. 4. Adequate sanitary facilities and ablutions must be provided for construction workers (1 toilet per every 15 workers).	-	2	1	0	0	-3
		Mass transport factor of permeability and gradient	-	2	2	1	1	-6		-	2	2	1	1	-6
		Depth to groundwater (shallow indicates higher risk)	-	2	1	2	2	-7		-	2	1	1	1	-5
		Aquifer vulnerability (sole source aquifer indicates high risk)	-	2	3	2	1	-8		-	2	3	1	1	-7
		Downstream users / receptors (human and aquatic)	-	1	1	2	2	-6		-	1	1	1	1	-4
	Sub-total (sum)							**-53**							**-38**
Surface water	All	Potential impact on infiltration	-	1	1	2	2	-6	1. Cement contaminated water must not enter the water system as this disturbs the natural acidity of the soil and affects plant growth 2. Site staff shall not be permitted to use any other open water body or natural water source adjacent to or within the designated site for the purposes of bathing, washing of clothing or for any construction or related activities. 3. Adequate measures will be put into place to control surface water flows across and around all construction sites. 4. The quantity of uncontaminated stormwater entering cleared areas will be minimised by appropriate site design and by installation of control structures and drains which direct such flows away from cleared areas and slopes to stable (vegetated) areas or effective treatment installations. 5. Site drainage lines will be identified and control measures installed to handle predicted stormwater.	-	1	1	1	0	-3
		Potential impact on surface water run-off	-	1	1	1	2	-5		-	1	1	1	0	-3
		Increased erodibility	-	1	1	2	2	-6		-	1	1	1	0	-3
		Impact on regional and local water resources	-	1	1	1	0	-3		-	1	1	1	0	-3
	Sub-total (sum)							**-20**							**-20**

			Alternative A (before mitigation)							Alternative B (after mitigation)					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Mitigation**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
Air Quality	All	Potential human health risk resulting from increased fugitive dust emissions	**N**	0	0	0	0	**0**	The following mitigation measures are proposed as best practice: 1. Retention of vegetation where possible will reduce dust travel 2. Excavations and other clearing activities must only be done during agreed working times and permitting weather conditions to avoid drifting of sand and dust into neighbouring areas. 3. Damping down of all exposed soil surfaces with a water bowser or sprinklers when necessary to reduce dust. 4. Blasting must be carried out in accordance with legislation using optimal and not excessive quantities of explosives. Blasting should only occur on calm days in order to reduce dust carry. The geotechnical report indicated that the probability of blasting is low. 5. The Contractor shall be responsible for dust control on site to ensure no nuisance is caused to the Landowner or neighbouring Communities. 6. A speed limit of 30km/h must not be exceeded. 7. Ensure that batching plants are fitted with the appropriate filters. 8. Spoil dumps will be positioned such that they are not vulnerable to wind erosion.	**N**	0	0	0	0	**0**
	Sub-total (sum)							**0**							**0**
Biological Environment															
Avifauna	Plant	Disturbance of avifauna	-	1	1	3	1	**-6**	1. A monitoring programme must be developed to monitor the impacts of the construction of the CSP plant on Avifauna. This monitoring programme should be set up in conjunction with the DEA / NC DENC.	-	1	1	2	1	**-5**
		Destruction of faunal habitat	-	1	1	3	3	**-8**		-	1	1	2	2	**-6**
		Impact on RD bird species	-	1	1	1	2	**-5**		-	1	1	1	1	**-4**
	Powerline (Garona	Disturbance of avifauna	-	1	1	3	1	**-6**		-	1	1	2	1	**-5**

			Alternative A (before mitigation)							Alternative B (after mitigation)					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Mitigation**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
	substation to plant)	Destruction of faunal habitat	-	1	1	3	1	**-6**	2. Demarcation of sensitive areas prior to construction activities starting	-	1	1	0	0	**-2**
		Impact on RD bird species	-	1	1	1	1	**-4**		-	1	1	0	0	**-2**
	Road (Garona substation to plant)	Disturbance of avifauna	-	1	1	3	1	**-6**		-	1	1	2	0	**-4**
		Destruction of faunal habitat	-	1	1	3	1	**-6**		-	1	1	2	0	**-4**
		Impact on RD bird species	-	1	1	1	1	**-4**		-	1	1	0	0	**-2**
	Pipeline (Section 1 and 2)	Disturbance of avifauna	-	1	1	3	1	**-6**		-	1	1	2	0	**-4**
		Destruction of faunal habitat	-	1	1	1	1	**-4**		-	1	1	0	0	**-2**
		Impact on RD bird species	-	1	1	1	1	**-4**		-	1	1	0	0	**-2**
	Sub-total (sum)							**-65**							**-42**
Biodiversity	Plant	**Open Shrub Plains**													
		Direct impacts on Red Data flora	-	4	4	1	3	**-12**	1. During the construction phase workers must be limited to areas under construction and access to the undeveloped areas, especially the surrounding open areas must be strictly regulated ("no-go" areas during construction activities 2. Protected or endangered species of plants shall not be removed unless they are interfering with a structure. Where such species have to be removed due to interference with a structure, the necessary permission and permits shall be obtained from Provincial Nature Conservation. 3. All natural areas impacted during construction must be rehabilitated with locally indigenous grasses. 4. The construction site / servitude must be well demarcated and no construction activities must be allowed outside of this demarcated footprint. 5. Vegetation removal must be phased in order to reduce impact of construction. 6. Construction site office and laydown areas must be	-	4	3	1	1	**-9**
		Direct impacts on Red Data fauna	-	4	4	1	3	**-12**		-	4	3	1	1	**-9**
		Destruction of sensitive / pristine regional habitat types	-	2	4	1	2	**-9**		-	2	3	1	1	**-7**
		Direct impact on common fauna species	-	2	3	2	1	**-8**		-	2	3	1	1	**-7**
		Species changes	-	2	3	2	2	**-9**		-	2	3	1	1	**-7**
		Faunal interactions with structures, servitudes and personnel	-	1	3	3	2	**-9**		-	1	3	1	1	**-6**
		Impacts on surrounding habitats	-	1	3	3	2	**-9**		-	1	3	1	1	**-6**
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	2	**-11**		-	2	4	1	1	**-8**
		Increase in environmental	-	2	3	1	2	**-8**		-	2	3	1	1	**-7**

