SOLAR-AFRICA ENERGY PROJECT IN THE HANOVER DISTRICT, NORTHERN CAPE

(DE AAR/HANOVER AREA)

AGRO-ECOSYSTEM SPECIALIST ASSESSMENT FOR: UPGRADING & DEVELOPMENT OF AN ACCESS ROAD FROM THE N10/'BURGERVILLE' DISTRICT ROAD (2448) TURN-OFF INTO THE FARM RIET FOUNTAIN NO. 39C AND TO THE SWITCHING STATION AND MAIN TRANSMISSION SUBSTATION ON SUN CENTRAL CLUSTER 1 (300 MW) SOLAR PV FACILITY BETWEEN DE AAR & HANOVER, EMTHANJENI LOCAL MUNICIPALITY, PIXLEY KA SEME DISTRICT MUNICIPALITY, NORTHERN CAPE PROVINCE, SOUTH AFRICA

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1. INTRODUCTION

A 15 km stretch from the N10/'Burgerville' District Road (2448) to the Switching Station and Main Transmission Substation (MTS) on Sun Central Cluster 1 (300 MW) Solar PV Facility, between De Aar and Hanover, Emthanjeni Local Municipality, must be upgraded to increase the capacity of the road. The access road must meet the minimum Eskom specifications to ensure the safe delivery of equipment to site during construction and during future maintenance and operations, if ever required. Other activities include the establishment of transmission lines and pylons, as well as water pipelines, from boreholes to water storage tanks, to be installed underground (see Figure 1).

1.1. Terms of Reference

An Agricultural Agro-Ecosystem Specialist Assessment was indicated for the Application for Environmental Authorisation by way of Basic Assessment (BA), 2. A Part 2 amendment to the current Environmental Authorisation (EA) and 3. Integrated Water Use License Application (IWULA) for additional activities associated with the Sun Central Cluster 1 300MW Solar PV project in the Northern Cape. The additional activities include the development and widening of roads; extending the transmission line from the MTS to Line 1 of the 400 kV Eskom powerline; and consolidation of water uses currently authorised under General Authorisation, including additional boreholes, into an Integrated Water Use License. This includes also a construction yard and O&M offices, and relocation of an 11 kV power line.

The following information was required:

- Determine how this development (and its separate elements) will impact on the agricultural resources, particularly the agricultural production capability of the site;
- Management recommendations regarding grazing practices;
- Identify and quantify the perceived impacts and propose mitigations to be included in the Environmental Management Programme (EMPr).

1.2. Study Area – SolarAfrica Energy

Location

The study area is in the Northern Cape, approximately 32 km from De Aar and 22 km from Hanover, directly northeast of the N10 highway.

Vegetation and soil surveys were conducted on three potential development footprints, namely Phases 1, 2 and 3.

A consolidated access road is already partially established to the MTS and transmission line that needs to be upgraded for this project. Certain sections of the access road route are existing and will be upgraded/widened. However, some sections of the access road are "new" development as there is no existing track to the MTS. The length and width of the new road build will be ± 2,65 km and 8 m (excluding the side/cut-off drain), but 11 m (including the side/cut-off drain) resulting in a loss of ± 2,9 ha of agricultural land. It begins at the Burgerville turn-off on the N10 between Hanover and De Aar for 5.1km on the Burgerville secondary road, then for a further 9.6km on the dirt road through Mr. Willem Retief's farm up towards the MTS. Only the last 3km of the access road falls within the initial study area of Phase 1 where veld condition assessments (VCA) were conducted during 2017. The access road, water pipelines, temporary construction yard and O&M offices, 11 kV and 400 kV transmission lines are indicated on Figure 1 below.

Figure 1. The access road (dark brown with black soil sampling sites no 1-5) to the MTS, water pipelines (blue), boreholes (blue dots), water storage (green squares), temporary construction yard + O&M offices (grey block), 11 kV power line (orange) and 400 kV transmission lines (purple) overlaid on a Sentinel satellite image (2020 12 20).

Figure 2 shows the areas covered by semi detailed soil and vegetation surveys from 2017-2022.

