PROPOSED ORYX SOLAR ENERGY FACILITY, FREE STATE PROVINCE

VISUAL ASSESSMENT - INPUT FOR SCOPING REPORT

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- May 2013 -

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Lourens du Plessis from MetroGIS (Pty) Ltd undertook the visual assessment in his capacity as a visual assessment and Geographic Information Systems specialist. Lourens has been involved in the application of Geographical Information Systems (GIS) in Environmental Planning and Management since 1990. He has extensive practical knowledge in spatial analysis, environmental modelling and digital mapping, and applies this knowledge in various scientific fields and disciplines. His GIS expertise are often utilised in Environmental Impact Assessments, State of the Environment Reports and Environmental Management Plans.

Lourens is familiar with the "Guidelines for Involving Visual and Aesthetic Specialists in EIA Processes" (Provincial Government of the Western Cape: Department of Environmental Affairs and Development Planning) and utilise the principles and recommendations stated therein to successfully undertake visual impact assessments. Although the guidelines have been developed with specific reference to the Western Cape province of South Africa, the core elements are more widely applicable (i.e. within the Free State Province).

Savannah Environmental (Pty) Ltd appointed MetroGIS (Pty) Ltd as an independent specialist consultant to undertake the visual impact assessment. Neither the author, nor MetroGIS will benefit from the outcome of the project decision-making.

1. INTRODUCTION

FRV Energy South Africa (Pty) Ltd is proposing the establishment of a 75MW export capacity Solar Photovoltaic (PV) Facility within the Matjhabeng Local Municipality within the Lejweleputswa District Municipality in the Free State Province. The proposed site identified for the facility is located approximately 11km south-west of Virginia (at the closest).

The proposed site is located along the *Theseus-Oryx 1 132kV* and *Beatrix-Theseus 132kV* power lines, near the Oryx Substation. The electricity generated by the facility is expected to be evacuated into the former of these lines using a loop-in/loop-out connection.

The project will be referred to as the Proposed Oryx Solar Energy Facility (after the substation located 1.6km (at the closest) south-west of the site) and will include the following infrastructure:

- An array of Photovoltaic (PV) panels with an export capacity of up to 75MW (either static or tracking panel technology).
- A new on-site substation to evacuate the power from the facility via a 132kV power line into the Eskom power line adjacent to the facility.
- Mounting structures to be either rammed steel piles or piles with pre-manufactured concrete footings to support the PV panels.
- Cabling between the project components, to be lain underground where practical.
- Internal access roads and fencing.
- Workshop area for maintenance, storage, and offices.

Solar energy generation is generally considered to be an environmentally friendly electricity generation option and the construction phase of the proposed facility is expected to be 18 months to 2 years whilst the lifespan of the facility is typically 30 years.

Solar energy facilities, such as those using PV panels use the energy from the sun to generate electricity through a process known as the **Photovoltaic Effect** (see Figure 1). This effect refers to photons of light colliding with electrons, and therefore placing the electrons into a higher state of energy to create electricity. The Solar PV facility will comprise of the following components:

The **Photovoltaic Cell**
Individual PV cells are linked and placed behind a protective glass sheet to form a photovoltaic panel. Other technologies that can be used include thin film

The **Inverter**
The photovoltaic effect produces electricity in direct current. Therefore an inverter must be used to change it to alternating current.

The **Support Structure**
The PV panels will be attached to a **support structure approximately 4m off the ground** set at an angle to receive the maximum amount of solar radiation (fixed technology), or set to track the sun (tracking technology) in order to increase the amount of energy produced. The angle of the panel is dependent on the latitude of the proposed facility and the angles may be adjusted to optimise for summer or winter solar radiation characteristics.

The PV panels are designed to operate continuously for more than 20 years, unattended and with low maintenance.

Figure 1: Illustration of a photovoltaic solar energy facility (from the Background Information Document).

2. SCOPE OF WORK

The scope of the work includes a scoping level visual assessment of the issues related to the visual impact.

