IMPACT ASSESSMENT REPORT

On contract research for

SAVANNAH ENVIRONMENTAL

Proposed Construction of a 75 MW Photovoltaic Power Plant, Lethabo Power Station, Free State Province

Soils and Agricultural Potential

EIA Study

By

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DECLARATION

I hereby declare that I am qualified to compile this report as a registered Natural Scientist and that I am independent of any of the parties involved and that I have compiled an impartial report, based solely on all the information available.

D G Paterson

September 2015

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1. TERMS OF REFERENCE

The ARC-Institute for Soil, Climate and Water (ARC-ISCW) was contracted by Savannah Environmental to undertake a soil investigation near Vereniging, in Free State Province. The purpose of the investigation is to contribute to the Environmental Impact Assessment (EIA) process for a proposed Photovoltaic (PV) power generation facility at Eskom's Lethabo Power Station.

EIA Report

The purpose of the EIA Report is to elaborate on the issues and potential impacts identified during the scoping phase of the proposed projects. This is achieved by site visits and research in the site-specific study area as well as a comprehensive assessment of the impacts identified during the scoping phase.

The EIA report must include:

» a description of the environment that may be affected by the activity and the manner in which the environment may be affected by the proposed project
» a description and evaluation of environmental issues and potential impacts (including direct, indirect, cumulative impacts and residual risks) that have been identified
» Direct, indirect, cumulative impacts and residual risks of the identified issues must be evaluated within the EIA Report in terms of the following criteria:
  * the nature, which shall include a description of what causes the effect, what will be affected and how it will be affected;
» a statement regarding the potential significance of the identified issues based on the evaluation of the issues/impacts
» a comparative evaluation of the identified feasible alternatives, and **nomination of a preferred alternative**
» Any aspects which are conditional to the findings of the assessment which are to be included as conditions of the Environmental Authorisation
» This must also include any gaps in knowledge at this point of the study. Consideration of areas that would constitute "acceptable and defendable loss" should be included in this discussion.
» A reasoned opinion as to whether the proposed project should be authorised.
» A summary of the positive and negative impacts and risks of the proposed project and identified alternatives.

» Mitigation measures and management recommendations to be included in the Environmental Management Programme to be submitted with the FEIR

The objectives of the study are;

- To obtain all existing soil information and to produce a soil map of the specified area as well as

- To assess broad agricultural potential and the potential impacts that might result from the proposed PV development.

2. SITE CHARACTERISTICS

2.1 Location

The areas that were investigated, on Portion 0 of the farm 1814, comprise a total of approximately 280 ha and lie approximately 15 km to the south-east of the town of Vereniging, adjacent to the Lethabo Power Station. The positions of the virtually adjoining sites are shown by the coloured areas on the map in Figure 1. The areas lie between 26° 43′ and 26° 45′ S and between 27° 56′ and 27° 59′ E.

At the time of the field visit (September 2015), both sites were unutilized. Alternative 1 consisted of grass cover in the north, with almost bare topsoil across much of the southern parts. Alternative 2 had a virtually continuous grass cover, but with extensive weed infestation across much of the area.

