REPORT

On contract research for

SAVANNAH ENVIRONMENTAL

SOIL INFORMATION FOR MOKOPANE INTEGRATION PROJECT, LIMPOPO PROVINCE

By

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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 in the north-west of the Limpopo Province. The purpose of the investigation is to look at the soils occurring, and their agricultural potential, within a corridor identified as part of the Mokopane Integration Project. The objectives of the study are;

- To obtain all existing soil information and to produce a soil map of the specified area
- To assess broad agricultural potential.
- To provide information on the soils of the proposed alternative sites of the new substation to the north of Mokopane.

2. SITE CHARACTERISTICS

2.1 Location

The area lies between the towns of Lephalale (Ellisras) and Mokopane (Potgietersrus), as shown in Figure 1.

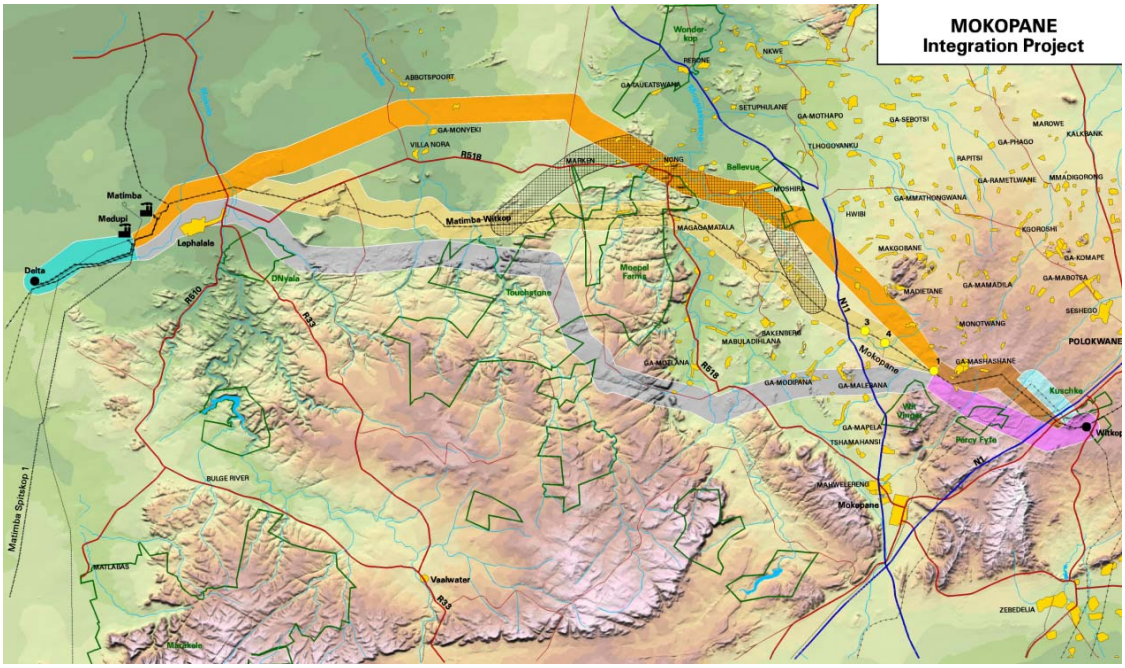

Figure 1 Locality map

2.2 Terrain

The area lies along the northern margin of the Waterberg mountain range. The surrounding plains comprise almost flat to gently undulating terrain, with altitudes of between 850 m and 1 100 m, while the mountains have steeper topography, with slopes up to 100% (45^{o}) in places, and maximum altitudes of 1 350 m to 1 400 m in places.

The area is drained by three major rivers, namely the Mokolo (Mogol), which flows past Lephalale, the Lephalala (Palala) and Mogalakwena Rivers, all of which flow northward from the Waterberg towards the Limpopo River, which forms the northern border of both the Province and of South Africa.

2.3 Climate

The climate of the area can be regarded as typical of the Bushveld, with mild to cool, dry winters and warm to hot, moist summers (Koch, 2005).

The rainfall on top of the Waterberg and surrounding hills will be in the order of around 600-650 mm, compared to the plains to the north, where only around 400-475 mm may be expected.

Temperatures for the Waterberg area vary from an average monthly maximum and minimum of 30ºC and 18ºC for January to 21ºC and 3ºC for July respectively, while the plains are around 2ºC warmer, both in winter and summer. The extreme high temperature that has been recorded is 44.5ºC and the extreme low –4.3ºC.