The study area for the visual assessment encompasses a geographical area of 298km^2 and includes a minimum 8km buffer zone from the proposed development area. It includes a small section of Merriespruit (a south-western suburb of Virginia), a long section of the R30 arterial road as well as a number of major secondary (local) roads.

3. METHODOLOGY

The study was undertaken using Geographic Information Systems (GIS) software as a tool to generate viewshed analyses and to apply relevant spatial criteria to the proposed facility. A detailed Digital Terrain Model (DTM) for the study area was created from 20m interval contours from the National Geo-spatial Information data supplied by the Department: Rural Development and Land Reform.

The methodology utilised to identify issues related to the visual impact included the following activities:

- The creation of a detailed digital terrain model of the potentially affected environment.
- The sourcing of relevant spatial data. This included cadastral features, vegetation types, land use activities, topographical features, site placement, etc.
- The identification of sensitive environments upon which the proposed facility could have a potential impact.
- The creation of viewshed analyses from the proposed development area in order to determine the visual exposure and the topography's potential to absorb the potential visual impact. The viewshed analyses take into account the dimensions of the proposed structures.

This report (scoping report) sets out to identify the possible visual impacts related to the proposed Oryx Solar Energy Facility.

4. ANTICIPATED ISSUES RELATED TO VISUAL IMPACT

Anticipated issues related to the potential visual impact of the proposed Solar PV Project include the following:

- The visibility of the facility to, and potential visual impact on, observers travelling along the R30 arterial road and the major local road traversing near the proposed facility.

- The visibility of the facility to, and potential visual impact on observers residing at homesteads (farm residences) located within close proximity of the site.

- Potential cumulative visual impacts (or alternately, consolidation of visual impacts) with specific reference to the existing power line infrastructure traversing the development site as well as the mining activity west of the site.

- The potential visual impact of the construction of ancillary infrastructure (i.e. the substation at the facility, associated power line and access roads) on observers in close proximity of the facility.

- The potential visual impact of operational, safety and security lighting of the facility at night on observers residing in close proximity of the facility.

- The visual absorption capacity of natural or planted vegetation (if applicable).

- Potential visual impacts associated with the construction phase.

- The potential to mitigate visual impacts.

It is envisaged that the issues listed above may constitute a significant visual impact at a local and/or regional scale. These need to be assessed in greater detail during the EIA phase of the project.

5. THE AFFECTED ENVIRONMENT

The identified site for the proposed PV facility is situated approximately 20km by road south-west of Virginia on portion 2 of the farm Kalkoen-Krans 225. This farm is located in an area that has a distinct rural and agricultural character, with some mining activity (BEISA mine) located west of the proposed development site. The Oryx substation is located within this mining land and has a number of 132kV power lines congregating at this point, namely: the *Theseus-Oryx 1 and 2* power lines, as well as the *Joel-Oryx* line. The *Theseus-Oryx 1* and *Beatrix-Theseus* power lines traverse the proposed PV development site, whilst the *Theseus-Oryx 2* lines traverses north-west of the farm, along the secondary road.

Access to the proposed development area is afforded by the R30 arterial road that functions as the main connecting route between Welkom (further north) and the site. The R73 regional road provides access between the site (via the R30) and Virginia.

The natural vegetation or land cover types of the region are described as *Grassland* and *Wetlands* (in the lower lying areas), with large tracts of agricultural fields (altered vegetation) interspersed (see **Map 1**). The higher lying sections of the study area are indicated as *Vaal-Vet Sandy Grassland*, whilst the lower lying sections along water courses are described as *Highveld Alluvial Vegetation*. Pans occur throughout the study area.