Issue	Development Aspect	Specific Impact	Alternative A (before mitigation) Status	Extent	Duration	Probability	Intensity	Significance	Mitigation	Alternative B (after mitigation) Status	Extent	Duration	Probability	Intensity	Significance
		degradation							clearly demarcated and no encroachment must occur beyond demarcated areas.						
		Sub-total (sum)						-87							-66
		Calcareous Low Shrub Plains													
		Direct impacts on Red Data flora	-	4	4	1	3	-12	Same as above	-	4	3	1	1	-9
		Direct impacts on Red Data fauna	-	4	4	1	3	-12		-	4	3	1	1	-9
		Destruction of sensitive / pristine regional habitat types	-	3	4	2	2	-11		-	2	3	1	1	-7
		Direct impact on common fauna species	-	2	3	2	2	-9		-	2	3	1	1	-7
		Species changes	-	2	3	2	2	-9		-	2	3	1	1	-7
		Faunal interactions with structures, servitudes and personnel	-	1	3	3	2	-9		-	1	3	1	1	-6
		Impacts on surrounding habitats	-	1	3	3	2	-9		-	1	3	1	1	-6
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	2	-11		-	2	4	1	1	-8
		Increase in environmental degradation	-	2	3	1	2	-8		-	2	3	1	1	-7
		Sub-total (sum)						-90							-66
		Open Shrub Duneveld													
		Direct impacts on Red Data flora	N	0	0	0	0	0	No mitigation required	N	0	0	0	0	0
		Direct impacts on Red Data fauna	N	0	0	0	0	0		N	0	0	0	0	0
		Destruction of sensitive / pristine	N	0	0	0	0	0		N	0	0	0	0	0

			Alternative A (before mitigation)							Alternative B (after mitigation)					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Mitigation**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		regional habitat types													
		Direct impact on common fauna species	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Species changes	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Faunal interactions with structures, servitudes and personnel	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Impacts on surrounding habitats	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Increase in local and regional fragmentation / isolation of habitat	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Increase in environmental degradation	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Sub-total (sum)						**0**							**0**
	Road (Garona substation to plant)	**Open Shrub Plains**													
		Direct impacts on Red Data flora	**N**	0	0	0	0	**0**	No mitigation required	**N**	0	0	0	0	**0**
		Direct impacts on Red Data fauna	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Destruction of sensitive / pristine regional habitat types	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Direct impact on common fauna species	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Species changes	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Faunal interactions with structures, servitudes and personnel	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Impacts on surrounding habitats	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**

			Alternative A (before mitigation)							Alternative B (after mitigation)					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Mitigation	Status	Extent	Duration	Probability	Intensity	Significance
		Increase in local and regional fragmentation / isolation of habitat	N	0	0	0	0	0		N	0	0	0	0	0
		Increase in environmental degradation	N	0	0	0	0	0		N	0	0	0	0	0
		Sub-total (sum)					0								0
		Calcareous Low Shrub Plains													
		Direct impacts on Red Data flora	-	4	4	1	3	-12	Same as above	-	4	3	1	1	-9
		Direct impacts on Red Data fauna	-	4	4	1	3	-12		-	4	3	1	1	-9
		Destruction of sensitive / pristine regional habitat types	-	3	4	2	2	-11		-	2	3	1	1	-7
		Direct impact on common fauna species	-	2	3	2	2	-9		-	2	3	1	1	-7
		Species changes	-	2	3	2	2	-9		-	2	3	1	1	-7
		Faunal interactions with structures, servitudes and personnel	-	1	3	3	2	-9		-	1	3	1	1	-6
		Impacts on surrounding habitats	-	1	3	3	2	-9		-	1	3	1	1	-6
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	2	-11		-	2	4	1	1	-8
		Increase in environmental degradation	-	2	3	1	2	-8		-	2	3	1	1	-7
		Sub-total (sum)						-90							-66
	Powerline	Open Shrub Plains													
		Direct impacts on Red Data flora	-	4	4	1	3	-12	Same as above	-	4	3	1	1	-9

			Alternative A (before mitigation)							Alternative B (after mitigation)					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Mitigation	Status	Extent	Duration	Probability	Intensity	Significance
		Direct impacts on Red Data fauna	-	4	4	1	3	-12		-	4	3	1	1	-9
		Destruction of sensitive / pristine regional habitat types	-	2	4	1	2	-9		-	2	3	1	1	-7
		Direct impact on common fauna species	-	2	3	2	1	-8		-	2	3	1	1	-7
		Species changes	-	2	3	2	2	-9		-	2	3	1	1	-7
		Faunal interactions with structures, servitudes and personnel	-	1	3	3	2	-9		-	1	3	1	1	-6
		Impacts on surrounding habitats	-	1	3	3	2	-9		-	1	3	1	1	-6
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	2	-11		-	2	4	1	1	-8
		Increase in environmental degradation	-	2	3	1	2	-8		-	2	3	1	1	-7
		Sub-total (sum)						-87							-66
		Calcareous Low Shrub Plains													
		Direct impacts on Red Data flora	-	4	4	1	3	-12	Same as above	-	4	3	1	1	-9
		Direct impacts on Red Data fauna	-	4	4	1	3	-12		-	4	3	1	1	-9
		Destruction of sensitive / pristine regional habitat types	-	3	4	2	2	-11		-	2	3	1	1	-7
		Direct impact on common fauna species	-	2	3	2	2	-9		-	2	3	1	1	-7
		Species changes	-	2	3	2	2	-9		-	2	3	1	1	-7
		Faunal interactions with structures, servitudes and	-	1	3	3	2	-9		-	1	3	1	1	-6

			Alternative A (before mitigation)							Alternative B (after mitigation)					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Mitigation	Status	Extent	Duration	Probability	Intensity	Significance
		personnel													
		Impacts on surrounding habitats	-	1	3	3	2	-9		-	1	3	1	1	-6
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	2	-11		-	2	4	1	1	-8
		Increase in environmental degradation	-	2	3	1	2	-8		-	2	3	1	1	-7
		Sub-total (sum)						-90							-66
	Pipeline - Section 1 (pipeline from settling tank to Garona substation)	No impacts expected for the section of the pipeline located within the Transnet service road servitude	**N**	0	0	0	0	**0**	Same as above	**N**	0	0	0	0	**0**
	Pipeline - Section 2 (pipeline from Garona substation to Water Treatment Works)	**Open Shrub Plains**													
		Direct impacts on Red Data flora	-	4	4	1	3	-12	Same as above	-	4	3	1	1	-9
		Direct impacts on Red Data fauna	-	4	4	1	3	-12		-	4	3	1	1	-9
		Destruction of sensitive / pristine regional habitat types	-	2	4	1	2	-9		-	2	3	1	1	-7
		Direct impact on common fauna species	-	2	3	2	1	-8		-	2	3	1	1	-7
		Species changes	-	2	3	2	2	-9		-	2	3	1	1	-7
		Faunal interactions with structures, servitudes and personnel	-	1	3	3	2	-9		-	1	3	1	1	-6
		Impacts on surrounding habitats	-	1	3	3	2	-9		-	1	3	1	1	-6
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	2	-11		-	2	4	1	1	-8

