PROPOSED KISON SOLAR ENERGY FACILITY, LIMPOPO PROVINCE

VISUAL ASSESSMENT - INPUT FOR SCOPING REPORT

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CONTENTS

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 Limpopo 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

Networx Renewables (Pty) Ltd is proposing the establishment of a 75MW total export capacity Solar Photovoltaic (PV) Facility within the Polokwane Local Municipality within the Capricorn District Municipality in the Limpopo Province. The proposed site identified for the facility is located approximately 15km south-west of Polokwane (previously Pietersburg).

The proposed site is situated immediately north-east of a great number of power lines originating at the Witkop substation. These include:

- *Warmbad to Witkop 1 275kV*
- *Witkop to Pprust 132kV*
- *Pietersburg to Witkop 1 and 2 132kV*
- *Sandsloot to Witkop 1 132kV*
- *SAR (South African Railways) Geyser to Witkop 1 132kV*

The electricity generated by the facility is expected to be evacuated into the *SAR Geyser to Witkop 1 132kV* power line.

The project is proposed to be developed in a single phase and will be referred to as the Proposed Kison Solar Energy Facility (SEF). This project will include the following infrastructure:

- Arrays of Photovoltaic (PV) panels (either static or tracking panel technology).
- Appropriate mounting structures.
- An inverter, on-site substation and power line to evacuate the power from the facility into the Eskom grid via the existing *SAR Geyser to Witkop 1 132kV* power line that traverses near the site.
- 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 Figures 1 and 2). 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 10m 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: A photovoltaic solar energy facility (taken from the Background Information Document).

Figure 2: Photograph of a photovoltaic solar energy facility (tracking technology - *from Sunworx Photovoltaic Systems website*).

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 212km^2 and includes a minimum 6km buffer zone from the proposed development area. It includes sections of the N1 national road and the R101 arterial (regional) road.

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 Kison Solar Energy Facility.

4. ANTICIPATED ISSUES RELATED TO VISUAL IMPACT

Anticipated issues related to the potential visual impact of the proposed SEF include the following:

- The visibility of the facility to, and potential visual impact on, observers travelling along the N1 national road and the R101 arterial road traversing alternately north and south of 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 and railway line traversing north of the development 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 on, or conflict with, tourism activities within the Kuschke Nature Reserve (located less than 1.5km (at the closest) from the proposed 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 Kison PV Solar Energy Facility is situated approximately 15km south-west of Polokwane on Portion 19 of the farm *Snymansbult 738*. This farm is wedged between the N1 national road and a railway line to the north, the R101 arterial road to the south-east, and no less than 6 power lines to the south-west. The general land use character of the area surrounding the site is representative of a rural and agricultural region, with little development other than the aforementioned power lines, railway line infrastructure and farm residences. The site is flanked, approximately 1km to the south (at the closest), by the *Mont Mare* hills which form a scenic backdrop when viewed from the N1 and R101. The northern section of the Kuschke Nature Reserve is partially located within these hills as well as the Kuschke Agricultural School located on the reserve. The Witkop substation is located another 2 to 3km south-east of these hills.

The site is easily accessible from the R101 arterial road by means of gravel roads that intersect with this regional route. The R101 is the alternative route to the N1 national toll road for traffic travelling between Gauteng and Polokwane, and destinations further north (e.g. Mussina and the Beit Bridge (Zimbabwe) border post).

Land use activities within the study area are described as mixed farming, which includes both dryland (e.g. maize) and irrigated (e.g. wheat) agriculture, cattle farming and game farming. Other livestock farming, such as poultry and goats are also found throughout the region. There are a number of lodges and tourist accommodation within the study area, catering mainly for travellers passing through the region. There are no major tourist attractions within the study area and the region is not considered to be a final tourist destination, although Polokwane does act as a gateway to other attractions (e.g. northern Kruger National Park and Zimbabwe) further north.

