BASIC ASSESSMENT REPORT

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

PROPOSED INCA KAKAMAS PHOTOVOLTAIC SOLAR ENERGY FACILITY: KAKAMAS, NORTHERN CAPE PROVINCE

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DECLARATION

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

- act as an independent specialist consultant in the fields of Soil Science and Agricultural Potential in this basic assessment report on the Soil, Land Use, Land Capability and Agricultural Potential Survey – Proposed INCA Kakamas Photovoltaic Solar Energy Facility: Kakamas, 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 my disposal regarding the application, whether such information is favourable to the applicant or not.

J.H. VAN DER WAALS
TERRA SOIL SCIENCE

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

1. TERMS OF REFERENCE

Terra Soil Science (TSS) was commissioned by Savannah Environmental (Pty) Ltd to undertake a basic assessment report (BAR) level soil, land use, land capability and agricultural potential survey for the proposed INCA Kakamas Photovoltaic Solar Energy Facility near Kakamas 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 (PV) 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.

The study has as objectives the identification and estimation of:

- » Diagnostic soil horizons, soil form (SA taxonomic system) and soil depth at auguring point localities that were designed to adequately cover the area;
- » Soil colour, texture, structure;
- » Presence and intensity/frequency of mottles, concretions, and rocks;
- » 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

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 agriculture 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 survey area lies between 28° 45′ 40″ and 28° 46′ 39″ south and 20° 34′ 56″ and 20° 35′ 25″ east 3 km west of the town of Kakamas in the Northern Cape Province (**Figure 1**).

2.4 Survey Area Physical Features

The survey area lies on undulating terrain with a northerly aspect, sloping down towards the Gariep River. The altitude above mean sea level varies predominantly between 660 and 680 m. The geology of the area varies with the dominance of migmatite, gneiss and granite with the occasional occurrence of ultrametamorphic rock of the Namaqualand Metamorphic Complex. The morphology of the landscape is dominated by a very dense subdendritic drainage and dissection pattern with the occasional occurence of lime nodules and calcrete (Land Type Survey Staff, 1972 – 2006)

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

3.1 Method of Survey

The scoping soil, land capability, land use and agricultural ptential 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).

