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Soil, Land Use, Land Capability and Agricultural Potential Assessment for the Proposed Hyperion Solar Development 2

Submitted by TerraAfrica Consult cc
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March 2019

DEFINITIONS AND ACRONYMS

Base status: A qualitative expression of base saturation. See base saturation percentage. Base saturation refers to the proportion of the cation exchange sites in the soil that are occupied by the various cations (hydrogen, calcium, magnesium, potassium). The surfaces of soil minerals and organic matter have negative charges that attract and hold the positively charged cations. Cations with one positive charge (hydrogen, potassium, sodium) will occupy one negatively charged site. Cations with two positive charges (calcium, magnesium) will occupy two sites.

Calcareous: Containing calcium carbonate or magnesium carbonate.

Cutan: Cutans occur on the surfaces of peds or individual particles (sand grains, stones). They consist of material which is usually finer than, and that has an organisation different to the material that makes up the surface on which they occur. They originate through deposition, diffusion or stress. Synonymous with clayskin, clay film, argillan.

Erosion: The group of processes whereby soil or rock material is loosened or dissolved and removed from any part of the earth's surface.

Fertilizer: An organic or inorganic material, natural or synthetic, which can supply one or more of the nutrient elements essential for the growth and reproduction of plants.

Fine sand: (1) A soil separate consisting of particles 0,25-0,1mm in diameter. (2) A soil texture class (see texture) with fine sand plus very fine sand (i.e. 0,25-0,05mm in diameter) more than 60% of the sand fraction.

Gleying: The process whereby the iron in soils and sediments is bacterially reduced under anaerobic conditions and concentrated in a restricted horizon within the soil profile. Gleying usually occurs where there is a high water table or where an iron pan forms low down in the soil profile and prevents run-off, with the result that the upper horizons remain wet. Gleyed soils are typically green, blue, or grey in colour.

Land capability: The ability of land to meet the needs of one or more uses under defined conditions of management.

Land type: (1) A class of land with specified characteristics. (2) In South Africa it has been used as a map unit denoting land, map able at 1:250000 scale, over which there is a marked uniformity of climate, terrain form and soil pattern.

Land use: The use to which land is put.

Orthic A horizon: A surface horizon that does not qualify as organic, humic, vertic or melanic topsoil although it may have been darkened by organic matter.

Ped: Individual natural soil aggregate (e.g. block, prism) as contrasted with a clod produced by artificial disturbance.

Pedology: The branch of soil science that treats soils as natural phenomena, including their morphological, physical, chemical, mineralogical and biological properties, their genesis, their classification and their geographical distribution.

Saline, soil: Soils that have an electrical conductivity of the saturation soil extract of more than 400 mS/m at 25°C.

Slickensides: In soils, these are polished or grooved surfaces within the soil resulting from part of the soil mass sliding against adjacent material along a plane which defines the extent of the slickensides. They occur in clayey materials with a high smectite content.

Swelling clay: Clay minerals such as the smectites that exhibit interlayer swelling when wetted, or clayey soils which, on account of the presence of swelling clay minerals, swell when wetted and shrink with cracking when dried. The latter are also known as heaving soils.

Texture, soil: The relative proportions of the various size separates in the soil as described by the classes of soil texture shown in the soil texture chart (see diagram on next page). The pure sand, sand, loamy sand, sandy loam and sandy clay loam classes are further subdivided (see diagram) according to the relative percentages of the coarse, medium and fine sand sub-separates.

Vertic, diagnostic A-horizon: A-horizons that have both, high clay content and a predominance of smectitic clay minerals possess the capacity to shrink and swell markedly in response to moisture changes. Such expansive materials have a characteristic appearance: structure is strongly developed, ped faces are shiny, and consistence is highly plastic when moist and sticky when wet.

Declaration of specialist

Details of specialist

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Declaration of Independence

I, Mariné Pienaar, hereby declare that TerraAfrica Consult, an independent consulting firm, has no interest or personal gains in this project whatsoever, except receiving fair payment for rendering an independent professional service.

I further declare that I was responsible for collecting data and compiling this report. All assumptions, assessments and recommendations are made in good faith and are considered to be correct to the best of my knowledge and the information available at this stage.

TerraAfrica Consult cc represented by M Pienaar
March 2019

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1. Introduction

Savannah Environmental (Pty) Ltd appointed Terra Africa Consult to conduct the soil, land use, land capability study and agricultural potential study as part of the Environmental Impact Assessment process for a proposed Hyperion Solar Development 2. The development area of the proposed Hyperion Solar Development 2 is located on the Remaining Extent of the Farm Lyndoch 432 (from here onwards referred to as "the project site"). The project site is located approximately 16 km north of Kathu in the Gamagara Local Municipality and within the greater John Taolo Gaetsewe District Municipality, in the Northern Cape Province (Figure **1**).

The purpose of the study is to determine and describe the baseline soil properties and the land capabilities and land uses associated with it within the proposed project's direct and indirect areas of influence from on-site investigations and data currently available. It also assists with the identification of gaps in information. This report complies with the requirements of the NEMA and environmental impact assessment (EIA) regulations (GNR 326 of 2014 as amended) as well as the Agricultural Study Requirements of the Department of Environmental Affairs.

2. Objective of the study

The objective of the Soil, Land Use and Land Capability study is to fulfill the requirements of the most recent South African Environmental Legislation with reference to the assessment and management of these natural resource aspects (stipulated in Section 3 below). The key components of assessment are to determine and describe the baseline soil properties and the land capabilities and land uses associated with it within the proposed project's direct and indirect areas of influence from on-site investigations and data currently available. It also assists with the identification of gaps in information.

Once these conditions have been established, the anticipated impacts of the project on these properties can be determined. Mitigation and management measures can be recommended to minimise negative impacts and to ensure that the integrity of the natural resources around the proposed project area is not affected by the impacts of the project.

3. Environmental legislation applicable to study

The following South African Environmental Legislation needs to be considered for any new or expanding developments with reference to the management of soil and land use:

- The Conservation of Agricultural Resources (Act 43 of 1983) states that the degradation of the agricultural potential of soil is illegal. This act requires the protection of land against soil erosion and the prevention of water logging and salinisation of soils by means of suitable soil conservation works to be constructed and maintained. The utilisation of marshes, water sponges and watercourses are also addressed.

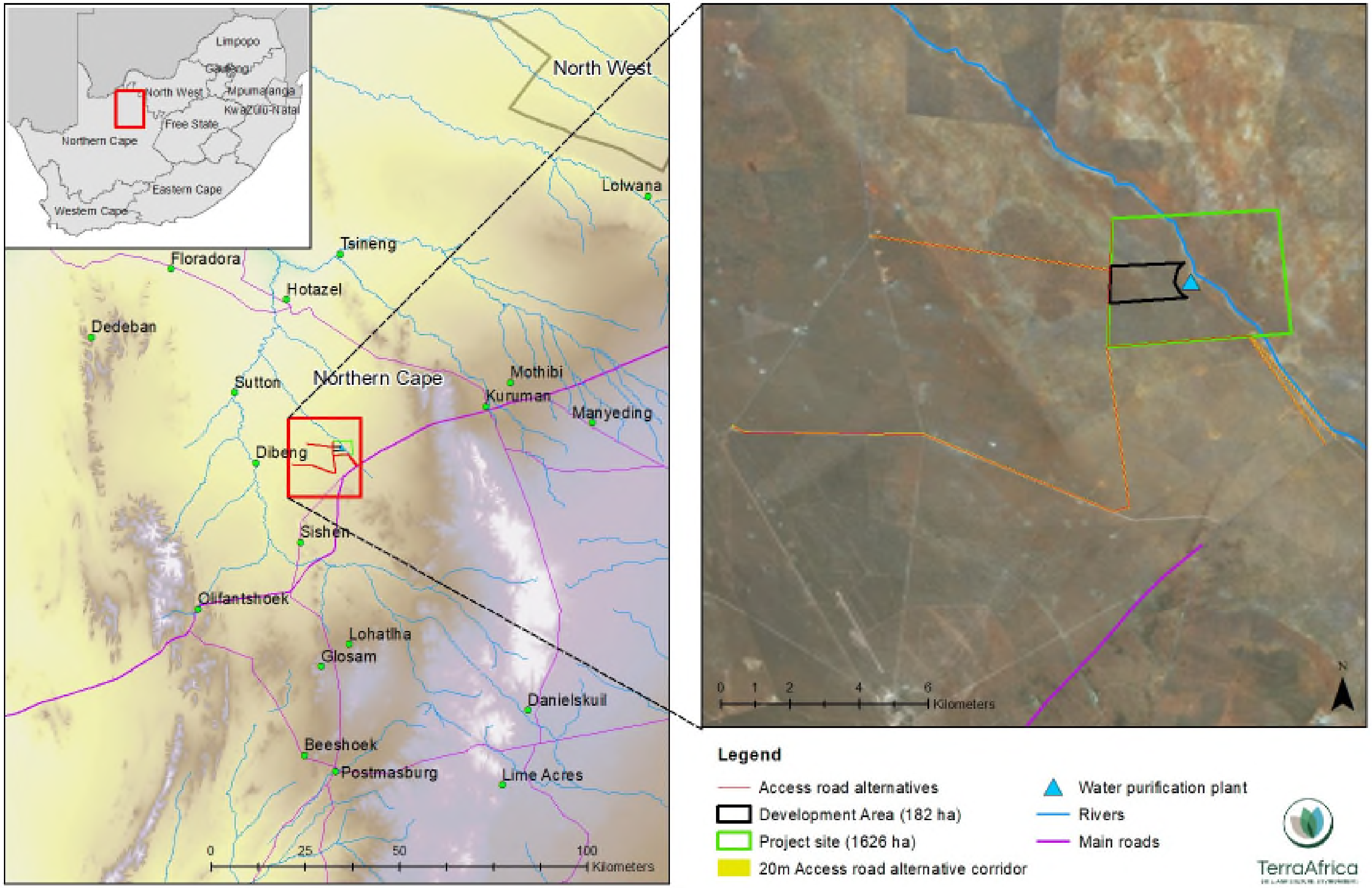

Figure 1: Locality map of the proposed Hyperion Solar Development 2 and access road alternatives associated with the project

- In addition to this, the National Water Act (Act 36 of 1998) deals with the protection of wetlands. This Act defines wetlands as "land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil." This Act therefore makes it necessary to also assess soil for its hydropedological properties.
- Section 3 of the National Environmental Management Act, the EIA Regulations, 2014 (as amended) and the Subdivision of Agricultural Land Act is also relevant to the development.

4. Terms of reference

The following Terms of Reference as stipulated by Savannah Environmental (Pty) Ltd applies to the soil, land use and land capability study:

- Undertake a desktop study and site investigation to establish broad baseline soil conditions, land capability and areas of environmental sensitivity at all the proposed alternative sites in order to rate their sensitivity to the proposed development;
- Compile a Soil, Land Use, Land Capability and Agricultural Potential Scoping Report for the proposed Hyperion Solar Development 2 that includes a study plan for the Environmental Impact Assessment Phase;
- Undertake a soil survey of the proposed subject property area focusing on all landscape features including areas with potentially wetland land capability;
- Describe soils in terms of soil texture, depth, structure, moisture content, organic matter content, slope and land capability of the area;
- Classify and describe soils using the South African Soil Classification: A Natural and Anthropogenic System for South Africa (2018);
- Identify, describe and assess potential soil, land use and land capability impacts resulting from the proposed Hyperion Solar Development 2;
- Identify, describe and assess potential cumulative soil, land use and land capability impacts resulting from the proposed development in relation to proposed and existing developments in the surrounding area;
- Recommend mitigation, management and monitoring measures to minimise impacts and/or optimise benefits associated with the proposed project.

5. Assumptions

- It is assumed that the two soil samples analysed are representative of the typical baseline soil conditions of the project site because of the homogeneity of the soil properties in the area.
- For the cumulative impact assessment, it was assumed that the mitigation measures will be implemented for the Hyperion Solar Development 2 and the comparison of the project in isolation to that of regional cumulative impacts were done with this in mind.

6. Uncertainties, limitations and gaps

The following uncertainties, limitations and gaps exist with regards to the study methodology followed and conclusions derived from it:

- The location of the access road alternatives was not yet available when the site visit was conducted on 20 September 2018. To address this data limitation, the client requested a desktop assessment of the additional areas where the access road alternatives are located. This is considered adequate for the purpose of the report. In order to address the data limitation though, it is recommended that a site walk-over be conducted in the area of the access road alternative that was chosen before the project commences. This is to identify any area that may have hydromorphic soil properties that was not detected by the desktop assessment of data for this area.
- Soil profiles were observed using a 1.5m hand-held soil auger. A description of the soil characteristics deeper than 1.5m can therefore not be given.
- The study does not include a land contamination assessment to determine pre-construction soil pollution levels (should there be any present).

