PROPOSED GAROB WIND ENERGY FACILITY
ON A SITE NEAR COPPERTON IN THE NORTHERN CAPE PROVINCE

VISUAL IMPACT ASSESSMENT
AS PART OF AN ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

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1. STUDY APPROACH

1.1. Qualification and Experience of the Practitioner

MetroGIS (Pty) Ltd, specialising in visual assessment and Geographic Information Systems, undertook this visual assessment in collaboration with V&L Landscape Architects CC.

Lourens du Plessis, the lead practitioner undertaking the assessment, has been involved in the application of Geographical Information Systems (GIS) in Environmental Planning and Management since 1990.

The team undertaking the visual assessment has extensive practical knowledge in spatial analysis, environmental modeling and digital mapping, and applies this knowledge in various scientific fields and disciplines. The expertise of these practitioners is often utilised in Environmental Impact Assessments, State of the Environment Reports and Environmental Management Plans.

The visual assessment team 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 utilises 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.

Savannah Environmental (Pty) Ltd appointed MetroGIS (Pty) Ltd as an independent specialist consultant to undertake the visual impact assessment for the proposed Garob Wind Energy Facility. Neither the author, MetroGIS or V&L Landscape Architects will benefit from the outcome of the project decision-making.

1.2. Assumptions and Limitations

This assessment was undertaken during the planning stage of the project and is based on information available at that time.

1.3. Level of Confidence

Level of confidence[1] is determined as a function of:

- The information available, and understanding of the study area by the practitioner:
    - 3: A high level of information is available of the study area and a thorough knowledge base could be established during site visits, surveys etc. The study area was readily accessible.
    - 2: A moderate level of information is available of the study area and a moderate knowledge base could be established during site visits, surveys etc. Accessibility to the study area was acceptable for the level of assessment.
    - 1: Limited information is available of the study area and a poor knowledge base could be established during site visits and/or surveys, or no site visit and/or surveys were carried out.

[1] Adapted from Oberholzer (2005).

- The information available, understanding of the study area and experience of this type of project by the practitioner:

  - 3: A high level of information and knowledge is available of the project and the visual impact assessor is well experienced in this type of project and level of assessment.
  - 2: A moderate level of information and knowledge is available of the project and/or the visual impact assessor is moderately experienced in this type of project and level of assessment.
  - 1: Limited information and knowledge is available of the project and/or the visual impact assessor has a low experience level in this type of project and level of assessment.

These values are applied as follows:

Table 1: Level of confidence.

	Information on the project & experience of the practitioner			
Information on the study area		**3**	**2**	**1**
	3	9	6	3
	2	6	4	2
	1	3	2	1

*The level of confidence for this assessment is determined to be **9** and indicates that the author's confidence in the accuracy of the findings is high:*

- The information available, and understanding of the study area by the practitioner is rated as **3** and
- The information available, understanding and experience of this type of project by the practitioner is rated as **3**.

1.4. Methodology

The study was undertaken using Geographic Information Systems (GIS) technology 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 supplied by the Chief Directorate National Geo-Spatial Information.

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

- The creation of a detailed digital terrain model (DTM) 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 (visual impact assessment) sets out to identify and quantify the possible visual impacts related to the proposed facility, including related infrastructure, as well as offer potential mitigation measures, where required.

The following methodology has been followed for the assessment of visual impact:

- **Determine Potential visual exposure**

  The visibility or visual exposure of any structure or activity is the point of departure for the visual impact assessment. It stands to reason that if the proposed facility and associated infrastructure were not visible, no impact would occur.

  Viewshed analyses of the proposed facility and related infrastructure indicate the potential visibility.

- **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 turbines.

  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.

  The visual distance theory and the observer's proximity to the facility are closely related, and especially relevant, when considered from areas with a high viewer incidence and a predominantly negative visual perception of the proposed 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 natural vegetation**

  This is the capacity of the receiving environment to absorb 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 discernible 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 natural vegetation of the region. It is therefore necessary to determine the VAC by means of the interpretation of the vegetation cover, 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 magnitude of each impact.

- **Determine Impact significance**

  The potential visual impacts identified and described are quantified in their respective geographical locations in order to determine the significance of the anticipated impact. Significance is determined as a function of extent, duration, magnitude and probability.

2. BACKGROUND

Juwi Renewable Energies (Pty) Ltd (Juwi) is proposing the establishment of a wind energy facility (WEF) and associated infrastructure on a site located approximately 7,5km north east of the town of Copperton within the Pixley Ka Seme District Municipality of the Northern Cape Province.

The site being considered for the proposed wind energy facility covers an area of approximately 5520 Ha.

A wind energy facility generates electricity by means of wind turbines that harness the wind of the area as a renewable source of energy. Wind energy generation, or wind farming as it is commonly referred to, is generally considered to be an environmentally friendly electricity generation option.

The efficiency of a wind energy facility, or amount of power generated, is dependent on the number of wind turbines erected in the area as well as the careful placement of the turbines in relation to the topography and each other in order to optimise the use of the wind resource.

This site will accommodate up to 58 wind turbines, each of which would generate up to 2,6 MW. The final turbine capacity and model is dependent on what is deemed suitable for the site following further studies of the wind regime, terrain, and potential environmental constraints. The total generating capacity of the facility will be 140MW.

The facility will have a combined energy producing capacity of up to 143 MW and will connect to the national grid via the Burchell-Culprum 1 (132kV) power line, which crosses over the proposed site in the south east.

A locality map indicating the proposed development site is shown on **Map 1**. Primary and ancillary infrastructure is expected to include the following:

- Underground cables between turbines.
- An on-site substation to facilitate the connection between the wind energy facility and the electricity grid.
- Internal access roads to each wind turbine.
- A workshop area and an office for control, maintenance and storage.

Two options are being considered for grid connection as follows:

- Option 1: Loop in and out of the existing BURCHELL/CUPRUM 132 kV line.
- Option 2: would be to connect directly to the existing Eskom Caprum substation via a 132 kV power line. Two alternatives are being considered for this option:
    - Alternative 1 would be to connect directly to the existing Eskom Caprum substation via the northern corridor parallel to the BURCHELL/CUPRUM 132 kV line. Two sub alternatives are being considered within this corridor:
        - Sub alternative 1A is the shortest route with a section crossing the wind farm site in a westerly direction.
        - Sub alternative 1B is the longer route (approximately 2.5 km longer than sub-alternative A):
    - Alternative 2 will be to connect directly to the existing Eskom Caprum substation via a southern corridor which follows a route to avoid traversing the adjacent property (Farm 103/7) and which forms part of another proposed renewable energy project.

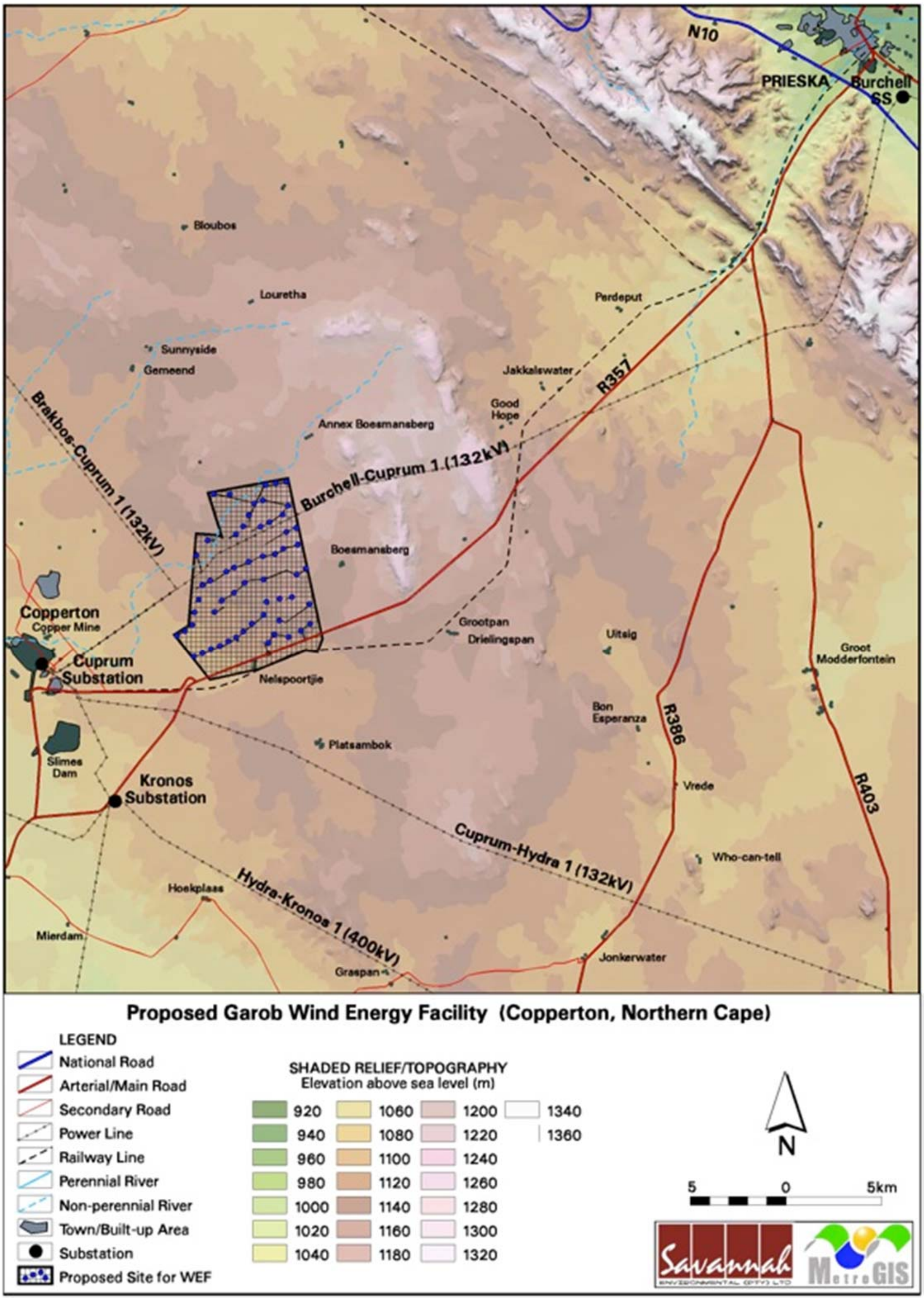
Each wind turbine is expected to consist of a concrete foundation, a steel tower, a hub or 'nacelle' (120m above ground level housing the generator / turbine) and three 60m long blades attached to the hub.

Variations of these dimensions may occur, depending on the preferred supplier or commercial availability of wind turbines at the time of construction. Refer to **Figure 1**.

Figure 1: Image of a typical wind turbine.

A facility consisting of up to 58 turbines will take approximately 18 months to construct and commission, and requires the expertise of skilled staff. A wind turbine is designed to operate continuously, with low maintenance for more than 20 years.

It is expected, from a visual impact perspective, that the wind turbines would constitute the highest potential visual impact of the wind energy facility.



Map 1: Shaded relief map of the study area (indicating the location of the proposed WEF, as well as the topography and elevation above sea level).

3. SCOPE OF WORK

The determination of the potential visual impacts is undertaken in terms of nature, extent, duration, magnitude, probability and significance of the construction and operation of the proposed infrastructure. Mitigation measures are where appropriate.

The Garob Wind Energy Facility is proposed on is proposed on Portion 5 of Farm 103 (Nelspoortje Farm). See **Map 1**.

The study area for the visual assessment encompasses a geographical area of approximately 2136km² (the extent of the maps displayed below) and includes a minimum 20km buffer zone from the proposed site boundary.

The scope of work for this assessment includes the determination of the potential visual impacts in terms of nature, extent, duration, magnitude, probability and significance of the construction and operation of the proposed infrastructure.

Anticipated issues related to the potential visual impact of the proposed WEF as identified through the scoping study include the following:

- The visibility of the facility from, and potential visual impact on observers travelling along arterial roads (i.e. the R357, R386 and R403) and secondary roads in close proximity[2] to the proposed facility and within the region[3].
- The visibility of the facility from, and potential visual impact on residents of homesteads and settlements in close proximity to the proposed facility and within the region.
- The potential visual impact on the town of Copperton.
- The potential visual impact of ancillary infrastructure (i.e. the substation, overhead power lines, internal access roads, workshop and office) on observers in close proximity to the proposed facility.
- The potential visual impact of shadow flicker on observers residing on or in close proximity to the proposed facility. This is the flicker of shadow as the rotor blades pass between the receptor and the sun. It occurs when the sky is clear, and when the rotor blades are between the sun and the receptor (i.e. when the sun is low).
- The potential visual impact of operational, safety and security lighting of the facility at night on observers in close proximity to the facility.
- Potential visual impacts associated with the construction phase on observers in close proximity to the proposed facility.
- The potential visual impact of the proposed facility on the visual quality of the landscape and sense of place region.
- The potential cumulative visual impact of the proposed wind energy facility in relation to other infrastructure and built forms.
- Potential residual visual impacts after the decommissioning of the proposed facility.
- The potential to mitigate visual impacts and inform the design process.