2.4 Parent Material

The study area is underlain by a variety of parent materials. Most of the central and southern parts comprise quartzite and conglomerate of the Waterberg Group, with some granite in the north and east. Close to Mokopane, norite of the Bushveld Complex occurs, while large parts in the north are underlain by various types of Quaternary sediments (Geological Survey, 1984).

3. METHODOLOGY

Existing information was obtained from the map sheets 2326 Ellisras (Paterson & Haarhoff, 1989) and 2328 Pietersburg (Botha, 1983) from the national Land Type Survey, published at 1:250 000 scale. A land type is defined as an area with a uniform terrain type, macroclimate and broad soil pattern. The soils are classified according to MacVicar *et al* (1977).

The various alternative routes under investigation are covered by a total of 84 land types, as shown in the map in the Appendix, namely:

Ab91, Ab92, Ab145, Ab146 (red, low to medium base status soils, usually deep)

Ac144, Ac146, Ac147, Ac149, Ac159, Ac160, Ac251, Ac252, Ac253 (red and yellow, low to medium base status soils, usually deep)
Ae224, Ae225, Ae227, Ae229, Ae233, Ae252, Ae253, Ae286, Ae289, Ae290, Ae292, Ae334, Ae335, Ae337 (red, high base status soils, usually deep)
Ah28, Ah75, Ah80, Ah85, Ah86 (red and yellow, high base status soils, usually deep)
Ba72 (red, low to medium base status soils with plinthic subsoils, usually deep)
Bb99, Bb116, Bb117 (non-red, low to medium base status soils with plinthic subsoils, usually deep)
Bc44, Bc45, Bc46 (red, high base status soils with plinthic subsoils, usually deep)
Bd39, Bd44, Bd45, Bd46, Bd51, Bd57 (non-red, high base status soils with plinthic subsoils, usually deep)
Ca117 (mixed plinthic and clay soils)
Db234 (clayey, duplex soils – non-red)
Ea207, Ea208, Ea209 (structured, swelling clay soils)
Fa276, Fa279, Fa295, Fa296, Fa531, Fa532, Fa533, Fa534, Fa757, Fa758, Fa760 (generally shallow soils, no lime)
Fb349, Fb437, Fb439 (generally shallow soils, occasional lime)
Fc478, Fc573, Fc731, Fc732 (generally shallow soils, usually with lime)
Ia109, Ia130, Ia131, Ia132, Ia167, Ia168 (alluvial soils, usually deep)
Ib280, Ib285, Ib286, Ib293, Ib296, Ib298, Ib307, Ib351, Ib446, Ib447 (shallow soils with rock)

It should be clearly noted that, since the information contained in the land type survey is of a reconnaissance nature, only the general dominance of the soils in the landscape can be given, and not the actual areas of occurrence within a specific land type. Also, other soils that were not identified due to the scale of the national Land Type Survey may also occur.

4. SOILS

A summary of the various classes of agricultural potential, based on the soils and/or rock occurring in each land type, is given in **Table 1** below. The colours of the land types correspond with the colours used in the map in Appendix 1.

The dominant agricultural potential class has been coloured in to correspond with the colours used in the map in Appendix 2.

From this table, it can easily be seen that certain land types are strongly dominated by a particular class of agricultural potential, e.g. Ae252 (89% high potential soils) or Ib285 (100% low potential soils).

However, certain land types have a much more even distribution of potential, e.g. Ab92, Ae335 and Fb437. Certain land types have almost an equal dominance of two classes, e.g. Bd46 and Ah28.

