AURECON SOUTH AFRICA (PTY) LTD

PROPOSED PV SOLAR ENERGY FACILITIES ON DU PLESSIS DAM FARM NEAR DE AAR

Soil and Agricultural Assessment Report

Issue Date: **28th August 2013**
Revision No.: **1.3**
Project No.: **12014**

Date:	28th August 2013
Document Title:	Proposed PV Solar Energy Facilities on Du Plessis Dam Farm Near De Aar: Soil and Agricultural Assessment Report
Author:	Kurt Barichievy (*Pr.Sci.Nat.*)
Revision Number:	# 1.3
Checked by:	Tarryn Curtis
Approved:	Kurt Barichievy (*Pr.Sci.Nat.*)
Signature:	
For:	Aurecon South Africa

Declaration

I, Kurt Barichievy, declare that I –

- act as an independent specialist consultant for the **soil and agricultural assessment report for the proposed PV Solar Energy Facilities on Farm Du Plessis near De Aar, Northern Cape Province**;
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2006;
- have and will not have any vested interest in the proposed activity proceeding;
- have no, and will not engage in, conflicting interests in the undertaking of the activity;
- undertake to disclose, to the competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the Environmental Impact Assessment Regulations, 2006; and
- will provide the competent authority with access to all information at our disposal regarding the application, whether such information is favourable to the applicant or not.

Mr. K. R. Barichievy *Pr.Sci.Nat*
Scientist
SiVEST Civil Engineering Division

CONTENTS

LIST OF FIGURES

1. INTRODUCTION AND TERMS OF REFERENCE

Aurecon South Africa (Pty) Ltd (Aurecon) on behalf of **Mulilo Renewable Energy (Pty) Ltd** (Mulilo) requested a baseline assessment of the soil, land use and agricultural characteristics for the areas affected by the proposed construction of three separate solar energy facilities, on Du Plessis Dam Farm (Remainder of Farm 179), near De Aar in the Northern Cape.

The primary objective of this assessment is to provide specialist soil and agricultural input into the overarching EIA Report. In order to achieve this objective, a study of the climate, soils, terrain, land capability, geology, current agricultural practices and agricultural potential was carried out. This report serves to summarise such a study, present the relevant results and mitigate the predicted impacts on local soil and agricultural resources.

A detailed soil and agricultural report was undertaken for Du Plessis Dam Farm in January 2012, as part of a larger environmental assessment (**SiVEST, 2012**). Environmental Authorisation for a 19.9 MW Photovoltaic (PV) solar energy facility, known as Du Plessis PV1, and associated infrastructure was granted for this project in late September 2012. Mulilo now plans to construct three additional PV facilities on Du Plessis Dam Farm. The area previously approved for PV1 (approximately 64 ha) will be included in the proposed layouts for the additional PV facilities as an attempt to maximise the generation capacity of the farm (**Aurecon, 2013**).

This assessment intends to supplement this previous soil and agricultural study, and along with the other specialist studies, hopes to minimise the predicted potential impacts on the receiving environment. The terms of reference of this study are to:

- Undertake a detailed soil assessment of the sites, incorporating a radius of 50m surrounding the site, on a scale of 1:10 000 or finer. The soil assessment should include:
    - Identification of the soil forms present on sites;
    - The size of the area where a particular soil form is found;
    - GPS readings of soil survey points;
    - The depth of the soil at each survey point;
    - Soil colour;
    - Limiting factors;
    - Clay content;
    - Size of the site;
    - Slope of the site; and
    - A detailed map indicating the locality of the soil forms within the specified areas.
- Provide the exact locality of the site;
- Describe current activities on the sites, developments and buildings;
- Describe surrounding developments/ land uses and activities in a radius of 500m of the sites, access routes and the condition thereof, the current status of the land (including erosion, vegetation and a degradation assessment) and possible land use options for the sites;
- Describe water availability, source and quality (if available);
- Detailed descriptions of why agriculture should or should not be the land use of choice;
- Undertake an assessment of the potential impacts on agriculture at the site in terms of the scale of impact (local, regional, national), magnitude of impact (low, medium or high) and the

duration of the impact (construction, up to 10 years after construction, more than 10 years after construction). The assessment is to indicate the potential cumulative impacts;

- Describe potential mitigation measures to reduce or eliminate the potential agricultural impacts identified;
- Provide a shape file containing the soil forms and relevant attribute data as depicted on the map; and
- Provide an erosion management plan for monitoring and rehabilitating of erosion events associated with the facility.

1.1 Brief Description of the Project and Study Area

The purpose of this section is to provide basic site information for later reference. Please note that a more detailed description of the site's characteristics are provided in **Sections 4 through 7** of this report.

The Northern Cape Province is considered to be one of the most suitable regions for the establishment of solar PV facilities due to the overriding climatic and environmental conditions. Accordingly, Du Plessis Dam Farm located outside of De Aar has been identified as a potential site. The Du Plessis Dam Farm (Remainder of Farm 179) covers approximately 1236ha and has the following mid-point co-ordinate: 30º37"45.70"S 24º03"13.35"E.

As indicated, the revised project includes the construction of three PV facilities, each with a generation capacity of 75MW AC on Du Plessis Dam Farm. The combined extent of the three proposed facilities, for Layout Alternative 1, would be approximately 755ha as summarised in **Table 1,** below.

Table 1: Summary of the PV Facilities on Du Plessis Dam Farm (Layout Alternative 1) (**Aurecon, 2013**)

Facility	Footprint (ha)	Capacity (MW)	Mid-Point Co-Ordinates
PV 2	273	75	30°38'11.38"S; 24° 4'22.75"E
PV 3	212	75	30°37'53.03"S; 24° 3'28.26"E
PV 4	374	75	30°37'27.44"S; 24° 2'31.14"E

The farm is situated in the Emthanjeni Local Municipality and is zoned as agricultural land. The farm borders the north eastern corner of De Aar (**Figure 3**) and consists of flat grassy plains which are used as unimproved grazing land for cattle production. Access to the site is obtained via the R48 and there are few internal farm roads. Water is the major limiting factor to local agricultural enterprises and the farm does not contain, nor does it directly border, a perennial river / freshwater impoundment which could be used as a source of irrigation water.

1.2 Description of Proposed Activities and Technical Details

The technical details provided in this section are primarily extracted from the Draft Scoping Report produced by Aurecon (**2013**).

Each of the three proposed PV facilities would consist of the following:

- **Solar energy facility:** A photovoltaic component comprising of numerous arrays of PV panels and associated support infrastructure to generate up to 75MW per facility, through the photovoltaic effect.
- **Transmission lines:** 132kV overhead transmission lines to connect each facility to the central onsite substation or an existing Eskom substation.
- **Facility substations:** An onsite 132kV, 3 bay central substation.
- **Boundary fence:** Each 75MW facility will be fenced for health, safety and security reasons **(Aurecon, 2013)**.

It is proposed that the following infrastructure be shared between the three facilities to lessen the impact on the surrounding environment:

- **Central substation:** One central 132kV substation and connection to the Eskom grid. This central substation will connect the PV facilities with Eskom's De Aar substation via either an existing overhead 132kV Eskom line or the previously authorised 132kV overhead transmission line directly to De Aar substation.
- **Roads:** Access road and internal access roads for servicing and maintenance of the site.
- **Water supply infrastructure:** It is proposed that potable water will be obtained from the Emthanjeni Municipality. Water will be transferred to the site via the municipal pipeline from the nearest municipal supply point and will be contained onsite in a jo-jo tank. However, the Municipality would need to confirm availability of capacity to do so.
- **Stormwater infrastructure:** Including drainage channels, berms, detention areas and kinetic energy dissipaters.
- **Buildings:** Buildings would likely include onsite substations, a connection building, control building, guard cabin, an electrical substation and solar resource measuring substation. Each of the project components are described in further detail below **(Aurecon, 2013)**.

Two proposed PV layouts for the Alternatives have been tabled:

<u>Layout Alternative 1</u>

This alternative consists of the three proposed 75MW PV facilities and associated infrastructure as indicated in Figure 4 (referred to as PV2, PV3 and PV4) (**Aurecon, 2013**).

<u>Layout Alternative 2</u>

This alternative consists of one 400MW PV facility, covering 1000 ha. The layout for this alternative was developed by extending and combining the proposed 75MW facilities. This alternative is thus not limited to the DOE's 75MW cap per project. By increasing the capacity it has the benefit of utilising industries at scale thereby reducing associated development and construction costs which reduces lending rates and essentially lower the tariff of electricity sold (**Aurecon, 2013**).

1.2.1 Single axis tracking PV technology

Photovoltaic solar energy facilities use light energy from the sun to generate electricity through a process known as the PV effect. The PV cells absorb light energy which energises the electrons to produce electricity. **Figure 1** depicts a typical PV facility in a landscape similar to De Aar. The proposed PV panels are approximately 2m wide and 1m long. These panels are arranged into modules that are durable and can last up to 25 years, due to the sturdiness of the structure and few moving parts. The PV modules (which will include a number of PV panels) will be physically mounted to a galvanized steel rotation tube, single axis tracking system to ensure ground connection from the module frames to the structure. The PV modules, fixed to the tracking system, are arranged into tracker blocks as indicated in **Figure 2**. These tracker blocks will be uniformly aligned to facilitate efficient sun-tracking. The dimensions of a tracker block range between 88m and 113m in an east to west direction and 35m to 38m in a north-south direction (**Mulilo, 2013** cited in **Aurecon, 2013)**.

The supports of the frame will be fixed on top of the steel piles. Since there is existence of rock (dolerite and siltstone) at shallow depths, the steel piles would be embedded into a concrete pile. However, the final design of the foundations will depend on the geotechnical conditions of the site which will be determined at a later stage **(Aurecon, 2013)**.

Figure 1: Example of a PV facility in a landscape similar to De Aar (image courtesy of Mulilo, cited in **Aurecon, 2013)**.

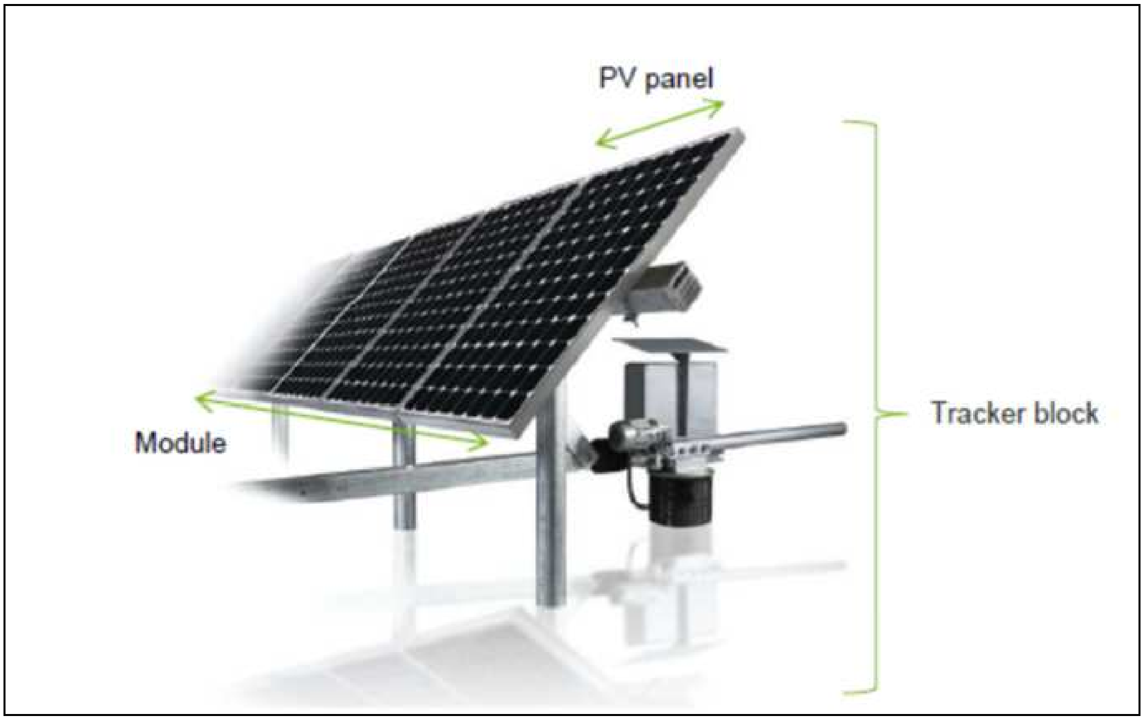


Figure 2: Single axis tracking system (image courtesy of Mulilo cited in **Aurecon, 2013**)

1.2.2 Transmission lines and substations

It is envisaged that each PV facility would require an onsite substation specific to each PV facility i.e. three onsite substations. These substations would feed into one central onsite substation by means of onsite overhead 132kV transmission lines. Based on the uncertainties regarding the capacity of Eskom's substations and transmission lines, it is proposed to assess a transmission line corridor instead of assessing the preliminary layouts subject to numerous changes **(Aurecon, 2013)**.

Alternative 1 transmission corridor

The proposed transmission corridor (alternative 1) would be approximately 10km in length. The width of the first section of the corridor is 31m and the second section is 160m. The first section of the corridor is from the De Aar substation travelling north for approximately 1.7km before turning south-east, crossing the R48, and then entering Du Plessis Dam Farm (**Figure 5**). The second section of the corridor would follow the southern boundary of the farm. The proposed corridor would house overhead transmission lines and substations to connect the proposed PV facilities to existing Eskom infrastructures **(Aurecon, 2013)**.

Alternative 2 transmission corridor

The proposed transmission corridor (alternative 2) would be approximately 8km in length. The width of the entire alternative 2 corridor is 31m. As mentioned above, the first section of alternative 1 and alternative 2 transmissions line corridors overlap. The second section of the corridor would follow the layout of the approved transmission line as indicated in **Figure 5**. The proposed corridor would house overhead transmission lines and substations to connect the proposed PV facilities to existing Eskom infrastructures **(Aurecon, 2013)**.

1.2.3 Additional infrastructures (road, buildings, stormwater, water pipeline)

An access road (6m in width and 6.8km long), including internal access roads, would be constructed to access the PV facilities from the R48. Where possible, the layout of the road will coincide with the existing dirt tracks. The proposed access and internal roads are shown in **Figure 6**. The natural water flow of the site will be interrupted by the execution of planned roads, and therefore new storm water drainage channels will be designed to facilitate natural water flow. The storm water drainage channels will guide water flow to one of several discharge points where riprap areas will slow down the velocity of water and disperse the flow to avoid any possible erosion issue at that discharge point. It is proposed that potable water be obtained from the Emthanjeni Municipality via a proposed underground pipeline (5km in length) from the nearest municipal supply point and will be contained onsite in a jo-jo tank. The Municipality still needs to confirm available capacity to facilitate this water requirement. **(Aurecon, 2013)**.