Issue	Development Aspect	Specific Impact	Alternative A (before mitigation) Status	Extent	Duration	Probability	Intensity	Significance	Mitigation	Alternative B (after mitigation) Status	Extent	Duration	Probability	Intensity	Significance
		Increase in environmental degradation	-	2	3	1	2	-8		-	2	3	1	1	-7
		Sub-total (sum)						-87							-66
		Calcareous Low Shrub Plains													
		Direct impacts on Red Data flora	-	4	4	1	3	-12	Same as above	-	4	3	1	1	-9
		Direct impacts on Red Data fauna	-	4	4	1	3	-12		-	4	3	1	1	-9
		Destruction of sensitive / pristine regional habitat types	-	3	4	2	2	-11		-	2	3	1	1	-7
		Direct impact on common fauna species	-	2	3	2	2	-9		-	2	3	1	1	-7
		Species changes	-	2	3	2	2	-9		-	2	3	1	1	-7
		Faunal interactions with structures, servitudes and personnel	-	1	3	3	2	-9		-	1	3	1	1	-6
		Impacts on surrounding habitats	-	1	3	3	2	-9		-	1	3	1	1	-6
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	2	-11		-	2	4	1	1	-8
		Increase in environmental degradation	-	2	3	1	2	-8		-	2	3	1	1	-7
		Sub-total (sum)						-90							-66
Social Environment															
Noise	All	Extent to which the existing noise climate is degraded	-	1	1	1	2	-5	1. With regard to unavoidable very noisy construction activities in the vicinity of noise sensitive areas, the contractor should liaise with local residents on how	-	1	1	1	1	-4

			Alternative A (before mitigation)							Alternative B (after mitigation)					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Mitigation	Status	Extent	Duration	Probability	Intensity	Significance
		Impact from CSP plant construction activities	-	1	1	3	1	-6	best to minimise the impact. 2. Construction site yards and other noisy fixed facilities should be located well away from noise sensitive areas adjacent to the development sites. Once the final CSP plant layout and water and powerline alignments are made available by the contractor(s), the sites must be evaluated in detail and specific measures designed into the system. 3. In general, operations should meet the noise standard requirements of the Occupational Health and Safety Act (Act No 85 of 1993). 4. Construction activities are to be contained to reasonable hours during the day and early evening. Night-time activities near noise sensitive areas should not be allowed.	-	1	1	1	1	-4
		Impact from CSP plant construction traffic	-	1	1	3	2	-7		-	1	1	1	1	-4
		Impact from CSP plant construction on farmhouses	-	1	1	1	1	-4		-	1	1	1	1	-4
		Impact from CSP plant construction on neighbouring farms	-	1	1	2	2	-6		-	1	1	1	1	-4
	Sub-total (sum)							-28							-20
Tourism	All	Visual impact on established tourism products and potential tourists	-	1	1	1	1	-4	1. Lighting must be subtle and not disturb passing motorists and surrounding residents. 2. Visual screening would reduce the visibility of the CSP plant, if possible. 3. Consider opening the CSP plant to visitors on certain days/times. This could also serve as an educational tool, to inform visitors on the safety and workings of an operational power plant. This way the CSP plant could enhance the tourism industry in the area. Strategic positioning of entry and exit points to ensure as little effect as possible on the traffic.	-	1	1	0	0	-3
		Impact on present tourism establishments in the area	+	2	1	3	3	9		+	2	1	3	4	10
		Impact of CSP plant on local traffic	-	1	1	1	1	-4		-	1	1	1	1	-4
		Impact of CSP plant on the growth of tourism in the area	N	0	0	0	0	0		N	0	0	0	0	0
	Sub-total (sum)							1							3
Heritage	All	Potential impact on heritage and cultural resources	N	0	0	0	0	0	No mitigation required	N	0	0	0	0	0
	Sub-total ((sum)							0							0
Social and	All	Job creation	+	1	1	4	4	10	1. Ensure that employment procedures / policy are	+	1	1	4	4	10

			Alternative A (before mitigation)							Alternative B (after mitigation)					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Mitigation**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
Land Use		Influx of job seekers	+	1	1	3	3	**8**	communicated to local stakeholders, especially community representative organisations and ward councillors. 2. Unskilled job opportunities should be afforded to local community members. Local trade unions could assist with the recruitment process to counteract the potential for social mobilisation. 3. Equal opportunities for employment should be created to ensure that the local female population also have access to these opportunities. Females should be encouraged to apply for positions. Implementation of safety measures, work procedures and first aid must be implemented on site. 4. A health and safety plan in terms of the Occupational Health and Safety Act (Act No. 85 of 1993) must be drawn up to ensure worker safety. 5. Workers should be thoroughly trained in using potentially dangerous equipment	+	1	1	3	3	**8**
		Increased demand for services	-	1	1	4	3	**-9**		-	1	1	1	1	**-4**
		Social problems arising from population increase	-	1	2	3	2	**-8**		-	1	2	1	1	**-5**
		Impacts of construction and operation on safety and daily movement patterns	-	1	1	3	3	**-8**		-	1	1	1	1	**-4**
		Impact on cultivated land	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
	Plant	Impact on grazing land	-	1	1	3	3	**-8**		-	1	1	3	3	**-8**
	Road (Garona substation to plant)	Impact on grazing land	-	1	1	3	1	**-6**		-	1	1	3	1	**-6**
	Powerline (Garona substation to plant)	Impact on grazing land	-	1	1	3	1	**-6**		-	1	1	3	1	**-6**
	Pipeline (sections 1 & 2)	Impact on grazing land	-	1	1	3	1	**-6**		-	1	1	3	1	**-6**
	Sub-total (sum)							**-33**							**-21**
Visual	Plant	Visual exposure of CSP plant components	-	3	1	1	1	**-6**	1. Reduce the construction period through careful planning and productive implementation of resources. 2. Restrict the activities and movement of construction workers and vehicles to the immediate construction site. 3. Ensure that the general appearance of construction activities, construction camps (if required) and lay-down areas are maintained by means of the timely removal of rubble and disused construction materials. 4. Restrict construction activities in populated places to daylight hours (where possible) in order to negate or reduce the visual impacts associated with lighting.	-	2	1	1	1	**-5**
		The length of time or duration the proposed CSP plant would be visible to road users	-	3	1	1	1	**-6**		-	2	1	1	1	**-5**
		Length of visual exposure of the facility from major roads	-	3	1	1	1	**-6**		-	2	1	1	1	**-5**
	All	Absence of existing visual clutter	-	1	0	1	1	**-3**		-	1	0	1	1	**-3**
		Level of disturbance of natural vegetation	-	1	1	3	2	**-7**		-	1	1	3	1	**-6**
	Sub-total (sum)							**-28**							**-25**