Table 1 Agricultural Potential Classes

Land Type	Agricultural Potential (%)		
	High	Medium	Low
Ab91	8.6	***64.6***	28.8
Ab92	***37.7***	37.1	25.2
Ab145	10.0	***63.5***	26.5
Ab146	***69.1***	12.5	8.4
Ac144	7.7	***88.5***	3.8
Ac146	3.9	***76.6***	19.5
Ac147	20.4	33.7	***45.9***
Ac149	24.3	***65.9***	19.8
Ac159	4.8	***51.1***	44.1
Ac160	43.8	***55.9***	0.3
Ac251	***66.5***	31.0	2.5
Ac252	16.6	35.8	***47.6***
Ac253	5.3	***51.6***	45.1
Ae224	7.5	***87.0***	5.5
Ae225	47.4	***49.1***	3.5
Ae227	5.0	***72.7***	22.3
Ae229	2.0	45.5	***52.5***
Ae233	4.0	***73.5***	22.5
Ae252	***89.0***	0.0	11.0
Ae353	0.0	***94.7***	5.3
Ae286	11.0	36.0	***53.0***
Ae289	12.5	***75.9***	11.6
Ae290	31.4	***63.8***	14.8
Ae292	31.3	***56.6***	12.1
Ae334	***70.5***	22.5	7.0
Ae335	***40.3***	33.9	25.8
Ae337	34.5	***47.5***	18.0
Ah28	3.5	45.9	***50.6***
Ah75	13.6	***58.3***	28.1
Ah80	1.5	46.5	***52.0***
Ah85	4.5	***93.6***	1.9
Ah86	7.6	***91.6***	0.8
Ba72	39.9	***43.5***	16.6
Bb99	***69.5***	19.4	11.1
Bb116	10.5	***74.4***	15.0
Bb117	21.0	***57.0***	22.0
Bc44	20.8	***76.4***	2.8
Bc45	***70.6***	18.8	10.6
Bc46	0.0	***86.2***	13.8
Bd39	3.8	46.1	***50.1***
Bd44	0.0	***87.6***	12.4
Bd45	***73.4***	16.6	10.0

Land Type	Agricultural Potential (%)		
	High	Medium	Low
Bd46	47.1	***48.1***	4.8
Bd51	19.1	***71.3***	9.6
Bd57	5.8	***48.8***	45.6
Ca117	0.0	***94.0***	6.0
Db234	0.0	***76.5***	23.5
Ea207	0.0	***100.0***	0.0
Ea208	0.0	***66.8***	33.2
Ea209	0.0	***100.0***	0.0
Fa276	5.3	3.0	***91.7***
Fa279	2.0	24.0	***74.0***
Fa295	1.6	40.8	***57.6***
Fa296	0.0	0.0	***100.0***
Fa531	0.0	7.0	***93.0***
Fa532	16.0	3.0	***81.0***
Fa533	0.0	20.0	***80.0***
Fa534	0.0	6.0	***94.0***
Fa757	0.0	34.0	***66.0***
Fa758	0.0	13.5	***87.5***
Fa760	0.0	34.0	***66.0***
Fb349	16.0	32.2	***51.8***
Fb437	28.7	***43.0***	28.3
Fb439	16.0	24.0	***60.0***
Fc478	22.6	0.0	***77.4***
Fc573	2.0	***65.0***	33.0
Fc731	12.0	***57.7***	30.3
Fc732	22.0	***51.0***	27.0
Ia109	***82.0***	0.0	17.8
Ia130	***82.2***	34.0	8.0
Ia131	***56.0***	34.0	8.0
Ia132	***78.0***	18.0	4.0
Ia167	***81.5***	6.5	12.0
Ia168	***40.0***	32.0	28.0
Ib280	0.0	3.0	***97.0***
Ib285	0.0	0.0	***100.0***
Ib286	0.0	0.0	***100.0***
Ib293	3.5	2.0	***94.5***
Ib296	0.0	9.5	***90.5***
Ib298	0.0	5.5	***94.5***
Ib307	0.0	20.1	***79.9***
Ib351	0.0	4.0	***96.0***
Ib446	0.0	0.0	***100.0***
Ib447	0.0	10.0	***90.0***

5. AGRICULTURAL POTENTIAL

However, it should be borne in mind that this refers to ***soil potential only***, with no prevailing climatic conditions taken into account.

5.1. Power line corridor

As can be seen from the information contained in Table 2, several land types (Ab92, Ab146, Ac251, Ae334, Ae252, Ae334, Ae335, Bb99, Bc45, Bd45, Ia109, Ia130, Ia131, Ia132, Ia167, Ia168) are dominated by high potential soils, generally deeper than 900 mm, with a friable nature, and no strong structure or extreme texture. The distribution of these land types is shown on the map in Appendix 2.

Special attention should be given to the Ia land types, as these areas comprise alluvial soils and are usually found close to the larger rivers, where irrigated areas my well occur, using the water source that the river may provide. In these areas, the siting of a power line may be problematic, due to intensive irrigation that may be present.

Conclusion

Matimba-Witkop (existing lines) (middle): little high potential soils, much rocky land.

Medupi-Mokopane 2 (north): mostly medium potential soils, with high potential soils west of the Lephalala River and between Steilloopbrug and Mokopane.

Medupi-Mokopane 3 (south): some high potential soils south-east of Lephalale, otherwise mostly low to medium potential soils.

Mokopane-Witkop 1-3: little variation, same land type (Ab91), with medium potential soils.

