Appendix D7

Soil, Land Use, Land Capability and Agricultural Potential Assessment for the Proposed Kareerand TSF Expansion Project

- TerraAfrica, 2020

Soil, Land Use, Land Capability and Agricultural Potential Assessment for the Proposed Kareerand TSF Expansion Project

Submitted by TerraAfrica Consult cc
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June 2020

Specialist Declaration of Independence

In support of an application in terms of the National Environmental Management Act 107 of 1998 (GNR983, GNR984 and GNR985, GG38282 of 4 December 2014 ("Listed Activities") that will require an environmental authorisation if triggered. As amended by GN 327 & GN 706,GN 325 and GN 324 & GN 706.

I, Mariné Pienaar, as a specialist, have been appointed in terms of regulation 12(1) or 12(2), and can confirm that I shall —

a. Be independent;
b. have expertise in undertaking specialist work as required, including knowledge of the Act, these Regulations and any guidelines that have relevance to the proposed activity;
c. ensure compliance with these Regulations;
d. perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the application'
e. take into account, to the extent possible, the matters referred to in regulation 18 when preparing the application and any report, plan or document relating to the application; and
f. disclose to the proponent or applicant, registered interested and affected parties to the proponent or applicant, registered interested and affected parties and the competent authority all material information in the possession of the EAP and, where applicable, the specialist, that reasonably has or may have the potential of influencing –
   i. any decision to be taken with respect to the application by the competent authority in terms of these Regulations; or
   ii. the objectivity of any report, plan or document to be prepared by the EAP or specialist, in terms of these Regulations for submission to the competent authority;

   Unless access to that information is protected by law, in which case it must be indicated that such protected information exists and is only provided to the competent authority.

Mariné Pienaar	
Name and Surname	Signature
2020-06-01	Johannesburg
Date	Signed at

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1. INTRODUCTION

TerraAfrica Consult cc was appointed by GCS (Pty) Ltd to conduct an Agricultural Agro-Ecosystem Specialist Assessment for the proposed Kareerand Tailings Storage Facility Expansion. The project applicant is Mine Waste Solutions (Pty) Ltd (MWS. Mine Waste Solutions (MWS), also known as Chemwes (Pty) Ltd (Chemwes), has been processing gold mining waste in the area east of Stilfontein since 1964.

The project area falls within two jurisdictions, namely City of Matlosana Local Municipality and JB Marks Local Municipality in North West province (
Figure *1*). Both these municipalities are part of the Dr Kenneth Kaunda District Municipality. The project area is approximately 10 km south-east of Stilfontein, 19 km east of Klerksdorp and 20 km north-east of Orkney. Khuma is the town in closest proximity at about 3 km away from the existing Kareeraand TSF.

2. PROJECT DESCRIPTION

The operations at Mine Waste Solutions entail the collection and reprocessing of mine tailings that were previously deposited on tailings storage facilities (TSFs) in order to extract gold and uranium. High pressure water cannons are used to slurry the tailings on the Source TSFs, then the slurry is pumped by three pump stations and a network of pipelines to the MWS/Chemwes Processing Plant, and the residues from the Processing Plants are pumped to the Kareerand TSF. Once an old Source TSF has been completely recovered, the objective is to clean it up and rehabilitate the site

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 Environmental Impact Assessment Report, is to ensure that the sensitivity of the site to the proposed land use change (from agriculture to waste processing and storage of waste materials) 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 Environmental Impact Assessment report for the proposed Kareerand Tailings Storage Facility Expansion.