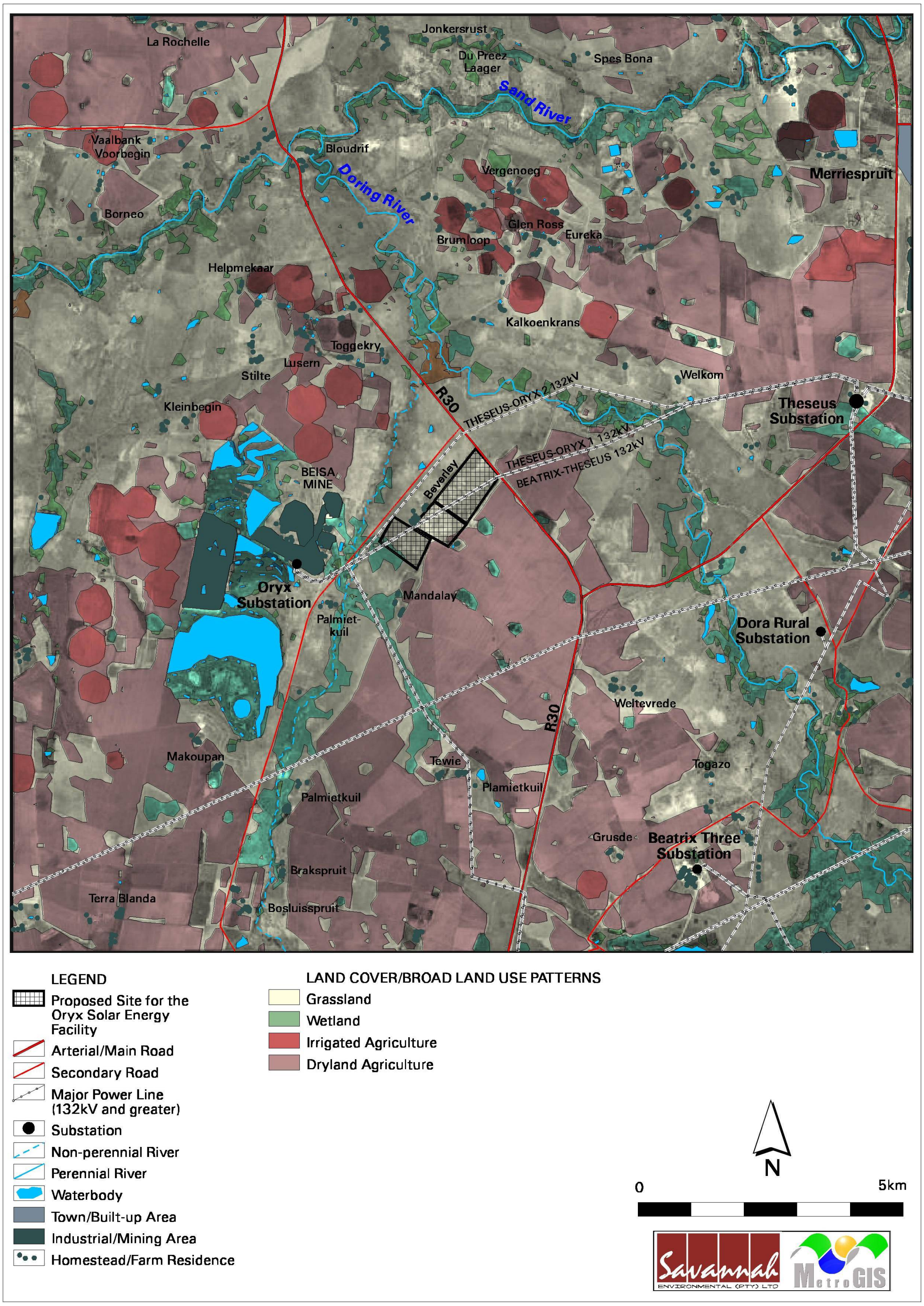
Land use activities within the broader region are predominantly described as maize farming, with some mining activity evident towards the west (BEISA mine) of the proposed site. The mining activities intensifies further north (beyond the study area boundary), towards Virginia and Welkom, where predominantly gold and uranium are mined.