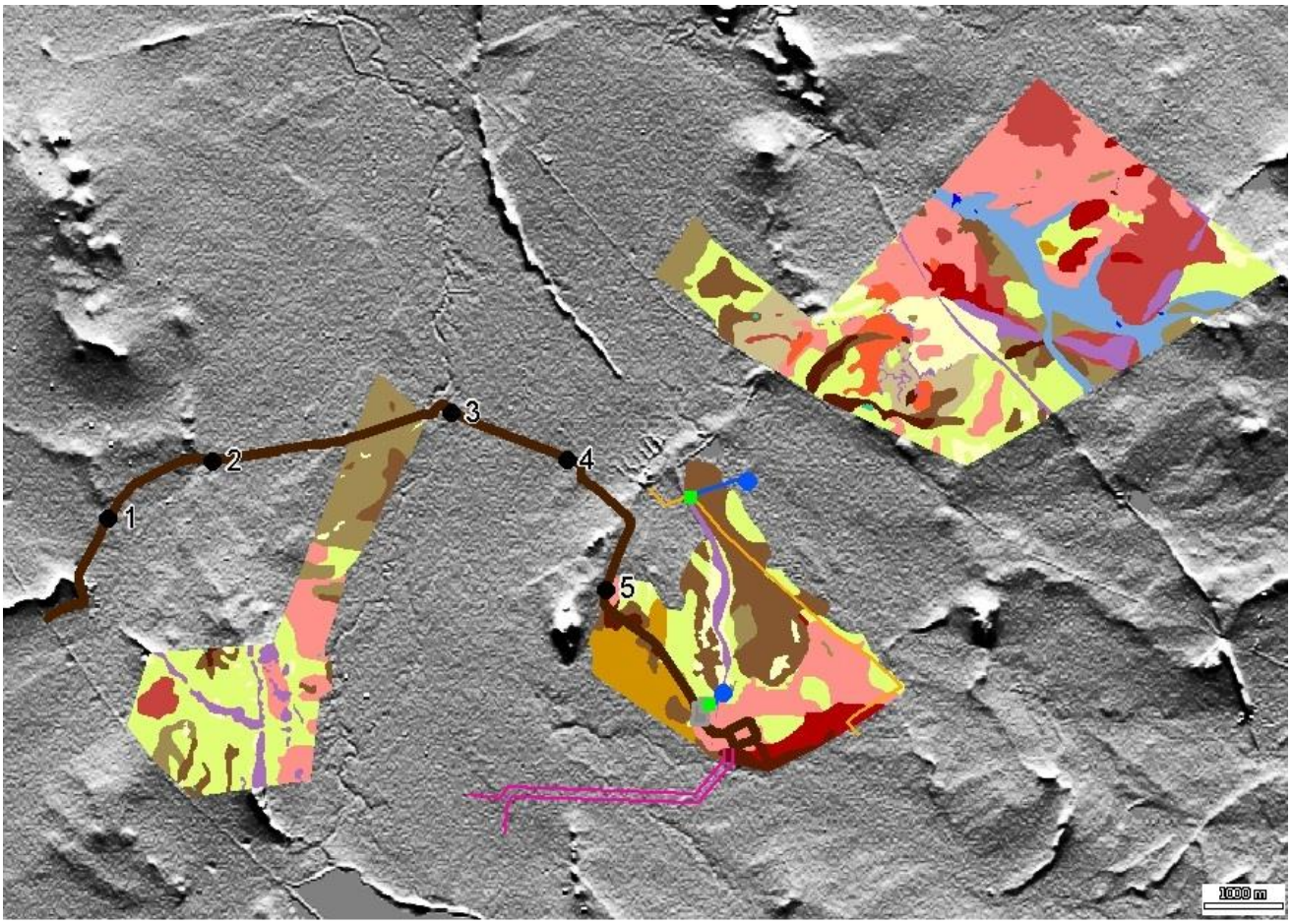


Figure 2. Areas covered by soil and vegetation surveys overlaid on a hill-shading of the terrain. The soil maps created for the different project areas from 2017-2022 are shown. Grazing unit maps cover exactly these areas and are based on the soil maps. The access road (dark brown with black soil sampling sites no 1-5) to the MTS, water pipelines (blue), boreholes (blue dots), water storage (green squares), temporary construction yard + O&M offices (grey block), 11 kV power line (orange) and 400 kV transmission lines (purple) are overlaid on the map.

Geology and Soils

Soil studies were carried out on Phase 1 (Van den Berg, (2017)), Phase 2 (Van den Berg (2021)) and Phase 3 (Van den Berg and Botha, (2022)). The dominate geology is shale with subordinate sandstone and dolerite intrusions. The area is dominated by shallow soils of the Mispah soil form. Please refer to these reports for more detail.

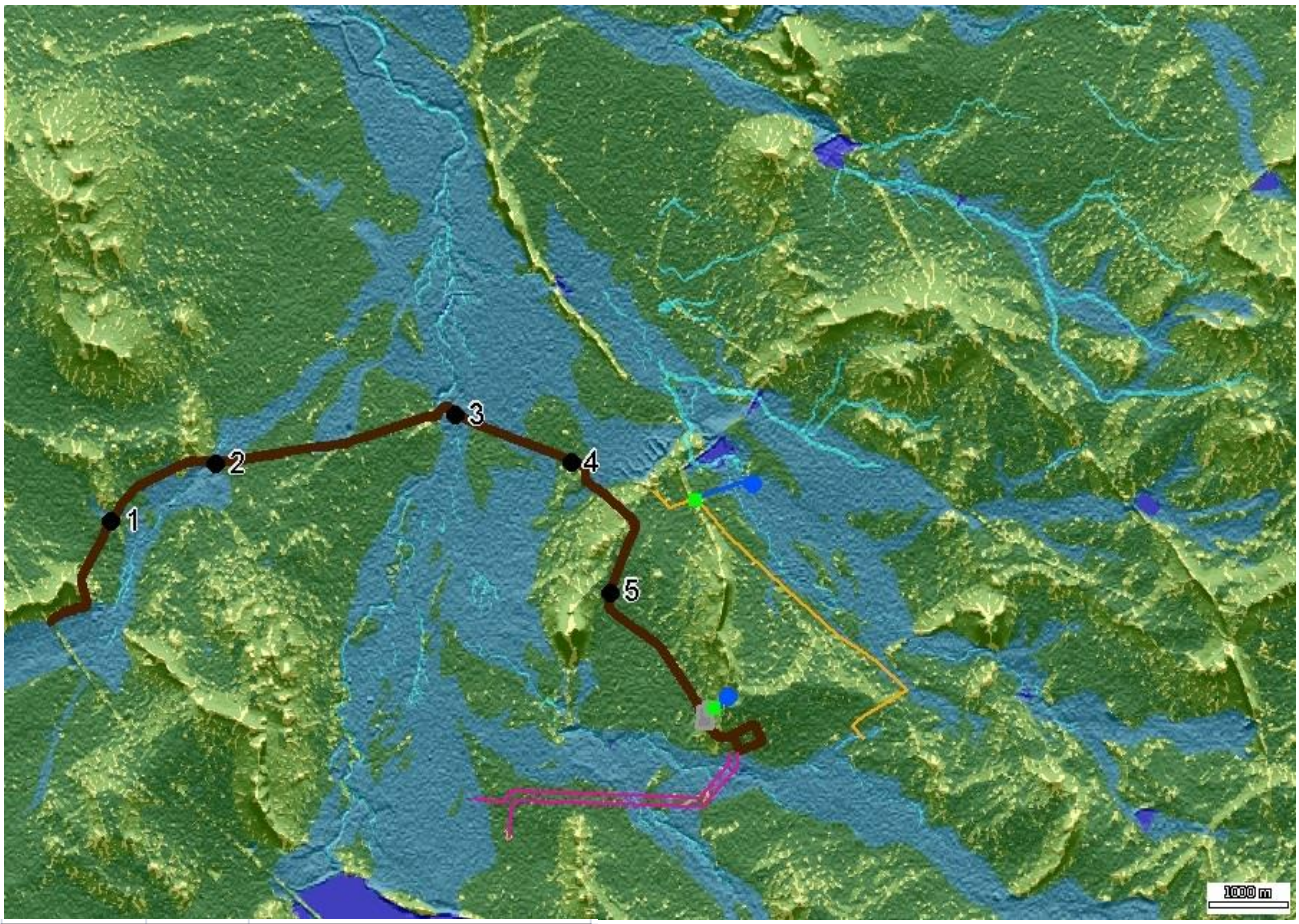
Vegetation and Veld Condition

The vegetation at the study area (Phase 1 but also wider PV areas) is classified as Eastern Upper Karoo (Vegetation unit NKu 4, Mucina and Rutherford (2006)). According to Acocks (1988) it is in Veld Type 36, i.e., False Upper Karoo.

