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Irrigation Suitability Report for a 6.5 ha field, in the Hopetown area, Northern Cape Province

for

Eco-Con

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Executive summary

A soil survey was conducted for Eco-con on a 6.5 ha field in the Hopetown area, Northern Cape Province. The aim of the survey to assess the suitability of the area for the cultivation of pumpkin under irrigation.

The soils of this study area are dominated by the Prieska soil form with an apedal structure which is well drained up until the hard carbonate horizon.

The clay contents of the soils, drainable depth, EC values and exchangeable sodium percentage are all within the norms as stipulated by the Department of Agriculture, Northern Cape. As a result, the whole site is described as suitable for irrigation (Figure A).

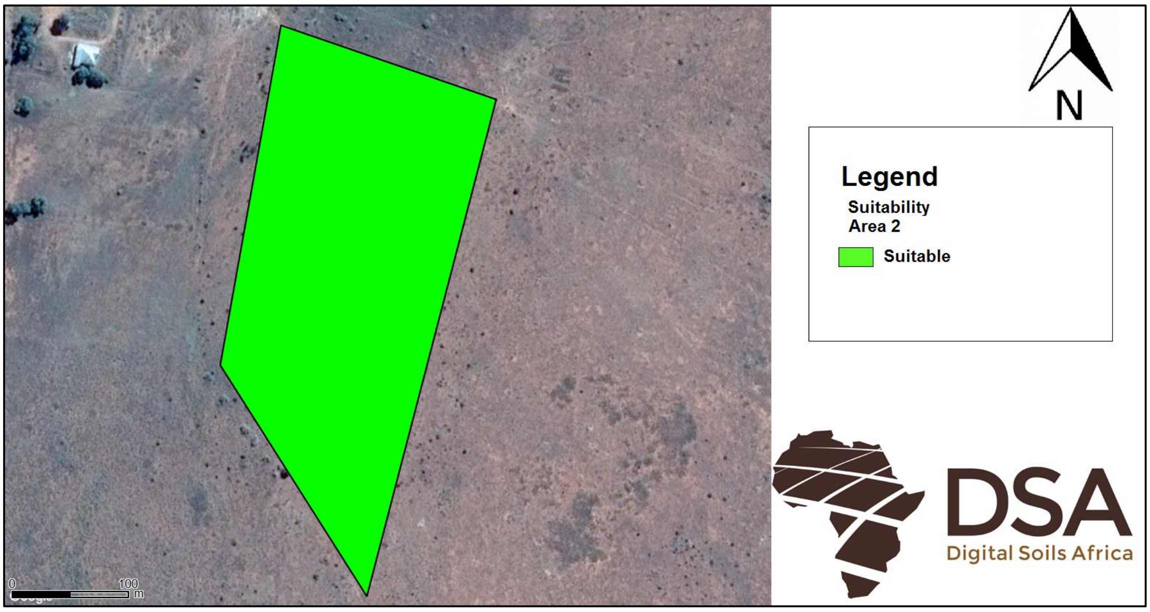

Figure A: Suitability of the surveyed area for irrigation.

1. Introduction

Digital Soils Africa conducted a soil survey on a 6.5 ha field near Hopetown, in the Northern Cape Province. The aim of the survey was to determine the suitability of the soils for the cultivation of pumpkin under irrigation. For sustainable irrigation of soil, the risks of water logging, salinization and drainage need to be established. When irrigation water is applied, dissolved salts are applied with the water. Plants mainly remove water through transpiration, resulting in the accumulation of salts in the soils, which may result in yield decreases and crop losses. In extreme cases, salinization will reach an extent that the soil cannot be vegetated anymore. These effects can be negated with proper management of soils with certain properties. For this reason, the Department of Agriculture, Northern Cape, has provided guidelines to which soil properties must adhere to before a ploughing certificate can be granted (de Bruyn, 2015). These properties are related to the water infiltration of the soil, as well as salt and sodium build-up. On this site, the properties of the soils and the distribution thereof, were investigated and areas where irrigation can be managed sustainable were identified.

2. Location

The site is located in the Hopetown area. The co-ordinates of the perimeter points of the surveyed area is shown in Table 1. The size of the surveyed area is 6.5 ha.