It is envisaged that the issues listed above may constitute a visual impact at a local and/or regional scale.

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[2] For the purpose of this study, close proximity is considered to be within 10km of the proposed wind energy facility. This would be a medium distance view where the structures would be easily and comfortably visible and constitutes a high visual prominence.

[3] For the purpose of this study, the region is considered to be beyond the 10km radius of the proposed wind energy facility. This would be a longer distance view where the facility would become part of the visual environment, but would still be visible and constitutes a medium to low visual prominence.

4. RELEVANT LEGISLATION AND GUIDELINES

The following legislation and guidelines have been considered in the preparation of this report:

- The Environmental Impact Assessment Amendment Regulations, 2010;
- Guideline on Generic Terms of Reference for EAPS and Project Schedules (DEADP, Provincial Government of the Western Cape, 2011).

5. THE AFFECTED ENVIRONMENT

Regionally, the proposed site for the proposed Garob Wind Energy Facility is located approximately 13km south west of Prieska in the Northern Cape.

The study area occurs on land that ranges in elevation from about 920m above sea level (a.s.l.) along the Orange River (located just north east of Prieska) to about 1360m a.s.l. at the tops of the Doringberge in the north east of the study area. With these mountains as the highest point, the topography slopes to the north east (towards the river) and to the south west. The site itself lies at an elevation of about 1100 – 1140 a.s.l. Refer to **Map 1**.

The topography consists of *Slightly irregular plains* and *Hills*. The Doringberge lie in the far north east of the study area, and some smaller local hills are situated in closer proximity to the site, to the north east. The terrain immediately surrounding the site is relatively flat.

Figure 2: Low hills typical of the study area.

The most significant hydrological feature within the region in the Orange River, which lies just beyond of the town of Prieska in the north east. A few non-perennial tributaries are present in the study area. These drain to the north east and south west. Some isolated pans / wetlands are located in the south east of the study area.

With its semi-arid climate, the broader study area receives between 185 mm and 248 mm of rainfall per year and the proposed site is situated within the *Orange River broken veld* vegetation type[4].

Figure 3: Shrubland vegetation typical of the study area

Copperton is a mining town with its economy largely dependent on the copper mine. Land use along the Orange River (i.e. north east of Prieska) consists of *irrigated agriculture,* but this is limited to a strip along the river. The remainder of the study area consists of *shrubland* with limited grazing potential. Refer to **Map 2.**

Built up areas within the study area are include the towns of Copperton and Prieska. In addition, a number homesteads and / or are dotted throughout the study area at a low density. The average population density within the Pixley Ka Seme District Municipality[5] is 1,8 people per km^2.

A number of arterial roads traverse the study area. These include the R357, which bisects the site, and links Prieska with Copperton, the R386 and the R403. A few secondary roads are also present in the vicinity of Prieska and Copperton respectively. A railway line also runs between Copperton and Prieska, roughly following the alignment of the R357.

Industrial type infrastructure includes mining in and around Copperton and some industry / mining in Prieska. In addition, a number of power lines are present, including the Burchell-Cuprum 1 (132kV) power line, which traverses the site, and four others ranging from 132kV to 400kV. The Kronos Substation lies some 8 km south west of the site and the Burchell Substation is situated in the far north east, outside Prieska.

[4] Department of Environmental Affairs and Tourism, 2001. *Environmental Potential Atlas for the NorthernCape Province (ENPAT NorthernCape)*
[5] http://en.m.wikipedia.org/wiki/Pixley_ka_Seme_District_Municipality

Figure 4: 132 kV powerlines travesing the study area

Figure 5: Infrastructure associated with the Copperton Mine.

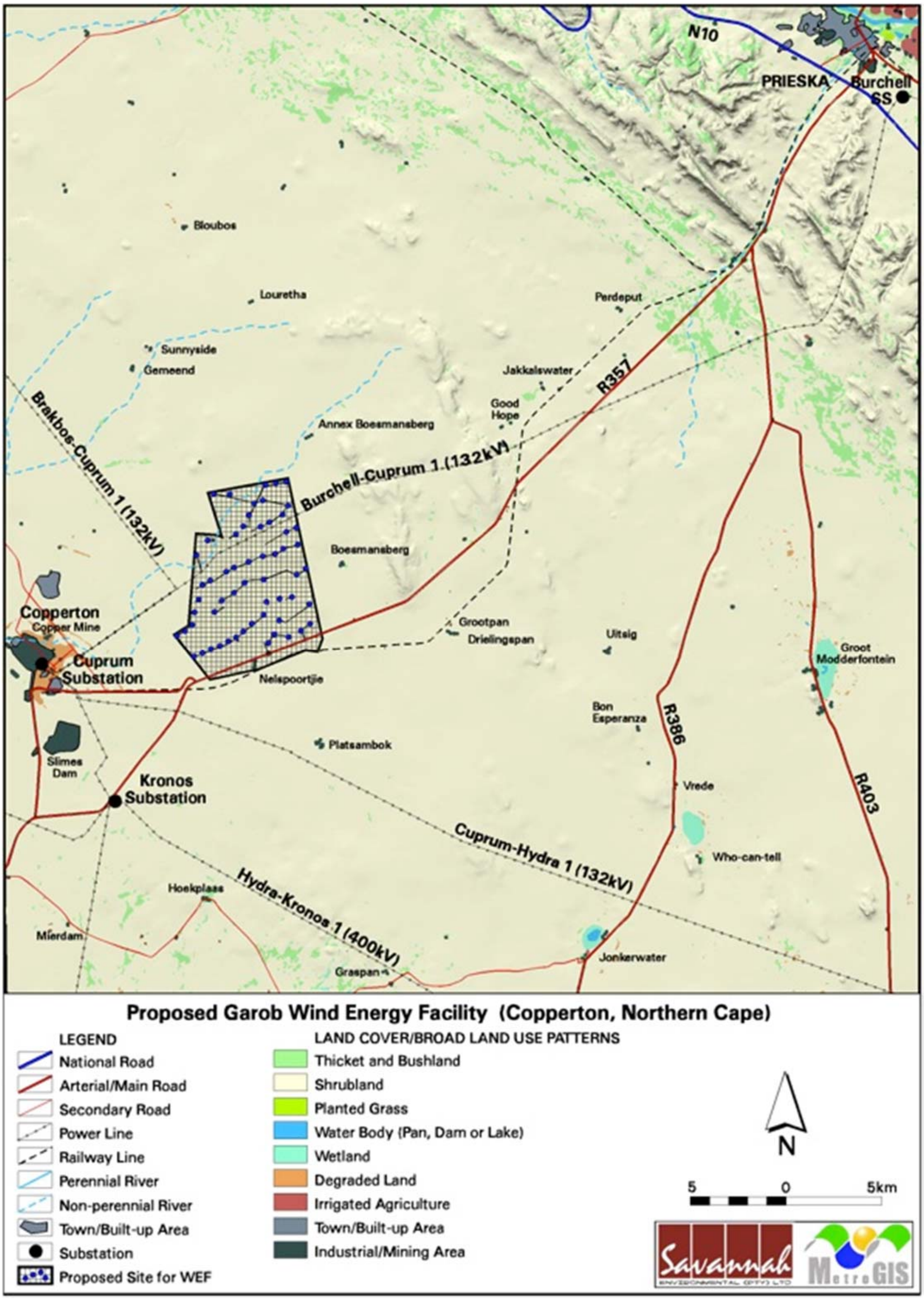
Figure 6: The residential town of Copperton.

There are no formally protected or conservation areas present within the study area, but the greater environment has a rural and undeveloped character once beyond the small towns and mining areas. Settlements, where these occur, are limited in extent and domestic in scale. A harsh and rugged sense of place characterises the greater region.

This area is not known as a tourist destination, but the N10 in the far north east is a main access route between the N1 and Upington.

The greater environment with its wide open, undeveloped landscapes is considered to have a high visual quality. A harsh and rugged sense of place characterises the greater region, but is not particular to this study area.

Sources: DEAT (ENPAT Northern Cape), NBI (Vegetation Map of South Africa, Lesotho and Swaziland) and NLC2000 (ARC/CSIR).



Map 2: Land cover and broad land use patterns within the study area.

6. RESULTS

6.1 Potential visual exposure

The result of the initial viewshed analyses for the proposed Garob Wind Energy Facility is shown on **Map 3**. The visibility analysis was undertaken from 58 wind turbine positions at an offset of 120m above average ground level (i.e. the maximum hub height of the proposed turbines).

The viewshed analysis does not include the effect of vegetation cover or existing structures on the exposure of the proposed wind turbines, therefore signifying a worst-case scenario.

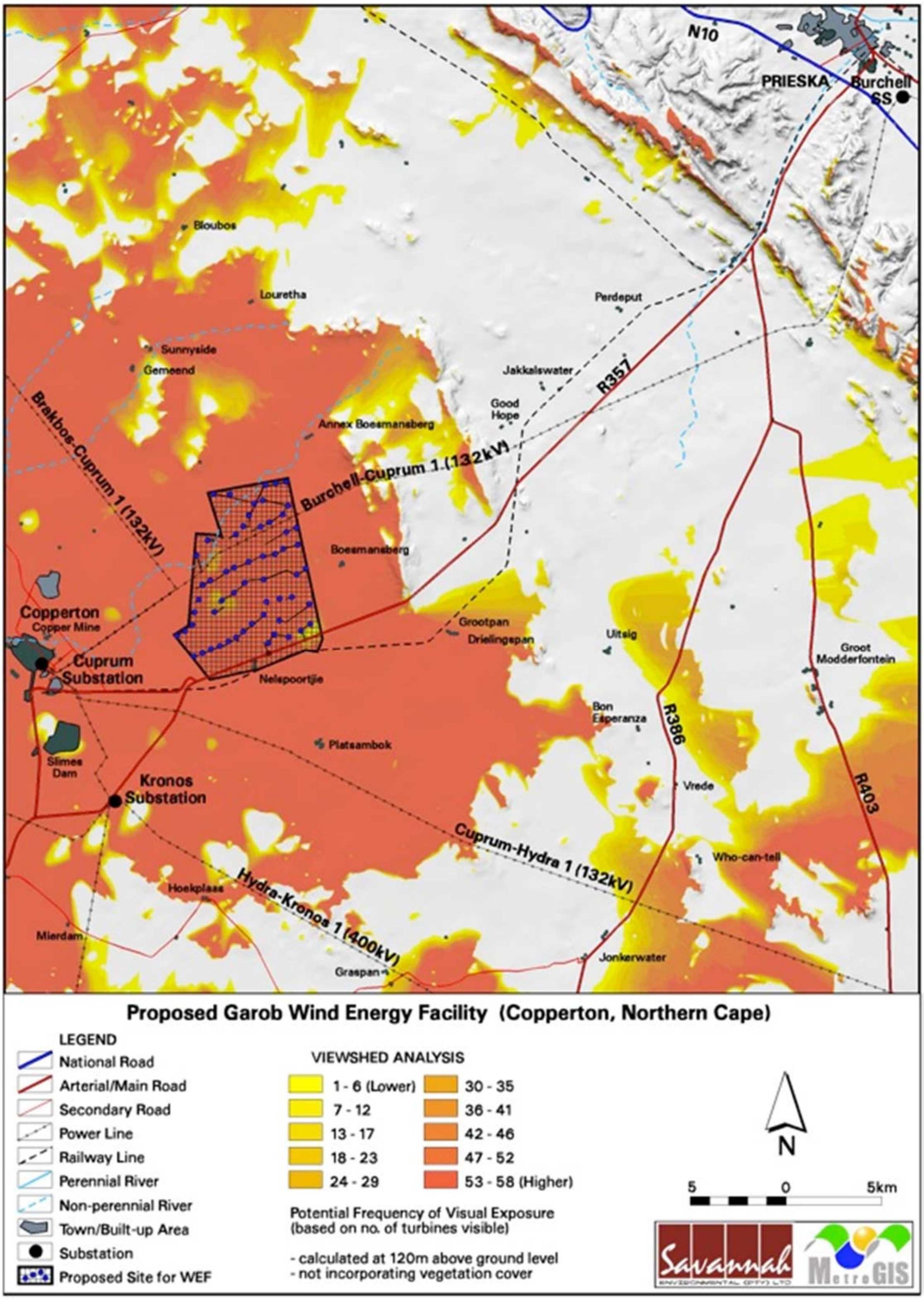
The viewshed not only indicates areas from which the wind turbines would be visible (any number of turbines with a minimum of one turbine), but also indicates the potential frequency of visibility (i.e. how many turbines are exposed). The dark orange areas indicate a high frequency (i.e. 53-58 turbines or parts thereof may be visible) while the yellow areas represent a low frequency (i.e. 1-6 turbines or parts thereof may be visible).

The proposed facility will have a large core area of potential visual exposure, with a high frequency of exposure, on the project site itself, and within a 5km offset.