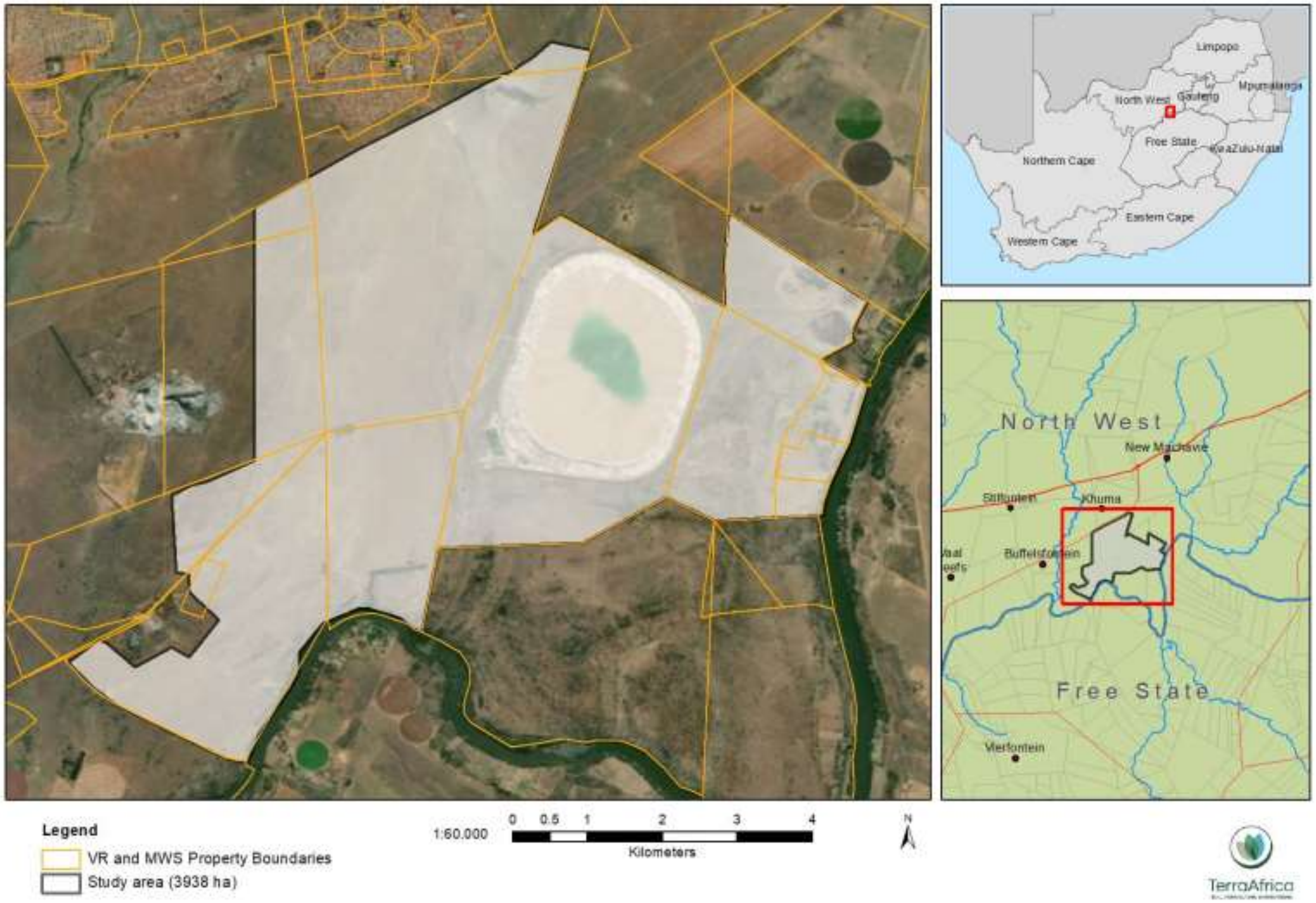

Figure 1 Locality of the proposed Kareerand Tailings Storage Facility Expansion Project

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.

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 also 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 hydromorphic soils with wetland functionality within the study area.

5. DEFINITION OF STUDY BOUNDARIES AND LIMITATIONS

The scope of the Agricultural Agro-Ecosystem assessment is limited to the determination of the soil properties and land capabilities of the study site and to assess the current and historical agricultural productivity of the area that will be affected by the impacts of the proposed TSF expansion project. Soil samples collected for the site was analysed for soil fertility parameters such as pH and plant-available nutrients in order to determine whether there may be inherent soil chemical limitations to crop production.

The pollution of nearby farms where crops and livestock are produced, may occur as a result of the transport of contaminant particles through the air or in water resources or as a result of radiation exposure. However, these aspects are dealt with in dedicated specialist reports and the spatial distribution of pollution plumes and its potential impacts on human and environmental health of the nearby farms, discussed in the following reports:

- Kareerand Expansion Project: Human Health Risk and Impact Assessment by EnviroSim (May 2020)
- Kareerand TSF Expansion Project: Radiological Public Impact Assessment by Aquisim Consulting (Pty) Ltd (May, 2020)
- Air Quality Specialist Report for Mine Waste Solutions Kareerand Extension Project by Airshed (2020)
- Hydrogeological Assessment for the Kareerand TSF & Expansion Project by GCS (2020)

6. ASSUMPTIONS, UNCERTAINTIES AND KNOWLEDGE GAPS

The following assumptions were made during the assessment and reporting phases:

- The assessment of the anticipated impacts assumes that the proposed surface footprint of the project will stay within the confines as depicted in the layout maps in this report.
- It was assumed that the layout will consist of the components stipulated in the final project layout and description that was provided by the applicant.
- Assumptions regarding the impacts of the proposed infrastructure were made and based on the author's knowledge of the nature and extent of the planned infrastructure.

Uncertainties are centred around the cumulative impacts that the project will have on soil health and food production outside the boundaries of the proposed TSF Expansion Project. While air quality and groundwater modelling can make rather accurate predictions on the size of the pollutant plumes associated with the project, there is currently no study available with quantitative values on the extent of soil pollution in the area around the existing Kareerand TSF.

The following knowledge gaps have been identified:

- There are no historical results on the soil pollution status of the land that was surveyed. As a result of the project area being in a larger area dominated by historical gold mining activities, there may be elevated levels of possible pollutants as a result of polluted dust blowing into areas over a long period of time. Soil pollution assessment was outside of the scope of this study.
- The survey was conducted using a hand-held soil auger that could drill down to 1.5m or refuse (also see Section 6.2). This methodology causes minimal to no impact during the study but in areas where shallow soil is present, it is not possible to determine the exact depth of soil available for stockpiling and rehabilitation as the limiting horizon is not homogeneous.

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 to determine areas of existing impact and land uses within the study area as well as the larger landscape. It was also scanned for any areas where crop production and farming infrastructure may be present.

To ensure a comprehensive analysis of the proposed development area, the following data was also analysed:

- 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 development area 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 North West and Free State Field Crop Boundaries (November 2019) data set was analysed to determine whether the proposed Kareerand TSF Expansion project infrastructure 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, old fields, smallholdings and subsistence farming. This data was also used to allocate a sensitivity rating for the proposed development area as well as a 50m buffer area around it.
- The climate data for the Kareerand TSF Expansion project area was obtained from the website of Meteoblue that avails climate data under a Creative Commons licence (Meteoblue, 2006 – 2020). The climate data for the town of Stilfontein was extracted and it is assumed that the Kareerand area experiences similar climatic conditions.

7.2. Site survey

The proposed Kareerand TSF Expansion Project went through an extensive planning period during which a number options for project layout and design were considered. During this time, the areas to be surveyed increased and changed until it was decided that all the properties in this area owned by AngloGold Ashanti will be included in the soil and land capability survey.

The entire soil survey was conducted by surveying the area in different sections. The first survey day was 30 January 2018 and the entire project was finalised on 6 December 2018. The survey points observed were between 80 and 250m apart over the entire study area. Although standard practice for a detailed soil survey recommends a grid of 1.0 to 1.5 ha, survey points in closer proximity were necessary for these sites as soil variety occurs over short distances. The desktop study conducted beforehand indicated that the presence of wetlands was a possibility.

The soil profiles were examined to a maximum depth of 1.5m or the point of refusal using an 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 were initially described using the S.A. Soil Classification Taxonomic System (Soil Classification Working Group, 1991) published as memoirs in the Agricultural Natural Resources of South Africa No.15. However, when the updated soil form descriptions of the recently launched system became available, the soil classification data points were revisited. The soil map units and descriptions are now based on the Soil Classification Working Group of 2018's *Soil Classification: A Natural and Anthropogenic System for South Africa*. For soil mapping of the areas assessed in detail, the soils were grouped into classes with relatively similar soil characteristics.