Table 69: Consolidated impact ratings table for the *Operational Phase* (after mitigation)

Issue	Development Aspect	Specific Impact	Alternative A (before mitigation) Status	Extent	Duration	Probability	Intensity	Significance	Mitigation	Alternative A (after mitigation) Status	Extent	Duration	Probability	Intensity	Significance
Physical Environment															
Soils	Plant (footprint)	Potential loss of soil types of high agricultural potential	-	1	3	0	0	-4	No mitigation required.	-	1	3	0	0	-4
	Road (Garona substation to plant)	Potential loss of soil types of high agricultural potential	-	1	3	0	0	-4		-	1	3	0	0	-4
	Powerline (Garona substation to plant)	Potential loss of soil types of high agricultural potential	-	1	3	0	0	-4		-	1	3	0	0	-4
	Pipeline (sections 1 & 2)	Potential loss of soil types of high agricultural potential	-	1	3	0	0	-4		-	1	3	0	0	-4
	Sub-total (sum)							**-16**							**-16**
Groundwater	All	Quantity of waste / overburden	-	1	1	2	2	-6	1. All water discharged from the works including effluent from wash water and stormwater from workshops and refuelling areas, as well as all runoff from areas with pollution potential will comply with national effluent standards. 2. All chemical/hydrocarbon storage areas must be bunded. This bund water must be removed from site by a licensed contractor. 3. All plant and chemical usage areas must be paved. 4. Potentially contaminated water must be directed to an oil/water separator. Oily water must be removed from the site by a licensed contractor. 5. Spills of potential contaminants must be immediately cleaned up and neutralised. Such spills must be handled with consideration to health and safety considerations. 6. Spill response procedures to include removal/disposal of potentially contaminated water and any used absorbent materials.	-	1	1	0	0	-2
		Leakage potential and liner / decant, seepage	-	1	3	1	3	-8		-	1	3	0	0	-4
		Toxicity of leakage / seepage	-	2	3	1	3	-9		-	2	1	0	0	-3
		Infiltration potential (permeability and gradient)	-	2	3	1	3	-9		-	2	3	0	0	-5
		Mass transport factor of permeability and gradient	-	2	3	1	1	-7		-	2	3	0	0	-5
		Depth to groundwater (shallow indicates higher risk)	-	2	3	1	2	-8		-	2	3	0	0	-5
		Aquifer vulnerability (sole source aquifer indicates high risk)	-	2	3	1	3	-9		-	2	3	0	0	-5
		Downstream users / receptors (human and aquatic)	-	1	3	1	3	-8		-	1	3	0	0	-4

			Alternative A (before mitigation)							Alternative A (after mitigation)					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Mitigation**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
	Sub-total (sum)							**-64**							**-33**
Surface water	All	Potential impact on infiltration	-	1	1	2	2	**-6**	Same as above.	-	1	1	0	0	**-2**
		Potential impact on surface water run-off	-	1	1	1	2	**-5**		-	1	1	0	0	**-2**
		Increased erodibility	-	1	1	2	2	**-6**		-	1	1	0	0	**-2**
		Impact on regional and local water resources	-	1	1	1	0	**-3**		-	1	1	0	0	**-2**
	Sub-total (sum)							**-20**							**-8**
Air Quality	All	Potential human health risk resulting from increased figutive dust emissions	**N**	0	0	0	0	**0**	1. Dust control mechanisms must be utilised to reduce the amount of dust being released. 2. Any dirt roads that are utilised by the contractor to access the site must be regularly maintained to ensure that dust levels are controlled. 3. The CSP plant's equipment must be performance tested during the commissioning phase to ensure that the manufacturer's standard has been delivered in respect of air emissions.	**N**	0	0	0	0	**0**
	Sub-total (sum)							**0**							**0**
Biological Environment															
Avifauna	Plant	Impact on RD bird species	-	1	3	2	2	**-8**	1. A monitoring programme must be developed to monitor the impacts of the construction of the CSP plant on Avifauna. This monitoring programme should be set up in conjunction with the DEA / NC DENC. 2. Marking the relevant sections of the powerline line with appropriate marking devices. These sections of line will be identified as part of the EMP phase, once the exact alignment is known.	-	1	3	1	1	**-6**
		Collision of birds with trough mirrors	-	1	3	1	4	**-9**		-	1	3	1	1	**-6**
		Burning when in vicinity of focal points	-	1	3	1	4	**-9**		-	1	3	1	1	**-6**
		Nesting	-	1	3	2	3	**-9**		-	1	3	1	2	**-7**
	Powerline (Garona substation to plant)	Collision of birds with powerlines	-	1	3	2	2	**-8**		-	1	3	1	1	**-6**
		Electrocution of birds on pylons	**N**	1	3	Don 't	Don 't	**0**		**N**	1	3	Don 't	Don't know	**0**

			Alternative A (before mitigation)							Alternative A (after mitigation)					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Mitigation	Status	Extent	Duration	Probability	Intensity	Significance
						know	know						know		
		Nesting of birds on pylons	N	1	3	Don't know	Don't know	0		N	1	3	Don't know	Don't know	0
	Road (Garona substation to plant)	Disturbance of avifauna	-	1	3	3	1	-8		-	1	3	1	1	-6
	Sub-total (sum)							-51							-37
Biodiversity	Plant	Open Shrub Plains													
		Direct impacts on Red Data flora	-	4	4	1	1	-10	1. All damaged areas shall be rehabilitated upon completion of the contract in accordance with design specifications. In accordance with the Conservation of Agricultural Resources Act, Act No 43 of 1983, slopes in excess of 2% must be contoured and slopes in excess of 12% must be terraced. Extra seed shall be sown on disturbed areas as directed by the ECO (see below for specifications). Other methods of rehabilitating disturbed sites may also be used at the discretion of the Project Manager to comply with the conditions of the EA and EMP, e.g. stone pitching, logging, etc. Contour banks shall be spaced according to the slopes. The type of soil shall also be taken into consideration. 2. A mixture of vegetation seed can be used provided the mixture is carefully selected to ensure the following: a) Annual and perennial species are chosen. b) Pioneer species are included. c) All the species shall not be edible. d) Species chosen will grow in the area under natural conditions.	-	4	4	1	1	-10
		Direct impacts on Red Data fauna	-	4	4	1	1	-10		-	4	4	0	0	-8
		Destruction of sensitive / pristine regional habitat types	-	2	4	1	1	-8		-	4	4	0	0	-8
		Direct impact on common fauna species	-	2	3	1	0	-6		-	2	4	0	0	-6
		Species changes	-	2	3	2	1	-8		-	2	3	0	0	-5
		Faunal interactions with structures, servitudes and personnel	-	1	3	1	1	-6		-	2	3	0	0	-5
		Impacts on surrounding habitats	-	1	3	3	1	-8		-	1	3	0	0	-4
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	1	-10		-	1	3	0	0	-4
		Increase in environmental degradation	-	2	3	0	1	-6		-	2	4	0	0	-6