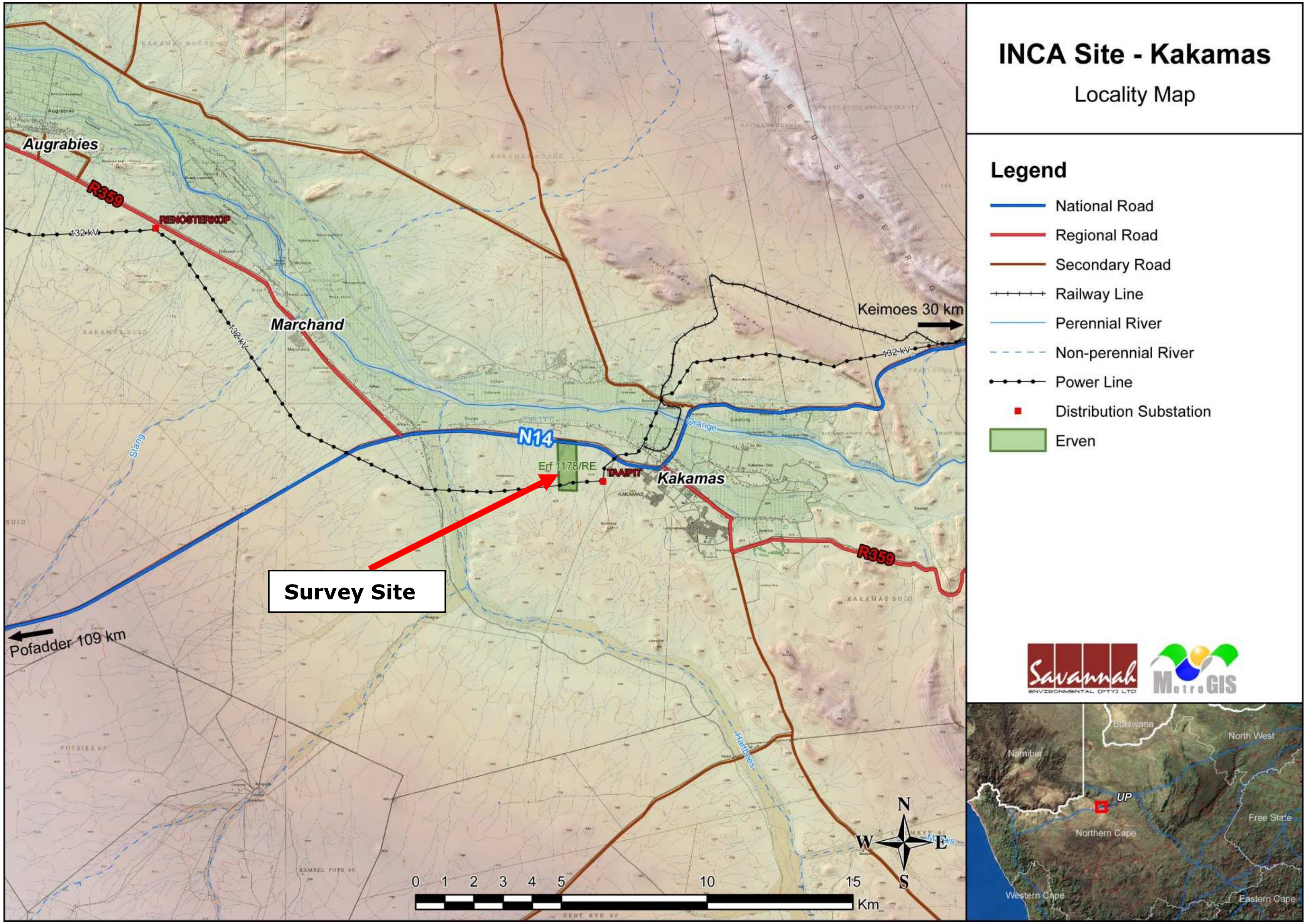

Figure 1: Locality of the survey site

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 as well as historic land uses such as cultivation.

3.1.3 Phase 3: Site Visit and Soil Survey

A site visit was conducted on the 13th of April, 2011, during which the soils were investigated. Fortunately, the neighbouring piece of land was in the process of being prepared for the establishment of irrigation infrastructure for grape producing purposes. As the soils in the area are shallow and difficult to auger the open trenches on the neighbouring land parcel were used to obtain good visual indication of soil and profile properties.

3.2 Survey Results

3.2.1 Phase 1: Land Type Data

The survey site lies in the **Ag2** land type (Land Type Survey Staff, 1972 - 2006). (Refer to **Map 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 Ag2

Soils: Shallow apedal (structureless) with regular occurrences of rock outcrops and lime in the soil profiles. The soils are typical of arid environment soils in that distinct soil formation is lacking and the soils exhibit only signs of physical weathering processes of parent materials. In drainage features varying thickness layers of sand have accumulated that are altered after every heavy rainfall event.

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: Very 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. The typical crops for this area are table grapes and raisins.

