2. DESCRIPTION OF THE PROPOSED PROJECT

In order to explore new generation options, find solutions that can contribute to meeting the growing electricity demand and in an effort to utilise renewable energy resources, Eskom is assessing the feasibility of constructing a Concentrating Solar Power (CSP) plant with a maximum capacity of 100 MW electrically in the Northern Cape. This facility will utilise the sun as its' fuel source.

2.1 The Proposed CSP Plant

The CSP plant is proposed to be constructed in the Northern Cape Province. It is intended to operate at an installed capacity of up to 100 MW electrical. The exact output will depend on the specification of the equipment installed and the ambient operating conditions. A 100 MW plant typically requires approximately 4 square kilometres of terrain with little relief to satisfy construction needs. The key factor, however, is the amount of thermal storage required, as this determines the number of heliostats to be installed. It estimated that approximately 6000 heliostats would be required to be constructed within the heliostat field in order to obtain a power output of approximately 100 MW electrical for up to eight hours after the sun has set. The heliostats to be utilized for the CSP plant in the Northern Cape are estimated to have a surface area of 130 m^2 each.

The proposed power plant would be a dry-cooled station. The use of dry-cooled technology is necessitated as a result of the lack of water in the area. The power plant would be a zero liquid effluent discharge plant.

Appropriate technology alternatives have been investigated by Eskom from a technical and economic feasibility perspective through pre-feasibility studies.

The proposed power plant would be similar to the proof-of-concept plant constructed in the late nineties in the United States in terms of operation and design. It is estimated that the central tower plus the receiver will be approximately 210 m in height, and is likely to be constructed using reinforced concrete, with similar technology as that used in the construction of power station smoke stacks. Figure 2.1. shows an example of a Concentrating Solar Power demonstration plant undertaken in the United States of America, this project was a 10 MW plant.

Figure 2.1: An example of a power plant using central receiver technology. This is a 10MW demonstration plant that was built in the United States – image courtesy NREL.

2.1.1 How is electricity generated at a CSP Plant?

The CSP Plant being considered is a molten salt-type, Central Receiver technology. This technology is based on the concept of thousands of large two-axis tracking mirrors (known as heliostats) which track the sun and reflect the beam radiation to a common focal point. This focal point (the receiver) is located well above the heliostat field in order to prevent interference between the reflected radiation and the other heliostats.

A heliostat (figure 2.2) is a mirror mounted on an axis by which the sun is steadily reflected onto one spot. Heliostats are arranged in an elliptical formation around the focal point with the majority of the reflective area weight to the more effective side of the heliostat field. It is estimated that approximately 6000 heliostats will be required to be constructed within the heliostat field in order to obtain a power output of approximately 100 MW electrically, while also enabling 8 hours of energy storage.