			Alternative A (before mitigation)							Alternative A (after mitigation)					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Mitigation	Status	Extent	Duration	Probability	Intensity	Significance
									e) Root systems must have a binding effect on the soil. f) The final product should not cause an ecological imbalance in the area. 3. To get the best results in a specific area, it is a good idea to consult with a vegetation specialist or the local Extension Officer of the Dept of Agriculture. Seed distributors can also give valuable advice as to the mixtures and amount of seed necessary to seed a certain area. 4. All natural areas impacted during construction must be rehabilitated with locally indigenous grasses. 5. Fragmentation must be kept to a minimum. Rehabilitation of the final servitude will ensure that fragmentation is kept to a minimum. 6. Rehabilitation must take place as soon as construction is complete to avoid the edge effect, the infiltration of alien species and soil erosion within the servitude. 7. Rehabilitation process must make use of species indigenous to the area. Seeds from surrounding seed banks can be used for re-seeding.						
		Sub-total (sum)						**-72**							**-56**
		Calcareous Low Shrub Plains													
		Direct impacts on Red Data flora	-	4	4	1	1	**-10**	Same as above	-	4	4	1	1	**-10**
		Direct impacts on Red Data fauna	-	4	4	1	1	**-10**		-	4	4	0	0	**-8**
		Destruction of sensitive / pristine regional habitat types	-	2	4	1	1	**-8**		-	4	4	0	0	**-8**
		Direct impact on common fauna species	-	2	3	1	0	**-6**		-	2	4	0	0	**-6**

			Alternative A (before mitigation)							Alternative A (after mitigation)					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Mitigation	Status	Extent	Duration	Probability	Intensity	Significance
		Species changes	-	2	3	2	1	**-8**		-	2	3	0	0	**-5**
		Faunal interactions with structures, servitudes and personnel	-	1	3	1	1	**-6**		-	2	3	0	0	**-5**
		Impacts on surrounding habitats	-	1	3	3	1	**-8**		-	1	3	0	0	**-4**
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	1	**-10**		-	1	3	0	0	**-4**
		Increase in environmental degradation	-	2	3	0	1	**-6**		-	2	4	0	0	**-6**
		Sub-total (sum)						-72							-56
		Open Shrub Duneveld													
		Direct impacts on Red Data flora	**N**	0	0	0	0	**0**	No mitigation required	**N**	0	0	0	0	**0**
		Direct impacts on Red Data fauna	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Destruction of sensitive / pristine regional habitat types	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Direct impact on common fauna species	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Species changes	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Faunal interactions with structures, servitudes and personnel	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Impacts on surrounding habitats	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Increase in local and regional fragmentation / isolation of habitat	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Increase in environmental	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**

			Alternative A (before mitigation)							Alternative A (after mitigation)					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Mitigation	Status	Extent	Duration	Probability	Intensity	Significance
		degradation													
		Sub-total (sum)						**0**							**0**
	Road (Garona substation to plant)	**Open Shrub Plains**													
		Direct impacts on Red Data flora	**N**	0	0	0	0	**0**	No mitigation required	**N**	0	0	0	0	**0**
		Direct impacts on Red Data fauna	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Destruction of sensitive / pristine regional habitat types	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Direct impact on common fauna species	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Species changes	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Faunal interactions with structures, servitudes and personnel	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Impacts on surrounding habitats	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Increase in local and regional fragmentation / isolation of habitat	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Increase in environmental degradation	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Sub-total (sum)						**0**							**0**
		Calcareous Low Shrub Plains													
		Direct impacts on Red Data flora	-	4	4	1	1	**-10**	1. All damaged areas shall be rehabilitated upon completion of the contract in accordance with design specifications. In accordance with the Conservation of Agricultural Resources Act, Act No 43 of 1983, slopes in excess of 2% must be contoured and slopes in excess of 12% must be terraced. Extra seed shall be	-	4	4	1	1	-10
		Direct impacts on Red Data fauna	-	4	4	1	1	**-10**		-	4	4	0	0	**-8**
		Destruction of sensitive / pristine regional habitat types	-	2	4	1	1	**-8**		-	4	4	0	0	**-8**

			Alternative A (before mitigation)							Alternative A (after mitigation)					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Mitigation**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		Direct impact on common fauna species	-	2	3	1	0	**-6**	sown on disturbed areas as directed by the ECO (see below for specifications). Other methods of rehabilitating disturbed sites may also be used at the discretion of the Project Manager to comply with the conditions of the EA and EMP, e.g. stone pitching, logging, etc. Contour banks shall be spaced according to the slopes. The type of soil shall also be taken into consideration. 2. A mixture of vegetation seed can be used provided the mixture is carefully selected to ensure the following: g) Annual and perennial species are chosen. h) Pioneer species are included. i) All the species shall not be edible. j) Species chosen will grow in the area under natural conditions. k) Root systems must have a binding effect on the soil. l) The final product should not cause an ecological imbalance in the area. 3. To get the best results in a specific area, it is a good idea to consult with a vegetation specialist or the local Extension Officer of the Dept of Agriculture. Seed distributors can also give valuable advice as to the mixtures and amount of seed necessary to seed a certain area. 4. All natural areas impacted during construction must be rehabilitated with locally indigenous grasses. 5. Fragmentation must be kept to a minimum. Rehabilitation of the final servitude will ensure that fragmentation is kept to a minimum. 6. Rehabilitation must take place as soon as construction is complete to avoid the edge effect, the infiltration of alien species and soil erosion within the	-	2	4	0	0	**-6**
		Species changes	-	2	3	2	1	**-8**		-	2	3	0	0	**-5**
		Faunal interactions with structures, servitudes and personnel	-	1	3	1	1	**-6**		-	2	3	0	0	**-5**
		Impacts on surrounding habitats	-	1	3	3	1	**-8**		-	1	3	0	0	**-4**
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	1	**-10**		-	1	3	0	0	**-4**
		Increase in environmental degradation	-	2	3	0	1	**-6**		-	2	4	0	0	**-6**