There were a number of rainfall events during the period in which the survey was conducted and this was sufficient to highlight hydromorphic (wetland) soil forms present in the landscape. However, the season in which the survey was conducted, is not a determining factor for soil assessment. As soils develop over thousands of years, seasons do not influence the soil properties present, especially in areas with low to average rainfall, such as that of the project site. Even impacts on soil properties as a result of hydropedology, occur over several years and are not influenced by the season of the assessment within a year or a few years.

7.3. Analysis of samples

Twenty-seven soil samples were collected from eighteen modal soil profiles in the study area. Soil samples were sealed in clean soil sampling plastic bags and sent to Eco Analytica Laboratory at North-West University for analyses. Samples taken to determine baseline soil fertility were analysed for pH(KCl), plant-available phosphorus (Bray1), exchangeable cations (calcium, magnesium, potassium, sodium) and texture classes (relative fractions of sand, silt and clay).

7.4. Verification of land capability

Once the soil classification survey was completed, the different soil form units were grouped together as the different land capability classes that are present on site. The same land capability classification criteria was used that is described in the metadata sheet that accompanies the land capability raster data layer (DAFF, 2017).

The new system has fifteen land capability classes as opposed to the initial eight classes that was described by Schoeman et al. (2002). 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 land capability class number.

It should be noted that this land capability classification system does not indicate wetland land capability (soils with hydromorphic properties) as a class in the same way the land capability classification system of the South African Chamber of Mines does for mining projects. Should hydromorphic soil forms be present though, it will be addressed and described using wetland delineation guidelines.

7.5. Agricultural income and employment

Determination of the agricultural potential of an area using theoretical soil potential formulas and high-level soil and/or land capability classification data, is prone to several flaws. With advances in agricultural science, such as genetic improvement of crops and better disease management, as well as increased expertise of farmers in soil fertility management, much higher yields are achieved under conditions previously considered less than optimal for crop production. Therefore it is always more accurate to obtain data from farmers in close proximity to the study site.

However, for this study, the entire area to be directly impacted upon by the project infrastructure, is used for extensive livestock farming. Therefore, the spatial data layer of the long-term grazing capacity of the area (DAFF, 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. The long-term grazing capacity data set for South Africa (as published in 2018), 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.

7.6. Impact assessment methodology

Below are the tables with the steps followed to do the impact rating according to the method prescribed by GCS (Pty) Ltd.

Table 1 Severity

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Highly significant / harmful	4
Extreme significance/ extremely harmful / within a regulated sensitive area	5

Table 2 Spatial scale

(*How big is the area that the aspect is impacting on?*)

Area specific (at impact site)	1
Whole site (entire surface right)	2
Local (within 5km)	3
Regional / neighboring areas (5km to 50km)	4
National	5

Table 3 Duration

One day to one month / immediate	1
One month to one year / Short term	2
One year to 10 years / medium term	3
Life of the activity / long term	4
Beyond life of the activity / permanent	5

Table 4 Frequency of the activity

(*How often do you do the specific activity?*)

Improbable / almost never / Annually or less	1
Low probability / Very seldom / 6 monthly	2
Medium probability / Infrequent / Temporary / Monthly	3
Highly probable / Often / semi-permanent / Weekly	4
Definite / Always / permanent / Daily	5

Table 5 Frequency of the incident/impact

(*How often does the activity impact on the environment?*)

Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5

Table 6 Legal issues

No legislation	1
Fully covered by legislation	5

Table 7 Detection

Immediately	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4
Covered	5

Table 8 Rating classes

Rating	Class
1 - 55	Low Risk (L)
56 - 169	Moderate Risk (M)
170 - 600	High Risk (H)

Table 9 Calculations

Consequence = Severity + Spatial Scale + Duration
Likelihood = Frequency of Activity + Frequency of Incident + Legal Issues + Detection
Significance/Risk = Consequence X Likelihood