7. Response to concerns raised by I&APs

Thus far, no concerns were raised by I & APs during the Public Participation Process pertaining to the continuation of existing land uses in the surrounding area. Should any comment in this regard be received, it will be addressed in the final report.

During the Scoping Phase Public Participation Process, concerns were raised by an I&AP about soil erosion caused by wind and water movement once the vegetation is removed from the soil surface during the construction phase. It was also stated there will be severe damage to the topsoil caused by heavy machinery used in the construction phase. It was also mentioned that run-off water from the solar panels must be controlled to minimise erosion and damage to the access road.

These concerns are valid and are addressed in Sections 10, 11 and 13 of this report that deal with impact assessment, mitigation measures and the Soil Management Plan.

8. Methodology

8.1 Desktop study

The following data was obtained and studied for the desktop study:

- Land type data for the site was obtained from the Institute for Soil Climate and Water

(ISCW) of the Agricultural Research Council (ARC) (Land Type Survey Staff, 1972 – 2006). 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).

- The newly released National Land Capability Evaluation Raster Data Layer was obtained from the Department of Agriculture, Forestry and Fisheries (DAFF) to determine the land capability classes of the project site according to this system. The new data was developed by DAFF to address the shortcomings of the 2002 national land capability data set. The new data was developed using a spatial evaluation modelling approach (DAFF, 2017).
- The most recent aerial photography of the area available from Google Earth was obtained. The aerial photography analysis was used to determine areas of existing impact, land uses within the project area as well as the larger landscape, wetland areas and preferential flow paths.

8.2 Study area survey

A systematic soil survey was undertaken during two days i.e. on 20 & 21 September 2018. The season in which the site visit took place has no influence on the results of the survey. A total of forty-eight (48) soil profiles were observed (
Figure 2). The soil profiles were examined to a maximum depth of 1.5m or refuse, using a hand-held auger. Observations were made regarding soil texture, structure, colour and soil depth at each survey point. A cold 10% hydrochloric acid solution was used on site to test for the presence of carbonates in the soil. The soils are described using the South African Soil Classification: A Natural and Anthropogenic System for South Africa (2018). A Munsell Colour Chart was used to classify soil colour. For soil mapping, the soils were grouped into classes with relatively similar soil characteristics. Two soil samples were collected on site (one topsoil and one subsoil) from a modal soil profile that represents the typical deep, structureless sandy soil profiles of the development area.

8.3 Analysis of samples at soil laboratory

The two soil samples collected on site were sealed in soil sampling plastic bags and sent to Eco Analytica Laboratory that is part of North West University for analyses. Samples taken to determine baseline soil fertility were analysed for pH (KCl), plant-available phosphorus (Bray1), cation exchange capacity (CEC), exchangeable cations (calcium, magnesium, potassium, sodium), organic carbon (Walkley-Black) and texture classes (relative fractions of sand, silt and clay).

8.4 Land capability classification

Agricultural potential is described through the term land capability. Land capability means “the most intensive long term use of land for purposes of rainfed farming, determined by the interaction of climate, soil and terrain” (Collet, 2014 referencing Schoeman et al., 2002). The newly developed land capability classification system that was released by the Department of Agriculture, Forestry and Fisheries (DAFF) was used to combine different soil forms into land capability units. The new system has a few strong departures from the old system developed by Schoeman et al. (2002). The new system has fifteen land capability classes as opposed to the initial eight classes. In the new system, Classes 1 to 7 are considered to be of very low land capability, making it only suitable for wilderness and grazing with a variety of management measures. The remaining classes (Class 8 to 15) are considered to have arable land capability with the potential for high yields increasing with the number of the land capability class.

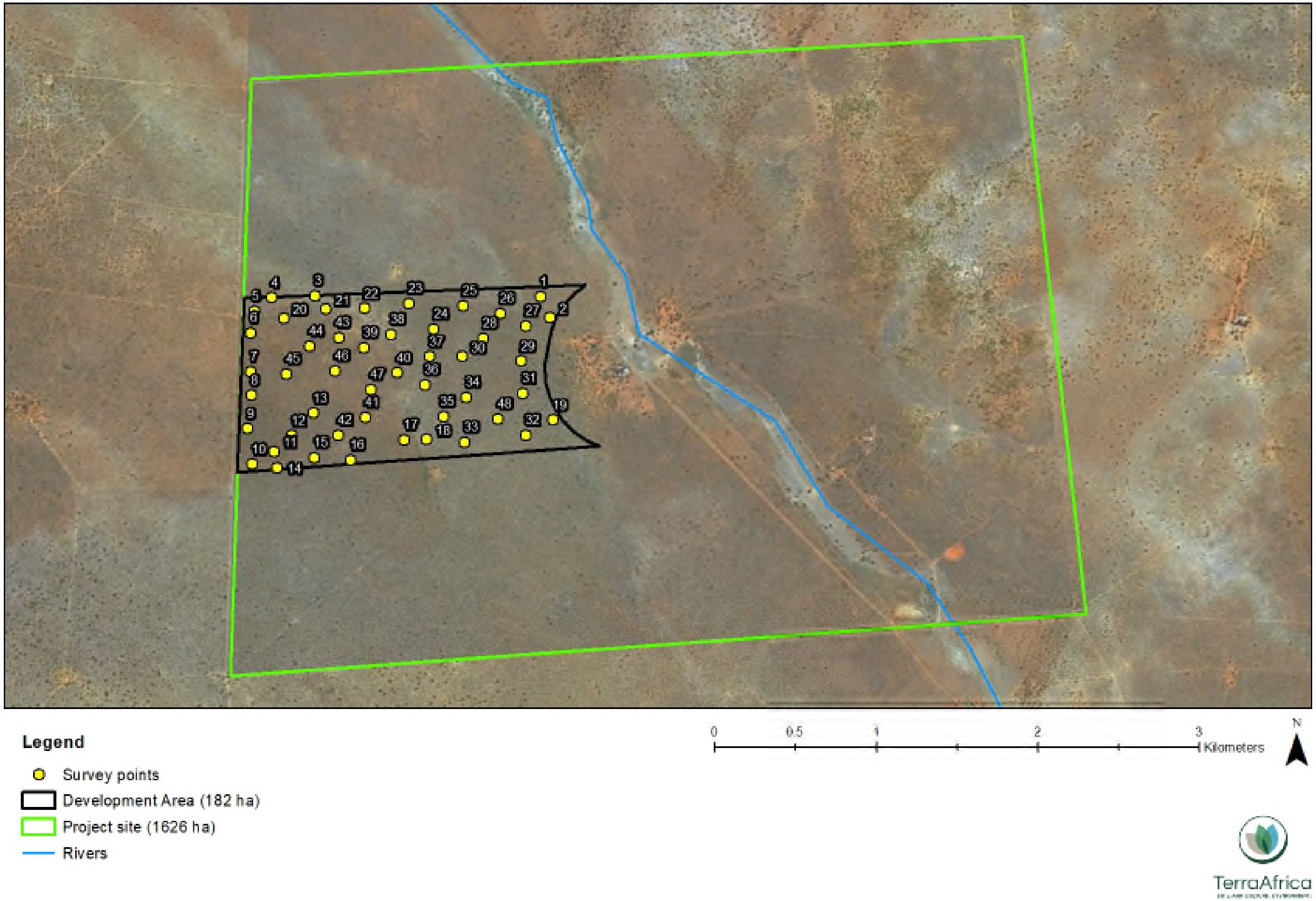

Figure 2 Survey points map of the soil profiles observed within the Development Area

8.5 Impact assessment methodology

Following the methodology prescribed by Savannah Environmental (Pty) Ltd., the direct, indirect and cumulative impacts associated with the project have been assessed 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.
- The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
- The **duration**, wherein it will be indicated whether:
  - the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  - the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  - medium-term (5–15 years) – assigned a score of 3;
  - long term (> 15 years) - assigned a score of 4; or
  - permanent - assigned a score of 5;

- The **magnitude**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not 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.
- The **probability** *of occurrence*, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- the **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
- the **status**, which will be described as either positive, negative or neutral.
- the degree to which the impact can be reversed.
- the degree to which the impact may cause irreplaceable loss of resources.
- the *degree* to which the impact can be *mitigated.*

The **significance** is calculated by combining the criteria in the following formula:

S=(E+D+M)P

S = Significance weighting
E = Extent
D = Duration

M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
- 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
- 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

9. Baseline conditions

9.1 Land types of the project site and access road alternatives

The entire development area of the proposed Hyperion Solar Development 2 as well as Access Road Alternatives 1 and 2 fall within Land Type Ah9. The most eastern sections of Access Road Alternatives 3 and 4 also fall within this Land Type while the western sections of these alternatives fall within Land Type Ag110 (Figure **5**). Each of the land types are described below.

Land Type Ah9

Land Type Ah9 consists of only two terrain units where Terrain Unit 4 is the vast flat areas that dominates the landscape and Terrain Unit 5 is the areas of slight depression where endorheic pans can develop. Therefore, the landscape can be described as flat to very slightly undulating with slopes ranging between 0 and 3%. The soil formed from Aeolian sand of Recent age and the riverbeds in the larger area around the Project area formed on outcrops of Tertiary Kalahari beds (in most cases limestone layers can be seen where it has been exposed through sediment transport by water and wind). The texture of soil in this land type is dominated by sand with the clay fraction estimated as always less than 10%. Deep Hutton and Clovelly soil forms (deeper than 1200 mm) constitutes the largest portion of this land type with very limited possibility for finding shallow, rocky soils of the Mispah and Glenrosa forms over the entire land type area (an estimated 3.5%).

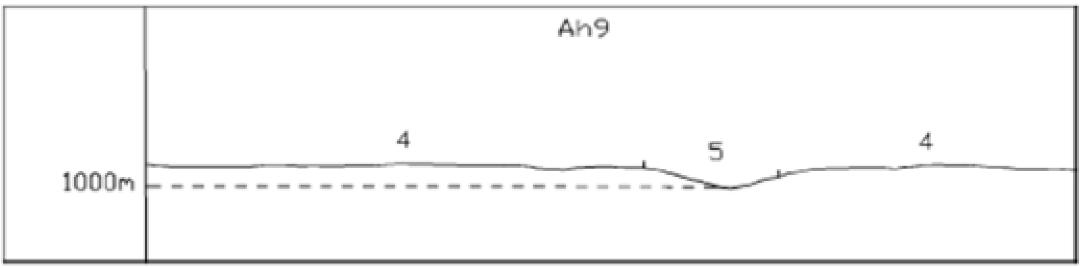

Figure 3 Terrain form sketch of Land Type Ah9

Land Type Ag110

Similar to Land Type Ah9, Land Type Ag110 also consists of only two terrain units where Terrain Unit 4 represent flat areas that dominates the landscape and Terrain Unit 5 represents the areas of slight depression at a variety of elevations where endorheic pans can develop. The landscape is also flat to very slightly undulating with slopes ranging from between 0 and 2%. However, the underlying geology differs from that of Land Type Ah9. The soil in this land type overlies surface limestone, alluvium and red wind-blown sand of Tertiary to Recent age with a few occurrences of amygdaloidal andesitic lava of the Ongeluk Formation.

The texture of soil in this land type is dominated by sand and sandy loam with the clay fraction estimated as always less than 15%. This land type mainly consists of shallow soil profiles of the Hutton and Mispah forms with an estimated 18.5% of areas in this land type consisting of deeper soil profiles of the Hutton form.

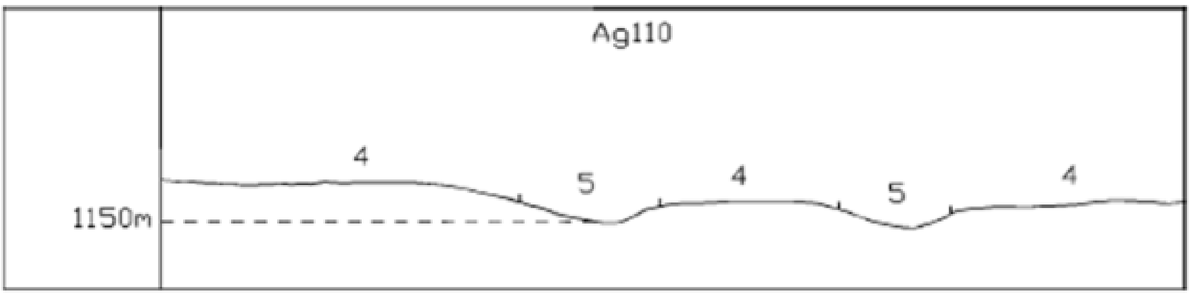

Figure 4 Depiction of the terrain forms of Land Type Ag110

9.2 Soil physical properties

The entire study area consists of the Hutton and Clovelly soil forms, that both belong to the Oxidic group (Fey, 2010). The homogeneity of soil properties of the development area correlates very well with the dominant soil forms Land Type Ah9, as described above.