Farm settlements or residences occur at irregular intervals throughout the study area. Some of these, in close proximity to the proposed development site, include: Beverley (located on the farm itself), Mandalay, Palmietkuil, Tewie, Weltevrede, Kalkoenkrans and Toggekry. The population density of the region is indicated as approximately 200 people per km^2, predominantly concentrated within the town of Virginia.

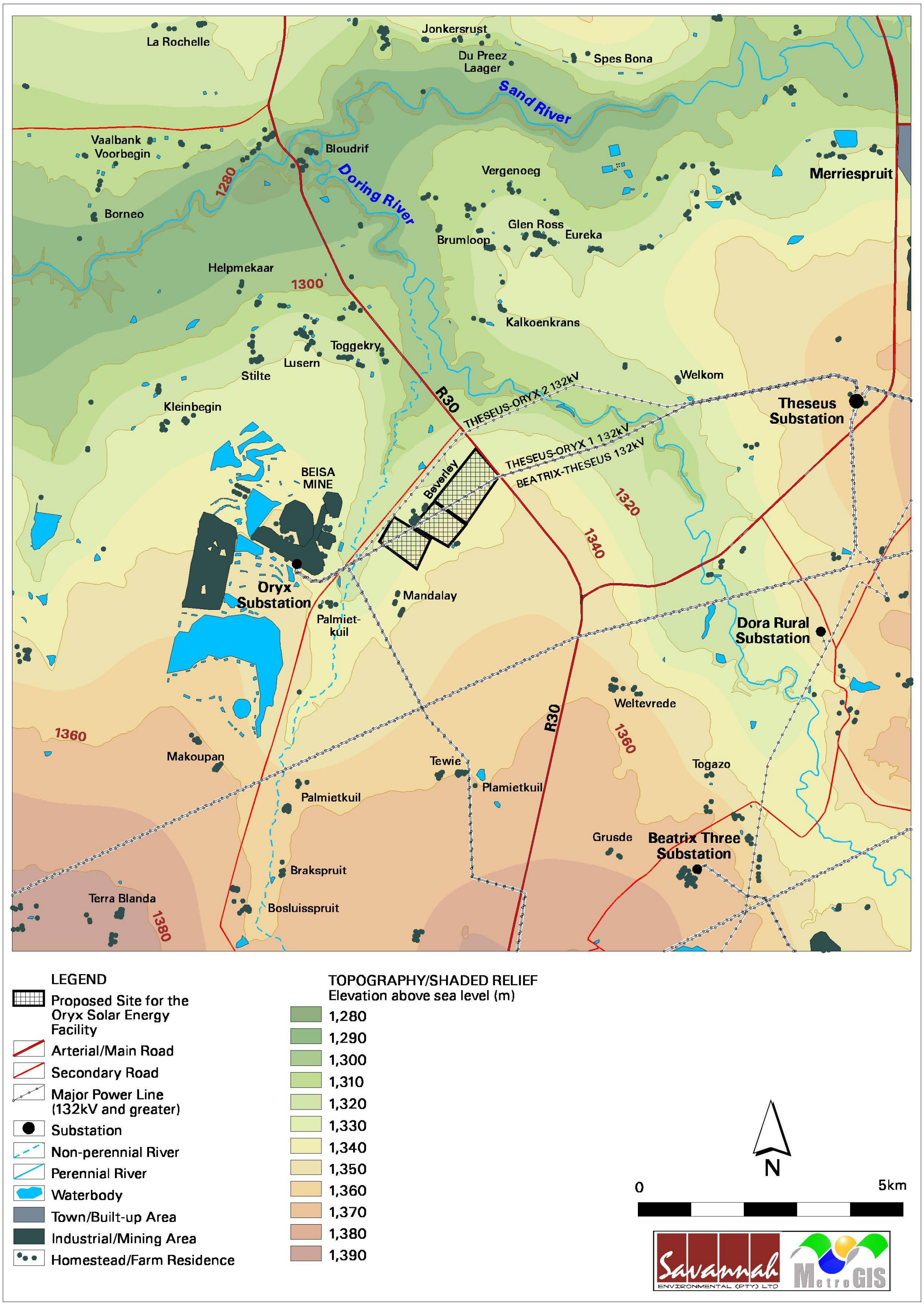
The topography or terrain morphology of the region is broadly described as *plains and pans* of the Central Interior Plain. The slope of the entire study area is even (flat) with a very gradual drop (approximately 100m) from the south-western section of the study area (1380m above sea level) to the confluence of the Doring and Sand Rivers (1280m) to the north. These perennial rivers, the pans and farm dams account for the dominant hydrological features within this region that receives between 500mm to 650mm rainfall per annum. See **Map 2** for the shaded relief/topography map of the study area.