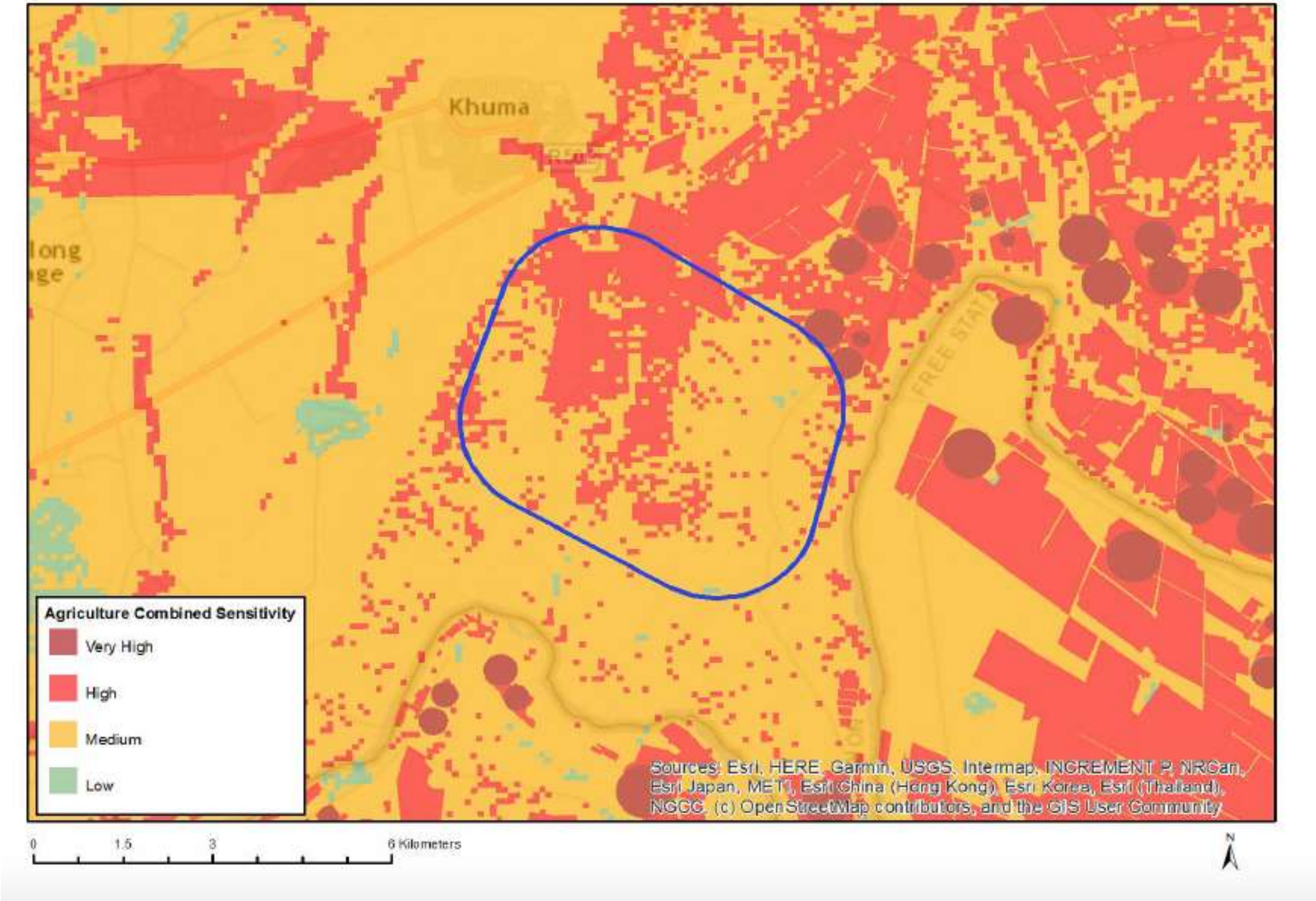

Figure 2 Illustration of the Agricultural Combined Sensitivity of the proposed project area according to the Environmental Screening Tool of DEA

8. RESULTS OF ENVIRONMENTAL SCREENING TOOL

The screening report was generated on by GCS on 24 April 2020 using the online Screening Tool of the Department of Environmental Affairs (DEA). A buffer area around the proposed Kareerand TSF Expansion footprint was used for the generation of the report and the depiction of the relative sensitivities of the receiving environment (Figure 2). According to this report, the area has high sensitivity to the proposed development because it includes portions of land with Moderate-High land capability (both Classes 09 and 10), old fields and the possibility that the area is used for annual crop cultivation or planted pastures. The buffer area used for the screening report also includes a small section of centre pivot irrigation (in the north-eastern corner) that has very high sensitivity to the proposed development. The eastern, southern and south-western sections of the area used for the screening process, has been rated as having medium sensitivity to the proposed development.

9. RESULTS OF DESKTOP ANALYSIS

9.1. Climate data

The mean daily maximum temperatures for the Stilfontein area (as modelled and presented by Meteoblue) range between 19°C in the winter months of June and July and 31°C in summer (the hottest months are December and January). The mean daily minimum temperatures range between 1°C in July and 16°C in December and January. Frost occurs in the winter months of May, June and July when temperatures can drop below 0°C on cold, clear winter nights. The highest precipitation is measured during December with an average of 90 to 95mm of rain, with the months of November and January having the second highest average precipitation rate of 75mm per month. The lowest average precipitation rate is in July (0 to 5mm), with the months of June and August also receiving less than 10mm rain per month. The climate data is visually depicted in Figure 3 below.

According to Climate-Data.org, the Stilfontein area had an average annual precipitation of 607mm per annum, using precipitation data of the years between 1982 and 2012. Although this average precipitation is suitable for crop production, it is important to note that the larger around Stilfontein (including the Kareerand TSF Expansion area) has been prone to cyclical droughts, including droughts as a result of the El Niño phenomenon. These droughts have caused crop failures, especially in areas where a lack of precipitation cannot be supplemented with irrigation water. As a result of the recurring droughts, farmers choose to convert crop fields with marginal crop yield potential, to fields with cultivated pasture.

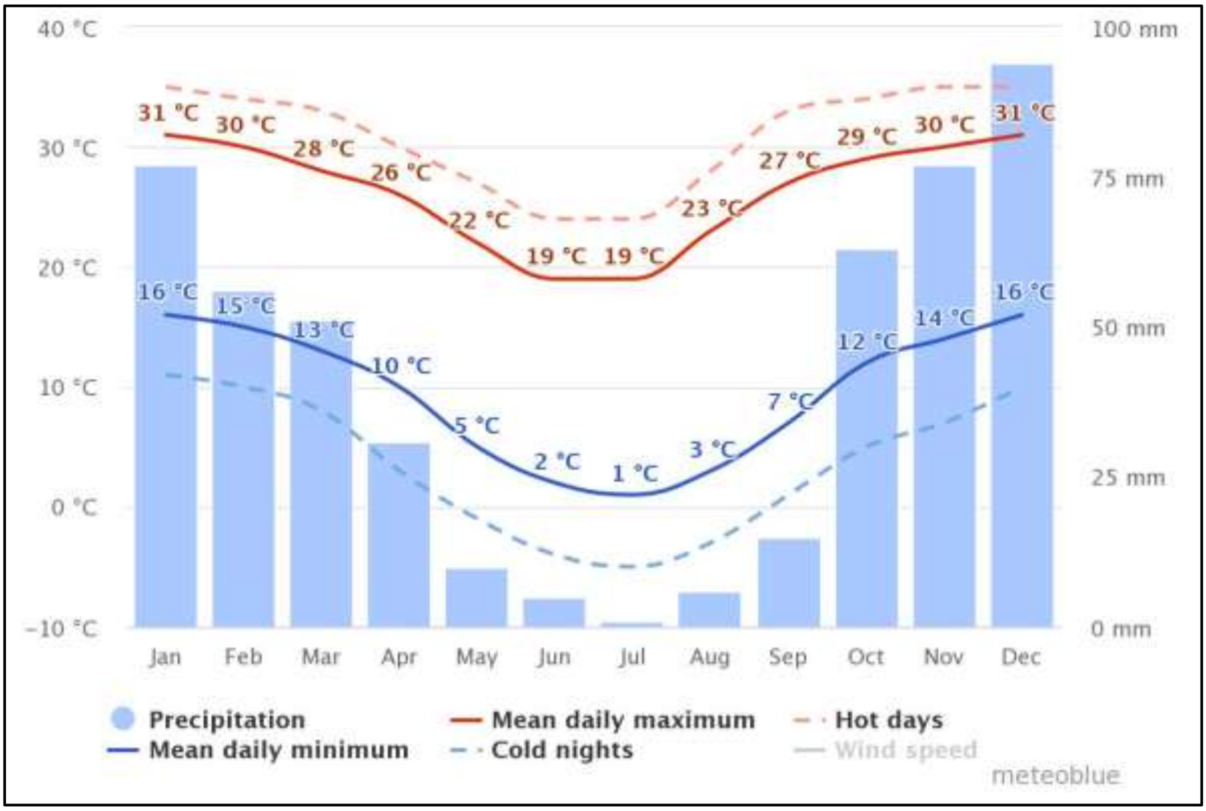

Figure 3 Average temperature and precipitation for Stilfontein (data source: www.meteoblue.com)

9.2. Land capability of the area according to DAFF raster data layer

The study area and the proposed Kareerand TSF expansion footprint was superimposed on the land capability raster data layer that DAFF published in 2017 (Figure 4). The data set is used as one part of the criteria for determination of agricultural sensitivity by the Environmental Screening Tool.