The natural vegetation or land cover types of the region are described as *Thicket and Bushland* and *Woodland*. Agricultural land uses including dryland agriculture and cultivated fields are evident when viewing the Land Cover/Land Use map of the region (see **Map 1**). Large areas of land cover degradation or sheet erosion scarring is also visible, especially to the north of the study area. The natural vegetation types of the study area are very homogenous and are indicated as *Polokwane Plateau Bushveld* and *Mamabolo Mountain Bushveld* on the *Mont Mare* hills.

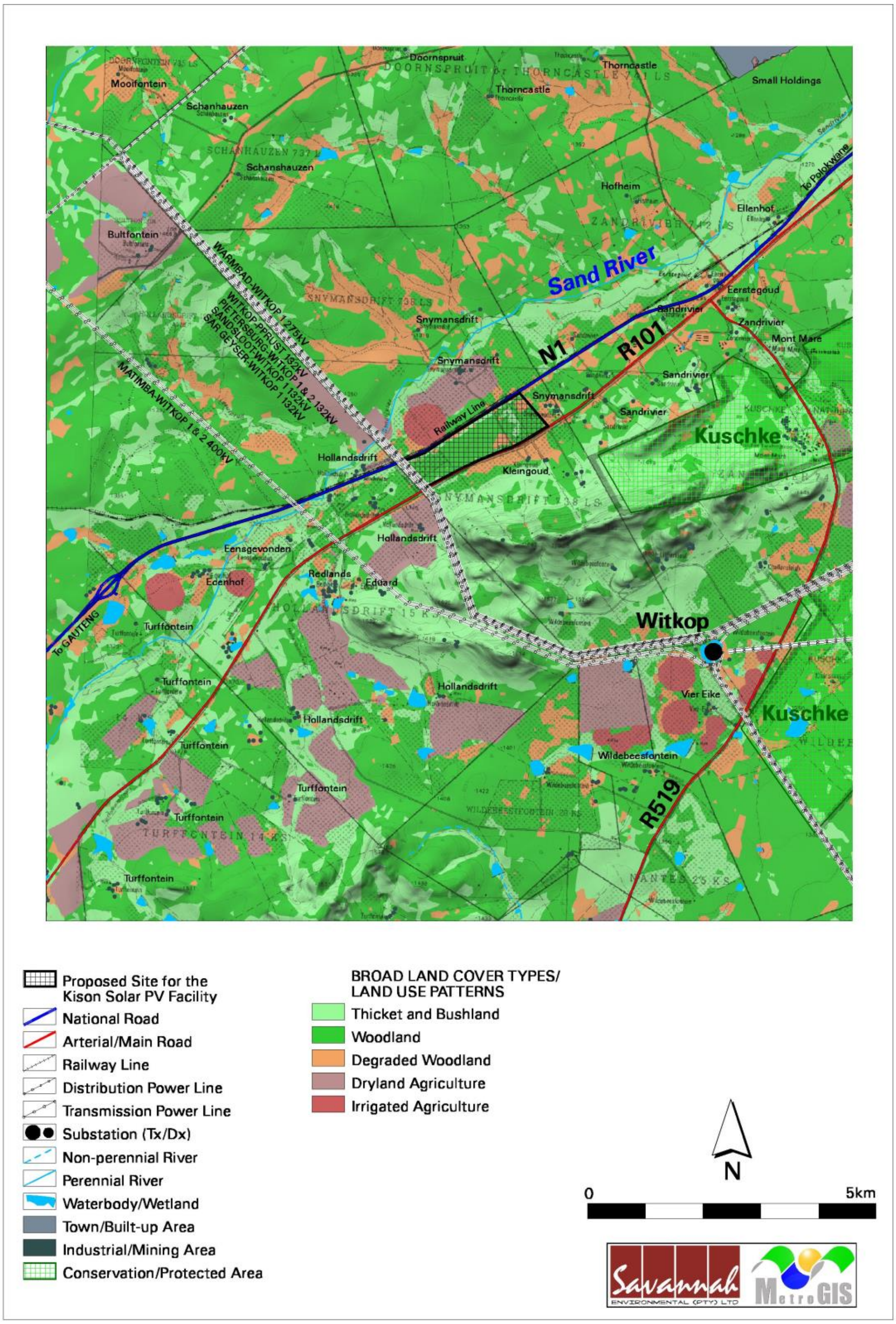
Homesteads or farm residences are found throughout the study area. Some of these, in close proximity to the proposed development site, include: *Sandrivier* (3), *Snymansdrift* (3)*, Kleingoud, Hollandsdrift (2)*, *Eduard*, *Redlands*, *Eensgevonden,* etc. The average population density of the district municipality is estimated at approximately 12 people per km^2, primarily concentrated within the town of Polokwane.