			Alternative A (before mitigation)							Alternative A (after mitigation)					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Mitigation	Status	Extent	Duration	Probability	Intensity	Significance
									servitude. 7. Rehabilitation process must make use of species indigenous to the area. Seeds from surrounding seed banks can be used for re-seeding.						
		Sub-total (sum)						**-72**							**-56**
	Powerline	**Open Shrub Plains**													
		Direct impacts on Red Data flora	-	4	4	1	1	**-10**	Same as above	-	4	4	1	1	**-10**
		Direct impacts on Red Data fauna	-	4	4	1	1	**-10**		-	4	4	0	0	**-8**
		Destruction of sensitive / pristine regional habitat types	-	2	4	1	1	**-8**		-	4	4	0	0	**-8**
		Direct impact on common fauna species	-	2	3	1	0	**-6**		-	2	4	0	0	**-6**
		Species changes	-	2	3	2	1	**-8**		-	2	3	0	0	**-5**
		Faunal interactions with structures, servitudes and personnel	-	1	3	1	1	**-6**		-	2	3	0	0	**-5**
		Impacts on surrounding habitats	-	1	3	3	1	**-8**		-	1	3	0	0	**-4**
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	1	**-10**		-	1	3	0	0	**-4**
		Increase in environmental degradation	-	2	3	0	1	**-6**		-	2	4	0	0	**-6**
		Sub-total (sum)						**-72**							**-56**
		Calcareous Low Shrub Plains													
		Direct impacts on Red Data flora	-	4	4	1	1	**-10**	Same as above	-	4	4	1	1	**-10**
		Direct impacts on Red Data fauna	-	4	4	1	1	**-10**		-	4	4	0	0	**-8**

			Alternative A (before mitigation)							Alternative A (after mitigation)					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Mitigation	Status	Extent	Duration	Probability	Intensity	Significance
		Destruction of sensitive / pristine regional habitat types	-	2	4	1	1	-8		-	4	4	0	0	-8
		Direct impact on common fauna species	-	2	3	1	0	-6		-	2	4	0	0	-6
		Species changes	-	2	3	2	1	-8		-	2	3	0	0	-5
		Faunal interactions with structures, servitudes and personnel	-	1	3	1	1	-6		-	2	3	0	0	-5
		Impacts on surrounding habitats	-	1	3	3	1	-8		-	1	3	0	0	-4
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	1	-10		-	1	3	0	0	-4
		Increase in environmental degradation	-	2	3	0	1	-6		-	2	4	0	0	-6
		Sub-total (sum)						-72							-56
	Pipeline - Section 1 (pipeline from settling tank to Garona substation)	No impacts expected for the section of the pipeline located within the Transnet service road servitude	N	0	0	0	0	0	No mitigation required	N	0	0	0	0	0
	Pipeline - Section 2 (pipeline from Garona substation to Water Treatment Works)	**Open Shrub Plains**													
		Direct impacts on Red Data flora	N	0	0	0	0	0	No mitigation required	N	0	0	0	0	0
		Direct impacts on Red Data fauna	N	0	0	0	0	0		N	0	0	0	0	0
		Destruction of sensitive / pristine regional habitat types	N	0	0	0	0	0		N	0	0	0	0	0
		Direct impact on common fauna species	N	0	0	0	0	0		N	0	0	0	0	0
		Species changes	N	0	0	0	0	0		N	0	0	0	0	0

			Alternative A (before mitigation)							Alternative A (after mitigation)					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Mitigation	Status	Extent	Duration	Probability	Intensity	Significance
		Faunal interactions with structures, servitudes and personnel	N	0	0	0	0	0		N	0	0	0	0	0
		Impacts on surrounding habitats	N	0	0	0	0	0		N	0	0	0	0	0
		Increase in local and regional fragmentation / isolation of habitat	N	0	0	0	0	0		N	0	0	0	0	0
		Increase in environmental degradation	N	0	0	0	0	0		N	0	0	0	0	0
		Sub-total (sum)						**0**							**0**
		Calcareous Low Shrub Plains													
		Direct impacts on Red Data flora	-	4	4	1	1	-10	1. All damaged areas shall be rehabilitated upon completion of the contract in accordance with design specifications. In accordance with the Conservation of Agricultural Resources Act, Act No 43 of 1983, slopes in excess of 2% must be contoured and slopes in excess of 12% must be terraced. Extra seed shall be sown on disturbed areas as directed by the ECO (see below for specifications). Other methods of rehabilitating disturbed sites may also be used at the discretion of the Project Manager to comply with the conditions of the EA and EMP, e.g. stone pitching, logging, etc. Contour banks shall be spaced according to the slopes. The type of soil shall also be taken into consideration. 2. A mixture of vegetation seed can be used provided the mixture is carefully selected to ensure the following: m) Annual and perennial species are chosen. n) Pioneer species are included. o) All the species shall not be edible. p) Species chosen will grow in the area under	-	4	4	1	1	-10
		Direct impacts on Red Data fauna	-	4	4	1	1	-10		-	4	4	0	0	-8
		Destruction of sensitive / pristine regional habitat types	-	2	4	1	1	-8		-	4	4	0	0	-8
		Direct impact on common fauna species	-	2	3	1	0	-6		-	2	4	0	0	-6
		Species changes	-	2	3	2	1	-8		-	2	3	0	0	-5
		Faunal interactions with structures, servitudes and personnel	-	1	3	1	1	-6		-	2	3	0	0	-5
		Impacts on surrounding habitats	-	1	3	3	1	-8		-	1	3	0	0	-4
		Increase in local and regional fragmentation / isolation of habitat	-	2	4	3	1	-10		-	1	3	0	0	-4
		Increase in environmental degradation	-	2	3	0	1	-6		-	2	4	0	0	-6