According to this data, the eastern half of the proposed new TSF footprint of 380ha, can be classified as land with Moderate-High land capability, while the western half of this area consists of small sections with Low land capability and larger areas with Moderate land capability. According to DAFF (2017), the area south of the existing TSF facility (where the new RWDs will be), consist largely of Moderate land capability. The stormwater trench that diverts clean water to the Vaal River, will run largely through land with Moderate land capability.

9.3. Field crop boundaries

The field crop boundaries data layers of both North West and Free State provinces (DAFF,2019), were depicted within and around the boundaries of the proposed Kareerand TSF Expansion. The data indicated that old fields are present within the footprint of the new TSF area as well as directly north of the existing TSF. Other crop fields include the rainfed crops or planted pastures north and east of the proposed development area as well as centre pivot irrigation north-west, east and south-east of this area.

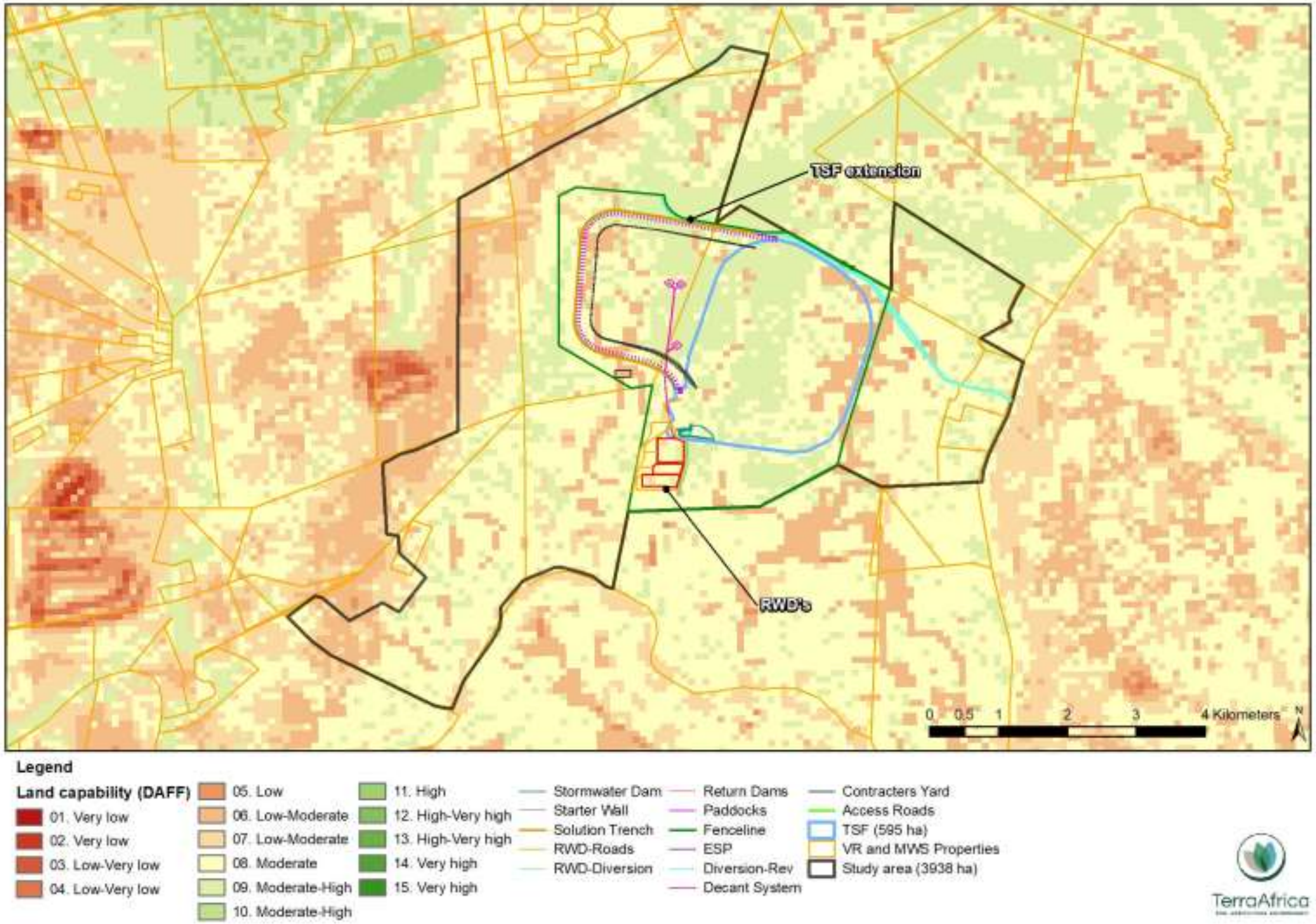

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Figure 4 Land capability of the project site and the surrounding area (data source: DAFF, 2017)