Both these soil forms consist of an orthic A horizon on an apedal B1 horizon overlying unspecified material. The only difference between the Hutton and Clovelly forms is the colour of the B1 horizon with the Hutton form having uniform red colours and the Clovelly form, uniform yellow-brown colours. The range of red and yellow-brown colours that is the key identification tool in differentiating between a red apedal and yellow-brown apedal is defined by the Soil Classification Working Group (2018).

Soil depths of the Hutton profiles surveyed on site are all beyond 150cm without signs of wetness. Hutton soils with no restrictions shallower than 50cm are generally good for crop production (Fey, 2010) permitting that the rainfall is suitable for crop production, especially in the absence of the availability of irrigation water and infrastructure.

Soil texture is dominated by the sand fraction and all the samples analysed indicated a sand fraction of 95.9%. The high sand fraction makes soil susceptible to soil erosion by wind and water. The very low clay content indicates that the soil has very limited buffering capacity against pollutants that may be brought into contact with the soil surface as a result of construction activities.

The lack of horizon differentiation of the Hutton and Clovelly soil forms within the development area, indicates that there are no complex pedohydrological systems of water storage depending on the arrangement of soil horizons. The construction of the infrastructure associated with the proposed project will therefore have limited impact on soil physical properties pertaining to vertical and lateral soil water movement.

9.3 Soil chemical conditions

The purpose of establishing baseline chemical composition of soil on a site before development commences is to determine whether there is any deterioration in soil fertility and what the nutrient status of the soil is associated with the natural vegetation. The analyses results obtained from the laboratory are attached as Appendix 1.

9.3.1 pH

The pH of the soil is measured potentiometrically in a supernatant suspension of a 1:2.5 soil to liquid mixture. For this assessment water (H_2O) was used. The pH levels will be described using the scale of general descriptive terminology as was defined by the United States Department of Agriculture Natural Resources Conservation Service (NRCS).

The pH values of the samples are slightly acidic (6,07 and 6,53 respectively). This is considered ideal pH values for balanced nutrient uptake by vegetation roots and do not induce any nutrient deficiencies or toxicities (permitting the nutrients are present in the sufficient concentrations).

Table 1 - Descriptive terminology for pH ranges (NRCS, USDA)

Description/Denomination	pH range
Ultra-acidic	<3,5
Extremely acidic	3,5 – 4,4
Very strongly acidic	4,5 – 5,0

Description/Denomination	**pH range**
Strongly acidic	5,1 – 5,5
Moderately acidic	5,6 – 6,0
Slightly acidic	6,1 – 6,5
Neutral	6,6 – 7,3
Slightly alkaline	7,4 – 7,8
Moderately alkaline	7,9 – 8,4
Strongly alkaline	8,5 – 9,0
Very strongly alkaline	>9,0

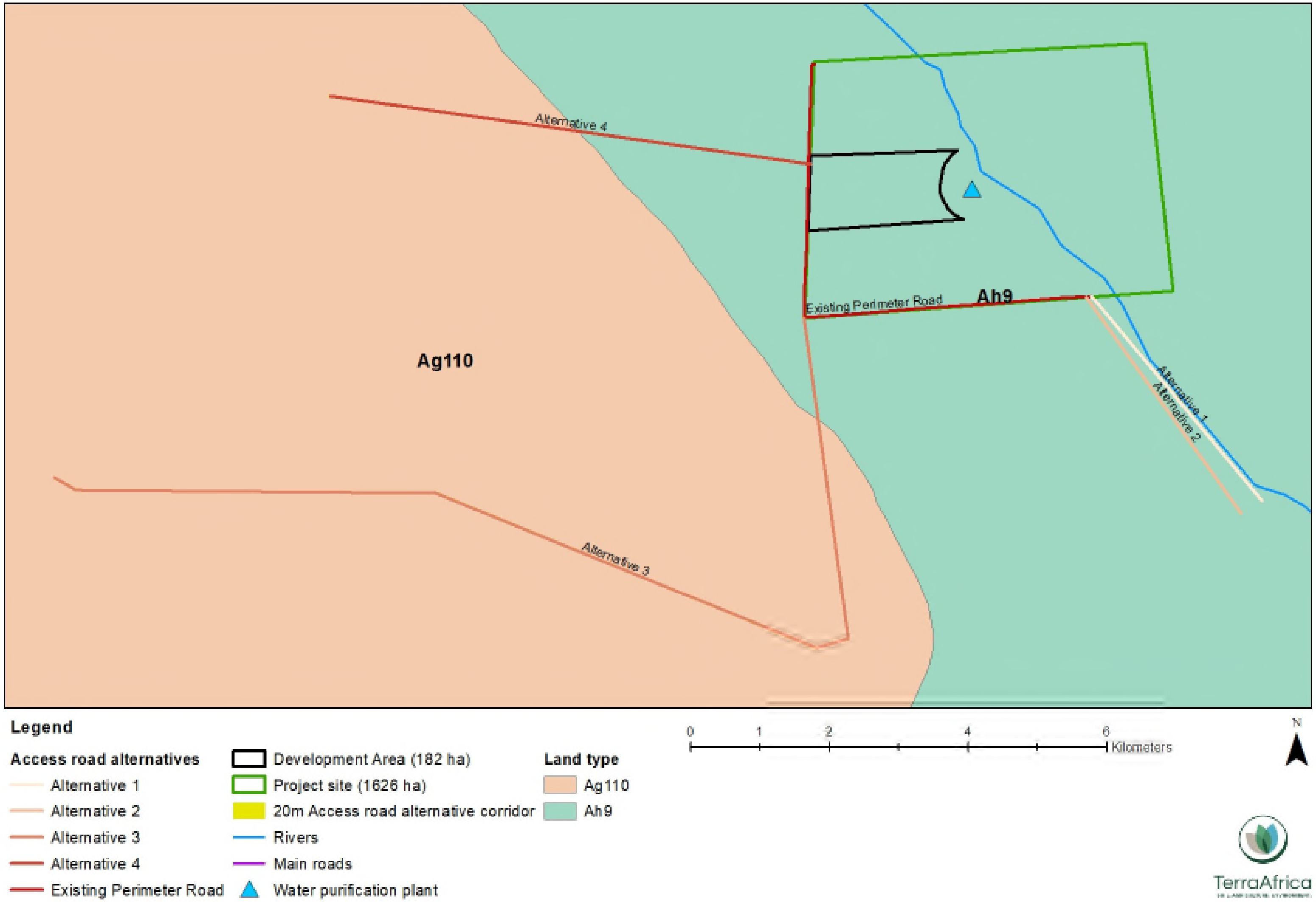

Figure 5: Land type map of the Hyperion Solar Development 2 (project site and access road alternatives)

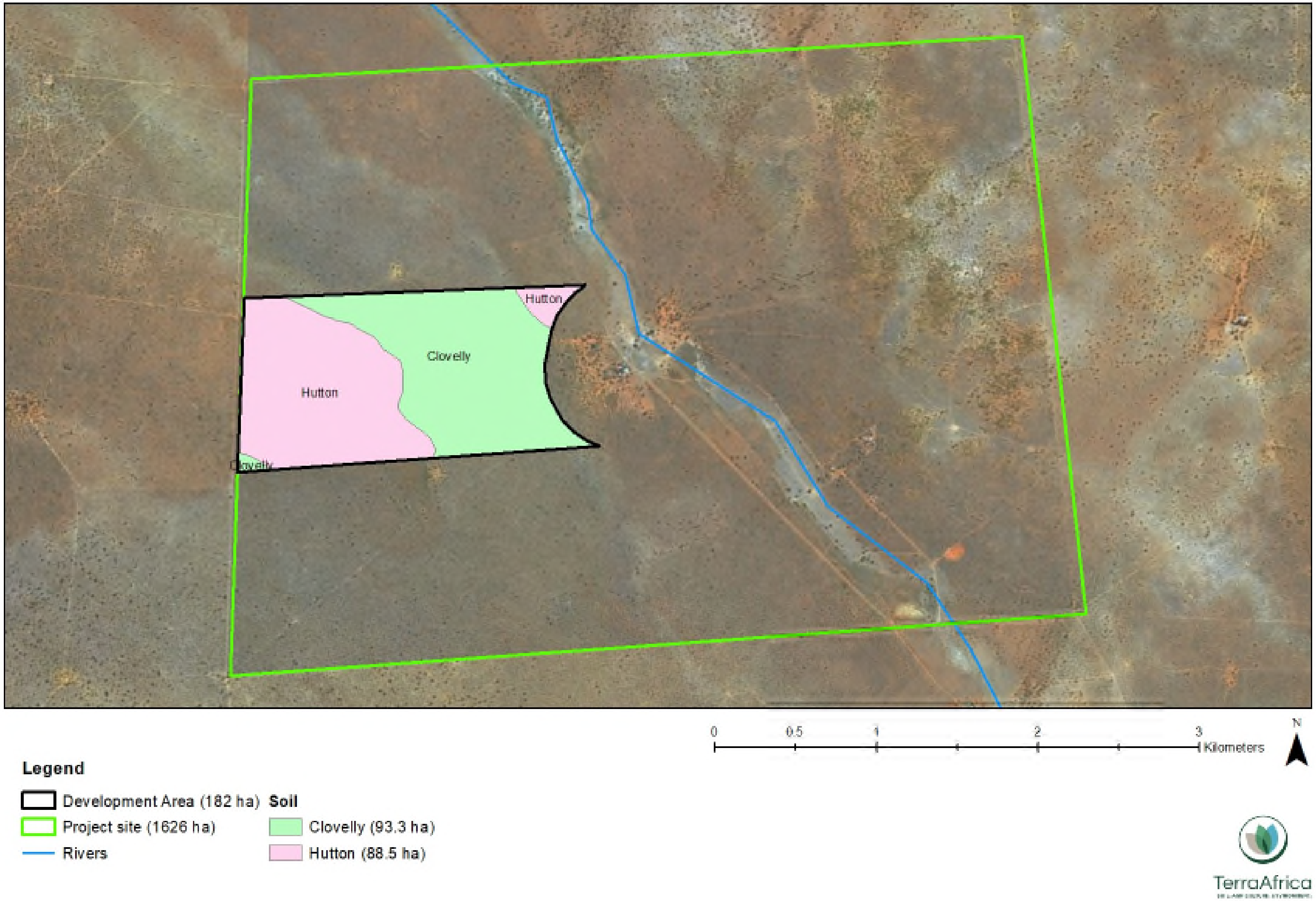

Figure 6: Soil map of the development area of the Hyperion Solar Development 2

9.3.2 Plant nutrients

The cation levels (calcium, magnesium, potassium) are present at sufficient levels for plant growth and sodium levels do not pose a threat of causing soil sodicity. Although plant-available phosphorus levels are low (7,3 and 6,1 mg/kg respectively), this is normal for South African veld conditions. Crop production in this soil would require regular application of phosphate fertilizer.

9.3.3 Soil texture and organic carbon

The texture of the soil is dominated by the sand fraction (95,9 and 93,9% respectively). This, together with the warm, dry climate results in very low organic carbon content in the soil (0,22% in both samples).

9.4 Land capability

Land capability can be defined as “the extent to which land can meet the needs of one or more uses under defined conditions of management” (Schoeman, 2002). The land capability of an area is the combination of the inherent soil properties and the climatic conditions as well as other landscape properties such as slope and drainage patterns that may inhibit agricultural land use or result in the development of specific land functionality such as wetlands. Land capability affects the socio-economic aspects of human settlements and determines the livelihood possibilities of an area. Baseline land capabilities are also used as a benchmark for rehabilitation of land in the case of project decommissioning.

Evaluation of the DAFF land capability raster data (2017) indicated that the larger area that includes the project site and access road alternatives, have three land capability classes ranging from Class 4 – Low-Very Low to Class 6 – Low-Moderate. Following the soil forms present as well as the good grazing quality of the veld, the Development Area can be classified as having Class 7 – Low-Moderate land capability.

9.5 Agricultural potential

The Hyperion 2 Development Area investigated as well as the area where the access road alternatives are located, has no potential for arable agriculture. While the deep apedal soil profiles are ideal for arable agriculture in the wetter eastern regions of South Africa, the erratic rainfall patterns and prolonged droughts experienced in the study area will result in dryland crop production failure. Irrigated agriculture is a possibility in the region, provided that there is a stable, licensed supply of irrigation water and the necessary irrigation infrastructure. The Hyperion 2 development area had no irrigation activities and the landowner did not indicate that there was any previous irrigated crop production.