The topography or terrain morphology of the region is broadly described as *Strongly Undulating Plains* of the Polokwane Plateau and *Hills* (Mont Mare), as shown on **Map 2** (Shaded Relief/Topography). The elevation above sea level ranges from 1700m on top of the *Mont Mare* hills, to 1260m along the Sand River floodplain (where it leaves the study area in the north-east). The slope elevation of the site itself is very flat.

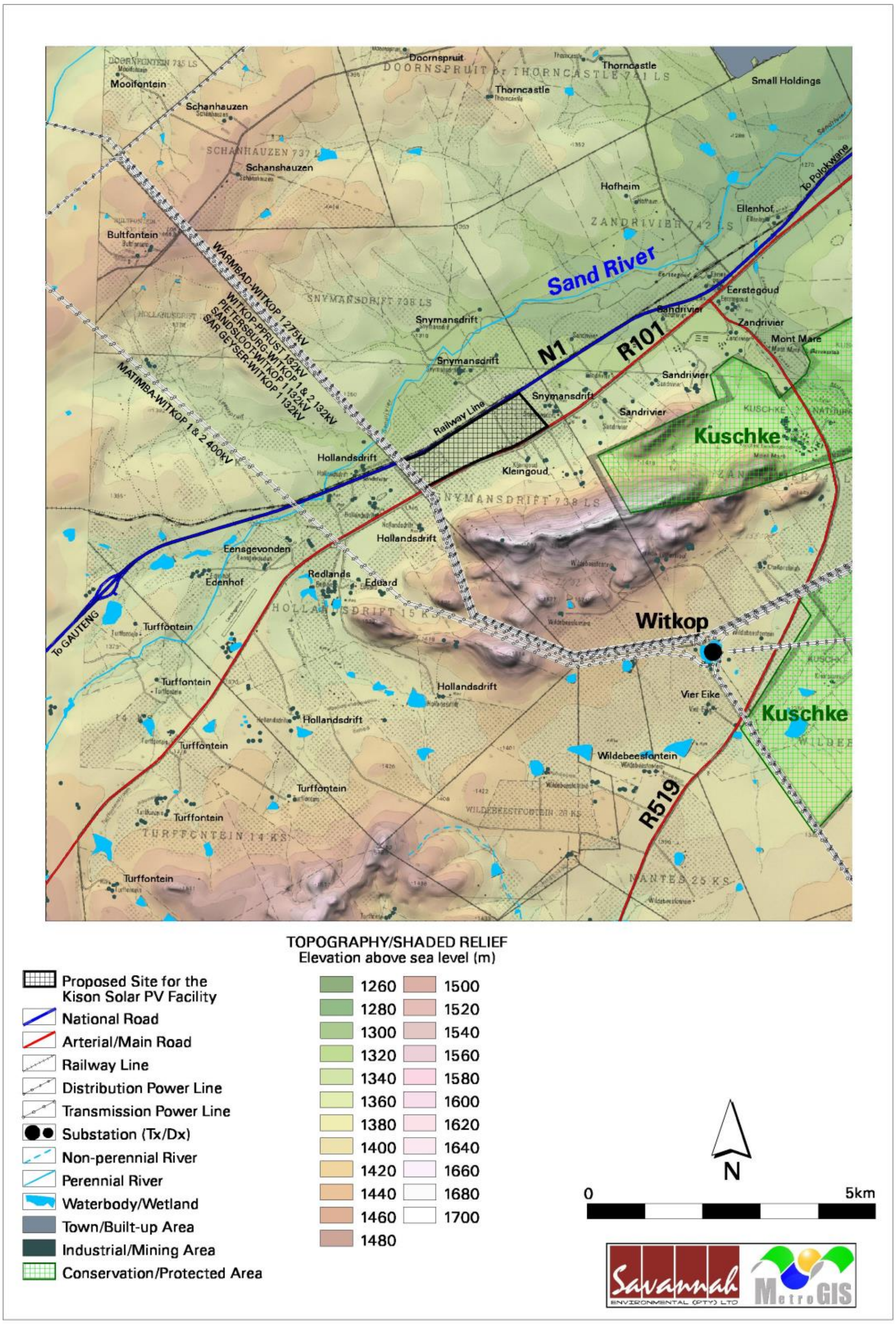
The region receives an average of 300-500mm rainfall per annum and is representative of the climate associated with the *Polokwane Plateau/Limpopo Plains*. The perennial Sand River is the only major hydrological feature, traversing the study area from the west to the east. Other non-perennial rivers or streams (e.g. *Leeuspruit* and *Hollandsdriftrivier*) are located in close proximity to the proposed site. A number of farm dams are found throughout the study area.

