BASIC ASSESSMENT LEVEL REPORT

SOIL, LAND USE, LAND CAPABILITY AND AGRICULTURAL POTENTIAL SURVEY:

PROPOSED DANIELSKUIL SOLAR ENERGY FACILITY: DANIELSKUIL, NORTHERN CAPE PROVINCE

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DECLARATION

I, Johan Hilgard van der Waals, declare that I –

- I act as the independent specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

J.H. VAN DER WAALS
TERRA SOIL SCIENCE

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SOIL, LAND USE, LAND CAPABILITY AND AGRICULTURAL POTENTIAL SURVEY – PROPOSED DANIELSKUIL SOLAR ENERGY FACILITY: DANIELSKUIL, NORTHERN CAPE PROVINCE

1. TERMS OF REFERENCE

Terra Soil Science (TSS) was commissioned by EnviroAfrica to undertake a Basic Assessment level soil, land use, land capability, and agricultural potential survey for the proposed Daniëlskuil Solar Energy Facility near Daniëlskuil in the Northern Cape Province.

2. INTRODUCTION

2.1 Study Aim and Objectives

The study area has been proposed to serve as a locality for the construction of a photovoltaic solar energy facility and associated infrastructure for power generation purposes. This study aims to determine the possible impact that this development could have on the soils, land use, land capability and agricultural potential as well as to identify areas of high sensitivity regarding solar panels and infrastructure.

The study has as objectives the identification and estimation of:

» Soil form (SA taxonomic system) and soil depth for the area;
» Soil potential linked to current land use and other possible uses and options;
» Discussion of the agricultural potential in terms of the soils, water availability, surrounding developments and current status of land; and
» Discussion of impacts (potential and actual) as a result of the development.

2.2 Agricultural Potential Background

The assessment of agricultural potential rests primarily on the identification of soils that are suited to crop production. In order to qualify as high potential soils they must have the following properties:

» Deep profile (more than 600 mm) for adequate root development,
» Deep profile and adequate clay content for the storing of sufficient water so that plants can weather short dry spells,
» Adequate structure (loose enough and not dense) that allows for good root development,
» Sufficient clay or organic matter to ensure retention and supply of plant nutrients,
» Limited quantities of rock in the matrix that would otherwise limit tilling options and water holding capacity,
» Adequate distribution of soils and size of high potential soil area to constitute a viable economic management unit, and

» Good enough internal and external (out of profile) drainage if irrigation practices are considered. Drainage is imperative for the removal (leaching) of salts that accumulate in profiles during irrigation and fertilization.

In addition to soil characteristics, climatic characteristics need to be assessed to determine the agricultural potential of a site. The rainfall characteristics are of primary importance and in order to provide an adequate baseline for the viable production of crops rainfall quantities and distribution need to be sufficient and optimal. The combination of the above mentioned factors will be used to assess the agricultural potential of the soils on the site.

2.3 Survey Area Boundary

The two alternative sites lie between 28° 12' 06'' and 28° 13' 35'' south and 23° 32' 24'' and 23° 33' 45'' east immediately south of the town of Daniëlskuil in the Northern Cape Province (**Figure 1**).

2.4 Survey Area Physical Features

The survey area lies on level terrain at about 1460 m above mean sea level with a general south-easterly aspect. The geology of the area consists of dolomite and chert with limestone and banded ironstone. On top of the hard geology the area is overlain by red to flesh –coloured wind-blown sands and surface limestone (Land Type Survey Staff, 1972 – 2006).

3. SOIL, LAND CAPABILITY, LAND USE SURVEY AND AGRICULTURAL POTENTIAL SURVEY

3.1 Method of Survey

The Basic Assessment level soil, land capability, land use and agricultural potential surveys were conducted in three phases.

3.1.1 Phase 1: Land Type Data

Land type data for the site was obtained from the Institute for Soil Climate and Water (ISCW) of the Agricultural Research Council (ARC). The land type data is presented at a scale of 1:250 000 and entails the division of land into land types, typical terrain cross sections for the land type and the presentation of dominant soil types for each of the identified terrain units (in the cross section). The soil data is classified according to the Binomial System (MacVicar et al., 1977). The soil data was interpreted and re-classified according to the Taxonomic System (MacVicar, C.N. et al. 1991).