Potential visual exposure is slightly reduced in the medium distance (i.e. between 5 and 10km), with some visually screened areas in the east and north east (beyond the local hills), and to a lesser extent to the north west and south. The frequency of exposure remains high, however.

In the longer distance (i.e. beyond the 10km offset), the extent and frequency of potential visual exposure is further reduced. Visually exposed areas occur mainly in the north and south west. Areas in the north east, east and south east are less exposed to potential visual impact. Visually exposed areas are fragmented due to topography.

The town of Prieska is not likely to be visually exposed, with the hills in the far north east of the study area protecting the town from potential visual exposure, The south western slopes of these hills are visually exposed, but it is unlikely that the facility will be visible from this distance.



Map 3: Potential visual exposure of the proposed WEF.

(Note: the visible area indicates areas from which any number of wind turbines (with a minimum of one turbine) may be visible.

6.2 Visual distance / observer proximity to the facility

MetroGIS / V&L determined proximity radii based on the anticipated visual experience of the observer over varying distances. The following factors are considered for the determination of appropriate proximity radii:

- The normal cone of vision for a stationary person, which is accepted to be 30 degrees in both the vertical and the horizontal fields. This cone of vision allows for no head or eye movement and no loss of focus of the object in question.
- The maximum horizontal extent or widest cross section of the proposed facility that an observer will be able to perceive.
- The maximum height of the tallest infrastructure.

For a wind energy facility, the horizontal extent is of most significance, and the proximity radii are calculated as a function of the critical point at which an observer will be able to perceive the full extent of the turbine structures within a normal 30 degree cone of vision.

MetroGIS / V&L developed this methodology in the absence of any known and/or acceptable standards for South African wind energy facilities.

These proximity radii (calculated from the proposed development area) are shown on **Map 4** and are described as follows:

- 0 – 5 km - Short distance view where the facility would dominate the frame of vision and constitute a very high visual prominence.
- 5 – 10 km - Medium distance views where the facility would be easily and comfortably visible and constitute a high visual prominence.
- 10 – 20 km - Medium to 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 20 km - Long distance view where the facility would still be visible though not as easily recognisable. This zone constitutes a low visual prominence for the facility.

6.3. Viewer incidence / viewer perception

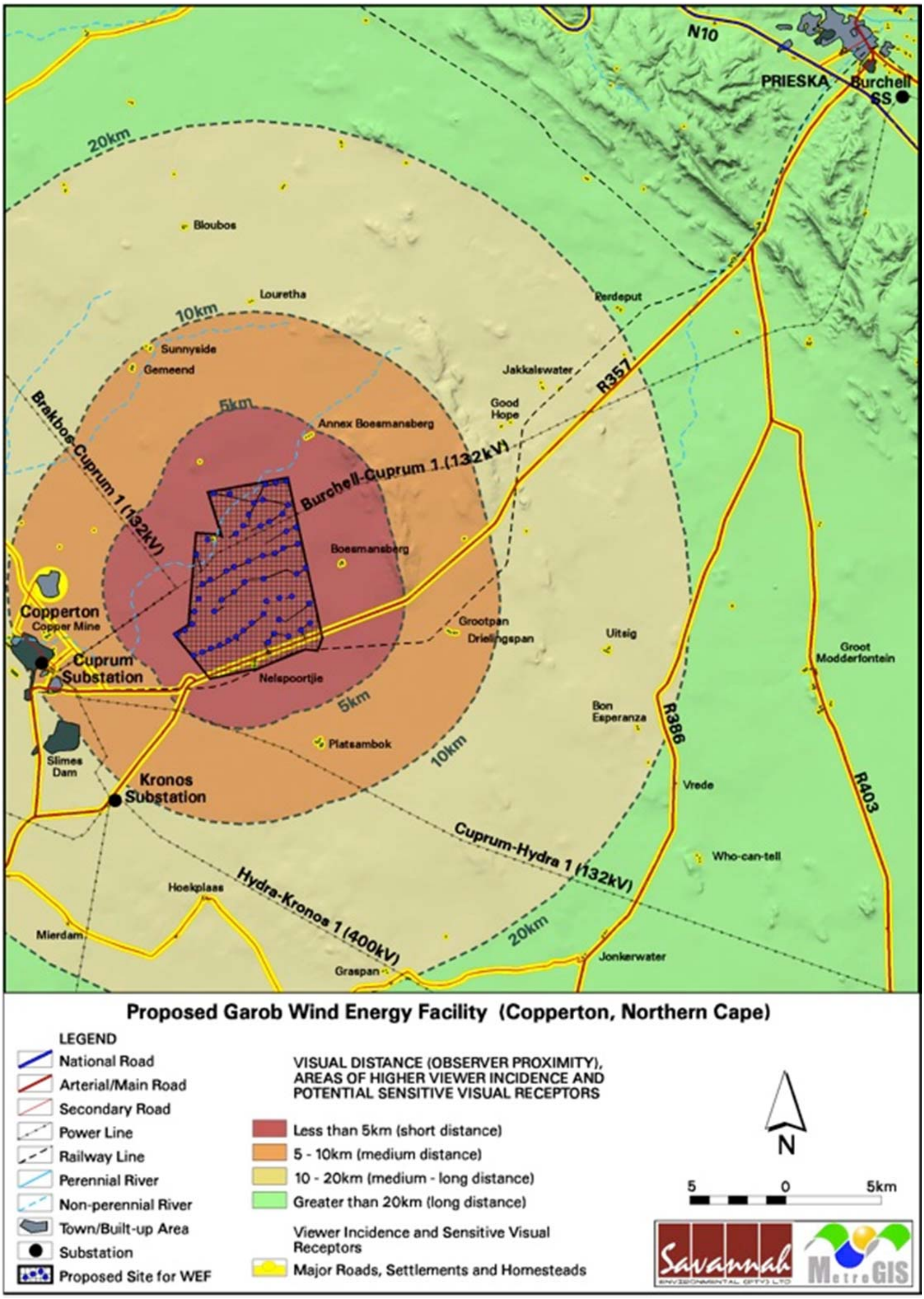
Refer to **Map 4**. Viewer incidence is calculated to be the highest in the residential area of Copperton. In addition, a high incidence of visual receptors is expected along the arterial roads (i.e. the R386 and the R403) as well as along the secondary roads within the study area. Commuters using these roads could be negatively impacted upon by visual exposure to the facility, and are thus considered to be sensitive to visual intrusion.

Other than the above, viewer incidence will be concentrated within the agricultural homesteads and settlements within the study area.

In terms of viewer sensitivity, the most vulnerable to potential visual impacts include residents of homesteads and settlements (who will be exposed while at home) and tourists visiting and travelling through the area.

Daily commuters (by road) are also considered to sensitive receptors, but as this exposure will be of shorter duration that for residents of homesteads, their sensitivity is somewhat lower.

The severity of the visual impact on visual receptors decreases with increased distance from the proposed facility.



Map 4: Observer proximity to the proposed WEF and areas of viewer incidence.

6.4. Visual absorption capacity

The broader study area receives between 185 mm and 248 mm of rainfall per year and the proposed site is situated within the *Orange River broken veld* vegetation type. Land use along the Orange River (i.e. north east of Prieska) consists of *irrigated agriculture,* but this is limited to a strip along the river. The remainder of the study area consists of *shrubland* with limited grazing potential.

Overall, the Visual Absorption Capacity (VAC) of the receiving environment and especially the area in close proximity to the proposed WEF is deemed low by virtue of the nature of the vegetation and the low occurrence of urban development.

The significant height of wind turbines adds to visual dominance of the WEF, with the tall towers and long blades of the turbines contrasted against the background of the horizon. In addition, the scale and form of the WEF structures means that it is unlikely that the environment will visually absorb them in terms of texture, colour, form and light / shade characteristics.

Where homesteads and settlements occur, some more significant vegetation and trees may have been planted, which would contribute to visual absorption. As this is not a consistent occurrence, however, VAC will not be taken into account for any of the homesteads or settlements, thus assuming a worst case scenario in the impact assessment.

Within the built-up area of Copperton, as well as some mining areas, VAC will be of relevance, due to the presence of buildings, structures and equipment, referred to as visual clutter. In this respect, the presence of the built-up environment will 'absorb' the visual impact to some extent.

VAC will be taken into account within the built up area of Copperton only. In areas where no VAC is present, especially in close proximity of the site, no VAC will be considered. This would ultimately simulate a worst case scenario.

Figure 7: The low VAC of the study area

6.5. Visual impact index

The combined results of the visual exposure, viewer incidence / perception and visual distance of the proposed WEF are displayed on **Map 5**. Here the weighted impact and the likely areas of impact have been indicated as a visual impact index. Values have been assigned for each potential visual impact per data category and merged in order to calculate the visual impact index.

An area with short distance, high frequency of visual exposure to the proposed facility, a high viewer incidence and a predominantly negative perception would therefore have a higher value (greater impact) on the index. This helps in focussing the attention to the critical areas of potential impact when evaluating the issues related to the visual impact.

The visual impact index for the WEF is further described as follows.

- The visual impact index map indicates a core zone of **high** visual impact within a 5 km radius of the proposed facility.

  Sensitive visual receptors within this zone include users of the R357 in the south and residents of the settlements of *Annex Boesmansberg, Boesmansber* and *Nelspoortjie* (amongst others). These receptors are likely to experience **very high** visual impact.

- The extent of potential visual impact remains high between the 5 km and 10 km. Some visually screened areas occur in the east and north east (beyond the local hills), and to a lesser extent to the north west and south. Visual impacts within this zone are mostly **moderate**, with limited areas of **low** to **very low** magnitude where the frequency of exposure is lower.

  Sensitive visual receptors again include users of the R357 in the south west, a number of secondary roads in the vicinity of Copperton and residents of Copperton. In addition, residents of homesteads and settlements beyond the town are also likely to be impacted upon. These include *Sunnyside, Gemeend, Copper Mine, Platsambok, Grootpan* and *Drielingspan* (amongst others). These receptors are likely to experience **high** visual impact.

- Between 10 km and 20 km, the extent of potential visual impact is reduced. Visually exposed areas occur mainly in the north and south west. Areas in the north east, east and south east are less exposed to potential visual impact. Visually exposed areas are fragmented due to topography. Visual impacts within this zone are likely to be mostly **low** with limited areas of **very low** to **negligible** magnitude where the frequency of exposure is lower.

  Sensitive visual receptors at this distance include users of short stretches of the R386 in the east of the study area, and various secondary roads south of Copperton. A few homesteads and settlements, including *Hoekplaas, Louretha* and *Bloubos* (amongst others) may also be impacted upon. Visual impacts on these sensitive receptors are likely to be **moderate.**

- Remaining impacts beyond the 20 km radius are expected to be **negligible,** where these occur at all.

Figure 8 overleaf helps to place the above explanations in context, illustrating what scale a turbine structure will be perceived at different viewing distances.

