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Agricultural Agro-Ecosystem Assessment for the proposed 30MW Harmony One Plant Solar PV Facility

Submitted by TerraAfrica Consult cc

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DOCUMENT AND QUALITY CONTROL

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1. Introduction

Terra-Africa Consult cc was appointed by Savannah Environmental (Pty) Ltd to conduct the agricultural specialist assessment as part of the Scoping and Environmental Impact Assessment process for the proposed development of a solar energy facility. The project entails the development of a Photovoltaic (PV) Solar Energy Facility and associated infrastructure with a capacity of up to 30MW on 82ha of land and will be known as Harmony One Plant Solar PV. The development of a renewable energy facility, overhead powerline and associated infrastructure is proposed by Free Gold Harmony (Pty) Ltd.

The development area the Harmony One Plant Solar PV is based near Harmony 1 Gold Plant mining operations located in the Town of Welkom and about 14km north west of the town of Virginia within the Matjhabeng Local Municipality, and within the Lejweleputswa District Municipality, Free State Province (**Error! Reference source not found.**).

The proposed PV Facility and grid connection infrastructure is located on the Remaining Extent of the Farm Marmageli 20 and on the Remaining Extent of the Farm Welkom 80

The development of a solar photovoltaic (PV) facility with a generating capacity of up to 30MW and associated infrastructure, including:

- PV modules and mounting structures.
- Inverters and transformers a SCADA room, and maintenance room.
- Cabling between the project components, to be laid underground where practical.
- Access roads, internal roads and fencing around the development area.
- Temporary and permanent laydown areas.
- Grid connection infrastructure including an on-site facility substation and a switching substation to be connected to the existing Brandgold Substation via an overhead power line (located ~2km north of the site).

2. Details of the specialist

Mariné is a scientist registered with the South African Council for Natural Scientific Professions (SACNASP) and is specialised in the fields of Agricultural Science and Soil Science. Her SACNASP Registration Number is 400274/10. Mariné holds a BSc. degree in Agricultural Science (with specialisation in Plant Production) from the University of Pretoria and a MSc. Degree in Environmental Science from the University of the Witwatersrand. She has consulted in the subject fields of soil, agriculture, pollution assessment and land use planning for the environmental sector of several African countries including Botswana, Mozambique, Democratic Republic of Congo, Liberia, Ghana and Angola. She has also consulted on the soil and agricultural assessment of a gas infrastructure project in Afghanistan. Her contact details are provided in Appendices 1 and 2 attached.

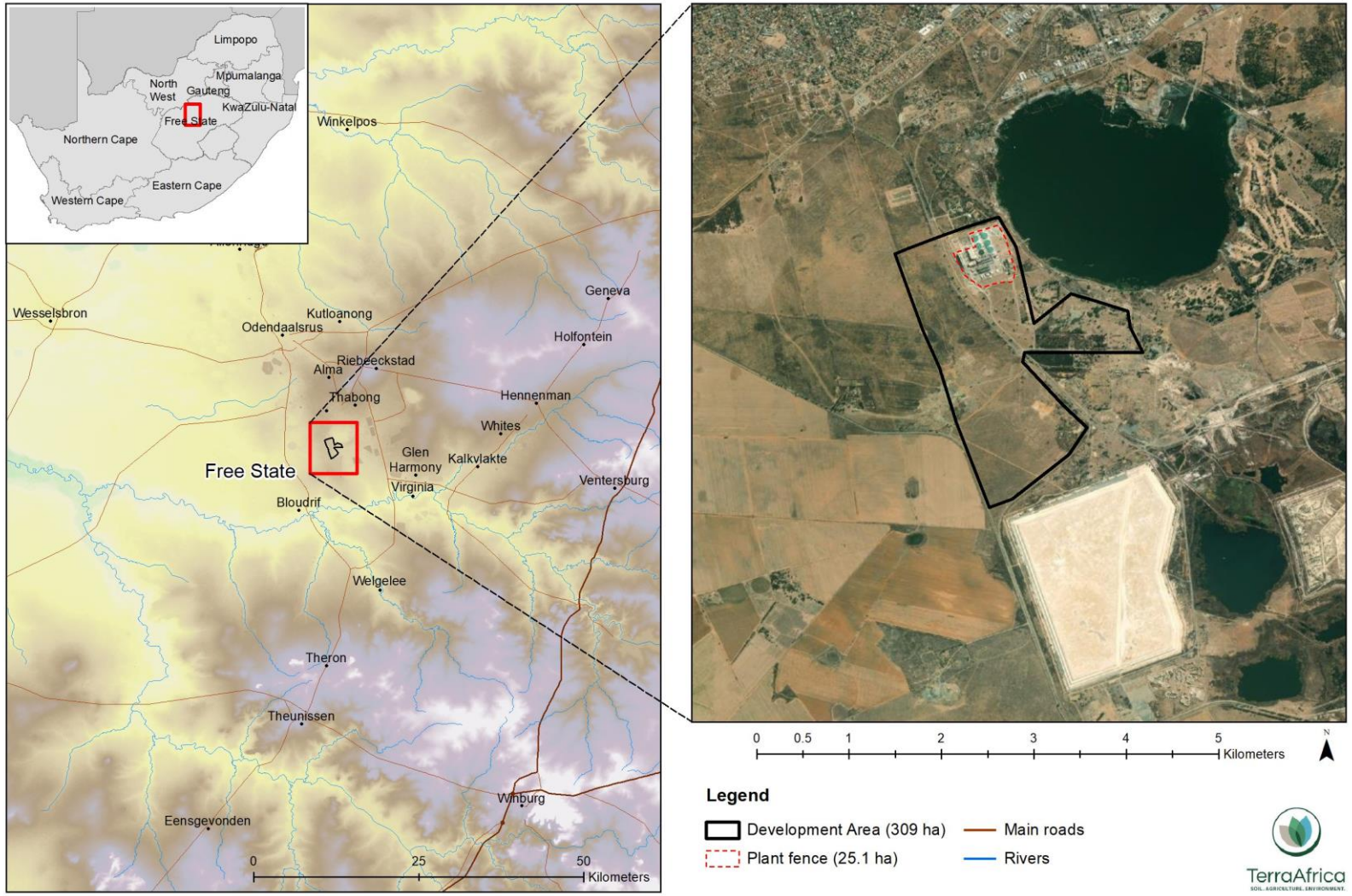

Figure 1 Locality of the proposed Harmony One Plant Solar PV facility development area

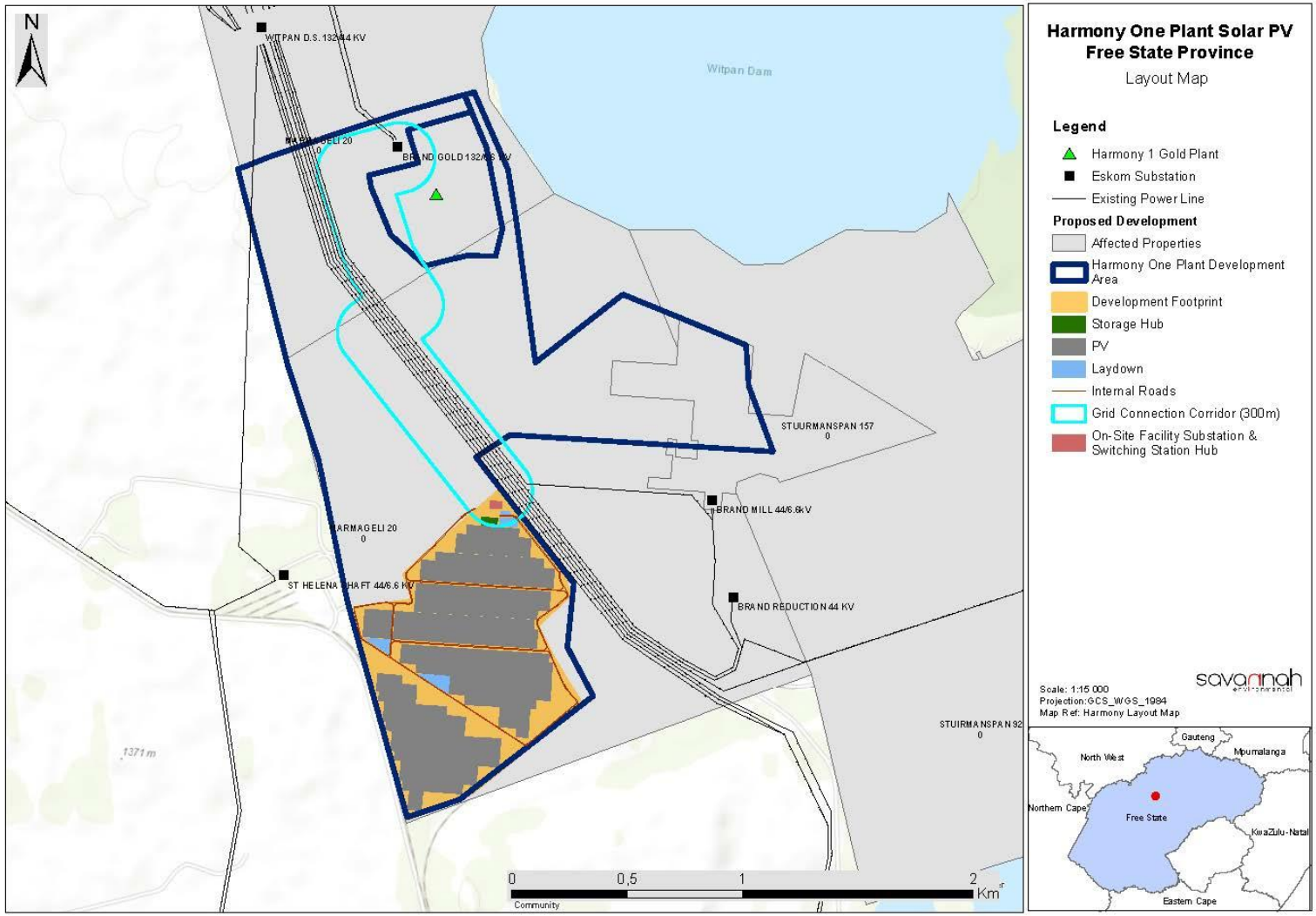

Figure 2 Layout map of the infrastructure of the proposed Harmony One Plant Solar PV facility (compiled by Savannah Environmental, November 2022)

3. Purpose and objectives of the assessment

The overarching purpose of the Agricultural Agro-Ecosystem Specialist Assessment (from here onwards also referred to as the Agricultural Assessment) that will be included in the final Environmental Impact Assessment Report, is to ensure that the sensitivity of the site to the proposed land use change (from agriculture to renewable energy generation) is sufficiently considered. Also, that the information provided in this report, enables the Competent Authority to come to a sound conclusion on the impact of the proposed project on the food production potential of the site. To meet this objective, site sensitivity verification must be conducted of which the results must meet the following objectives:

- It must confirm or dispute the current land use and the environmental sensitivity as was indicated by the National Environmental Screening Tool.
- It must contain proof of the current land use and environmental sensitivity pertaining to the study field.
- All data and conclusions are submitted together with the Basic Assessment report for the proposed Harmony One Plant Solar PV Facility.

According to GN320, the Agricultural Agro-Ecosystem Assessment that is submitted must meet the following requirements:

- It must identify the extent of the impact of the proposed development on the agricultural resources.
- It has to indicate whether or not the proposed development will have an unacceptable impact on the agricultural production capability of the site, and in the event where it does, whether such a negative impact is outweighed by the positive impact of the proposed development on agricultural resources.

The following checklist is supplied as per the requirements of GNR 320, detailing where in the report the various requirements have been addressed:

GNR 320 requirements of an Agricultural Agro-Ecosystem Statement (High to Very High Sensitivity)	**Reference in this report**
Details and relevant experience as well as the SACNASP registration number of the soil scientist or agricultural specialist preparing the assessment including a curriculum vitae;	Section 3 and Appendices 1 & 2
A signed statement of independence by the specialist;	Appendix 1
The duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment;	Section 8.2
A description of the methodology used to undertake the on-site assessment inclusive of the equipment and models used, as relevant;	Section 8.2
A map showing the proposed development footprint (including supporting infrastructure) with a 50m buffered development envelope, overlaid on the agricultural sensitivity map generated by the screening tool;	Section 6, Figure 3
An indication of the potential losses in production and employment from the change of the agricultural use of the land as a result of the proposed development;	Section 10

An indication of possible long term benefits that will be generated by the project in relation to the benefits of the agricultural activities on the affected land;	Section 10.2
Additional environmental impacts expected from the proposed development based on the current status quo of the land including erosion, alien vegetation, waste, etc.;	Section 12
Information on the current agricultural activities being undertaken on adjacent land parcels;	Section 9.5
A motivation must be provided if there were development footprints that were identified as having a “medium” or “low” agriculture sensitivity and that were not considered appropriate;	Sections 11.1 and 11.2
Confirmation from the soil scientist or agricultural specialist that all reasonable measures have been considered in the micro-siting of the proposed development to minimise fragmentation and disturbance of agricultural activities;	Section 11
A substantiated statement from the soil scientist or agricultural specialist with regards to agricultural resources on the acceptability or not of the proposed development and a recommendation on the approval or not of the proposed development;	Section 14
Any conditions to which this statement is subjected;	Sections 12 and 14
Where identified, proposed impact management outcomes or any monitoring requirements for inclusion in the Environmental Management Programme (EMPr);	Section 13
A description of the assumptions made and any uncertainties or gaps in knowledge or data;	Section 7
Calculations of the physical development footprint area for each land parcel as well as the total physical development footprint area of the proposed development (including supporting infrastructure);	**Error! Reference source not found.**
Confirmation whether the development footprint is in line with the allowable development limits set in Table 1 above, including where applicable any deviation from the set development limits and motivation to support the deviation, including: a) Where relevant, reasons why the proposed development footprint is required to exceed the limit; b) Where relevant, reasons why this exceedance will be in the national interest; and c) Where relevant, reasons why there are no alternative options available including evidence of alternatives considered; and	Section 11.3, Table 4
A map showing the renewable energy facilities within a 50km radius of the proposed development.	Section 13, **Error! Reference source not found.**

4. Legislative framework for the assessment

The report follows the protocols as stipulated for the Agricultural Assessment in Government Notice 320 of 2020 (GN320). This Notice provides the procedures and minimum criteria for reporting in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental

Management Act (No. 107 of 1998) (from here onwards referred to as NEMA). It replaces the previous requirements of Appendix 6 of the Environmental Impact Assessment Regulations of NEMA.