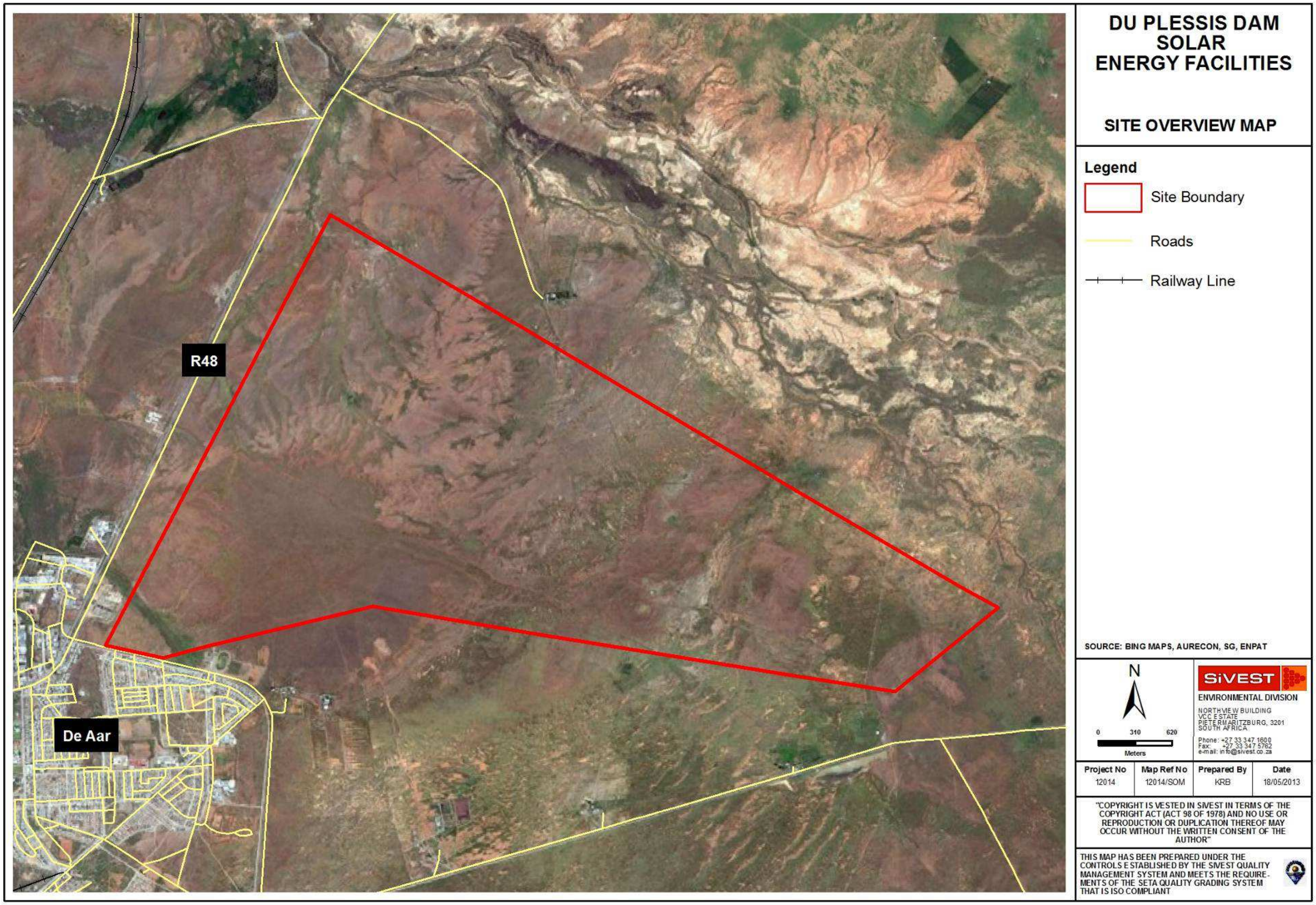
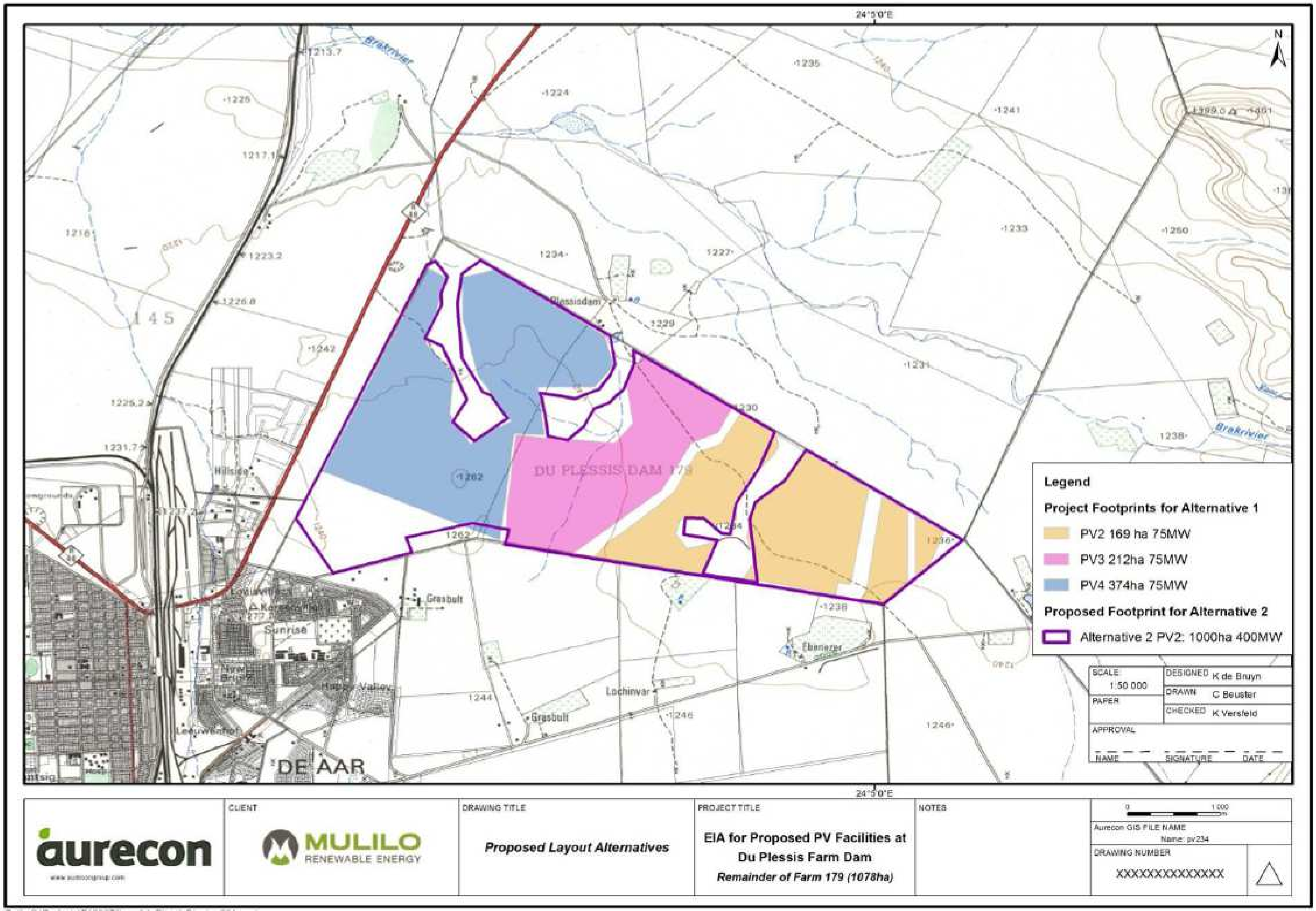
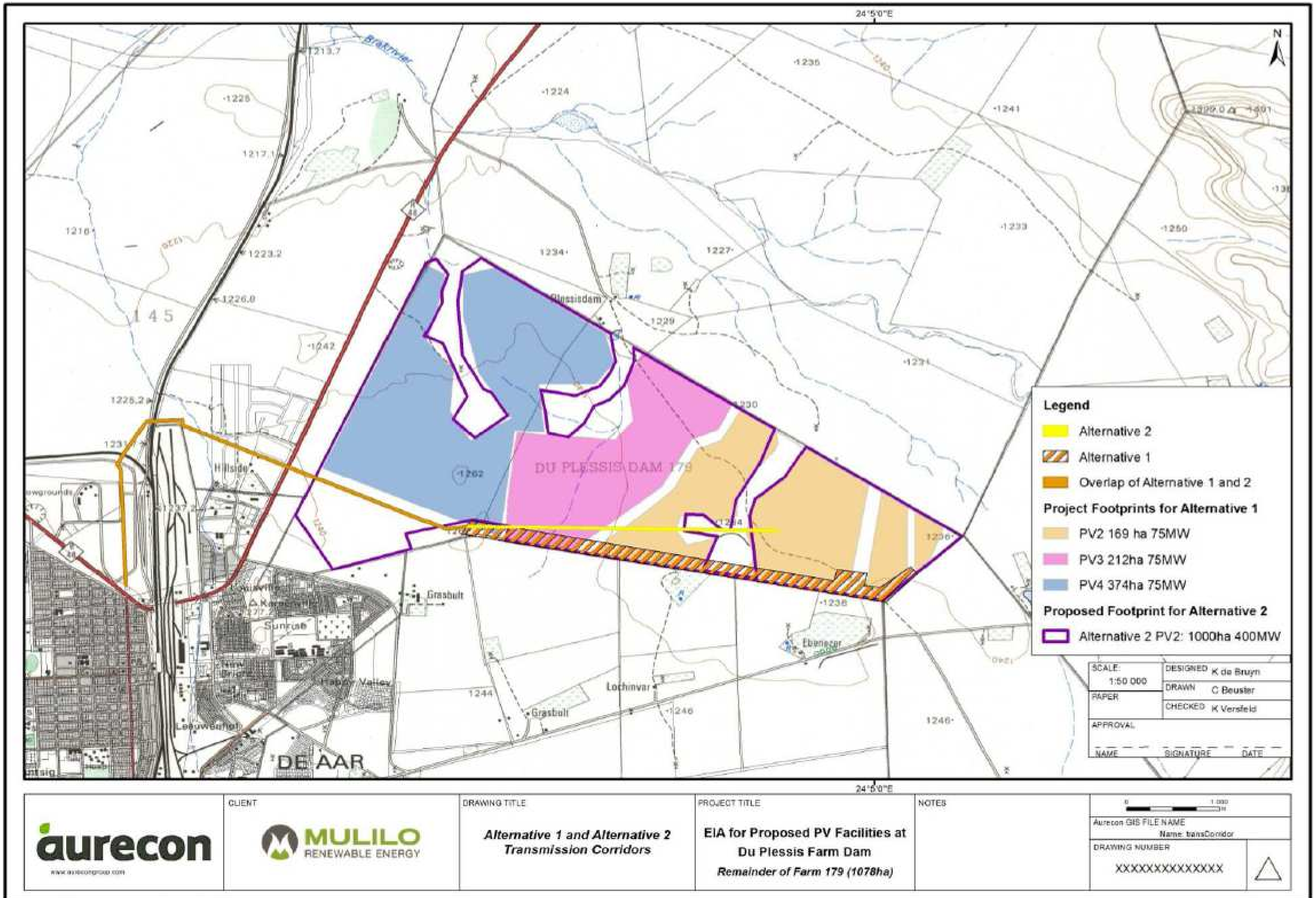


Figure 3: Site overview map



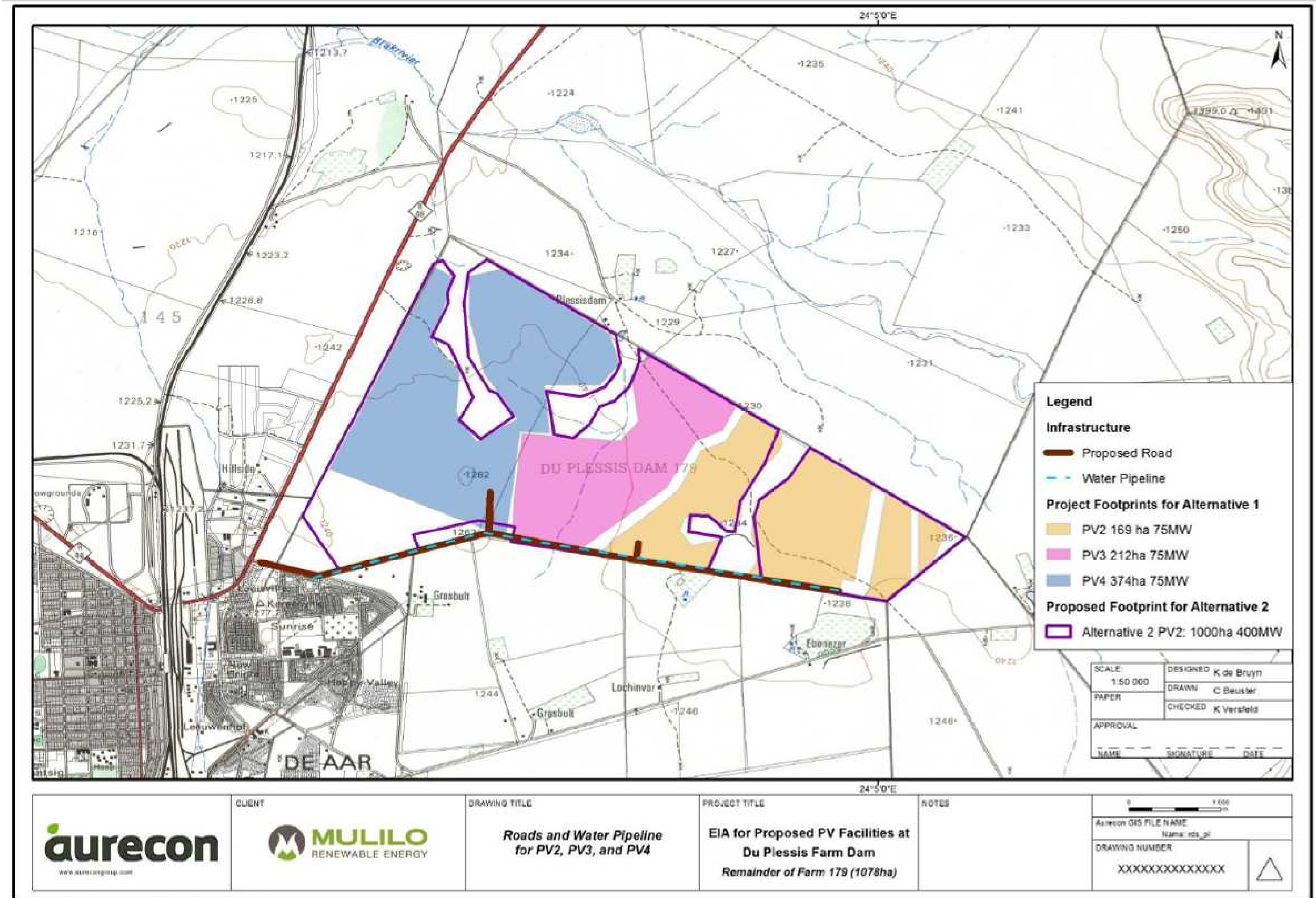
Path: S:\Projects\E109378\mxd\duPlessisDam\pv234.mxd

Figure 4: Proposed layout alternatives (**Aurecon, 2013**)



Path: S:\Projects\E108378\mxd\duPlessisDam\transCorridor.mxd

Figure 5: Proposed transmission corridors (**Aurecon, 2013**)



Path: S:\Projects\E109378\mxd\duPlessisDam\rds_pl.mxd

Figure 6: Proposed road and water pipeline (**Aurecon, 2013**)

2. METHODOLOGY

The following methodology was followed in order to ascertain the *status quo* of soil and agricultural resources within the study area. Further, to outline the predicted impacts resulting from the proposed development and activities in the in the study area.

2.1 Desktop Study

A detailed desktop assessment was undertaken for the project area. The objective of this study is to broadly evaluate the soil and land use of the sites and receiving environment by interrogating relevant climate, topographic, landuse and soil datasets. By utilising these data resources one is able to broadly assess the current soil, agricultural and land use characteristics and provide a basis for a more detailed and spatially relevant assessment.

2.2 Soil Survey

A detailed soil survey was conducted in late 2012 and May 2013. At each sample point a hand auger was used to identify and describe the diagnostic horizons to form and family level according to "Soil Classification - A Taxonomic System for South Africa" as well as noting relevant soil characteristics such as depth, texture and limiting layers. At each auger point the relevant soil and land use data were recorded and the location of the auger point captured using a handheld GPS. This information was combined to produce detailed soil polygon maps.

2.4 Agricultural Potential Assessment

In terms of this study, agricultural potential is described as an area's suitability and capacity to sustainably accommodate an agricultural land use. The soil information gained from the survey along with the land use assessment is combined with climate, water resources, crop information and topographic data in order to provide a spatial classification of the land based on its agricultural potential. A study of local agricultural practises was also carried out.

2.5 Impact Assessment

The impact assessment utilises the findings of the soil survey and agricultural potential assessment in order to determine reference conditions of the soil and agricultural resources. Potential soil and agricultural impacts, as a result of the proposed activities, are described in this Section and any major impacts/fatal flaws will be identified for consideration by the pertinent authorities.

3. DESKTOP AGRICULTURAL POTENTIAL ASSESSMENT

The objective of the desktop component of this assessment is to provide broad soil and agriculturally related characteristics of the project area. It should be clearly noted that, since the spatial information used to drive this portion of the assessment is of a reconnaissance nature, only large scale climate, land use and soil details are provided. More detailed and site specific information for the study area is provided in subsequent sections of this report (**Sections 4, 5 and 6**).

In order to ascertain the broad soil and agricultural potential characteristics of the project area relevant climate, topographic, landuse and soil datasets were sourced and interrogated. Existing high level GIS data was sourced from National GIS Datasets as well as the Environmental Potential Atlas for South Africa (ENPAT) Database for the Northern Cape Province of South Africa, compiled by the Department of Environmental Affairs and Tourism (**DEAT, 2001**).

The main purpose of ENPAT is to proactively indicate potential conflicts between development plans and critical, endangered or sensitive environments. By combining the aforementioned data resources, one is able to broadly assess the site, receiving environment, and its ability to accept change, in the form of development. More agriculturally relevant spatial information was obtained from the AGIS Database **(*http://www.agis.agric.za,*** accessed 15/05/2013).