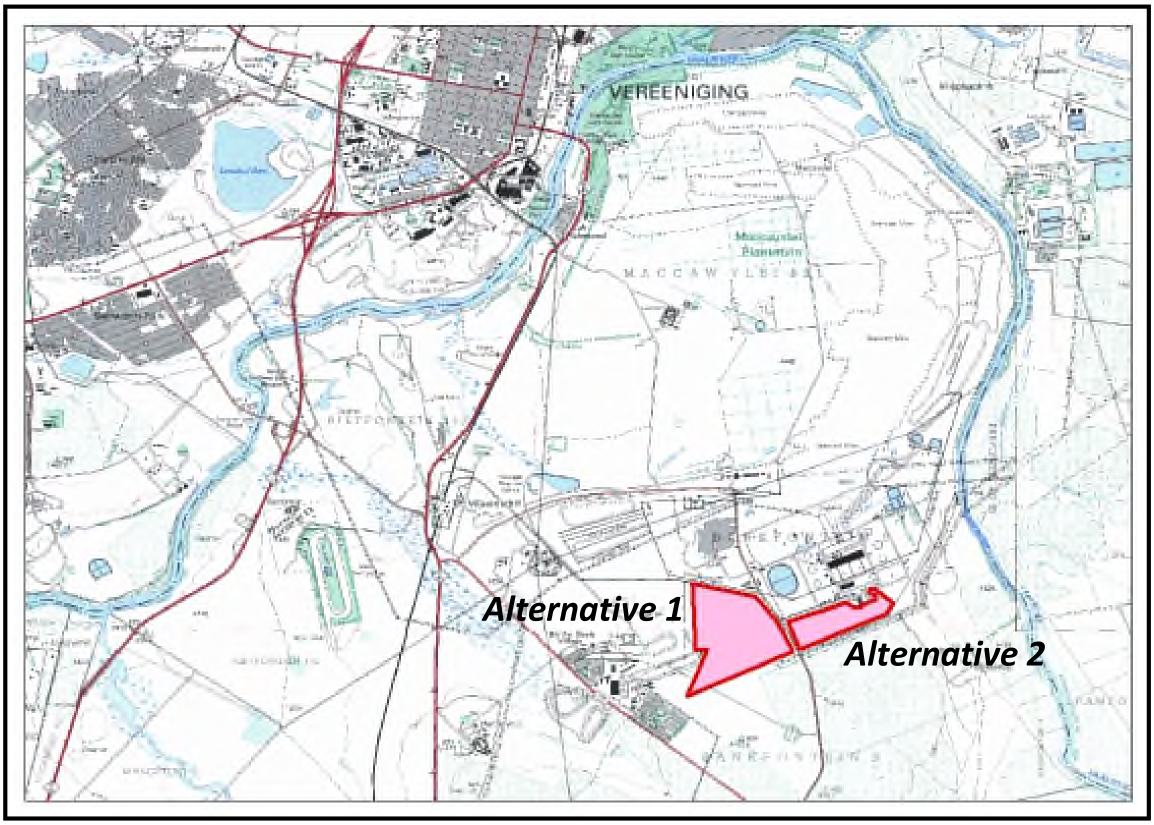

Figure 1 Locality map

Two specific areas have been identified, namely the larger one to the south-west of the Power Station (**Alternative 1, 183.8 ha**) and a smaller one to the south (**Alternative 2, 65.98 ha**).

2.2 Terrain

Alternative 2 is virtually flat, while Alternative 1 slopes towards the north of less than 2%, and the study areas lie at a height of approximately 1 460 metres above sea level. No perennial or non-perennial streams could be observed, but a potentially wet area was identified in Alternative 2. In addition, large parts of Alternative 1 seem to have been subject to removal of the sandy soil, with the result that the surface is undulating, which has caused some small channels, ridges and depressions to form as a result of this excavation.

2.3 Climate

The climate of the area (Kotze, 1985) can be regarded as warm to hot, with rain in summer and dry winters. The long-term average annual rainfall in this region is 638 mm, of which 530.8 mm, or 83%, falls from November to April. The total annual evaporation is 2 187 mm per year, peaking at 7.8 mm per day in November and December.

Temperatures vary from an average monthly maximum and minimum of 28.0ºC and 18.2ºC for January to 13.9ºC and -2.2°C for July respectively. The extreme high temperature that has been recorded is 38.1°C and the extreme low –12.8ºC. Frost occurs most years on around 50 days on average between mid-May and early September.

2.4 Parent Material

The geology of the areas comprises sandstone, grit and shale of the Vryheid Formation, Ecca Group, along with some Quaternary deposits (Geological Survey, 1978).