In addition to the specific requirements for this study, the following South African legislation is also considered applicable to the interpretation of the data and conclusions made with regards to environmental sensitivity:

- 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.
- Section 3 of the Subdivision of Agricultural Land Act 70 of 1970 may be relevant to the development.
- In addition to this, the National Water Act (Act 36 of 1998) deals with the protection of water resources, including wetlands. This legislation is considered for the purpose of identifying hydric soils with wetland functionality within the study area (should it be present).

5. Agricultural Sensitivity

For the purpose of the assessment, the development area of the Harmony One Plant Solar PV Facility, was screened for agricultural sensitivity using the National Environmental Screening Tool (www.screening.environment.gov.za). The screening report for the PV project site was generated by Savannah Environmental on 6 June 2022 and presented as Figure 3. The requirements of GN320 stipulates that a 50m buffered development envelope must be assessed with the screening tool. While the development area was used for the screening, the surrounding area is also visible in each map (which shows a buffered area of 1km or more around the development area boundary).

According to Figure 3, approximately 75% of the development area consists of land with Medium agricultural sensitivity. The remaining 25% consists of scattered areas with High sensitivity. These areas occur mainly along the western and northern boundaries as well as few in the middle of the development area. Outside of the development area, the area directly west of the development area, consists of land with High agricultural sensitivity. The areas located north, east and south of the development area consists largely of Medium agricultural sensitivity with areas of Low and Medium sensitivity, scattered in between.

In alignment with the CARA, the Department of Agriculture, Land Reform and Rural Development (DALRRD) developed spatial data that depict High Potential Agricultural Areas (HPAAs) of the different provinces of South Africa (DALRRD, 2019). According to the DALRRD, these areas can be defined as: *"large, relative homogeneous portions of high value agricultural land that has the potential to sustainably, in the long-term, contribute significantly to the production of food.*"

According to this data, the entire development area falls is located outside any HPAA (Figure **4**). The nearest HPAA, is a rainfed agricultural area with Category A priority rating (with Class A being the highest priority) located about 1km west of to the Harmony One development. The proposed development will therefore not affect the HPAA or result in fragmentation of it.

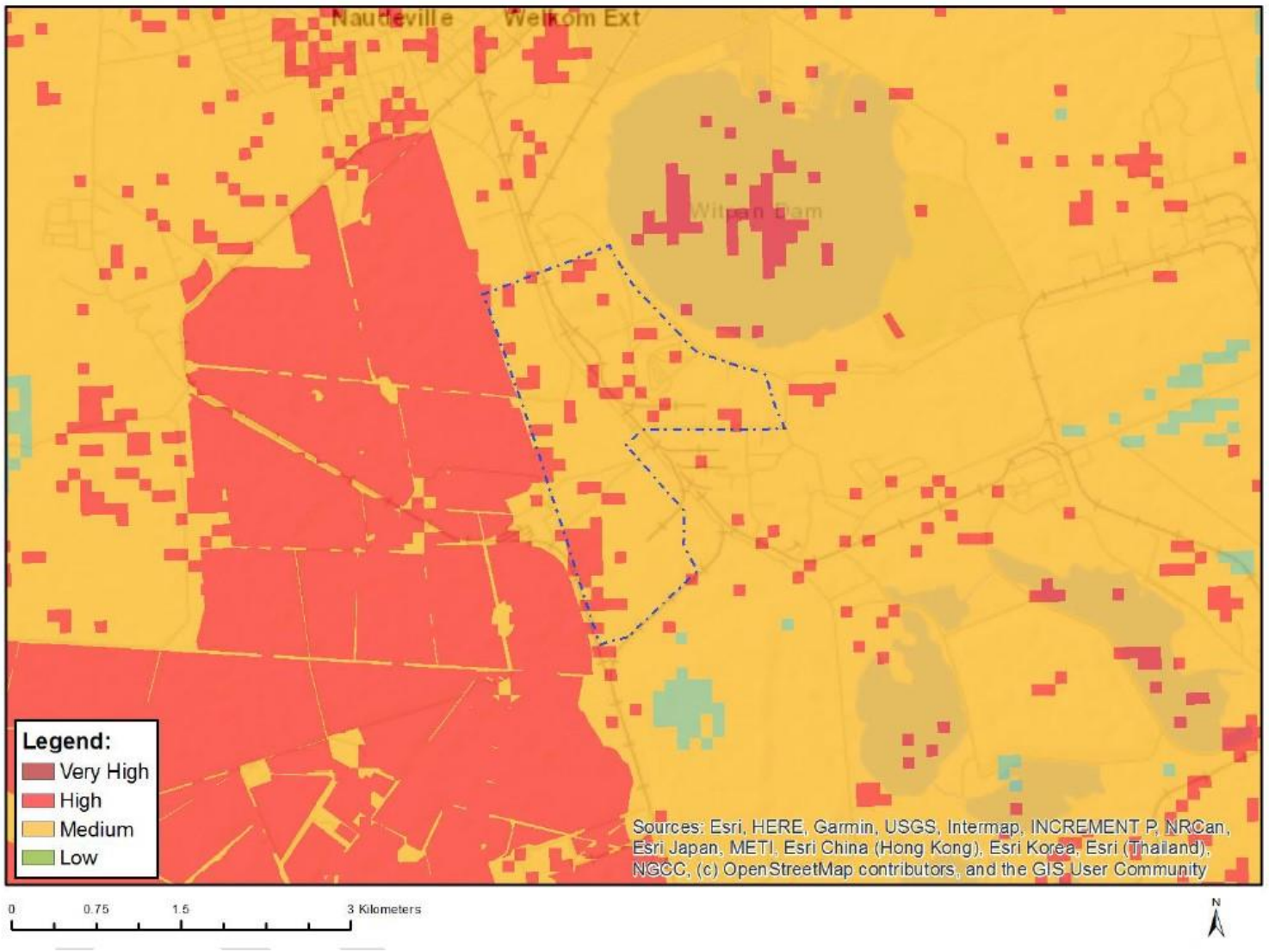

Figure 3 Relative Agricultural Sensitivity from DFFE's Screening Tool of the Harmony One Plant Solar PV Facility development area (generated by Savannah Environmental, 06 June 2022)

Figure 4 Position of High Agricultural Areas around the Harmony One Plant Solar PV Facility development area (data source: DALRRD, 2021)

6. Assumptions, limitations and information gaps

The following assumptions are embedded within the results and discussions of this report:

- It is assumed that the development footprint will remain within the boundaries of the development area and be located where the development footprint of 82 ha is indicated in Figure **2**.
- It is also assumed that the grid connection infrastructure will remain within the grid corridor that was assessed.
- It is assumed that the development footprint of the PV facility will be fenced off and excluded as land available for any future farming activities;
- It is assumed that the grid connection area will not be fenced off and that grazing around the powerline will be possible, and
- It is further assumed that the activities for the construction and operation of the infrastructure are limited to that typical for the construction and operation of a solar PV facility, inclusive of the infrastructure listed in Section 10.1.

The following limitation is part of the assessment:

- the anticipation and rating of impacts are based on the report author's knowledge and experience on the nature of construction and operation of PV facilities and grid connection infrastructure. Therefore, it is done as accurately as possible but must not be considered as absolute measures.

No other information gaps or uncertainties are identified.

7. Methodology

7.1 Desktop analysis of satellite imagery and other spatial data

The most recent aerial photography of the area available from Google Earth was obtained. The satellite imagery was analysed prior to the site visit to determine any areas of existing impacts and land uses within the Harmony One development area as well as the surrounding areas. It was also scanned for any areas where crop production and farming infrastructure may be present. To get a comprehensive overview of the natural resources that contribute to the agro-ecosystem of the proposed project site, the following spatial data was analysed:

- The National Land Capability Evaluation Raster Data Layer was obtained from the DAFF to determine the land capability classes of the project area according to this system. The data was developed using a spatial evaluation modelling approach (DAFF, 2017).
- The long-term grazing capacity for South Africa 2018 was analysed for the area and surrounding area of the project assessment zone. This data set includes incorporation

of the RSA grazing capacity map of 1993, the Vegetation type of SA 2006 (as published by Mucina L. & Rutherford M.C.), the Land Types of South Africa data set as well as the KZN Bioresource classification data. The values indicated for the different areas represent long term grazing capacity with the understanding that the veld is in a relatively good condition.

- The Free State Field Crop Boundaries (November 2019) was analysed to determine whether the proposed project assessment zone falls within the boundaries of any crop production areas. The crop production areas may include rainfed annual crops, non-pivot and pivot irrigated annual crops, horticulture, viticulture, old fields, small holdings and subsistence farming.

8.2 Site assessment

The development area was visited on 11 June 2022 (winter). The site assessment included a soil classification survey, the collection of soil samples as well as the collection of photographic evidence about the current land uses. The season has no effect on the outcome of the assessment. The soil profiles were examined to a maximum depth of 1.5 m or the point of refusal using a hand-held soil 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 S.A. Soil Classification: A Natural and Anthropogenic System for South Africa (Soil Classification Working Group, 2018). For soil mapping of the development area, the soils were grouped into classes with relatively similar soil characteristics. The locality of each of the survey points, are indicated in Figure **5** below. Photographic evidence of soil properties, current land uses and other evidence were taken with a digital camera.

8.3 Analysis of samples

Four soil samples were collected at two of the observation points. At each of the two observation points, a topsoil and subsoil sample were collected. The soil was stored and sealed in clean sampling bags and submitted to Van's Lab in Bloemfontein for analysis. Samples were analysed for the following parameters:

- pH (using potassium chloride);
- Major cationic plant nutrients (calcium, magnesium, potassium, sodium) using ammonium acetate;
- Plant-available phosphorus (using Bray 1 extract); and
- Texture (using the three-sieve technique to determine the particle size distribution).

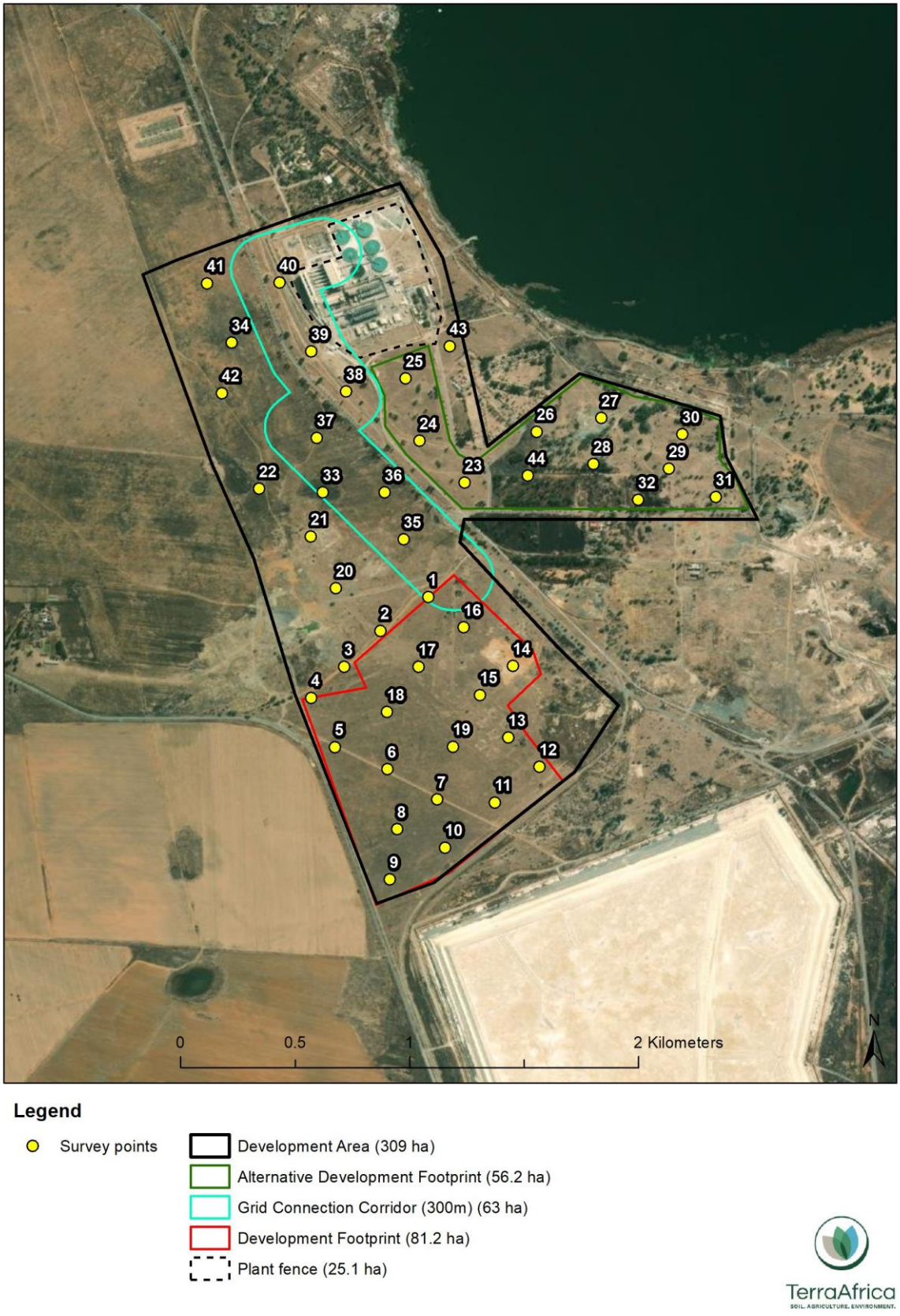

Figure 5 Locality of the observation points within the development area

8.4. Agricultural income and employment

The landowner (Harmony gold) indicated that the development area has not been used for agricultural production after they purchased the land. During the site visit, it was observed that cattle belonging to the locality community traverse through the area and it is likely that they use the area occasionally as grazing for their livestock. No crops have ever been cultivated within the development area. Therefore, the spatial data layer of the long-term grazing capacity of the area (DALRRD, 2018), was used for the calculations of the potential agricultural gross income of the land as well as the agricultural employment opportunities that it provides.