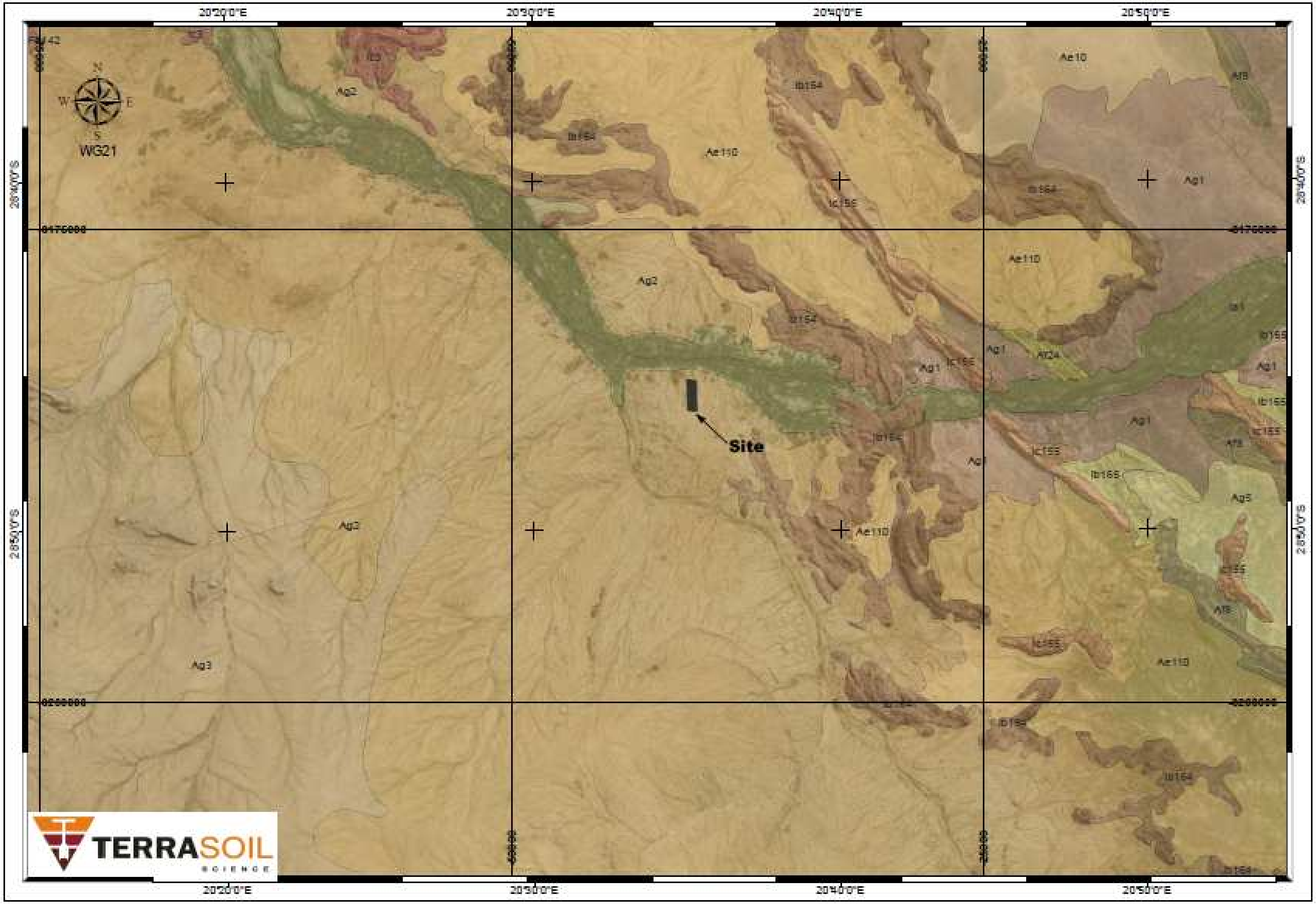

Figure 2 Land type map of the survey site

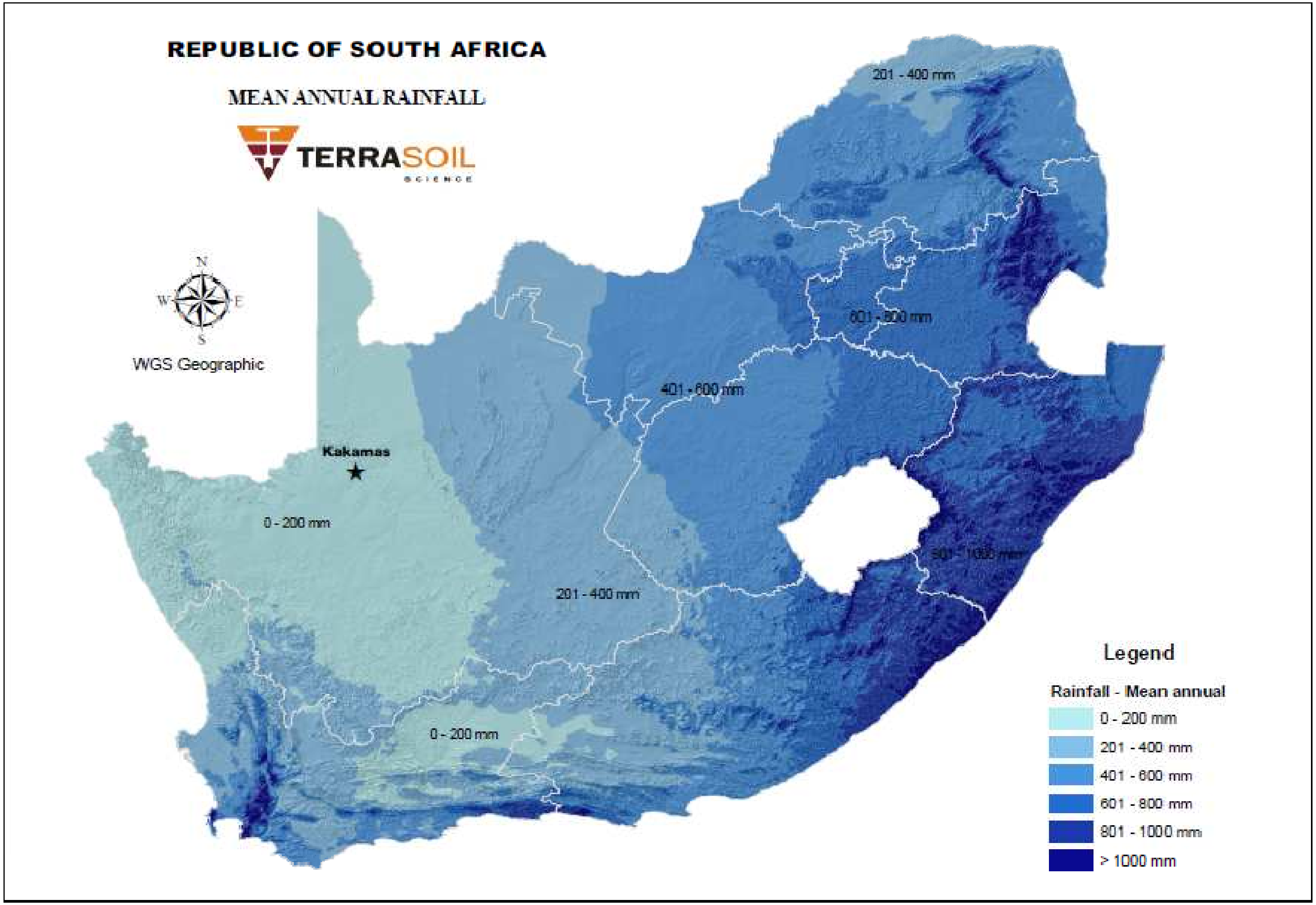

Figure 3 Rainfall map of South Africa indicating the survey site

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 (**Figure 4**). The grazing on the site seems to have been ceased a number of years ago. The surrounding land has been tilled and cultivated with irrigation of vineyards. The establishment of vineyards on land in this area is an intensive and costly exercise and the soil requirements and changes will be dealt with in the next section.

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) and Glenrosa (Orthic A-horizon / Lithocutanic B-horizon) forms. The classification of these soil forms is general as a range of other soil forms can occur on the site. These soils, however, occur sporadically due to nuances in the topography and differences in the rock outcrops and underlying rock topography. The soils that occur with the Mispah and Glenrosa forms include shallow Hutton (Orthic A-horizon / Red Apedal B-horizon / Unspecified – usually hard or weathering rock on this site), Dundee (Orthic A-horizon /Stratified Alluvium), Brandvlei (Orthic A-horizon / Soft Carbonate B-Horizon),Coega (Orthic A-horizon / Hardpan Carbonate Horizon) and Knersvlakte (Orthic A-horizon / Dorbank Horizon) forms. These soils are typical of arid environments and predominantly exhibit signs of physical weathering processes. Chemical weathering processes are not very pronounced but these are probably best exhibited in the accumulation of lime in a number of different subsoil horizons and weathering rock. The soils on the entire site are covered with pebbles (often quartz) and rocks leading to the near impossibility of auguring of holes with a hand soil auger (**Figures 5** to **7**). Erosion channels occur throughout the site and these are filled with recently transported soil material (Dundee soil form) (**Figure 8**).

The agricultural use of the soils is very limited due to their physical limitations. In order to establish vineyards these soils have to be ripped and the surface levelled (**Figures 9** and **10**) – leading to massive establishment costs. The resultant soil matrix is one of mixed soil and broken rock fragments that (**Figures 11** to **14**) is suitable for irrigation (**Figure 15**) as this matrix can be used as an open hydroponic system.