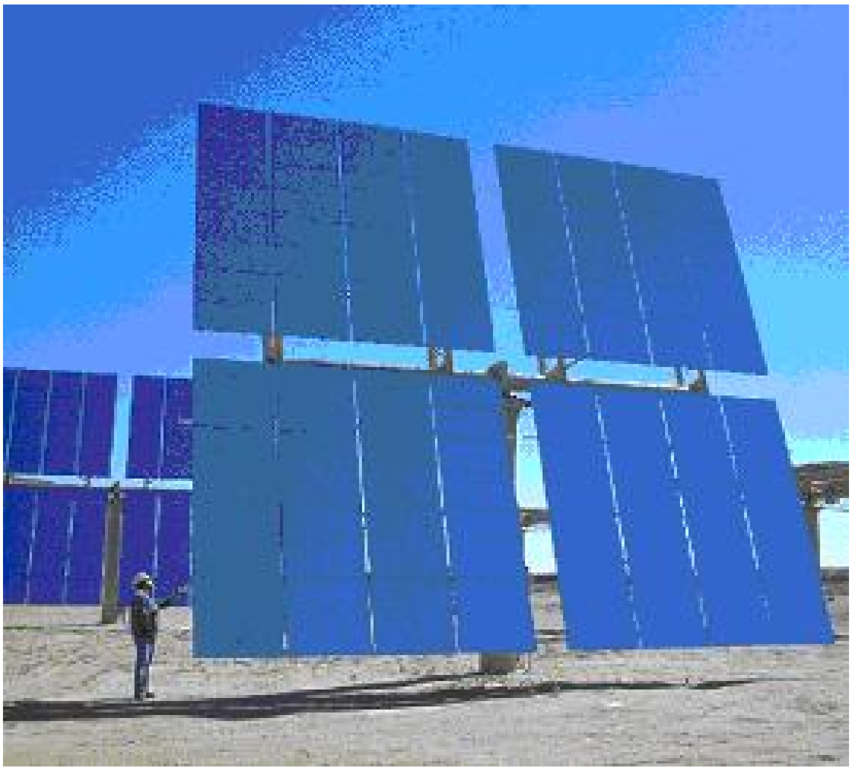

Figure 2.2: Single heliostat – image courtesy NREL

The central receiver (figure 2.3) is situated on the top of the central tower. The central tower will be approximately 210 m high, with the central receiver taking up the top 20 m of the structure. This receiver is in essence 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) which is in turn used to generate steam for conventional power generation.

Figure 2.3: The Central Receiver - The image on the left shows the heat exchange panels, while the image on the right shows what the receiver looks like during operation (image courtesy NREL)

Power is generated through a conventional Rankine cycle (steam turbine process). The working fluid is a salt mix of a 60:40 ratio of Sodium Nitrate ($NaNO_3$) and Potassium Nitrate (KNO_3). The cold salt is pumped up the central tower at approximately 300°C and flows through the central receiver where it is heated to approximately 600°C by the sun after which it can be stored and subsequently utilised in the steam generation and conventional power generation process (figure 2.4).

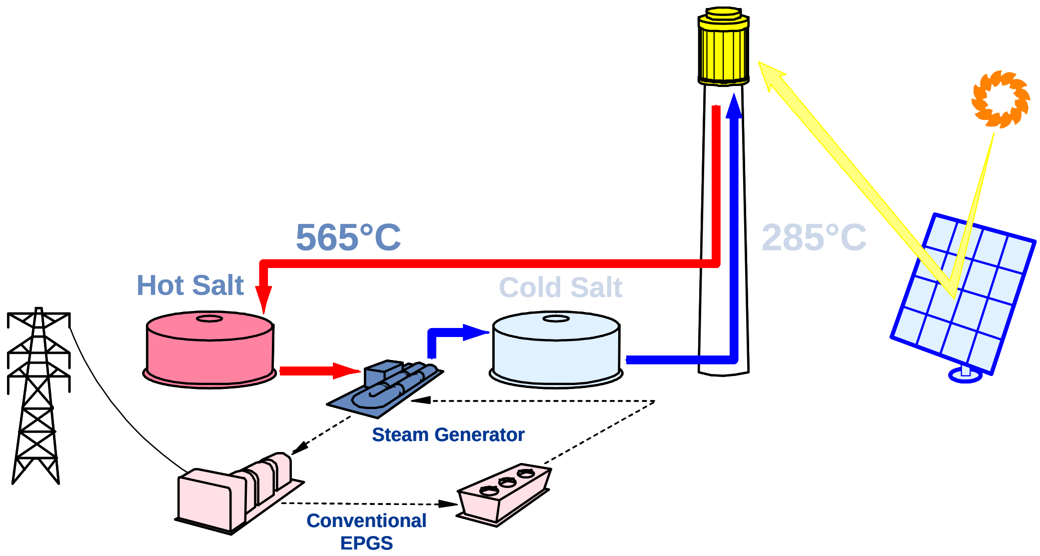

Figure 2.4: Flow diagram showing the power generation process in a CSP plant.

2.2 Project Alternatives

In terms of the Environmental Impact Assessment (EIA) Regulations, feasible alternatives were required to be considered within the Environmental Scoping Study. All identified, feasible alternatives were required to be evaluated in terms of social, biophysical, economic and technical factors.