Table 1: Coordinates of the perimeter points of the sites

Nr	X	Y
	Area 2	
1	24.10074	-29.48058
2	24.10240	-29.48107
3	24.10240	-29.48107
4	24.10027	-29.48285

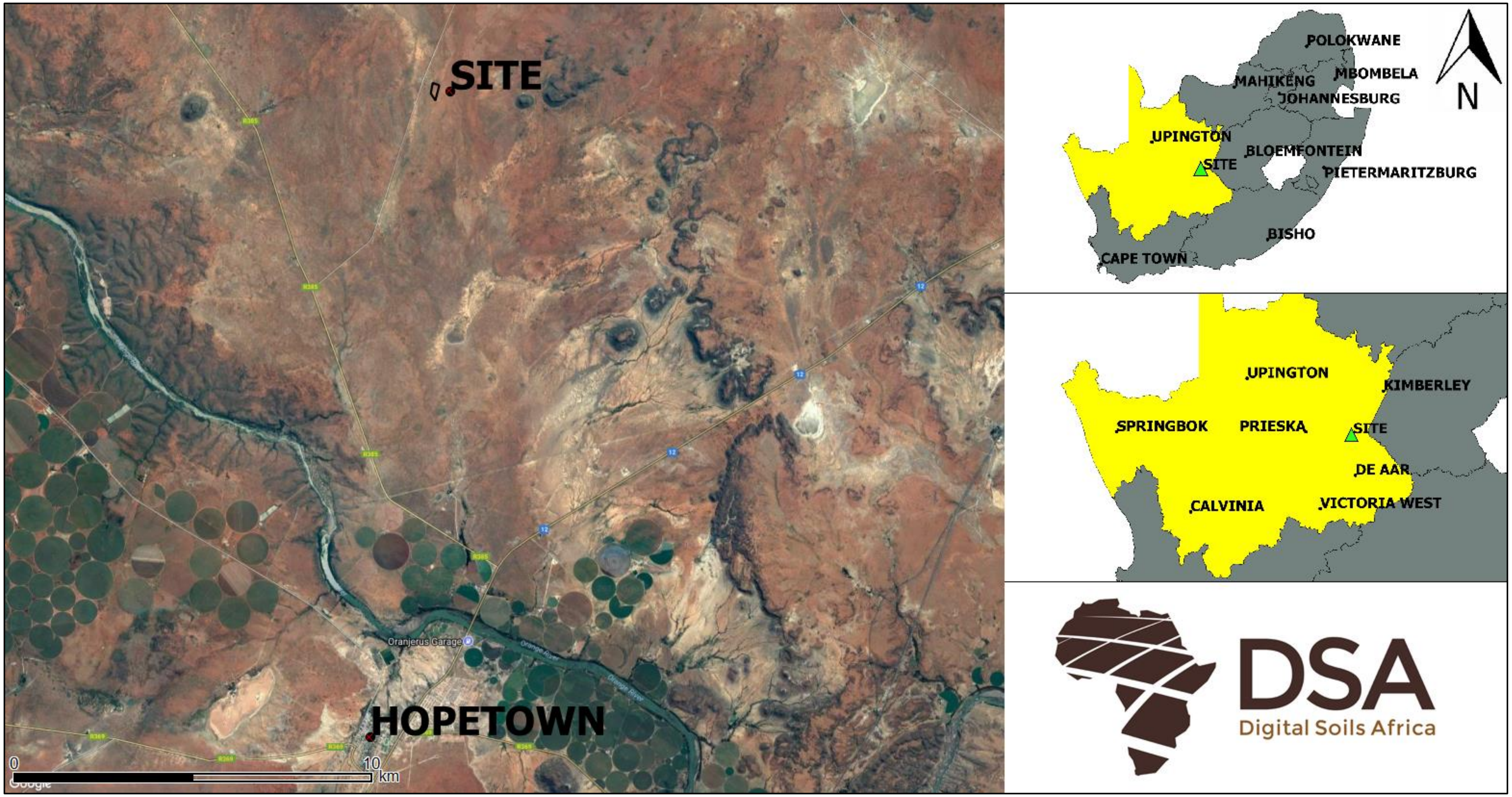

Figure 1: The location of the study site.

3. Methodology

A field visit was conducted on the 26th of March 2018. Two soil profiles were opened by the client to a depth of refusal using a TLB. A third observation was augured by the soil surveyor to refusal. Soils were classified according to the South African Soil Classification System (Soil Classification Working Group, 1991). Soil depth and limiting material were noted and mapped. Two samples of a modal profile were taken for chemical and physical analysis, which included one topsoil sample (A horizon) and one subsoil sample (B horizon). Figure 2 shows the locations of the observation positions, while their GPS co-ordinates and other relevant information are given in Appendix 1.