3. METHODOLOGY

The area was investigated using a hand-held soil auger to a maximum depth of 1.2 m. The grid of observation was approximately 150 x 150 m, with the positions controlled by GPS. At each soil observation point, the most important soil characteristics, including texture, colour, structure, mottling, coarse fragments and internal drainage were identified and noted. The soils were then classified (Soil Classification Working Group, 1991) and similar soils grouped into mapping units, whose distribution is shown in the soil map in the Appendix.

In addition, samples of topsoil and subsoil were collected at three localities and taken for analysis at the laboratories at ARC-ISCW. Parameters analyzed include particle size (sand, silt and clay), exchangeable cations (Ca, Mg, Na, Mg) and cation exchange capacity (CEC), organic carbon, pH (H_2O) and P (Bray 1).

4. SOILS

The soils occurring in the study area are yellow-brown to grey-brown, sandy soils, usually with a grey, mottled subsoil horizon indicating signs of wetness.

A summary of the dominant soil characteristics is given in **Table 1** below.

Table 1 Soil legend

Map Unit	Dominant soils	Sub-dominant soils	Depth (mm)	Characteristics	Area (ha)
Av	Avalon 2100	Longlands 2000, Pinedene 2100	700-1200+	Brown to grey-brown, structureless to weakly structured, loamy sand to sandy loam topsoil on yellow-brown, structureless to weakly structured, loamy sand to sandy loam subsoil on grey, mottled, weakly structured sandy clay loam soft plinthic.	Alt 1: 51.73 Alt 2: 31.66 **Tot: 83.39**
Lo	Longlands 2000	Kroonstad 1000, Wasbank 1000	600-1200+	Brown to grey-brown, structureless to weakly structured, loamy sand to sandy loam topsoil on grey, structureless, sand to loamy sand subsoil on grey, mottled, weakly structured sandy clay loam soft plinthic (occasionally with hard, cemented nodules).	Alt 1: 23.56 Alt 2: None **Tot: 23.56**
Kd	Kroonstad 1000	Longlands 2000, Pinedene 2100	450-1000	Brown to grey-brown, structureless to weakly structured, loamy sand to sandy loam topsoil on grey, structureless, sand to loamy sand subsoil on grey, mottled, moderately structured, sandy clay loam to clay loam subsoil.	Alt 1: 32.68 Alt 2: 20.29 **Tot: 53.97**
Ka	Katspruit 1000	Kroonstad 1000	100-350	Brown to grey-brown, weakly structured, loamy sand to sandy loam topsoil on grey, mottled, moderately structured, sandy clay loam to clay loam subsoil. Occurs in lower-lying areas (wetlands).	Alt 1: None Alt 2: 14.03 **Tot: 14.03**
Wb	Witbank 1000	Katspruit 1000, Glenrosa 1121	200-600	Brown to grey-brown, weakly structured, loamy sand to sandy loam topsoil on hard, mottled, gravelly material. Occasionally, patches of shallow gleyed soils (**Ka** unit) also occur. Apparently* resulting from previous human disturbance (including dumping and excavation).	Alt 1: 75.83 Alt 2: None **Tot: 75.83**
				Totals	Alt 1: 183.8 Alt 2: 65.98 **Tot: 279.78**

* This information supplied by Mr Pieter Muller of Lethabo Power Station

4.1 Soil Analyses

The results of the soil analyses are given in Table 2.

Table 2 Soil analyses (Lethabo)