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).

8. Baseline description of the agro-ecosystem

9.1 Climate

The modelled climate data for Welkom (as modelled and presented by Meteoblue, 2022) was used to describe the climate of the development area as Welkom is located approximately 20 km away. The climate data is depicted in Figure 6.

The mean daily maximum temperatures for Welkom ranges between 18°C June and 31°C in summer (the hottest months are December and January). The mean daily minimum temperatures range between 0°C in June and July and 16°C in December and January. The area has summer rainfall with the onset of the dry winter months from May through to September. The highest precipitation is in November and December with an average of 61 mm per month, with the month of January having the second highest average precipitation rate of 59 mm, respectively. The lowest average precipitation rate is from June to August with monthly averages of 2 to 8 mm.

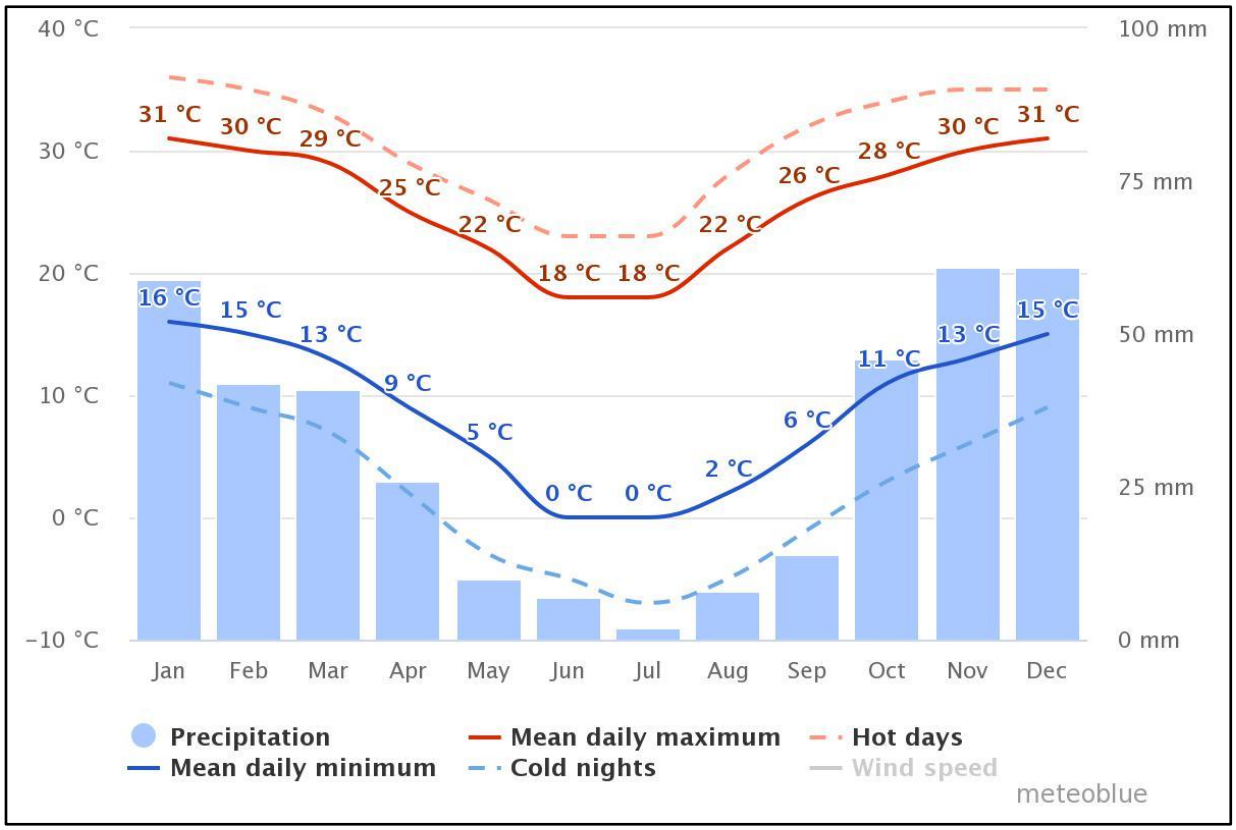

Figure 6 Climate data for Welkom (source: Meteoblue, 2022)

The Department of Agriculture, Forestry and Fisheries (2017) compiled an updated description of the agricultural suitability of South African climatic conditions, accompanied by a raster data layer of the entire country. The description of climate capability refers to a definition by Strydom (2014) that defines it as the “capability of a geographic area to grow an agricultural crop under existing climatic conditions” (DAFF, 2017). The climate capability includes three parameters i.e., moisture supply capacity, physiological capacity, and climatic constraints. The climate capability classes range from 1 (the lowest or worst) to 9 (the highest or best climate for agricultural production).

According to the climate capability raster data, the entire development area has Low-Moderate (Class 04) climate capability (refer to **Error! Reference source not found.**). This indicates t hat the climate of the area is marginally suitable for rainfed crop production and climate limitations include periods of drought during the summer months, frost during winter months and the possibility of hail that presents hazards to rainfed crop production.

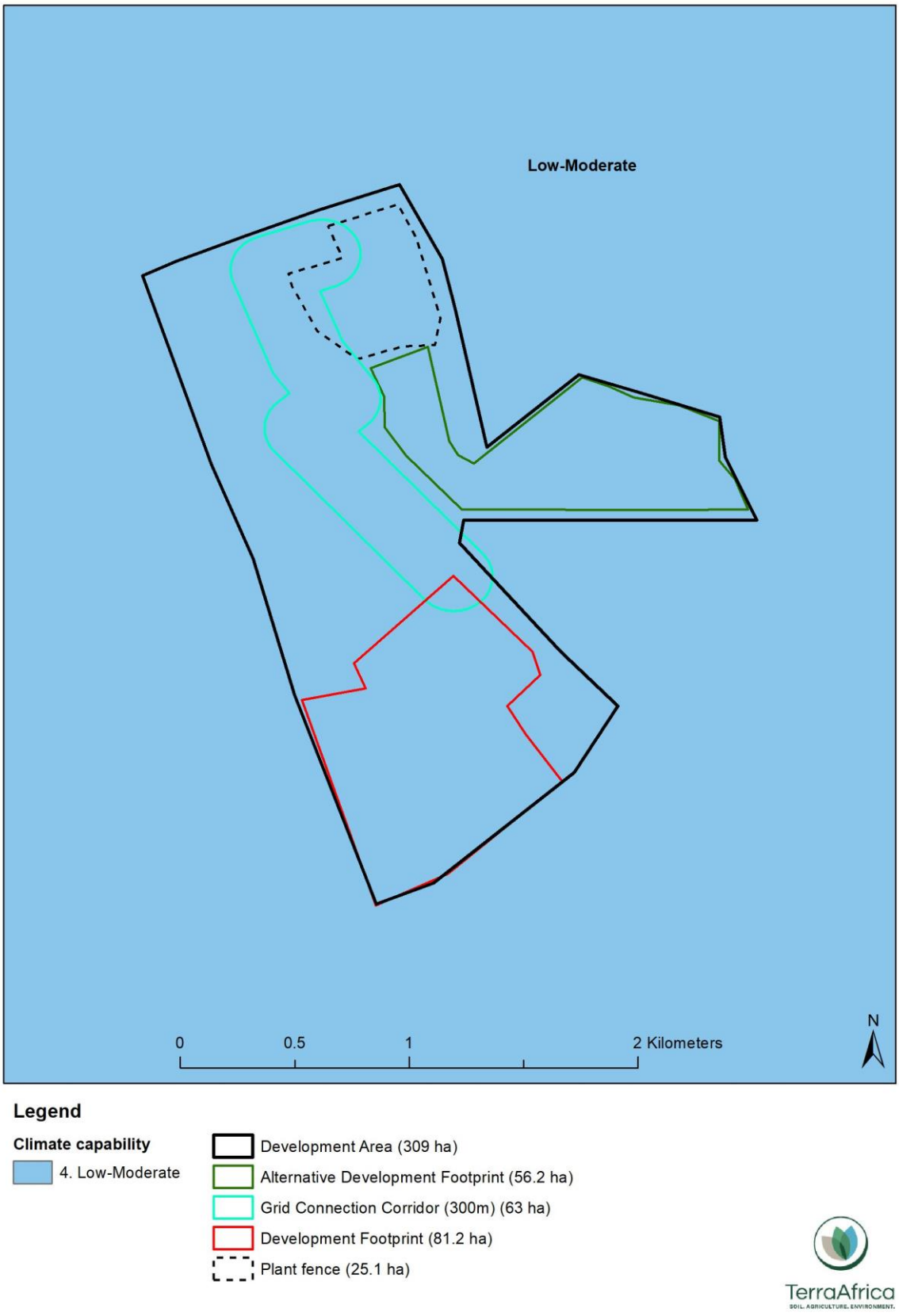

Figure 7 Climate capability rating of the Harmony One Plant development area (source: DALRRD, 2017)

9.2 Land type classification

The entire development area as well as the area around it, consists of Land Type Bd20 (see Figure 8).

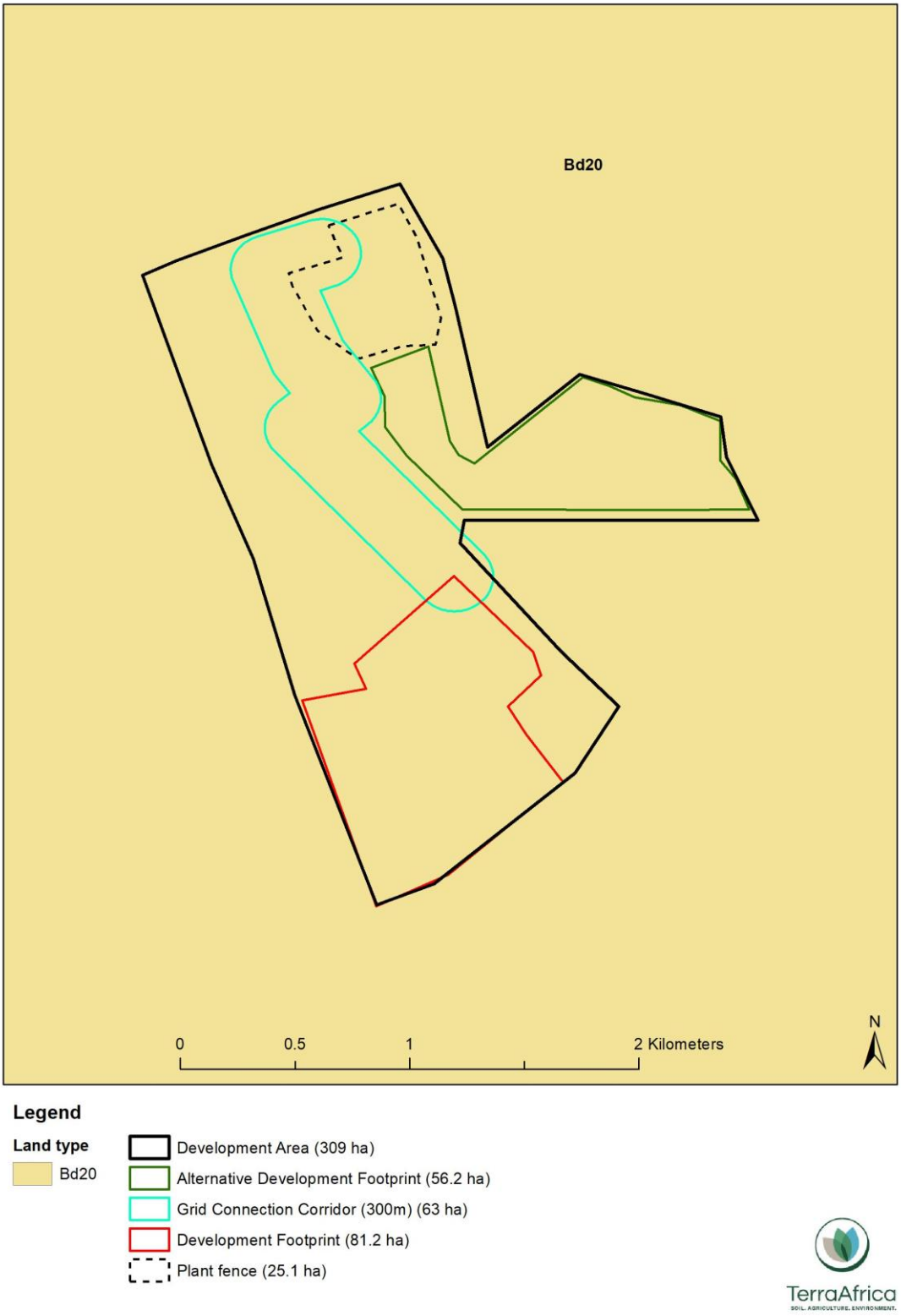

Figure 8 Land type classification of the Harmony One development area

This land type consists of four terrain units and the landscape can be described as flat to slightly undulating with the slope ranging between 1 and 2% (refer to Figure 9). The soil formed from sandstone, mudstone and shale of the Ecca and Beaufort Groups. The entire land type area consists of 55% crests (Terrain unit 1) and 40% mid-slopes (Terrain unit 3). The crests (Terrain unit 1) of deep Clovelly, Avalon and Hutton soil forms (mostly deeper than 1.2m). The texture of soil in this terrain unit is sandy-loam and sand-clay-loam.