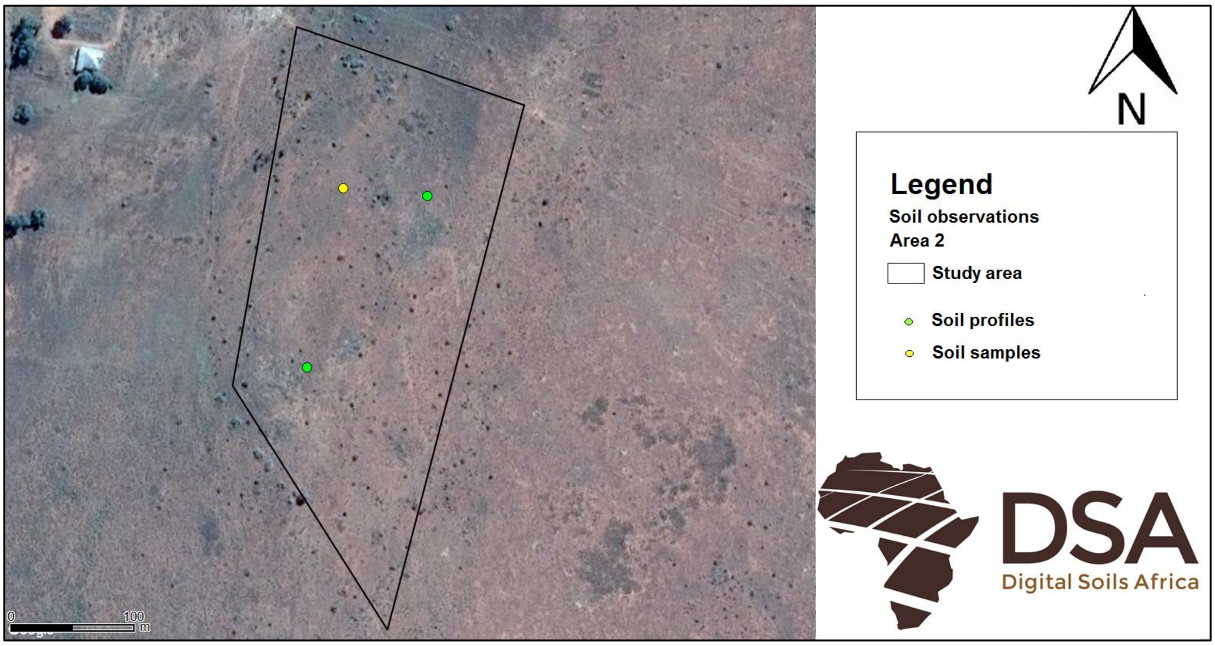

Figure 2: Soil observation locations for the study site.

4. Results

4.1. Soils forms

Prieska soil forms, were observed at all three profiles (see Figure 3 and Figure 4). The Prieska soil form consist of an orthic A horizon overlaying a neocarbonate B horizon on hardpan carbonate. General characteristics of the horizons are presented below.

Orthic A

The orthic A is sandy, red, and structureless (apedal). The transition to the neocarbonate B horizon is diffuse.

Neocarbonate B

This soil horizon contains enough lime to effervescence with 10% HCl. They are red, apedal and sandy. The clay percentage measured was 18.3%. Salinity is expected to be relatively high, due to the presence of lime. It is expected that the lime could be leached from the profile under irrigation, depending on the conductivity of the harpan carbonate horizon.

Hardpan Carbonate

Within this horizon lime has accumulated to the point that it dominates the morphology of the horizon and has hardened that it cannot be cut with a spade. This horizon is generally impeding to water movement and does not drain well. It can however be mechanically broken which can increase the hydraulic conductivity significantly and thereby increase drainage.