No formally protected or conservation areas or major tourist attractions/resorts were identified within the study area.

Figure 2: Google Earth Street View of the proposed development site from the R30 (with the *Theseus-Oryx 1* and *Beatrix-Theseus* power lines in the foreground).



Map 1: Land cover/land use map.



Map 2: Shaded relief map (indicating the location of the proposed facility and the topography and elevation above sea level) of the broader study area.

6. VISUAL EXPOSURE/VISIBILITY

The result of the preliminary viewshed analyses for the proposed facility is shown on the map below (**Map 3**). The initial viewshed analyses were undertaken from a number of vantage points within the proposed development area at an offset of 4m above average ground level. This was done in order to determine the general visual exposure (visibility) of the area under investigation, simulating the maximum height of the proposed structures (PV panels) associated with the facility.

It must be noted that the viewshed analyses do not include the effect of vegetation cover or existing structures on the exposure of the proposed facility, therefore signifying a worst-case scenario. It is expected that the planted vegetation cover (primarily maize) within the study area and in close proximity to the facility, may reduce the visual exposure to some extent.

The viewshed analyses will be refined once a preliminary and/or final layout of the facility is completed and will be regenerated for the actual position of the infrastructure on the site, and per structure position (and actual proposed technology) during the EIA phase of the project.

Map 3 also indicates proximity radii from the proposed development area for the proposed facility in order to show the viewing distance (scale of observation) of the facility in relation to its surrounds.

It is evident from the preliminary viewshed analyses that the pattern of visual exposure is influenced mainly by the depressed nature of the Doring and Sand River valleys. This slightly lower-lying terrain will not be exposed to the proposed PV development, whilst the very weak ridges surrounding the valleys may be exposed. This area of exposure is generally restricted to vacant farmland and agricultural fields, but may contain some potentially sensitive visual receptors.