The mid-slopes consist of a similar combination of soil forms with similar textures. While the foot-slopes consist of 50% Hutton soils deeper than 1m, it also includes soils with higher clay content and stronger structure such as the Valsrivier, Arcadia, Rensburg, Katspruit and Oakleaf forms. The valley bottoms consist exclusively of these soils with moderate to strong structure and higher clay content

The complete land type sheet of each land type is attached as Appendix 3.

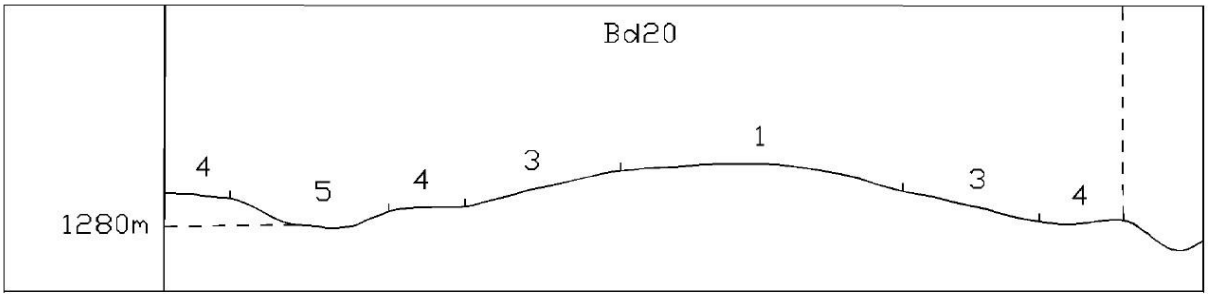

Figure 9 Terrain form sketch of Land Type Bd20

9.3 Soil properties

9.3.1 Soil forms

Seven natural soil forms and one anthropogenic soil (Technosols) are present within the Harmony One development area (see **Error! Reference source not found.**). The area of each s oil form as well as the horizon organisation and depths, are summarised in Table 1.

The Technosols is present at approximately 126.2 ha of the development area, located in five separate areas. Technosols are defined as material from mining, industrial, construction or urban activities that supply parent materials for new anthropogenic soils (Soil Classification Working Group, 2018).

All five the areas of Technosols are associated with existing mine infrastructure or previous disturbance to soil as a result of the mining activities. The nature of the disturbance in the areas of the Technosols is a mixture of transported materials, areas of previous excavation and areas previously compacted by temporary infrastructure. The scope of this assessment does not include analysis of samples for soil contamination; therefore, it is not known whether there are any chemically polluted Technosols present on site.

Figure 10 Area with Technosols within the development area

Figure 11 Example of the gley horizon of the Katspruit soil within the development area

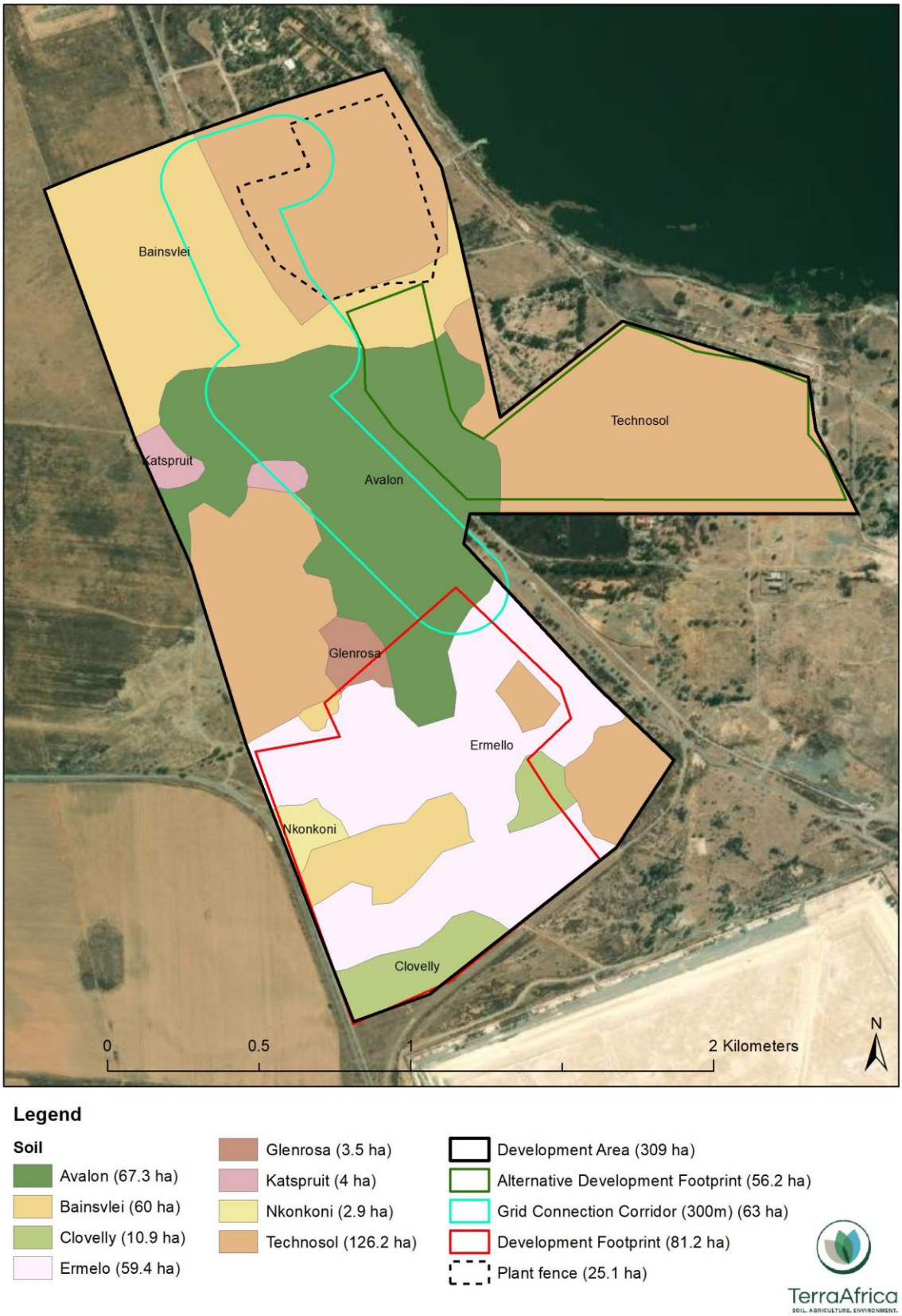

Figure 12 Soil map of the Harmony One development area

Table 1 Summary of the soil properties of the natural soils at the Harmony One development area

Soil form	**Family**	**Depth (m)**	**Area within the development area (ha)**
Glenrosa	2110	Orthic (0.15) Lithic (0.5)	3.5
Nkonkoni	2111	Orthic (0.2) Red apedal (0.9) Lithic (1.2)	2.9
Avalon	2210	Orthic (0.2m) Yellow-brown apedal (1.2) Soft plinthite	67.3
Bainsvlei		Orthic (0.2m) Red apedal (1.3) Soft plinthite	60
Clovelly	2211	Orthic (0.2m) Yellow-brown apedal (0.9) Lithic (1.1)	10.9
Katspruit	2120	Orthic (0.3) Gley	13.4

9.3.2 Soil texture

The soil texture of the Avalon and Bainsvlei soils present within the proposed development area, was calculated by using the results of the particle size analysis for the soil texture triangle formulas as provided on the website of the United States Department of Agriculture's under Natural Resource Conservation Services (Soil) (www.nrcs.usda.gov). The results of the particle size analysis of the soil samples as well as the soil texture class into which results translate, are presented in Table 2 below. Following the results, the topsoils within the development area has Sandy Loam texture and the subsoils have Sandy Clay Loam texture, showing an increase in clay content with depth of the profiles.

Table 2 Summary of particle size distribution and soil texture classes of the soil samples analysed

Sample no:	**Particle size distribution (%)**			**Texture class**
	Sand	**Silt**	**Clay**	
H1 A (Topsoil)	73,2	9,2	17,6	Sandy Loam
H1 B (Subsoil)	68,2	11,0	21,2	Sandy Clay Loam
H8 A (Topsoil)	78,5	5,4	16,9	Sandy Loam
H8 B (Subsoil)	46,2	22,1	32,1	Sandy Clay Loam

9.3.3 Soil fertility parameters

From the perspective of the soil fertility parameters analysed, the soil does not have any limitations to crop production. The soil pH(KCl) values range between strongly acidic (pH 5.36 for sample H8 A) and moderately acidic (pH 5.74 for sample H8 B). For crop production, pH values above 4.5 is recommended to prevent aluminium toxicities, prevent phosphate fixation, and allow for optimal nutrient uptake by crop roots. However, should the soil have been used for crop production, the soil pH levels are suitable and can be raised through the addition of agricultural lime.

The calcium levels range between 599 mg/kg in sample H1 A and 2523.44 mg/kg in sample H8 B. The magnesium levels are the lowest in sample H8 A (137.83 mg/kg) and highest in sample H8 B (550.76 mg/kg). The potassium levels range between a low of 262.47 mg/kg in sample H8 A and 414.69 mg/kg in sample H8 B. The cation concentrations (calcium, magnesium and potassium) are present at sufficient concentrations should the soil have been used for crop production.

The plant-available phosphorus levels are low in all samples analysed and range between 3.38 mg/kg (sample H1 B) and 7.36 mg/kg (sample H1 A). The low phosphorus levels are an indication that any previous crop production within the project site has been abandoned a few years ago and that no phosphorus containing fertilizer has been applied in the area since then. Low soil phosphorus concentrations are typical of soils under natural vegetation (and without the addition of fertilizer) in South Africa.

9.4 Land capability

9.4.1 Land capability according to DALRRD data

The land capability as determined by Department of Agriculture, Land Reform and Rural Development (DALRRD) through a spatial delineation process, was shown by overlying the project site boundary on the land capability raster data (DALRRD, 2016). According to DALRRD (2016), land capability is defined as the most intensive long-term use of land for purposed of **rainfed farming** determined by the interaction of climate, soil and terrain.

The Harmony One Plant Solar PV development area includes three different land capability classes according to the land capability data (DALRRD, 2016). Figure **13** shows the position of the different classes within the farm portions that form the proposed development area. The entire development area largely consists of land with Moderate (Class 08) land capability. Smaller patches in the western and eastern side consist of land with Moderate to High (Class 09) land capability, while Low-Moderate (Class 06) classes are found in the northern, middle and southern parts.