2. SOIL AND TERRAIN MAPPING

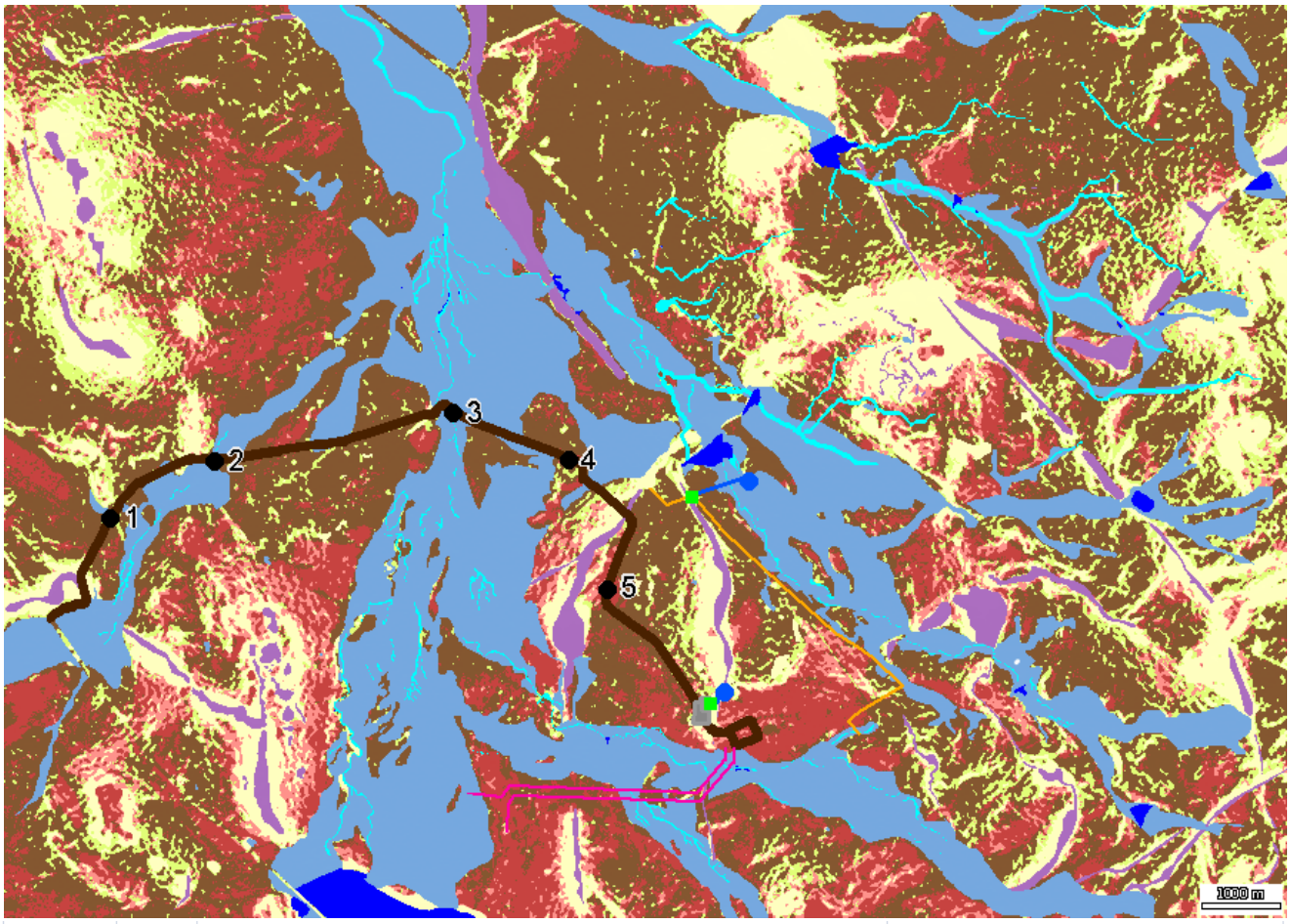
A Copernicus Digital Surface Model (DSM) - 30m resolution - was interpolated to 2.5m. Hill-shading, slope and terrain units were derived from the DSM. Floodplains and streambeds were mapped from Sentinel satellite imagery. Figure 3 shows the terrain units integrated with floodplains and streambeds. Soil mapping was done for the wider area surrounding all the PV projects (19 600ha). This was done by using the relationships between soil patterns, terrain position, geology and

features on Sentinel satellite imagery as established during the field surveys and image and DSM interpretations from the 2017-2022 mapping. The resulting soil map is shown by Figure 4. A soil capability map was derived from the soil map (Figure 5).