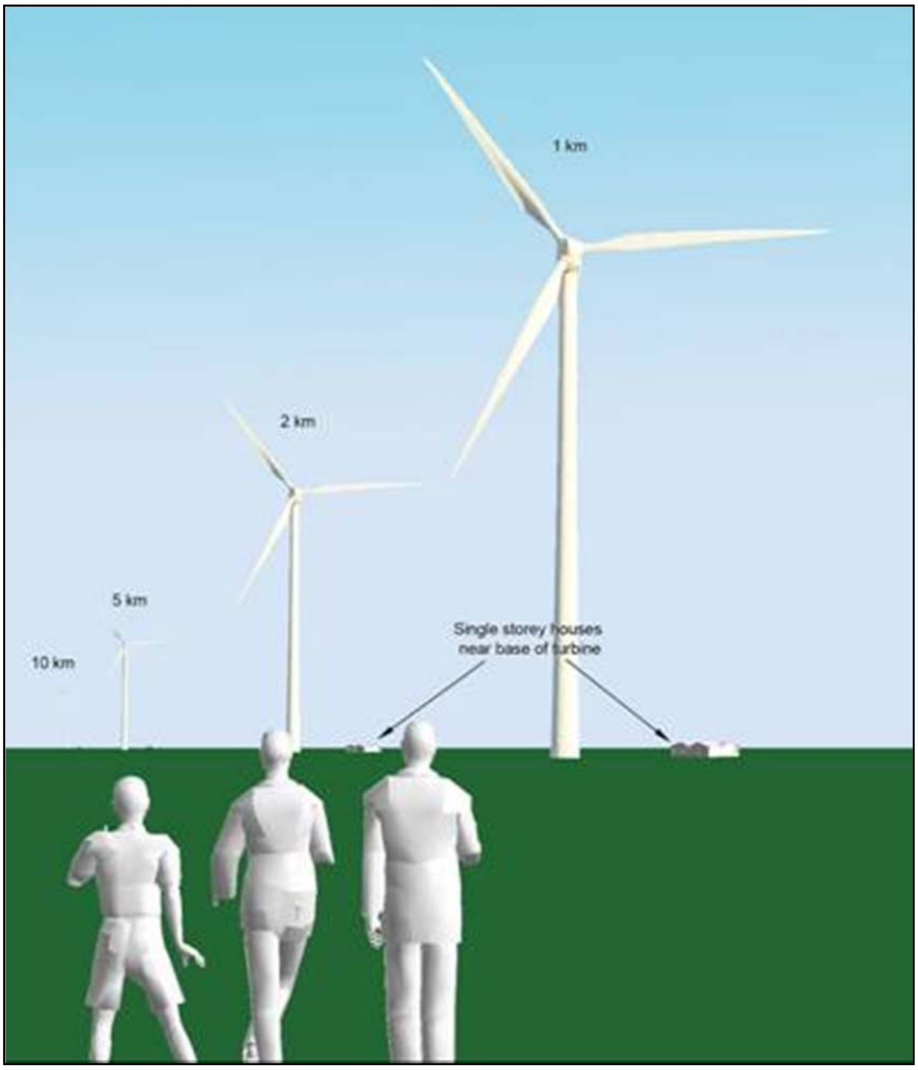
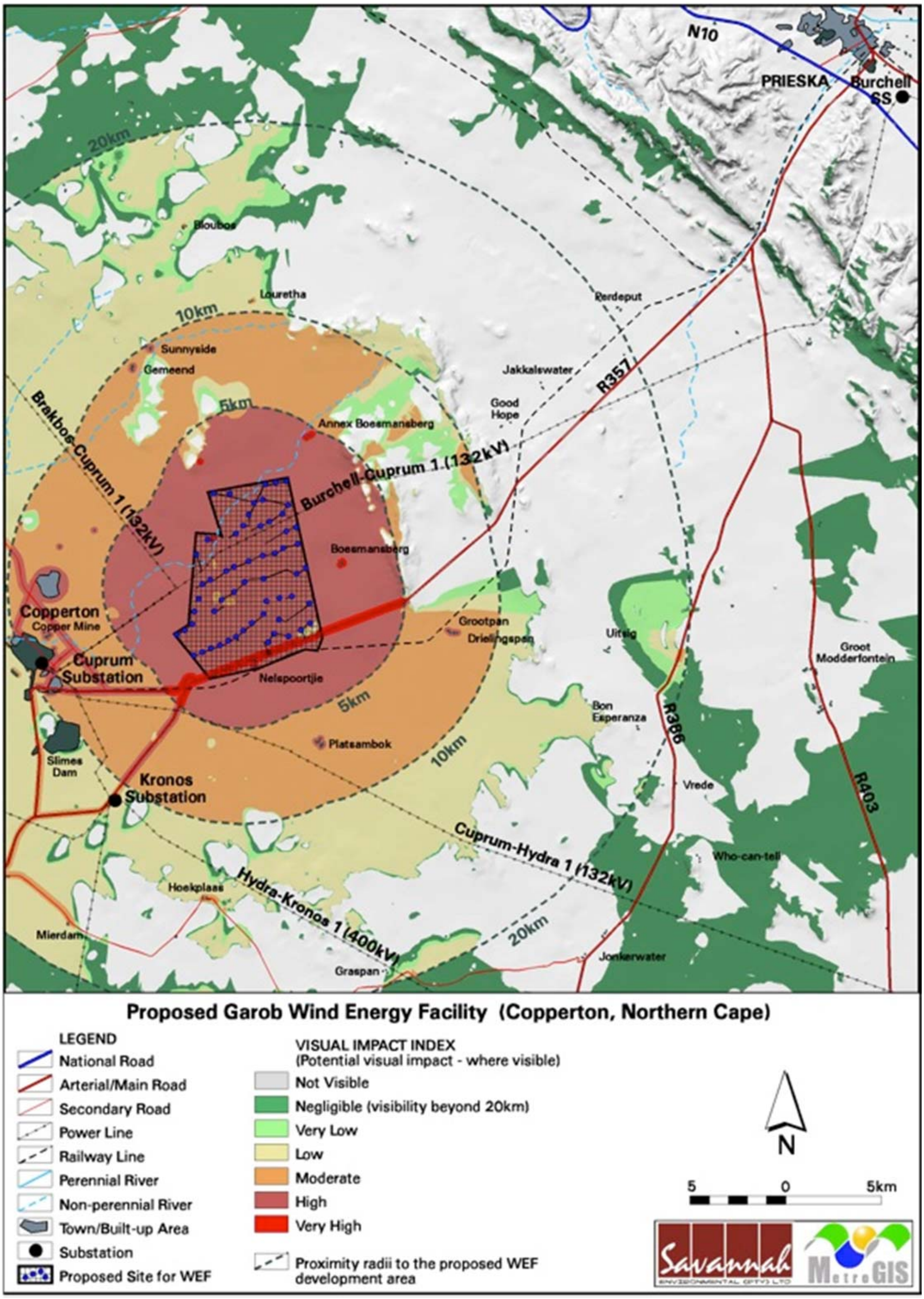


Figure 8: Visual experience of a wind turbine structure at a distance of 1km, 2km, 5km and 10km.



Map 5: Visual impact index of the proposed WEF.

6.6 Visual impact assessment: methodology

The previous section of the report identified specific areas where likely visual impacts would occur. This section will attempt to quantify these potential visual impacts in their respective geographical locations and in terms of the identified issues (see Chapter 3: SCOPE OF WORK) related to the visual impact.

The methodology for the assessment of potential visual impacts states the **nature** of the potential visual impact (e.g. the visual impact on users of major roads in the vicinity of the proposed facility) and includes a table quantifying the potential visual impact according to the following criteria:

- **Extent** - site only (very high = 5), local (high = 4), regional (medium = 3), national (low = 2) or international (very low = 1)[6].
- **Duration** - very short (0-1 yrs = 1), short (2-5 yrs = 2), medium (5-15 yrs = 3), long (>15 yrs = 4), and permanent (= 5).
- **Magnitude** - None (= 0), minor (= 2), low (= 4), medium/moderate (= 6), high (= 8) and very high (= 10)[7].
- **Probability** – very improbable (= 1), improbable (= 2), probable (= 3), highly probable (= 4) and definite (= 5).
- **Status** (positive, negative or neutral).
- **Reversibility** - reversible (= 1), recoverable (= 3) and irreversible (= 5).
- **Significance** - low, medium or high.

The **significance** of the potential visual impact is equal to the **consequence** multiplied by the **probability** of the impact occurring, where the consequence is determined by the sum of the individual scores for magnitude, duration and extent (i.e. **significance = consequence (magnitude + duration + extent) x probability**).

The significance weighting for each potential visual impact (as calculated above) is as follows:

- <30 points: Low (where the impact would not have a direct influence on the decision to develop in the area)
- 31-60 points: Medium/moderate (where the impact could influence the decision to develop in the area)
- >60: High (where the impact must have an influence on the decision to develop in the area)

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[6] Due to the declining visual impact over distance, the **extent** (or spatial scale) rating is reversed (i.e. a localised visual impact has a higher value rating than a national or regional value rating). This implies that the visual impact is highly unlikely to have a national or international extent, but that the local or site-specific impact could be of high significance.

[7] This value is read from the visual impact index. Where more than one value is applicable, the higher of these will be used as a worst case scenario.

6.7 Visual impact assessment: primary impacts

The primary visual impacts of the proposed WEF are further assessed as follows:

6.7.1 The WEF

6.7.1.1 Potential visual impact on users of arterial and secondary roads in close proximity to the proposed facility.

Visual impacts of the WEF on the R357 arterial road and on various secondary roads in the vicinity of Copperton are expected to be of **high** significance within a radius of 10 km from the proposed facility.

The relatively low incidence of roads (and the anticipated low usage thereof) within this environment and the proximity of the proposed facility to the existing Copperton Mine and associated infrastructure reduces the probability of this impact occurring.

No mitigation of this impact is possible, but measures are recommended as best practice. The table below illustrates this impact assessment.

Table 2: Visual impact on users of arterial and secondary roads in close proximity to the proposed facility.

Nature of Impact: Visual impact on users of arterial and secondary roads in close proximity to the proposed facility		
	No mitigation	***Mitigation considered***
Extent	Local **(4)**	N/a
Duration	Long term **(4)**	N/a
Magnitude	Very high **(10)**	N/a
Probability	High **(4)**	N/a
Significance	High **(72)**	N/a
Status (positive, neutral or negative)	Negative	N/a
Reversibility	Recoverable **(3)**	N/a
Irreplaceable loss of resources?	No	N/a
Can impacts be mitigated?	No	
Mitigation / Management: <u>Planning:</u> ➢ Retain / re-establish and maintain natural vegetation in all areas outside of the development footprint. <u>Operations:</u> ➢ Maintain the general appearance of the facility as a whole. <u>Decommissioning:</u> ➢ Remove infrastructure not required for the post-decommissioning use of the site. ➢ Rehabilitate all areas. Consult an ecologist regarding rehabilitation specifications. ➢ Monitor rehabilitated areas post-decommissioning and implement remedial actions.		
Cumulative impacts: The construction of wind turbines together with the associated infrastructure will increase the cumulative visual impact of industrial type infrastructure within the region. This is relevant in light of the power line infrastructure already present in the area as well as other alternative energy facilities proposed in the region.		
Residual impacts: The visual impact will be removed after decommissioning, provided the facility and ancillary infrastructure is removed. Failing this, the visual impact will remain.		

6.7.1.2 Potential visual impact on residents of homesteads and settlements in close proximity to the proposed facility.

The potential visual impact on residents of settlements and homesteads within a 10 km radius of the proposed WEF is expected to be of **high** significance. These settlements and homesteads include *Annex Boesmansberg, Boesmansber, Nelspoortjie*, *Sunnyside, Gemeend, Copper Mine, Platsambok, Grootpan* and *Drielingspan* (amongst others).

The relatively low incidence of homesteads and settlements within this environment and the proximity of the proposed facility to the existing Copperton Mine and associated infrastructure reduces the probability of this impact occurring.

No mitigation of this impact is possible, but measures are recommended as best practice. The table below illustrates this impact assessment.

Table 3: Visual impact on residents of homesteads and settlements in close proximity to the proposed facility.

Nature of Impact: Visual impact on residents of homesteads and settlements in close proximity to the proposed facility		
	No mitigation	***Mitigation considered***
Extent	Local **(4)**	N/a
Duration	Long term **(4)**	N/a
Magnitude	Very High **(10)**	N/a
Probability	High **(4)**	N/a
Significance	High **(72)**	N/a
Status (positive or negative)	Negative	N/a
Reversibility	Recoverable **(3)**	N/a
Irreplaceable loss of resources?	No	N/a
Can impacts be mitigated?	No	
Mitigation / Management: <u>Planning:</u> ➢ Retain / re-establish and maintain natural vegetation in all areas outside of the development footprint. <u>Operations:</u> ➢ Maintain the general appearance of the facility as a whole. <u>Decommissioning:</u> ➢ Remove infrastructure not required for the post-decommissioning use of the site. ➢ Rehabilitate all areas. Consult an ecologist regarding rehabilitation specifications. ➢ Monitor rehabilitated areas post-decommissioning and implement remedial actions.		
Cumulative impacts: The construction of wind turbines together with the associated infrastructure will increase the cumulative visual impact of industrial type infrastructure within the region. This is relevant in light of the power line infrastructure already present in the area as well as other alternative energy facilities proposed in the region.		
Residual impacts: The visual impact will be removed after decommissioning, provided the facility and ancillary infrastructure is removed. Failing this, the visual impact will remain.		

6.7.1.3 Potential visual impact on sensitive visual receptors within the region.

The visual impact on the users of roads and the residents of settlements and homesteads within the region (i.e. beyond the 10 km radius) is expected to be of **low** significance.

Again, the relatively low incidence of visual receptors within this environment and the proximity of the proposed facility to the existing Copperton Mine and associated infrastructure reduces the probability of this impact occurring.

No mitigation of this impact is possible, but measures are recommended as best practice. The table below illustrates this impact assessment.

Table 4: Visual impact on sensitive visual receptors within the region.

Nature of Impact: Visual impact on sensitive visual receptors within the region		
	No mitigation	***Mitigation considered***
Extent	Regional **(3)**	N/a
Duration	Long term **(4)**	N/a
Magnitude	Moderate **(6)**	N/a
Probability	Improbable **(2)**	N/a
Significance	Low **(26)**	N/a
Status (positive or negative)	Negative	N/a
Reversibility	Recoverable **(3)**	N/a
Irreplaceable loss of resources?	No	N/a
Can impacts be mitigated?	Yes	
Mitigation / Management: Planning: ➢ Retain / re-establish and maintain natural vegetation in all areas outside of the development footprint. Operations: ➢ Maintain the general appearance of the facility as a whole. Decommissioning: ➢ Remove infrastructure not required for the post-decommissioning use of the site. ➢ Rehabilitate all areas. Consult an ecologist regarding rehabilitation specifications. ➢ Monitor rehabilitated areas post-decommissioning and implement remedial actions.		
Cumulative impacts: The construction of wind turbines together with the associated infrastructure will increase the cumulative visual impact of industrial type infrastructure within the region. This is relevant in light of the power line infrastructure already present in the area as well as other alternative energy facilities proposed in the region.		
Residual impacts: The visual impact will be removed after decommissioning, provided the facility and ancillary infrastructure is removed. Failing this, the visual impact will remain.		