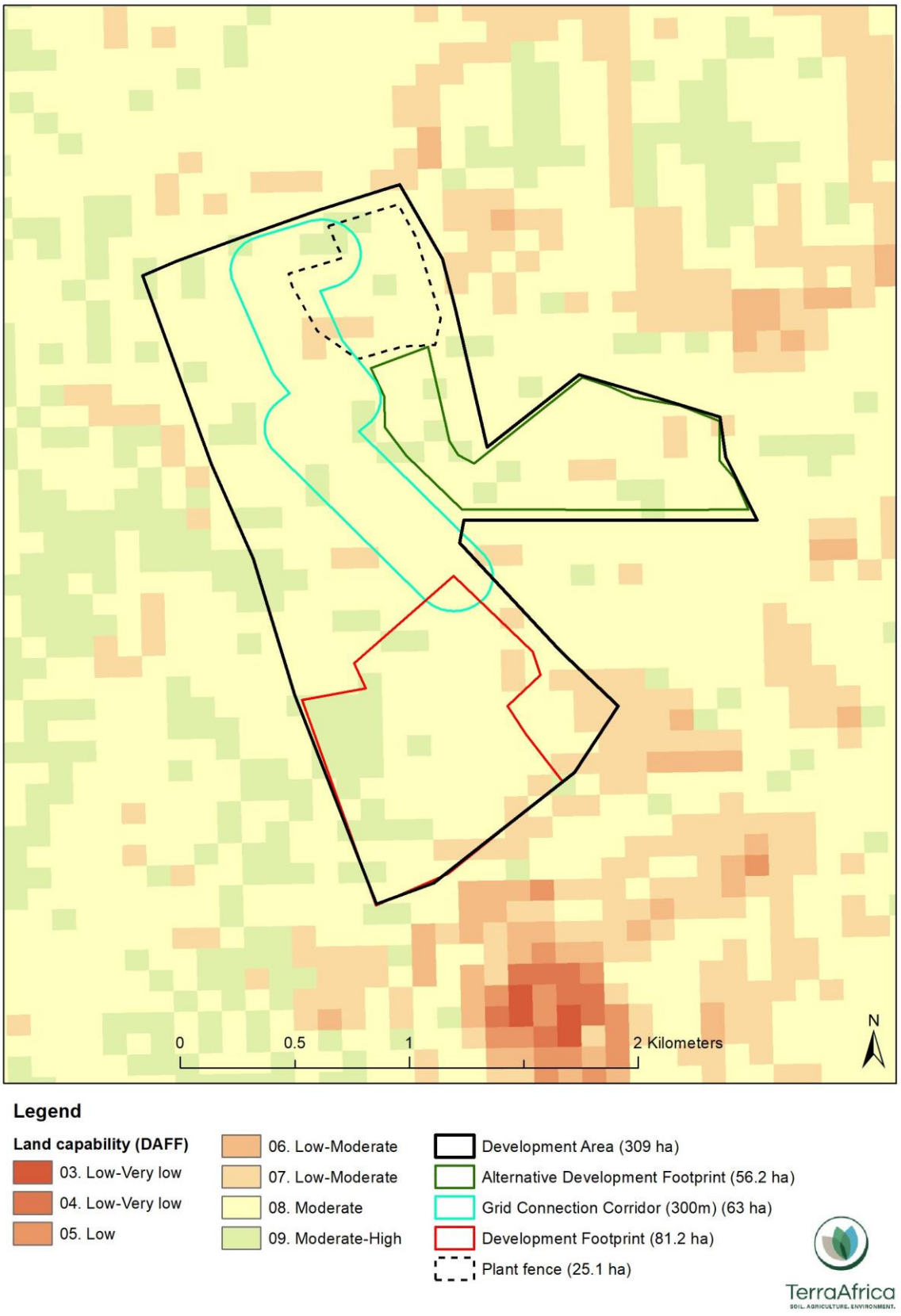

Figure 13 Land capability map of the Harmony One development area (DALRRD, 2016)

9.4.2 Verified land capability

Following the soil classification and the integration of the soil classification data with the terrain and climate capability of the development area, the confirmed land capabilities of the development area was determined. The delineation is shown in Figure 14.

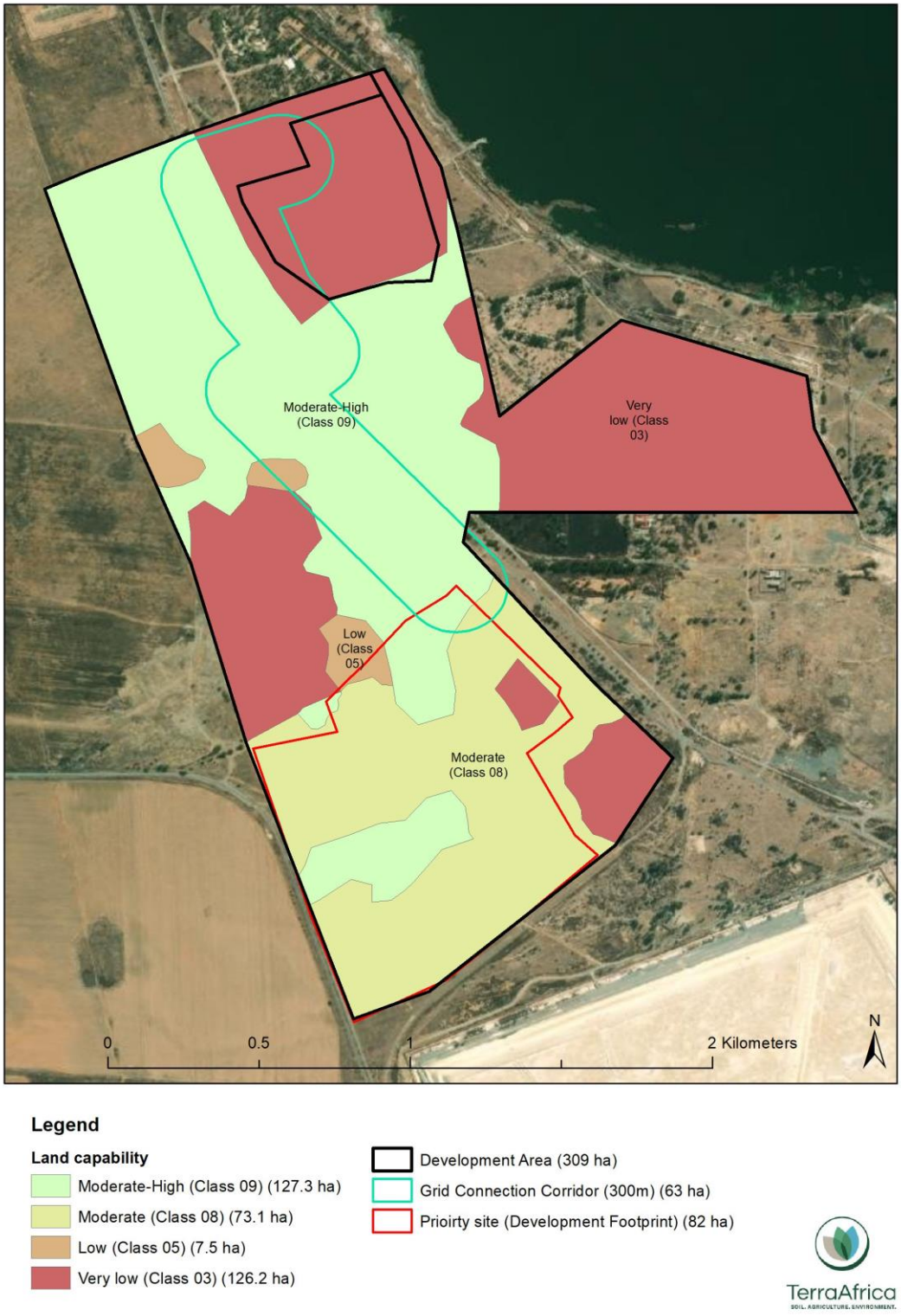

Figure 14 Verified land capability classification of the Harmony One development area

Within the development area, the areas where soil has been disturbed by activities associated with the nearby mining infrastructure, and that has been classified as Technosols, have Very low (Class 03) land capability. The areas are no longer suitable for rainfed crop production and has limited suitability for livestock farming because of the uneven terrain in these areas.

The Katspruit and Glenrosa soils have Low (Class 05) land capability for the effective depth is limited by the presence of water-saturated gley or lithic material. Moderate (Class 08) land capability was assigned to soils of the Nkonkoni, Clovelly and Ermelo forms. While these soils have potential for rainfed crop production, the yield potential is limited by the sandy texture of these soils that have low water-holding and nutrient retention capacity.

The Avalon and Bainsvlei soils have Moderate-High (Class 09) land capability. These soils are better suited to rainfed crop production as a result of the soft plinthic horizon that underlies the deep apedal B1 subsoil-horizons. The soft plinthic horizon retains soil moisture and this is available for crop roots during periods of water stress.

9.5 Land use

9.5.1 Current and historical land use of the development area

The current landowner (Harmony Gold) owns the properties where the development area is located. The development area is currently not fenced off and cattle were observed traversing through the area during the site visit, it is assumed that it belongs to the local community. It is uncertain whether there is any lease agreement between Harmony Gold and the local community. It is therefore assumed that livestock grazing of livestock owned by the local community, may be the only agricultural land use. The site has most likely also been used for livestock grazing historically as older aerial imagery doesn't show any areas with crop fields within the development area. The field crop boundary delineations of the Crop Estimates Consortium, confirms that the development area is void of any crop fields (see Figure 15).

9.5.2 Surrounding land use

The surrounding land uses include mining, residential and agriculture. The mining areas are located west, east and south of the site and are centred around the Harmony Saaiplaas and Harmony Central plants. The residential areas are located north of the development area and includes the towns of Virginia and Welkom. The agricultural areas consist of crop fields and grazing areas with livestock, located northwest, west, and further south of the development area. Two centre pivot areas are located just east of the development area.

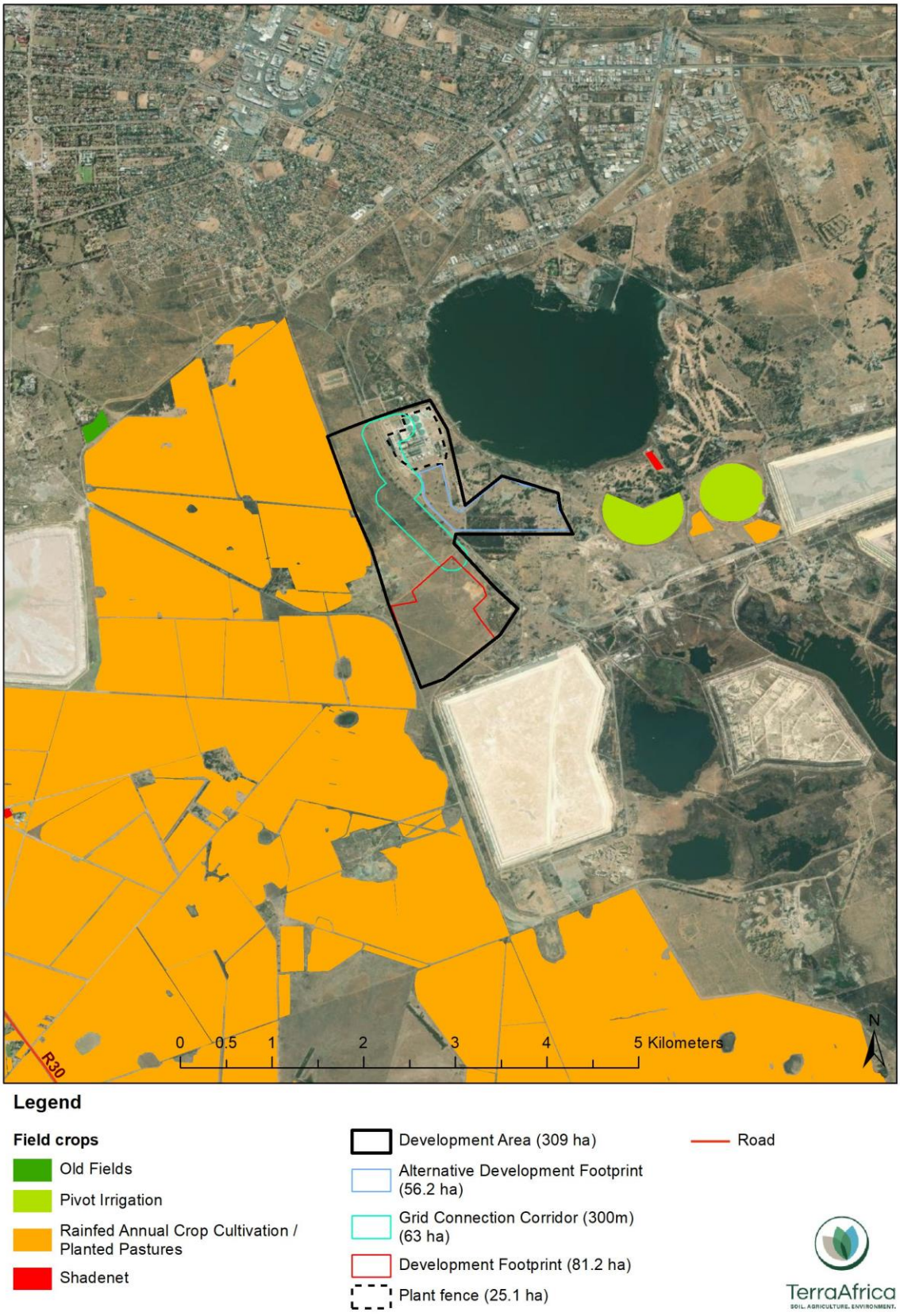

Figure 15 Locality of field crops around the development area of the Harmony One Plant Solar PV (source: DALRRD, 2019)

9. Agricultural production and employment

9.1 Agricultural income and employment

There are currently no formal agricultural production activities within the development area. The area is likely grazed periodically by livestock of the local community, as was observed during the site visit. However, it is unlikely that this is through a formal agreement with Harmony Gold. The potential gross income that can therefore be generated from the land annually, with the current land use, was calculated by using the long-term average grazing capacity of the area that will be affected by the proposed project. The long-term grazing capacity of the entire development area is 6 ha/LSU (DALRRD, 2018) (refer to Figure 16).