The Hyperion 2 development area has no boreholes but the boreholes used are present in close proximity to the proposed water treatment plant. The quality and quantity analysis of these boreholes are not known.

The grazing capacity of a specified area for domestic herbivores is given either in large animal unit per hectare or in hectares per large animal unit. One large animal unit is regarded as a steer of 450kg whose weight increases by 500g per day on veld with a mean energy digestibility of 55%. Large animal units can again be converted to small animal units or small stock units. The conversion factor is 4 small stock units that equates one large stock unit.

The recommended grazing capacity for veld for the development area as well as the access road alternatives is 21 – 30 hectares per Large Stock Unit (ha/LSU) (Morgenthal et al., 2005). This indicates that the proposed Hyperion 2 development area can accommodate 6 to 9 head of cattle for grazing purposes. Cattle farming is a viable long-term land use of the site provided that the current crippling drought conditions ceases and as long as the field quality is maintained by never exceeding the grazing capacity. Post-project land use should aim to re-establish the livestock farming potential of the land.

9.6 Land use and surrounding land use

The current land use of the development area is extensive livestock farming. The farmer indicated during an interview that the field is stocked at a capacity of one head of cattle (LSU) per every 15 ha of land. The veld is in good condition and there are no signs of overgrazing, land degradation or erosion. The only areas where vegetation is more sparse is in areas where drinking points are located. Water is provided for the cattle in water troughs. Other infrastructure on the property site includes the farm buildings and farmhouse. The grazing camps have two-track farm roads that are in good conditions.

Surrounding land uses include other livestock farms and game farming. There is also a small engineering business that is operated from one of the neighbouring farms. A long unsurfaced access road that runs from the N14 provides access to these farms.

9.7 Sensitivity analysis

Considering all the baseline properties as discussed in Sections 9.1 to 9.5, the site has low sensitivity to the proposed development. The deep red and yellow-brown apedal soil profiles have no physical limitations to crop production but land capability of the area is severely impeded by the dry, semi-arid climate. Although the site is suitable for livestock production, the grazing capacity is also limited by the low rainfall of the area. The development of a renewable energy project such as the Hyperion Solar Development 2 project will have very little to no negative effect on the agricultural economy of the region.

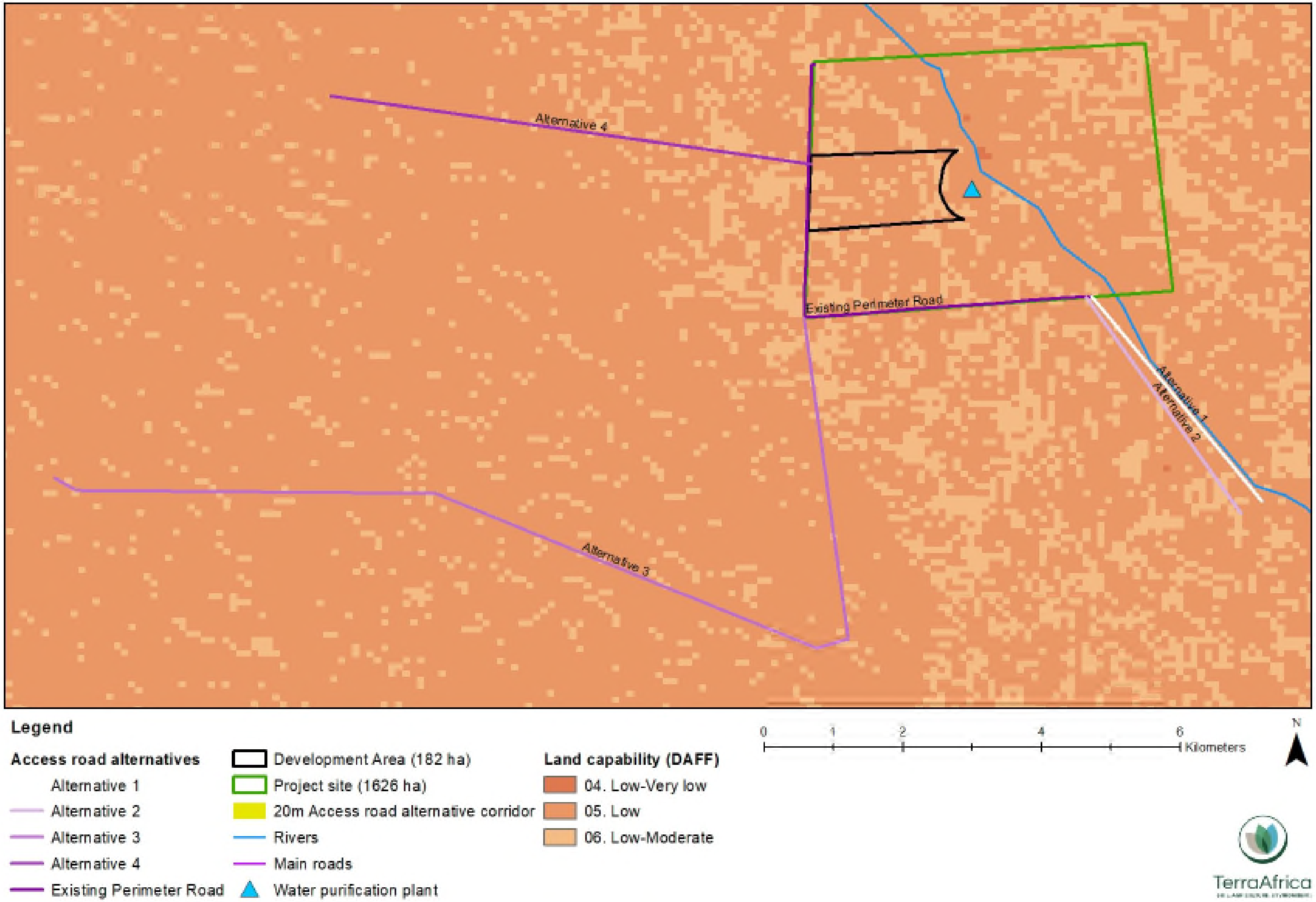

Figure 7: Land capability of the Hyperion 2 development area and access road alternatives (data source: DAFF, 2017)

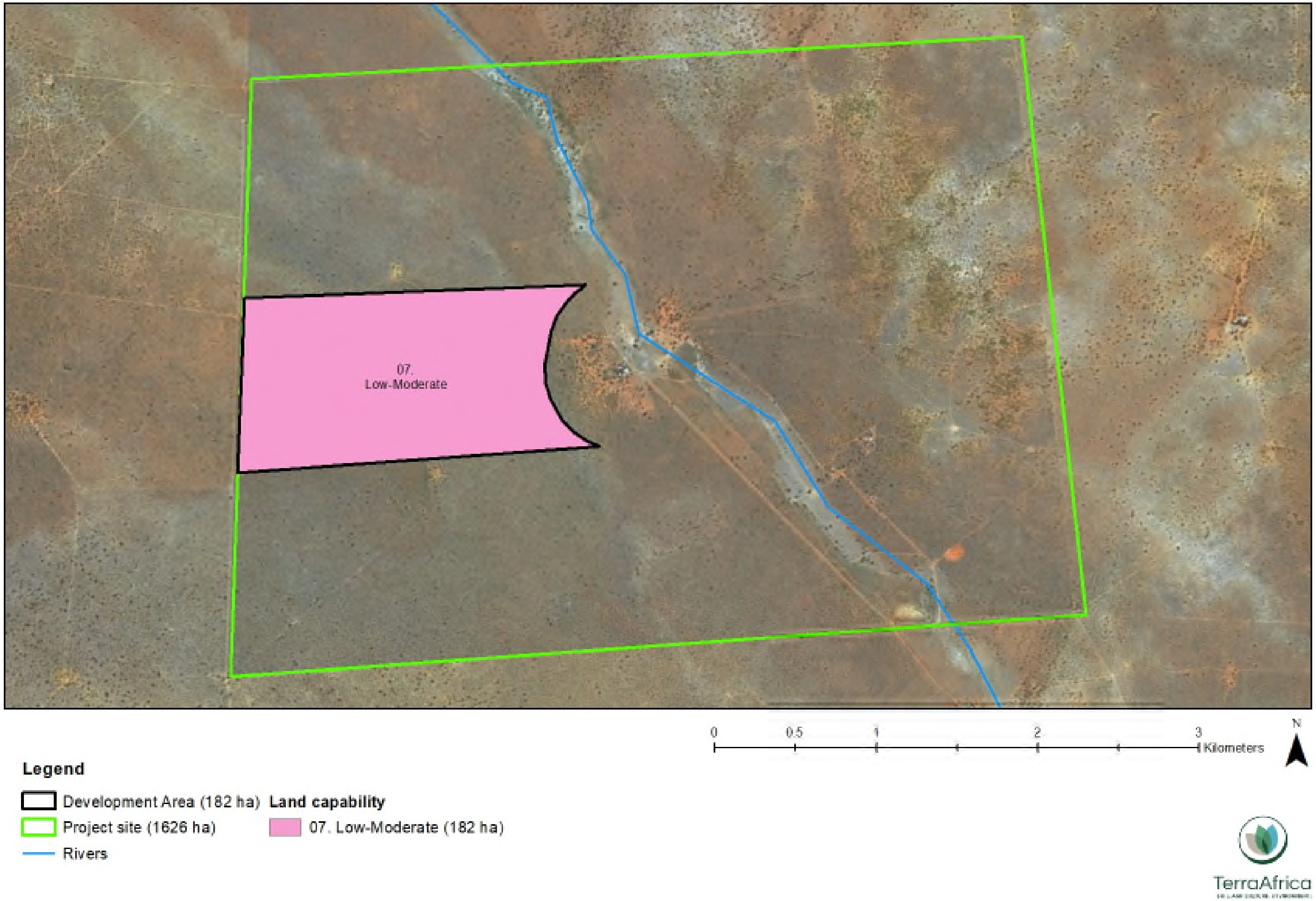

Figure 8: Land capability of the development area of the Hyperion Solar Development 2

10. Impact Assessment

10.1 Project description

The project will be designed to have a contracted capacity of up to 75MW, and will make use of either fixed-tilt, single-axis tracking, or dual-axis (double-axis) tracking photovoltaic (PV) solar technology for the generation of electricity.

The proposed project will comprise the following key infrastructure and components:

- Arrays of PV panels (static or tracking PV system) with a contracted capacity of up to 75MW.
- Mounting structures to support the PV panels.
- On-site inverters (to convert the power from Direct Current (DC) to Alternating Current (AC)), and distribution power transformers.
- An on-site substation to facilitate the connection between the project and the Eskom electricity grid.
- A new 132kV power line between the on-site substation and the existing Ferrum Substation[1].
- Cabling between the project's components (to be laid underground where practical).
- Battery storage mechanism with a storage capacity of up to 300MWh.
- Water purification plant.
- Site Offices and Maintenance Buildings, including workshop areas for maintenance and storage.
- Batching plant.
- Temporary laydown area.
- Main access road to the site, internal access roads and fencing around the development area.

The development area is on 182 ha of land, about 11,2% of the project site area which 1626 ha in extent.

10.2 Description of the impacts anticipated for the project phases

The main envisaged activities during the project development include the following:

- site establishment which will require the limited clearance of vegetation and site levelling;

[1] The construction of the 132kV overhead power line will be assessed as part of a separate Basic Assessment process which will consider feasible alternatives for the power line route.

- construction of permanent access routes which entails the stripping of topsoil, dynamic compaction and the importation of gravel;

- construction of photovoltaic power plant (mounting frame structure installation, installation of modules onto frames, digging of trenches to lay cables between modules);

- construction of campsite and laydown area including:

  - workshops and maintenance area;
  - stores (for handling and storage of fuel, lubricants, solvents, paints and construction material);
  - contractor laydown areas;
  - mobile site offices;
  - temporary waste collection and storage area; and
  - parking area for cars and equipment.

The site preparation activities are disruptive to natural soil horizon distribution and will impact on the current soil hydrological properties and functionality of soil.

The following anticipated impacts have been assessed.

* Soil erosion is anticipated due to vegetation clearance. The impacts of soil erosion are both direct and indirect. The direct impacts are the reduction in soil quality which results from the loss of nutrient-rich upper layers of the soil and the reduced water-holding capacity of severely eroded soils. The off-site indirect impacts of soil erosion include the disruption of riparian ecosystems and sedimentation.