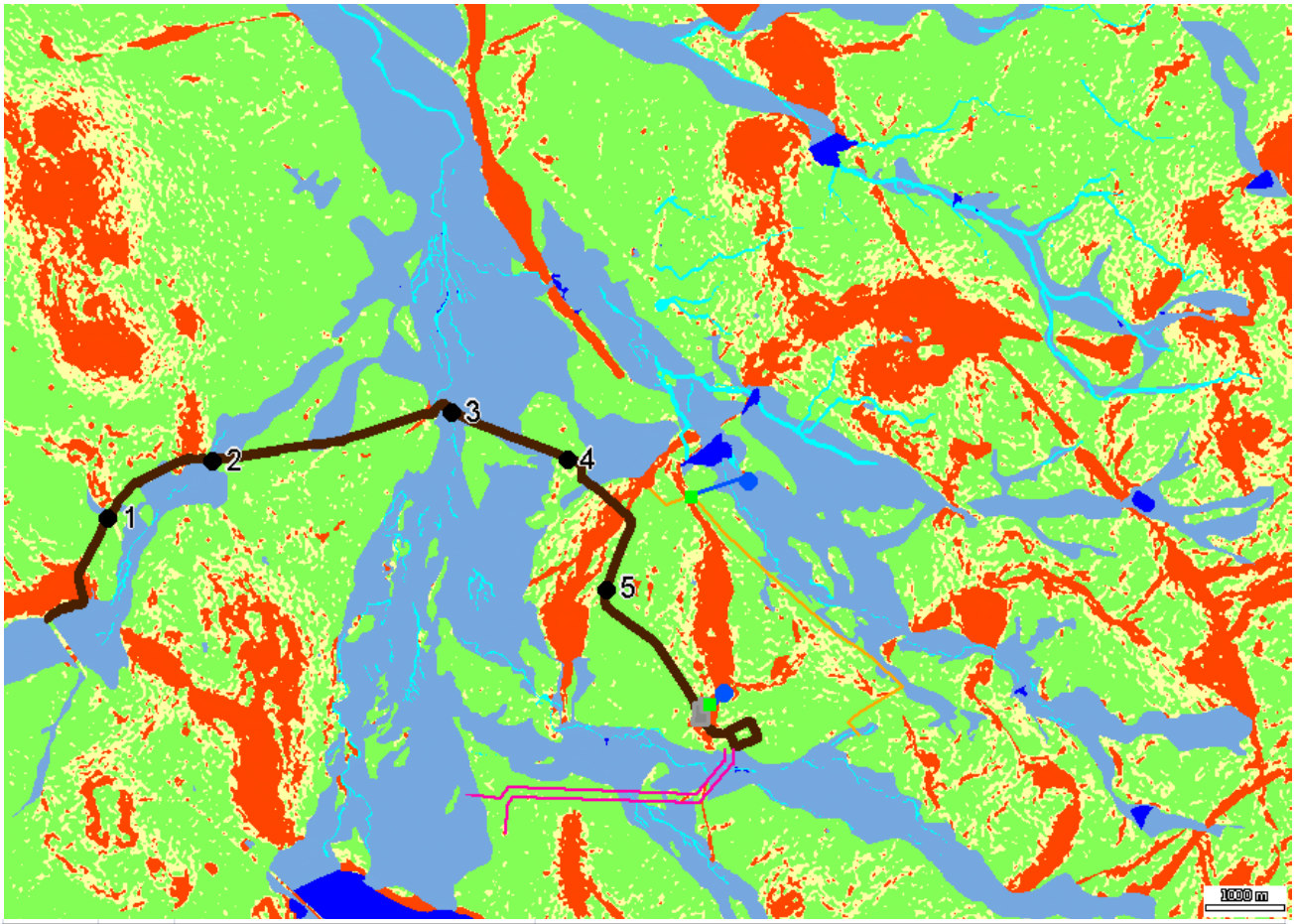
Colour	No	Class
	1	Crest
	2	Convex midslopes
	3	Concave midslopes
	4	Floodplains
	5	Streambeds
	6	Water

Figure 3. Terrain units overlaid on a hill-shading of the terrain. The access road (dark brown with black soil sampling sites no 1-5) to the MTS, water pipelines (blue), boreholes (blue dots), water storage (green squares), temporary construction yard + O&M offices (grey block), 11 kV power line (orange) and 400 kV transmission lines (purple) are overlaid on the map.



Colour	No	Class	Dominant soils
	1	Sandstone outcrops (sub dominant dolerite)	Outcrop/Ms complex
	2	Dolerite outcrops	Outcrop
	3	Very shallow yellow brown loamy soils	Ms, (Gs)
	4	Very shallow red loamy soils	Ms, (Gs)
	5	Shallow to medium deep yellow brown loamy to clayey soils	Gs, Oa, Sw, Va, (Ms, Cv. Ad, Ag)
	6	Shallow to medium deep red loamy to clayey soils	Hu, Gs, Oa, Et, Ky, Sw, Va. (Ms)
	7	Floodplains	Oa, Tu, Va, Du
	8	Streambeds	
	9	Water	

Figure 4. Soil map for the wider PV project areas. The access road is shown in shown in dark brown and the transmission lines in purple. Soil sampling sites along the access road are indicated by the black dots. The access road (dark brown with black soil sampling sites no 1-5) to the MTS, water pipelines (blue), boreholes (blue dots), water storage (green squares), temporary construction yard + O&M offices (grey block), 11 kV power line (orange) and 400 kV transmission lines (purple) are overlaid on the map.



Colour	No	Class	Soil depth, dominant soils and slope limitations
	1	Low to moderate soil capability	Shallow to medium deep soils, Hu, Cv, Oa, Ad, Ag, Et, Ky, Va
	2	Low soil capability	Very shallow soils, Ms, Gs, Sw, (Hu) and all areas with slopes 6%-8%
	3	Very low soil capability	Outcrops and all areas with slopes >8%
	4	Floodplains	Oa, Tu, Va, Du
	5	Streambeds	
	6	Water	

Figure 5. Soil capability map for the wider PV project areas. The access road (dark brown with black soil sampling sites no 1-5) to the MTS, water pipelines (blue), boreholes (blue dots), water storage (green squares), temporary construction yard + O&M offices (grey block), 11 kV power line (orange) and 400 kV transmission lines (purple) are overlaid on the map.

3. SOIL SAMPLE ANALYSIS

Top and subsurface soils samples were taken at 5 sampling sites along the access road (see Figure 4) - in total 10 samples were chemically analyzed. See Appendix A for the chemical analysis results and Appendix B for the physical properties of the soils sampled. The purpose for the soil sample analysis is to understand the observed sheet erosion and areas of bare soil better and to provide recommendations to improve soil conditions for water infiltration (this includes veld management practices).