6.7.1.4 Potential visual impact on the town of Copperton

Copperton is situated less than 8 km from the nearest boundary of the proposed facility, and is therefore considered to be in close proximity thereto. Visual impacts on residents as a result of the proposed WEF are expected to be of **moderate** significance.

The potential for visual exposure within Copperton is high, but due to the existence of buildings and other structures typical of a more built up area, the visual impact of the proposed WEF will be somewhat reduced.

This in addition to the proximity of the proposed facility to the existing Copperton Mine and associated infrastructure reduces the probability of this impact occurring.

No mitigation of this impact is possible, but measures are recommended as best practice. The table below illustrates this impact assessment.

Table 5: Visual impact on the town of Copperton.

Nature of Impact: Visual impact on the town of Copperton		
	No mitigation	***Mitigation considered***
Extent	Local **(4)**	N/a
Duration	Long term **(4)**	N/a
Magnitude	High **(8)**	N/a
Probability	Probable **(3)**	N/a
Significance	Moderate **(48)**	N/a
Status (positive or negative)	Negative	N/a
Reversibility	Recoverable **(3)**	N/a
Irreplaceable loss of resources?	No	N/a
Can impacts be mitigated?	No	
Mitigation / Management: Planning: ➢ Retain / re-establish and maintain natural vegetation in all areas outside of the development footprint. Operations: ➢ Maintain the general appearance of the facility as a whole. Decommissioning: ➢ Remove infrastructure not required for the post-decommissioning use of the site. ➢ Rehabilitate all areas. Consult an ecologist regarding rehabilitation specifications. ➢ Monitor rehabilitated areas post-decommissioning and implement remedial actions.		
Cumulative impacts: The construction of wind turbines together with the associated infrastructure will increase the cumulative visual impact of industrial type infrastructure within the region. This is relevant in light of the power line infrastructure already present in the area as well as other alternative energy facilities proposed in the region.		
Residual impacts: The visual impact will be removed after decommissioning, provided the facility and ancillary infrastructure is removed. Failing this, the visual impact will remain.		

6.7.2 Ancillary infrastructure

6.7.2.1 Potential visual impact of on site ancillary infrastructure on sensitive visual receptors in close proximity to the proposed facility.

In site ancillary infrastructure associated with the WEF includes the substation, internal access roads, workshop and office. This infrastructure will be located within the facility footprint, as is indicated on the layout in Map 1, but may still be visible to visual receptors in close proximity to the proposed WEF.

The roads have the potential of manifesting as landscape scarring. Other infrastructure have the potential of creating visual clutter, contributing to cumulative impacts, therefore having the potential of visual impact within the viewshed areas.

No dedicated viewsheds have been generated for the ancillary infrastructure, as the range of visual exposure will fall within that of the turbines, as indicated on Map 3. The anticipated visual impact resulting from this infrastructure is likely to be of **low** significance both before and after mitigation.

The table below illustrates this impact assessment.

Table 6: Visual impact of on site ancillary infrastructure on sensitive visual receptors in close proximity to the proposed facility.

Nature of Impact: Visual impact of on site ancillary infrastructure on sensitive visual receptors in close proximity to the proposed facility		
	No mitigation	***Mitigation considered***
Extent	Local **(4)**	Local **(4)**
Duration	Long term **(4)**	Long term **(4)**
Magnitude	Moderate **(6)**	Low **(4)**
Probability	Improbable **(2)**	V Improbable **(1)**
Significance	Low **(28)**	Low **(12)**
Status (positive or negative)	Negative	Negative
Reversibility	Recoverable **(3)**	Recoverable **(3)**
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	
Mitigation / Management: Planning: ➢ Plan ancillary infrastructure in such a way and in such a location that clearing of vegetation is minimised. Consolidate existing infrastructure as much as possible, and make use of already disturbed areas rather than pristine sites wherever possible. ➢ Retain / re-establish and maintain natural vegetation in all areas outside of the development footprint. Construction: ➢ Rehabilitation of all construction areas. ➢ Ensure that vegetation is not cleared unnecessarily to make way for access roads and ancillary buildings. Operation: ➢ Maintenance of roads to avoid erosion and suppress dust. Decommissioning: ➢ Removal of infrastructure and roads not required for post decommissioning use and rehabilitation of the footprint areas. ➢ Monitor rehabilitated areas post-decommissioning and implement remedial actions.		
Cumulative impacts: The construction of the substation, internal access roads, workshop and office will increase the cumulative visual impact of buildings and industrial type infrastructure within the region. This is relevant in light of existing roads and power lines already present in the area.		

Residual impacts: The visual impact will be removed after decommissioning, provided the facility and ancillary infrastructure is removed. Failing this, the visual impact will remain.

6.7.2.2 Potential visual impact of the overhead powerline on sensitive visual receptors in close proximity thereto.

Two options are being considered for grid connection as follows:

- Option 1: Loop in and out of the existing BURCHELL/CUPRUM 132 kV line.
- Option 2: would be to connect directly to the existing Eskom Caprum substation via a 132 kV power line. Two alternatives are being considered for this option:
    - Alternative 1 would be to connect directly to the existing Eskom Caprum substation via the northern corridor parallel to the BURCHELL/CUPRUM 132 kV line. Two sub alternatives are being considered within this corridor:
        - Sub alternative 1A is the shortest route with a section crossing the wind farm site in a westerly direction.
        - Sub alternative 1B is the longer route (approximately 2.5 km longer than sub-alternative A).
    - Alternative 2 will be to connect directly to the existing Eskom Caprum substation via a southern corridor which follows a route to avoid traversing the adjacent property (Farm 103/7) and which forms part of another proposed renewable energy project.

From a visual perspective, Option 1 (as a loop in and out) would be the favoured option, as this entails the least additional infrastructure. If for some reason this option is not feasible, then one of the alternatives for option 2 would need to be considered.

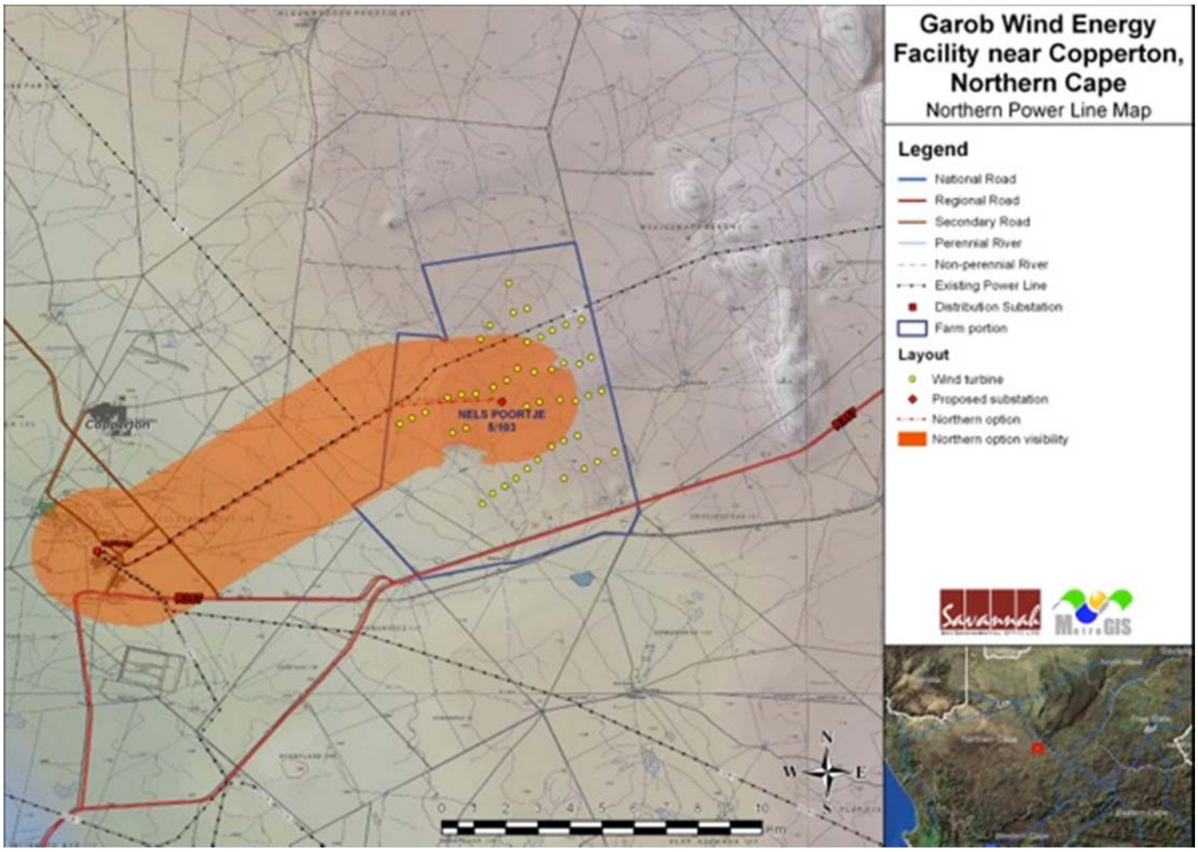
Maps 6a and 6b below illustrate the potential visual exposure of the power line alternatives for option 2 within an offset of 2km on either side of the power line alignment.

Due to the flat topography, both alignments for Option 2 will be visually exposed to almost the entire area within the above 2km offset. Alternative 1 will be exposed to a single homestead (on the proposed development site), while Alternative 2 will not be exposed to any.

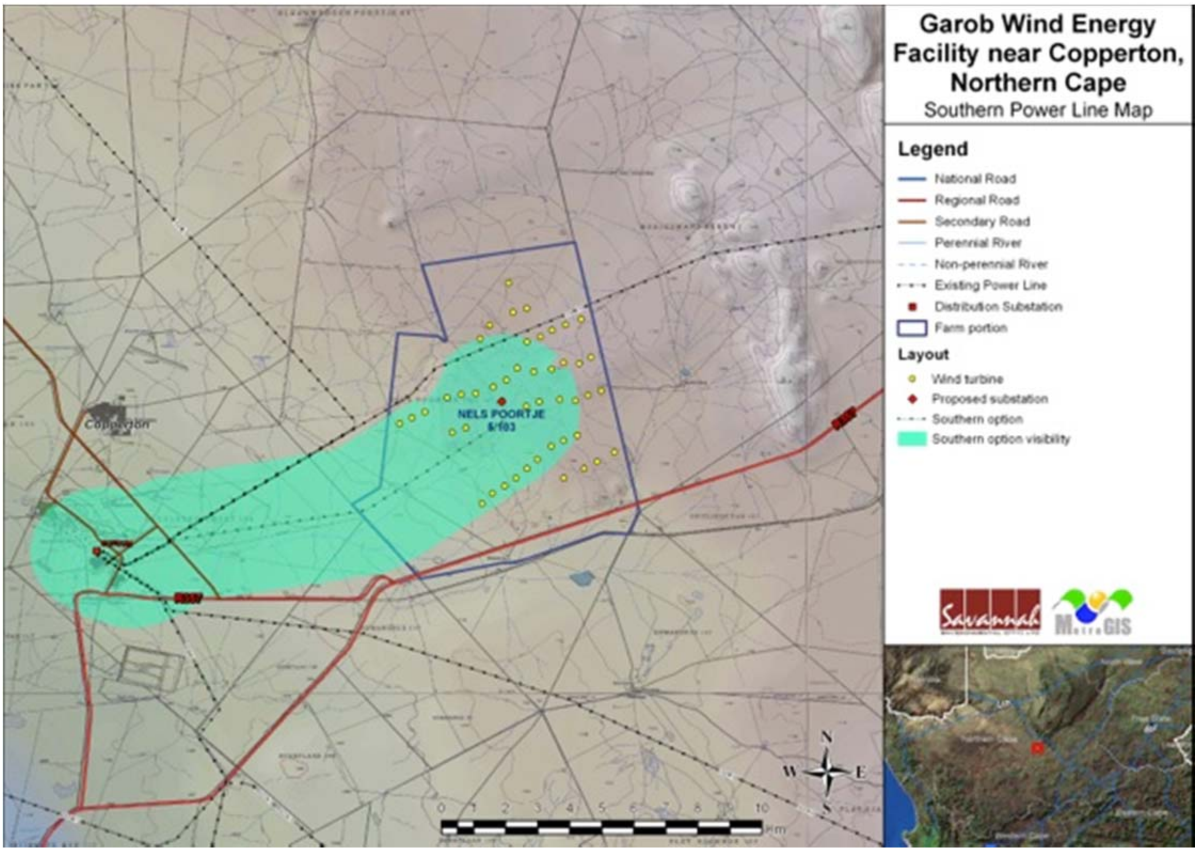
Of relevance is that Alternative 1 follows an existing line, while Alternative 2 does not. From a visual perspective, the consolidation and concentration of infrastructure is favoured, as this limits the extent of visual exposure to an area within which some visual disturbance is already present. In this regard, Alternative 1 is favoured from a visual perspective.