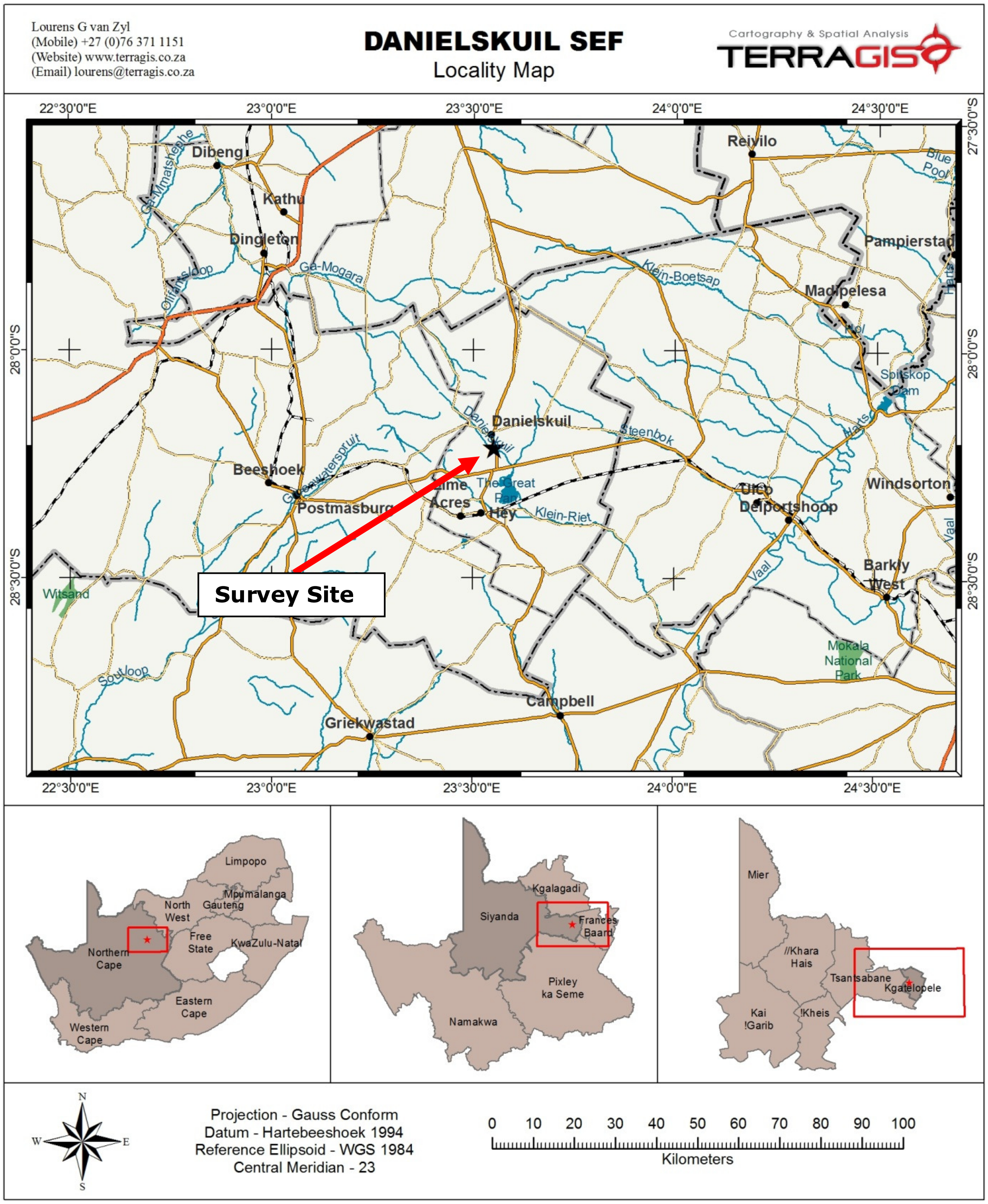

Figure 1 Locality of the survey site

3.1.2 Phase 2: Aerial Photograph Interpretation and Land Use Mapping

The most up to date aerial photographs of the site were obtained from Google Earth. The image was used to interpret aspects such as land use and land cover.