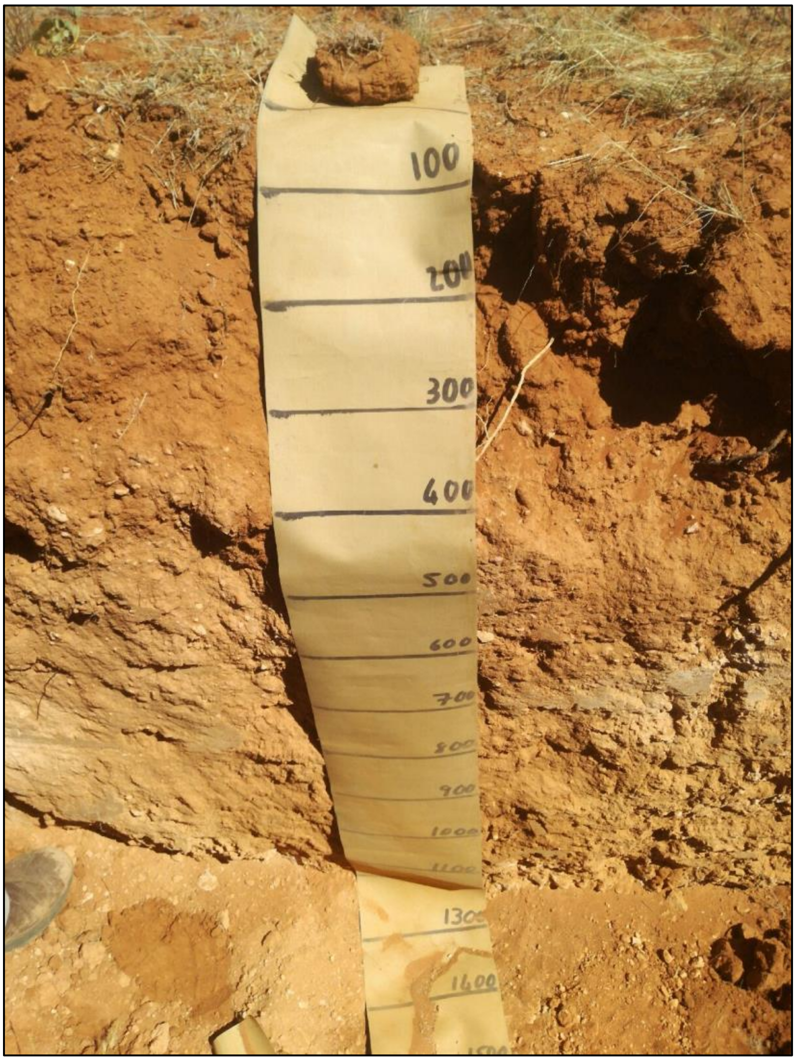

Figure 3: Example of the Prieska soil form observed.

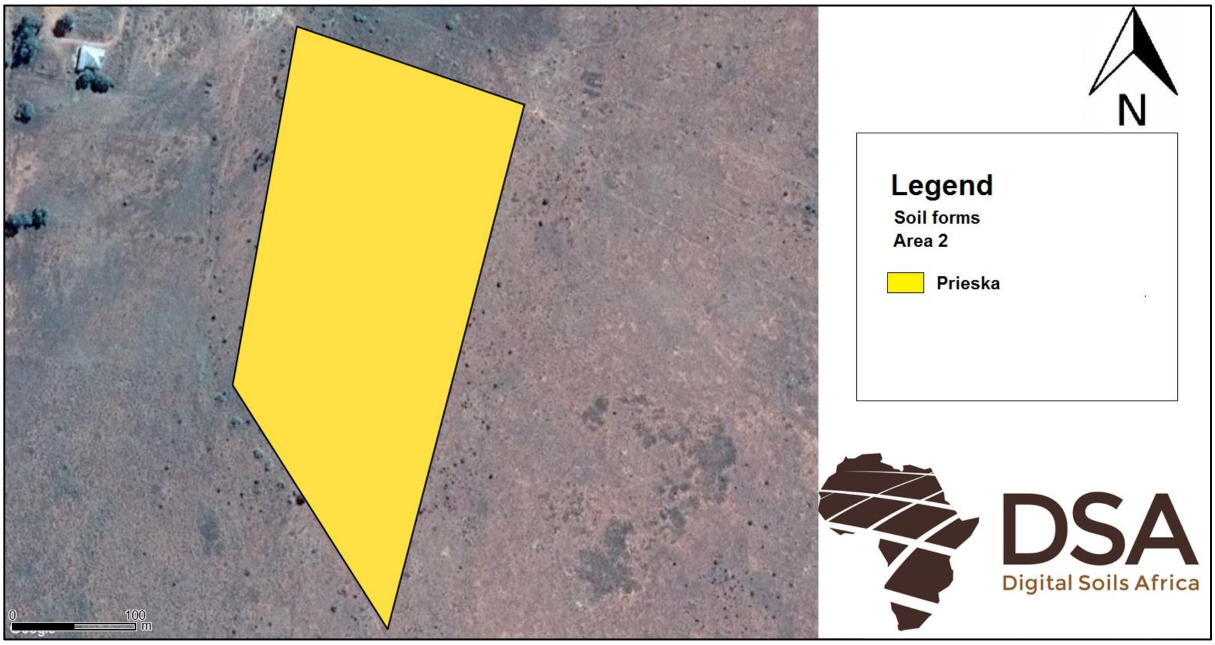

Figure 4: Distribution of the soil form on the study site.

4.2. Soil Depth

The soil map of the surveyed area is shown in Figure 4. Figure 5 shows the depth of the freely drained soil. This freely drained depth is the depth of the orthic A and neocarbonate horizon, because the hard carbonate horizon is not freely drained. Figure 6 shows the drainable depth, which is the observation depth.