Sample No.	**S1 (Av)**		**S2 (Kd)**		**S3 (Av)**	
	0-300 mm	**300-600 mm**	**0-300 mm**	**300-600 mm**	**0-300 mm**	**300-600 mm**
Co-ordinates	26° 45′ 20.5″S 27° 57′ 29.9″ E		26° 44′ 46.3″S 27° 57′ 36.2″ E		26° 44′ 57.8″S 27° 58′ 39.6″ E	
Sand (%)	90	92	90	94	88	88
Silt (%)	4	2	2	0	4	0
Clay (%)	6	6	8	6	8	12
Na (cmol (+) kg $^{-1}$)	0.025	0.020	0.027	0.018	0.026	0.027
K (cmol (+) kg $^{-1}$)	0.350	0.068	0.223	0.066	0.349	0.121
Ca (cmol (+) kg $^{-1}$)	2.202	0.149	1.609	0.554	2.378	0.931
Mg (cmol (+) kg $^{-1}$)	0.585	0.154	0.385	0.247	0.678	0.582
CEC* (cmol (+) kg $^{-1}$)	6.342	1.328	2.806	1.705	4.065	2.480
P# (ppm)	25.63	1.41	59.71	3.77	20.80	0.84
Organic C (%)	1.35	0.34	0.94	1.12	1.27	0.27
pH (H_2O)	6.23	5.20	5.89	6.47	6.04	5.10

= Bray No. 1 Method
* = Cation Exchange Capacity

The analysis results show the sandy nature of the soils, with consequent low cation values. P levels are reasonable in the topsoils, but very low in the subsoils, showing that there has probably been some sort of fertilization or soil amendment in the past. The soils are slightly acidic, with low organic carbon content, especially in the subsoils. These results confirm that the soils are not naturally fertile, due to the sandy texture and leaching of bases that has occurred.

No abnormal or unexpected results were obtained.

5. AGRICULTURAL POTENTIAL

Much of the areas consist of grey or yellow-brown, sandy or loamy apedal soils on soft (or occasionally hard) plinthite. The depths vary somewhat, with zones of shallow, disturbed soils or wetter clay soils also occurring (as can be seen from the information contained in Table 1).

The moderately high rainfall in the area (Section 2.3) means that rain-fed cultivation can be successfully practiced on suitable soils. However, the low clay content in the subsoil means that water infiltration in these soils will be rapid and that the soils will tend to dry out quickly in any period without rainfall.

The broad agricultural potential is summarized in Table 3 below.

Table 3 Agricultural potential

Agric. Potential Class	**Map Unit(s)**	**Limitations**	**Area (ha)**
Moderate	Av	Loamy sand (occasionally sandy) nature of subsoil means water infiltration will be rapid, leading to potential droughtiness of crops under rain-fed conditions	Alt 1: 51.73 Alt 2: 31.66 **Tot: 83.39**
Low	Lo, Kd	Sandy to extremely sandy subsoil, coupled with reduced natural fertility, means crop yields will often be less than optimal, coupled with drought hazard	Alt 1: 56.24 Alt 2: 20.29 **Tot: 76.53**
Very Low	Wb	Widespread shallow depth to underlying hard layer, coupled with gleyed patches and uneven surface means arable agriculture will be very problematic.	Alt 1: 75.83 Alt 2: None **Tot: 75.83**
Wetland	Ka	Restricted depth to gleyed clay, coupled with wetness hazard in rainy season, means this area should be avoided for all agriculture	Alt 1: None Alt 2: 14.03 **Tot: 14.03**
		Totals	Alt 1: 183.8 Alt 2: 65.98 **Tot: 279.78**

From Table 3, it can be seen that areas with moderate agricultural potential occupy less than 30% of the study area

6. IMPACTS

The major impact on the natural resources of the two alternative sites within the study area would be the loss of arable land due to the construction of the various types of infrastructure. With the lack of high potential soils in the vicinity, this impact would in all probability have a limited significance. At the end of the project life, it is anticipated that removal of the structures would enable the land to be returned to more or less a natural state following rehabilitation, with little impact.

In addition, due to the sandy nature of many of the soils occurring, the danger of increased susceptibility to wind erosion must also be addressed.