3.1.3 Phase 3: Site Visit and Soil Survey

A site visit was conducted on the 6th of March, 2012, during which a soil survey was conducted. The site was traversed on foot with the aim of ascertaining as much of the soil variability as possible. Soils were described and photographs were taken of pertinent soil, landscape and land use characteristics.

3.2 Survey Results

3.2.1 Phase 1: Land Type Data

The site falls into the **Ae9** land type (Land Type Survey Staff, 1972 - 2006). (Refer to **Figure 2** for the land type map of the area). Below follows a brief description of the land type in terms of soils, land capability, land use and agricultural potential.

Land Type Ae9

Soils: Ae land types denote areas with red soils of high base status that are deeper than 300 mm. The soils in the land type are therefore predominantly red and of high base status, often with a regular occurrence of calcrete. The soils are predominantly shallow and do not exhibit morphological signs of wetness at depth in the profile due to the dominance of dolomite geology. Rock outcrops and surface rock and limestone occur frequently.

Land capability and land use: Mainly extensive grazing due to climatic and soil constraints. Crop production is only possible with very intensive preparation, in the form of ripping and land form shaping, and if water is supplied through irrigation. The preparation and establishment costs are such that it is only considered if a long term plan, with adequate market research and funding, has been drawn up.

Agricultural potential: Low in the natural state due to soil and climate (rainfall – **Figure 3**) constraints with the potential of improvement in the case of land preparation, provision of water through irrigation and intensive management of water, salts, pests and markets.

3.2.2 Phase 2: Aerial Photograph Interpretation and Land Use/Capability Mapping

The interpretation of aerial photographs yielded one dominant land use namely extensive grazing (**Figures 4** and **5**). The carrying capacity of the site is moderate to low as rainfall and soils are limiting with regards to biomass production. Additional feeding of animals and proper grazing management (camps) are imperative for the sustainable production of the livestock.