RECOMMENDATIONS SPECIFIC FOR THE SOIL SAMPLING SITES:

Soil sample site 1

- Soil pH is satisfactory and no lime application is recommended.

- Broadcast 150 kg/ha 3:2:0(32)+Zn directly before planting and work in 5cm.
- Top-dress 120 kg/ha LAN six weeks after planting.

Soil sample site 2

- Soil pH is satisfactory and no lime application is recommended.
- Broadcast 150 kg/ha 3:2:0(32)+Zn directly before planting and work in 5cm.
- Top-dress 120 kg/ha LAN six weeks after planting.

Soil sample site 3

- This sample site is in the alluvial floodplain where there is an accumulation of silt and clay as well as base cations like Magnesium (Mg) and Sodium (Na). These elements have dispersive properties.
- Soil pH is very high and indicative of sodic conditions.
- Apply 2 ton/ha gypsum and work in 15cm two weeks before planting.
- Good drainage is a requirement for gypsum treatment.
- Topsoil and subsoil samples have extremely high sodium (Na, SAR) concentrations and will inhibit plant growth.
- This might be an indication of poor drainage or lateral seepage of sodium.
- It is recommended that these soils should be allowed to drain and sodium leached out of the soil profile.
- Rip against contour, cut-off drains and artificial drains might be needed.
- Broadcast 200 kg/ha Superphosphate and 200 kg/ha Ammoniumsulphate directly before planting and work in 5cm.

Soil sample site 4

- Soil pH is satisfactory and no lime application is recommended.
- Broadcast 150 kg/ha 3:2:0(32)+Zn directly before planting and work in 5cm.
- Topdress 120 kg/ha LAN six weeks after planting. Soil pH is satisfactory and no lime application is recommended.

Soil sample site 5

- Soil pH is satisfactory and no lime application is recommended.
- Broadcast 150 kg/ha 3:2:0(32)+Zn directly before planting and work in 5cm.
- Topdress 120 kg/ha LAN six weeks after planting.

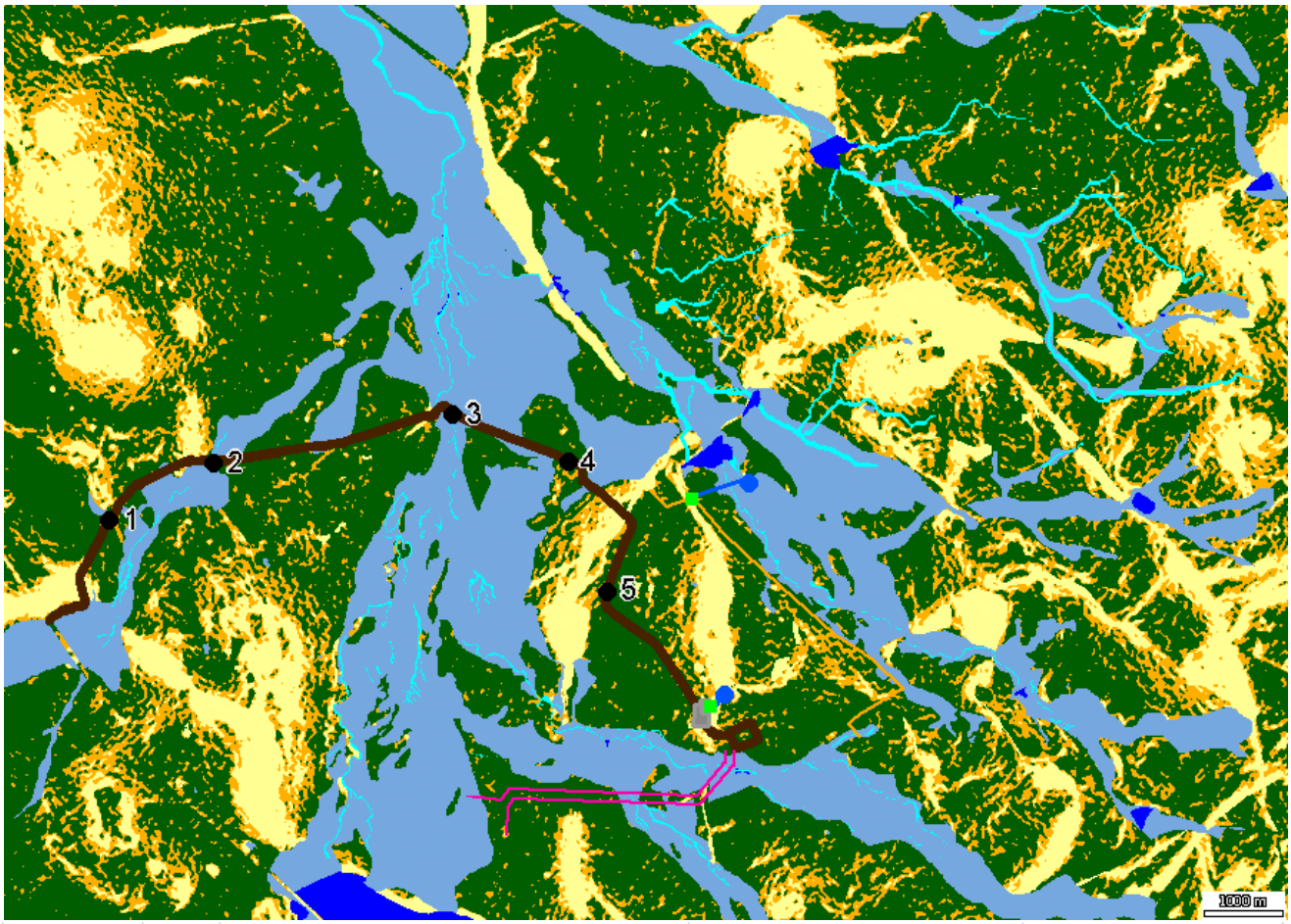
GENERAL RECOMMENDATIONS

Organic matter in the form of manure and/or humic products can be used with the chemical fertilisers to ameliorate the soil and improve soil health. These potential actions must be coordinated with the grazing recommendations.