Based on the above, it would appear as if the preferred route would be the Medupi-Mokopane 3 (potentially fewer high potential soils) followed by the existing Matimba-Witkop corridor, and the least favoured, Alternative 2 (where the most amount of high potential soils occur).

In addition, two possible deviations from the existing line (Corridor 8) to Medupi-Mokopane 2 (north) were proposed. However, neither of these deviations will impact on a new land type and, as can be seen from the potential map (Appendix

2), the agricultural potential of the soils being traversed does not significantly vary from either of the two original corridors in the vicinity.

From Mokopane to Witkop, there is no preference, based on soils.

5.2. Substation site

At a scoping level, there is little to choose between the dominant soils occurring at Alternative 1 and Alternative 2 (land type Ah 28) and at Alternative 3 (land type Bd57), while Alternative 4 should be avoided, since it occurs just inside land type Ae335, where higher potential soils could occur.

A detailed survey was therefore carried out for each of the proposed substation sites, in order to assess the soils at a much greater level of detail.

5.2.1 Location

The three sites that were investigated are all adjoining the present Matimba-Witkop transmission line.

Site 1 is on the farm Aronsfontein 722LS, on the northern side of the power line and on the southern side of a dirt road. Site 3 is on the farm Zuid Holland 773LS, on the southern side of the power line and northern side of a dirt road. Site 4 lies between Site 1 and Site 3, on the farm Noord Braband 774LR and is on the southern side of the power line.

5.2.2 Methodology

Each of the three sites was investigated on a 150 x 150 m grid, using a hand-held soil auger. The soils occurring were described and classified according to the latest edition of the South African soil classification system (Soil Classification Working Group, 1991). Similar soils were then grouped into reasonably homogeneous mapping units and the boundaries of these units were then drawn onto a map.

Samples were collected at three locations (one in each area) for analysis in the laboratories at ARC-ISCW. The soils were analysed for particle size (sand, silt and clay), exchangeable cations (Na, Mg, K, Ca), pH, organic carbon and P. These sample sites are marked on the soil maps.

5.2.3 Soils

The soils were generally shallow, grey-brown, often gravelly sandy loams. Only small areas of deeper soils were encountered. The details of the soils occurring are given in Table 2.

Table 2 Soil legend

Map Unit	Depth (mm)	Dominant Soil Form	Soil Characteristics	Agric. Pot.
dVa(lm)	600-1000	Valsrivier	Brown to grey-brown, weakly structured, sandy clay loam topsoil on brown, moderately structured, sandy clay subsoil	Low to moderate
mCv(m)	600-900	Clovelly	Brown, structureless, sandy loam topsoil on yellow-brown, weakly structured, sandy clay loam subsoil on rock	Moderate
mAv(m)	600-900	Avalon	Brown, structureless, sandy loam topsoil on yellow-brown, weakly structured, sandy clay loam subsoil on grey, mottled soft plinthite	Moderate
sCv(l)	200-500	Clovelly	Brown, structureless, sandy loam topsoil on yellow-brown, weakly structured, sandy clay loam subsoil on rock	Low
sMs(l)	50-250	Mispah	Brown to grey-brown, structureless to weakly structured, sandy loam topsoil on rock	Low

5.2.4 Analytical results

The results of the soil analyses that were carried out are given in Table 3.

The results show that the soils are not highly leached, and are light-textured, especially in the topsoil, with texture from loamy sand to sandy loam. They are also neutral to very slightly acidic.

The P levels are fairly low, as would be expected from natural vegetation, while the organic carbon levels are very low, which is partly a result of the sparse vegetation cover in the area.

No abnormal or unexpected values were encountered.

Table 3 Soil analytical results

Sample site		**S1**		**S2**	**S3**	
Co-ordinates (Lat/Long)		23°52'31.1"S 28°55'40.4"E		23°54'11.1"S 28°58'33.2"E	23°56'51.0"S 29°04'32.2"E	
Locality		Site 3		Site 4	Site 1	
Soil Form		Avalon		Clovelly	Estcourt	
Horizon		A1	B1	A1	A1	B1
Depth (mm)		0-200	200-450	0-200	0-200	400-700+
Sa	**%**	74.3	67.7	85.9	90.6	55.3
Si		5.7	8.3	6.1	3.4	12.7
Cl		20	24	8	6	32
Na	**cmol kg^{-1}**	0.137	1.813	0.136	0.367	0.060
K		0.203	0.297	0.248	0.205	0.197
Ca		0.812	5.721	0.988	1.534	0.633
Mg		0.508	3.718	0.867	1.494	0.322
CEC		5.308	15.698	5.847	6.799	2.541
P (ppm)		9.46	3.29	5.80	1.45	12.61
pH (H_2O)		6.49	7.38	6.53	7.31	6.24
Org C (%)		0.77	0.52	0.46	0.26	0.32