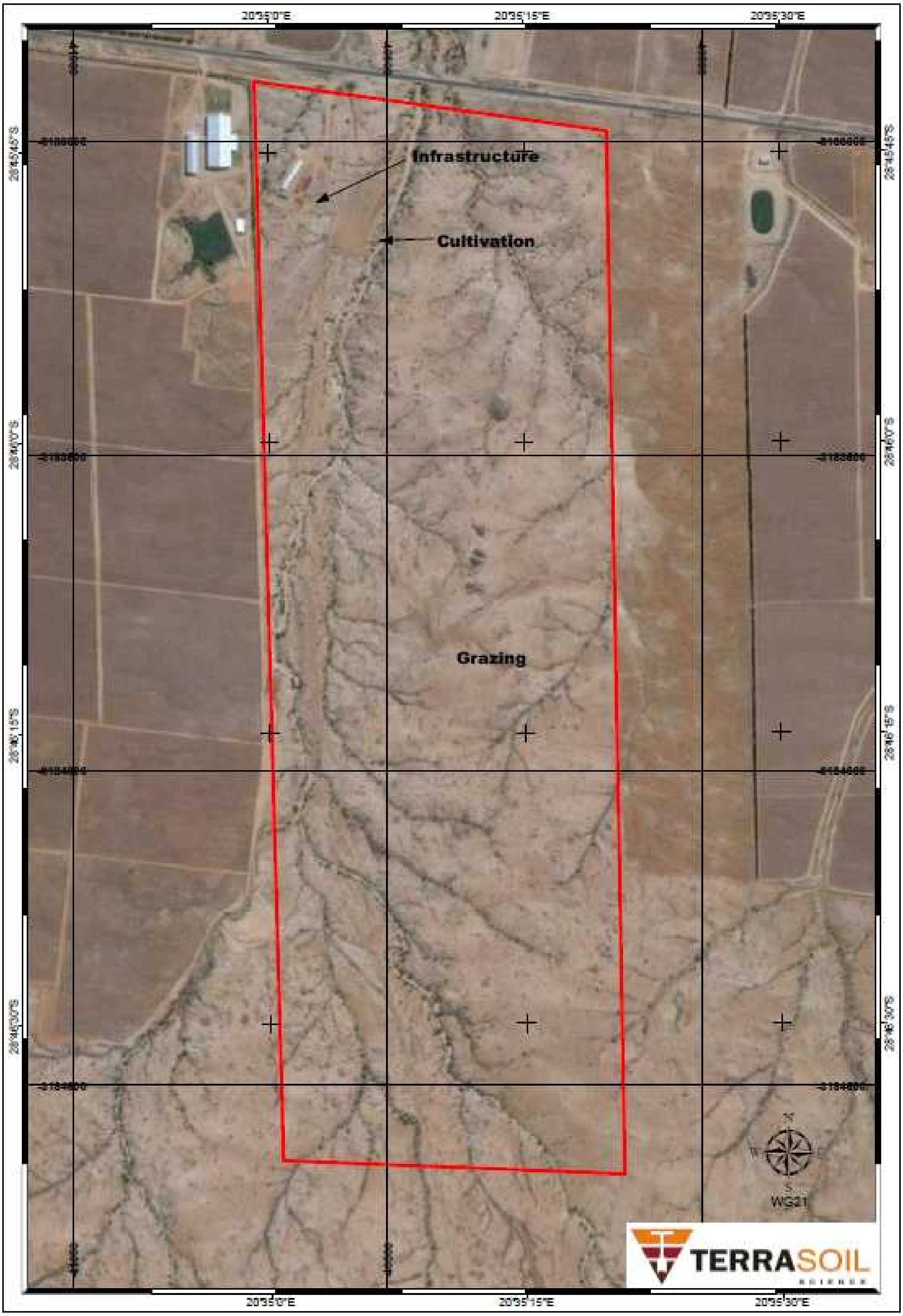

Figure 4 Land use on the survey site

Figure 5 Soils covered with pebbles on the site

Figure 6 Soils with rock outcrops and covered with pebbles on the site

Figure 7 Soils with rock outcrops and covered with pebbles on the site

Figure 8 Erosion channel with transported soils

Figure 9 Prepared soils (ripped and levelled) on the eastern side (right) of the site and original soils on the western side (left)