In terms of the two sub alternatives 1A and 1B, the minimising of infrastructure is favoured, as this limits the extent of visual exposure. In this respect, sub alternative 1B is favoured, and is assessed below.

The low occurrence of visual receptors within the viewshed of the power line, as well as the fact that the existing line will absorb the visual impact to some extent, lowers the probability of this impact occurring.



Map 6a: Potential visual exposure of Alternative 1



Map 6b: Potential visual exposure of Alternative 2

The anticipated visual impact resulting from this infrastructure is likely to be of **low** significance. No mitigation of this impact is possible, but measures are recommended as best practice. The table below illustrates this impact assessment.

Table 7: Visual impact of the overhead power line on sensitive visual receptors in close proximity thereto.

Nature of Impact: Visual impact of the overhead power line on sensitive visual receptors in close proximity thereto		
	No mitigation	***Mitigation considered***
Extent	Local **(4)**	N/a
Duration	Long term **(4)**	N/a
Magnitude	Moderate **(6)**	N/a
Probability	Improbable **(2)**	N/a
Significance	Low **(28)**	N/a
Status (positive or negative)	Negative	N/a
Reversibility	Recoverable **(3)**	N/a
Irreplaceable loss of resources?	No	N/a
Can impacts be mitigated?	No	
Mitigation / Management: Construction: ➢ Rehabilitation of all construction areas, including the power line servitude. ➢ Ensure that vegetation is not cleared unnecessarily. Operation: ➢ Maintenance of servitude. Decommissioning: ➢ Removal of infrastructure not required for post decommissioning use and rehabilitation of the servitude areas. ➢ Monitor rehabilitated areas post-decommissioning and implement remedial actions.		
Cumulative impacts: The construction of the overhead power lines will increase the cumulative visual impact of buildings and industrial type infrastructure within the region. This is relevant in light of existing roads and power lines already present in the area.		
Residual impacts: The visual impact will be removed after decommissioning, provided the facility and ancillary infrastructure is removed. Failing this, the visual impact will remain.		

6.7.3 Shadow flicker

Potential visual impact of shadow flicker on sensitive visual receptors in close proximity to the proposed facility.

Shadow flicker only occurs when the sky is clear, and when the turbine rotor blades are between the sun and the receptor (i.e. when the sun is low). De Gryse in Scenic Landscape Architecture (2006) found that "*most shadow impact is associated with 3-4 times the height of the object*". Based on this research, a 480m buffer along the edge of the outer most turbines is submitted as the zone within which there is a risk of shadow flicker occurring.

There are no roads or places of residence within the 480 m buffer. The significance of shadow flicker is therefore anticipated to be **low**. The table below illustrates the assessment of this anticipated impact. There is no mitigation recommended.

Table 8: Visual impact of shadow flicker on sensitive visual receptors in close proximity to the proposed facility.

Nature of Impact: Visual impact of shadow flicker on sensitive visual receptors in close proximity to the proposed facility.		
	No mitigation	***Mitigation considered***
Extent	Local **(4)**	N/a
Duration	Long term **(4)**	N/a
Magnitude	None **(0)**	N/a
Probability	Very Improbable **(1)**	N/a
Significance	Low **(8)**	N/a
Status (positive or negative)	Negative	N/a
Reversibility	Recoverable **(3)**	N/a
Irreplaceable loss of resources?	No	N/a
Can impacts be mitigated?	No	
Mitigation / Management: None.		
Cumulative impacts: The construction of the substation, overhead power lines, internal access roads, workshop and office will increase the cumulative visual impact of buildings and industrial type infrastructure within the region. This is relevant in light of existing roads and power lines already present in the area.		
Residual impacts: The visual impact will be removed after decommissioning, provided the facility and ancillary infrastructure is removed. Failing this, the visual impact will remain.		

6.7.4 Lighting impacts

Potential visual impact of lighting at night on sensitive visual receptors in close proximity to the proposed facility.

Lighting impacts relate to the effects of glare and sky glow. Source of glare light in include both direct lighting the aircraft warning lights mounted on top of the hub of the wind turbines. These lights are less aggravating due to the toned-down red colour, but have the potential to be visible from a great distance.

Sky glow is the condition where the night sky is illuminated when light reflects off particles in the atmosphere such as moisture, dust or smog. The sky glow intensifies with the increase in the amount of light sources. Each new light source, especially upwardly directed lighting, contribute to the increase in sky glow. The WEF may contribute to the effect of sky glow within this environment.

Mitigation of direct lighting impacts and sky glow entails the pro-active design, planning and specification of lighting for the facility. The correct specification and placement of lighting and light fixtures for both the turbines and the ancillary infrastructure will go far to contain rather than spread the light.

The tables overleaf illustrate the assessment of this anticipated impact, which is likely to be of **moderate** significance, and may be mitigated to **low.**

Table 9: Visual impact of lighting at night on sensitive visual receptors in close proximity to the proposed facility.

Nature of Impact: Visual impact of lighting at night on sensitive visual receptors in close proximity to the proposed facility.		
	No mitigation	***Mitigation considered***
Extent	Local **(4)**	Local **(4)**
Duration	Long term **(4)**	Long term **(4)**
Magnitude	High **(8)**	Moderate **(6)**

Probability	Probable **(3)**	Improbable **(2)**
Significance	Moderate **(48)**	Low **(28)**
Status (positive or negative)	Negative	Negative
Reversibility	Recoverable **(3)**	Recoverable **(3)**
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	
Mitigation: Planning & operation: ➢ Limit aircraft warning lights to the turbines on the perimeter, thereby reducing the overall requirement. ➢ Shield the sources of light by physical barriers (walls, vegetation, or the structure itself). ➢ Limit mounting heights of lighting fixtures, or alternatively use foot-lights or bollard level lights. ➢ Make use of minimum lumen or wattage in fixtures. ➢ Make use of down-lighters, or shielded fixtures. ➢ Make use of Low Pressure Sodium lighting or other types of low impact lighting. ➢ Make use of motion detectors on security lighting. This will allow the site to remain in relative darkness, until lighting is required for security or maintenance purposes.		
Cumulative impacts: The town of Copperton and the Copperton Mine already generates lighting impacts at night. The impact of the proposed WEF will contribute to a regional increase in lighting impact.		
Residual impacts: The visual impact will be removed after decommissioning, provided the facility and ancillary infrastructure is removed. Failing this, the visual impact will remain.		

6.7.5 Construction Impacts

Potential visual impact of construction on sensitive visual receptors in close proximity to the proposed facility.

During construction, there will be a noticeable increase in heavy vehicles utilising the roads to the development site that may cause, at the very least, a visual nuisance a visual nuisance to other road users and land owners in the area.

The clearing of vegetation during construction is unavoidable. Given the large footprint of WEF development, it is likely that large tracks of land will be affected. The rehabilitation of vegetation in this region is difficult, given the hot, dry climatic conditions. Dust from construction work could also result in potential visual impact.

This anticipated impact is likely to be of **moderate** significance, and may be mitigated to **low**.

Table 10: Visual impact of construction on sensitive visual receptors in close proximity to the proposed facility.

Nature of Impact: Visual impact of construction on sensitive visual receptors in close proximity to the proposed facility.		
	No mitigation	***Mitigation considered***
Extent	Local **(4)**	Local **(4)**
Duration	Long term **(4)**	Short term **(2)**
Magnitude	Moderate **(6)**	Low **(4)**
Probability	Highly Probable **(4)**	Probable **(3)**
Significance	Moderate **(56)**	Low **(30)**
Status (positive or negative)	Negative	Negative
Reversibility	Recoverable **(3)**	Recoverable **(3)**
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	

Mitigation: Planning: ➢ Retain and maintain natural vegetation in all areas outside of the development footprint. Construction: ➢ Ensure that vegetation is not unnecessarily removed during the construction period. ➢ Reduce the construction period through careful logistical planning and productive implementation of resources. ➢ Plan the placement of lay-down areas and temporary construction equipment camps in order to minimise vegetation clearing (i.e. in already disturbed areas) wherever possible. ➢ Restrict the activities and movement of construction workers and vehicles to the immediate construction site and existing access roads. ➢ Ensure that rubble, litter, and disused construction materials are appropriately stored (if not removed daily) and then disposed regularly at licensed waste facilities. ➢ Reduce and control construction dust using approved dust suppression techniques as and when required (i.e. whenever dust becomes apparent). ➢ Restrict construction activities to daylight hours whenever possible in order to reduce lighting impacts. ➢ Rehabilitate all disturbed areas immediately after the completion of construction works.
Cumulative impacts: None.
Residual impacts: None, provided rehabilitation works are carried out as specified.

6.8 Visual impact assessment: secondary impacts

6.8.1 The WEF and ancillary infrastructure

Potential visual impact of the proposed facility on the visual quality of the landscape and sense of place of the region.

Sense of place refers to a unique experience of an environment by a user, based on his or her cognitive experience of the place. Visual criteria, specifically the visual character of an area (informed by a combination of aspects such as topography, level of development, vegetation, noteworthy features, cultural / historical features, etc), play a significant role.

An impact on the sense of place is one that alters the visual landscape to such an extent that the user experiences the environment differently, and more specifically, in a less appealing or less positive light.

The greater environment has a rural and undeveloped character. Settlements, where these occur, are limited in extent and domestic in scale. These vast, generally undeveloped landscapes are considered to have a high visual quality, except where development such as mining (i.e. the Copperton Mine) represent existing visual disturbances.

A specific sense of place related to the wide open, undeveloped space characterises the region, but is not particular to this study area.

The anticipated visual impact of the facility on the regional visual quality, and by implication, on the sense of place, is expected to be of **low** significance.

The relatively low incidence of visual receptors within this environment and the proximity of the proposed facility to the existing Copperton Mine and associated infrastructure reduces the probability of this impact occurring.

No mitigation of this impact is possible, but measures are recommended as best practice. The table below illustrates this impact assessment.

Table 11: Visual impact of the proposed facility on the visual quality of the landscape and sense of place of the region.

Nature of Impact: Visual impact of the proposed facility on the visual quality of the landscape and sense of place of the region		
	No mitigation	***Mitigation considered***
Extent	Regional **(3)**	N/a
Duration	Long term **(4)**	N/a
Magnitude	Low **(4)**	N/a
Probability	Improbable **(2)**	N/a
Significance	Low **(22)**	N/a
Status (positive or negative)	Negative	N/a
Reversibility	Recoverable **(3)**	N/a
Irreplaceable loss of resources?	No	N/a
Can impacts be mitigated?	No	
Mitigation / Management: Planning: ➢ Retain / re-establish and maintain natural vegetation in all areas outside of the development footprint. Operations: ➢ Maintain the general appearance of the facility as a whole. Decommissioning: ➢ Remove infrastructure not required for the post-decommissioning use of the site. ➢ Rehabilitate all areas. Consult an ecologist regarding rehabilitation specifications. ➢ Monitor rehabilitated areas post-decommissioning and implement remedial actions.		
Cumulative impacts: The construction of wind turbines together with the associated infrastructure will increase the cumulative visual impact of industrial type infrastructure within the region. This is relevant in light of the power line infrastructure already present in the area as well as other alternative energy facilities proposed in the region.		
Residual impacts: The visual impact will be removed after decommissioning, provided the facility and ancillary infrastructure is removed. Failing this, the visual impact will remain.		

6.9 The potential to mitigate visual impacts

The primary visual impact, namely the appearance of the wind turbines is not possible to mitigate. The functional design of the structures cannot be changed in order to reduce visual impacts.

Alternative colour schemes (i.e. painting the turbines sky-blue, grey or darker shades of white) are not permissible as the CAA's *Marking of Obstacles* expressly states, "*Wind turbines shall be painted bright white to provide the maximum daytime conspicuousness*".

Failure to adhere to the prescribed colour specifications will result in the fitting of supplementary daytime lighting to the wind turbines, once again aggravating the visual impact. The overall potential for mitigation is generally low or non-existent.

Secondary impacts anticipated as a result of the proposed facility (i.e. visual character and sense of place) are also not possible to mitigate.

The following mitigation is, however possible:

- Retain / re-establish and maintain natural vegetation in all areas outside of the development footprint. This measure will help to soften the appearance of the facility within its context.

- In terms of ancillary infrastructure, it is recommended that the loop in and out option (option 1) for grid connection be favoured. If for some reason this option is not feasible, then Alternative 1B for option 2 would need to be considered. The substations, access roads and ancillary buildings be planned so that clearing of vegetation is minimised. This implies consolidating infrastructure as much as possible and making use of already disturbed areas rather than pristine sites wherever possible.