3.1 Climate

The study area has a semi-arid to arid continental climate with a summer rainfall regime i.e. most of the rainfall is confined to summer and early autumn. Mean Annual Precipitation (MAP) is approximately 300 mm per year (**Figure 7**). An MAP of 300 mm is deemed low as 500 mm is considered the minimum amount of rain required for sustainable dry land farming (**Smith, 2006**). Thus, without some form of supplementary irrigation natural rainfall for the study area is insufficient to produce sustainable harvests. This is reflected in the lack of dry land crop production within the study area De Aar typically experiences hot days and cold nights with the highest maximum temperature of approximately 40 ^{o}C and the lowest minimum temperature of approximately - 8 ^{o}C (**Table 2** and **Figure 8**). Evaporation is estimated to be in the region of 2000 mm per annum and thus the area is characterised by very severe moisture availability restrictions (**AGIS, 2013**)

In summary the climate for the study area is to severely restrictive to arable agriculture which is primarily due to the lack of rainfall and severe moisture availability restrictions.

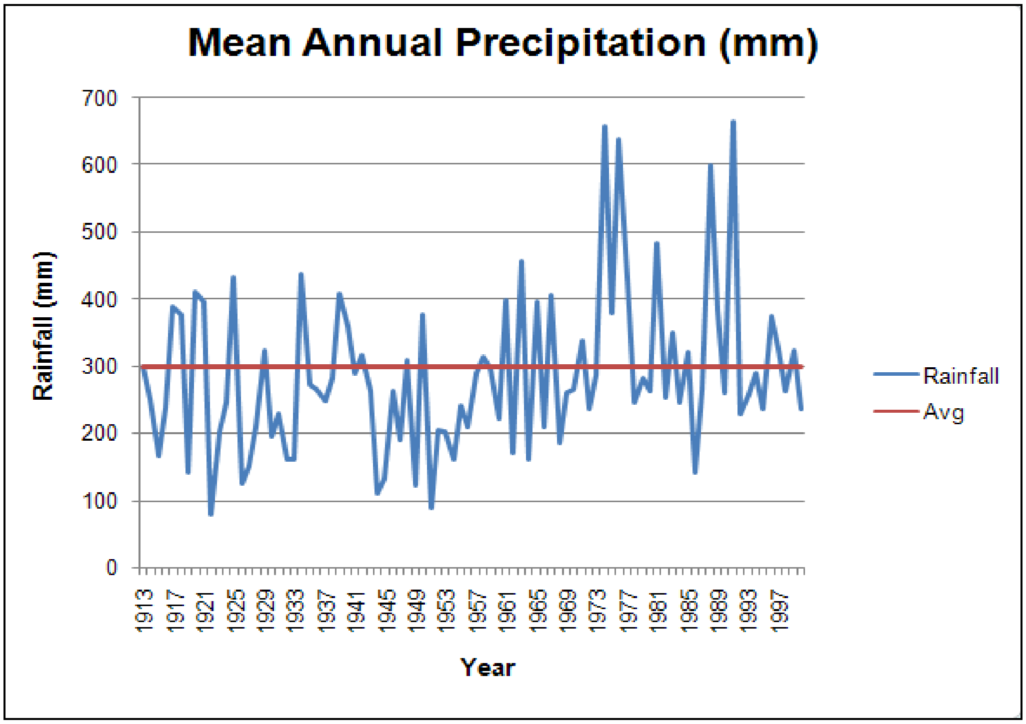


Figure 7: Long term annual rainfall (1913 – 1998) for the study area and long term average (indicated by the red line) (Source: **SAWS, 2010**)

Table 2: Monthly temperature summary for De Aar (**SAWS, 2010**)

Month	**Temperature (° C) (1961 – 1990)**			
	Highest Recorded	**Average Daily Maximum**	**Average Daily Minimum**	**Lowest Recorded**
January	40	32	16	7
February	38	31	15	4
March	37	28	13	1
April	34	24	9	-1
May	30	20	4	-5
June	26	16	1	-7
July	25	17	1	-8
August	28	19	2	-8
September	35	23	6	-5
October	36	26	9	-3
November	38	29	12	-1
December	39	31	14	3
Year	**40**	**25**	**9**	**-8**

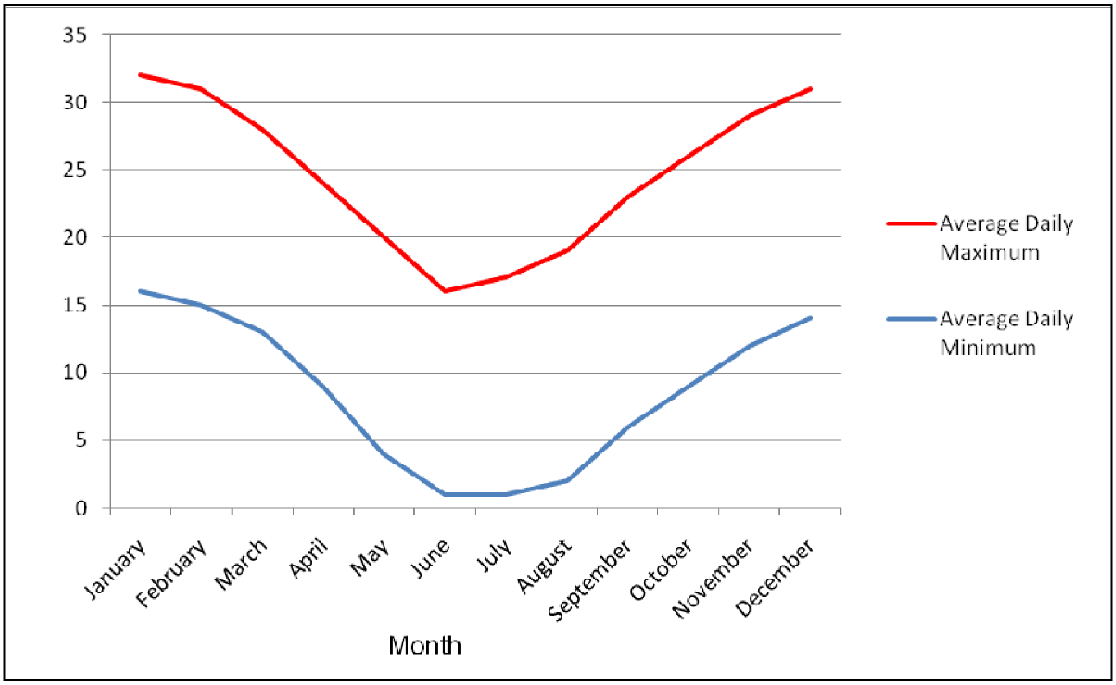


Figure 8: Average daily minimum and maximum temperatures for De Aar **(SAWS, 2010)**

3.2 Geology

The study area is completely underlain by shale (**Figure 9**). Shale, a clastic sedimentary rock, is formed by the settling and accumulation of clay rich minerals and other sediments. Due to the settling process this parent material usually takes the form parallel rock layers which lithifies over time.

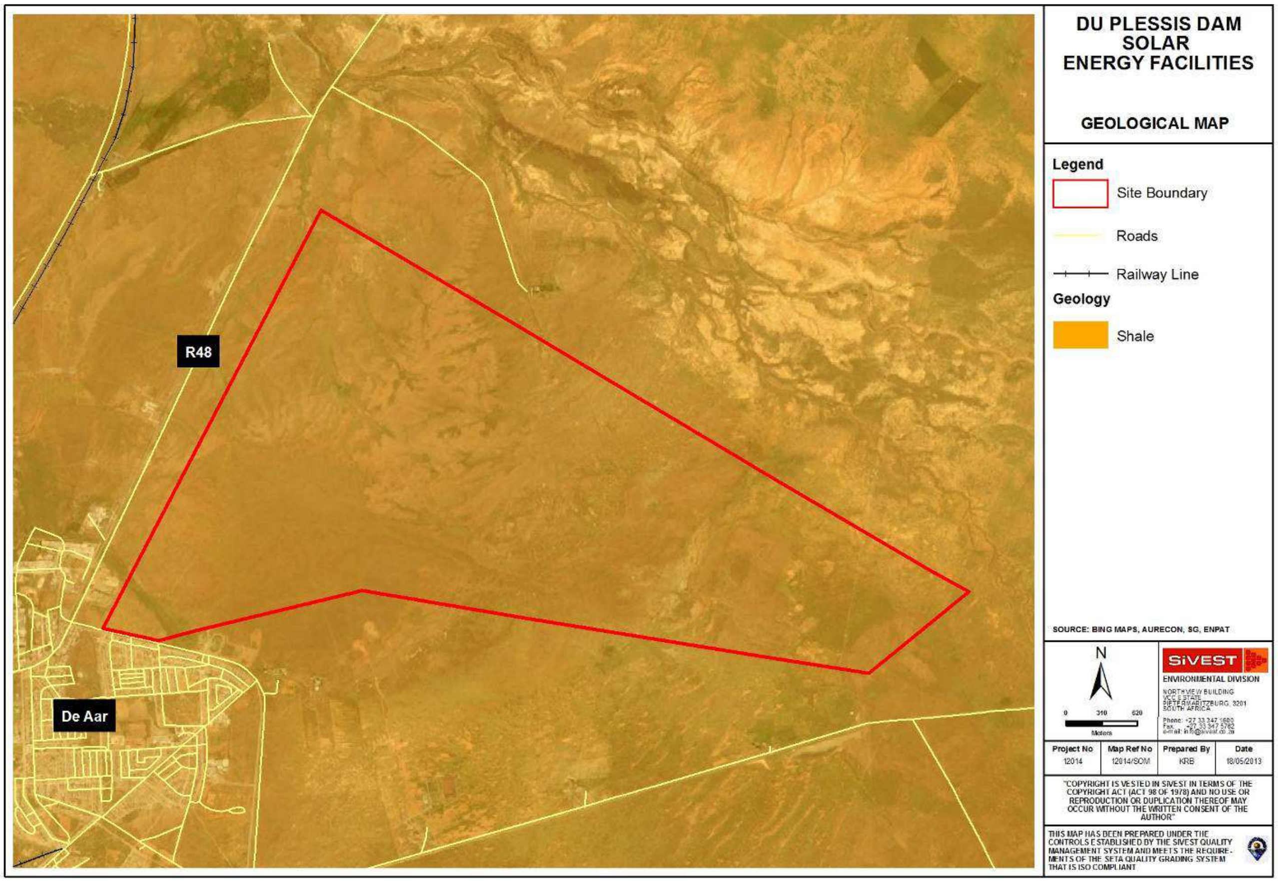


Figure 9: Geological map

3.3 Terrain

Slope or terrain is used to describe the lie of the land. Terrain influences climate, soils characteristics, and thus plays a dominant role in determining whether land is suitable for agriculture. In most cases sloping land is more difficult to cultivate and usually less productive than flatland, and is subject to higher rates of water runoff and soil erosion (**FAO, 2007**).

The study area is characterised by flat and gently sloping topography with an average gradient of less than 5% (**Figure 10**) making this area ideal for intensive agriculture with high potential for large scale mechanisation. From a developmental perspective, the flat topography will also allow for minimal earthworks and site preparation.

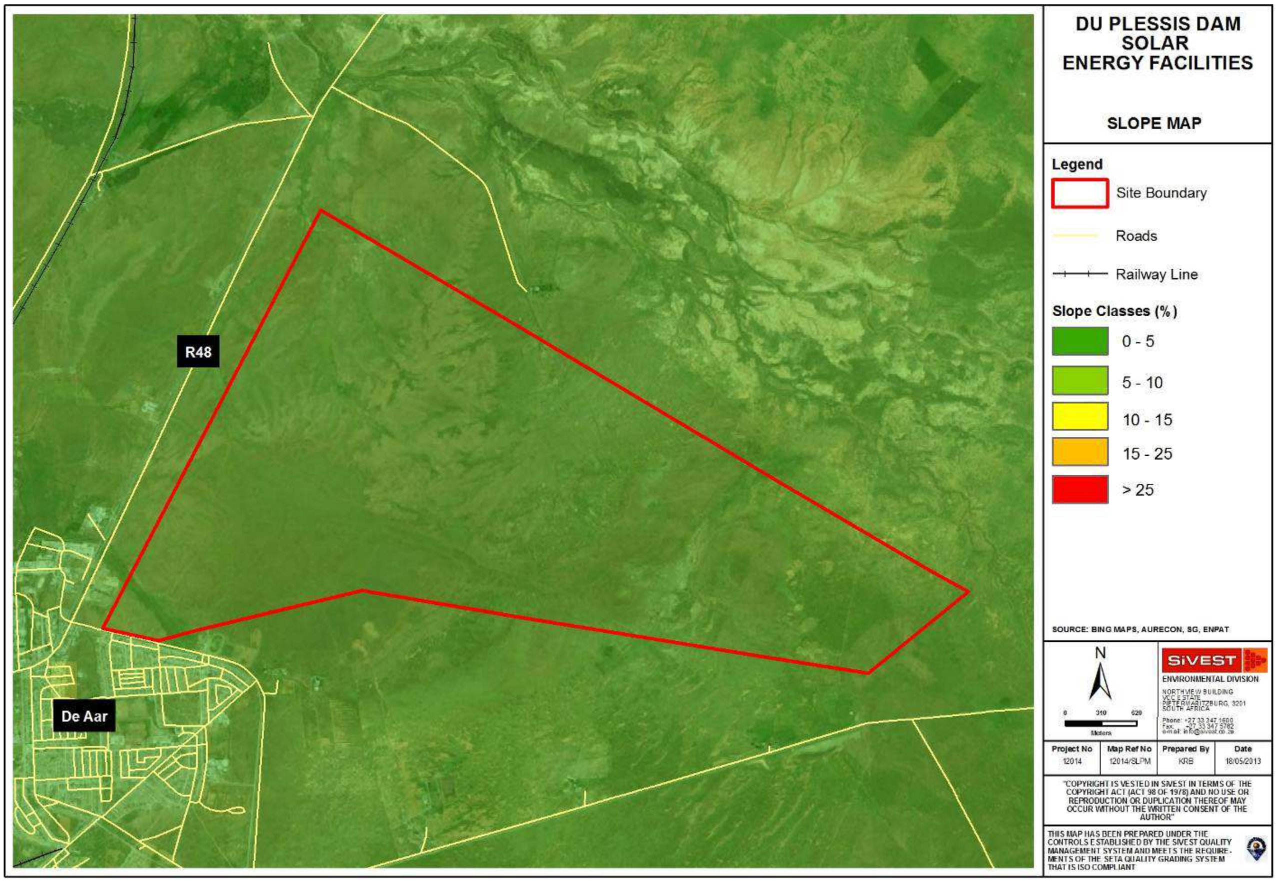


Figure 10: Slope Analysis of the study area

3.4 Land Cover

Mucina and Rutherford (**2006**), classify the site as *Northern Upper Karoo* vegetation type, which forms part of the *Nama-karoo* biome. According to the ENPAT Database and 2010 land cover data, the broad study area consists of a mix of natural veld and unimproved shrub-land which is used as grazing land for sheep, cattle and springbok (**Figure 11**). Vast grazing land is interspersed with incised river channels which flow intermittently and seasonal pans dot the landscape. According to the spatial databases there are no cultivated fields, irrigated lands which could be detrimentally impact upon by the proposed developments. Stocking rates are estimated at 1:4.5 (1 sheep per 4.5 hectares of land) for a small animal unit (sheep) and 1:18 for a large animal unit (cattle).