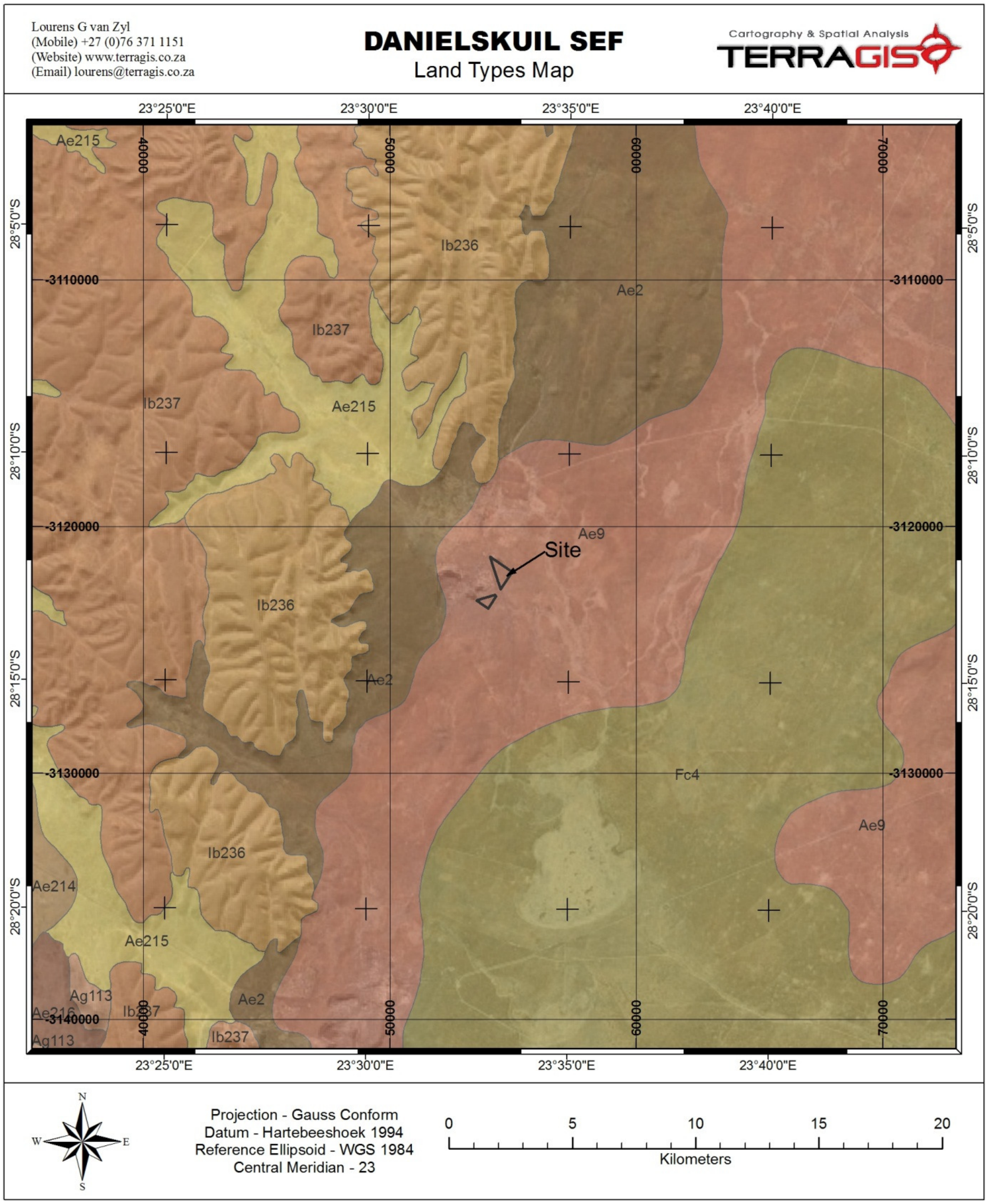

Figure 2 Land type map of the survey area

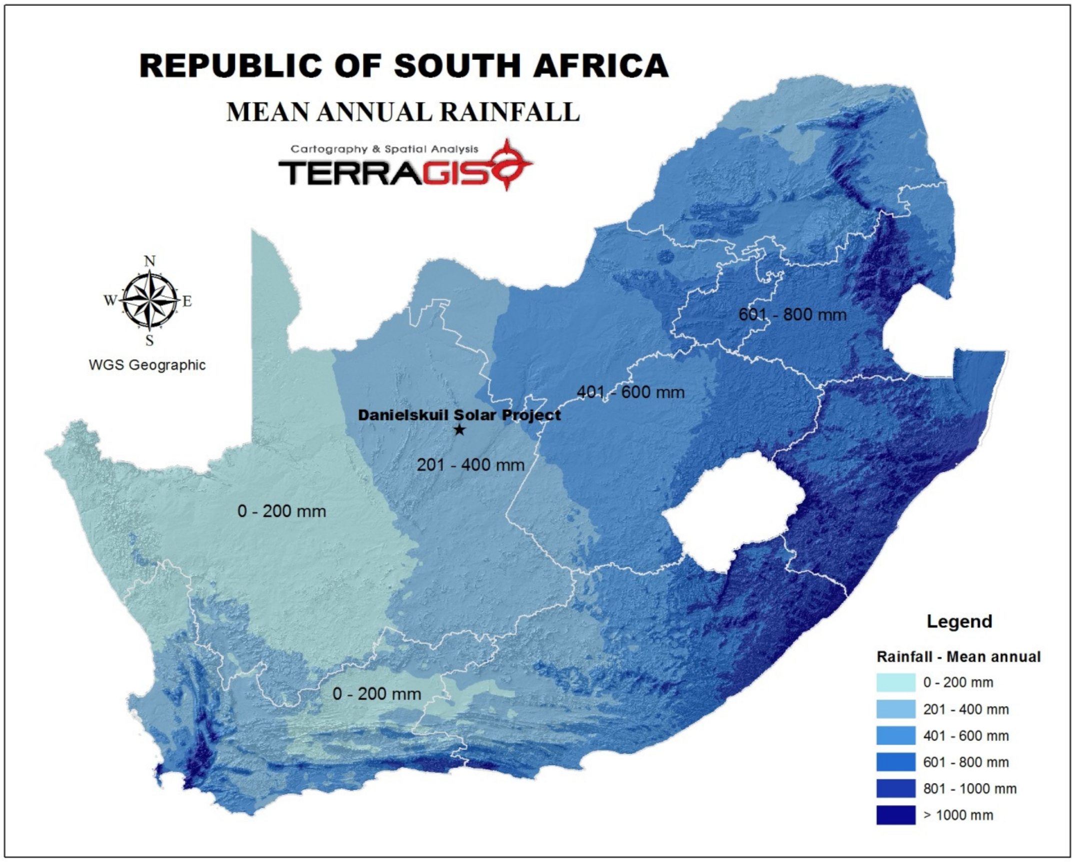

Figure 3 Rainfall map of South Africa indicating the survey site

3.2.3 Phase 3: Site Visit and Soil Survey

The soil survey revealed that the site consists of shallow rocky soils dominantly of the Mispah (Orthic A-horizon / Hard Rock), Glenrosa (Orthic A-horizon / Lithocutanic B-horizon) and shallow Hutton (Orthic A-horizon / Red Apedal B-horizon) forms. The soils on the site are very homogenous in their distribution and there are no signs of drainage depression on the preferred site. The alternative site exhibits clear indications of a drainage depression (**Figure 6**) although the soils do not exhibit clear signs of hydromorphism. This is due to the relatively high Mn content of the soils and the redox poising effect the Mn has under conditions of fluctuating moisture. The more pronounced effect on the site is the presence of salts in the soils that give a higher reflectance signature on aerial photographs. From a practical and legislative (NWA) perspective the northern most site is preferred for the development.

The practical placement of the solar facility could be problematic in terms of the atmospheric dust loads as generated by the neighbouring activities. The dust load and settlement effect is quite visible on the soil surface in the development areas as the surface is grey (typical dolomitic lime colour) and the subsurface is red (original soil colour). The effect of ant activities illustrates this problem (**Figures 7** and **8**) although the deposition rates are not known.

Figure 4 Satellite map of the general and the survey area

Figure 5 Land cover of the site

Figure 6 The alternative site with a delineated drainage depression with a pan in the centre

Figure 7 Grey soil surface due to significant long-term dust deposition