- It is recommended that the northern power line option be favoured, as this represents the consolidation and concentration of visual impacts and limits the extent of visual exposure to an area within which some visual disturbance is already present.

- The Civil Aviation Authority (CAA) prescribes that the mounting of aircraft warning lights atop the turbines. Therefore, the potential to mitigate their visual impacts is low. The regulations for the CAA's Marking of Obstacles should be strictly adhered to (unless otherwise agreed with the CAA), as the failure to comply with these guidelines may result in the developer being required to fit additional light fixtures at closer intervals thereby aggravating the visual impact.

- It is possible to limit the overall number of aircraft warning lights to some extent. By fitting warning lights to the turbines on the outer perimeter facility, the facility is demarcated along its perimeter, thereby reducing the requirement for warning lights on each turbine.

- Possible mitigation of other lighting impacts includes the pro-active design, planning and specification lighting for the facility. The correct specification and placement of lighting and light fixtures for the Wind Energy Facility and the ancillary infrastructure will go far to contain rather than spread the light. Mitigation measures include the following:

    - Shielding the sources of light by physical barriers (walls, vegetation, or the structure itself);
    - Shielding of open luminaries to direct light downward towards the ground;
    - Limiting mounting heights of lighting fixtures, or alternatively using foot-lights or bollard level lights;
    - Making use of minimum lumen or wattage in fixtures;
    - Making use of down-lighters, or shielded fixtures;
    - Making use of Low Pressure Sodium lighting or other types of low impact lighting.
    - Making use of motion detectors on security lighting. This will allow the site to remain in relative darkness, until lighting is required for security or maintenance purposes.

- Mitigation of visual impacts associated with the construction phase, albeit temporary, would entail proper planning, management and rehabilitation of the construction site. Recommended mitigation measures include the following:

    - Ensure that vegetation is not unnecessarily cleared or removed during the construction period.
    - Reduce the construction period through careful logistical planning and productive implementation of resources.
    - Plan the placement of lay-down areas and any potential temporary construction camps in order to minimise vegetation clearing (i.e. in already disturbed areas) wherever possible.
    - Restrict the activities and movement of construction workers and vehicles to the immediate construction site and existing access roads.

- Ensure that rubble, litter, and disused construction materials are appropriately stored (if not removed daily) and then disposed regularly at licensed waste facilities.
- Reduce and control construction dust through the use of approved dust suppression techniques as and when required (i.e. whenever dust becomes apparent).
- Restrict construction activities to daylight hours in order to negate or reduce the visual impacts associated with lighting.
- Rehabilitate all disturbed areas, construction areas, roads, slopes etc immediately after the completion of construction works. If necessary, an ecologist should be consulted to assist or give input into rehabilitation specifications.

- During operation, the maintenance of the turbines, the internal roads, the power line servitude and other ancillary structures and infrastructure will ensure that the facility does not degrade, thus aggravating visual impact.

- Roads must be maintained to forego erosion and to suppress dust, and rehabilitated areas must be monitored for rehabilitation failure. Remedial actions must be implemented as a when required.

- Once the Wind Energy has exhausted its life span, the main facility and all associated infrastructure not required for the post rehabilitation use of the site should be removed and all disturbed areas appropriately rehabilitated. An ecologist should be consulted to give input into rehabilitation specifications.

- All rehabilitated areas should be monitored for at least a year following decommissioning, and remedial actions implemented as and when required.

Good practice requires that the mitigation of both primary and secondary visual impacts as listed above be implemented and maintained on an ongoing basis.

7. PHOTOGRAPHIC SIMULATIONS

Photo simulations were undertaken (in addition to the above spatial analyses) in order to illustrate the potential visual impact of the proposed Garob WEF within the receiving environment.

The purpose of the photo simulation exercise is to support the findings of the VIA, and is not an exercise to illustrate what the facility will look like from all directions.

The photo simulations indicate the anticipated visual alteration of the landscape from various sensitive visual receptors located at different distances from the facility. The simulations are based on the wind turbine dimensions and layout as indicated on **Map 1**.

The photograph positions are indicated on **Map 6** below and should be referenced with the photo simulation being viewed in order to place the observer in spatial context.

The simulated views show the placement of the wind turbines during the longer-term operational phase of the facility's lifespan. It is assumed that the necessary post-construction phase rehabilitation and mitigation measures, as proposed by the various specialists in the environmental impact assessment report, have been undertaken.

It is imperative that the natural vegetation be restored to its original (current) status for these simulated views to ultimately be realistic. These photographs can therefore be seen as an ideal operational scenario (from a visual impact point of view) that should be aspired to. The additional infrastructure (e.g. the proposed power line, substation, access roads, etc.) associated with the facility is not included in the photo simulations.

Each photographic simulation is preceded by a panoramic overview of the landscape from the specified viewpoint being discussed. The panoramic overview allows for a more realistic viewer scale that would be representative of the distance over which the turbines are viewed. Where relevant, each panoramic overview indicates the section that was enlarged to show a more detailed view of the WEF.

The simulated wind turbines, as shown on the photographs, were adapted to the atmospheric conditions present when the original photographs were taken. This implies that factors such as haze and solar glare were also simulated in order to realistically represent the observer's potential view of the facility.

The following technical data are of relevance:

- The camera used to take the initial photographs is a standard Canon EOS 1000D with an 18-55mm lens. Photos intended for panoramas are taken with focal length at 55mm to minimize edge distortion and to facilitate the panoramic software's stitching process.

- Canon's stitching software (Photostitch v3.1.21) is used to create the panoramas. This software automatically compensates for slight variations in the focal length on each photo used in the panorama (i.e. the camera model, focal length, F-number, etc are embedded into each photo, so the software recognizes these parameters and adjusts the output image accordingly).

- The photo simulation process begins with the DTM, as this is effectively the "ground surface" of the virtual environment. The accuracy of the DTM in representing the Earth's surface is very much dependent on the quality of available contour data as this is what it is derived from. The raster DTM that is used to show shaded relief in a map is usually the same dataset that is used as the virtual ground surface.

- The DTM is visualised in 3D with an application called ArcScene. ArcScene works in much the same way as ArcMap except that the geometry and attributes of shapefiles cannot be edited, and of course, that is displayed in a Cartesian plane. Any existing shapefile can be added into the 3D environment and will automatically be displayed in its correct geographic position. Shapes that do not contain Z-values (height above mean sea level) can be assigned height values using the DTM. Point shapefiles, for example, will typically already have X/Y coordinates but can be placed at the virtual ground level, or at any height above ground level as specified in the attribute table. Lines and polygons work in the same way, thus enabling any vector shapefile to be "draped" onto the 3D terrain surface.

- 3D models from such applications as 3D StudioMax or Sketchup are compatible with the ArcScene environment and work by assigning a model to be rendered at points geographically specified by a point shapefile. Each model itself consists of many polygons, and depending on the number of models used, can impact severely on a computer's performance in displaying the virtual environment.

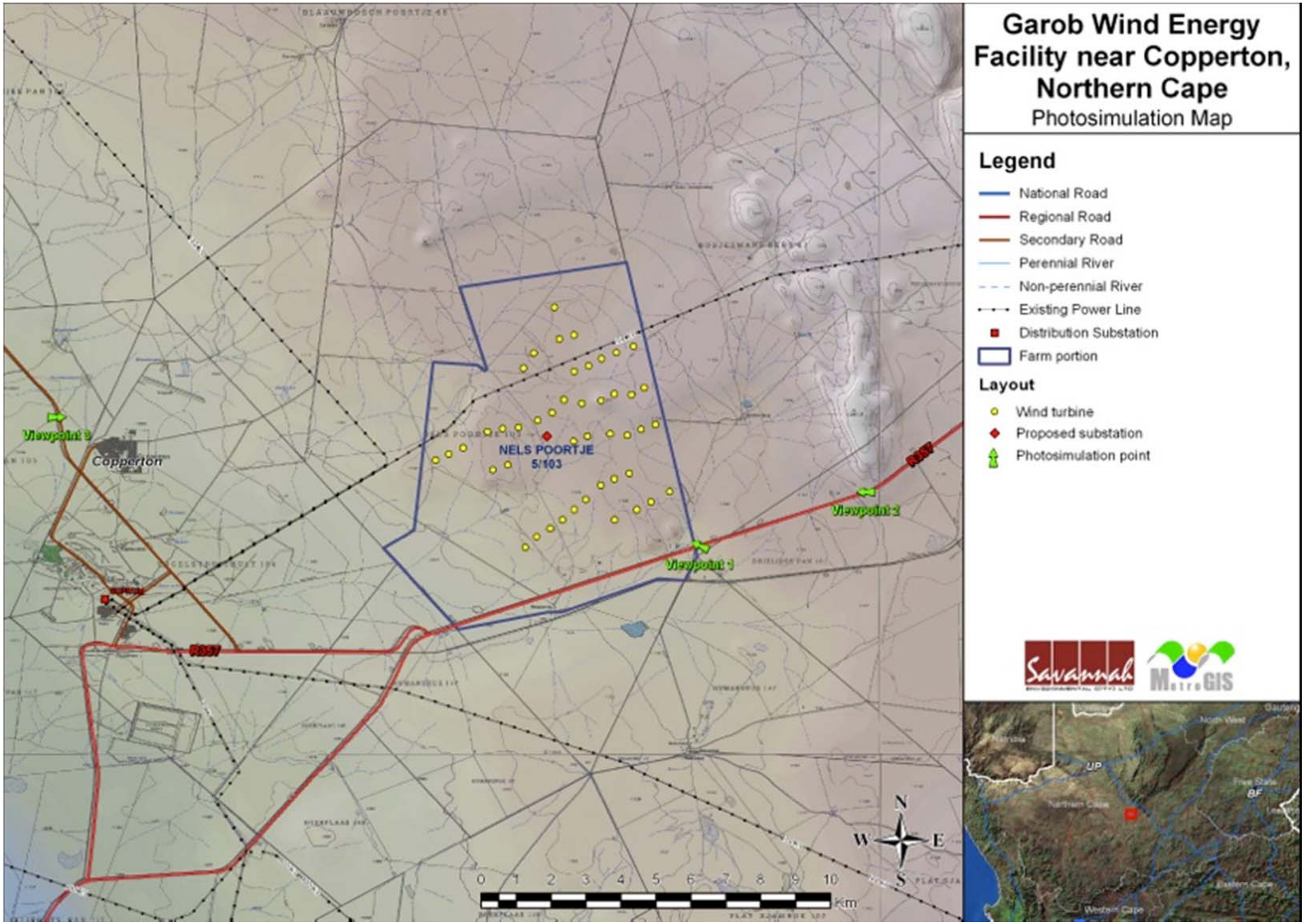
- For the purposes of placing wind turbines onto a virtual landscape, a layout of the exact turbine positions is required in the form of a point shapefile. This shapefile is added three times to the environment. The first instance is displayed as a point at ground level to indicate where the turbine tower meets the ground level. The second instance is extruded to half the height of the tower and displayed in a certain colour. The third instance is extruded from half to the full height of the tower and displayed in a different colour. Thus, from any virtual viewpoint on the landscape, it can be determined which turbines will be in full view and which will be partially obscured by undulations of the terrain. The terrain can also be made semi-transparent to check whether anything is completely obscured.

- Each photo viewpoint is then recreated within the virtual environment by setting the "camera" coordinates to those of the GPS coordinates logged when each photo was taken. Several other data may be added for landmark purposes, such as roads, rivers, power lines, or even trees if they can be accurately digitized. The virtual output is then rendered at a focal length matching that of the photos originally used to create the panoramas (using a field-of-view calculator that also compensates for the digital equivalent of 35mm film cameras). Several virtual "snapshots" are taken in sequence in the same manner as for the panoramic photos as the virtual output suffers from the same edge distortion as a photo. These are then stitched in the same manner as the photographs.

- Both the panoramic photos and the virtual simulation output are now graphic formats that are loaded into Adobe Photoshop. Some enhancements of the panoramas may be necessary as weather conditions tend to adversely affect image quality. The horizon and landscape of the virtual viewpoint is then matched up to what can be seen in the panoramas and sample images of the wind turbines are then overlaid where the extruded points are visible. Scaling is maintained since the top and mid-point of the tower are usually visible, so the ground point can be established even though it may be obscured by the landscape. Some graphic editing is usually necessary to address such things intervening vegetation or power lines as well as sufficient blurring to mimic the effect of distance.

- The scene is then typically rendered twice as "before" and "after" views.

The photo simulations below indicate the pre-construction landscape with no wind turbines at all, followed by a simulation showing the proposed Garob WEF turbines.



Map 7: Photograph positions for photo simulations.

7.1 Viewpoint 1

Viewpoint 1 is located to the immediate south east of the proposed WEF, looking to the north west from the R357. This viewpoint lies less than 2km from the closest turbine and is indicative of a close range view which will potentially be seen when travelling to the south west from Prieska. 41 turbines are fully to partially visible in the landscape.