A key challenge of the EIA process is the consideration of alternatives. Most guidelines use terms such as 'reasonable', 'practicable', 'feasible' or 'viable' to define the range of alternatives that should be considered. Essentially there are two types of alternatives:

- incrementally different (modifications) alternatives to the project; and
- fundamentally (totally) different alternatives to the project.

Fundamentally different alternatives are usually assessed at a strategic level, and EIA practitioners recognise the limitations of project-specific EIAs to address fundamentally different alternatives. Any discussions around this topic have been addressed as part of the Integrated Strategic Electricity Plan (ISEP) undertaken by Eskom, as well as the National Integrated Resource Plan (NIRP) from the National Energy Regulator of South Africa (NERSA). Environmental issues are integrated into the ISEP and the NIRP using the strategic environmental assessment approach, focussing on environmental life-cycle assessments, site-specific studies, water-related issues and climate change considerations.

2.2.1. Technology Alternatives

A number of technology alternatives were evaluated by Eskom, before the CSP Plant was chosen as the most technically feasible technology for further consideration.

Eskom initiated the South African Bulk Renewable Energy Generation (SABRE-Gen) programme in 1998 under its Research department with the aim of identifying renewable energy generation options that could be used for large-scale power generation within South Africa.

The first step of this programme was to assess the availability of the different renewable energy resources in terms of their abundance and geographic location. This was done through a joint project with the Department of Minerals and Energy (DME) and the CSIR and led to the compilation of the South African Renewable Energy Resource Database. Though this database, compiled in ArcView GIS format, Eskom could identify which renewable energy option would represent the most suitable option for which geographic area. The database clearly showed that solar will be the most suitable option in terms of generation resources in the Northern Cape Province.

In order to identify the most suitable solar technology option, Eskom contracted with an independent consultant to complete a technology screening and evaluation. The consultant that was selected was Sunlab, a cooperation between two U.S. national laboratories namely the National Renewable Energy Laboratory (NREL) and Sandia National Laboratory.

Sunlab identified the following 5 technology categories, resulting in 14 technology options being considered:

- **Dish technology.** These systems are highly efficient and modular and can provide higher power levels when multiple units are combined. Small dishes using Stirling engines at the focal point were considered in the study, along with larger dishes producing steam for a central steam turbine. Two dish options were considered
- **Trough technology.** This is the only solar thermal electric technology that has seen long-term commercial use. Six different types of trough systems

were considered. The systems vary from commercially available to prototype designs that are currently being developed.

- **Tower technology.** Towers are attractive because of their economies of scale and demonstrated low-cost thermal energy storage. Four alternative tower technologies were considered.
- **Solar chimney.** Solar chimneys have had a number of proponents within South Africa because of their potential for low operation cost and large-scale deployment.
- **Solar Concentrator Off-Tower (SCOT) technology.** The SCOT technology is one of the newest approaches selected for the study. It offers the potential for very-high-efficiency operation.

The above options were evaluated by assessing information compiled from published literature and where possible from demonstration facilities or operational plants. The technologies were then screened in terms of a list of selection criteria. The criteria were compiled from inputs received from the Eskom Research Supply Side Steering Committee. The screening process identified two technologies as possible near tern options, to be evaluated further.

The second task comprised the compilation of a typical meteorological year (TMY) data file for a reference site.

Using the TMY data file compiled in task 2, annual simulation models were developed to predict the performance and cost of the two CSP technologies, identified through the screening process, as task 3. Pilot plant designs were developed around 100-MWe systems and optimised to provide the lowest Levelised Energy Cost (LEC) for the location. Long-term cases were also evaluated to provide an indication of the lowest possible energy costs that could be expected with future development.

The results from the Sunlab study, together with input from international project developers and South African industry identified the molten salt-type central receiver technology as the most promising option in the near term.

The Scoping Study, only considered alternatives in terms of a proposed new concentrating solar power plant in the Northern Cape province, and did not evaluate any other power generation options being considered by Eskom.