Figure 8 Grey soil surface due to significant long-term dust deposition with underlying natural red soil having been brought to the surface through ant activity

4. INTERPRETATION OF SOIL, LAND CAPABILITY AND LAND USE SURVEY RESULTS

The interpretation of the land use and land capability results yielded a number of aspects that are of importance to the project.

4.1 Agricultural Potential

The agricultural potential of the site is very low due to climatic constraints as well as the dominance of shallow soils. Due to the underlying dolomite, chert and limestone and lack of water for irrigation purposes the improvement of the agricultural potential through significant inputs is considered non-viable. The grazing potential of the site is moderate but the distinct dust deposition is considered to be detrimental to such land uses. The Mn content of the dust could have detrimental effects on grazing animals' health.

4.2 Overall Soil and Land Impacts

Due to the low agricultural potential of the site as well as the low rainfall the impacts on soils and agriculture is expected to be low – provided that adequate storm water management and erosion prevention measures are implemented. These measures should be included in the layout and engineering designs of the development.

5. ASSESEMENT OF IMPACT

5.1 Assessment Criteria

The following assessment criteria (**Table 1**) will be used for the impact assessment.

Table 1 Impact Assessment Criteria

CATEGORY	DESCRIPTION OF DEFINITION
Direct, indirect and cumulative impacts	In relation to an activity, means the impact of an activity that in itself may not be significant but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area.
Nature	A description of the cause of the effect, what will be affected and how it will be affected.
Extent (Scale) • 1 • 2 • 3 • 4 • 5	The area over which the impact will be expressed – ranging from local (1) to regional (5).