Figure 9a: Pre construction panoramic overview from Viewpoint 1

Figure 9b: Post construction panoramic overview from Viewpoint 1

7.2 Viewpoint 2

Viewpoint 2 is also located on the R357, some 5km to the north east of viewpoint 1. The point lies approximately 6km form the closest turbine, and is indicative of a medium distance view that visual receptors will have of the facility. The viewing direction is westerly, and 31 turbines are fully to partially visible in the landscape.

Figure 10a: Pre construction panoramic overview from Viewpoint 2

Figure 10b: Post construction panoramic overview from Viewpoint 2

7.3 Viewpoint 3

Viewpoint 3 is located on a secondary road to the immediate north west of Copperton, and lies some 1km from the closest turbine. The viewing direction is easterly, and the viewpoint is indicative of longer distance views commuters using these secondary roads and residents of Copperton will have of the proposed facility. 45 turbines are fully to partially visible in the landscape.

Figure 11a: Pre construction panoramic overview from Viewpoint 3

Figure 11b: Post construction panoramic overview for Alternative 1 (4 turbines) from Viewpoint 3

8. CONCLUSION AND RECOMMENDATIONS

The construction and operation of the proposed Garob Wind Energy Facility and its associated infrastructure, will have a visual impact on the study area, especially within (but not restricted to) a 10km radius of the proposed facility. The visual impact will differ amongst places, depending on the distance from the facility.

Affected visual receptors include people travelling along roads, those residing in Copperton, and residents of rural homesteads and settlements.

There are no formally protected or conservation areas present within the study area, but the greater environment has a rural and undeveloped character once beyond the small towns and mining areas. Settlements, where these occur, are limited in extent and domestic in scale.

This area is not known as a tourist destination, but the N10 in the far north east is a main access route between the N1 and Upington.

The greater environment is considered to have a high visual quality. A specific sense of place related to the wide open, undeveloped space characterises the region, but is not particular to this study area.

In light of the above, and considering all factors, it is concluded that a limited number of sensitive visual receptors will be impacted upon visually should this facility be developed. It is furthermore concluded that due to the existing disturbances to the visual environment, the significance of anticipated visual impacts are of acceptable significance levels within this receiving environment.

A number of mitigation measures have been proposed (Section 6.9). Mitigation will be effective in terms of lighting and construction. Regardless of whether or not mitigation measures will reduce the significance of the anticipated visual impacts, they are considered to be good practice and should all be implemented and maintained throughout the contruction and operational life span of the proposed facility.

9. IMPACT STATEMENT

The finding of the Visual Impact Assessment undertaken for the proposed Garob Wind Energy is that the visual environment surrounding the site, specifically within a radius of 10 km, will be visually impacted upon for the anticipated operational lifespan of the development (i.e. 20 - 30 years).

The following is a summary of impacts remaining, assuming mitigation as recommended is exercised:

- Visual impacts of the WEF on the R357 arterial road and on various secondary roads in the vicinity of Copperton are expected to be of **high** significance within a radius of 10 km from the proposed facility.

- The visual impact on residents of settlements and homesteads within a 10 km radius of the proposed WEF is expected to be of **high** significance.

- The visual impact on the users of roads and the residents of settlements and homesteads within the region (i.e. beyond the 10 km radius) is expected to be of **low** significance.

- Visual impacts on residents of Copperton (located in close proximity to the proposed WEF) are expected to be of **moderate** significance.

- The visual impact of on site ancillary infrastructure (i.e. the substation, the overhead power line, the internal access roads and the office / workshop) on observers in close proximity to the WEF is expected to be of **low** significance.

- The visual impact of the overhead power line on sensitive visual receptors in close proximity thereto will be of **low** significance.

- The visual impact of shadow flicker on sensitive visual receptors in close proximity to the proposed WEF will be of **low** significance.

- The visual impact of lighting at night on sensitive visual receptors in close proximity to the proposed WEF will be of **low** significance.

- Similary, the visual impacts related to construction on sensitive visual receptors in close proximity to the proposed WEF will be of **low** significance.

- In terms of secondary visual impacts, the significance of the anticipated impact on the visual quality of the landscape and the sense of place of the region will be of **low** significance.

The anticipated visual impacts listed above (i.e. post mitigation impacts) range from high to low, with the persistent high impacts related to impacts on sensitive visual receptors located in close proximity to the proposed facility.

Notwithstanding the residual high significance ratings, these impacts are not considered to be fatal flaws for the proposed wind energy. The reasons being the relatively low occurrence of receptors within the region (both residents of homesteads and users of roads) and the existing visual disturbance of the Copperton Mine.

It is therefore recommended that the development of the facility as proposed be supported, subject to the implementation of the recommended mitigation measures (Section 6.9) and management plan (Section 9).

10. MANAGEMENT PROGRAMME

The following management plan tables aim to summarise the key findings of the visual impact report and to suggest possible management actions in order to mitigate the potential visual impacts.

(Refer to tables overleaf).

Table 12: Management Programme – Planning.

OBJECTIVE: The mitigation and possible negation of visual impacts associated with the planning of the Proposed Garob Wind Energy Facility.		
Project Component/s	Wind energy facility and ancillary infrastructure (i.e. the substation, overhead power lines, internal access roads, workshop and office).	
Potential Impact	Primary visual impact of the facility due to the presence of ancillary infrastructure as well as the visual impact of lighting at night.	
Activity/Risk Source	The viewing of the above mentioned by observers on or near the site (i.e. within 10 km of the site) as well as within the region.	
Mitigation: Target/Objective	Optimal planning of infrastructure to minimise visual impact.	
Mitigation: Action/control	**Responsibility**	**Timeframe**
Retain and maintain natural vegetation in all areas outside of the development footprint.	Developer / design consultant	Early in the planning phase.
Plan the ancillary buildings, roads and other infrastructure in such a way and in such a location that clearing of vegetation is minimised. Consolidate infrastructure and make use of already disturbed sites rather than pristine areas.	Developer / design consultant	Early in the planning phase.
Favour the loop in and out grid connection (option 1) or powerline alternative 1B (option 2)	Developer / design consultant	Early in the planning phase.
Consult a lighting engineer in the design and planning of lighting to ensure the correct specification and placement of lighting and light fixtures for the facility and the ancillary infrastructure. The following is recommended: o Limit aircraft warning lights to the turbines on the perimeter, thereby reducing the overall requirement. o Shielding the sources of light by physical barriers (walls, vegetation, or the structure itself); o Limiting mounting heights of lighting fixtures, or alternatively using foot-lights or bollard level lights; o Making use of minimum lumen or wattage in fixtures; o Making use of down-lighters, or shielded fixtures; o Making use of Low Pressure Sodium lighting or other types of low impact lighting. o Making use of motion detectors on security lighting. This will allow the site to remain in relative darkness, until lighting is required for security or maintenance purposes.	Developer / design consultant	Early in the planning phase.
Performance Indicator	No ancillary infrastructure is apparent from surrounding areas and lighting impact is minimal.	
Monitoring	Not applicable.	

Table 13: Management Programme – Construction.

OBJECTIVE: The mitigation and possible negation of visual impacts associated with the construction of the Proposed Garob Wind Energy Facility.		
Project Component/s	Construction site	
Potential Impact	Visual impact of general construction activities, and the potential scarring of the landscape due to vegetation clearing and resulting erosion.	
Activity/Risk Source	The viewing of the above mentioned by observers on or near the site (i.e. within 10 km of the site).	
Mitigation: Target/Objective	Minimal visual intrusion by construction activities and intact vegetation cover outside of immediate works areas.	
Mitigation: Action/control	**Responsibility**	**Timeframe**
Ensure that vegetation is not unnecessarily cleared or removed during the construction period.	Developer / contractor	Early in the construction phase.
Reduce the construction period through careful logistical planning and productive implementation of resources.	Developer / contractor	Early in the construction phase.
Plan the placement of lay-down areas and temporary construction equipment camps in order to minimise vegetation clearing (i.e. in already disturbed areas) wherever possible.	Developer / contractor	Early in and throughout the construction phase.
Restrict the activities and movement of construction workers and vehicles to the immediate construction site and existing access roads.	Developer / contractor	Throughout the construction phase.
Ensure that rubble, litter, and disused construction materials are appropriately stored (if not removed daily) and then disposed regularly at licensed waste facilities.	Developer / contractor	Throughout the construction phase.
Reduce and control construction dust through the use of approved dust suppression techniques as and when required (i.e. whenever dust becomes apparent).	Developer / contractor	Throughout the construction phase.
Restrict construction activities to daylight hours in order to negate or reduce the visual impacts associated with lighting.	Developer / contractor	Throughout the construction phase.
Rehabilitate all disturbed areas, construction areas, servitudes etc immediately after the completion of construction works. Consult an ecologist to give input into rehabilitation specifications.	Developer / contractor	Throughout and at the end of the construction phase.
Performance Indicator	Vegetation cover on and in the vicinity of the site is intact (i.e. full cover as per natural vegetation within the environment) with no evidence of degradation or erosion.	
Monitoring	Monitoring of vegetation clearing during construction (by contractor as part of construction contract). Monitoring of rehabilitated areas quarterly for at least a year following the end of construction (by contractor as part of construction contract).	

Table 14: Management Programme – Operation.

OBJECTIVE: The mitigation and possible negation of visual impacts associated with the operation of the Proposed Garob Wind Energy Facility.		
Project Component/s	Wind energy facility and ancillary infrastructure (i.e. the substation, overhead power lines, internal access roads, workshop and office).	
Potential Impact	Visual impact of facility degradation and vegetation rehabilitation failure.	
Activity/Risk Source	The viewing of the above mentioned by observers on or near the site (i.e. within 10 km of the site).	
Mitigation: Target/Objective	Well maintained and neat facility.	
Mitigation: Action/control	**Responsibility**	**Timeframe**
Maintain the general appearance of the facility as a whole, including the turbines the internal roads, servitudes and the ancillary buildings.	Developer / operator	Throughout the operational phase.
Maintain roads to forego erosion and to suppress dust.	Developer / operator	Throughout the operational phase.
Monitor rehabilitated areas, and implement remedial action as and when required.	Developer / operator	Throughout the operational phase.
Performance Indicator	Well maintained and neat facility with intact vegetation on and in the vicinity of the facility.	
Monitoring	Monitoring of the entire site on an ongoing basis (by operator).	

Table 15: Management Programme – Decommissioning.

OBJECTIVE: The mitigation and possible negation of visual impacts associated with the decommissioning of the Proposed Garob Wind Energy Facility.		
Project Component/s	Wind energy facility and ancillary infrastructure (i.e. the substation, overhead power lines, internal access roads, workshop and office).	
Potential Impact	Visual impact of residual visual scarring and vegetation rehabilitation failure.	
Activity/Risk Source	The viewing of the above mentioned by observers on or near the site (i.e. within 10 km of the site).	
Mitigation: Target/Objective	Only the infrastructure required for post decommissioning use of the site retained and rehabilitated vegetation in all disturbed areas.	
Mitigation: Action/control	**Responsibility**	**Timeframe**
Remove infrastructure not required for the post-decommissioning use of the site. This may include the internal roads, substation, power line, ancillary buildings etc.	Developer / operator	During the decommissioning phase.
Rehabilitate access roads not required for the post-decommissioning use of the site. Consult an ecologist to give input into rehabilitation specifications.	Developer / operator	During the decommissioning phase.
Monitor rehabilitated areas quarterly for at least a year following decommissioning, and implement remedial action as and when required.	Developer / operator	Post decommissioning.
Performance Indicator	Vegetation cover on and in the vicinity of the site is intact (i.e. full cover as per natural vegetation within the environment) with no evidence of degradation or erosion.	
Monitoring	Monitoring of rehabilitated areas quarterly for at least a year following decommissioning.	

11. REFERENCES / DATA SOURCES

Civil Aviation Authority (CAA), 1997. *SA-CATS AH 139.01.33: Obstacle Limitations and Markings Outside Aerodrome or Heliport (Marking of Obstacles) and Aviation Act, 1962 (Act No. 74 of 1962)* Thirteenth Amendment of the Civil Aviations Regulations (CAR's).

Chief Directorate National Geo-Spatial Information, varying dates. *1:50 000 Topo-cadastral Maps and Data.*

CSIR/ARC, 2000. *National Land-cover Database 2000 (NLC 2000).*

DEADP, Provincial Government of the Western Cape, 2011. *Guideline on Generic Terms of Reference for EAPS and Project Schedules*

Department of Environmental Affairs and Tourism (DEA&T), 2001. *Environmental Potential Atlas (ENPAT) for the Northern Cape Province*

National Botanical Institute (NBI), 2004. *Vegetation Map of South Africa, Lesotho and Swaziland (Unpublished Beta Version 3.0)*

Oberholzer, B. (2005). *Guideline for involving visual and aesthetic specialists in EIA processes: Edition 1.*

Scenic Landscape Architecture (2006). *Cullerin Range Wind Farm; Visual Impact Assessment.* Unpublished Report.

The Environmental Impact Assessment Amendment Regulations. In Government Gazette Nr 33306, 18 June 2010.