2.2.2. The 'Do Nothing' Alternative

The ‘do-nothing’ alternative is the option of not establishing a new concentrating solar power plant at a site in the Northern Cape Province.

The electricity demand in South Africa is placing increasing pressure on Eskom's existing power generation capacity. South Africa is 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.

Without the new proposed concentrating solar power plant in the Northern Cape, the potential future use of this renewable technology will be unknown.

Eskom have identified that a wide range of capacity options are required to be developed simultaneously in order to successfully meet the future electricity needs of South Africa. Alternative energy sources such as gas, nuclear, coal and wind power may have benefits in terms of some biophysical and social aspects, but must be considered in terms of cost, efficiency, available timeframes and associated environmental impacts.

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 was not considered as a feasible option on this proposed project and was rejected during the Scoping Process.

2.3 Location Alternatives for the Establishment of a New Concentrating Solar Power plant within South Africa

In determining the most appropriate site for the establishment of a new concentrating solar power plant, various options were investigated by Eskom through the IEP process. 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 Direct Normal Insolation) 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;
- 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 within which the above criteria were evaluated, the Northern Cape province ranked as the most favourable area for the establishment of a new concentrating solar power plant.

2.4 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 a Pre-scoping study undertaken in 2002, it was concluded that there was the potential to establish a new power 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 bodies.

2.4.1 Description of Identified Site Alternatives

Figure 2.5 shows the locality of the three alternative sites in relation to the two major towns, namely Upington and Groblershoop. The alternative sites identified and evaluated during the Scoping Phase are as follows:

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

  This site is located on the farm Olyvenhouts Drift (figure 2.6). The south-eastern part of the farm borders on the Orange River, and is used as agricultural land currently cultivated with grapes. The farm is also traversed by the N14 highway. 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.

- *Site 2: Farm Bokpoort 390 (North of Garona Transmission Substation)*.

  This site is located on the farm Bokpoort 390 (figure 2.7). The southern part of the farm borders on the Orange River. There is some cultivated land and settlements on the south-eastern part of the farm. The Gorona Substation is located on the eastern part of the farm, and it is traversed by a number of powerlines as well as by the Sishen- Saldahna railway line.

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

- *Site 3: Farm Tampansrust (North-west of Groblershoop)*

  This site is located on the farm Tampansrus (figure 2.8). The south-western boundary of the farm borders on the Orange River, and is also traversed by the N8 highway. The south-western portion of the farm is currently cultivated with grapes with the remainder of the farm being utilised for cattle farming purposes.