These impacts can be summarized as follows:

Table 4 Impact significance

Nature: Loss of agricultural potential		
	Without mitigation	**With mitigation**
Extent (E)	Low (2)	Low (2)
Duration (D)	Long-term (4)	Long-term (4)
Magnitude (M)	Slight (4)	Minor (2)
Probability (P)	Probable (3)	Improbable (2)
Significance (E+D+M)*P	**Low (24)**	**Low (16)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	Yes
Mitigation: The main mitigation measure will be to develop the facility on low potential soils, wherever possible		
Cumulative impacts: Little or none foreseen at this time		
Residual Risks: Little or none, as long as proper rehabilitation measures are carried out.		

Table 5 Impact significance

Nature: Increased wind erosion hazard		
	Without mitigation	**With mitigation**
Extent (E)	Medium (3)	Low (2)
Duration (D)	Long-term (4)	Short-term (2)
Magnitude (M)	Moderate (6)	Minor (2)
Probability (P)	Probable (3)	Improbable (2)
Significance (E+D+M)*P	**Medium (39)**	**Low (12)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	Yes
Mitigation: This will involve ensuring that a vegetation cover (probably locally adapted grass mixture) remains on the soil surface as far as possible. In addition, dust suppression measures (watering, gravel cover of roads/tracks etc) should be taken		
Cumulative impacts: Removal of topsoil by wind would mean that the removed dust would be deposited on neighbouring properties.		
Residual Risks: Loss of topsoil would cause a drop in the natural fertility of the area, even in the ability to provide for grazing of livestock.		

6.1 Evaluation of alternatives

Alternative 1 has a distinct difference in soils between the northern and southern halves. The northern half (north of the dirt track) has largely disturbed, poor quality soils (Map unit **Wb**), while the southern half has better agriculture potential, especially in the south-west. The disturbed area (**Wb**) has areas where the soil depth seems to be relatively unaffected, but most of the area has subsurface limiting layers, such as spoil material, coal-like material and layers of impenetrable clay-rich material. The **Kd** unit is less disturbed, but has a subsurface clay layer with grey colours indicating signs of wetness. The depth of this layer varies, occurring both above and below the 500 mm threshold depth for a soil to be considered as occurring in a wetland area. It is possible that a more intensive soil investigation than the 150 x 150 m grid used in the area would allow a more definite classification of this area. In addition, cognizance of the findings of the wetland specialists regarding vegetation (amongst other indicators) also needs to be taken.

Alternative 2 has a wetland (Map unit **Ka**), which should be avoided completely. Surrounding the **Ka** unit are some areas of disturbance, where previous dumping and excavations can be observed, as well as some structures, concrete surfaces and other isolated infrastructure.

Based on the soil survey, it is recommended that, if possible, the proposed PV facility be developed on Alternative 1. To avoid possible wetness during the rainy season, the **Kd** unit be avoided, and if possible, as much of the **Av** unit (where the soils are of moderate agricultural potential) as possible should also be avoided.

Due to the sandy nature of the topsoil across much of the area, wind erosion is a definite possibility if the surface vegetation is removed. Therefore, care should be taken to minimize this risk by applying preventative measures, such as keeping the surface moist, reducing the spatial extent of vegetation removal and the time involved, and re-covering the soil surface as soon as possible once construction is completed.

REFERENCES

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Kotze, A.V., 1985. Climate data. In: Land types of the maps 2628 East Rand and 2630 Mbabane. *Mem. Agric. nat. Res. S. Afr*. No. 5. Department of Agriculture and Water Supply, Pretoria.