			Alternative A (before mitigation)							Alternative A (after mitigation)					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Mitigation**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
									natural conditions. q) Root systems must have a binding effect on the soil. r) The final product should not cause an ecological imbalance in the area. 3. To get the best results in a specific area, it is a good idea to consult with a vegetation specialist or the local Extension Officer of the Dept of Agriculture. Seed distributors can also give valuable advice as to the mixtures and amount of seed necessary to seed a certain area. 4. All natural areas impacted during construction must be rehabilitated with locally indigenous grasses. 5. Fragmentation must be kept to a minimum. Rehabilitation of the final servitude will ensure that fragmentation is kept to a minimum. 6. Rehabilitation must take place as soon as construction is complete to avoid the edge effect, the infiltration of alien species and soil erosion within the servitude. 7. Rehabilitation process must make use of species indigenous to the area. Seeds from surrounding seed banks can be used for re-seeding.						
		Sub-total (sum)						**-72**							**-56**
Social Environment															
Noise	Plant	Extent to which the existing noise climate is degraded (reducing the impact of the new Plant)	-	1	3	2	2	**-8**	1. The design of the CSP plant is to incorporate all the necessary acoustic design aspects required in order that the overall generated noise level from the new installation does not exceed a maximum equivalent continuous daytime rating level ($L_{Req,d}$), namely a noise level of 70 dBA (just inside the property projection plane, namely the property boundary) as specified for industrial districts in SANS 10103.	-	1	3	1	0	**-5**
		Impact from CSP Plant operations on urban areas	**N**	0	0	0	0	**0**		**N**	0	0	0	0	**0**
		Impact from CSP Plant	-	1	3	1	1	**-6**		-	1	3	1	0	**-5**

			Alternative A (before mitigation)							Alternative A (after mitigation)					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Mitigation**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
		operations on settlements							Notwithstanding this provision, the design is also to take into account the maximum allowable equivalent continuous day/night rating level of the potentially impacted sites outside the new installation's property. Where the $L_{Req,d}$ for the external site is presently lower than the maximum allowed, the maximum shall not be exceeded. Where the $L_{Req,d}$ for the external site is presently at or exceeds the maximum, the existing $L_{Req,d}$ shall not be increased. 2. The latest technology incorporating maximum noise mitigating measures for the CSP plant components should be designed into the system. 3. The design process is to consider, inter *alia*, the following aspects: a. The position and orientation of buildings on the site. b. The enclosure of noisy plant in buildings where possible and practical. c. The design of the buildings to minimise the transmission of noise from the inside to the outdoors. d. The insulation of particularly noisy plant and equipment. e. All plant and equipment, including vehicles,						
		Impact from CSP Plant operations on farmhouses	-	1	3	1	2	**-7**		-	1	3	1	0	**-5**
		Impact from CSP Plant operational traffic	-	1	3	1	0	**-5**		-	1	3	1	0	**-5**
		Impact from CSP Plant on neighbouring farms	-	1	3	2	3	**-9**		-	1	3	1	0	**-5**
	Sub-total (sum)							**-35**							**-25**
Tourism	Plant	Visual impact on established tourism products and potential tourists	-	2	1	1	1	**-5**	1. Lighting must be subtle and not disturb passing motorists and surrounding residents. 2. Visual screening would reduce the visibility of the CSP plant, if possible. 3. Consider opening the CSP plant to visitors on certain days/times. This could also serve as an educational tool, to inform visitors on the safety and workings of	-	2	1	1	1	**-5**
		Impact on present tourism establishments in the area	+	2	3	2	1	**8**		+	2	3	3	3	**11**
		Impact of CSP plant on local traffic	-	2	1	1	1	**-5**		-	2	1	0	0	**-3**

			Alternative A (before mitigation)							Alternative A (after mitigation)					
Issue	Development Aspect	Specific Impact	Status	Extent	Duration	Probability	Intensity	Significance	Mitigation	Status	Extent	Duration	Probability	Intensity	Significance
		Impact of CSP plant on the growth of tourism in the area	N	0	0	0	0	0	an operational power plant. This way the CSP plant could enhance the tourism industry in the area. Strategic positioning of entry and exit points to ensure as little effect as possible on the traffic.	N	0	0	0	0	0
	Sub-total (sum)							-2							3
Heritage	All	Potential impact on heritage and cultural resources	N	0	0	0	0	0	No mitigation required	N	0	0	0	0	0
	Sub-total ((sum)							0							0
Social and Land Use	All	Social impacts derived from environmental benefits of solar power	+	4	3	3	4	14	1. Ensure that employment procedures / policy are communicated to local stakeholders, especially community representative organisations and ward councillors. 2. Unskilled job opportunities should be afforded to local community members. Local trade unions could assist with the recruitment process to counteract the potential for social mobilisation. 3. Equal opportunities for employment should be created to ensure that the local female population also have access to these opportunities. Females should be encouraged to apply for positions. Implementation of safety measures, work procedures and first aid must be implemented on site. 4. A health and safety plan in terms of the Occupational Health and Safety Act (Act No. 85 of 1993) must be drawn up to ensure worker safety. 5. Workers should be thoroughly trained in using potentially dangerous equipment	+	4	3	3	4	14
		Social impacts derived from economic benefits of solar power	+	4	3	3	4	14		+	4	3	3	4	14
		Job creation	+	1	3	4	3	11		+	1	3	4	3	11
		Increased demand for services	-	1	2	4	2	-9		-	1	2	2	1	-6
		Social investment initiatives by Solafrica	+	1	3	3	2	9		+	1	3	3	2	9
		Impacts of construction and operation on safety and daily movement patterns:	-	1	3	3	1	-8		-	1	3	1	1	-6
		Hazards imposed by the power station	-	1	3	1	2	-7		-	1	3	1	1	-6
		Effect on sense of place	-	3	3	2	3	-11		-	3	3	1	1	-8
	Plant	Impact on grazing land	-	1	3	0	0	-4		-	1	3	0	0	-4
	Road (Garona substation to plant)	Impact on grazing land	-	1	3	0	0	-4		-	1	3	0	0	-4
	Powerline (Garona	Impact on grazing land	-	1	3	0	0	-4		-	1	3	0	0	-4

			Alternative A (before mitigation)							Alternative A (after mitigation)					
Issue	**Development Aspect**	**Specific Impact**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**	**Mitigation**	**Status**	**Extent**	**Duration**	**Probability**	**Intensity**	**Significance**
	substation to plant)														
	Pipeline (sections 1 & 2)	Impact on grazing land	-	1	3	0	0	**-4**		-	1	3	0	0	**-4**
	Sub-total (sum)							**-3**							**6**
Visual	Plant	Visual exposure of CSP plant components	-	3	3	1	1	**-8**	1. The CSP plant and its unique technology have the potential of becoming a tourist attraction. It is therefore recommended that the exterior design in terms of buildings, fences and landscaping be planned in such a way that it will not deter travellers from visiting the site. 2. All lighting where practical, must be "down" to minimise the visual impact of the facility at night. Lighting must be directed towards the areas they are supposed to illuminate. 3. Use of light fixtures and the fitment of covers and shields designed to contain rather than spread light where practical the minimum amount of lighting must be used. 4. If a visually intrusive component of the site is identified, the procedures must be altered or updated to ensure effective management.	-	3	3	1	0	**-7**
		The length of time or duration the proposed CSP plant would be visible to road users	-	3	3	1	1	**-8**		-	3	3	1	0	**-7**
		Length of visual exposure of the facility from major roads	-	3	3	1	1	**-8**		-	3	3	1	0	**-7**
	All	Absence of existing visual clutter	-	1	0	1	1	**-3**		-	1	0	1	0	**-2**
	Powerline (Garona substation to plant)	Distance from existing transmission line infrastructure	-	1	0	2	1	**-4**		-	1	0	1	1	**-3**
	Sub-total (sum)							**-31**							**-26**

8 IMPACT STATEMENT

8.1 Key Findings

8.1.1 Negative Impacts

- The destruction of terrestrial and aquatic fauna and flora habitat.
- The loss of functional ecological corridors which allows for the movement of fauna species, locally and regionally.
- Increased traffic volumes during construction.
- Demand for services during the construction.
- High volumes of water required should wet cooling method be deployed.
- Changes in the local landscape from rural to industrial.
- Increased noise due to construction activities and the operation of the plant.