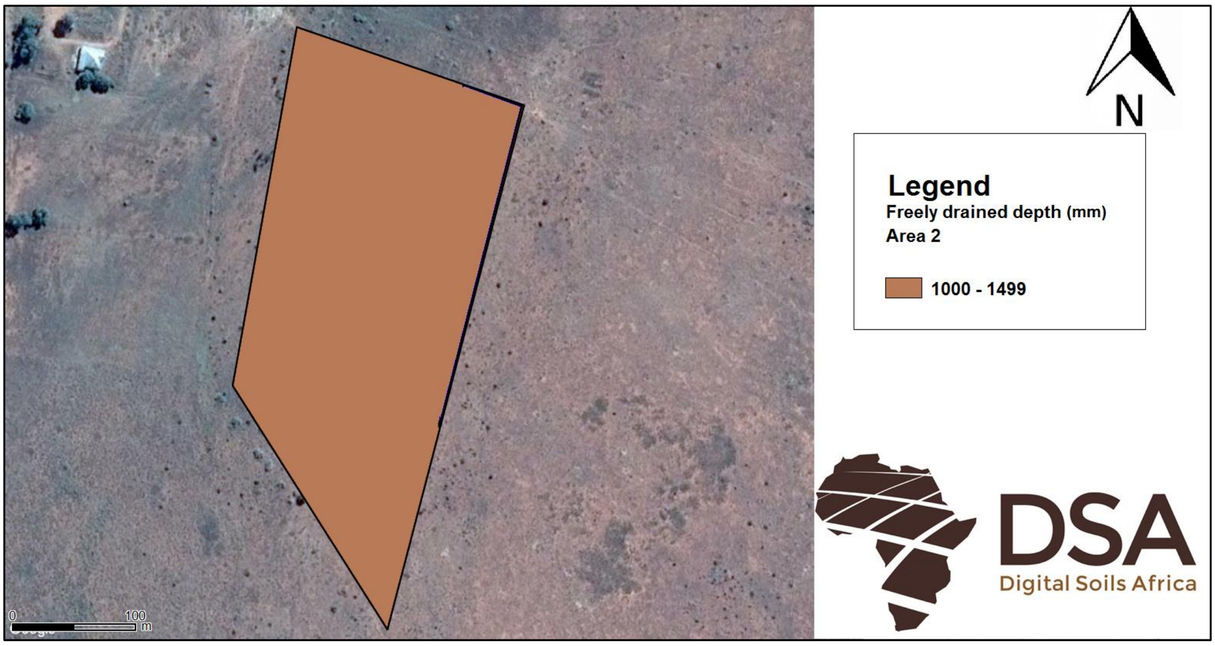

Figure 5: Depth of the freely drainable soil, before it reaches the hard carbonate horizon.

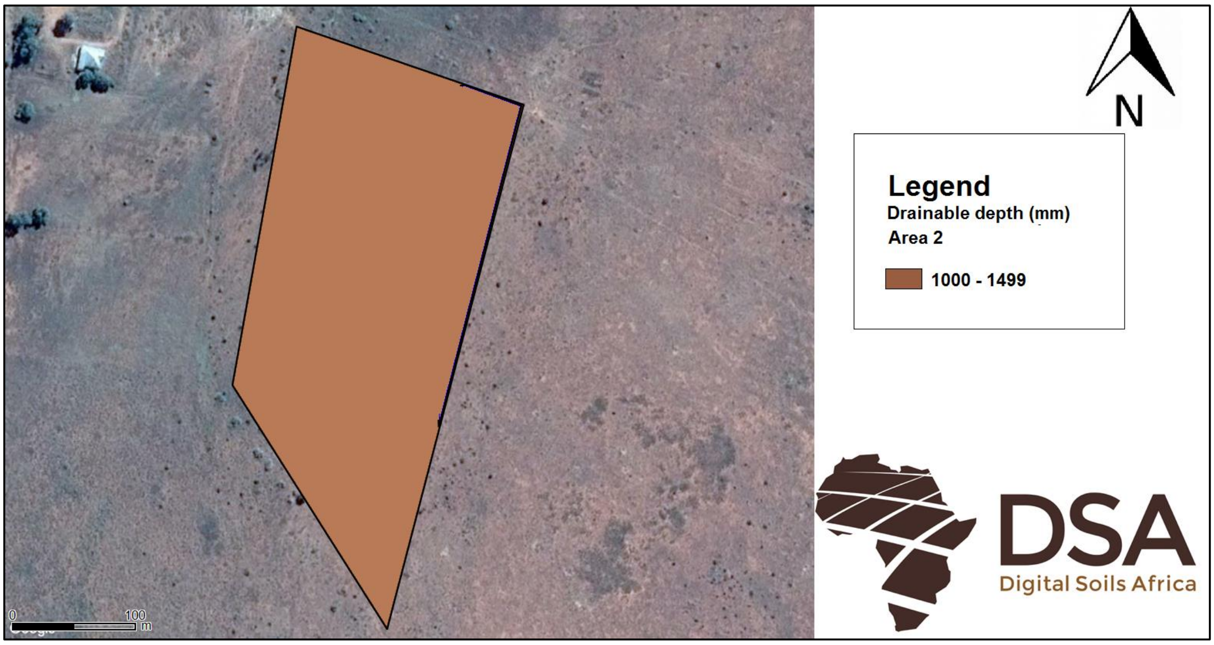

Figure 6: Drainable depth of the study site.