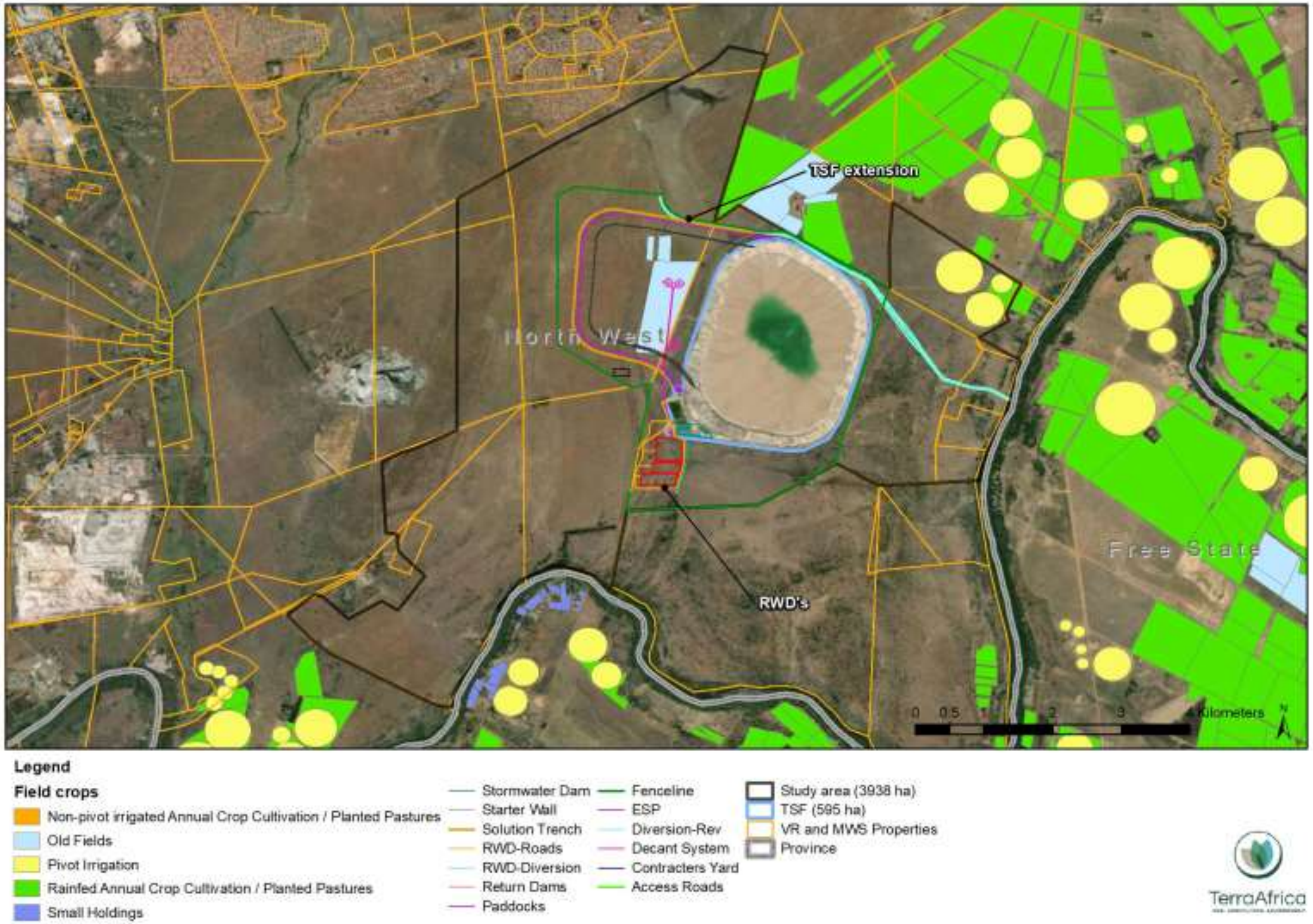

Figure 5 Field crop boundaries within study area as well as the surrounding area (data source: DAFF, 2017)

10. RESULTS OF SITE ASSESSMENT

10.1. Soil classification

The total area of land where soil classification was conducted is 3938 ha. In this area, twenty-two different soil forms were identified. These soil forms are Hutton, Oakleaf, Fernwood, Sepane, Sterkspruit, Swartland, Valsrivier, Mayo, Willowbrook, Bonheim, Steendal, Milkwood, Arcadia, Katspruit, Rensburg, Shortlands, Clovelly, Glencoe, Dresden, Lichtenburg, Mispah and Glenrosa. The position of these soil forms within the landscape is presented in Figure 7.

However, a larger portion of the study area will not be affected by the construction and operation of the Kareerand TSF Expansion. The areas considered for the proposed project is the entire area within the proposed boundary fence as well as the stormwater trench that will run in an easterly direction towards the Vaal River. A buffer zone of 50m on each side of the trench was included in the description of the soil forms and their land associated capabilities. Within the area considered for the proposed project, seventeen soil forms are present. These soil forms are Hutton, Clovelly, Lichtenburg, Shortlands, Swartland, Valsrivier, Oakleaf, Mayo, Oakleaf, Willowbrook, Milkwood, Arcadia, Katspruit, Rensburg, Glencoe, Dresden, Mispah and Glenrosa forms. These soil forms are presented as fifteen different mapping units in Figure 8. The soil physical properties of these mapping units are discussed below.

Vaalbos form:
The largest portion of the proposed project area (366ha), consists of soil of the Vaalbos form. The soil depth in the Vaalbos profiles ranges in depth between 0.5 and 1.0m. Red apedal soils (previously referred to as the Hutton form) with no restrictions shallower than 0.5m are generally good for crop production (Fey, 2010), permitting that the climate is suitable for crop production. The Vaalbos soil form consist of an orthic A horizon on a red apedal B horizon overlying hard rock.

Carolina form:
Approximately 48ha of the proposed project area consist of the Carolina soil form. The Carolina soil form has structural and textural characteristics similar to that of the Vaalbos form, except for the colour of the B1 apedal horizon. In the case of the Carolina form, the B1 horizon consists of yellow-brown structureless (apedal), sandy soil. The Carolina form is present in the western section of the development area where the proposed expanded TSF will be located.

Lichtenburg form:
A total area of approximately 14ha, occurring in two separate areas along the western and northern boundary of the proposed development, consists of Lichtenburg soil profiles. The Lichtenburg form on site ranges in depth between 0.7 and 0.9m. This soil form consists of an orthic A horizon, underlain by a red apedal B1 subsoil horizon that is limited in depth by hard plinthic material.

Glencoe form:
Approximately 4ha of the Glencoe soil form is located along the northern section of the proposed development area. The soil depth of these soil profiles are between 0.6 and 0.9m.

The Glencoe form consists of an orthic A horizon, underlain by a yellow-brown apedal horizon that is restricted in depth by hard plinthic material (also known as ferricrete).