Figure 3: Google Earth Street View along the N1 national road, approaching from the south-west.

Figure 4: Google Earth Street View (from the R101) of the power line infrastructure traversing along the south-western boundary of the proposed development site.



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 10m 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 natural *thicket and bushland* and *woodland* within the study area and in close proximity to the facility (where intact), would 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.

General
It is evident from the preliminary viewshed analyses that the proposed facility would have a relatively contained area of potential visual exposure, especially to the south and east. This is due to the location of the Mont Mare hills south and east of the proposed site. Visual exposure to the north and west is also generally contained within a 6km radius of the site, due to the undulating nature of the topography. This area of potential visual exposure (in terms of surface area) mainly encompasses agricultural land or vacant natural land, generally devoid of sensitive visual receptors. It does however include a number of homesteads and sections of major roads that may contain sensitive visual receptors.

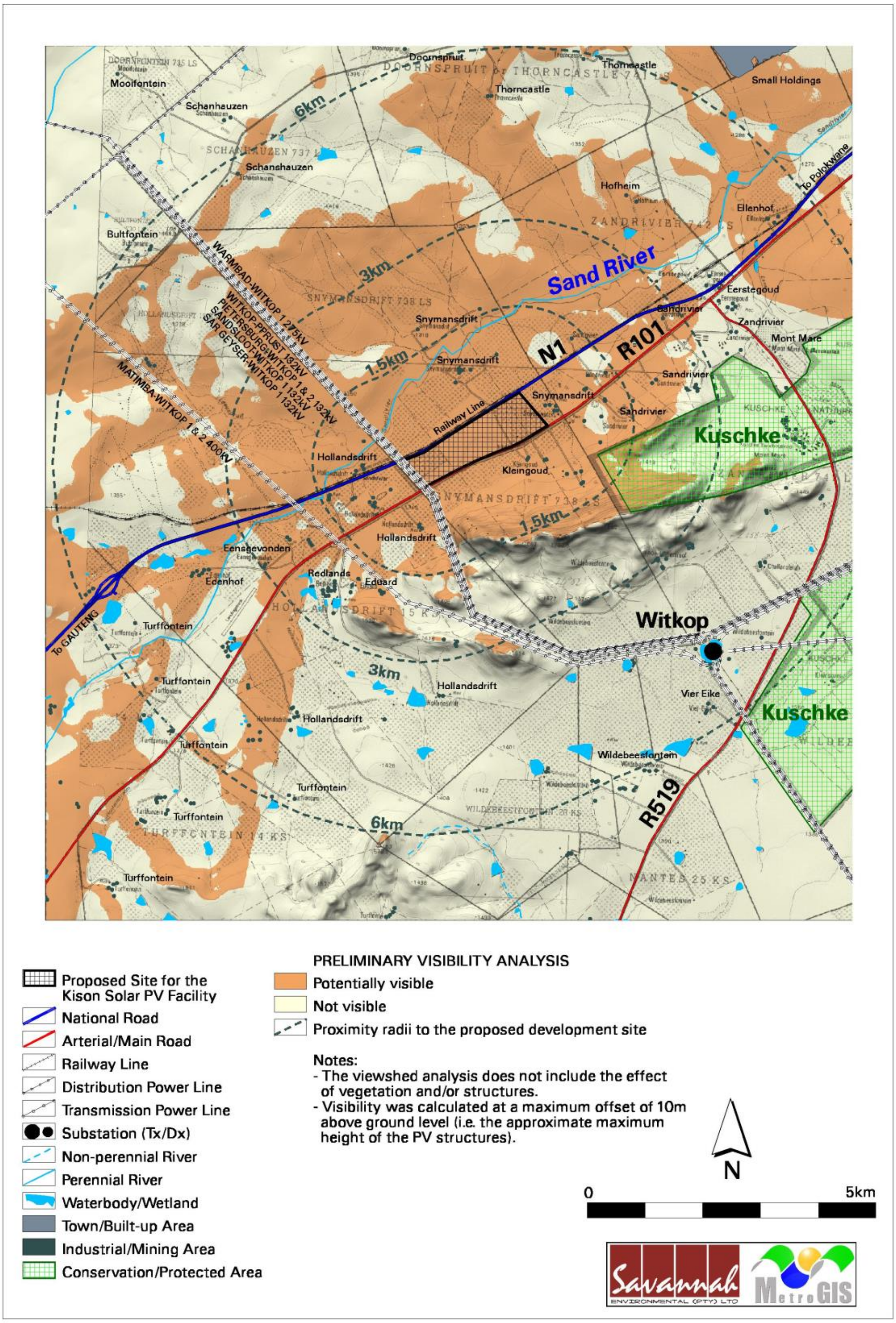
0 - 1.5km
Theoretical visibility within a 1.5km radius of the proposed facility includes mainly vacant agricultural or natural land, sections of the N1 and R101 roads (both north and south-bound) and a number of homesteads/residences. These include: *Sandrivier, Snymansdrift (2), Kleingoud* and *Hollandsdrift (3).* Visibility within this zone further includes the western section of the Kuschke Nature Reserve and the north facing slopes of the *Mont Mare* hills.

1.5 – 3km