4. GRAZING INFORMATION

4.1. Grazing Units and Grazing Capacity

The soil maps and rangeland surveys of 2017-2022 were used create grazing unit maps for all the PV project areas (De Wet (2017), De Wet (2021) and De Wet and Arnoldi (2022)). The same rationale was used to extrapolate these grazing units by using the newly created soil map (Figure 4) to create grazing units for the full 19 600 ha covering the wider area around all the PV projects (Figure 6).



COLOUR	NO	GRAZING UNITS	GRAZING CAPACITY RANGE	MEDIAN GRAZING CAPACITY
	1	GRAZING UNIT I (Soils at lower part of catena - usually medium deep)	5-30 ha/LSU	17 ha/LSU
	2	GRAZING UNIT II (Shallow soils)	15-55 ha/LSU	35 ha/LSU
	3	GRAZING UNIT III (Koppies)	20-90 ha/LSU	55 ha/LSU
	4	GRAZING UNIT IV (Floodplains)	10-90 ha/LSU	50 ha/LSU
	5	Streambeds		
	6	Water		

Figure 6. Grazing units map for the wider PV project areas. The access road (dark brown with black soil sampling sites no 1-5) to the MTS, water pipelines (blue), boreholes (blue dots), water storage (green squares), temporary construction yard + O&M offices (grey block), 11 kV power line (orange) and 400 kV transmission lines (purple) are overlaid on the map.

The grazing capacity derived from the 2017 assessments was between 15 and 17 ha/LSU for better veld conditions, or an average of just less than 23 ha/LSU, applicable at the time when the assessment was done, for all veld conditions in the study area (Phase 1) (De Wet, 2017). VCAs during drought conditions, in 2017, as well as later, in 2021 and 2022, when rainfall was slightly higher than the drought experienced in 2017, indicated that the veld was overgrazed. Please also refer to the reports of De Wet (2021) and De Wet and Arnoldi (2022) for results obtained during those years.

The floodplain is not part of the PV project areas surveyed in the past. However, in 2022 two VCA sampling sites were surveyed on the floodplain (bottomlands with braided streamlines) that divides the Phase 3 project area. See De Wet and Arnoldi (2022). In general the vegetation cover was very good for this small section of floodplain. This is in stark contrast with the wider floodplain area that has very little vegetation cover and has, as indicated by soil sampling site 3, potentially severe sodic conditions that inhibits plant growth. For this reason the low end of the grazing capacity range is estimated as very low and in the order of the rock outcrops and koppies.

4.2. Access road

It appears that the access road mostly runs through areas where the impact of the operations with Phase 1 should not have a major effect on the vegetation. To confirm this, physical surveys (VCAs) must be carried out in some of the areas where surveys have not yet been conducted, and the assumption is therefore speculative in nature. However, the aerial view indicates that the access road intercepts a floodplain (Figure 1) of approximately 1.7 km, just past the Staging area towards the MTS. It is important to mention that, among other things, a soil analysis was carried out at this flood plain. The finding was that the topsoil and subsoil samples have extremely high sodium (Na, SAR) concentrations that will inhibit plant growth. This might be an indication of poor drainage or lateral seepage of sodium.

It is also observed that the first part of the 400 kV transmission lines passes through a floodplain of approximately 1.7 km. No soil analysis was conducted here (This include the smaller areas for the water pipelines, O&M office and temporary construction camp and 11 kV transmission line).

4.3. Grazing management recommendations

- It is of utmost importance not to exclude sheep from this area. *Kraaling must be applied to specific severely degraded areas, as a first step in regenerative management.
- It's important to mention the access road that crosses part of a floodplain as it can be considered a sensitive area due to the extremely high sodium (Na, SAR) concentrations in the topsoil and subsoil which inhibit plant growth. The veld condition will not improve at this specific sensitive area by only applying sound grazing management, for chemical intervention is necessary to ameliorate these soil conditions, as recommended by the laboratorium. This statement applies to rangeland where topsoil had already been eroded. However, regenerative grazing management principles should always be included even after applying chemical amelioration. Kraaling is recommended for areas where grass cover is poor and to areas where topsoil has already been eroded.
- A holistic approach must be followed in terms of veld management where a balance must be found between planned rest and grazing rather than excluding grazing (De Wet, 2022).
- In terms of the construction of the access road, transmission lines (11 kV and 400 kV), the water pipes from the boreholes O&M office and temporary construction camp, the following grazing practices and mitigations will apply.
- Sheep must be *included* as a tool for restoration (by kraaling) and to improve the veld condition at disturbed and overgrazed areas (through regenerative grazing). This should be done according to a grazing management plan, as recommended by De Wet, (2017), De Wet, (2021) and De Wet and Arnoldi (2022).
- It is not foreseen that the development of the access road, transmission lines and constructions for water pipes will have a significant negative impact on the flora or local ecological processes if the mitigation actions, as discussed above, are taken.
- An option to consider is to isolate (e.g. fencing) the areas that will be disturbed temporarily during this project, such as the areas on either side of the access road, water pipelines, O&M office and temporary construction camp and 11 kV and 400 kV transmission line areas, at the start of this project to camp The reason for that will be to give the rehabilitated plants a chance to establish. Note that this is only a consideration, and not a recommendation. If fencing is implemented, the following guidelines must be followed:

    - When rehabilitation of plants have been done and the plants have established, the fences can be removed while restoration of bare ground can be achieved through kraaling.
    - After the fences have been removed, active grazing management, based on regenerative grazing management principles, should be applied on the wider area, as referred to by De Wet and Arnoldi (2022).

*Kraaling period is for a night only. Grazers are removed to natural grazing areas after each kraaling period. The kraaled area is afterwards temporary excluded from grazing for two years, to enable seed depositied through dung to germinate and for grass to develop roots.