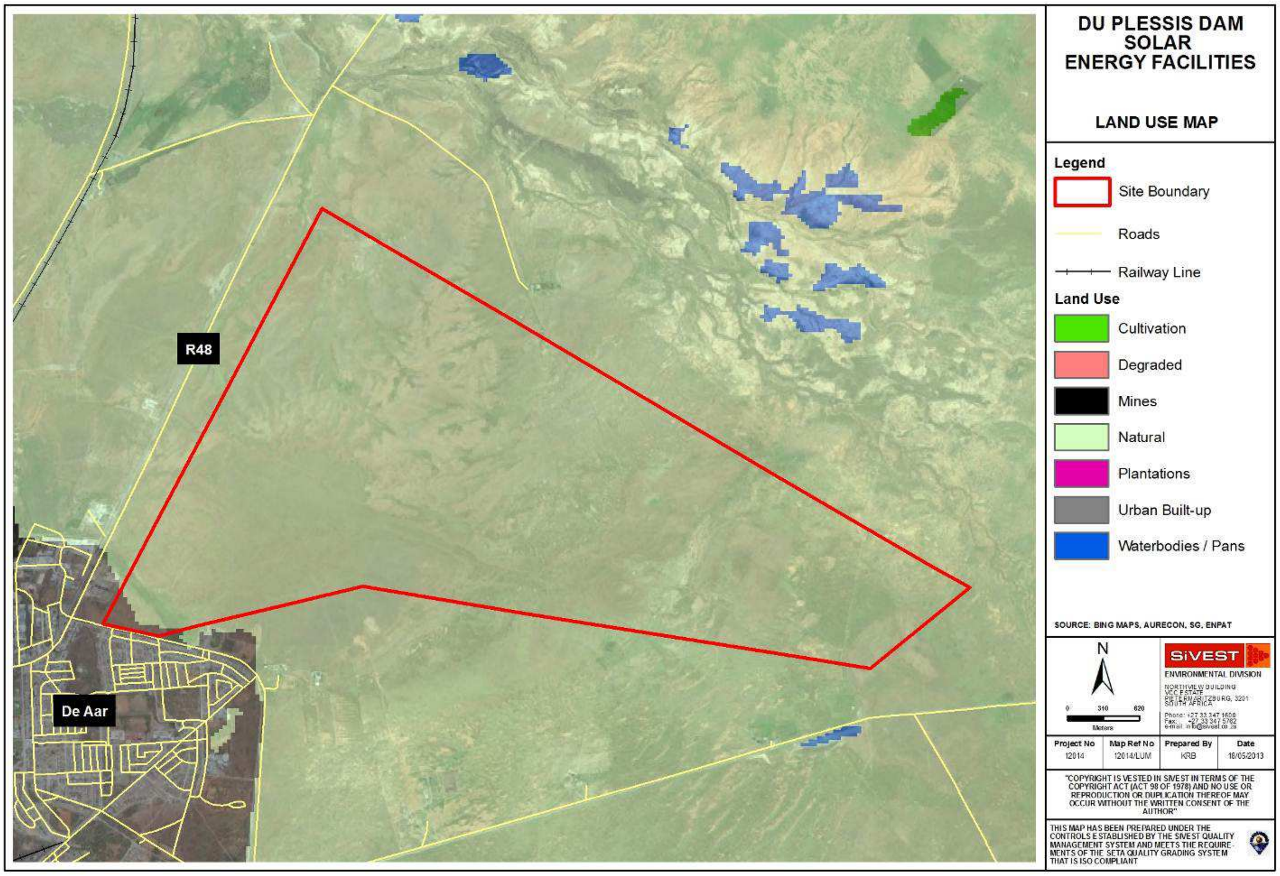


Figure 11: Land Cover Map

3.5 Soil Characteristics

The ENPAT spatial dataset for the Northern Cape Province also provides details pertaining to the broad soil type and approximate agricultural potential for the study area. **Figure 12,** provides a spatial characterisation of the major soil groups which underlie Du Plessis Dam Site. According to this dataset the site are dominated by shallow Red Apedal soils with a high base status. Apedal soils lack well formed peds other than porous micro-aggregates and are weakly structured. Apedal soils tend to be freely drained, and due to overriding climate conditions these soils will tend to be Eutrophic (high base status).

The entire study area is classified as having an effective soil depth, depth to which roots can penetrate the soil, of less than 0.45 m deep which is a limiting factor in terms of sustainable crop production (**Figure 13**).

According to the AGIS database the project area is associated with soils with a moderately low organic matter content (0.6 - 1%) and an average pH of between 7.5 and 8.4 (basic).

The ENPAT Database provides an overview of the study area's agricultural potential based on its soil characteristics, it should be noted this spatial dataset does not take prevailing climate into account. The site is characterised by soils which are not suitable for arable agriculture but remain suitable to grazing (**Figure 14**). A severely restrictive climate rating, due to low rainfall and moisture / heat stress further reduces the agricultural potential of the project area.

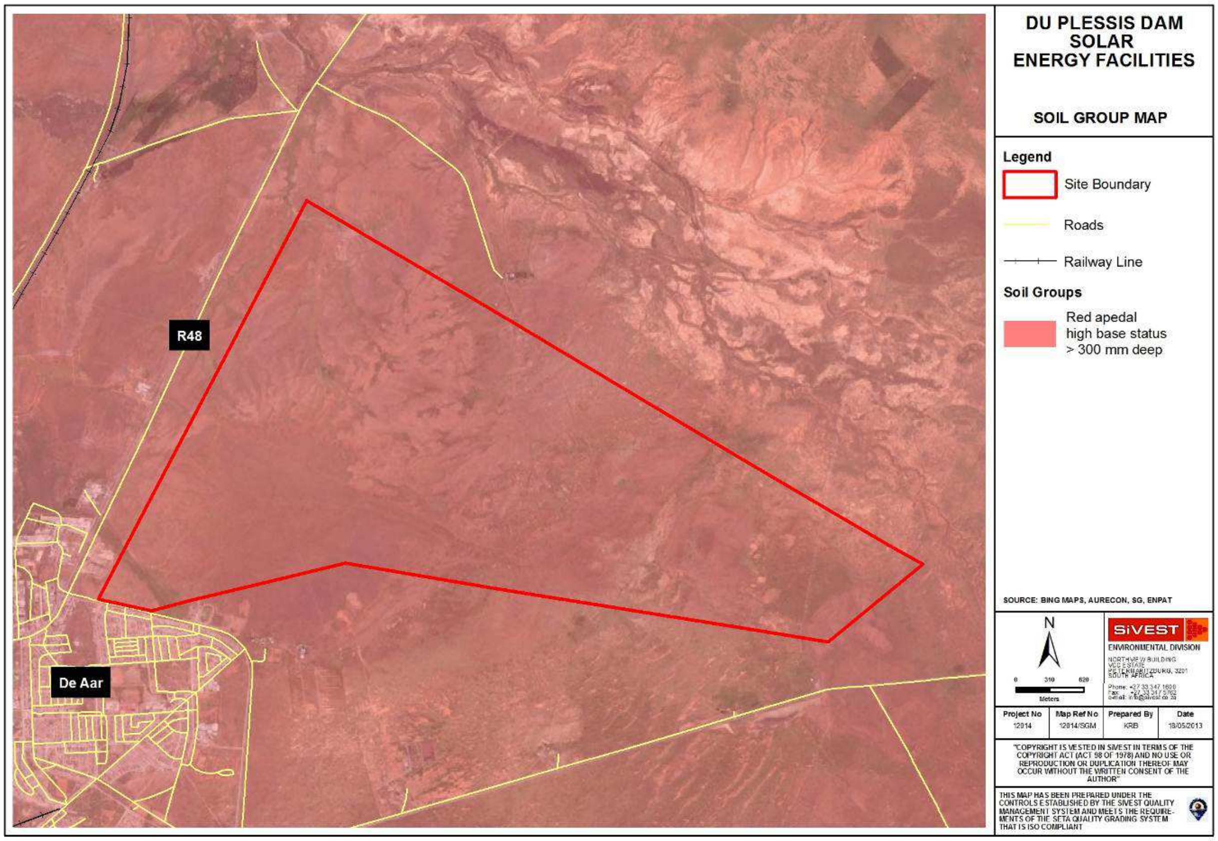


Figure 12: Broad soil type map

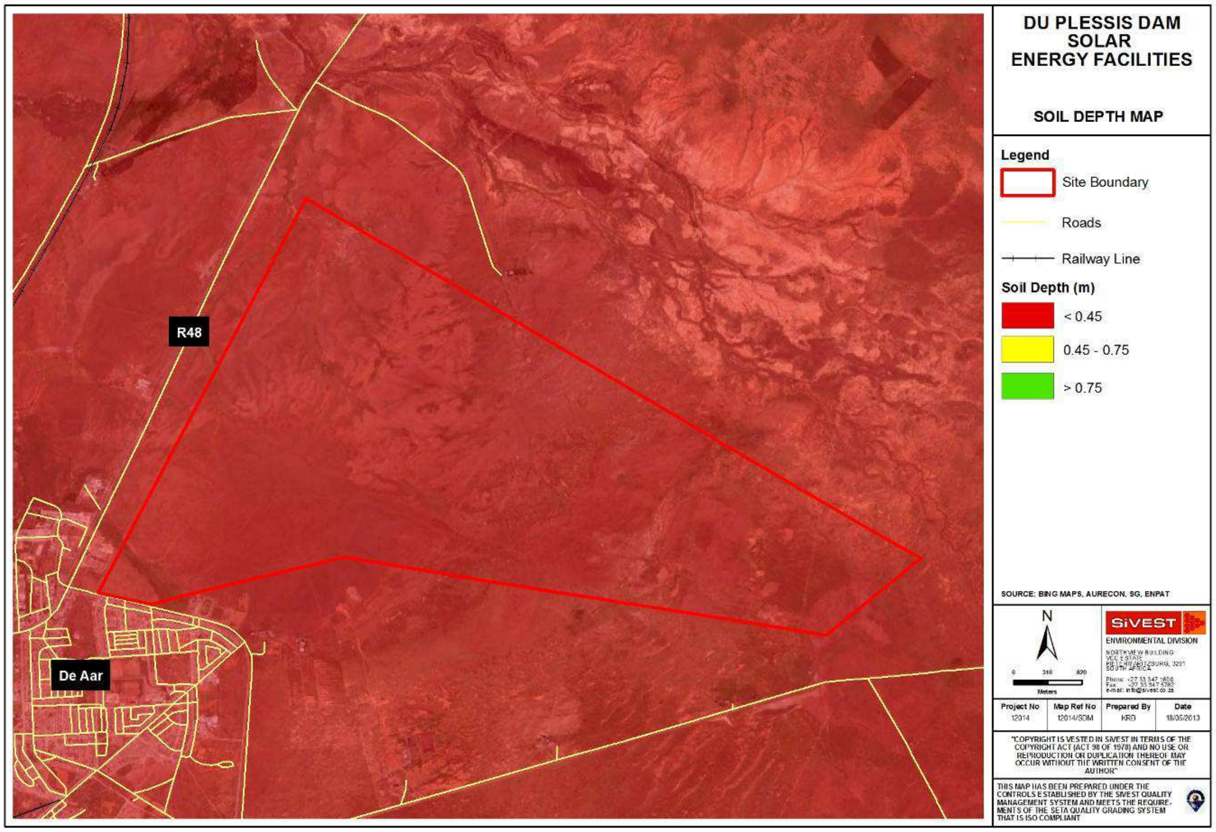


Figure 13: Soil depth map

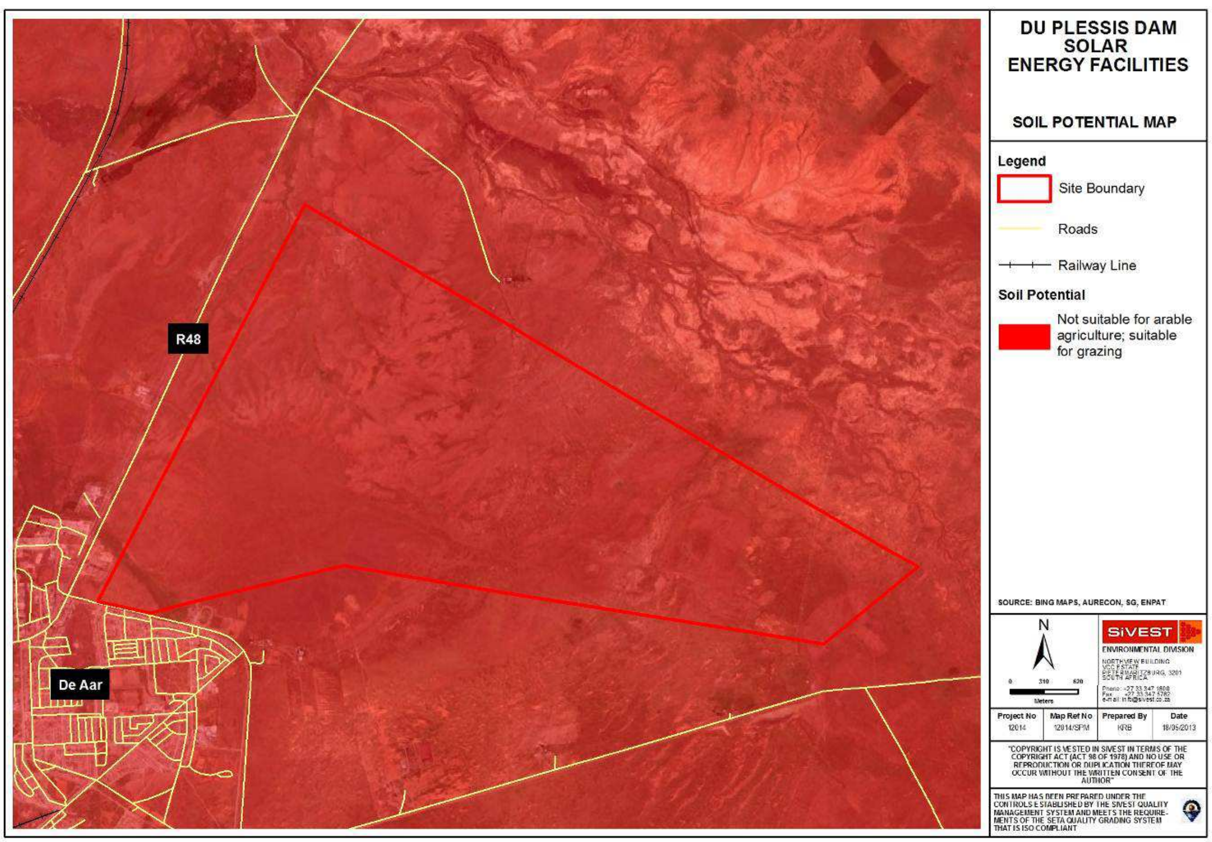


Figure 14: Soil Potential Map

3.6 Desktop Agricultural Assessment: Results Summary

By taking all the site characteristics (climate, geology, land use, slope and soils) into account, the agricultural potential for the majority of the study area is classified as being extremely low for crop production while moderate to moderately low for grazing. This poor agricultural potential rating is primarily due to restrictive climatic characteristics and soil depth limitations. The site is not classified as high potential nor is it a unique dry land agricultural resource.

4. SOIL SURVEY AND FIELD VERIFICATION

A detailed soil survey was undertaken for the Du Plessis Dam Site using a hand auger and GPS to record the location of each of the auger points. At each survey point the soil was described to form and family level according to "Soil Classification - A Taxonomic System for South Africa" (**Soil Classification Working Group, 1991**) and the following properties were noted:

- Estimation of the soils clay content,
- Permeability of upper B horizon,
- Effective rooting depth and pedological depth,
- Limiting layers,
- Soil Colour via the Munsell Soil Colour Charts,
- Signs of wetness,
- Surface rockiness,
- Surface crusting,
- Vegetation cover, and
- Detailed description of the particular area such as slope.

4.1 Soil Descriptions

This Section lists the **major soil forms** encountered during the soil survey along with a site-specific description of each soil form.

4.1.1 Mispah Form

Soil Family: Mostly 1200 (Non bleached, Calcareous), limited bleached and/or non-calcareous
Diagnostic Horizons and Materials:
A-Horizon: Orthic
B-Horizon: Hard Rock

Site Specific Description:
The Mispah soil form falls within the lithic soil group. Lithic soils are associated with shallow soils where parent rock is found close to the soil surface. The Mispah soil form dominates large areas of all three sites. The A-horizon varied from reddish-brown to ivory in colour and was generally 10-20 cm deep, directly overlying various hard rock materials. In many instances surface rocks are clearly visible

(**Figure 15**). Large areas of the site contained non-contiguous bands of Lithocutanic B horizons overlying hard rock which lead to areas being classified as a Mispah / Glenrosa complex.

Land Use Capability:

This soil has low agricultural potential due to the distinct lack of rooting depth and as such these soils are generally utilised for grazing land. If ripped and cultivated however, precise irrigation scheduling is imperative. These soils also exhibit high soil erosion hazard ratings thus soil conservation practices such as minimum tillage and trash blankets should be employed.

Figure 15: Shallow, rocky soils dominate large areas of the Du Plessis Dam Site

4.1.2 Glenrosa Form

Family: Mostly 1212 (A-horizon not bleached, B1 Hard, no signs of wetness and calcareous)
Diagnostic Horizons and Materials:
A-Horizon: Orthic
B-Horizon: Lithocutanic

Site Specific Description:

Like the Mispah soil form, the Glenrosa form falls within the lithic soil group. This soil form is found throughout the surveyed areas where bands of weathering rock are found close to the soil surface. In most cases the Orthic A is approximately 10-20 cm deep and varied from dark brown to red depending on topographic position.