CATEGORY	DESCRIPTION OF DEFINITION
Duration • 1 • 2 • 3 • 4 • 5	Indicates what the lifetime of the impact will be. • Very short term: 0 – 1 years • Short-term: 2 – 5 years • Medium-term: 5 – 15 years • Long-term: > 15 years • Permanent
Magnitude • 2 • 4 • 6 • 8 • 10	This is quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
Probability • 1 • 2 • 3 • 4 • 5	Describes the likelihood of an impact actually occurring. • Very Improbable • Improbable • Probable • Highly probable • Definite
Significance	The significance of an impact is determined through a synthesis of all of the above aspects. S = (E + D + M)*P S = Significance weighting E = Extent D = Duration M = Magnitude
Status • Positive • Negative • Neutral	Described as either positive, negative or neutral
Other	• Degree to which the impact can be reversed • Degree to which the impact may cause irreplaceable loss of resources • Degree to which the impact can be mitigated

5.2 List of Activities for the Site

Table 2 lists the anticipated activities for the site. The last two columns in the table list the anticipated forms of soil degradation and geographical distribution of the impacts.

5.3 Assessment of the Impacts of Activities

Many of the impacts are generic and their impacts will remain similar for most areas on the site. The generic activity will therefore be assessed. The impacts associated with the different activities have been assessed below for each activity. These impacts have been summarized in **Table 8**. **Note:** The impacts listed below indicate that no mitigation is possible. It is important to note that any soil impact in the form of drastic physical disturbance (as with construction activities) is a permanent one and no mitigation is possible. The mitigation that can be applied is the restriction of off-site effects due to developments through adequate implementation of environmental management measures (discussed later in the report).

Table 2 List of activities and their associated forms of soil degradation

Activity	**Form of Degradation**	**Geographical Extent**	**Comment (Section described)**
Construction Phase			
Construction of solar panels and stands	Physical degradation (surface)	Two dimensional	Impact small due to localised nature (Section 5.3.1)
Construction of buildings and other infrastructure	Physical degradation (compound)	Two dimensional	(Section 5.3.2)
Construction of roads	Physical degradation (compound)	Two dimensional	(Section 5.3.3)
Construction and Operational Phase Related Effects			
Vehicle operation on site	Physical and chemical degradation (hydrocarbon spills)	Mainly point and one dimensional	(Section 5.3.4)
Dust generation	Physical degradation	Two dimensional	(Section 5.3.5)

5.3.1 Construction of Solar Panels and Stands

Table 3 presents the impact criteria and a description with respect to soils, land capability and land use for the construction of solar panels and stands.

Table 3 Construction of solar panels and stands

Criteria	**Description**	
Cumulative Impact	The cumulative impact of this activity will be small as it is constructed on land with low agricultural potential.	
Nature	This activity entails the construction of solar panels and stands with the associated disturbance of soils and existing land use.	
	Without Mitigation	With Mitigation
Extent	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed
Duration	5 – Permanent (unless removed)	5 – Permanent (unless removed)
Magnitude	2	2
Probability	4 (highly probable due to inevitable changes in land use)	4 (highly probable due to inevitable changes in land use)
Significance of impact	S = (1 + 5 + 2)*4 = 32 (low)	S = (1 + 5 + 2)*4 = 32 (low)
Status	Negative	Negative
Mitigation	None possible. Limit footprint to the immediate development area	None possible. Limit footprint to the immediate development area

5.3.2 Construction of Buildings and Other Infrastructure

Table 4 presents the impact criteria and a description with respect to soils, land capability and land use for the construction of solar panels and stands.