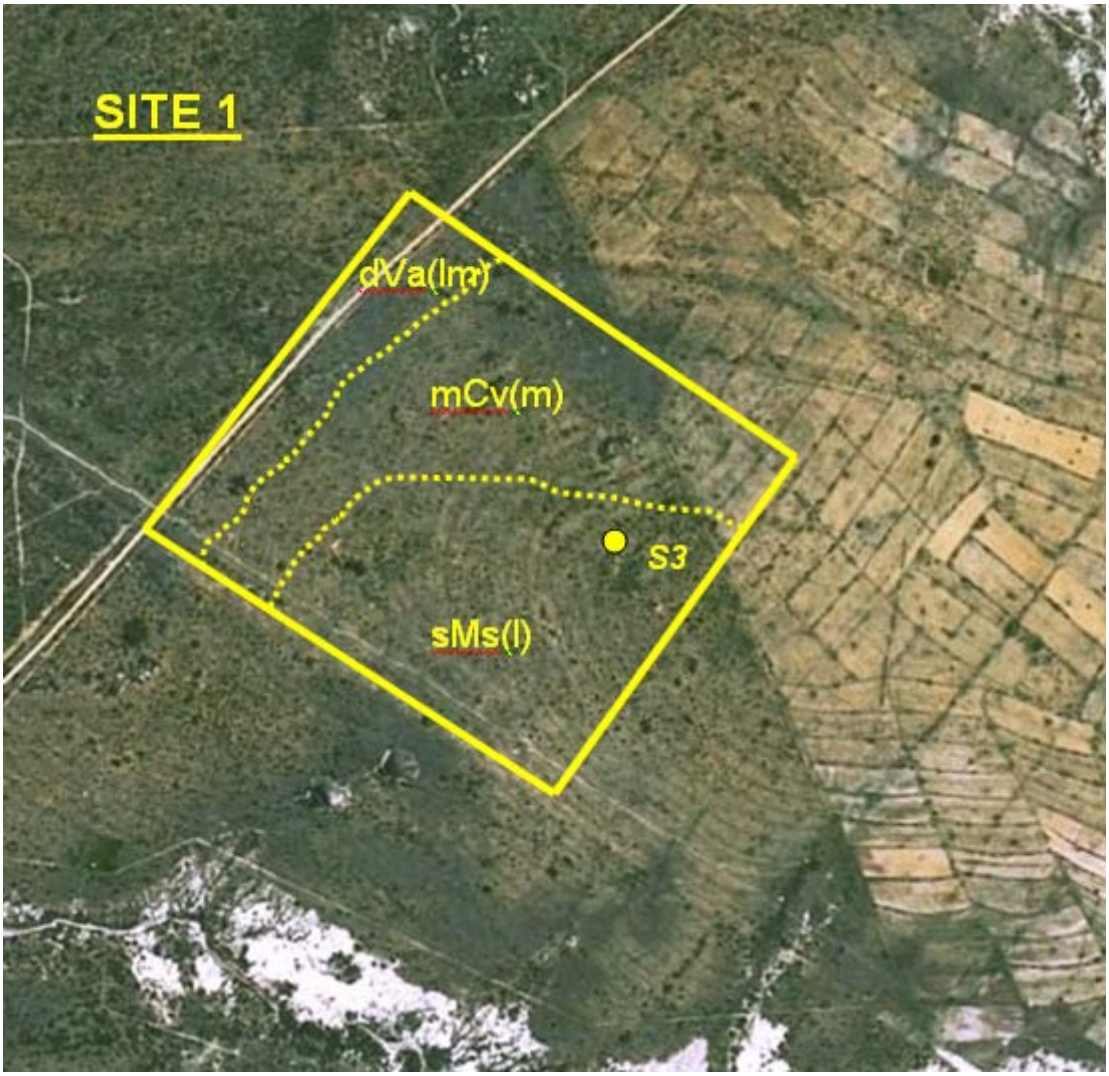

Figure 2 Soil map of substation site 1

Figure 3 Soil map of substation site 3

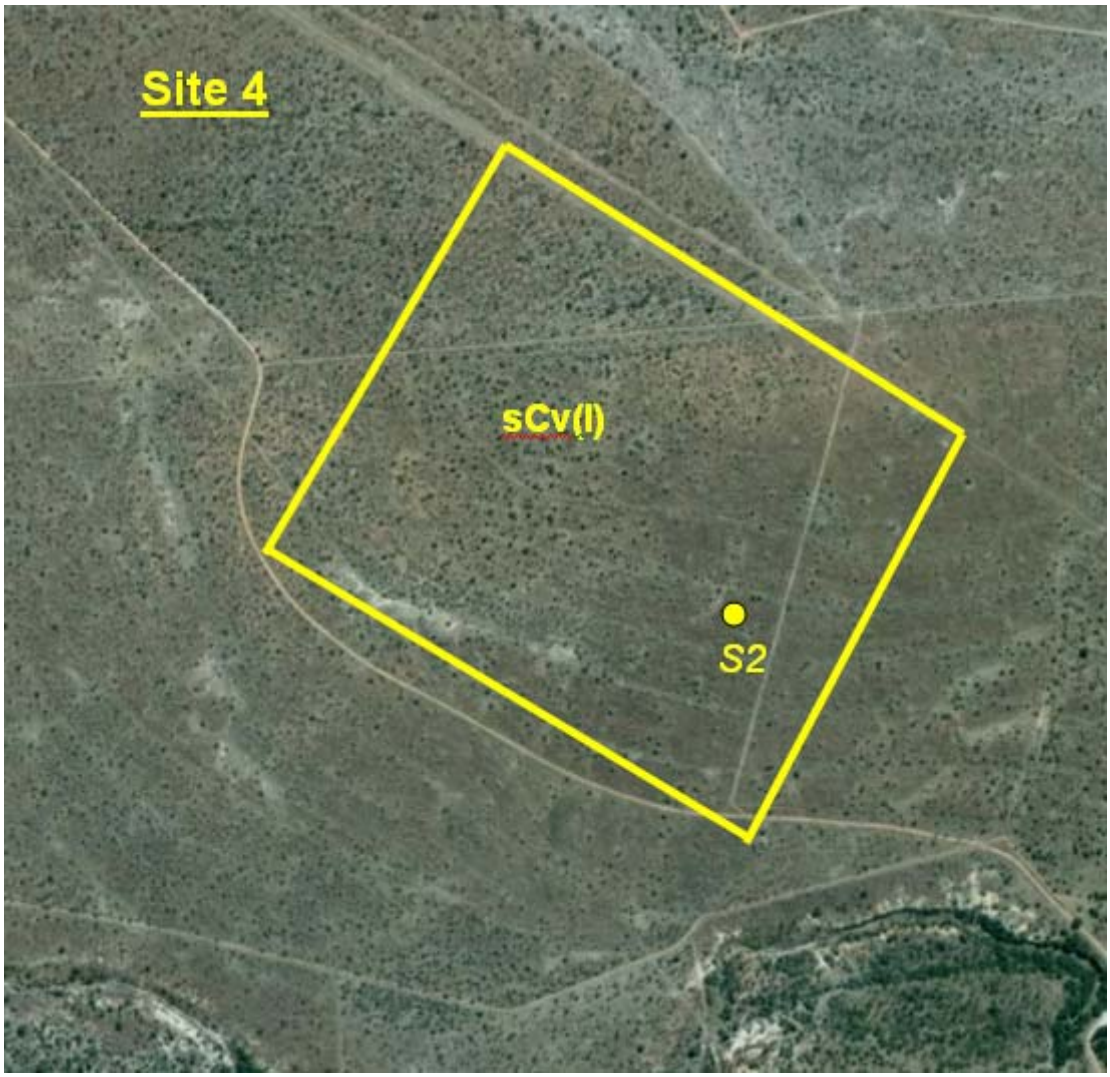

Figure 4 Soil map of substation site 4

5.2.5 Agricultural Potential

It can clearly be seen from the soil maps that both Site 4 and Site 3 have predominately soil with a low agricultural potential (shallow, gravelly, rocky in places – map units **sCv(l)** and **sMs(l)**), while Site 1 has mixed soils, with the southern half comprising the same shallow soils (**sMs(l)**), while the northern half has some deeper soils (**mCv(m)** map unit), although these soils are no deeper than 900 mm, so are classed as having moderate agricultural potential.

Therefore, in terms of soils, the recommendations are as follows:

Strongly Recommended:	**Site 4** (all shallow soils)
Recommended:	Site 3 (>90% shallow soils)
Not recommended:	**Site 1** (±40% shallow soils)

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