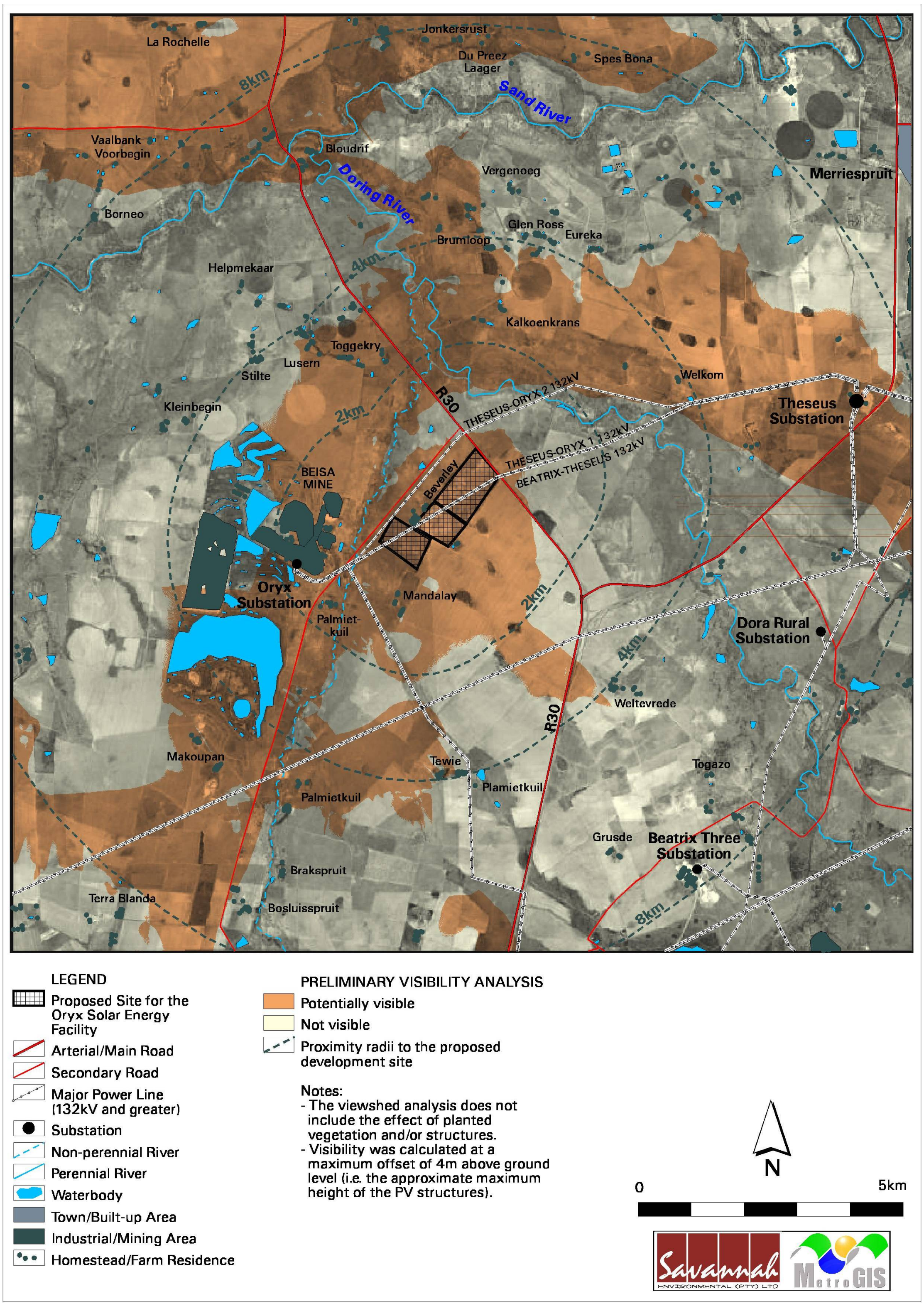
Theoretical visibility within a 2km radius of the facility includes mainly vacant land or agricultural fields, parts of the BEISA mine, a section of the R30 arterial road, the secondary road north-west of the site and farmsteads south of the site. These include Mandalay and Palmietkraal.

Visibility between the 2-4km radii includes a section of the R30, the BEISA mining area and a number of farm residences, namely Tewie to the south and Lusern, Toggekry and Kalkoenkrans to the north.

Visibility subsides considerably beyond a 4km radius with only limited exposure expected to the south-west and north-east of the site along higher lying areas. This zone includes limited potentially sensitive visual receptors and comprises mainly vacant land and agricultural fields.

Visibility beyond 8km from the proposed development is expected to be negligible and highly unlikely due to the distance between the object (development) and the observer.

It is envisaged that the structures (where visible from shorter distances) may constitute a high visual prominence, potentially resulting in a high visual impact.



Map 3: Map indicating the potential visual exposure of the proposed facility.

7. CONCLUSION/RECOMMENDATIONS

The fact that some components of the proposed facility may be visible does not necessarily imply a high visual impact. Sensitive visual receptors within (but not restricted to) an 8km buffer zone from the facility need to be identified and the severity of the visual impact assessed within the EIA phase of the project.