The shallow Orthic A horizon overlies a Lithocutanic B-Horizon, which contains a high proportion of weathering rocks (**Figure 16**). The B-Horizon is generally limiting to plant roots but gaps between the weathering rock fragments can be opened by larger tree roots and thus the land use potential of this soil can be higher than expected. The Lithocutanic B generally contained a high proportion of shale. The Lithocutanic B merges into solid rock layers which are limiting to plant roots and generally found between 20 and 50 cm below the soil surface. Surface rocks were evident across the land surface where this soil form was found. Large portions of the sites contained non-contiguous bands of Lithocutanic B horizons and hard rock which lead to large areas being classified as a Mispah and Glenrosa complex.

Agricultural Potential:

Without careful management or preparation this soil has low agricultural potential as the effective soil depth is approximately 30 cm. If these soils are cultivated, careful irrigation scheduling would be essential. This soil form also exhibits high soil erosion hazard ratings; thus soil conservation practices such as minimum tillage and trash blankets should be employed.

Figure 16: A shallow Glenrosa form encountered on the Du Plessis Dam Site

4.1.3 Swartland Form

Soil Family: Various (Bleached and Non-Bleached A, Calcareous and Non-Calcareous B)
Diagnostic Horizons and Materials:
A-Horizon: Orthic
B-Horizon: Pedocutanic
C-Horizon: Saprolite

Site Specific Description:
The Swartland soil form falls within the duplex soil group whose defining characteristic is the enrichment of clay within the soil profile. Duplex soils are mostly found in the drier parts of South Africa and have in common the development of strong structure in the B-horizon and a marked increase in clay compared to the overlying horizon (**Fey, 2010**). This form was commonly found between rocky outcrops and provided deeper routing than the adjacent soils.

The Orthic A Horizon was generally dark brown to bleached in colour and was weakly structured. This Orthic A horizon overlies a strongly structured B-Horizon, which contains a high proportion of clay due to illuviation. The B-Horizon has a strong cutanic character which has a blocky structure (**Figure 17**). This soil can be classified as duplex in nature and in certain instances the B-Horizon was considered an impediment to root growth and water movement. The pedocutanic merged into weathering rock. Signs of calcium carbonate were often noted in the lower B horizon.

Agricultural Potential:
Duplex soils occur widely in South Africa and present a variety of management factors to farmers and engineers. This soil form, in the context of this assessment, has a moderately low agricultural potential owing to the strongly structured Pedocutanic B and duplex character of the soil horizon which curtail root growth and water movement. This soil form also exhibits high soil erosion hazard ratings; thus soil conservation practices such as minimum tillage and trash blankets should be employed. Then main cause of erosion is clay dispersion which gives rise to surface sealing and intensifies surface runoff. If cultivated the chemical properties of duplex soils will most likely also need attention. This could include sodicity and salinity correction.

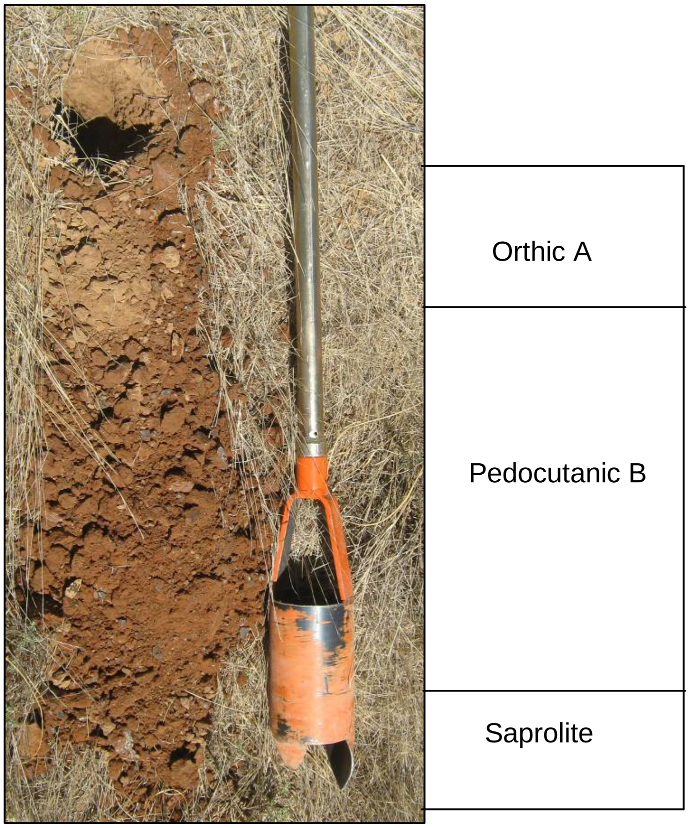


Figure 17: An example of Swartland Soil Form identified on the Du Plessis Dam Site (2121: Bleached, Non-Red B, Medium Coarse angular B, Non-Calcareous)

4.1.4 Coega Form

Family: 2000 (Calcareous A Horizon)
Diagnostic Horizons and Materials:
A-Horizon: Orthic
B-Horizon: Hardpan Carbonate

Site Specific Description:
The Coega form is a calcic soil whose profile contains at least one carbonate-rich horizon. Carbonate retention in the soil profile is a result of an arid climate where evaporation far exceeds rainfall. When encountered on the PDA the A-horizon of this soil form was light brown, thin and calcareous. This Orthic A-horizon overlies a hard pan carbonate which was limiting to plant growth. The surface Hard Pan Carbonate horizon was not contiguous and is concentrated near the western border of the site. The effective soil depth, depth to which roots can penetrate the soil, was generally less than 0.2 m (**Figure 18**).

Agricultural Potential:
Calcic soils are associated with arid regions and thus the use of these carbonate rich soils in South Africa is limited. Limitations in terms of sustainable agricultural use include shallow rooting depth, high pH, high salinity and low Phosphorus available for plant utilisation (**Fey, 2010**). Such limitations restrict calcic soils to extensive grazing unless irrigation is available. These soils also exhibit high soil erosion

hazard ratings thus soil conservation practices such as minimum tillage and trash blankets should be employed.

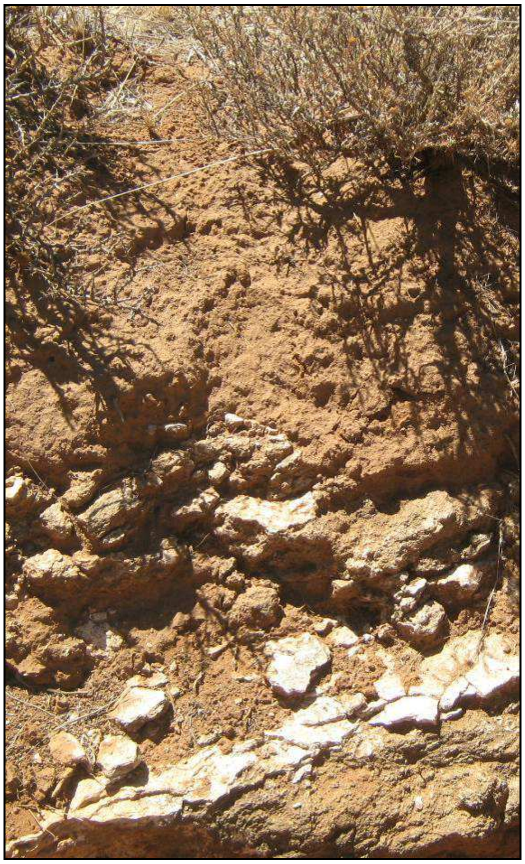


Figure 18: An example of a Shallow calcic soil

4.2 Soil Summary

The soils identified on the Du Plessis Dam Site are predominantly shallow and rocky with a low agricultural potential. Rocky soils (Mispah and Glenrosa Forms) cover 71% of the surveyed area (**Figure 20**) while shallow duplex soils (Swartland) cover 24%. Most soils contained a layer that was limiting to plant growth and these layers included rock, saprolite, hard pan carbonate and strongly structured cutanic horizons.

The location and description of the sample points are provided in **Appendix A: Soil Properties**. This information was used to create a verified soil map showing homogeneous soil bodies for on the Du Plessis Dam Site (**Figure 19**). Combining the effective depth information (i.e. depth to root limiting layer) and Inverse Distance Weighting one is able to obtain a generalised soil depth for the PDA (**Figure 21**). Soils with an effective depth of greater than 50 cm were rarely observed during the soil survey.

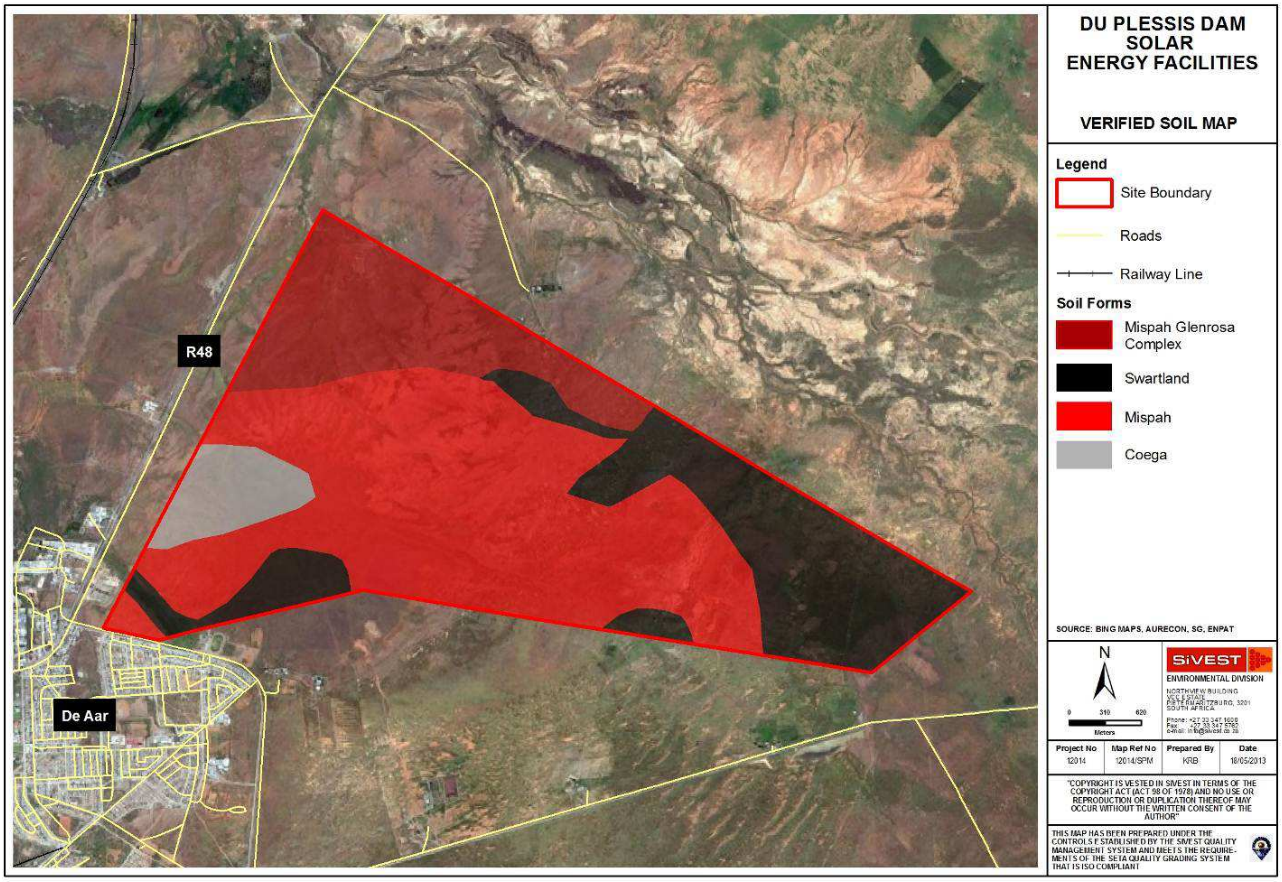


Figure 19: Verified Soil Map for Du Plessis Dam Farm

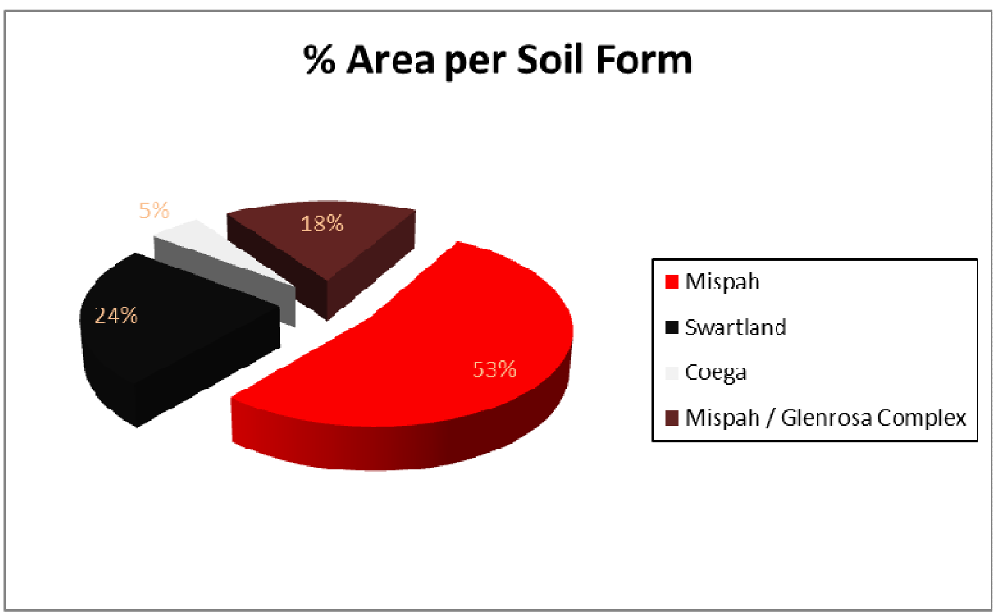


Figure 20: Graph showing the percentage area per soil form

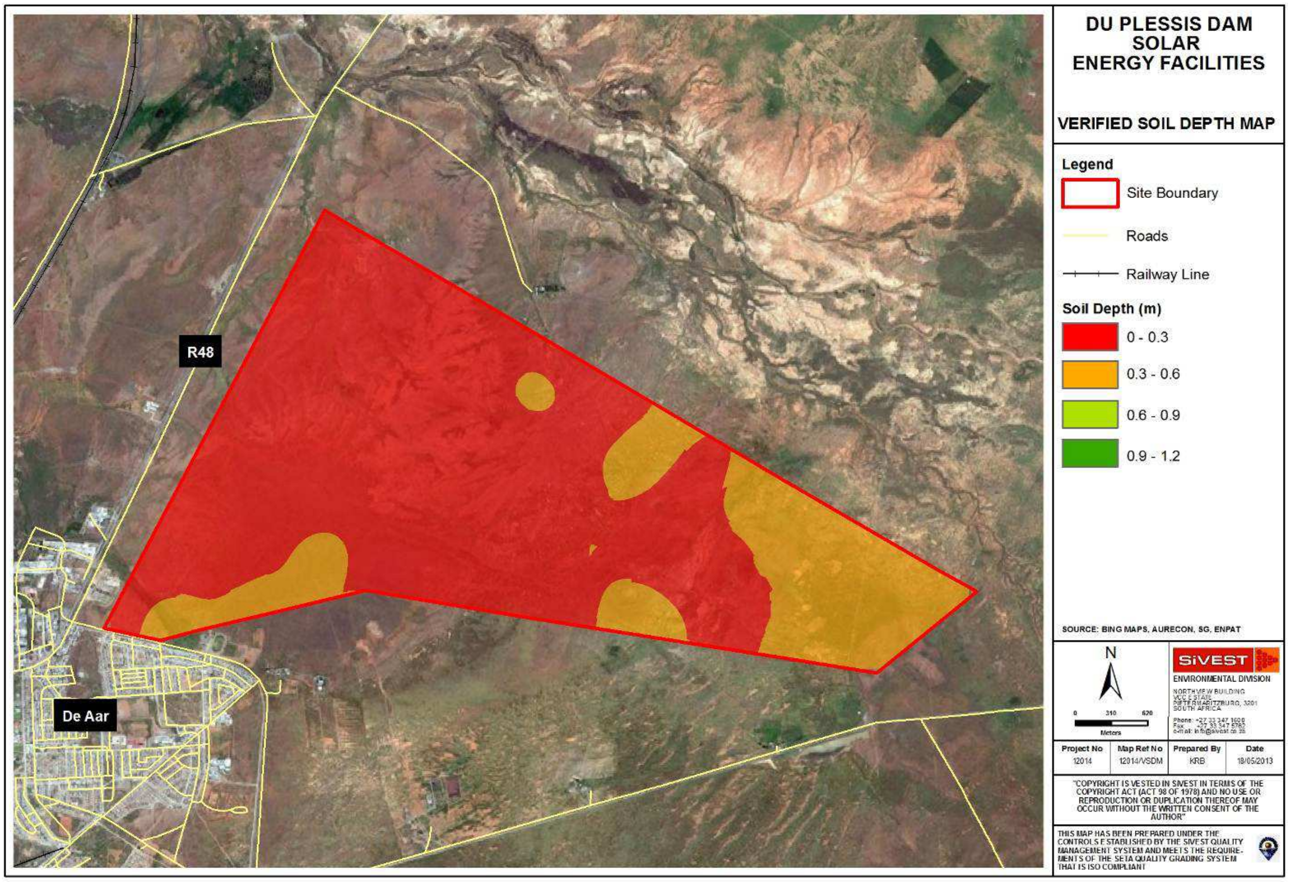


Figure 21: Verified Soil Depth Map

5. AGRICULTURAL POTENTIAL ASSESSMENT

In terms of this study, agricultural potential is described as an area's suitability and capacity to sustainably accommodate an agricultural land use with this potential being benchmarked against crop production.