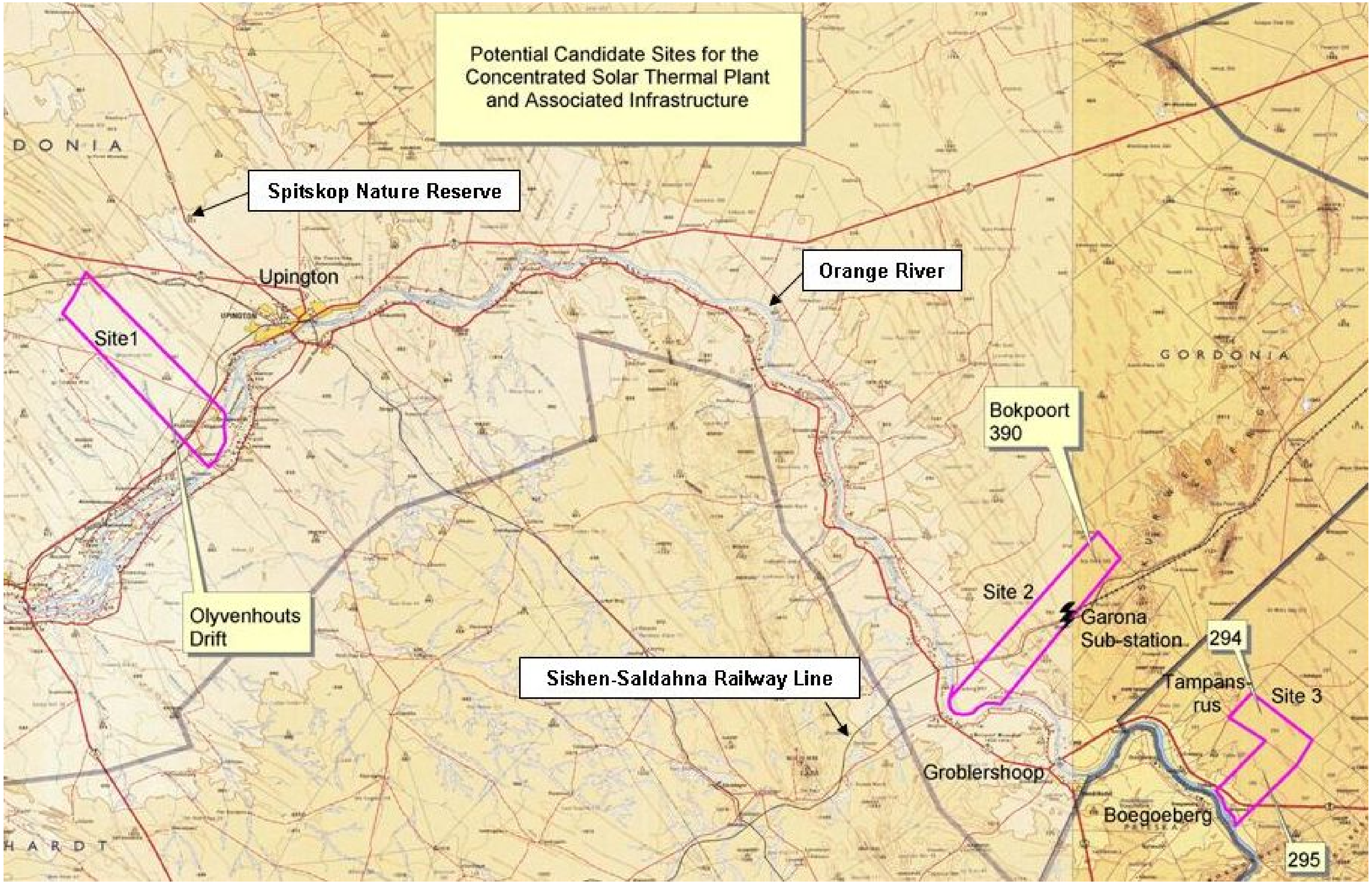

Figure 2.5: A map indicating the locality of the three alternative sites

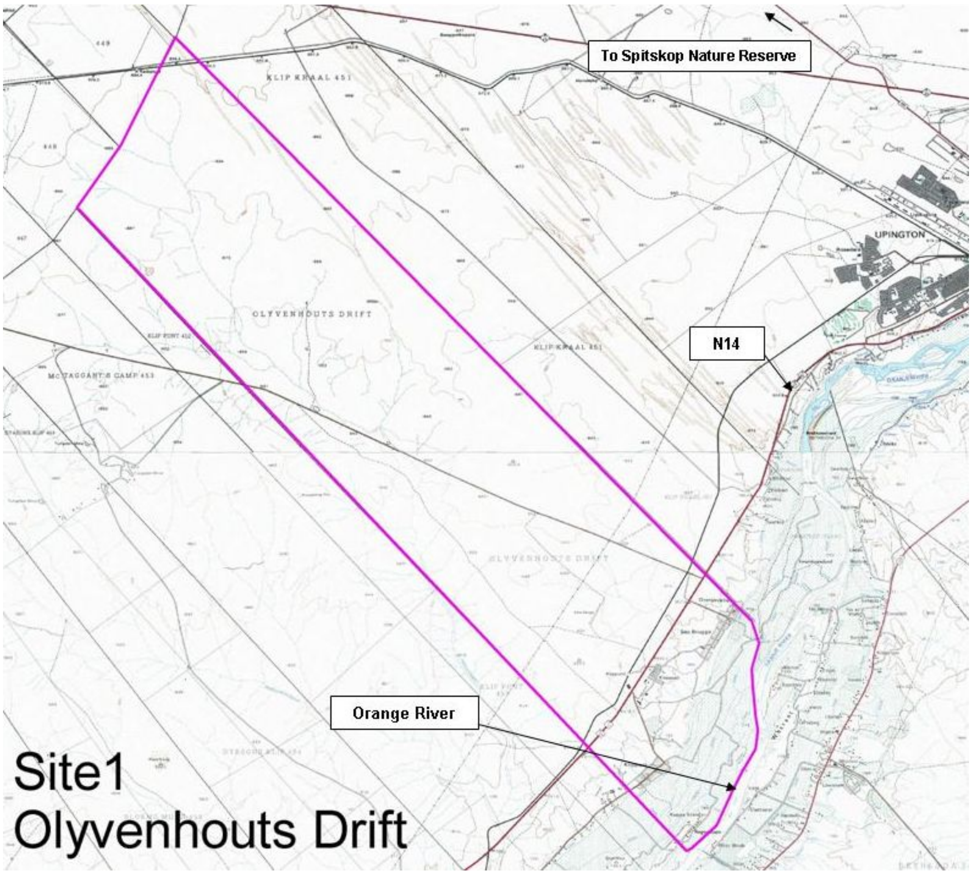