Table 4 Construction of buildings and other infrastructure

Criteria	**Description**	
Cumulative Impact	The cumulative impact of this activity will be small as it is constructed on land with low agricultural potential.	
Nature	This activity entails the construction of buildings and other infrastructure with the associated disturbance of soils and existing land use.	
	Without Mitigation	With Mitigation
Extent	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed
Duration	5 – Permanent (unless removed)	5 – Permanent (unless removed)

Magnitude	2	2
Probability	4 (highly probable due to inevitable changes in land use)	4 (highly probable due to inevitable changes in land use)
Significance of impact	S = (1 + 5 + 2)*4 = 32	S = (1 + 5 + 2)*4 = 32 (low)
Status	Negative	Negative
Mitigation	None possible. Limit footprint to the immediate development area	None possible. Limit footprint to the immediate development area

5.3.3 Construction of Roads

Table 5 presents the impact criteria and a description with respect to soils, land capability and land use for the construction of roads.

Table 5 Construction of roads

Criteria	**Description**	
Cumulative Impact	The cumulative impact of this activity will be small as it is linear and limited in geographical extent.	
Nature	This activity entails the construction of roads with the associated disturbance of soils and existing land use.	
	Without Mitigation	With Mitigation
Extent	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed along the road	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed along the road
Duration	5 – Permanent (unless removed)	5 – Permanent (unless removed)
Magnitude	2	2
Probability	4 (highly probable due to inevitable changes in land use)	4 (highly probable due to inevitable changes in land use)
Significance of impact	S = (1 + 5 + 2)*4 = 32 (low)	S = (1 + 5 + 2)*4 = 32 (low)
Status	Negative	Negative
Mitigation	None possible. Limit footprint to the immediate development area and keep to existing roads as far as possible	None possible. Limit footprint to the immediate development area and keep to existing roads as far as possible

5.3.4 Vehicle Operation on Site

It is assumed that vehicle movement will be restricted to the construction site and established roads. Vehicle impacts in this sense are restricted to spillages of lubricants and petroleum products. **Table 6** presents the impact criteria and a description with respect to soils, land capability and land use for the operation of vehicles on the site.

Table 6 Assessment of impact of vehicle operation on site

Criteria	**Description**	
Cumulative Impact	The cumulative impact of this activity will be small if managed.	
Nature	This activity entails the operation of vehicles on site and their associated impacts in terms of spillages of lubricants and petroleum products	
	Without Mitigation	With Mitigation
Extent	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed
Duration	2 – Short-term	2 – Short-term
Magnitude	2	2
Probability	4	2 (with prevention and mitigation)
Significance of impact	S = (1 + 2 + 2)*4 = 20	S = (1 + 2 + 2)*2 = 10 (with prevention and mitigation)
Status	Negative	Negative
Mitigation	Maintain vehicles, prevent and address spillages	Maintain vehicles, prevent and address spillages

5.3.5 Dust Generation

Generated dust can impact large areas depending on environmental and climatic conditions. **Table 7** presents the impact criteria and a description with respect to soils, land capability and land use for dust generation on the site. For the sake of this assessment contributions of dust generation other than the activities on the site have been ignored.

Table 7 Assessment of impact of dust generation on site

Criteria	**Description**	
Cumulative Impact	The cumulative impact of this activity will be small if managed but can have widespread impacts if ignored.	
Nature	This activity entails the operation of vehicles on site and their associated dust generation	
	Without Mitigation	With Mitigation
Extent	2 - Local: The impact is diffuse (depending on environmental and climatic conditions) and will probably be limited to within 3 – 5 km of the site	2 - Local: The impact is diffuse (depending on environmental and climatic conditions) and will probably be limited to within 3 – 5 km of the site
Duration	2 – Short-term	2 – Short-term
Magnitude	2	2
Probability	4	2 (with mitigation and adequate

		management)
Significance of impact	S = (2 + 2 + 2)*4 = 24	S = (2 + 2 + 2)*2 = 12 (with mitigation and adequate management)
Status	Negative	Negative
Mitigation	Limit vehicle movement to absolute minimum, construct proper roads for access	Limit vehicle movement to absolute minimum, construct proper roads for access

Table 8 Summary of the impact of the development on agricultural potential and land capability

Nature of Impact	*Loss of agricultural potential and land capability owing to the development*	
	Without mitigation	With mitigation
Extent	Low (1) – Site	Low (1) – Site
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (2)	Low (2)
Probability	Highly probable (4)	Highly probable (4)
Significance*	32 (Low)	32 (Low)
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	No	No
Mitigation: The loss of agricultural land is a long term loss and there are no mitigation measures that can be put in place to combat this loss.		
Cumulative impacts: Soil erosion may arise owing to increased surface water runoff. Adequate management and erosion control measures should be implemented.		
Residual Impacts: The loss of agricultural land is a long term loss. This loss extends to the post-construction phase. The agricultural potential is very low though.		