5.1 Current Situation

The Du Plessis Dam Site is zoned as agricultural land, and is currently used as extensive grazing land for cattle production (**Figure 20**). Stocking rates are estimated at around 1 SSM (small stock unit) per 4.5 hectares and 1 LSU (large stock unit) per 18 hectares. The site does not currently accommodate any centre pivots, irrigation schemes or active agricultural fields. Urban expansion and the increasing rate of stock theft are increasing pressure on the productivity and sustainability of this farm unit. The evidence for this is that many of the farms in close proximity to De Aar have abandoned small stock farming in favour of game and in this case beef production.

5.2 Verified Agricultural Potential

Overall agricultural potential of the site is based on assessing a number of inter-related factors including climate, topography, soil type, soil limitations and current land use. The overriding climate is the major limiting factor for the site. The combination of low rainfall and an extreme moisture deficit means that sustainable arable agriculture generally cannot take place without some form of irrigation. The site does not contain and is not bounded by a reliable surface water irrigation resource, and the use of borehole water for this purpose does not seem agriculturally and economically feasible. This is due to the current human pressure on borehole water, the expense of using borehole water as a source of irrigation and the brackish nature of the local groundwater resources.

The project area is characterised by flat undulating topography with an average gradient of less than 5%. The soils identified on the PDA are predominantly shallow and rocky with a low agricultural potential. Rocky soils (Mispah and Glenrosa Forms) cover 71% of the surveyed area while shallow duplex soils (Swartland) cover 24%. Most soils contained a layer that was limiting to plant growth and these layers included rock, saprolite, hard pan carbonate and strongly structured cutanic horizons.

A map indicating the agricultural potential in terms of **crop production** for the Du Plessis Dam Farm is provided in **Figure 22**. The majority of the site has been classified as having low potential for crop production due to an arid climate and highly restrictive soil characteristics. The site is not classified as high potential, nor is it a unique dry land agricultural resource. The physical and chemical limitations associated with the dominant forms restrict these soils to extensive and low density grazing land. The site is considered to have a moderate to moderately low value when utilised as grazing land, which is its current use.

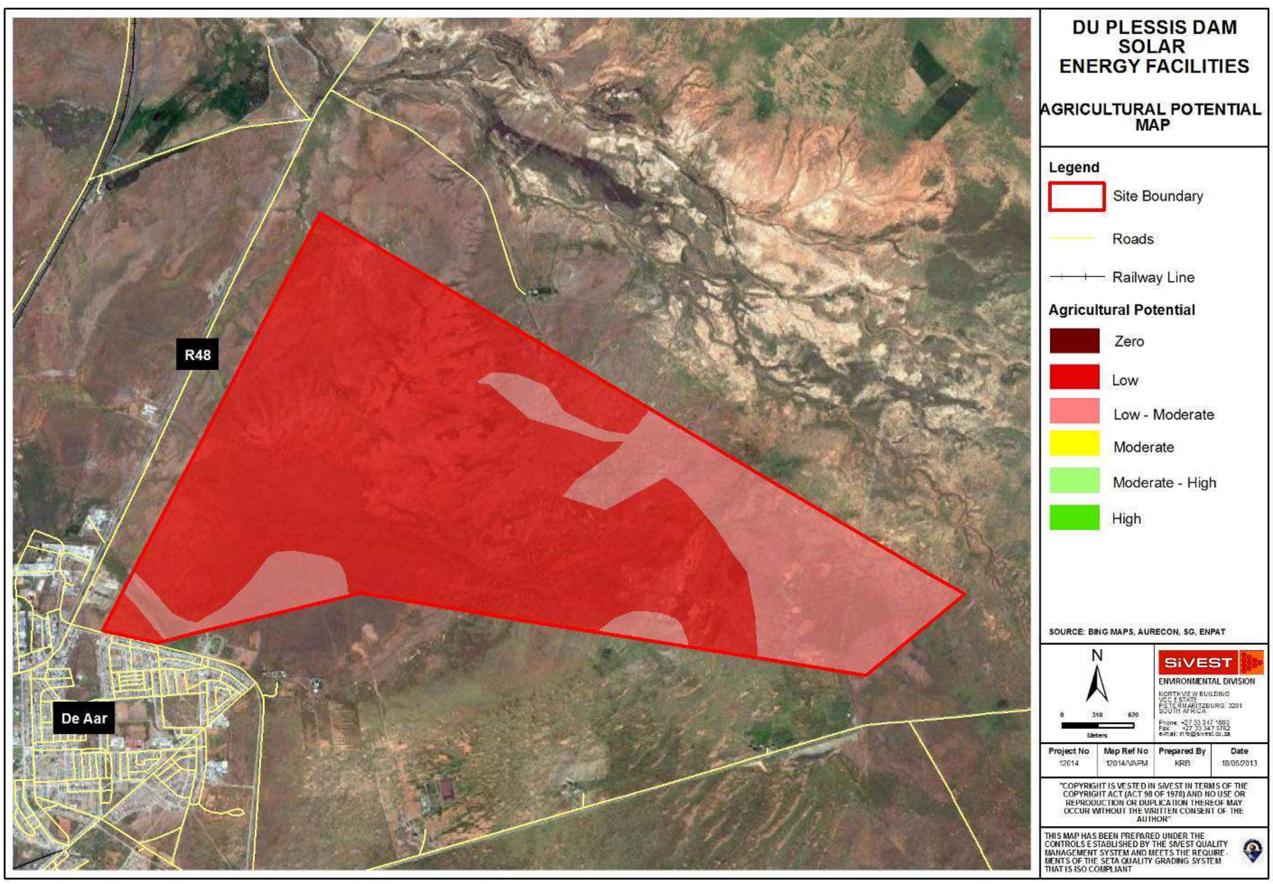


Figure 22: Agricultural Potential Map

6. AGRICULTURAL IMPACT ASSESSMENT

From an agricultural perspective the loss of high value farm land and / or food security production, as a result of the proposed activities, is the primary concern of this assessment. In South Africa there is a scarcity of high potential agricultural land, with less than 14% of the total area being suitable for dry land crop production (**Smith, 2006**). Consequently areas which can sustainably accommodate dry land production need to be protected from non-agricultural land uses. The desktop assessment, field verification and agricultural potential assessment (**Sections 3, 4 and 5**) has already shown that the study area is unsuitable for crop production and is dominated by unimproved grazing land[1].

The results of agricultural assessment indicate that the Du Plessis Dam Farm has low agricultural value and is replaceable when assessed within the context of the proposed development. Consequently, the overall impact of the Solar Energy Facility on the study area's agricultural potential and production will be low, due to the site's low inherent agricultural potential and value. There are no centre pivots, irrigation schemes or active agricultural fields which will be influenced by the proposed development. As such, when considering the agricultural assessment as a standalone specialist study, there are no problematic or fatal flaw areas for the proposed solar energy facilities.

[1] Unimproved grazing land can be defined as areas of veld which are in a relatively natural condition and which have not been previously cultivated or physically/chemically improved for agricultural purposes.

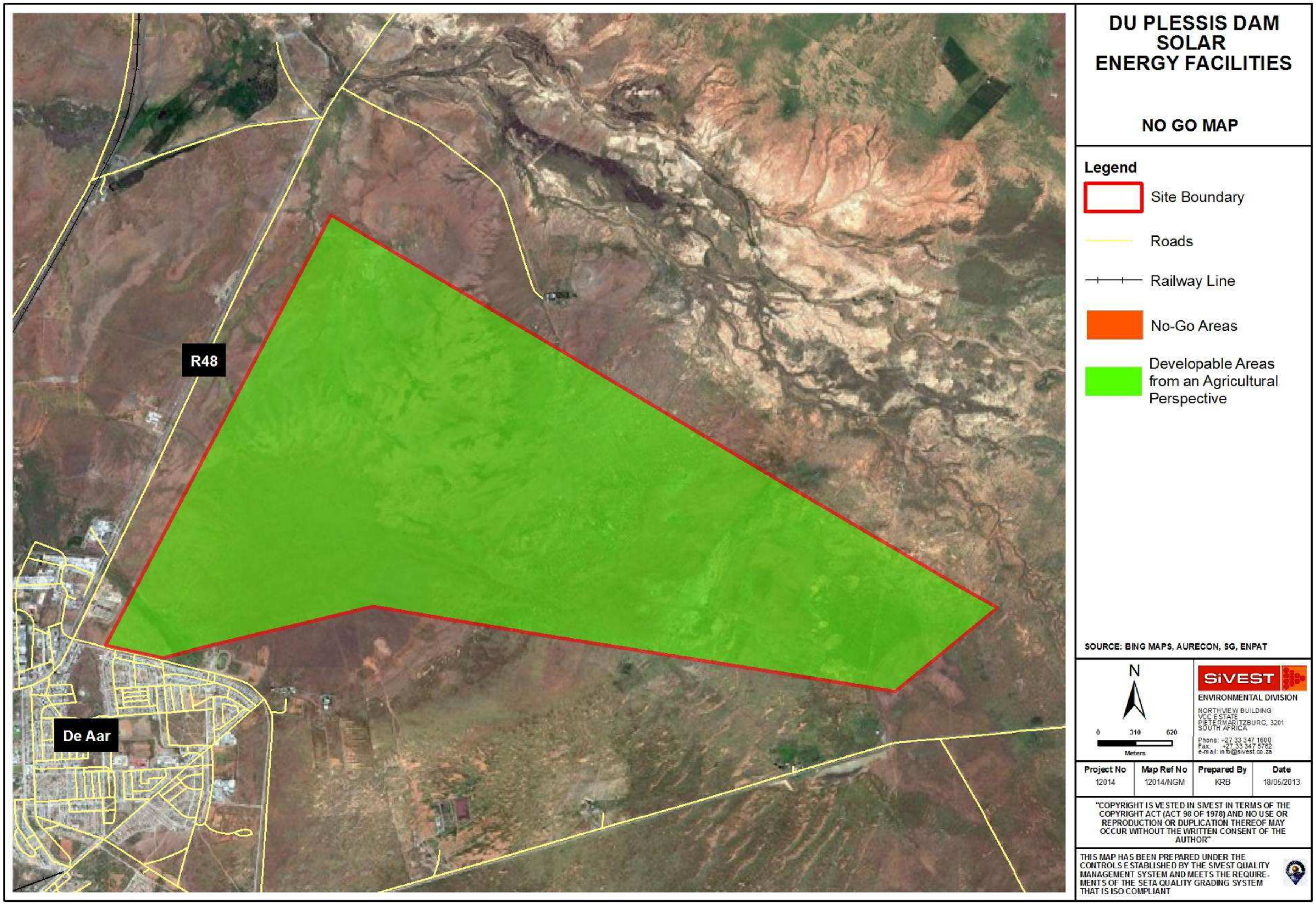


Figure 23: No Go Map (Agriculture)

6.1 Impact of the proposed PV solar facilities

6.1.1 Construction Phase

The proposed development's primary impact on agricultural activities includes the construction of the solar fields and associated infrastructure, which entails the clearing of vegetation and levelling of the site. This will effectively eliminate the impacted land's agricultural potential in terms of crop production (or in this case grazing) during the construction phase, which is estimated to last between 12 and 24 months per PV facility. The construction of the solar fields will influence a portion of each of the farms total area. The remaining land will continue to function as it did, prior to the development. Furthermore, facilities on the farm will be phased and constructed consecutively, depending on whether the projects are approved by the DoE and DEA (**Aurecon, 2013**). Stocking rates will need to be temporarily reduced during the construction phase in order to reduce the risk of overgrazing the remaining un-impacted areas. The footprint of each proposed PV facility is summarised below and illustrated in **Figure 4**.

Table 3: Summary of the 3 PV Facilities and Alternatives on Du Plessis Dam Farm (**Aurecon, 2013**)

Layout Alternatives	Facility	Individual Footprint (ha)	Cumulative Footprint (ha) and Remaining land (ha)	Capacity (MW)	Mid-Point Co-Ordinates
1	PV 2	273	859 (377)	75	30°38'11.38"S; 24° 4'22.75"E
1	PV 3	212		75	30°37'53.03"S; 24° 3'28.26"E
1	PV 4	374		75	30°37'27.44"S; 24° 2'31.14"E
2	Extended PV 1	1000	1000 (236)	400	30°37'51.78"S; 24°3'14.27"E

6.1.2 Operational Phase

After construction the land will need to be rehabilitated, including the re-vegetation of the solar fields. It is recommended that more palatable grass species are planted to enable faster stocking initiation. Pertinent plant species should be obtained from a vegetation specialist when the site specific EMP is compiled. It is unlikely that typical vegetation species (Karoo shrubs) will return to the PV fields. The shading of the panels could also influence the vegetation pattern within the PV fields.

In order to further mitigate the potential impacts it is highly recommended that periodic grazing within the PV fields is allowed. This mitigation minimizes the loss of grazing land and reduces the overall impact on agricultural production. Interestingly, the farmers around De Aar have changed from sheep to beef production due to the high prevalence of stock theft. Unfortunately, cattle grazing will not be permitted within the PV fields as the animals could damage the PV panels. In order to overcome this limitation, it is recommended that the farms convert back to sheep production and use the proposed PV facilities as rotational grazing camps. The problem of small stock theft should be mitigated by the additional security and fencing associated with the PV facilities.

A simplified and generic phased construction approach and related mitigations are illustrated in **Figure 24**, where

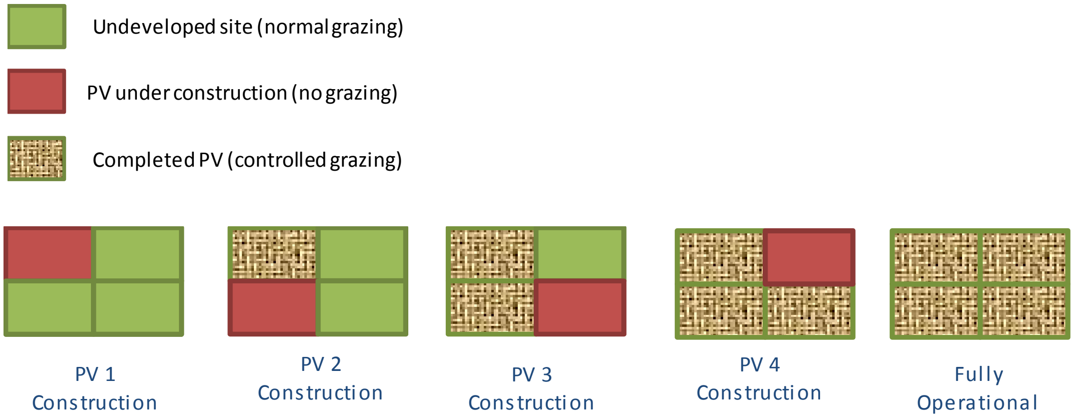


Figure 24: The proposed phased construction approach and grazing schedule (This simplified example is based on the construction of 4 PV facilities but can be adapted to any number of proposed PV facilities)

6.1.3 Cumulative Impacts

A number of solar and renewable energy projects have been proposed in the De Aar area, and thus, the cumulative impact of these developments on surrounding farms could become detrimental to local agricultural resources if the loss of usable grazing land is not taken into account when determining optimum herd size. A phased approach in combination with erosion control and land rehabilitation, within each farm, will reduce this impact. The inherently low agricultural potential of the region also reduces the overall cumulative impact.