* Soil chemical pollution as a result of storage of hazardous chemicals, concrete mixing, broken PV panels, temporary sanitary facilities and potential oil and fuel spillages from vehicles. This impact will be localised within the site boundary.

* In areas of permanent changes such as roads and the erection of infrastructure and topsoil stockpiles, the current land capability and land use will be lost permanently. This impact will however be localised within the site boundary.

All infrastructure and activities required for the operational phase will be established during the construction phase. Once construction has ceased, a number of impacts remain during the operational phase (as described below). During the operation phase the impacts related to loss of land use and land capability will stay the same. Areas under permanent buildings, substations, transformers and other covered surfaces are no longer susceptible to erosion, but hard surfaces will increase run-off during rain storms onto bare soil surfaces.

Soil chemical pollution during the operation phase will be minimal. Possible sources are oil that needs to be replaced and oil and fuel spillage from maintenance vehicles. This impact will be localised within the site boundary.

Although wind erosion may have an impact before revegetation on adjacent areas, the loss of soil as a resource is restricted to the actual footprint of the solar photovoltaic (PV) power facility. The only impact that may have effects beyond the footprint area is erosion which may cause the sedimentation of the adjacent wetlands.

10.3 Susceptibility to soil erosion due to construction and operation of the solar PV facility and access road

Table 2 Summary of soil erosion impact assessment

Nature: The construction of the solar facility, access road, water treatment plant, camp site and laydown area will require the clearing and levelling of a limited area of land. The following construction activities will result in bare soil surfaces that will be at risk of erosion:

1. vegetation removal during site clearing;
2. creating impenetrable surfaces during the construction phase that will increase run-off onto bare soil surfaces; and
3. leaving soil surfaces uncovered during the rainy season during the construction phase.

During the operation phase the impenetrable surfaces such as paved areas and covered roads stay intact, however, the impact of increased run-off persists on surrounding areas.

	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Medium (30)**	**Low (24)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	

Mitigation:

- Land clearance must only be undertaken immediately prior to construction activities;
- Unnecessary land clearance must be avoided;
- Soil stockpiles must be dampened with dust suppressant or equivalent;
- Soil stockpiles must be located away from any waterway or preferential water flow path in the landscape, to minimise soil erosion from these;
- Geo-textiles or similar measures must be used to stabilise soil stockpiles and uncovered soil surfaces during the construction phase and to serve as a sediment trap to contain as much soil as possible that might erode away;
- A Stormwater Management Plan (SWMP) should be developed and should provide for a drainage system sufficiently designed to prevent water run-off from the solar panels to cause soil erosion;
- Where discharge of rainwater on roads will be channeled directly into the natural environment, the application of diffuse flow measures must be included in the design; and
- Revegetate cleared areas as soon as possible after construction activities.

Residual Impacts:

The residual impact from the construction and operation of the Hyperion Solar Development 2 and access road on the susceptibility to erosion will be negligible.

10.4 Chemical pollution due to construction and operation of the solar facility and access road

Table 3 Summary of soil chemical pollution impact assessment

Nature: The following construction activities can result in the chemical pollution of the soil:

1. Hydro-carbon spills by machinery and vehicles during earthworks and the mechanical removal of vegetation during site clearing.
2. Spills from vehicles transporting workers, equipment and construction material to and from the construction site.
3. The accidental spills from temporary chemical toilets used by construction workers.
4. The generation of domestic waste by construction and operational workers.
5. Spills from fuel storage tanks during construction.
6. Polluted water from wash bays and workshops during the construction phase.
7. Accidental spills of other hazardous chemicals used and stored on site.
8. Pollution from concrete mixing.

The operation of the PV power facility can result in the chemical pollution of the soil:

1. Spills from vehicles transporting workers and equipment to and from the operation site.
2. The generation of domestic waste by operational workers.
3. Accidental spills of other hazardous chemicals used and stored on site.

	Without mitigation	**With mitigation**
Extent	High (3)	Low (1)
Duration	Medium-term (3)	Short-term (2)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (36)**	**Low (14)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	

Mitigation:

- High level maintenance must be undertaken on all vehicles and construction machinery to prevent hydrocarbon spills;
- Impermeable and bunded surfaces must be used for storage tanks and to park vehicles on;
- Site surface water and wash water must be contained and treated before reuse or discharge from site;
- Spills of fuel and lubricants from vehicles and equipment must be contained using a drip tray with plastic sheeting filled with adsorbent material;
- Spill kits must be available on site throughout the construction and operation phase;
- Waste disposal at the construction site must be avoided by separating, trucking out and recycling of waste;
- Potentially contaminating fluids and other wastes must be contained in containers stored on hard surface levels in bunded locations; and
- Accidental spillage of potentially contaminating liquids and solids must be cleaned up immediately by trained staff with the correct equipment and protocols as outlined in the EMPr. Contaminated soils must be disposed of to a registered hazardous waste landfill site.

Residual Impacts:

The residual impact from the construction and operation of the proposed project will be low to negligible

10.5 Loss of land capability as a result of the Hyperion Solar Development 2 and access road

Table 4 Summary of land capability impact assessment

Nature: The land capability of the project site where soil layers are changed and construction of infrastructure is done, will be lost. The impact remains present through the operational phase. The following activities can result in the loss of land capability within the project development footprint: 1. The removal of vegetation during site clearing; 2. Earthworks which destroy the natural layers of the soil profiles; and 3. The construction of the photovoltaic power plant (frame structures and installation of modules onto frames), mid-grid line and infrastructure which will cover soil surfaces.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (4)	Minor (2)
Probability	Definite (4)	Probable (4)
Significance	**Medium (36)**	**Low (28)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	
Mitigation: • Keep the project footprint as small as possible; and • Avoid areas with wetland land capability.		
Residual Impacts: The residual impact from the construction and operation of the Hyperion Solar Development 2 and supporting infrastructure will be of low significance.		

11. Assessment of cumulative impacts

11.1 Assessment rationale

"Cumulative Impact", in relation to an activity, means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity that in itself may not be significant, but may become significant when added to existing and reasonably foreseeable impacts eventuating from similar or diverse activities[2].

[2] Unless otherwise stated, all definitions are from the 2014 EIA Regulations (GNR 326).

The role of the cumulative assessment is to test if such impacts are relevant to the proposed project in the proposed location (i.e. whether the addition of the proposed project in the area will increase the impact). This section should address whether the construction of the proposed development will result in:

- Unacceptable risk
- Unacceptable loss
- Complete or whole-scale changes to the environment or sense of place
- Unacceptable increase in impact

11.2 Other projects in the area

At least twenty-two (22) other solar facilities around the proposed Hyperion Solar Development 2 are in different phases of the development process. Three PV projects and one CSP project are in operation.

Such a large number of projects will change the dominant current land use of the area from livestock farming to electricity generation. In addition to this, cumulative impacts will be an increased risk for soil erosion when vegetation is removed and possible pollution of soil resources. The contribution of the Hyperion Solar development 2 to cumulative impacts is considered to be low due to the limited footprint of the facility and the limited land capability.

Table 5 Assessment of cumulative impact of decrease in areas available for livestock farming

Nature: Decrease in areas with land capability for livestock farming.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (1)	Regional (2)
Duration	Long-term (4)	Long-term (4)
Magnitude	Minor (2)	Moderate (3)
Probability	Probable (4)	Probable (4)
Significance	**Low (28)**	**Medium (36)**
Status (positive/negative)	Negative	Negative
Reversibility	Low	Low
Loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	No
Confidence in findings: High.		
Mitigation: The only mitigation measures for this impact is to keep the footprints of all solar energy facilities as small as possible and within areas of low-moderate land capability.		

Table 6 Assessment of cumulative impact of areas susceptible to soil erosion

Nature: Increase in areas susceptible to soil erosion		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Local (1)	Regional (2)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Low (4)	Moderate (3)
Probability	Probable (3)	Probable (4)
Significance	**Low (24)**	**Medium (40)**
Status (positive/negative)	Negative	Negative
Reversibility	Low	Low
Loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	No
Confidence in findings: High.		
Mitigation: Each of the projects should adhere to the highest standards for soil erosion prevention and management as defined in Section 10.3 above.		

Table 7 Assessment of cumulative impact of increased risk of soil pollution

Nature: Increase in areas susceptible to soil pollution		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Low (1)	Regional (2)
Duration	Short-term (2)	Permanent (5)
Magnitude	Low (4)	Moderate (3)
Probability	Improbable (2)	Probable (4)
Significance	**Low (14)**	**Medium (40)**
Status (positive/negative)	Negative	Negative
Reversibility	Low	Low
Loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	No
Confidence in findings: High.		
Mitigation: Each of the projects should adhere to the highest standards for soil pollution prevention and management as defined in Section 10.4 above.		

12. Consideration of alternatives

Based on the outcome of the meeting and consultations with affected landowners during the Scoping Phase, the following four access road alternatives were identified for consideration:

Alternative 1:

This alternative formed part of the Scoping Phase and entails the upgrade of approximately 3.6km of the existing T26 gravel road situated between the project site and the N14 national road. The existing road will be upgraded from 5m to 9m in width and will traverse four properties; the Remaining Extent of the Farm Lyndoch 432; Portion 1, 2 and the Remaining Extent of the Farm Cowley 457.

Alternative 2:

This is a new alternative identified for consideration in the EIA process. Alternative 2 entails the establishment of a new access road approximately 3.6km in length and 9m in width. The new access road is proposed to be located adjacent to the existing T26 gravel road and will traverse four properties; the Remaining Extent of the Farm Lyndoch 432, Portion 1, 2 and the Remaining Extent of the Farm Cowley 457.

Alternative 3:

Alternative 3 entails the establishment of a new access road approximately 5.1km in length and 9m in width and the upgrade of approximately 10.3km of the existing T25 gravel road from xm in width to 9m in width. This alternative was previously known as Alternative 2 in the Scoping Phase and was realigned in order to avoid the protected Kathu Forest. Alternative 3 will traverse five properties; the Remaining Extent of the Farm Lyndoch 432, Portion 1 of the Farm Selsden 464, the Remaining Extent of the Farm Kathu 465, Portion 1 of the Farm Halliford 466 and the Remaining Extent of the Farm Marsh 467.

Alternative 4:

Access Road Alternative 4 entails the establishment of a new access road approximately 6.2km in length and 9m in width situated between the western boundary of the project site and the R380 regional road. This alternative was proposed by the DAFF as an additional alternative which will traverse four properties; the Remaining Extent of the Farm Lyndoch 432, Portion 1 and the Remaining Extent of the Farm Selsden 464 and the Remaining Extent of the Farm Halliford 466.

A 20m wide corridor for each of the four alternatives has been considered and assessed during the EIA in order to determine the most preferred route from an environmental perspective.

With regards to impacts on soil, land use, land capability and agricultural potential there are a few considerations:

- The avoidance of areas with high arable agricultural potential as this is a scarce natural resource in South Africa.
- Areas with wetland land capability where surface disturbance of the hydromorphic soil forms will result in disabling the functionality of the wetland areas.
- The minimization of the project surface footprint as this is directly proportional to the extent of the impact.

With these principles in mind, Alternative 1 is considered to be the Preferred Alternative as it will be on soil already affected by traffic and the impacts on soil and land capability will only be for the widening of the existing road. None of the other three alternatives are No-go alternatives, but Alternative 3 is the Least Favourable alternative because of the larger area of in situ soil profiles that will be disturbed and will be affected by soil compaction.