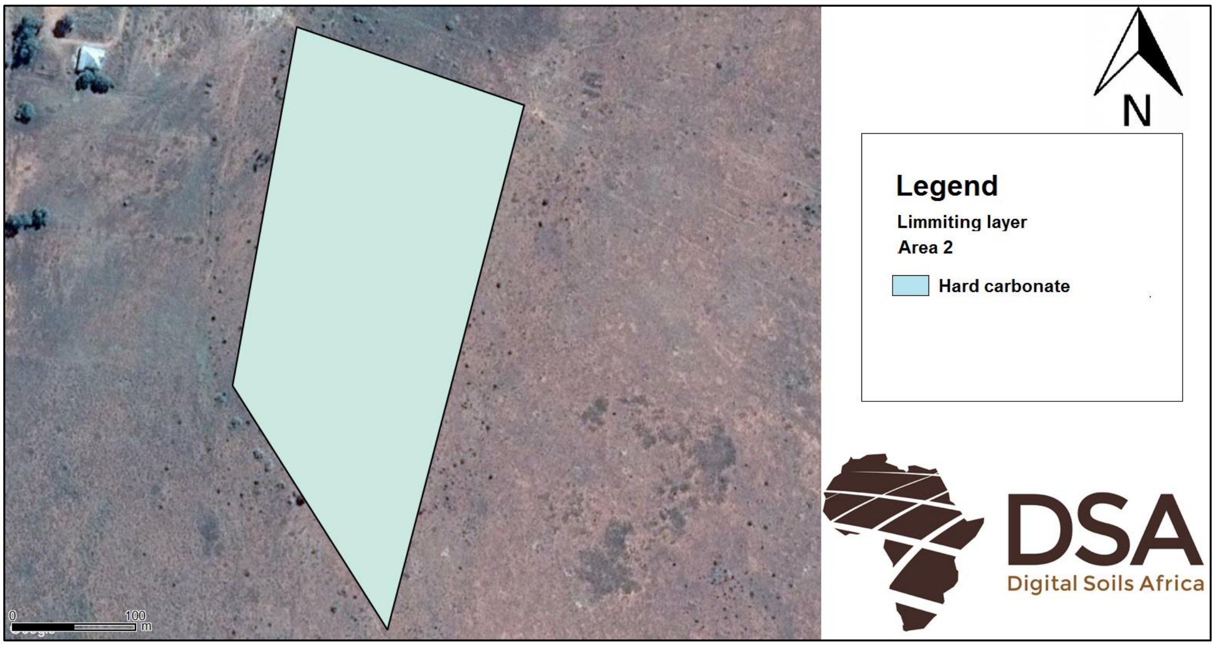

Figure 7: Depth limiting layers of the study site.

4.3. Laboratory analysis

Tables 2 (chemical) and 3 (texture) present selected soil properties of samples taken from modal profiles.

The pH of the A and B horizons is alkaline (8.08 and 8.07 respectively), above the threshold value of 7.5. It is however suspected irrigation will leach some of the base forming cations and lower pH of the soil (dependable on the quality of the irrigation water).

The salt content of the soils is low in the A horizon and B horizon when compared to the threshold value of 400 mS.m^{-1}. The measured EC of the A horizon is 30.2 mS.m^{-1} and 23.4 mS.m^{-1} for the B horizon. The ESP values ranges from low in the A-horizon (0.69%) to very low in the B-horizon (0.33%). This is below the threshold value of 5%. Therefore, the sodicity is currently not a threat in the surveyed area.

The textural analyses confirm the morphological indication that the soils are sufficiently drained. The clay percentages of the A horizon and B horizon are approximately 20%, which is well below the acceptable threshold of 35%.

Table 2: Selected chemical properties for modal soil profiles.

Sample	Soil Form	Diagnostic horizon	pH KCl	EC ms/m	ESP %	CEC cmol(+)/kg
7A	Prieska	Orthic A	8.08	30.2	0.69	17.92
7B		Neocarbonate B	8.07	23.4	0.33	37.40

Table 3: Texture analysis for modal soil profiles.

Sample	Soil Form	Diagnostic horizon	Clay %	Silt %	Sand %
7A	Prieska	Orthic A	20.29	6.30	74.85
7B		Neocarbonate B	18.30	3.19	80.00

5. Suitability

Based on the soil morphology and laboratory analysis, the areas shown in Figure 8 are suitable for irrigation according to the norms of the Department of Agriculture, Northern Cape. The perimeter points are the same as mentioned in Table 1.