6.2 Impact of the Transmission Line and Associated Infrastructure

Three new 132 kV transmission line will be constructed in order to connect the new solar PV facilities to the Eskom grid. Two routing alternatives have been proposed. According to spatial Land Use data and in-field verification, these routes are dominated by vacant land and peri-urban land uses. Owing to this, the crossing of this land by these power lines will have a very limited impact on agricultural production. Where the lines do cross farm land normal grazing can still take place under the power lines. The only loss of agricultural land will be directly below the tower's footprint. In terms of line routing, there is no significant variance between agricultural characteristics within the assessment corridor and as such, from an agricultural perspective, the lines may be routed anywhere within this corridor.

Due to spatial extent and impacts associated with the remaining supporting infrastructure, *inter alia* road and water pipe line construction, it is envisioned that this supporting will a negligible impact on agricultural resources and production.

6.3 Determination of Impact Significance: Methodology

Significance is determined through a synthesis of impact characteristics which include the context and the intensity of an impact. Context refers to the geographical scale (i.e. site, local, national or global) whereas Intensity is defined by the severity of the impact (e.g. the magnitude of deviation from background or baseline conditions, the size of the area affected, the duration of the impact and the overall probability of occurrence). Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The total number of points scored for each impact indicates the level of significance of the impact. The rating system used in this assessment is based on **Aurecon's Methodology** and is summarised below:

For each impact, the EXTENT (spatial scale), MAGNITUDE and DURATION (time scale) would be described. These criteria would be used to ascertain the SIGNIFICANCE of the impact, firstly in the case of no mitigation and then with the most effective mitigation measure(s) in place.

The tables below indicate the scale used to assess these variables, and defines each of the rating categories.

Table 4: Assessment criteria for the evaluation of impacts

CRITERIA	CATEGORY	DESCRIPTION
Extent or spatial influence of impact	**Regional**	Beyond a 10 km radius of the candidate site.
	Local	Within a 10 km radius of the candidate site.
	Site specific	On site or within 100 m of the candidate site.
Magnitude of impact (at the indicated spatial scale)	**High**	Natural and/ or social functions and/ or processes are *severely* altered
	Medium	Natural and/ or social functions and/ or processes are *notably* altered
	Low	Natural and/ or social functions and/ or processes are *slightly* altered
	Very Low	Natural and/ or social functions and/ or processes are *negligibly* altered
	Zero	Natural and/ or social functions and/ or processes remain *unaltered*

CRITERIA	CATEGORY	DESCRIPTION
Duration of impact	**Construction period**	Up to 4 years if PV facilities is constructed consecutively
	Short Term	Up to 5 years after construction
	Medium Term	5-15 years after construction
	Long Term	More than 15 years after construction

The SIGNIFICANCE of an impact is derived by taking into account the temporal and spatial scales and magnitude. The means of arriving at the different significance ratings is explained in **Table 5**.

Table 5: Definition of significance ratings

SIGNIFICANCE RATINGS	LEVEL OF CRITERIA REQUIRED
High	• High magnitude with a regional extent and long term duration • High magnitude with either a regional extent and medium term duration or a local extent and long term duration • Medium magnitude with a regional extent and long term duration
Medium	• High magnitude with a local extent and medium term duration • High magnitude with a regional extent and construction period or a site specific extent and long term duration • High magnitude with either a local extent and construction period duration or a site specific extent and medium term duration • Medium magnitude with any combination of extent and duration except site specific and construction period or regional and long term • Low magnitude with a regional extent and long term duration
Low	• High magnitude with a site specific extent and construction period duration • Medium magnitude with a site specific extent and construction period duration • Low magnitude with any combination of extent and duration except site specific and construction period or regional and long term • Very low magnitude with a regional extent and long term duration
Very low	• Low magnitude with a site specific extent and construction period duration • Very low magnitude with any combination of extent and duration except regional and long term
Neutral	• Zero magnitude with any combination of extent and duration

Once the significance of an impact has been determined, the PROBABILITY of this impact occurring as well as the CONFIDENCE in the assessment of the impact, would be determined using the rating systems outlined in **Table 6** and **Table 7** respectively. It is important to note that the significance of an impact should always be considered in concert with the probability of that impact occurring. Lastly, the REVERSIBILITY of the impact is estimated using the rating system outlined in **Table 8**.

Table 6: Definition of probability ratings

PROBABILITY RATINGS	CRITERIA
Definite	Estimated greater than 95 % chance of the impact occurring.
Probable	Estimated 5 to 95 % chance of the impact occurring.
Unlikely	Estimated less than 5 % chance of the impact occurring.

Table 7: Definition of confidence ratings

CONFIDENCE RATINGS	CRITERIA
Certain	Wealth of information on and sound understanding of the environmental factors potentially influencing the impact.

Sure	Reasonable amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact.
Unsure	Limited useful information on and understanding of the environmental factors potentially influencing this impact.

Table 8: Definition of reversibility ratings

REVERSIBILITY RATINGS	CRITERIA
Irreversible	The activity will lead to an impact that is in all practical terms permanent.
Reversible	The impact is reversible within 2 years after the cause or stress is removed.

6.4 Impact Summaries: Solar Energy Facilities

This impact summary investigates the construction, operational and decommissioning phases of the two Layout Alternatives tabled for Du Plessis Dam Farm.

Table 9: Impact rating table for the loss of agricultural land and degradation of soil resources during the construction phase (**Solar Energy Facility: Layout Alternative 1: PV 2, 3 and 4**)

Layout Alternative 1: Construction Phase		
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	**Site specific**	**Site specific**
Magnitude	**Med**	**Low**
Duration	**Construction**	**Construction**
Significance rating	**Low**	**Low**
Probability	**Definite**	**Definite**
Confidence	**Sure**	**Sure**
Reversibility	**Irreversible**	**Reversible**
Mitigation measures	▪ A planned phased approach must be adopted. ▪ Allow normal agricultural activities to continue in unaffected areas. ▪ Stocking rates will need to be temporarily reduced during the construction phase in order to reduce the risk of overgrazing the remaining land portions. ▪ Initiate land rehabilitation and re-vegetation as soon as possible. ▪ Due to the overarching site characteristics, and the nature of the proposed development, the remaining viable mitigation measures are limited and will most likely revolve around erosion control: ➢ The soil erosion plan and associated recommendations should	

	be employed. ➢ Clearing activities should be kept to a minimum. ➢ In the unlikely event that heavy rains are expected, activities should be put on hold to reduce the risk of erosion. ➢ If additional earthworks are required, any steep or large embankments that are expected to be exposed during the 'rainy' months should be armoured with fascine like structures. A fascine structure usually consists of a natural wood material and is used for the strengthening of earthen structures or embankments. ➢ If earth works are required then storm water control and wind screening should be undertaken to prevent soil erosion.

Table 10: Impact rating table for the loss of agricultural land and degradation of soil resources during the construction phase (**Solar Energy Facility: Layout Alternative 2: PV 1)**

Layout Alternative 2: Construction Phase		
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	**Site specific**	**Site specific**
Magnitude	**Med**	**Med**
Duration	**Construction**	**Construction**
Significance rating	**Low**	**Low**
Probability	**Definite**	**Definite**
Confidence	**Sure**	**Sure**
Reversibility	**Irreversible**	**Reversible**
Mitigation measures	▪ Allow normal agricultural activities to continue in unaffected areas. ▪ Stocking rates will need to be temporarily reduced during the construction phase in order to reduce the risk of overgrazing the remaining land portions. ▪ Initiate land rehabilitation and re-vegetation as soon as possible. ▪ Due to the overarching site characteristics, and the nature of the proposed development, the remaining viable mitigation measures are limited and will most likely revolve around erosion control: ➢ The soil erosion plan and associated recommendations should be employed. ➢ Clearing activities should be kept to a minimum. ➢ In the unlikely event that heavy rains are expected, activities should be put on hold to reduce the risk of erosion. ➢ If additional earthworks are required, any steep or large embankments that are expected to be exposed during the 'rainy' months should be armoured with fascine like structures.	

	A fascine structure usually consists of a natural wood material and is used for the strengthening of earthen structures or embankments. ➢ If earth works are required then storm water control and wind screening should be undertaken to prevent soil erosion.

Table 11: Impact rating table for the loss of agricultural land and degradation of soil resources during the operational phase (**Solar Energy Facility: Layout Alternative 1: PV 2, 3 and 4**)

Layout Alternative 1: Operational Phase		
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	**Site specific**	**Site specific**
Magnitude	**Medium**	**Very Low**
Duration	**Long Term**	**Long Term**
Significance rating	**Medium**	**Very Low**
Probability	**Definite**	**Definite**
Confidence	**Sure**	**Sure**
Reversibility	**Irreversible**	**Reversible**
Mitigation measures	▪ Initiate land rehabilitation and re-vegetation as soon as possible and continue to monitor land degradation. ▪ It is recommended that more palatable species form part of the re-vegetation plan to enable faster stocking initiation. Pertinent plant species should be obtained from a vegetation specialist when the site specific EMP is compiled. ▪ Allow normal agricultural activities to continue in unaffected areas. ▪ Allow periodic grazing within the PV fields (sheep and wildlife). This mitigation will minimise the loss of grazing land and reduce the impact on agricultural production. ▪ Unfortunately cattle grazing will not be permitted within the PV fields as the animals could damage the PV panels. In order to overcome this limitation it is recommended that the farms convert back to sheep production and use the proposed PV facilities as rotational grazing camps.	

Table 12: Impact rating table for the loss of agricultural land / production and degradation of soil resources during the operational phase **(Solar Energy Facility: Layout Alternative 2: PV 1)**

Layout Alternative 2: Operational Phase		
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	**Site specific**	**Site specific**
Magnitude	**Medium**	**Very Low**
Duration	**Long Term**	**Long Term**
Significance rating	**Medium**	**Very Low**
Probability	**Definite**	**Definite**
Confidence	**Sure**	**Sure**
Reversibility	**Irreversible**	**Reversible**
Mitigation measures	▪ Initiate land rehabilitation and re-vegetation as soon as possible and continue to visually monitor land for early detection of degradation. ▪ It is recommended that more palatable species form part of the re-vegetation plan to enable faster stocking initiation. Pertinent plant species should be obtained from a vegetation specialist when the site specific EMP is compiled. ▪ Allow normal agricultural activities to continue in unaffected areas. ▪ Allow periodic grazing within the PV fields (sheep and wildlife). This mitigation will minimise the loss of grazing land and reduce the impact on agricultural production. ▪ Unfortunately cattle grazing will not be permitted within the PV fields as the animals could damage the PV panels. In order to overcome this limitation it is recommended that the farms convert back to sheep production and use the proposed PV facilities as rotational grazing camps.	

Table 13: Impact rating table for soil disturbance and temporary disturbance to grazing regime during the decommissioning phase (**Solar Energy Facility: Layout Alternative 1: PV 2, 3 and 4)**

Layout Alternative 1: Decommissioning Phase		
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	**Site specific**	**Site specific**
Magnitude	**Very Low**	**Very Low**
Duration	**Construction**	**Construction**

Significance rating	**Very Low**	**Very Low**
Probability	**Definite**	**Definite**
Confidence	**Sure**	**Sure**
Reversibility	**Reversible**	**Reversible**
Mitigation measures	▪ A planned phased approach must be adopted. ▪ Allow normal agricultural activities to continue in unaffected areas. ▪ Initiate land rehabilitation as soon as possible. ▪ Due to the overarching site characteristics, and the nature of the proposed activities, the remaining viable mitigation measures are limited and will most likely revolve around erosion control: ➢ The soil erosion plan and associated recommendations should be employed. ➢ Clearing activities should be kept to a minimum. ➢ In the unlikely event that heavy rains are expected, activities should be put on hold to reduce the risk of erosion.	

Table 14: Impact rating table for soil disturbance and temporary disturbance to grazing regime during the decommissioning phase (**Solar Energy Facility: Layout Alternative 2: PV 1)**

Layout Alternative 2: Decommissioning Phase		
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	**Site specific**	**Site specific**
Magnitude	**Medium**	**Very Low**
Duration	**Long Term**	**Long Term**
Significance rating	**Medium**	**Very Low**
Probability	**Definite**	**Definite**
Confidence	**Sure**	**Sure**
Reversibility	**Irreversible**	**Reversible**
Mitigation measures	▪ A planned phased approach must be adopted. ▪ Allow normal agricultural activities to continue in unaffected areas. ▪ Initiate land rehabilitation as soon as possible. ▪ Due to the overarching site characteristics, and the nature of the proposed activities, the remaining viable mitigation measures are limited and will most likely revolve around erosion control: ➢ The soil erosion plan and associated recommendations should be employed. ➢ Clearing activities should be kept to a minimum. ▪ In the unlikely event that heavy rains are expected, activities should	

	be put on hold to reduce the risk of erosion.

Table 15: Impact rating table for the predicted cumulative loss of agricultural land and degradation of soil resources

Cumulative Impacts		
	Pre-mitigation impact rating	Post mitigation impact rating
Extent	**Regional**	**Regional**
Magnitude	**Low**	**Very Low**
Duration	**Long Term**	**Long Term**
Significance rating	**Medium**	**Low**
Probability	**Probable**	**Probable**
Confidence	**Unsure**	**Unsure**
Reversibility	**Reversible**	**Reversible**
Mitigation measures	▪ A planned phased approach must be adopted. ▪ Allow normal agricultural activities to continue in unaffected areas. ▪ Initiate land rehabilitation and re-vegetation as soon as possible and continue to monitor land for early signs of degradation and erosion.	

6.5 Impact Assessment: 132kV Transmission Lines

a) Planning Phase

Loss of agricultural land and / or production is not envisioned during this phase of the project.

b) Construction and Operational Phases: 132 kV Transmission Lines

Due to the nature of the development, the construction and operational phases have been combined for this particular activity. Desktop and field data indicates that both Alignment Alternatives (1 and 2) share virtually identical agricultural potential and value, and are both suitable to accommodate the proposed transmission lines. As result the impact assessment for both Alternatives have been rated in a single table (**Table 13**)

Table 16: Combined Impact rating table for construction and operation of a 132 kV Transmission Lines (Alternatives 1 and 2)

	Pre-mitigation impact rating	Post mitigation impact rating
Extent	**Local**	**Local**
Magnitude	**Very Low**	**Very Low**

Duration	**Long Term**	**Long Term**
Significance rating	**Very Low**	**Very Low**
Probability	**Definite**	**Definite**
Confidence	**Certain**	**Certain**
Reversibility	**Reversible**	**Reversible**
Mitigation measures	▪ Due to the overarching route characteristics, and the nature of the proposed development, viable mitigation measures are limited and will most likely revolve around erosion control: ➢ Clearing activities should be kept to a minimum. ➢ In the unlikely event that heavy rains are expected, activities should be put on hold to reduce the risk of erosion. ➢ If additional earthworks are required, any steep or large embankments that are expected to be exposed during the 'rainy' months should be armoured with fascine like structures. A fascine structure usually consists of a natural wood material and is used for the strengthening of earthen structures or embankments. ▪ If earth works are required then storm water control and wind screening should be undertaken to prevent soil erosion. ▪ Interact with landowners during the routing process.	

6.7 Preferred Alternatives

It is evident that if the proposed mitigation measures are implemented, then the proposed activities will have a low impact on current agricultural production and soil resources.

From an agricultural perspective, **Layout Alternative 1** is preferable due to the phased approach and the smaller developmental footprint. Pre and post-mitigation scores in the construction phase are also lower for Alternative Layout 1.

Desktop and field data indicates that both Alignment Alternatives (1 and 2) share virtually identical agricultural potential and value, and are both suitable to accommodate the proposed transmission lines. However, **Alternative 2** is recommended as it represents the shortest proposed power line route.

7. EROSION MANAGEMENT PLAN

Soil is a natural resource, is non-renewable in the short term and is expensive either to reclaim or improve following degradation (**van Lynden & Oldeman, 1997**). Even though the areas directly affected by the proposed developments have low agricultural value and capability, the activities still have the potential to negatively impact the immediate and surrounding soil and land resources. The

International Soil Reference and Information Centre **(ISRIC)**, the producers of the World Map of Human-Induced Soil Degradation, recognises two categories of human-induced soil degradation processes.

The **first category** deals with soil degradation by displacement of soil material mainly through water and wind erosion. Soil erosion causes land degradation through a reduction in agricultural potential in many parts of South Africa. The major issues surrounding soil erosion are the loss of the top soil layer required for plant growth, reduction of soil nutrients, siltation of aquatic systems as well as the general land and ecosystem degradation.