Figure 6 Small stockpile of hard plinthite chunks in the area where the Glencoe soil profiles are present

Dresden form:

The Dresden form occurs in a small, narrow section of approximately 3ha along the south-eastern corner of the proposed fence that will be constructed. The Dresden soil profiles have shallow soil depth (less than 0.4m) and consist of an orthic A horizon underlain by hard plinthite. No mottling was observed directly above the hard plinthite.

Oakleaf form:

The Oakleaf form is present in the most easterly section of the proposed stormwater diversion trench in an area of approximately 2ha. The Oakleaf form consists of an orthic A horizon underlain by a thick neocutanic horizon (thicker than 1.5m). The neocutanic horizon consist of a mixture of soil colours and have weakly developed structure. The development of the thick neocutanic horizon is likely a result of alluvial deposits from the Vaal River that has undergone an intermediate level of pedogenesis.

Nshawu form:

Approximately 66ha of the proposed development area consists of the Nshawu soil form. The largest portion of the 66ha is located in the south-eastern corner of this area and a smaller section is present around the middle of the eastern extension of the stormwater diversion channel that will run into the Vaal River. The horizon organisation of these soil profiles consist of an orthic A horizon that is underlain by a red structured B1 subsoil horizon. The depth limiting material underneath the red structured horizon consist of hard rock.