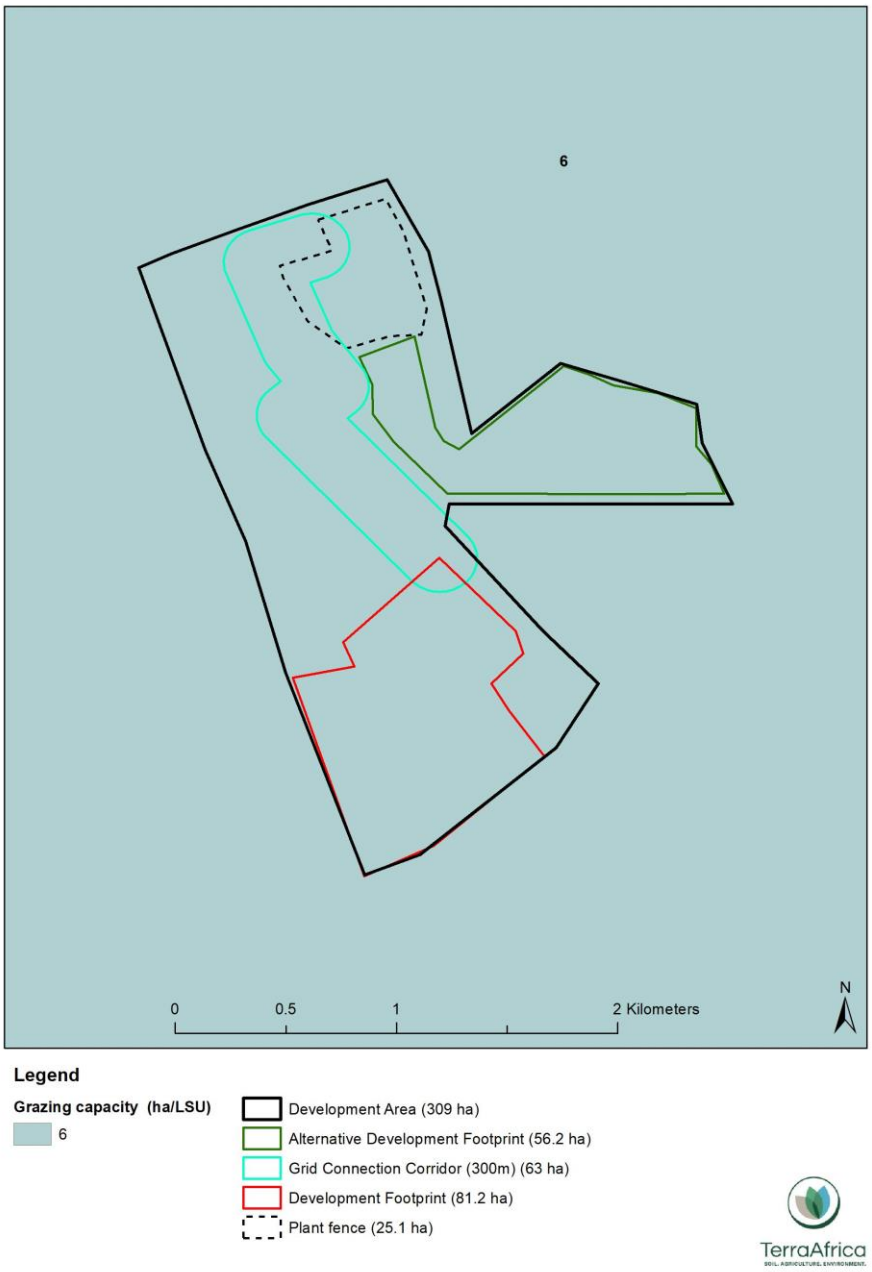

Figure 16 Long-term grazing capacity of the Harmony One development area

The following assumptions have been made in the calculations:

- The construction of the Harmony One Solar PV facility infrastructure will include fencing off the development footprint of 82ha. This will exclude any cattle farming activities from the fenced-off area.
- The 132 kV overhead powerline will not be fenced off and once the construction phase has been completed, livestock will be able to graze in this area.
- At a long-term average grazing capacity of 6 hectare per Large Stock Unit (/ha/LSU) (DAFF, 2018), the development footprint of 82 ha, provide forage to a maximum of 14 head of cattle.
- If it is assumed that the livestock produce offspring at about a 70 to 80% weaning rate, four weaners will be available for sale each year. This is considered an optimistic figure and does not take any potential losses from stock theft into consideration.
- The average weight of a weaner is estimated at 220 kg and the average auction price for live weight (or "hoof weight") the past six months, was approximately R39.50/kg. The calculated total live weight that can be produced with the grazing available within the development footprint area, and sold annually, is 2420 kg.

The total gross income that could possibly be generated by livestock farming in the area the past year, is therefore estimated to be R95 590.00 per annum.

Following the requirements of GN320, the potential gross income loss from agricultural activities in the area for five years, must be considered. For this estimation, it was assumed that there will be a price increase of 6% per annum for live weight of cattle. The estimates for four years as well as the total gross income lost from agricultural production, is presented in the table below.

Table 3 Gross livestock income forecast for the proposed development footprint

Year	Price of live weight (R/kg)	Gross annual income (R)
2022	39.50	R95 590.00
2023	41.87	R101 325.00
2024	44.38	R107 400.00
2025	47.04	R113 837.00
2026	49.86	R120 661.00
Estimated total gross income from livestock production between 2021 and 2026		**R538 813.00**

No information is available on the structure of community livestock farming in the area, but the estimated annual income of R95 590.00 is expected to contribute to the household income of three to four families. There is no formal employment associated with the development footprint currently.

9.2 Comparative benefit analysis

At this stage of the report (Draft for Comments by Applicant and EAP), no gross or nett income figures associated with the proposed Harmony One Solar PV Facility, were provided.

Therefore, no comparison between the financial benefits of the proposed renewable energy development and the existing land use (communal livestock farming), can be made. There are also no figures available on the employment opportunities that will be generated by the Harmony One Solar PV facility.

10. Agricultural sensitivity of the site

10.1 Sensitivity rating of current development area and development footprint

Following the consideration of all the baseline and desktop data discussed in the sections above, the proposed Harmony One Solar PV facility development area can be categorised as either High, Medium or Low sensitivity. The largest part of the development area has High sensitivity (127.3 ha), followed by Low sensitivity (133.7 ha) and Medium sensitivity (73.1 ha) (see Figure 16).

10.2 Consideration of Alternatives

During the initial phases of the assessment, an alternative development footprint was considered that is mostly located on land with Low agricultural sensitivity (the most eastern section of the development area, to the south of Witpan Dam). Based on the environmental sensitivities noted in the screening phase, the location alternative immediately to the south of the Witpan Dam within the development area was determined as not feasible due to the potential for impacts on avifauna and the freshwater resource. The further consideration of this part of the development area has therefore been discarded.

The ‘No-go’ alternative will not result in any land use change from grazing of communal livestock and land left derelict to the generation of renewable energy. There will be no additional impacts on soil properties and the current soil quality will remain as it is, permitting that the livestock grazing does not result in soil degradation. However, there will also be no gain in employment and income generation opportunities as Harmony Gold does not plan to ever develop intensive agriculture or crop production within the development area.

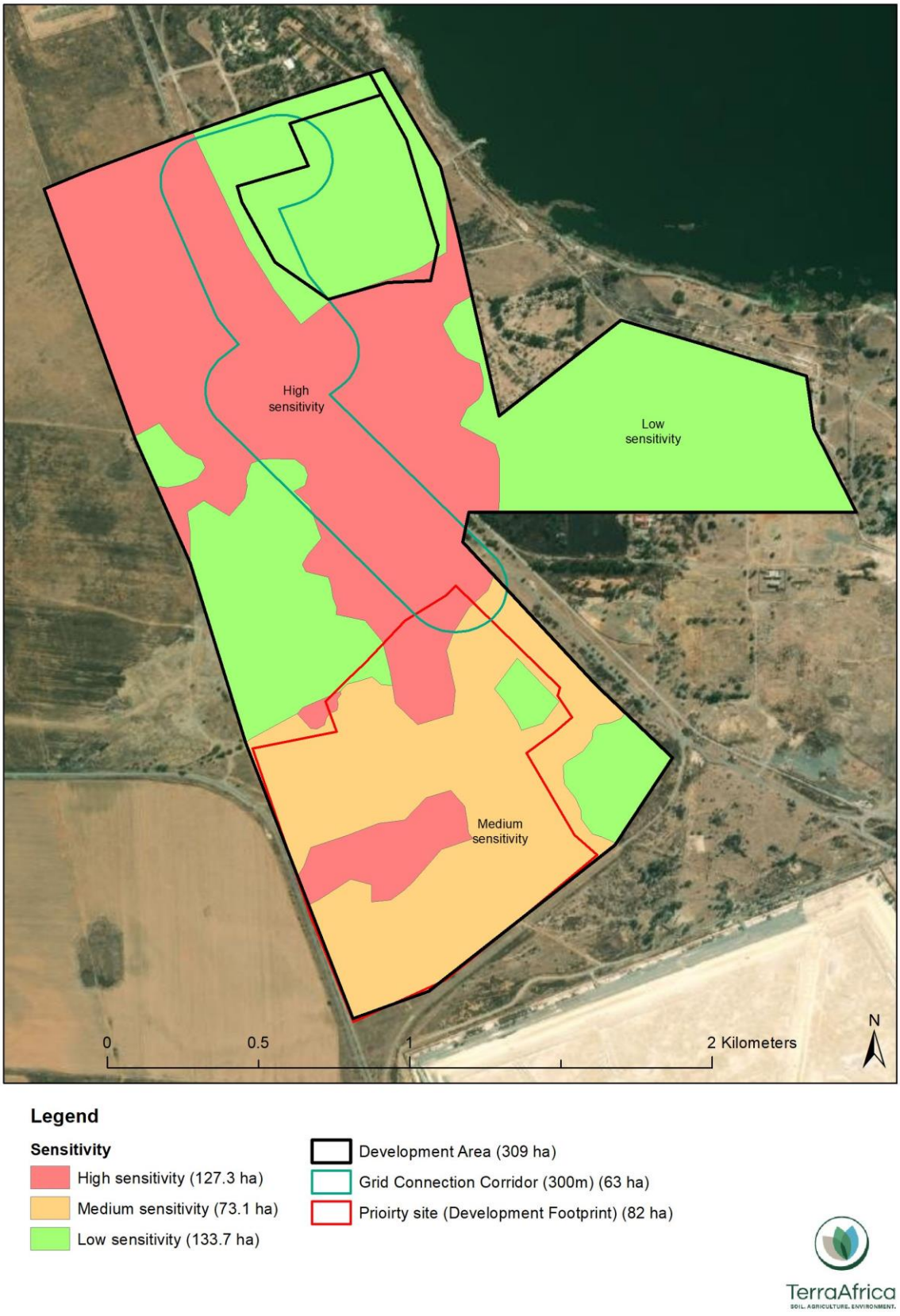

Figure 17 Agricultural sensitivity of the Harmony One development area

10.3 Allowable development limits

Following the sensitivity delineation of the development area, the allowable development limit for the development footprint of 82ha, was calculated. The allowable development limit for areas outside crop field boundaries were used. The results of the calculations are provided in Table 4 below.

Table 4 Calculated allowable development limits of the development footprint

Sensitivity class	Area that will be affected by development footprint (ha)	Allowable limit (ha/MW)	Area allowed for a 30MW development (ha)	Area that exceeds allowable limit (ha)
High	16.4	0.35	10.5	5.9
Medium	62.0	0.35	10.5	62.0
Low	3.3	2.50	35	0

11. Impact assessment of additional environmental impacts

11.1 Project description

The development of a solar photovoltaic (PV) facility with a generating capacity of up to 30MW and associated infrastructure, will include:

- PV modules and mounting structures.
- Inverters and transformers a SCADA room, and maintenance room.
- Cabling between the project components, to be laid underground where practical.
- Access roads, internal roads and fencing around the development area.
- Temporary and permanent laydown areas.
- Grid connection infrastructure including an on-site facility substation and a switching substation to be connected to the existing Brandgold Substation via an overhead power line (located ~2km north of the site).

11.2 Impact significance rating

The most significant impacts of the proposed Harmony One Solar PV facility project on soil and agricultural productivity, will occur during the construction phase when the vegetation is removed and the soil surface is prepared for infrastructure commissioning. During the operational phase, the risk remains that soil will be polluted by the waste generated during the operational phase or affected by soil erosion in areas where vegetation has not re-established after the construction phase. During the decommissioning phase, soil will be prone to erosion

when the infrastructure is removed from the soil surface. Below follows a rating of the significance of each of the impacts.