The **second category** of soil degradation deals with in-situ soil physical ,chemical and biological deterioration. In-situ soil degradation due to anthropogenic activities can be divided into various classes and subclasses:

- **Physical Degradation** (waterlogging, compaction, crusting, pore modification, etc.)
- **Chemical Degradation** (eutrophication, acidification, salinisation, heavy metal pollution, etc.)
- **Biological Degradation** (pathogen introduction, modification of microbial activity etc.)

A single or combination of the aforementioned degradations leads to a decrease in soil quality/health, which in turn influences land capability ratings (**ISRIC, 1990**). Due to the proposed activities this management plan focuses primarily on soil erosion however generic soil contamination mitigations are provided in **Section 7.3**.

7.1 Soil Erosion Monitoring

Due to the size of the site and without rigorous scientific methods and equipment, soil erosion will need to be monitored visually by the appointed Environmental Control Officer (ECO)[2]. Soil erosion is a natural process, whose rate and intensity can be anthropogenically increased. Excessive erosion can lead to land degradation and the reduction of the area's carrying capacity. It is recommended that areas around roads, stockpiles and PV panels are visually monitored during audits. A photographic record of the on-site conditions will also aid in the identification of erosion problems. A quarterly (3 month) photographic frequency is recommended. However, photographs should be taken immediately after significant rainfall events, as these events are associated with the highest rate of erosion. Signs of rill and gully erosion should be remediated as soon as possible. Typical remediation techniques are provided in **Section 7.2**, below.

7.2 Proposed Soil Erosion Mitigatory Measures

Clearing activities should be kept to a minimum and must only be undertaken during agreed working times, as well as permitted weather conditions. If heavy rains are expected clearing activities should be put on hold. In this regard, the contractor must be aware of weather forecasts. The further unnecessary removal of groundcover vegetation from slopes must be prevented. Following the clearing of an area, the surfaces of all exposed slopes must be roughened to retain water and

[2] The person appointed will provide direction to the Contractor concerning the activities within the Construction Zone, and who will be responsible for conducting the Environmental Audit of the project during the construction and operational phases of the project.

increase infiltration (especially important during the wet season). Any steep or large embankments that are expected to be exposed during the ‘rainy’ months should either be armoured with fascine like structures or vegetated. If a cleared area is not going to be built on immediately, the top layer (nominally 150 mm) of soil should be removed and stockpiled in a designated area approved by the ECO. Vegetation shall be stripped in a sequential manner as the work proceeds so as to reduce the time that stripped areas are exposed to the elements. Top-soiling and re-vegetation shall start immediately after the completion of an activity and at an agreed distance behind any particular work front. It is highly recommended that existing farm roads are used as much as possible, while the additional creation of access roads should be kept to a minimum.

Storm water control and wind screening should be undertaken to prevent soil loss from the site. All embankments shall be protected by a cut off drain to prevent water from running down the face of the embankment, resulting in soil erosion. Typical erosion control measures such as the installation of silt fences, hay bales, EcoLogs™ and Bio Jute™ are recommended if erosion problems are noted during construction and operation phases (**Figure 25**).

Figure 25: Typical soil erosion mitigatory measure: BioJute Installtion (**top left**); a silt fence protecting a stockpile (**top right**) and pegged hay bale wall used to reduce runoff velocities (**bottom**)

7.3 Proposed Groundwater and Soil Contamination Mitigatory Measures

Every precaution must be taken to ensure that chemicals and hazardous substances do not contaminate the soil or groundwater on site.
For this purpose the Contractor must:

- Ensure that the mixing /decanting of all chemicals and hazardous materials should take place on a tray or impermeable surface.
- Dispose of any generated waste at a registered landfill site.

- Ensure all storage tanks are designed and managed in order to prevent pollution of drains, groundwater and soils.
- Construct separate storm water collection areas and interceptors at storage tanks, and other associated potential pollution activities.
- Ensure the control of fuels and chemicals in order to prevent spillage potential ground leaching. Adequate spillage containment measures shall be implemented, such as cut off drains, etc. Fuel and chemical storage containers shall be set on a concrete plinth. The containment capacity shall be equal to the full amount of material stored, plus 10%.
- Appoint appropriate contractors to remove any residue from spillages from site. Handling, storage and disposal of excess or containers of potentially hazardous materials shall be in accordance with the requirements of the above-mentioned Regulations and Acts.
- Ensure that used oils/lubricants are not disposed of on/near the site, and that contractors purchasing these materials understand the liability under which they must operate. The ECO will be responsible for reporting the storage/use of any other potentially harmful materials to the relevant authority.
- Ensure that potentially harmful materials are properly stored in a dry, secure environment, with concrete or sealed flooring. The ECO will ensure that materials storage facilities are cleaned/maintained on a regular basis, and that leaking containers are disposed of in a manner that allows no spillage onto the bare soil or surface water. The management of such storage facilities and means of securing them shall be agreed upon.
- Site staff shall not be permitted to use any stream, river, other open water body or natural water source adjacent to or within the designated site for the purposes of bathing, washing of clothing or for any other construction or related activities. Municipal water or another source approved by the ECO should rather be used for all activities such as washing of equipment, dust suppression, concrete mixing and compacting.

7.4 Stockpile Management

General requirements for stockpiles include that they should be situated in an area that should not obstruct the natural water pathways on site. Topsoil stockpiles will be kept separate from other stockpiles, shall not be compacted, and shall not exceed 2m in height. If exposed to windy conditions or heavy rain, stockpiles should be protected by re-vegetation using an indigenous grass seed mix or cloth, depending on the duration of the project. The construction of a berm consisting of sand bags, or a low brick wall, can be placed around the base of the stockpile for retention purposes. Stockpiles should be weeded regularly; to ensure they are kept free of alien vegetation and shall be kept free of any contaminants whatsoever, including paints, building rubble, cement, chemicals, oil, etc.

Subsoil and topsoil stockpiles will be moved to areas of final utilisation as soon as possible to avoid unnecessary erosion. Stockpiles not utilized within three months of the initial stripping process (or prior to the onset of seasonal rains) will be seeded with appropriate grass seed mixes, including indigenous grasses to further avoid possible erosion.

7.5 Land Rehabilitation

All rubble is to be removed from the site to an approved landfill site as per the construction phase requirements. No remaining rubble is to be buried on site. The site is to be free of litter, and surfaces are to be checked and cleared of waste products resulting from activities such as concreting or asphalting.

After construction the land will need to be rehabilitated, which includes a re-vegetation plan. It is recommended that more palatable species are planted to enable the faster stocking initiation.

8. SUMMARY AND RECOMMENDATIONS

Aurecon on behalf of Mulilo Renewable Energy requested a baseline assessment of the soil, land use and agricultural characteristics for the areas affected by the proposed construction of three separate solar energy facilities, on Du Plessis Dam Farm (Remainder of Farm 179), near De Aar in the Northern Cape.

A detailed soil and agricultural report was undertaken for Du Plessis Dam Farm in January 2012, as part of a larger environmental assessment. Environmental Authorisation for a 19.9 MW Photovoltaic (PV) solar energy facility, known as Du Plessis PV1, and associated infrastructure was granted for this project in late September 2012. Mulilo now plans to construct three additional PV facilities on the Du Plessis Dam Farm. The area previously approved for PV1 (approximately 64 ha) will be included in the proposed layouts for the additional PV facilities as an attempt to maximise the generation capacity of the farm (**Aurecon, 2013**).

The farm is situated in the Emthanjeni Local Municipality, and is zoned as agricultural land. The farm borders the north eastern corner of De Aar and consists of flat grassy plains which are used as unimproved grazing land for cattle production. Water is the major limiting factor to local agricultural enterprise, and the farm neither contains nor directly borders a perennial river / freshwater impoundment which could be used as a source of irrigation water.

The study area has a semi-arid to arid continental climate with a summer rainfall regime i.e. most of the rainfall is confined to summer and early autumn. MAP is approximately 300 mm per year. The low rainfall and moisture availability is reflected in the lack of dry land crop production within the study area. The climate for the study area is severely restrictive to arable agriculture, primarily due to the lack of rainfall and severe moisture availability restrictions. The majority of the study area is characterised by flat plains and gently sloping topography with an average gradient of less than 5%. These plains are ideal areas for intensive agriculture, with a high potential for large scale mechanisation. From a developmental perspective, the flat topography will also allow for minimal earthworks and site preparation.

The soils identified on the PDA are predominantly shallow and rocky with a low agricultural potential. Rocky soils (Mispah and Glenrosa Forms) cover 71% of the surveyed area while shallow duplex soils (Swartland) cover 24%. Most soils contained a layer that was limiting to plant growth, including rock, saprolite, hard pan carbonate and strongly structured cutanic horizons. Virtually all the soil encountered in the study area contained a layer, close to the soil surface, that was limiting to plant growth and these layers included rock, hard pan carbonate and dorbank. Soils with an effective depth of greater than 50 cm were rarely observed during the soil survey. The physical and chemical limitations associated with the dominate forms, will in most instances, restrict these soils to extensive grazing.

The majority of the site has been classified as having low potential for crop production due to an arid climate and highly restrictive soil characteristics. The site is not classified as high potential nor is it a unique dry land agricultural resource. The site is considered to have a moderate to moderately low value when utilised as grazing land, its current use.

There are no centre pivots, irrigation schemes or active agricultural fields which will be influenced by the proposed development, and as such there are no problematic or fatal flaw on-site areas for the proposed solar energy facilities, based on the agricultural assessment as a standalone specialist study.

The proposed development's primary impact on agricultural activities will involve the construction of the solar fields and associated infrastructure. This will entail the clearing of vegetation and levelling of the site. This will effectively eliminate the impacted land's agricultural potential in terms of crop production, or in this case grazing, during the construction phase, which is estimated to last between 12 and 24 months. The construction of the solar fields will influence a portion of the farms total area. The remaining land will continue to function as it did prior to the development. Furthermore, facilities on the farm will be phased and constructed consecutively depending on whether the projects are approved by the DoE and DEA. Stocking rates will need to be temporarily reduced during the construction phase in order to reduce the risk of overgrazing on the remaining land portions.

After construction the land will need to be rehabilitated, including the re-vegetation of the solar fields. It is recommended that more palatable species are planted to enable the faster stocking initiation.

In order to further mitigate the potential impacts it is highly recommended that periodic grazing within the PV fields is allowed. This mitigation will minimise the loss of grazing land and reduce the overall impact on agricultural production. Interestingly the farmers around the De Aar have changed from sheep to beef production due to the high prevalence of stock theft. Unfortunately cattle grazing will not be permitted within the PV fields as the animals could damage the PV panels. In order to overcome this limitation it is recommended that the farms convert back to sheep production and use the proposed PV facilities as rotational grazing camps. The problem of small stock theft should be mitigated by the additional security and fencing associated with the PV facilities.

A number of solar and renewable energy projects have been proposed in the De Aar area and thus, the cumulative impact of these developments on surrounding farms could become detrimental to local agricultural resources, if the loss of usable grazing land is not taken into account when determining optimum herd size. A phased approach for each farm in combination with erosion control and land rehabilitation within each farm will reduce this impact. The inherently low agricultural potential of the region also reduces the overall cumulative impact.

From an agricultural perspective **Layout Alternative 1** is preferred due to the phased approach and the smaller developmental footprint. Pre and post-mitigation scores in the construction phase are also lower for Alternative Layout 1 (low negative).

Desktop and field data indicates that both Alignment Alternatives (1 and 2) share virtually identical agricultural potential and value and are both suitable to accommodate for the proposed transmission lines. However, **Alternative 2** is recommended as it represents the shortest of the proposed power line routes.

<u>If the suggested mitigation measures and erosion management plan are correctly implemented there is no reason why the proposed solar energy facilities and supporting infrastructure cannot be accommodated on the Du Plessis Dam Site.</u>

9. REFERENCES

AGIS Database. (2013). Source: *http://www.agis.agric.za/agisweb/agis.html*

Aurecon South Africa. (2013). Draft Scoping Reports for the Proposed Photovoltaic (solar) Energy Facilities on Du Plessis Dam Farm near De Aar, Northern Cape.

Brady, N.C., and Weil, R.R. (2004). Elements of The Nature and Properties of Soils, 2nd edn. Upper Saddle, NJ: Prentice-Hall.

Department of Environmental Affairs and Tourism. (2001). *Environmental Potential Atlas for South Africa.* Source: www.environment.gov.za/enviro-info/enpat.htm.

FAO. (2007) Mapping biophysical factors that influence agricultural production and rural vulnerability. Source: www.fao.org/docrep/010/a1075e/a1075e00.HTM.

Fey, M. (2010). Soils of South Africa. Cambridge University Press.

Mucina, L. and Rutherford, M.C.(eds). 2006. The Vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

SAWS. (2010). Climate Information for De Aar. Source: *http://www.weathersa.co.za/Climat/Climstats/DeAarStats.jsp*

Smith, B. (2006). The Farming Handbook. University of KwaZulu-Natal Press.

SiVEST (2012). Proposed Solar Energy Facilities Near De Aar: Final Soil and Agricultural Assessment Report.

Soil Classification Working Group. (1991). Soil Classification: a taxonomic system for South Africa. ARC-Institute for Soil, Climate and Water, Pretoria.

Van Lyden, **G.W.J.** and **Oldeman**, **L.R.(1997)** The Assessment of the Status of Human-Induced Soil Degradation in South and Southeast Asia. International Soil Reference and Information Centre.

10. APPENDIX A: SOIL PROPERTIES

PV Site	Auger Number	Soil Form	Soil Family	Effective Depth (m)	Limiting Layer	X	Y
PV 4	79	Ms	1200	0.1	Rock	24.051640	-30.621820
PV 4	80	Sw	1122	0.4	Saprolite	24.058060	-30.622250
PV 4	81	Gs	1112	0.2	Rock	24.062960	-30.624080
PV 4	82	Sw	1122	0.5	Saprolite	24.066400	-30.627790
PV 4	83	Ms	1200	0.1	Rock	24.069040	-30.630210
PV 4	84	Sw	1122	0.4	Saprolite	24.074180	-30.631220
PV 4	85	Sw	1122	1.2	Saprolite	24.077780	-30.633890
PV 4	86	Sw	1122	0.5	Saprolite	24.080610	-30.635680
PV 4	87	Sw	1122	0.6	Saprolite	24.083010	-30.636920
PV 4	88	Sw	1122	0.5	Saprolite	24.082340	-30.640960
PV 4	89	Sw	1122	0.4	Saprolite	24.081870	-30.643920
PV 4	90	Sw	1122	1	Saprolite	24.078050	-30.643420
PV 4	91	Ms	1200	0.2	Rock	24.072930	-30.642450
PV 4	92	Sw	1122	0.5	Saprolite	24.066470	-30.641460
PV 4	93	Ms	1200	0.2	Rock	24.059150	-30.640310
PV 4	94	Ms	1200	0.1	Rock	24.051540	-30.638930
PV 4	95	Ms	1200	0.1	Rock	24.046580	-30.638240
PV 4	96	Sw	1122	0.4	Saprolite	24.041090	-30.636360
PV 4	97	Ms	1200	0.1	Rock	24.035700	-30.634160
PV 4	98	Cg	2000	0.2	HPC	24.037630	-30.628980
PV 4	99	Ms	1200	0.2	Rock	24.041500	-30.624470
PV 4	100	Gs	1112	0.2	Rock	24.043670	-30.620270
PV 4	101	Ms	1200	0.2	Rock	24.048270	-30.622250
PV 4	102	Ms	1200	0.1	Rock	24.052260	-30.625610
PV 4	103	Ms	1200	0.1	Rock	24.057710	-30.627720
PV 4	104	Sw	1122	0.3	Saprolite	24.063700	-30.629820
PV 4	105	Ms	1200	0.2	Rock	24.069160	-30.633240
PV 4	106	Ms	1200	0.1	Rock	24.071090	-30.636170
PV 4	107	Ms	1200	0.2	Rock	24.072710	-30.638130
PV 4	108	Ms	1200	0.1	Rock	24.060010	-30.620360
PV 4	109	Gs	1112	0.2	Rock	24.027000	-30.64100

SiVEST Civil Engineering

VCC Estate, North View Building,
170 Peter Brown Drive, Montrose, Pietermaritzburg, 3201
PO Box 707, Msunduzi, 3231
South Africa
Tel + 27 33 347 1600
Fax +27 33 347 5762
Email info@sivest.co.za
www.sivest.co.za
Contact Person: Kurt Barichievy
Cell No.: 084 5549442
Email: Kurtb@sivest.co.za