MANAGEMENT CHALLENGES		IMPACT ENVISAGED	ASSOCIATED MITIGATION & NOTES
CONSTRUCTION OF ACCESS ROAD:	Areas outside floodplains and drainage lines	Minimal negative impact – Most of the vegetation next to the road is severely disturbed due to previous activities and run-offs.	• Avoid moving too far from the access road with vehicles during the construction period. • At the end of the construction phase, where possible, landscape the site and rehabilitate the disturbed area through kraaling sheep. In areas where kraaling by sheep cannot be done, reseeding must be with locally indigenous species, especially grasses (Vlok, 2019). • To facilitate the restoration of the site at the end of the construction phase, remove all the topsoil (to a depth of 100 mm) during the construction phase and store it in berms not wider than 2 m or higher than 1 m. The stored topsoil must be used to cover the landscaped area at the end of the construction phase (Vlok, 2019). • Kraaling with sheep at selected areas, followed by controlled recovery periods, are recommended along the disturbed areas arising from this project. Regenerative grazing is recommended post initial kraaling/recovery periods, i.e., after two years after the initial rehabilitation measures commenced.
	In floodplains and drainage lines	Medium impact – Loss in plant basal cover, increase in pioneer plants such as weedy forbs and annual grasses	• Special care should be taken on the preparation on possible slopes in the operational area to prevent erosion in the long term. • Avoid moving too far from the access road with vehicles during the construction period. • Chemical intervention is recommended at areas where topsoil had eroded, to ameliorate these soil conditions. See the recommendations for soil Sampling Site 3.

MANAGEMENT CHALLENGES		IMPACT ENVISAGED	ASSOCIATED MITIGATION & NOTES
OFF-ROAD OPERATIONS:	Transmission Lines 11 and 400 kV	Low agricultural impact – The surface for the concrete supports for the pylons and mechanical impact are relatively small.	• Limit the number of new routes through the veld, especially with the development of the transmission lines and digging of the trenches for the pipelines to reduce the mechanical impact on the veld. • Rehabilitate the disturbed areas after the construction phase in the same way as with the construction of the access road. • Ultra-high density kraaling with sheep is recommended at selected areas with low vegetation cover, followed by controlled recovery periods along the severely disturbed areas arising from this project. Regenerative grazing is recommended post the initial rehabilitation period.
	Water pipelines, O&M office and temporary construction camp	Low agricultural impact – The trench for the pipelines for Boreholes 5 and 13 will be 600 mm deep and 300 mm wide. i) Water pipelines to be installed underground from borehole 13, which is situated in a separate Hydrological Response Unit (HRU), to a water storage tank. This pipeline is crossing a drainage line on the northern edge of Cluster 1 solar field footprint which is an unnamed tributary of the Brak River. ii) From Borehole 5 which is situated in a drainage line, that will be extended to a few separate water storage tanks in the Cluster 1 solar field footprint.	• Limit the number of new routes through the veld, especially with the development of the transmission lines and digging of the trenches for the pipelines to reduce the mechanical impact on the veld. • Rehabilitate the disturbed areas after the phase in the same way as with the construction of the access road.

5. AGRICULTURAL SENSITIVITY

From a grassland ecological and soil erosion perspective, the opinion is that the current planned development (and the cumulative effect of 30km from other PV-projects), will not have a significant impact on the current veld condition and potential grazing potential, reflected from the baseline study in 2017. It is envisaged that the potential impact from the planned development would then also need to be considered and be mitigated for. However, if the proposed mitigations are not followed (as stipulated in all the reports from 2017 for the full project areas of PV development), it is envisaged that deterioration in veld condition will occur, associatedwith increased bare ground and accelerated soil erosion. The effects of enhanced soil erosion in the case of rangeland mismanagement and the effects of increased runoff and sediment load downstream, in relation with other PV developments within 30 km downstream, are quantified in the soil report (Van den Berg and Botha, 2022). The access road and transmission lines from part of the area inside the catchment that were assessed for runoff contribution from Phases 1, 2 and 3 in relation with other PV projects within a 30 km radius. The results showed that the effect from these 3 PV phases would be minimal and would contribute less than 1.5% of the total runoff from the catchment and only about 10% of the runoff from all PV projects combined within a 30 km radius.

The screening tool used for site sensitivity verifications requirements (https://screening.environment.gov.za/screeningtool) was used for a screening of the area around the access road and the transmission lines (Figure 7). The results are shown by Figure 7. The results show that the access road, water pipelines, O&M office and temporary construction camp and 11 kV and 400 kV transmission line areas are dominated by low and medium agriculture sensitivity (animal production). The soil capability map (Figure 5) confirms this result with the area that is dominated by very low to moderate soil capability.