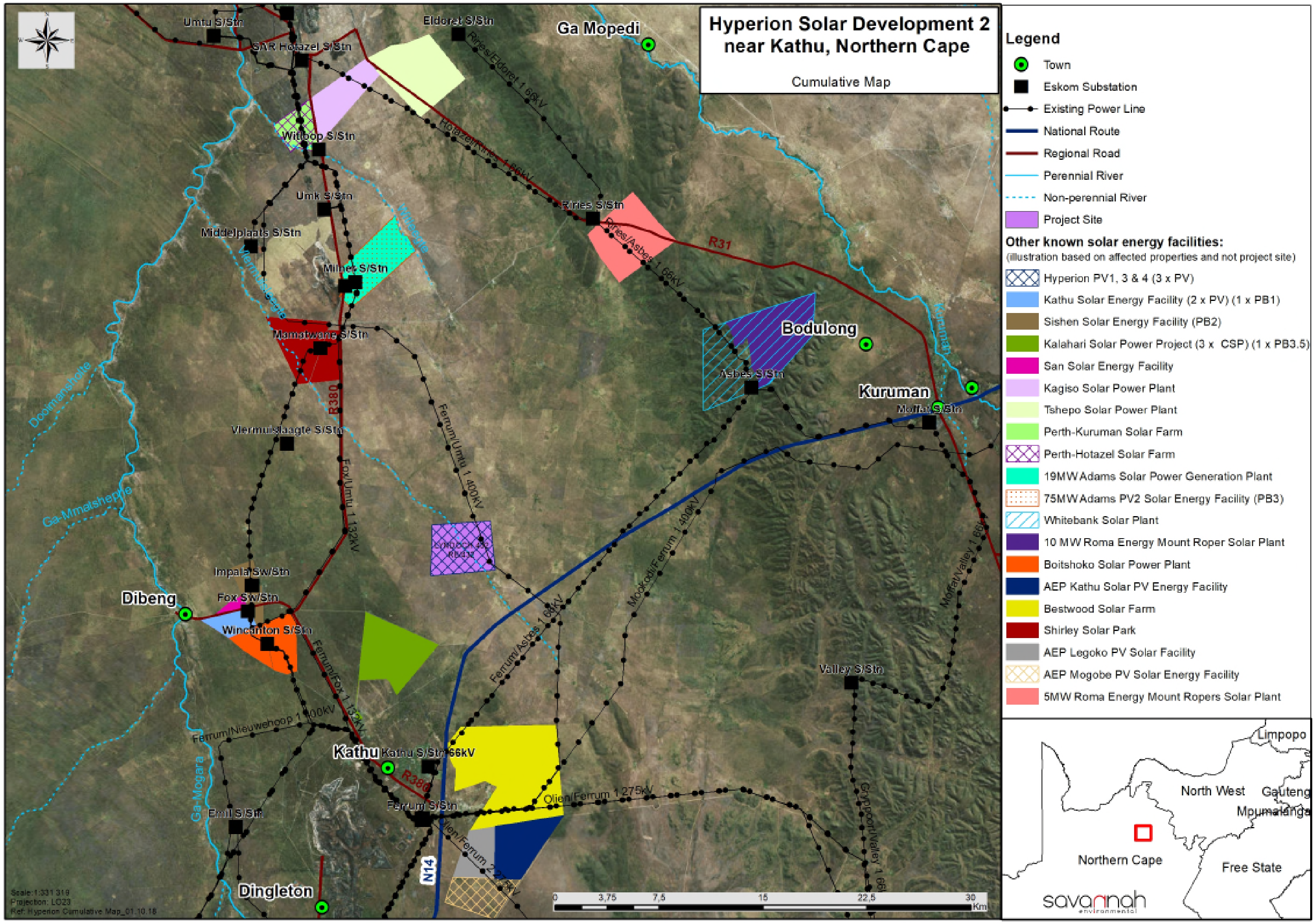

Figure 9: Map depicting other solar developments surrounding the Hyperion 2 Solar Development (Savannah Environmental, 2019)

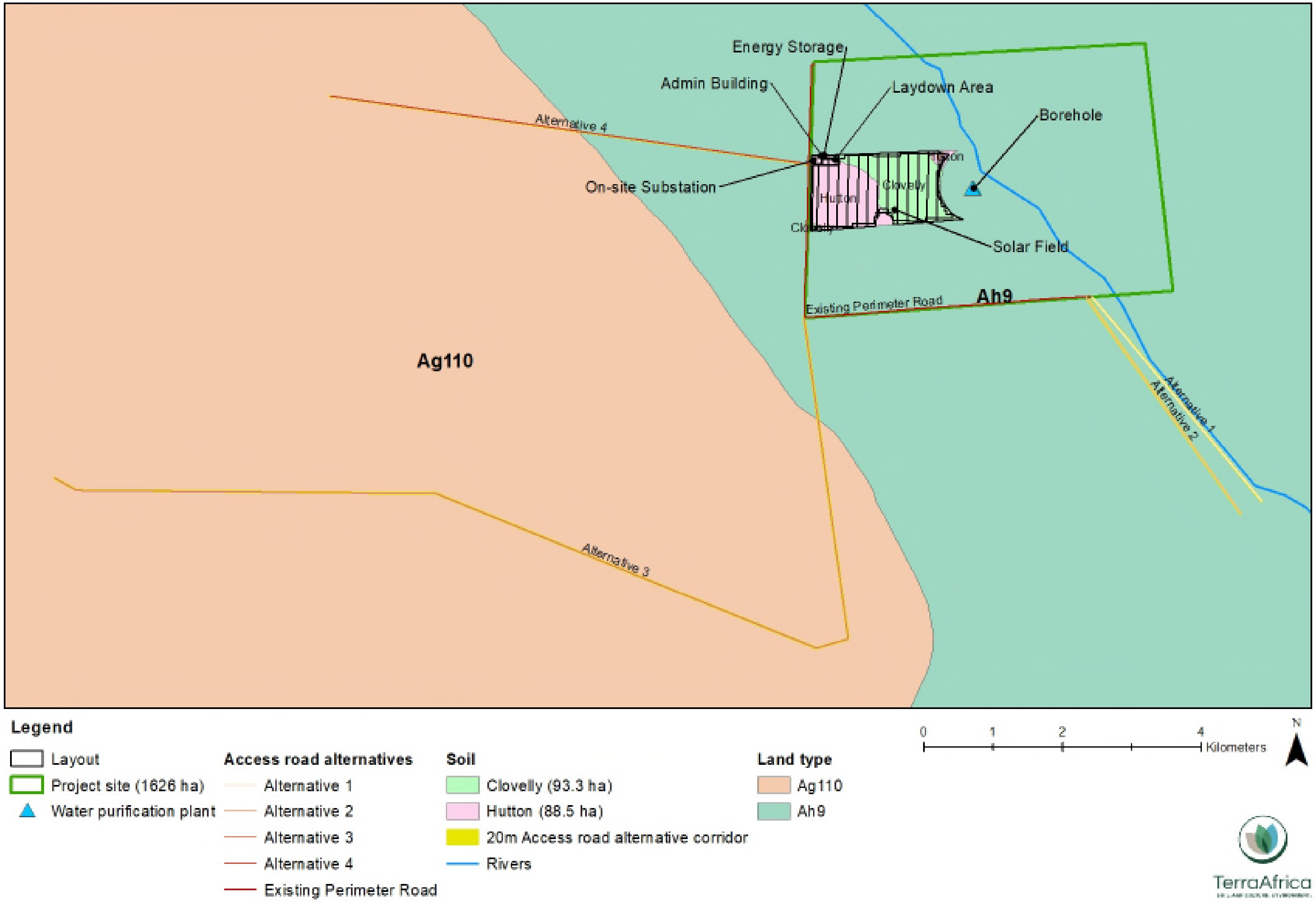

Figure 10: Layout and position of site infrastructure and access road alternatives, superimposed on soil and land type data

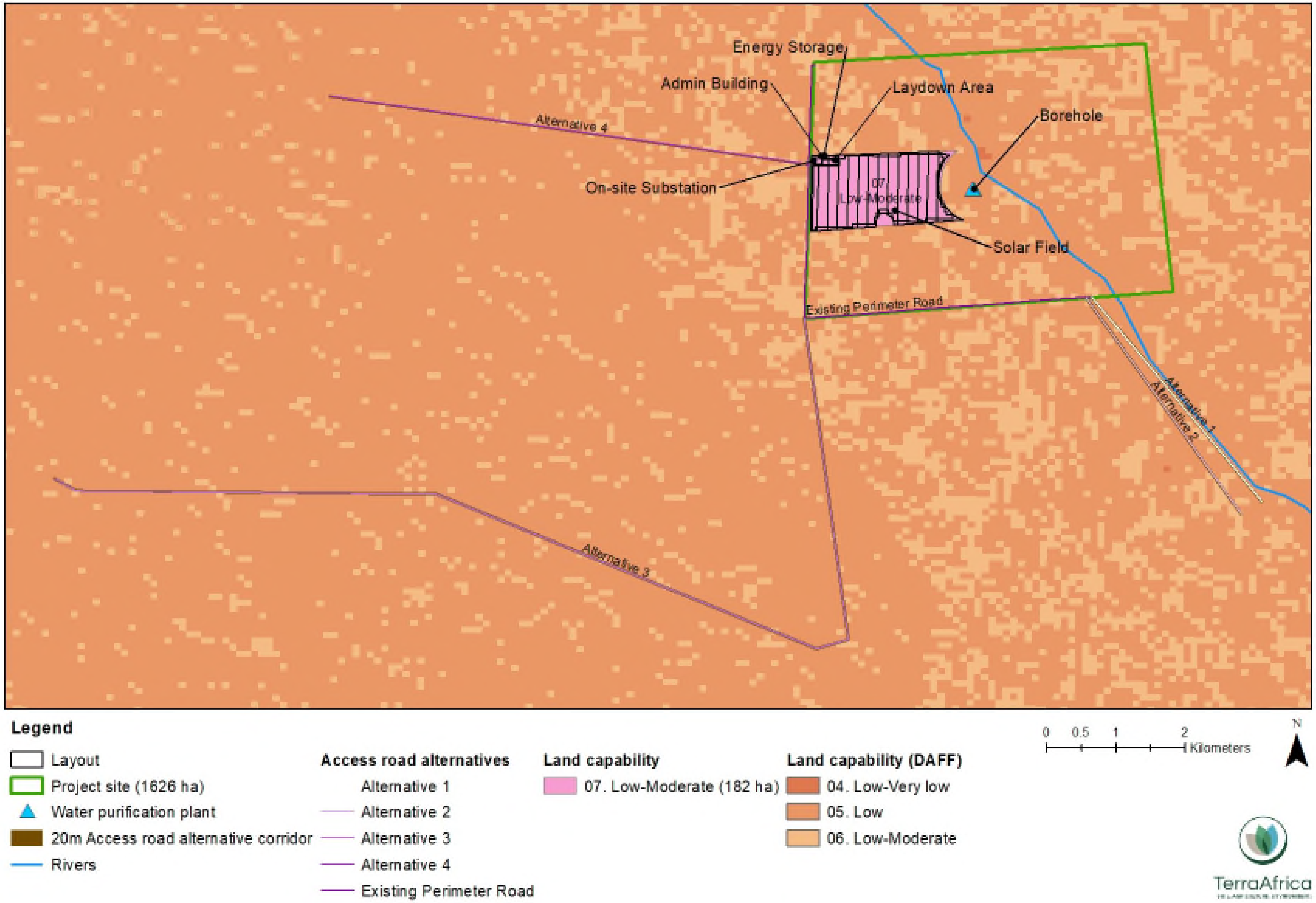

Figure 11: Layout and position of site infrastructure and access road alternatives, superimposed on land capability data (data sources: DAFF 2017 and survey data)

13. Soil, land use and land capability management plan

The management plan for the management of the impacts described in Section 10.

Table 8 Measures to mitigate, manage and monitor soil for susceptibility to erosion

OBJECTIVE: To construct and operate the facility in a manner that ensures the protection of soils against erosion caused by the removal of vegetation cover and compaction of soil, and to maintain and monitor the terrain of the Hyperion Solar Development 2 as well as the access road alternatives.		
Project Component/s	Construction and Operation Phases	
Potential Impact	Susceptibility to erosion.	
Activity / Risk source	• Vegetation removal during site clearing; • Creating impenetrable surfaces; • Leaving soil surfaces uncovered by vegetation.	
Mitigation: Target / Objective	Revegetate, maintain and monitor Hyperion Solar Development site.	
Mitigation: Action/control	**Responsibility**	**Timeframe**
• Soil stockpiles must be dampened with dust suppressant or equivalent to prevent erosion by wind. • Land clearance must only be undertaken immediately prior to construction activities. • Unnecessary land clearance must be avoided. • All graded or disturbed areas which will not be covered by permanent infrastructure such as paving, buildings or roads must be stabilised with erosion control mats (geo-textiles) and revegetated. • Ensure vegetation is re-established on disturbed surfaces as soon as construction has been completed in an area. • Any signs of soil erosion on site should be documented (including photographic evidence and coordinates of the problem areas) and submitted to the management team of the Hyperion Solar Development 2 project for further action. • Monitor compliance of construction workers to restrict	» EPC Contractor » EO	Ongoing during construction. Revegetate as soon as possible after construction is completed.

construction work to the clearly defined limits of the construction site to keep footprint as small as possible. • Where vegetation is not re-establishing itself in areas where surface disturbance occurred, soil samples must be collected, analysed for pH levels, electrical conductivity (EC) and major plant nutrient levels (calcium, magnesium, potassium) and sodium. • When vegetation re-establishment still remains unsatisfactory, the bulk density of the soil should be measured with a penetrometer to determine whether compaction is an issue. • The results must be submitted to a professional soil or agricultural scientist for recommendations on the amendment of the issue to ensure that the vegetation cover is established and erosion prevented.		
Performance indicator	Minimal to no soil erosion on site. Soil surfaces are either vegetated or protected by erosion control materials. There are no signs of sedimentation outside of the surface footprint that originates from soil erosion on site.	
Monitoring	• On-going visual assessment of compliance with erosion prevention by EPC Contractor and EO. • Monitor visual signs of erosion such as the formation of gullies after rainstorms and the presence of dust emissions during wind storms.	