Figure 10 Dumped soil material for levelling purposes

Figure 11 Mixed soil material after preparation

Figure 12 Mixed soil material after preparation

Figure 13 Mixed soil material after preparation

Figure 14 Lime mass ripped out of the soil

Figure 15 Trenches for the laying of irrigation infrastructure

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 shallow and rocky soils. The improvement of the agricultural potential is dependent on extensive soil preparation and establishment of irrigation infrastructure –a very intensive and costly exercise. During the current economic climate many of the farmers or farming enterprises along the Gariep River have faced financial ruin. Under such conditions the investment into additional irrigated agriculture in this area is considered unsound.

4.2 Overall Soil Impacts

The overall soil impacts are expected to be low as the establishment of solar energy structures and infrastructure will not impact negatively on high potential agricultural land, and will not significantly alter the soil conditions on the site. Erosion control measures will have to be implemented to prevent and contain erosion associated with soil surface disturbance due to construction activities. The impacts on this site are viewed in a very favourable light as it pales into insignificance when compared to open cast coal mining (on the Eastern Highveld on high agricultural potential soil) for the production of similar quantities of electricity.

5. ASSESSMENT 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).
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 willnot 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.

CATEGORY	DESCRIPTION OF DEFINITION
	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.

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 5.4.1)
Construction of buildings and other infrastructure	Physical degradation (compound)	Two dimensional	(Section 5.4.2)
Construction and Operational Phase Related Effects			
Vehicle operation on site	Physical and chemical degradation (hydrocarbon spills)	Mainly point and one dimensional	(Section 5.4.3)
Dust generation	Physical degradation	Two dimensional	(Section 5.4.4)

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 7**.

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.
Extent	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed
Duration	5 – Permanent (unless removed)
Magnitude	2
Probability	2 (improbable due to low baseline agriculture potential)
Significance of impact	S = (1 + 5 + 2)*2 = 16 (low)
Status	Negative
Mitigation	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 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 buildings and other infrastructure with the associated disturbance of soils and existing land use.
Extent	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed
Duration	5 – Permanent (unless removed)
Magnitude	2
Probability	2 (improbable due to low baseline agriculture potential)
Significance of impact	S = (1 + 5 + 2)*5 = 16 (low)
Status	Negative
Mitigation	None possible. Limit footprint to the immediate development area

5.3.3 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 5** 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 5 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
Extent	1 - Site: The impact is two dimensional but then limited to the immediate area that is being developed
Duration	2 – Short-term
Magnitude	2
Probability	4 (2 with prevention and mitigation)
Significance of impact	S = (1 + 2 + 2)*4 = 20 (10 with prevention and mitigation) (low)
Status	Negative
Mitigation	Maintain vehicles, prevent and address spillages

5.3.4 Dust Generation

Generated dust can impact large areas depending on environmental and climatic conditions. **Table 6** presents the impact criteria and a description with respect to soils, land capability and land use for dust generation on the site.

Table 6 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
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
Duration	2 – Short-term
Magnitude	2
Probability	4 (2 with mitigation and adequate management)
Significance of impact	S = (2 + 2 + 2)*4 = 24 (12 with mitigation and adequate management) (low)
Status	Negative
Mitigation	Limit vehicle movement to absolute minimum, construct proper roads for access

Table 7 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	Improbable (2)	Improbable (2)
Significance*	16 (Low)	16 (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 nd 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.

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 development of irrigation infrastructure is costly and will in all probability have similar impacts.

There are three aspects that have to be managed on the site. These 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 affect surrounding vineyards.

REFERENCES

LAND TYPE SURVEY STAFF. (1972 – 2006). *Land Types of South Africa: Digital map (1:250 000 scale) and soil inventory databases*. ARC-Institute for Soil, Climate and Water, Pretoria.

MACVICAR, C.N. et al. 1977. *Soil Classification. A binomial system for South Africa.* Sci. Bull. 390. Dep. Agric. Tech. Serv., Repub. S. Afr., Pretoria.

MACVICAR, C.N. et al. 1991. *Soil Classification. A taxonomic system for South Africa. Mem. Agric. Nat. Resour. S.Afr.* No.15. Pretoria.