11.2.1 Construction phase

Impact: Change in land use from livestock grazing to energy generation

Nature: Prior to construction of the PV plant, the 82ha development footprint will be fenced off. The area where infrastructure will be constructed will be stripped of vegetation and will no longer be suitable for livestock grazing. As there is currently no crop farming within the development footprint, there will be no negative impacts on crop production.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Medium duration (3)	Medium duration (3)
Magnitude	Low (4)	Low (4)
Probability	Definite (4)	Definite (4)
Significance	**Medium (32)**	**Medium (28)**
Status (positive or negative)	Negative	Negative
Reversibility	Moderate	Moderate
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	No	N/A
Mitigation: • Vegetation clearance must be restricted to areas where infrastructure is constructed. • No materials removed from development area must be allowed to be dumped in nearby livestock farming areas. • All left-over construction material must be removed from site once construction on a land portion is completed. • No open fires made by the construction teams are allowable during the construction phase. • No fences of neighbouring crop fields and farming areas must be damaged during the construction phase.		
Residual Impacts: The residual impact from the construction and operation of the Harmony One Solar PV facility is considered negligible.		
Cumulative Impacts: Any additional infrastructure development in support of the Harmony One Solar PV facility, will result in additional areas where grazing veld will be disturbed.		

Impact: Soil erosion

Nature: All areas where vegetation is removed from the soil surface in preparation for the infrastructure construction, will result in exposed soil surfaces that will be prone to erosion. This includes the areas where internal access roads will be constructed. Both wind and water erosion are a risk, especially when there are heavy rainstorms during the summer months.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (30)**	**Low (16)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	No

Can impacts be mitigated?	Yes	N/A
Mitigation: • Land clearance must only be undertaken immediately prior to construction activities and only within the development footprint; • Unnecessary land clearance must be avoided; • Level any remaining soil removed from excavation pits that remained on the surface instead of allowing small stockpiles of soil to remain on the surface. • Where possible, conduct the construction activities outside of the rainy season.		
Residual Impacts: The residual impact from the construction and operation of the proposed Harmony One Solar PV facility on the susceptibility to erosion is considered low.		
Cumulative Impacts: Any additional infrastructure development in support of the Harmony One Solar PV facility, will result in additional areas exposed to soil erosion through wind and water movement.		

Impact: Soil compaction

Nature: The clearing and levelling of land where required for the PV facility's infrastructure, will result in soil compaction. In the area where internal roads will be constructed, topsoil will be removed and the remaining soil material will be deliberately compacted to ensure a stable road surface.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (30)**	**Low (16)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	N/A
Mitigation: • Vehicles and equipment must travel within demarcated areas and not outside of the construction footprint; • Unnecessary land clearance must be avoided; • Where possible, conduct the construction activities outside of the rainy season; and • Vehicles and equipment must park in designated parking areas.		
Residual Impacts: The residual impact from the construction and operation of the proposed Harmony One Solar PV facility on soil compaction is considered low.		
Cumulative Impacts: Any additional infrastructure development in support of the Harmony One Solar PV facility, will result in additional areas exposed to soil compaction.		

Impact: Soil pollution

During the construction phase, construction workers will access the land for the preparation of the terrain and the construction of the PV plant and grid connection. Both potential spills and leaks from construction vehicles and equipment as well as waste generation on site, can result in soil pollution.

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

1. Petroleum hydrocarbon (present in oil and diesel) spills by machinery and vehicles during earthworks and the removal of vegetation as part of site preparation.
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 workers.
5. Spills from fuel storage tanks during construction.
6. Pollution from concrete mixing.
7. Pollution from road-building materials.
8. Any construction material remaining within the construction area once construction is completed.

	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Short-term (2)	Short-term (2)
Magnitude	Moderate (6)	Low (4)
Probability	Low (4)	Improbable (2)
Significance	**Medium (36)**	**Low (14)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	
Can impacts be mitigated?	Yes	N/A

Mitigation:

- Maintenance must be undertaken regularly on all vehicles and construction/maintenance machinery to prevent hydrocarbon spills;
- Any waste generated during construction, must be stored into designated containers and removed from the site by the construction teams.
- Any left-over construction materials must be removed from site.

Residual Impacts:

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

Cumulative Impacts:

Any additional infrastructure that will be constructed to strengthen and support the operation of the Harmony One Solar PV facility and where waste is not removed to designated waste sites, will increase the cumulative impacts associated with soil pollution in the area.

11.2.2 Operational phase

Impact: Soil erosion

During the operational phase, staff and maintenance personnel will access the Harmony One Solar PV facility daily. This phase will have no additional impact on the livestock farming potential of the area. The following impacts on soil is expected for this phase:

Nature: The areas where vegetation was cleared, will remain at risk of soil erosion, especially during a rainfall event when runoff from the cleared surfaces will increase the risk of soil erosion in the areas directly surrounding the Harmony One Solar PV facility.

	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Improbable (2)

Significance	**Medium (30)**	**Low (16)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	N/A
Mitigation: • The area around the development footprint must regularly be monitored to detect early signs of soil erosion on-set. • If soil erosion is detected, the area must be stabilised by the use of geo-textiles and facilitated re-vegetation.		
Residual Impacts: The residual impact from the operation of the proposed Harmony One Solar PV facility on the susceptibility to erosion is considered low.		
Cumulative Impacts: Any additional infrastructure that will be constructed to strengthen and support the operation of the Harmony One Solar PV facility, will result in additional areas where exposed to soil erosion through wind and water movement.		

Impact: Soil pollution

Nature: During the operational phase, potential spills and leaks from maintenance vehicles and equipment as well as waste generation on site, can result in soil pollution.		
	Without mitigation	**With mitigation**
Extent	Local (1)	Local (1)
Duration	Short-term (2)	Short-term (2)
Magnitude	Moderate (6)	Low (4)
Probability	Low (4)	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	N/A
Mitigation: • Maintenance must be undertaken regularly on all vehicles and maintenance machinery to prevent hydrocarbon spills; • No domestic and other waste must be left at the site and must be transported with the maintenance vehicles to an authorised waste dumping area.		
Residual Impacts: The residual impact from the operation of the proposed project will be low to negligible.		
Cumulative Impacts: The operation of any additional infrastructure to strengthen and support the operation of the Harmony One Solar PV facility and where waste is not removed to designated waste sites, will increase the cumulative impacts associated with soil pollution in the area.		

11.2.3 Decommissioning phase

The decommissioning phase will have the same impacts as the construction phase i.e. soil erosion, soil compaction and soil pollution. It is anticipated that especially the risk of soil erosion will remain until the vegetation growth has re-established in the area where the Harmony One Solar PV facility will be decommissioned.

12 Cumulative Impacts

"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[1].

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

For the determination of cumulative impacts, all other renewable energy projects within a 50km radius from the Harmony One Solar PV facility development area, were considered. There are six other authorised renewable energy projects within this area around the proposed Harmony One Solar PV facility. The position of these projects' areas is depicted in Figure **18**.

The cumulative impacts of the proposed project are discussed below.

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

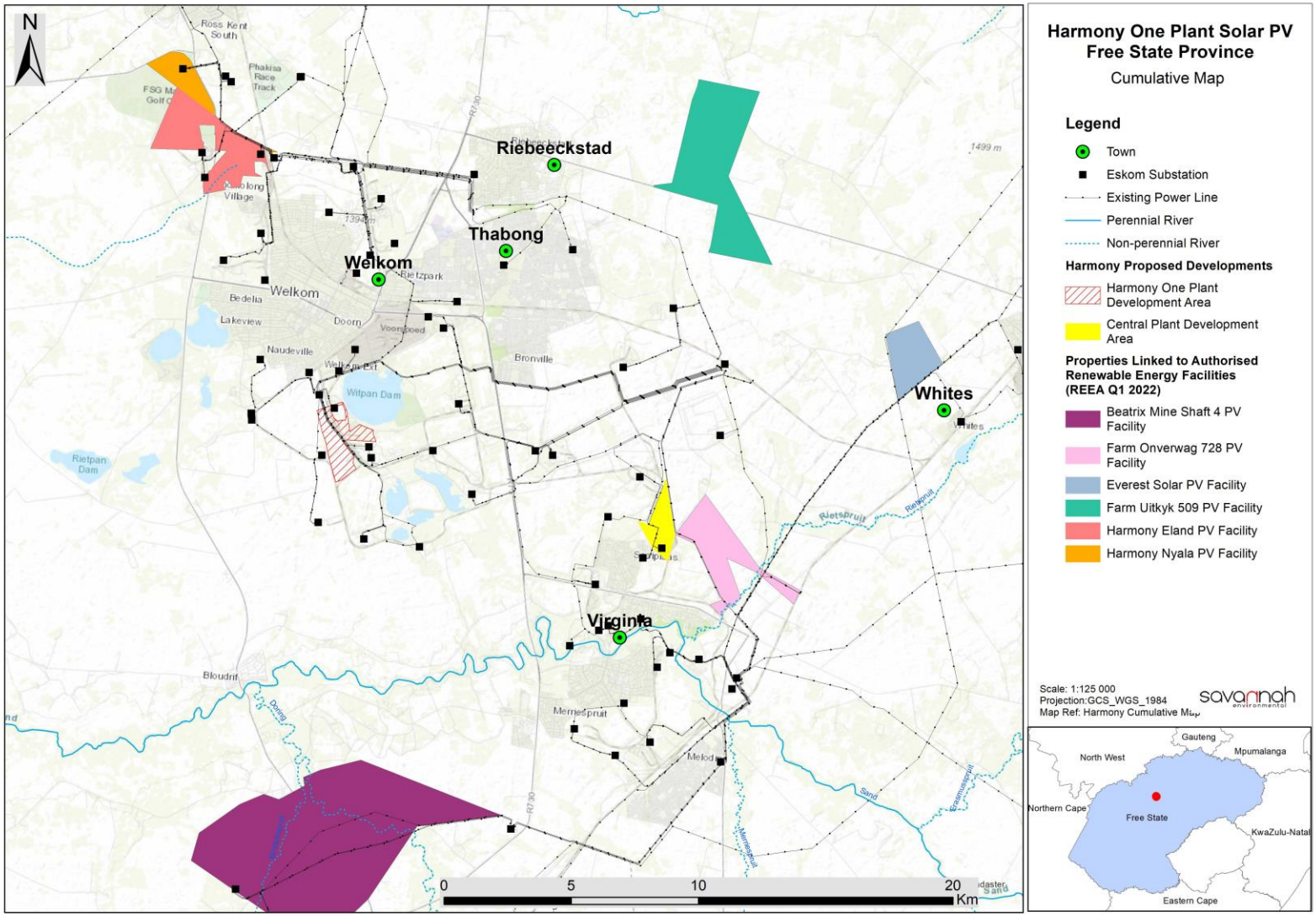

Figure 18 Other renewable energy projects within a 50km radius of the Harmony One Solar PV facility development area (source: Savannah Environmental)

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

Nature: Decrease in areas with suitable land capability for cattle 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	Medium duration (3)	Long-term (4)
Magnitude	Low (4)	Low (4)
Probability	Definite (4)	Highly likely (4)
Significance	**Medium (32)**	Medium (40)
Status (positive/negative)	Negative	Negative
Reversibility	Low	Low
Loss of resources?	Yes	Yes
Can impacts be mitigated?	N/A	No
Confidence in findings: High.		
Mitigation: The only mitigation measure for this impact is to keep the footprints of all renewable energy facilities as small as possible and to manage the soil quality by avoiding far-reaching soil degradation such as erosion.		

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	Moderate (6)	Moderate (6)
Probability	Probable (3)	Probable (3)
Significance	**Medium (30)**	**Medium (33)**
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 11.2.2 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	Local (1)	Regional (2)
Duration	Short-term (2)	Short-term (2)
Magnitude	Moderate (6)	Moderate (6)
Probability	Probable (3)	Probable (3)
Significance	**Low (27)**	**Medium (30)**
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 11.2.3 above.		

13 Mitigation and management measures

The objective of the mitigation and management measures presented below are to reduce the risk of soil degradation that will in turn result in affect the ability of soils in within the project site to support the natural vegetation and provide ecosystem services.

Prevention and management of soil erosion:

Project component/s	• Construction of infrastructure • Construction of the access road
Potential Impact	Soil particles can be removed from the area through wind and water erosion
Activity/risk source	The removal of vegetation in areas where infrastructure will be constructed
Mitigation: Target/Objective	To avoid the onset of soil erosion that can spread into other areas

Mitigation: Action/control	Responsibility	Timeframe
• Limit vegetation clearance to only the areas where the surface infrastructure will be constructed. • Avoid parking of vehicles and equipment outside of designated parking areas. • Plan vegetation clearance activities for dry seasons (late autumn, winter and early spring). • Design and implement a Stormwater Management System where run-off from surfaced areas are expected. • Re-establish vegetation along the access road to reduce the impact of run-off from the road surface.	Environmental Control Officer / SHEQ division	During the entire construction, operational and decommissioning phases

Performance Indicator	No visible signs of soil erosion around the project infrastructure
Monitoring	• Regular inspections around the constructed infrastructure to detect early signs of soil erosion developing.

	• When signs of erosion is detected, the areas must be rehabilitated using a combination of geo-textiles and re-vegetation to prevent the eroded area(s) from expanding.

Prevention and management of soil pollution:

Project component/s	• Construction of infrastructure • Daily activities and maintenance during the operational phase
Potential Impact	Potential fuel and oil spills from vehicles as well as the generation of waste can cause soil pollution.
Activity/risk source	• Petroleum hydrocarbon (present in oil and diesel) spills by machinery and vehicles during earthworks and the removal of vegetation as part of site preparation. • Spills from vehicles transporting workers, equipment, and construction material to and from the construction site. • The accidental spills from temporary chemical toilets used by construction workers. • The generation of domestic waste by construction workers. • Spills from fuel storage tanks during construction. • Pollution from concrete mixing. • Pollution from road-building materials. • Any construction material remaining within the construction area once construction is completed. • Containment breaches related to the battery units and any inadvertent chemical exposure therefrom.
Mitigation: Target/Objective	To avoid soil pollution that can harm the surrounding environment and human health.