Table 9 Measures to mitigate, manage and monitor soil for susceptibility to soil pollution

OBJECTIVE: To construct and operate the Hyperion Solar Development 2 and access road in a manner that minimises the pollution of soil by hydrocarbon spills from vehicles and machinery, chemicals or oils, and resultant waste material and pollution that may result from damaged PV panels and oil during the operation phase. To store and use fuel, lubricants, pesticides, herbicides and other hazardous chemicals safely, and to prevent spills and contamination of the soil resource.	
Project Component/s	Construction and Operation Phases
Potential Impact	Soil pollution
Activity / Risk source	• Hydrocarbon spills by vehicles and machinery, chemicals or oils during levelling, vegetation clearance and transport of workers, materials and equipment and fuel storage tanks; • Accidental spills of hazardous chemicals; • Generation of domestic waste by construction and operation workers; • Polluted water from wash bays and workshops

	• Pollution from concrete mixing and damaged PV panels.	
Mitigation: Target / Objective	Prevent and contain hydrocarbon leaks. Undertake proper waste management. Store hazardous chemicals safely in a bunded area.	
Mitigation: Action/control	**Responsibility**	**Timeframe**
• Check vehicles and machinery daily for oil, fuel and hydraulic fluid leaks and undertake regular high standard maintenance on vehicles; • Losses of fuel and lubricants from the oil sumps and steering racks of vehicles and equipment must be contained using a drip tray with plastic sheeting filled with absorbent material when not parked on hard standing. • Waste disposal at the construction site must be avoided by separating and trucking out of waste. • All hazardous chemicals must be in safe storage on site and should be used with care by skilled individuals who understand the pollution risk associated with the chemicals. • Accidental spillage of potentially contaminating liquids and solids must be cleaned up immediately in line with procedures by trained people with the appropriate equipment. • Spill kits must be available on site and must be maintained in working order • Records of all incidents that caused chemical pollution must be kept and a summary of the results must be reported to the Hyperion Solar Development 2 Management team annually. • Gaps must be identified and procedures must be amended if necessary by the Hyperion 2 Solar Development Project Management team.	» EPC Contractor » EO	On-going visual assessment during the construction and operation phases to detect polluted areas and the application of clean-up and preventative procedures. .

Performance indicator	No soil chemical pollution on site that can eventually seep into the groundwater system. Also, no signs of any physical waste on the soil surface that can cause soil pollution.	
Monitoring	• On-going visual assessment to detect polluted areas and the application of clean-up and preventative procedures. • Monitor hydrocarbon spills from vehicles and machinery during construction continuously and record volume and nature of spill, location and clean-up actions. • Monitor maintenance of drains and intercept drains weekly. • Analyse soil samples for pollution in areas of known spills or where a breach of containment is evident when it occurs. • Records of accidental spills and clean-up procedures and the results thereof must be audited on an annual basis by the EO	

Table 10 Measures to mitigate, manage and monitor loss of land capability

OBJECTIVE: To keep the Hyperion Solar Development 2 and access road footprint as small as possible and minimise the loss of land capability.		
Project Component/s	Construction and Operation Phases	
Potential Impact	Loss of Land Capability	
Activity / Risk source	• The removal of vegetation during site clearing; • Earthworks which destroy the natural layers of the soil profiles; and • The construction of access roads and photovoltaic power plant (frame structures and installation of modules onto frames) and infrastructure which will cover soil surfaces.	
Mitigation: **Target / Objective**	Keep the project footprint as small as possible	
Mitigation: Action/control	**Responsibility**	**Timeframe**
• Keep the project footprint as small as possible; and • Avoid areas with wetland land capability. • Stay within the boundary of the PV power facility site as designed and agreed upon.	» Developer » EPC Contractor » EO	On-going visual assessment of compliance by EPC Contractor to stay within the design footprint. .
Performance indicator	Land capability of the development area is only affected where the solar panels are located.	
Monitoring	• Monitor compliance of construction workers to restrict construction work to the clearly defined limits of the construction site by EO. • Reporting by EO to the Hyperion Solar Development 2 Project Management team if any impacts outside the PV facility fence take place. • If any transgressions occur, corrective actions should be taken.	

14. Reasoned opinion

The proposed Hyperion Solar Development 2 is located on deep apedal soil that has low-moderate land capability and low potential for crop production. While irrigation can increase the yield of marginal land, South Africa is a water-stressed country where a large fraction of the available water has already been allocated to food production. Irrigated crop production also requires significant capital investment and running costs that may not be financially viable for the landowner.

The proposed Hyperion Solar Development 2 with the associated infrastructure will have low to minor impacts on soil and land capability properties as well as current land uses in the areas where the footprint will result in surface disturbance. Cumulative impacts are related to an increase in the loss of agricultural land used for livestock farming in addition to the other areas where solar PV projects will be constructed. These impacts can be reduced by keeping the footprints minimised where possible and strictly following soil management measures pertaining to erosion control and management and monitoring of any possible soil pollution sources such as vehicles traversing over the sites. The contribution of the Hyperion Solar Development 2 to cumulative impacts in the area is low due to its limited footprint and land capability.

From the perspective of soil and land capability conservation, access road Alternative 1 is the Preferred Alternative because it disturbs only in situ profiles where the road is widened while the other access road alternatives will result in disturbance of new areas that will lead to soil compaction. While the other alternatives are not no-go alternatives and may be acceptable, it will have a higher impact on the receiving landscape. Alternative 3 is considered to be the least preferred alternative.

The land capability and soil quality of land affected by the surface footprint of the proposed photovoltaic power plant infrastructure will be slightly compromised. If soil management measures are followed as outlined in this report and the land rehabilitated to the highest standard possible, livestock farming will be possible on the rehabilitated land.

It is therefore of my opinion that the activity should be authorised. It follows that the recommendations and monitoring requirements as set out in this report should form part of the conditions of the environmental authorisation for the proposed project.

15. Reference list

The Soil Classification Working Group (2018). *Soil Classification: A Natural and Anthropogenic System for South Africa.* ARC-Institute for Soil, Climate and water, Pretoria.

Fey, M. (2010). *Soils of South Africa*. Cambridge. Cape Town.

Morgenthal, T.L., D.J. du Plessis, T.S. Newby and H.J.C. Smith (2005). *Development and Refinement of a Grazing Capacity Map for South Africa.* ARC-ISCW, Pretoria.

Appendix 1 – Laboratory analyses sheet

NORTH-WEST UNIVERSITY
ECO-ANALYTICA

Eco Analytica
P.O. Box 19140
NOORDBRUG 2522
Tel: 018-285 2732/3/4

TERRA AFRICA (HYPERION 2)

30/10/2018 **Nutrient Status**

Sample no.	Ca	Mg	K	Na	P	$pH(H_2O)$	EC
	(mg/kg)						(mS/m)
3 (Topsoil	328,1	31,0	97,9	41,9	7,3	6,07	7
4 (Subsoil	405,2	76,3	93,9	58,9	6,1	6,53	8

Exchangeable cations

Sample no.	Ca	Mg	K	Na	CEC	Base saturation (%)	LOI %C
	(cmol(+)/kg)						
3 (Topsoil	1,64	0,26	0,25	0,18	9,20	25,28	0,22
4 (Subsoil	2,02	0,63	0,24	0,26	14,46	21,75	0,22

HANDBOOK OF STANDARD SOIL TESTING METHODS FOR ADVISORY PURPOSES

Exchangeable cations: 1M NH_4-Asetaat pH=7

CEC: 1 M Na-asetaat pH=7

Extractable, Exchangeable micro-elements: 0.02M $(NH_4)_2$ EDTA.H_2O

EC: Saturated Extraction

pH H_2O/KCl: 1:2.5 Extraction

Phosphorus: P-Bray 1 Extraction

30/10/2018 **Particle Size Distribution**

Sample no.	**> 2mm (%)**	**Sand**	**Silt**	**Clay**
		(% < 2mm)		
3 (Topsoil)	0,0	95,9	1,6	2,4
4 (Subsoil)	0,0	93,9	1,6	4,5

This laboratory participates in the following quality control schemes:

International Soil-Analytical Exchange (ISE), Wageningen, Nederland.

No responsibility is accepted by North-West University for any losses due to the use of this data

APPENDIX 2 – FIELD SURVEY DATA SHEET

Survey Point	X Coordinates	Y Coordinates	Soil Form	Depth	Slope
1	23,07993500	-27,55153800	Hutton	150+ cm	0-10 %
2	23,08047800	-27,55269400	Hutton	150+ cm	0-10 %
3	23,06738300	-27,55146000	Clovelly	150+ cm	0-10 %
4	23,06495700	-27,55157100	Hutton	150+ cm	0-10 %
5	23,06400300	-27,55233100	Hutton	150+ cm	0-10 %
6	23,06380932	-27,55353489	Hutton	150+ cm	0-10 %
7	23,06381243	-27,55568900	Hutton	150+ cm	0-10 %
8	23,06382753	-27,55701407	Hutton	150+ cm	0-10 %
9	23,06360725	-27,55887000	Hutton	150+ cm	0-10 %
10	23,06390200	-27,56085500	Clovelly	150+ cm	0-10 %
11	23,06510700	-27,56013600	Hutton	150+ cm	0-10 %
12	23,06610500	-27,55925500	Hutton	150+ cm	0-10 %
13	23,06731100	-27,55801400	Hutton	150+ cm	0-10 %
14	23,06526800	-27,56107900	Hutton	150+ cm	0-10 %
15	23,06735700	-27,56049800	Hutton	150+ cm	0-10 %
16	23,06937200	-27,56062400	Hutton	150+ cm	0-10 %
17	23,07235900	-27,55949600	Hutton	150+ cm	0-10 %
18	23,07360000	-27,55945000	Hutton	150+ cm	0-10 %
19	23,08064347	-27,55839350	Clovelly	150+ cm	0-10 %
20	23,06564887	-27,55272139	Hutton	150+ cm	0-10 %
21	23,06799026	-27,55222646	Clovelly	150+ cm	0-10 %
22	23,07014130	-27,55216936	Clovelly	150+ cm	0-10 %
23	23,07261594	-27,55190286	Clovelly	150+ cm	0-10 %
24	23,07400554	-27,55333053	Clovelly	150+ cm	0-10 %
25	23,07560454	-27,55201707	Clovelly	150+ cm	0-10 %
26	23,07767943	-27,55245489	Clovelly	150+ cm	0-10 %
27	23,07912614	-27,55315921	Clovelly	150+ cm	0-10 %
28	23,07672764	-27,55384450	Clovelly	150+ cm	0-10 %
29	23,07887868	-27,55511989	Clovelly	150+ cm	0-10 %
30	23,07556647	-27,55483435	Clovelly	150+ cm	0-10 %
31	23,07893578	-27,55690924	Clovelly	150+ cm	0-10 %
32	23,07912614	-27,55923160	Clovelly	150+ cm	0-10 %
33	23,07569972	-27,55961231	Clovelly	150+ cm	0-10 %
34	23,07581393	-27,55711864	Clovelly	150+ cm	0-10 %
35	23,07455758	-27,55820367	Clovelly	150+ cm	0-10 %

Survey Point	X Coordinates	Y Coordinates	Soil Form	Depth	Slope
36	23,07352965	-27,55643335	Clovelly	150+ cm	0-10 %
37	23,07375808	-27,55485339	Clovelly	150+ cm	0-10 %
38	23,07160704	-27,55363510	Clovelly	150+ cm	0-10 %
39	23,07008419	-27,55435846	Hutton	150+ cm	0-10 %
40	23,07194969	-27,55576710	Hutton	150+ cm	0-10 %
41	23,07019840	-27,55824174	Hutton	150+ cm	0-10 %
42	23,06867555	-27,55923160	Hutton	150+ cm	0-10 %
43	23,06873266	-27,55380643	Hutton	150+ cm	0-10 %
44	23,06705751	-27,55428232	Hutton	150+ cm	0-10 %
45	23,06580116	-27,55582421	Hutton	150+ cm	0-10 %
46	23,06848519	-27,55565289	Hutton	150+ cm	0-10 %
47	23,07050297	-27,55669985	Hutton	150+ cm	0-10 %
48	23,07754618	-27,55831788	Clovelly	150+ cm	0-10 %

APPENDIX 3 - CURRICULUM VITA OF SPECIALIST (Mariné Pienaar)

- **Personal Details**

  Last name: **Pienaar**
  First name: **Mariné**
  Nationality: **South African**
  Employment: **Self-employed (Consultant)**

- **Contact Details**

  Email address: mpienaar@terraafrica.co.za
  Website: **www.terraafrica.co.za**
  Mailing address: **PO Box 433, Ottosdal, 2610**
  Telephone: **+27828283587**
  Address: **57 Kruger Street, Wolmaransstad, 2630, Republic of South Africa**
  Current Job: **Lead Consultant and Owner of Terra Africa Consult**

- **Concise biography**

Mariné Pienaar is a professionally registered soil- and agricultural scientist (SACNASP) who has consulted extensively for the past eleven years in the fields of soil, land use and agriculture in several African countries. These countries include South Africa, Liberia, Ghana, DRC, Mozambique, Botswana, Angola, Swaziland and Malawi. She has worked with mining houses, environmental consulting companies, Eskom, government departments as well as legal and engineering firms. She conducted more than three hundred specialist studies that included baseline soil assessment and rehabilitation planning for new projects or expansion of existing projects, soil quality monitoring, land rehabilitation assessment and monitoring, natural resource assessment as part of agricultural project planning, evaluation and development of sustainable agriculture practices, land use assessment and livelihood restoration planning as part of resettlement projects and land contamination risk assessments. She holds a BSc. Agriculture degree with specialisation in Plant Production and Soil Science from the University of Pretoria and a MSc in Environmental Science from the University of the Witwatersrand. In addition to this, she has attended a number of courses in Europe, the USA and Israel in addition to those attended in South Africa. Mariné is a contributing author of a report on the balance of natural resources between the mining industry and agriculture in South Africa (published by the Bureau for Food and Agricultural Policy, 2015).