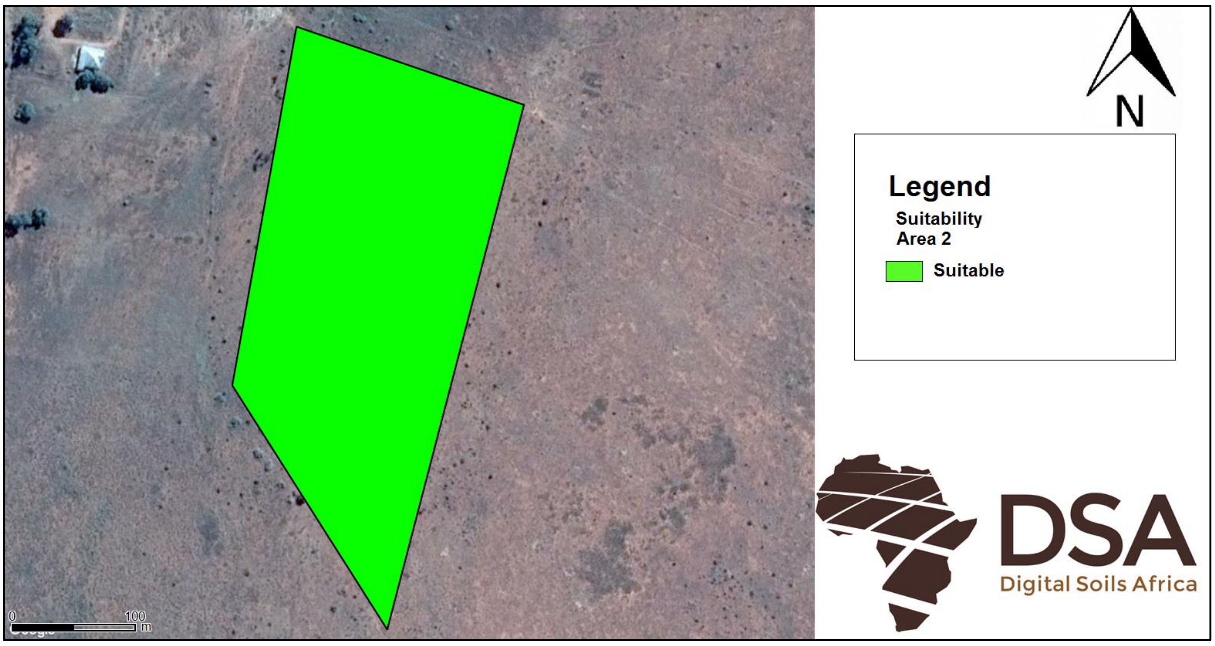

Figure 8: Suitability for pumpkin cultivation and irrigation of the study site.

6. Conclusion

Soil morphological indicators and laboratory analysis indicate that the entire site of 6.5 ha is conducive to irrigation.

7. References

De Bruyn, W.J.J., 2015. Departmental norms to conduct soil investigations for the cultivation of virgin soil. Sustainable Resource Management Frances Baard Districts, Northern Cape.

Fertilizer Handbook, 2016. The Fertilizer Society of South Africa, Hennopsmeer.

Soil Classification Working Group, 1991. Soil classification – a Taxonomical System for South Africa. Department of Agriculture, Pretoria.

8. Disclaimer

Digital Soils Africa cannot be held responsible for any advice given based on incorrect laboratory analysis given by our providers. Although all care is taken to ensure that the results reported are correct, we are dependent on services from other companies.

9. Appendices

Appendix 1: Observation locations of the study site

Nr	X	Y	Soil Form	Limiting Material	Freely Drained Depth (mm)	Drainable Depth (mm)
1	24.10109	-29.48160	Prieska	Hard carbonate	1200	1200
2	24.10109	-29.48160	Prieska	Hard carbonate	1300	1300
3	24.10170	-29.48166	Prieska	Hard carbonate	1000	1200

Appendix 2: Modal soil profile descriptions

General Information						
Site:	Hopetown				Soil form:	Prieska
Map/Photo example:	Figure 7				Soil family:	1210
GPS Position:	24.10109; -29.48160				Colour	red
Surface stones:	N/A				Occurrence of flooding:	None
Altitude:	1124 m				Wind erosion potential:	moderate
Terrain unit:	upper slope				Water erosion potential:	low
Slope:	2%				Vegetation/Land use:	Natural Veld
Slope shape:	Planform	Straight	Profile	Convex	Water table:	None
Aspect:	None					
Micro-relief:	None				Described by:	CJ du Plessis
Parent material solum:	Not reached				Date described:	2018-03-26
Geological group:	Prins Albert formation, Ecca Group				Weathering of underlying material:	Stones