Visibility between the 1.5 - 3km radii includes sections of the N1 and R101 roads, limited parts of the Kuschke Nature Reserve and a number of homesteads (*Eduard, Eensgevonden, Snymansdrift* and *Sandrivier* (2)).

3 – 6km
The intensity of visual exposure is expected to subside beyond a 3km radius. This zone contains large tracts of agricultural or natural land, limited sections of the N1 and R101 roads and a number of farm residences. These include: *Edenhof, Schanshausen, Thorncastle*, *Hofheim* and *Eikenhof*.

Greater than 6km
Visibility beyond 6km from the proposed development is expected to be negligible and highly unlikely due to the distance between the object (development) and the observer.

Conclusion
It is envisaged that the structures, where visible from shorter distances (e.g. less than 3km), 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 solar energy facility may be visible does not necessarily imply a high visual impact. Sensitive visual receptors within (but not restricted to) a 6km 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 the 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 footprint 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 development footprint of the PV facility) are as follows:

- 0 – 1.5km. Short distance view where the facility would dominate the frame of vision and constitute a very high visual prominence.
- 1.5 - 3km. Medium distance view where the structures would be easily and comfortably visible and constitute a high visual prominence.
- 3 - 6km. 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 6km. 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.

Note: These distances may be revised once a provisional layout of the proposed facility becomes available.

- **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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