It is recommended that additional spatial analyses be undertaken in order to create a visual impact index that will further aid in determining potential areas of visual impact. This exercise should be undertaken for the core facility as well as for the ancillary infrastructure, as these structures (e.g. the substation and power line) are envisaged to have varying levels of visual impact at a more localised scale. The site-specific issues (as mentioned earlier in the report) and potential sensitive visual receptors should be measured against this visual impact index and be addressed individually in terms of nature, extent, duration, probability, severity and significance of visual impact.

In this respect, the Plan of Study for EIA is as follows:

- **Determine Visual Distance/Observer Proximity to the facility**

In order to refine the visual exposure of the facility on surrounding areas / receptors, the principle of reduced impact over distance is applied in order to determine the core area of visual influence for the PV structures.

Proximity radii for the proposed development site are created in order to indicate the scale and viewing distance of the facility and to determine the prominence of the structures in relation to their environment.

MetroGIS determined the proximity radii based on the anticipated visual experience of the observer over varying distances. The distances are adjusted upwards for larger facilities and downwards for smaller facilities (i.e. depending on the size and nature of the proposed infrastructure). MetroGIS developed this methodology in the absence of any known and/or acceptable standards for South African solar energy facilities.

The proximity radii (calculated from the boundary lines of the PV facility) are as follows:

- 0 – 2km. Short distance view where the facility would dominate the frame of vision and constitute a very high visual prominence.
- 2 - 4km. Medium distance view where the structures would be easily and comfortably visible and constitute a high visual prominence.
- 4 - 8km. Longer distance view where the facility would become part of the visual environment, but would still be visible and recognisable. This zone constitutes a medium visual prominence.
- Greater than 8km. Very long distance view of the facility where the facility could potentially still be visible, though not as easily recognisable. This zone constitutes a low visual prominence for the facility.

- **Determine Viewer Incidence/Viewer Perception**

The number of observers and their perception of a structure determine the concept of visual impact. If there are no observers, then there would be no visual impact. If the visual perception of the structure is favourable to all the observers, then the visual impact would be positive.

It is therefore necessary to identify areas of high viewer incidence and to classify certain areas according to the observer's visual sensitivity towards the proposed facility and its related infrastructure.

It would be impossible not to generalise the viewer incidence and sensitivity to some degree, as there are many variables when trying to determine the perception of the observer; regularity of sighting, cultural background, state of mind, and purpose of sighting which would create a myriad of options.

- **Determine the Visual Absorption Capacity of the landscape**

This is the capacity of the receiving environment to absorb or screen the potential visual impact of the proposed facility. The VAC is primarily a function of the vegetation, and will be high if the vegetation is tall, dense and continuous. Conversely, low growing sparse and patchy vegetation will have a low VAC.

The VAC would also be high where the environment can readily absorb the structure in terms of texture, colour, form and light / shade characteristics of the structure. On the other hand, the VAC for a structure contrasting markedly with one or more of the characteristics of the environment would be low.

The VAC also generally increases with distance, where discernable detail in visual characteristics of both environment and structure decreases.

The digital terrain model utilised in the calculation of the visual exposure of the facility does not incorporate the potential visual absorption capacity (VAC) of the region. It is therefore necessary to determine the VAC by means of the interpretation of the natural visual characteristics, supplemented with field observations.

- **Determine the Visual Impact Index**

The results of the above analyses are merged in order to determine where the areas of likely visual impact would occur. These areas are further analysed in terms of the previously mentioned issues (related to the visual impact) and in order to judge the severity of each impact.

The above exercise should be undertaken for the core solar energy facility as well as the ancillary infrastructure, as these structures (e.g. the substation and power line) are envisaged to have varying levels of visual impact at a more localised scale.

The site-specific issues (as mentioned earlier in the report) and potential sensitive visual receptors should be measured against this visual impact index and be addressed individually in terms of nature, extent, duration, probability, severity and significance of visual impact, as well as suggested mitigation measures.

8. REFERENCES/DATA SOURCES

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