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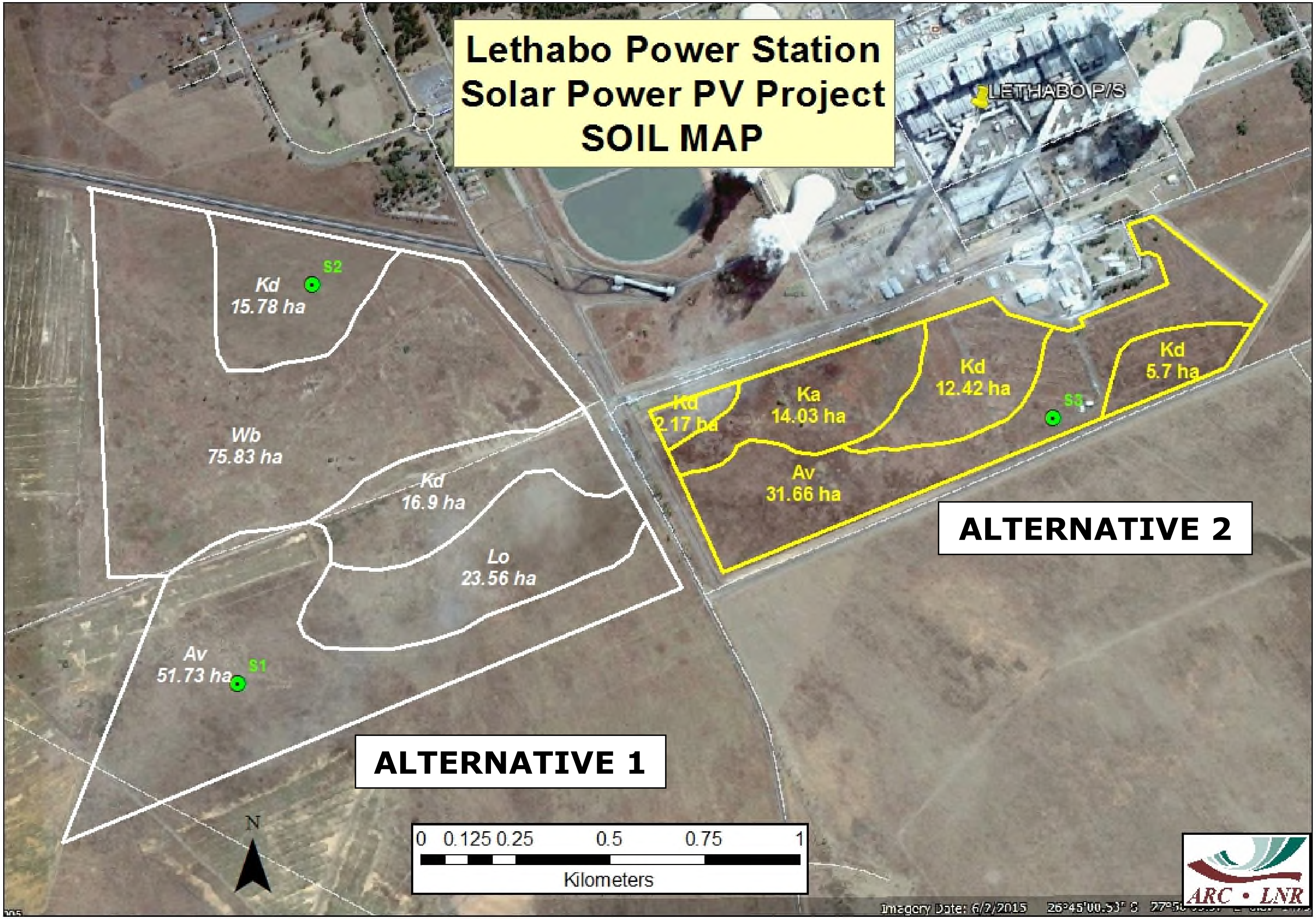
APPENDIX A

SOIL MAP

(LETHABO P/S PV FACILITY)



Lethabo Power Station
Solar Power PV Project
SOIL MAP
LETHABO P/S
Kd
15.78 ha
S2
Wb
75.83 ha
Kd
16.9 ha
Lo
23.56 ha
Av
51.73 ha
S1
Kd
2.17 ha
Ka
14.03 ha
Kd
12.42 ha
Kd
5.7 ha
S3
Av
31.66 ha
ALTERNATIVE 1
ALTERNATIVE 2
N
0 0.125 0.25 0.5 0.75 1
Kilometers
ARC • LNR
Imagery Date: 6/2/2015