- **Qualifications**

  Academic Qualifications:

  - **MSc Environmental Science**; University of Witwatersrand, South Africa, 2017

- **BSc (Agric) Plant Production and Soil Science;** University of Pretoria, South Africa, 2004
- **Senior Certificate / Matric;** Wolmaransstad High School, South Africa, 2000

Courses Completed:

- **World Soils and their Assessment;** ISRIC – World Soil Information, Wageningen, 2015
- **Intensive Agriculture in Arid- and Semi-Arid Environments** – Gilat Research Centre, Israel, 2015
- **Hydrus Modelling of Soil-Water-Leachate Movement;** University of KwaZulu-Natal, South Africa, 2010
- **Global Sustainability Summer School 2012;** Institute for Advanced Sustainability Studies, Potsdam, Germany, 2012
- **Wetland Rehabilitation;** University of Pretoria, South Africa, 2008
- **Enviropreneurship Institute;** Property and Environment Research Centre [PERC], Montana, U.S.A., 2011
- **Youth Encounter on Sustainability;** ACTIS Education [official spin-off of ETH Zürich], Switzerland, 2011
- **Environmental Impact Assessment │Environmental Management Systems – ISO 14001:2004 │Environmental Law;** University of Potchefstroom, South Africa, 2008
- **Carbon Footprint Analyst Level 1;** Global Carbon Exchange Assessed, 2011
- **Negotiation of Financial Transactions;** United Nations Institute for Training and Research, 2011
- **Food Security: Can Trade and Investment Improve it?** United Nations Institute for Training and Research, 2011

- **Language ability**

Perfectly fluent in English and Afrikaans (native speaker of both) and conversant in French.

- **Professional Experience**

Name of firm	Terra Africa Environmental Consultants
Designation	Owner | Principal Consultant
Period of work	December 2008 to Date

- **Prior Tenures**

Integrated Development Expertise (Pty) Ltd; **Junior Land Use Consultant** [July 2006 to October 2008]
Omnia Fertilizer (Pty) Ltd; **Horticulturist and Extension Specialist** [January 2005 to June 2006]

- **Professional Affiliations**

- South African Council for Natural Scientific Professions [SACNASP]
- Soil Science Society of South Africa [SSSA]
- Soil Science Society of America
- South African Soil Surveyors' Organisation [SASSO]
- International Society for Sustainability Professionals [ISSP]

Summary of a selected number of projects completed successfully:

[Comprehensive project dossier available on request]

1. *Sekoko Railway Alignment and Siding Soil, Land Use and Capability Study* in close proximity to the Medupi Power Station in the Lephalale area, Limpopo Province.

2. *Italthai Rail and Port Projects, Mozambique* – The study included a thorough assessment of the current land use practices in the proposed development areas including subsistence crop production and fishing as well as livestock farming and forestry activities. All the land uses were mapped and intrinsically linked to the different soil types and associated land capabilities. This study was used to develop Livelihood Restoration Planning from.

3. *Bomi Hills Railway Alignment Project, Liberia:* soil, land use and agricultural scientist for field survey and reporting of soil potential, current land use activities and existing soil pollution levels, as well as associated infrastructure upgrades of the port, road and railway.

4. *Kingston Vale Waste Facility, Mpumalanga Province, South Africa*: Soil and vegetation monitoring to determine the risk of manganese pollution resulting from activities at the waste facility.

5. *Keaton Mining's Vanggatfontein Colliery, Mpumalanga*: Assessment of soil contamination levels in the mining area, stockpiles as well as surrounding areas as part of a long-term monitoring strategy and rehabilitation plan.

6. *Richards Bay Minerals, KwaZulu-Natal*: Contaminated land assessment of community vegetable gardens outside Richards Bay as a result of spillages from pipelines of Rio Tinto's Richards Bay Minerals Mine.

7. *Buffelsfontein Gold Mine, Northwest Province, South Africa:* Soil and land contamination risk assessment for as part of a mine closure application. Propose soil restoration strategies.

8. Glenover Phosphate Mining Project near Steenbokpan in the Lephalale area – Soil, Land Use and Land Capability Study as part of the environmental authorisation process.

9. *Waterberg Coal 3 and 4 Soil, Land Use and Land Capability Study* on 23 000 ha of land around Steenbokpan in the Lephalale area.

10. *Lesotho Highlands Development Agency, development of Phase II (Polihali Dam and associated infrastructure)*: External review and editing of the initial Soil, Land Use and Land Capability Assessment as requested by ERM Southern Africa.

11. *Tina Falls Hydropower Project, Eastern Cape , South Africa*: Soil, land use and land capability assessment as part of the ESIA for the construction of a hydropower plant at the Tina Falls.

12. *Graveyard relocation as part of Exxaro Coal's Belfast Resettlement Action Plan*: Soil assessment to determine pedohydrological properties of the relocation area in order to minimise soil pollution caused by graveyards.

13. *Rhino Oil Resources: Strategic high-level soil, land use and land capability assessment of five proposed regions to be explored for shale gas resources in the KwaZulu-Natal, Eastern Cape, North-West and Free State provinces of South Africa.*

14. *Eskom Kimberley Strengthening Phase 4 Projec*t, Northern Cape & Free State, South Africa: soil, agricultural potential and land capability assessment.

15. *Mocuba Solar Project, Mozambique* – The study included a land use assessment together with that of the soil and land capabilities of the study area. All current land uses were documented and mapped and the land productivity was determined. This study advocated the resettlement and livelihood restoration planning.

16. *Botswana (Limpopo-Lipadi Game Reserve).* Soil research study on 36 000 ha on the banks of the Limpopo River. This soil study forms part of an environmental management plan for the Limpopo-Lipadi Game Reserve situated here as well as the basis for the Environmental Impact Assessment for the development of lodges and Land Use Management in this area.

17. *TFM Mining Operations [proposed] Integrated Development Zone, Katanga, DRC* [part of mining concession between Tenke and Fungurume]: soil and agricultural impact assessment study.

18. *Closure Strategy Development for Techmina Mining Company – Lucapa, Angola.* Conducted an analysis of the natural resources (soil, water) to determine the existing environmental conditions on an opencast diamond mine in Angola. The mine currently experience severe problems with kimberlite sediment flowing into the river. A plan is currently being developed to change the mining area into a sustainable bamboo farming operation.

19. *Closure of sand mining operations, Zeerust District.* Succesfully conducted the closure application of the Roos Family Sand Mine in the Zeerust District. Land Use Management Plans for rehabilitated soil were developed. The mine has closed now and the financial provision has been paid out to the applicant.

20. *ESIA for [proposed] Musonoi Mine, Kolwezi area, Katanga, DRC:* soil, land use and land capability assessment.

21. *Bauba A Hlabirwa Moeijelik Platinum mine [proposed] project, Mpumalanga, South Africa:* soil, land use and land capability assessment and impact on agricultural potential of soil.

22. *Commissiekraal Coal Mine [proposed] project, KwaZulu*-Natal, South Africa: sustainable soil management plans, assessment of natural resource and agricultural

potential and study of the possible impacts of the proposed project on current land use. Soil conservation strategies included in soil management plan.

23. *Cronimet Chrome Mine [proposed] project, Limpopo Province, South Africa:* soil, land use and land capability of project area and assessment of the impacts of the proposed project.
24. *Moonlight Iron Ore Land Use Assessment, South Africa* – Conducted a comprehensive land use assessment that included interviews with land users in the direct and indirect project zones of influence. The study considered all other anticipated social and environmental impacts such as water, air quality and noise and this was incorporated into a sensitivity analysis of all land users to the proposed project.

25. *Project Fairway Land Use Assessment, South Africa* – The study included an analysis of all land users that will directly and indirectly be influenced by the project. It analysed the components of their land uses and how this components will be affected by the proposed project. Part of the study was to develop mitigation measures to reduce the impact on the land users.

26. *Bekkersdal Urban Renewal Project – Farmer Support Programme,* Independent consultation on the farmer support programme that forms part of Bekkersdal Renewal Project. This entailed the production of short and long term business plans based on soil and water research conducted. Part of responsibilities were the evaluation of current irrigation systems and calculation of potential water needs, etc. as well as determining quantities and prices of all project items to facilitate the formalisation of tender documents.

27. *Area-based agricultural business plans for municipalities in Dr. Kenneth Kaunda Municipal District.* Evaluation of the agricultural and environmental status of the total district as well as for each municipality within the district. This included the critical evaluation of current agricultural projects in the area. The writing of sustainable, executable agricultural business plans for different agricultural enterprises to form part of the land reform plans of each Municipality within the district.

28. *Batsamaya Mmogo, Hartswater.* Conducted a soil and water assessment for the farm and compiled management and farming plans for boergoats grazing on *Sericea lespedeza* with pecan nuts and lucerne under irrigation.

29. *Anglo Platinum Twickenham Mine – Irrigated Cotton Project.* Project management of an irrigated cotton production project for Twickenham Platinum Mine. This project will ensure that the community benefit from the excess water that is available from the mine activities.

30. *Grasvally Chrome (Pty) Ltd Sylvania Platinum [proposed] Project, Limpopo Province, South Africa:* Soil, land use and agricultural potential assessment.

31. *Jeanette Gold mine project [reviving of historical mine], Free State, South Africa:* Soil, land use and agricultural potential assessment.

32. *Kangra Coal Project, Mpumalanga, South Africa:* Soil conservation strategies proposed to mitigate the impact of the project on the soil and agricultural potential.

33. *Richards Bay Integrated Development Zone Project, South Africa* [future development includes an additional 1500 ha of land into industrial areas on the fringes of Richards Bay]: natural resource and agricultural potential assessment, including soil, water and vegetation.

34. *Exxaro Belfast Coal Mine [proposed] infrastructure development projects* [linear: road and railway upgrade | site-specific coal loading facilities]: soil, land capability and agricultural potential assessment.

35. *Marikana In-Pit Rehabilitation Project of Aquarius Platinum, South Africa:* soil, land capability and land use assessment.
36. *Eskom Bighorn Substation proposed upgrades, South Africa:* soil, land capability and agricultural potential assessment.

37. *Exxaro Leeuwpan Coal Mining Right Area, South Africa:* consolidation of all existing soil and agricultural potential data. Conducted new surveys and identified and updated gaps in historic data sets.

38. *Banro Namoya Mining Operation, DRC:* soil, land use and agricultural scientist for field survey and reporting of soil potential, current land use activities and existing soil pollution levels, including proposed project extension areas and progressive soil and land use rehabilitation plan.

39. *Kumba Iron Ore's Sishen Mine, Northern Cape, South Africa: soil, land use and agricultural scientist* | *Western Waste Rock Dumps [proposed] Project:* soil, land use and agricultural potential assessment, including recommendations regarding stripping/stockpiling and alternative uses for the large calcrete resources available.

40. *Vetlaagte Solar Development Project, De Aar, South Africa:* soil, land use and agricultural scientist. Soil, land use and agricultural potential assessment for proposed new 1500 ha solar development project, including soil management plan.