Mitigation: Action/control	**Responsibility**	**Timeframe**
• Maintenance must be undertaken regularly on all vehicles and construction/maintenance machinery to prevent hydrocarbon spills; • Any waste generated during construction, must be stored into designated containers and removed from the site by the construction teams. • Any left-over construction materials must be removed from site. • Ensure battery transport and installation by accredited staff / contractors. • Compile (and adhere to) a procedure for the safe handling of battery cells during transport and installation.	Environmental Control Officer / SHEQ division	During the entire construction, operational and decommissioning phases

Performance Indicator	• No visible signs of waste and spills within the project site.

	• No accumulation of contaminants in the soils of the project site.
Monitoring	• Regular inspections of vehicles and equipment that enter the project site. • Analysis of soil samples around high-risk areas to determine whether soil contaminants are present. • In the case that soil pollution is detected, immediate remediation must be done.

14 Acceptability statement

The soil and agricultural properties and sensitivities of the proposed Harmony One Solar PV facility development was the subject of the Agricultural Agro-Ecosystem Assessment conducted. The study found that the area consists of seven different natural soil forms, i.e. Avalon, Bainsvlei, Clovelly, Glenrosa, Katspruit, Ermelo and Nkonkoni, ranging from 0.3m to 1.5m in effective soil depth. The areas with existing soil disturbance, are classified as Technosols. The largest portion of the development footprint has land with Moderate (Class 08) land capability that is suitable for dryland crop production with limitations. Three smaller areas have Moderate-High (Class 09) land capability while the areas with existing disturbance, has Very low (Class 03) land capability.

It is anticipated that the construction and operation of the Harmony One Solar PV facility will have impacts that range from medium to low. Through the consistent implementation of the recommendation mitigation measures, most of impacts can all be reduced to low. Since the area around the development footprint will be fenced off, it is not anticipated that the impact on livestock grazing can be mitigated as this area will now be excluded from livestock farming.

Considering that the infrastructure components, will be placed in close proximity to each other, I confirm that as far as I know, all reasonable measures have been taken to avoid or minimize fragmentation and disturbance of agricultural activities, provided that the mitigation measures provided in this report are implemented.

It is my professional opinion that even though the development footprint include areas with High and Medium agricultural sensitivity that exceeds the allowable development limits, this application be considered favourably. The area has never been used for crop production. The development is currently used for cattle grazing by the local community although no formal lease agreement has been made between the landowner and anyone using the land for grazing purposes.

Therefore, the project is considered acceptable permitting that the mitigation measures stipulated in this report are followed to prevent soil erosion and soil pollution and to minimise impacts on the veld quality of the farm portions that will be affected. The project infrastructure should also remain within the proposed footprint boundaries that will be fenced off.

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APPENDIX 1 – CURRICULUM VITAE OF SPECIALIST

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Specialist Scientist

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EXPERTISE

Soil Quality Assessment

Soil Policy and Guidelines

Agricultural Agro-Ecosystem Assessment

Sustainable Agriculture

Data Consolidation

Land Use Planning

Soil Pollution

Hydropedology

EDUCATION

MASTER'S DEGREE
Environmental Science
University of Witwatersrand
2010 – 2018

BACHELOR'S DEGREE
Agricultural Science
University of Pretoria
2001 – 2004

PROFESSIONAL PROFILE

I contribute specialist knowledge on agriculture and soil management to ensure long-term sustainability of projects in Africa. For the past thirteen years, it has been my calling and I have consulted on more than 200 projects. My clients include environmental and engineering companies, mining houses, and project developers. I enjoy the multi-disciplinary nature of the projects that I work on and I am fascinated by the evolving nature of my field of practice. The next section provide examples of the range of projects completed. A comprehensive project list is available on request.

PROJECT EXPERIENCE

Global Assessment on Soil Pollution

Food and Agricultural Organisation (FAO) of the United Nations (UN)

Author of the regional assessment of Soil in Sub-Saharan Africa. The report is due for release in February 2021. The different sections included:

- Analysis of soil and soil-related policies and guidelines for each of the 48 regional countries
- Description of the major sources of soil pollution in the region
- The extent of soil pollution in the region and as well as the nature and extent of soil monitoring
- Case study discussions of the impacts of soil pollution on human and environmental health in the region
- Recommendations and guidelines for policy development and capacitation to address soil pollution in Sub-Saharan Africa

Data Consolidation and Amendment

Range of projects: Mining Projects, Renewal Energy

These projects included developments where previous agricultural and soil studies are available that are not aligned with the current legal and international best practice requirements such as the IFC Principles. Other projects are expansion projects or changes in the project infrastructure layout. Tasks on such projects include the incorporation of all relevant data, site verification, updated baseline reporting and alignment of management and monitoring measures.

Project examples:

- Northam Platinum's Booysendal Mine, South Africa
- Musonoi Mine, Kolwezi District, Democratic Republic of Congo
- Polihali Reservoir and Associated Infrastructure, Lesotho
- Kaiha 2 Hydropower Project, Liberia
- Aquarius Platinum's Kroondal and Marikana Mines

MARINÉ PIENAAR

Specialist Scientist

PROFESSIONAL MEMBERSHIP

South African Council for Natural Scientific Professions (SACNASP)

Soil Science Society of South Africa (SSSSA)

Soil Science Society of America (SSSA)

Network for Industrially Contaminated Land in Africa (NICOLA)

LANGUAGES

English (Fluent)

Afrikaans (Native)

French (Basic)

PRESENTATIONS

There is spinach in my fish pond
TEDx Talk
Available on YouTube

♦

Soil and the Extractive Industries
Session organiser and presenter
Global Soil Week, Berlin (2015)

♦

How to dismantle an atomic bomb
Conference presentation (2014)
Environmental Law Association (SA)

PROJECT EXPERIENCE (Continued)

Agricultural Agro-Ecosystem Assessments

Range of projects: Renewable Energy, Industrial and Residential Developments, Mining, Linear Developments (railways and power lines)

The assessments were conducted as part of the Environmental and Social Impact Assessment processes. The assessment process includes the assessment of soil physical and chemical properties as well as other natural resources that contributes to the land capability of the area.

Project examples:

- Mocuba Solar PV Development, Mozambique
- Italthai Railway between Tete and Quelimane, Mozambique
- Lichtenburg PV Solar Developments, South Africa
- Manica Gold Mine Project, Mozambique
- Khunab Solar PV Developments near Upington, South Africa
- Bomi Hills and Mano River Mines, Liberia
- King City near Sekondi-Takoradi and Appolonia City near Accra, Ghana
- Limpopo-Lipadi Game Reserve, Botswana
- Namoya Gold Mine, Democratic Republic of Congo

Sustainable Agriculture

Range of projects: Policy Development for Financial Institutions, Mine Closure Planning, Agricultural Project and Business Development Planning

Each of the projects completed had a unique scope of works and the methodology was designed to answer the questions. While global indicators of sustainable agriculture are considered, the unique challenges to viable food production in Africa, especially climate change and a lack of infrastructure, in these analyses.

Project examples:

- Measurement of sustainability of agricultural practices of South African farmers – survey design and pilot testing for the LandBank of South Africa
- Analysis of the viability of avocado and mango large-scale farming developments in Angola for McKinsey & Company
- Closure options analysis for the Tshipi Borwa Mine to increase agricultural productivity in the area, consultation to SLR Consulting
- Analysis of risks and opportunities for farm feeds and supplement suppliers of the Southern African livestock and dairy farming industries
- Sustainable agricultural options development for mine closure planning of the Camutue Diamond Mine, Angola

MARINÉ PIENAAR

Specialist Scientist

PROFESSIONAL DEVELOPMENT

Contaminated Land Management 101 Training
Network for Industrially Contaminated Land in Africa
2020

Intensive Agriculture in Arid & Semi-Arid Environments
CINADCO/MASHAV R&D Course, Israel
2015

World Soils and their Assessment Course
ISRIC – World Soil Information Centre, Netherlands
2015

Wetland Rehabilitation Course
University of Pretoria
2010

Course in Advanced Modelling of Water Flow and Solute Transport in the Vadose Zone with Hydrus
University of Kwazulu-Natal
2010

Environmental Law for Environmental Managers
North-West University Centre for Environmental Management
2009

PROJECT EXPERIENCE (Continued)

Soil Quality Assessments

Range of projects: Rehabilitated Land Audits, Mine Closure Applications, Mineral and Ore Processing Facilities, Human Resettlement Plans

The soil quality assessments included physical and chemical analysis of soil quality parameters to determine the success of land rehabilitation towards productive landscapes. The assessments are also used to understand the suitability for areas for Human Resettlement Plans

Project examples:

- Closure Planning for Yoctolux Colliery
- Soil and vegetation monitoring at Kingston Vale Waste Facility
- Exxaro Belfast Resettlement Action Plan Soil Assessment
- Soil Quality Monitoring of Wastewater Irrigated Areas around Matimba Power Station
- Keaton Vanggatfontein Colliery Bi-Annual Soil Quality Monitoring

REFERENCES

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LAND TYPE / *LANDTIPE* : **Bd20**

CLIMATE ZONE / *KLIMAATSONE* : 40S

Area / *Oppervlakte* : 97270 ha

Estimated area unavailable for agriculture
Beraamde oppervlakte onbeskikbaar vir landbou : 1570 ha

Occurrence (maps) and areas / *Voorkoms (kaarte) en oppervlakte* :
2726 Kroonstad (11240 ha) 2826 Winburg (86030 ha)

Inventory by / *Inventaris deur* :
J F Eloff

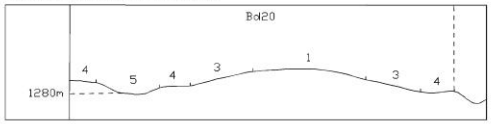
Modal Profiles / *Modale profiele* :
P485 P487 P488 P489
123 125 126 127

Terrain unit / *Terreineenheid*	1	3	4	5
% of land type /*% van landtipe*	55	40	3	2
Area / *Oppervlakte (ha)*	53499	38908	2918	1945
Slope / *Helling (%)*	1 - 2	1 - 2	1 - 2	1 - 2
Slope length / *Hellingslengte (m)*	1000 - 3000	500 - 2000	50 - 300	50 - 200
Slope shape / *Hellingsvorm*	Z-Y	Z-Y	Z	Z
MB0, MB1 (ha)	53498	38908	2918	1945
MB2 - MB4 (ha)	0	0	0	0

Soil series or land classes / ***Grondseries of landklasse***	**Depth** / ***Diepte*** (mm)	**MB**		**Total** / ***Totaal*** ha	%	**Clay content %** / ***Klei-inhoud %*** A	E	B21	Hor	**Texture** / ***Tekstuur*** Class / *Klas*	***Diepte-beperkende materiaal*** (**Depth limiting material**)
Blinkklip Cv36	>1200	0	:	40513	41.7	6-15		15-25	B	fiSaLm-SaClLm	
Soetmelk Av36	600-1000	0	:	24123	24.8	6-15		15-25	B	fiSaLm-SaClLm	sp
Annandale Cv33	>1200	0	:	11916	12.3	4-12		6-15	B	fiSa-SaLm	
Shorrocks Hu36	>1000	0	:	8073	8.3	6-15		15-25	B	fiSaLm-SaClLm	R
Mangano Hu33	>1200	0	:	3404	3.5	4-12		6-15	B	fiSa-SaLm	
Arniston Va31, Waterval Va11	100-300	0	:	2626	2.7	10-25		35-50	B	fiSaCl-Cl	vp,vr
Gelykvlakte Ar20, Rensburg Rg20	450-900	0	:	1342	1.4	45-55			A	fiSaCl-Cl	R,G
Lindley Va41, Valsrivier Va40	100-300	0	:	1177	1.2	10-25		30-50	B	fiSaCl-Cl	vp
Killarney Ka20	100-250	0	:	1051	1.1	15-30		45-60	A	fiSaLm-SaClLm	G
Limpopo Oa46, Mutale Oa47	600-900	0	:	340	0.4	10-25		25-45	B	fiSaCl	R
Killarney Ka20	100-300	0	:	195	0.2	15-30		45-60	A	fiSaLm-SaClLm	G
Gelykvlakte Ar20	450-1000	0	:			45-55			A	fiSaCl-Cl	R
Pans/Panne:			:								
Lindley Va41	100-250	0	:	2510	2.6	10-25		40-55	B	fiSaCl-Cl	vp

Terrain type / *Terreintipe* : A2

Terrain form sketch /*Terreinvormskets*



For an explanation of this table consult LAND TYPE INVENTORY (table of contents)
Ter verduideliking van hierdie tabel kyk LANDTIPE - INVENTARIS (inhoudsopgawe)

Geology: Shale, mudstone and sandstone of the Ecca and Beaufort Groups. Aeolian and possibly colluvial sand overlies the rocks.

Geologie: Skalie, moddersteen en sandsteen van die Groepe Ecca en Beaufort. Eoliese en moontlike kolluviale sande bedek die gesteentes.

10 November 2006

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