5.4 Environmental Management Plan

Tables 9 to **11** provide the critical aspects for inclusion in the EMP.

Table 9 Measures for erosion mitigation and control

Objective: Erosion control and mitigation		
Project components	Soil stabilisation, construction of impoundments and erosion mitigation structures	
Potential Impact	Large scale erosion and sediment generation	
Activity / risk source	Poor planning of rainfall surface runoff and storm water management	
Mitigation: Target / Objective	Prevention of eroded materials and silt rich water running off the site	
Mitigation: Action/control	**Responsibility**	**Timeframe**
Plan and implement adequate erosion control measures	Construction team and engineer	Throughout project
Performance indicator	Assessment of storm water structures and erosion mitigation measures. Measurement of actual erosion and sediment generation.	
Monitoring	Monitor and measure sediment generation and erosion damage	

Table 10 Measures for limiting vehicle operation impacts on site (spillages)

Objective: Erosion control and mitigation		
Project components	Maintenance of vehicles and planning of vehicle service areas	
Potential Impact	Oil, fuel and other hydrocarbon pollution	
Activity / risk source	Poor maintenance of vehicles and poor control over service areas	
Mitigation: Target / Objective	Adequate maintenance and control over service areas	
Mitigation: Action/control	**Responsibility**	**Timeframe**
Service vehicles adequately	Construction team and engineer	Throughout project
Maintenance of service areas, regular cleanup	Construction team and engineer	Throughout project
Performance indicator	Assessment number and extent of spillages on a regular basis.	
Monitoring	Monitor construction and service sites	

Table 11 Measures for limiting dust generation on site

Objective: Dust generation suppression		
Project components	Limit and address dust generation on site linked to construction activities	
Potential Impact	Large scale dust generation on site	
Activity / risk source	Inadequate dust control measures, excessive vehicle movement on unpaved roads	
Mitigation: Target / Objective	Minimise generation of dust	
Mitigation: Action/control	**Responsibility**	**Timeframe**
Implement dust control strategy including dust suppressants and tarring of roads	Construction team and engineer	Throughout project
Limit vehicle movement on unpaved areas to the absolute minimum	Construction team and engineer	Throughout project
Performance indicator	Assessment of dust generated on site	
Monitoring	Monitor construction site and surrounds	

6. CONCLUSIONS AND RECOMMENDATIONS

It is concluded that the proposed development of a photovoltaic facility on the site will not have large impacts due to the low agricultural potential of the site. The low agricultural potential of the site is the result of a dominance shallow and rocky soils as well as the low rainfall of the area.

It is imperative though that adequate storm water management measures be put in place as the soils on the site have no cohesion due to inherent soil properties as well as lack of plant roots. The main impacts that have to be managed on the site are:

1. Erosion must be controlled through adequate mitigation and control structures.
2. Impacts from vehicles, such as spillages of oil and hydrocarbons, should be prevented and mitigated.
3. Dust generation on site should be mitigated and minimised as the dust can negatively affect the quality of pastures as well as sheep production.

The effect of dust on the development and efficacy of solar energy generation has not been assessed in this report as it falls outside of its scope. It is recommended however that this aspect be investigated in detail as site conditions indicate the possibility of large volumes of dust being generated by surrounding activities, with a potential detrimental effect on the development.

The impacts on the site need to be viewed in relation to the opencast mining of coal in areas of high potential soils – such as the Eastern Highveld. With this comparison in mind the impact of a solar energy facility is negligible compared to the damaging impacts of coal mining – for a similar energy output. Therefore, in perspective, the impacts of the proposed facility can be motivated as necessary in decreasing the impacts in areas where agriculture potential plays a more significant role.

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