Figure 2.6: Site 1: Farm Olyvenhouts Drift (15 km west of Upington)

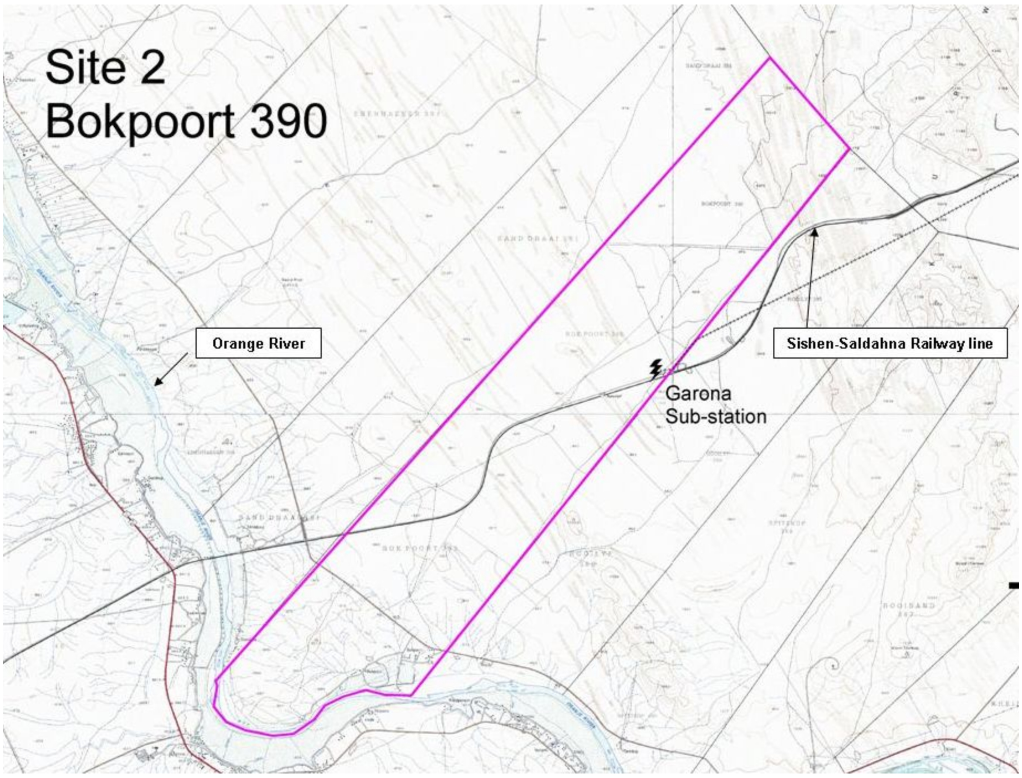

Figure 2.6: Site 2: Farm Bokpoort 390 (North of Garona Transmission Substation).