8.1.2 Positive Impacts

- Job creation in the short term during the construction phase generated by a demand for skilled and unskilled labour.
- Job creation in the medium to long term during the operational phase generated by operational components including security, administration, operators, etc.
- Social investment initiatives for the upliftment of the local community
- Opportunity for skills transfer to and training of local community member.
- Removal of invasive vegetation in order to restore the natural state of terrestrial habitats.
- Limiting high impact development constituents to areas of low sensitivity.
- Implementation of sustainable technology alternatives for supply of services including water and electricity.
- Contribution to rates and taxes for the !Kheis Local Municipality for the development of engineering services infrastructure.
- Increased contribution to municipal rates and taxes to be generated by the proposed development.

Two alternatives (development area alternatives) were rated for impact significance. The following are key findings of the impact analysis:

- Alternative A reflects the lowest incidence of negative impacts, and
- Alternative B reflects the highest incidence of negative impacts of high severity.

It is evident from the impact significance summary (above) that the impacts associated with the development of Alternative A is considered to be of lowest severity.

8.1.3 Impact Mitigation

The significant impacts associated with Alternative A (preferred) can be adequately mitigated through the implementation of the mitigation measures proposed in the draft EMP (***Appendix J***).

9 RECOMMENDATIONS AND CONCLUSIONS

The Environmental Impact Assessment (EIA) process for the proposed establishment of a Concentrating Solar Power (CSP) Plant in the Northern Cape Province has been undertaken in accordance with the EIA Regulations published in Government Notice R385 to R387 (as amended), in terms of the National Environmental Management Act (No 107 of 1998).

The essence of any EIA process is aimed at ensuring informed decision-making and environmental accountability, and to assist in achieving environmentally sound and sustainable development. In terms of NEMA (No 107 of 1998), the commitment to sustainable development is evident in the provision that "*development must be socially, environmentally and economically sustainable…and requires the consideration of all relevant factors…*". NEMA also imposes a *"duty of care"*, which places a positive obligation on any person who has caused, is causing, or is likely to cause damage to the environment to take *reasonable steps* to prevent such damage. In terms of NEMA's preventative principle, potentially negative impacts on the environment and on people's environmental rights (in terms of the Constitution of the Republic of South Africa, Act 108 of 1996) should be anticipated and prevented, and where they cannot be altogether prevented, they must be minimised and remedied in terms of "*reasonable measures*".

In assessing the environmental feasibility of the proposed project, the requirements of all relevant legislation has been considered. This relevant legislation has informed the identification and development of appropriate management and mitigation measures that should be implemented in order to minimise potentially significant impacts associated with the project.

The conclusions of this EIA are the result of comprehensive studies and specialist assessments. These studies were based on issues identified through the EIA process and the parallel process of public participation. The public consultation process has been rigorous and extensive, and every effort has been made to include representatives of all stakeholders within the process.

9.1 Evaluation of the Proposed Project

The preceding chapters of this report provide a detailed assessment of the predicted environmental impacts on specific components of the social and biophysical environment as a result of the proposed project. This chapter concludes the EIA report by providing a holistic evaluation of the most important environmental impacts identified through the process. 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 about the proposed project.

The CSP plant is proposed to be located in the Groblershoop area of the Northern Cape Province which is proposed to operate at an installed capacity of approximately 75 MWe. The additional infrastructure will include the upgrading of existing access roads, the construction of a 132 kV sub-transmission line and a water pipeline to supply water to the plant.

The Environmental Scoping Study investigated two sites identified as potentially feasible sites for the establishment of the proposed CSP plant. Through numerous specialist environmental studies (both social and biophysical) the Farm Bokpoort was nominated for detailed investigation in the EIA phase of the project:

The potentially significant environmental impacts associated with the proposed project as discussed in the EIA included:

- Potential impacts on *surface* and *groundwater* resources;
- Potential *visual* impacts associated with the proposed project and associated impacts;
- Potential impacts on *tourism* in the region;
- Potential *noise* impacts on surrounding landowner;
- Potential impacts on *biodiversity* (i.e. flora and fauna);
- Potential impacts on *avifaunal* species;
- Potential *social* impacts;
- Potential impacts on *cultural* and *heritage* resources, and
- Potential impacts on *current land use* practices.

The EIA process has not revealed any environmental fatal flaws associated with any of the alternatives under consideration. Impacts likely to occur as a result of the construction and operation of the CSP plant can be mitigated to acceptable levels.

9.2 Overall Conclusion

The findings of the specialist studies undertaken within this EIA provide an assessment of both the benefits and potential negative impacts anticipated as a result of the proposed project. The findings conclude that there are no environmental fatal flaws that should prevent the proposed project from proceeding, provided that the recommended mitigation and management measures are implemented.

9.3 Overall Recommendations

In order to achieve appropriate environmental management standards and ensure that the findings of the environmental studies are implemented through practical measures, the recommendations from this EIA must be included within an EMP. This EMP should form part of the contract with the contractors appointed to construct and maintain the proposed plant and associated infrastructure. The EMP would be used to ensure compliance with environmental specifications and management measures. The implementation of this EMP for all life cycle phases (i.e. construction, operation and de-commissioning) of the proposed project is considered to be imperative in achieving the appropriate environmental management standards as detailed for this project.

It is also recommended that the process of communication and consultation with the community representatives is maintained after the closure of this EIA process, and, in particular, during the construction phase associated with the proposed project.

Based on the information contained in this report, it is the opinion of the EAP that the negative impacts resulting from the Solafrica CSP development (in particular Alternative A) can be mitigated to acceptable levels provided that the mitigation measures proposed in the EMP are implemented during the construction and operational phases of the project life-cycle.

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