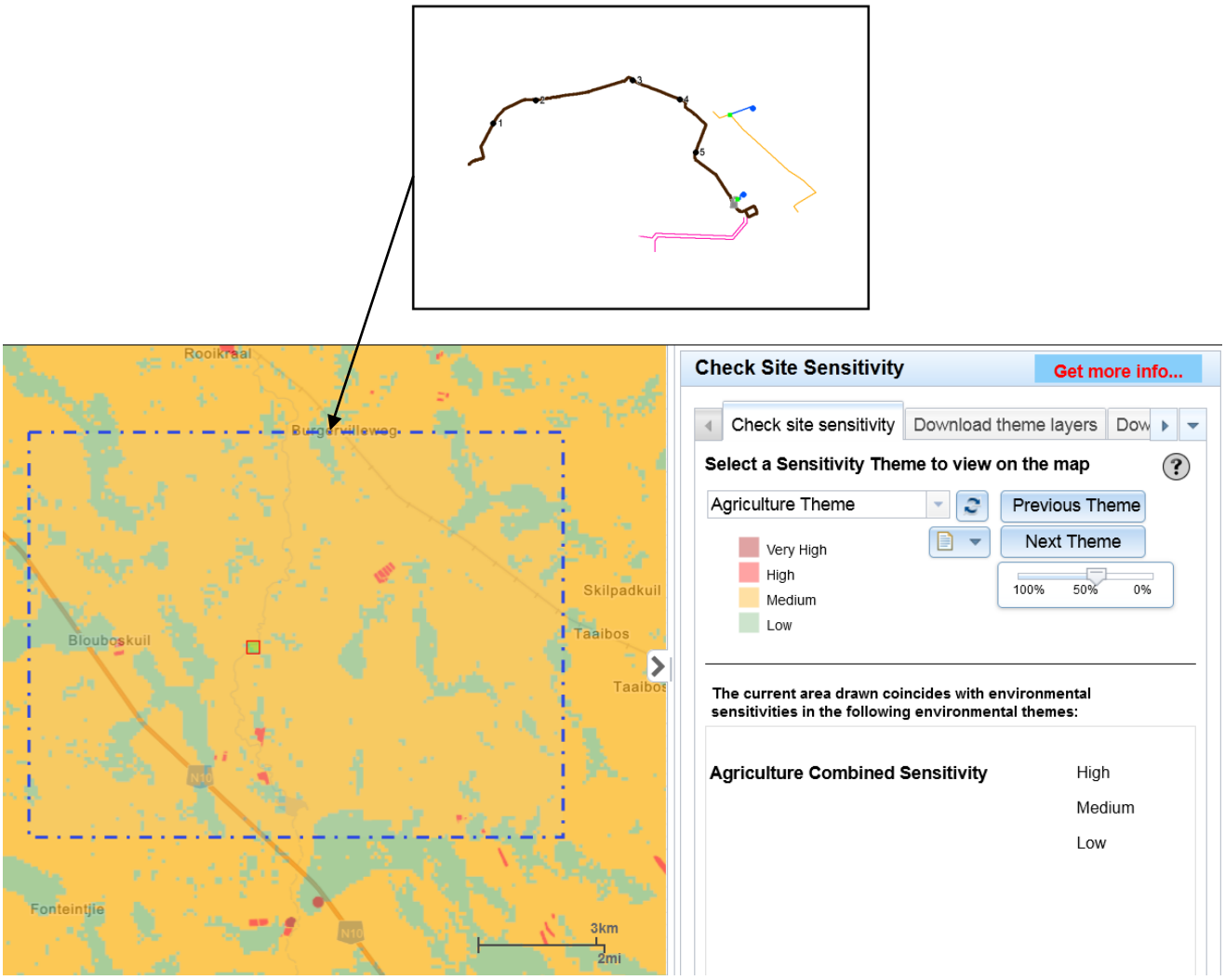


Figure 7. Site sensitivity map for access road, water pipelines, O&M office and temporary construction camp and 11 kV and 400 kV transmission line areas. The small high sensitivity areas shown by the red areas are mostly irrigated planted pastures (Lucerne).

Please note:

It is known that the total exclusion of grazers in such environments will be detrimental to maintaining important ecological processes such as the energy cycle, mineral cycle, and water cycle.

Mismanagement through selective grazing and uncontrolled grazing and resting will affect Agricultural potential negative though.

There are examples of veld improvement and the restoration of degraded veld under holistic or regenerative grazing under the following management, where high stocking densities are applied within short periods, followed by planned rest (under time control).

The following recommendations are made:

1. *The grazing management should be allowed with the construction of the consolidated access road, the solar Photovoltaic facility and all their separate elements at all the camps affected through these developments;*
2. *With the preparation and construction of the access road and all its elements, special care should be to maintain current vegetation undisturbed, as far as possible, i.e., not to disturb the topsoil surface due to erosion risk and to maintain vegetation cover as far as possible. This recommendation applies to all phase developments;*
3. *Follow-up grazing assessments and annual monitoring of veld condition is recommended to determine the progress of the recovery process on the disturbed, rehabilitated areas arising from this project as well as the existing sites (and possible new sites) on Phase 1 ;*
4. *Because the number of survey points did not cover all the variations within the grazing units (De Wet,2017), it is recommended to conduct more survey points in this study area that cover the variations that were left out, especially the floodplains and drainage lines that are considered sensitive. The floodplains and drainage lines together represent a large proportion of this study area as well as on the study areas of the other phases. Only two survey points have been conducted in floodplains and on drainage lines since the start of the first surveys in 2017, which therefore underrepresents surveys in these specific areas.*

6. CONCLUSIONS

The proposed widening and sealing of the existing access road and new sections of the road (13.7 km in total), the construction of the two parallel 400 kV transmission lines (3,7 km) and the water pipelines (1 km) should have a very limited effect in the long term on soil erosion and rangeland potential. This includes also the O&M office and temporary construction camp and relocation of the existing 11 kV power line. However, good rangeland practices should be applied at all areas, including the wider area surrounding the PV project areas. The floodplains are areas where there is evidence of extensive soil erosion, and the vegetation cover is in general very low. It is acknowledged that these "degraded" floodplains are typical of the Karoo area and a function of the geology of the area. Historical overgrazing played a role, but it only accelerated natural relative high soil erosion processes (due to the high sodium content of the soil), since the settlement of humans practicing commercial farming in the area. It is expected that soil sodic problems will be widely spread over these floodplains. It is recommended that more soil samples are taken from these floodplains and analyzed for soil sodicity. VCA sites should also be added in these flood plain areas and monitored regularly in the long term, together with all the VCA sites from the 2017-2022 projects, to ensure sound rangeland management for the wider area.

7. ACKNOWLEDGEMENTS

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9. LIST OF ABBREVIATIONS, ACRONYMS AND EXPLANATION OF TERMS

DSM: Digital Surface Model

EMPr: Environmental Management Programme

Koppie: A small hill on an otherwise flat area.

Kraaling: A method of Ultra High Density Grazing where livestock, e.g. sheep, is gathered in a confined space to overnight at different spots for short durations (one spot per night). Its objective is to improve the veld condition of disturbed areas with low vegetation cover.

MTS: Main Transmission Substation

PV: Photovoltaic

Soil sodicity: Sodicity in soil is the presence of a high proportion of sodium ions relative to other cations. This has a negative impact on soil structure and prevents water infiltration into the soil.

VCA: Veld Condition Assessment – Veld condition is the health of the veld with regards to its ecological status, the ability to resist soil erosion and the forage production potential. Methods of classifying an area's veld condition through assessments have been developed as a tool for making informed management decisions.

10. APPENDICES A AND B

Appendix A: Chemical analysis results - see Excel spreadsheet

Appendix B: for the physical properties - see Excel spreadsheet