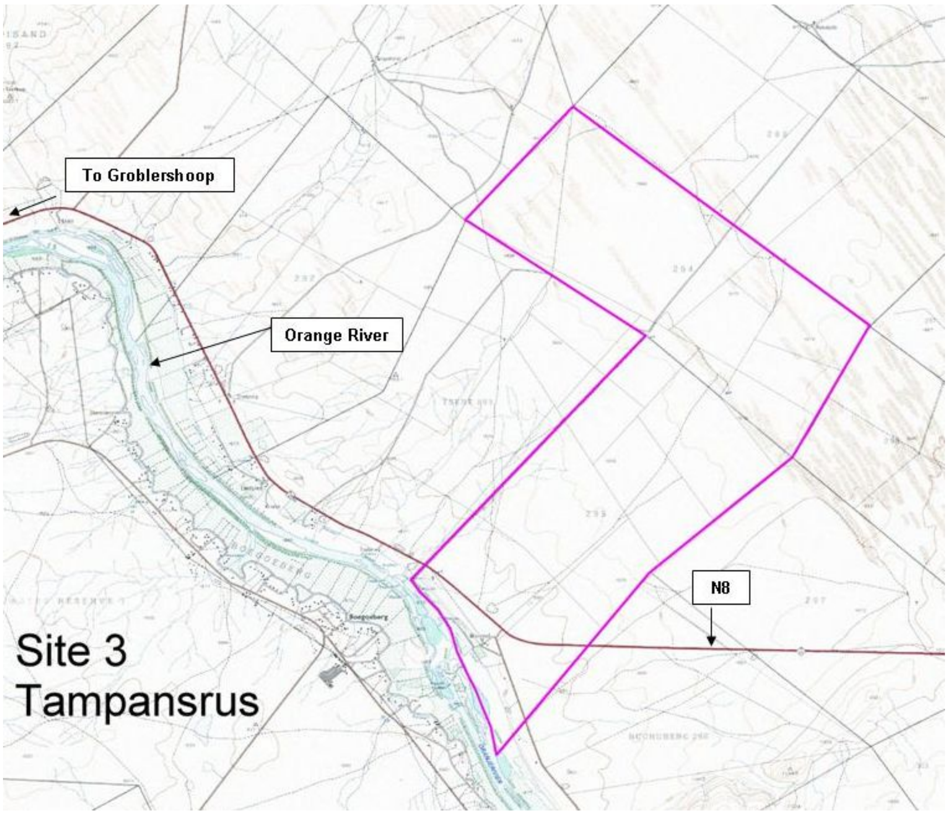

Figure 2.6: Site 3: Farm Tampansrust (North-west of Groblershoop)

These alternative sites were evaluated in terms of social, biophysical and economic criteria in order to determine their potential impact on the surrounding environment. The Environmental Scoping Study nominated Site 1 – Farm Olyvenhouts Drift as the preferred site for the establishment of the Concentrating Solar Power Plant and associated infrastructure. This farm has undergone detailed investigation during the EIA phase of the project, the results of which are included within Chapters 7 – 13.

2.5. Associated Infrastructure

The detailed studies undertaken within the Environmental Impact Assessment Phase of the project also took into account the associated infrastructure of the CSP Plant. This infrastructure includes:

- 132 kV sub-transmission line linking the CSP Plant to the National Grid;
- The upgrading of the access road into the plant itself;
- A water pipeline linking to a potable water pipeline from Upington; and
- A visitors centre.

During discussions with the Department of Environmental Affairs and Tourism it was agreed that all linear infrastructure will follow the existing road as shown in Figure 2.7.