Profile Information

Horizon Depth (mm)	*Diagnostic Horizon*	*Colour*	*Structure*	*Redoximorphic features*	*Lime*	*Transition*
A 300	Orthic A	red	apedal	None	no	Diffuse
B1 1200	Neocarbonate	red	apedal	None	Yes	Clear
C 1200+	Hard carbonate	white	N/A	None	Yes	N/A

Appendix 3: Selected chemical soil properties

	Ca				Mg			
Sample nr	mg/l	mg/kg	me/kg	cmol(+)/kg	mg/l	mg/kg	me/kg	cmol(+)/kg
07 NC	304.98	6099.59	304.98	30.50	8.37	167.33	13.72	1.37
07 ot	112.51	2250.16	112.51	11.25	20.76	415.25	34.04	3.40

	Na				K			
Sample nr	mg/l	mg/kg	me/kg	cmol(+)/kg	mg/l	mg/kg	me/kg	cmol(+)/kg
07 NC	1.21	24.23	1.05	0.11	5.44	108.86	2.79	0.28
07 ot	1.20	24.06	1.05	0.10	10.94	218.78	5.61	0.56

	P		Suur versadiging%	Ca:Mg	Mg:K	(Ca+Mg)/K	%Ca/BK
Sample nr	mg/l	mg/kg	(norm 5 - 30)	(norm 1.5 - 4.5)	(norm 3 - 4)	(norm 10 - 20)	(norm +-65)
07 NC	0.34	6.80	13.77	22.24	4.93	114.46	94.56
07 ot	0.38	7.60	14.51	3.31	6.08	26.19	73.45

	%Mg/BK	%Na/BK	%K/BK	BK	KUK	EC	ESP	SAR
Sample nr	(norm +-25)	(norm <2)	(norm +-10)	cmol(+)/kg	cmol(+)/kg	ms/m	%	%
07 NC	4.25	0.326653358	0.86	32.25	37.40	23.40	0.33	0.05
07 ot	22.22	0.682860365	3.65	15.32	17.92	30.20	0.69	0.10

Appendix 4: Agronomical Report

1. General soil requirements pumpkin production

The suitability in the area of Hopetown site described in this report for pumpkin production is based on the physical and chemical soil properties presented in this report.

Pumpkins can be cultivated in a wide range of climates but prefer wetter areas of South Africa. A uniform moisture supply during the growing season is important for maximum quality and yields. During the seedling stage, the top 50 mm of soil should be moist and during the rest of the growing season the top 50 mm layer should be dry but the lower 250 mm should be kept moist. Pumpkins can develop good root systems that proliferate in the top 300 mm with the taproot going down to 1000 mm and that are able to effectively utilize nutrients and water available in the soil. Therefore, they grow well and produce excellent quality fruit in rich, light-textured soils. Sandy loam or well-drained loamy fertile soils, deeper than 1000 mm, are ideal for pumpkins. However, heavier soils can also be used as long as the drainage is adequate.

2. Physical properties

a. Soil depth

Pumpkin roots can extend, if root growth is not restricted, to a depth of 1000 m. The soils on the site has a freely drainable depth of 1000 mm to 1300 mm and is therefore suitable for pumpkin production.

b. Soil texture

Pumpkin can be cultivated on soils with a clay content that varies from less than 10% to more than 30%. The preferred texture classes are however between 10% and 30% as a result of air and water regimes that are optimal for high potential pumpkin production. The texture of the soil profiles within the suitable area is sandy-loam with a topsoil clay percentage of 20.29% and a subsoil clay percentage of 18.3%. This is within the optimal range for pumpkin production. Wind erosion, surface encrustation after planting and soil compaction might however occur. These factors can and has to be managed by the producer in accordance to the selected tillage system.

3. Chemical properties

a. pH

Pumpkin can be produced on soils with a $pH_{(H2O)}$ of 5.5-7.5, but the optimum $pH_{(H2O)}$ range for pumpkin production is between 6 and 6.5. The $pH_{(KCl)}$ of the soil samples are in the area of 8. It is anticipated that the pH will lower once irrigation commence and regular soil sampling will inform the farmer of best management practices concerning alkalinity/acidity.

b. Salinity

The highest Electrical Conductivity and Resistance measurements are within the norms and standards for pumpkin production. In terms of soil salinity this area is therefore conducive to pumpkin production.

c. Other chemical elements

Pumpkin requires N, P, K, Ca and Mg; fertilizer requirements should however be based on soil analysis of soil samples which should preferably be taken in May – June on established crops or prior to establishment.

4. Conclusion

The available soil properties, soil depth, soil texture, and EC values are all inside the required range for pumpkin production under irrigation. Management should be commenced with the high pH values.