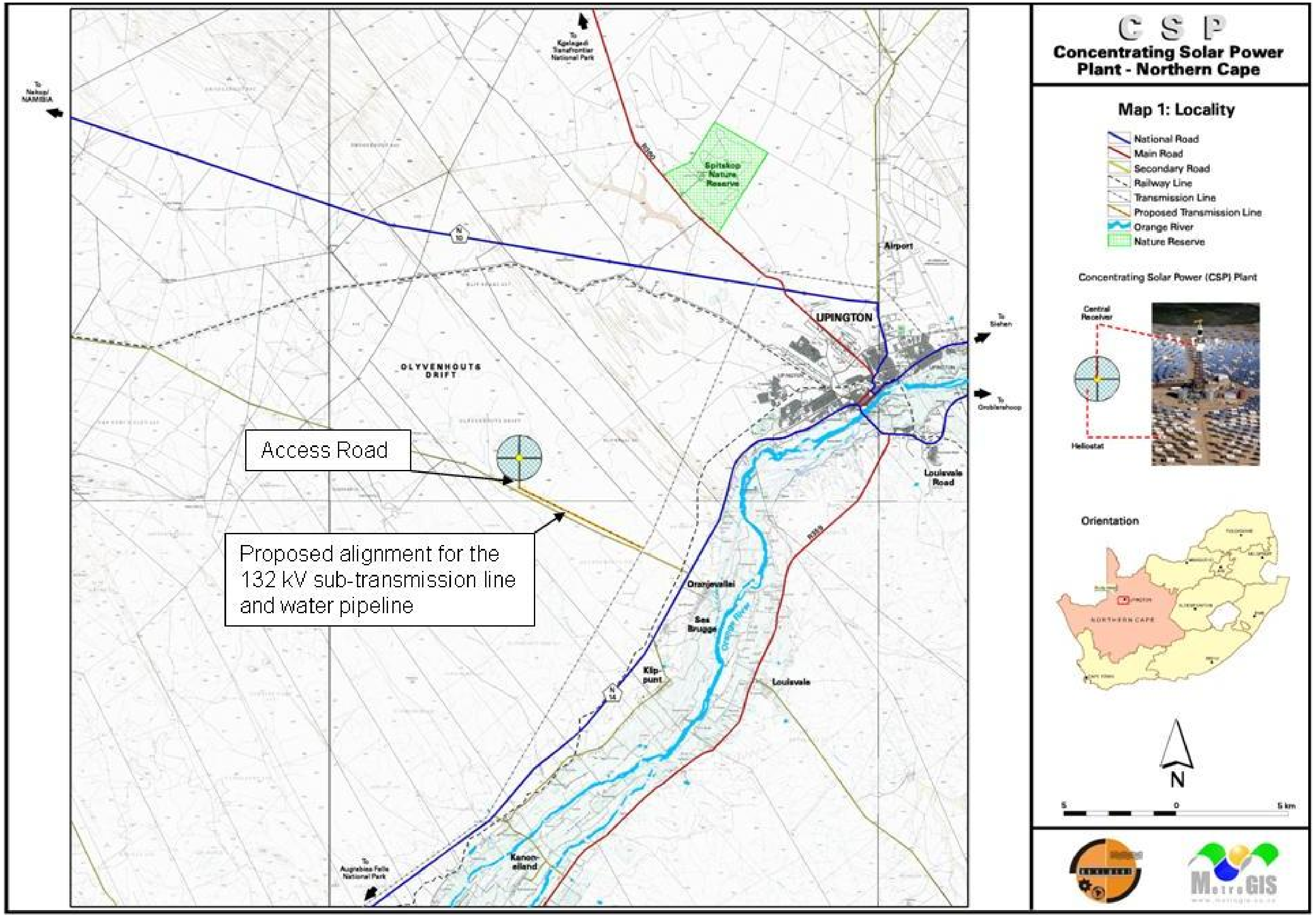

Figure 2.7: A map indicating the location of the CSP Plant on the nominated preferred site (Farm Olyvenhouts Drift) also showing the additional infrastructure.