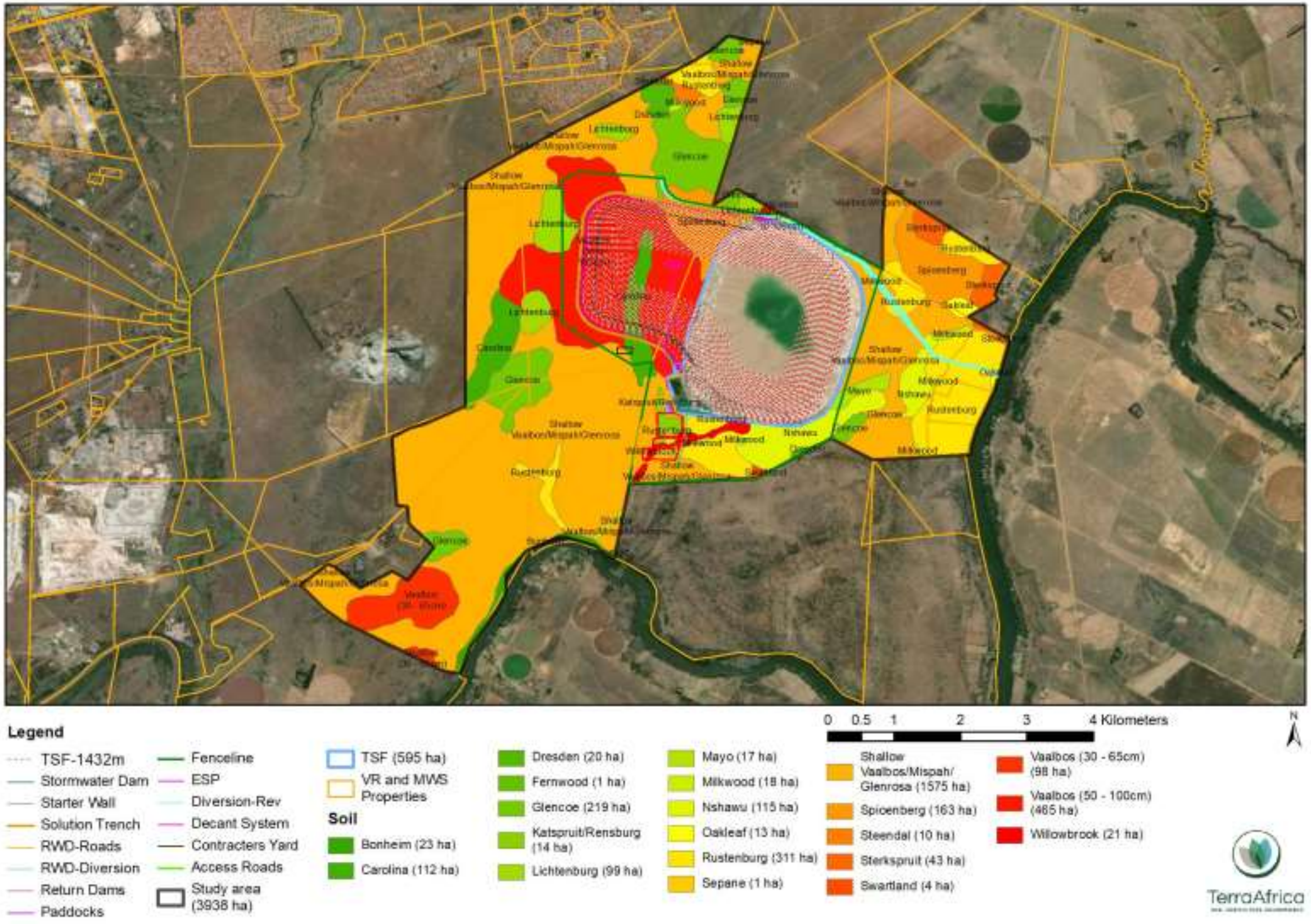

Figure 7 Soil classification map of the entire study area

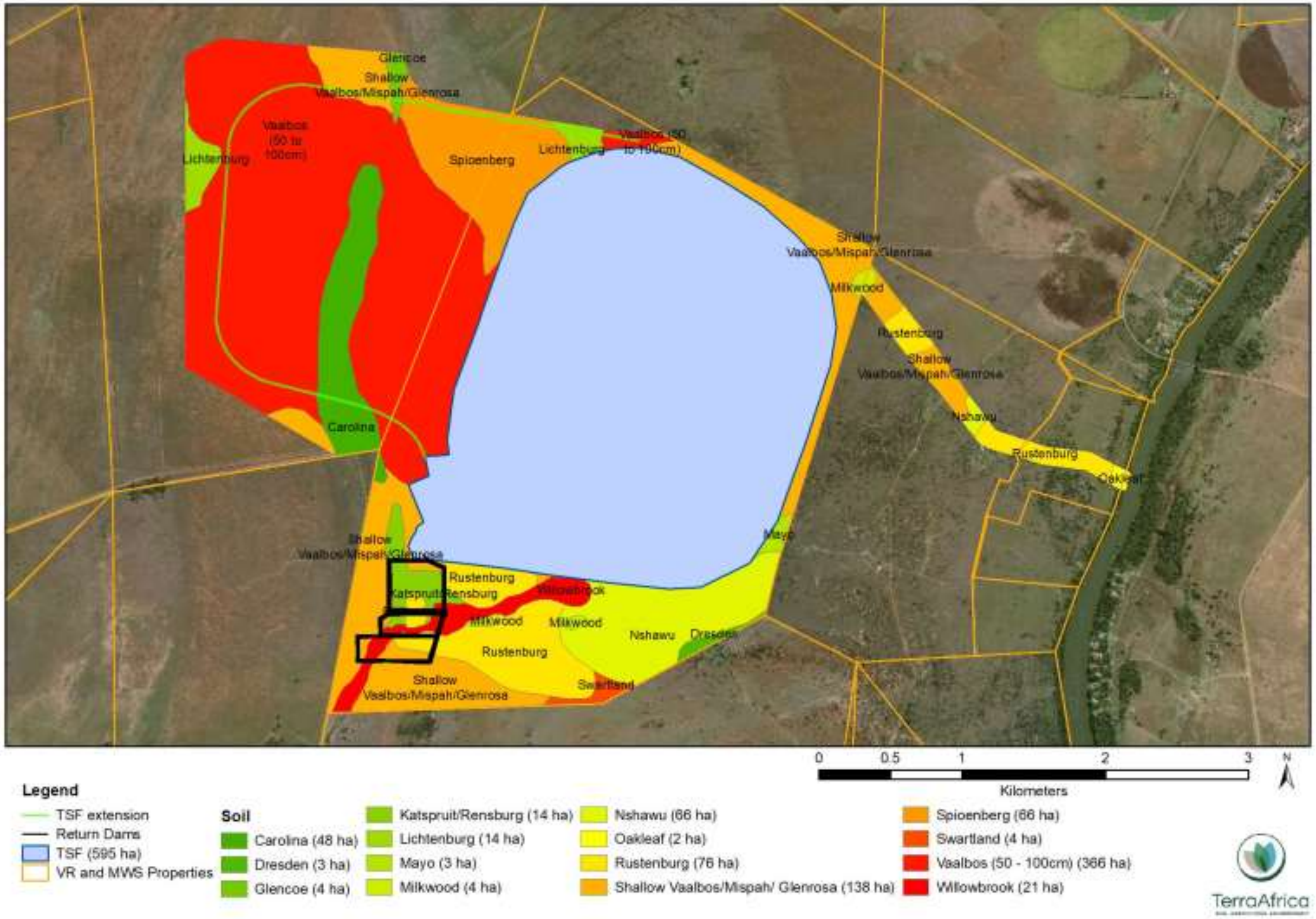

Figure 8 Soil classification map of the proposed TSF Expansion project's footprint

Spioenberg form:
The Spioenberg form has been identified in an area of approximately 66ha along the northern boundary of the proposed development area. The Spioenberg form consists of an orthic A horizon that is underlain by a pedocutanic subsoil horizon. The pedocutanic horizon is limited in depth by hard rock that occurs at soil depths of between 1.0 and 1.3m.

Milkwood form:
Two small pockets of Milkwood soil profiles are present south of the existing Kareerand TSF and one small pocket is located directly east of the north-eastern corner of the existing TSF. The total area of Milkwood profiles within the proposed development area is approximately 4ha. The Milkwood form represent shallow melanic topsoil (between 0.2 and 0.4m deep) on hard rock.

Mayo form:
An area of around 3ha of Mayo soil profiles were identified along the south-eastern corner of the existing Kareerand TSF. The profiles consist on a melanic topsoil horizon (between 0.2 and 0.4m deep) underlain by lithic material.

Willowbrook form:
The Willowbrook form supports the wetland functionality of the landscape south of the existing Kareerand TSF. The Willowbrook form is indicative of a permanent wetland zone and consists of a melanic topsoil horizon that is underlain by gley. Approximately 21ha of land in this area are made up of Willowbrook soil.

Katspruit/Rensburg forms:
The Katspruit and Rensburg soil forms have been grouped together into one soil map unit as it occurs in short proximity from each other in the areas the permanent wetland zone directly south of the existing Kareerand TSF. The two soil forms are present on approximately 14ha of land within the proposed development area.

Rustenburg form:
Within the proposed development area, 76ha of soil consist of the Rustenburg form. The Rustenburg form consists of a vertic surface horizon that is underlain by hard rock. The vertic horizon is dark brown to black in colour and ranges in depth between 0.7 and 1.1m deep on site. Vertic soil has high clay content with swelling-shrinking properties under conditions of fluctuating water content. When the vertic soil horizon dries out (especially during winter months), small cracks are visible on the soil surface.

Mispah/Glenrosa forms:
Shallow soil underlain by either hard rock or lithic material are present along the northern and southern fringes of the existing TSF, as well as the south-western corner of the proposed Kareerand TSF expansion footprint. These two soil forms are grouped together as they are present in short distances from each other. The only difference between the Mispah and Glenrosa forms are the depth-limiting material underlying the orthic A horizon. For the Mispah form, the underlying material is hard rock and for the Glenrosa form, it is lithic material. Approximately 138ha of soil within the proposed development area, consists of this soil form combination.

10.2. Soil texture

The soil texture of the soil forms 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 The soil pH(KCl) values range between a strongly acidic value of 4.16 for sample KR09 to a slightly acidic value of 6.05 for sample KR02. None of the samples analysed have neutral to alkaline pH values. For the purpose of 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, the areas from which the samples were collected have not been used for crop production at least ten years and the soil pH analysis results are not considered problematic for livestock production.

The calcium levels range between 382.5 mg/kg in sample KR09 and 2 885.6 mg/kg in sample KR16. The magnesium levels are the lowest in sample KR09 at 128.5 mg/kg and the highest value was measured in sample KR 15 at 1340.6 mg/kg. The potassium levels range between a low of 23.5 mg/kg in sample KR08 and 211.6 mg/kg in sample KR16.

The plant-available phosphorus levels are low in all samples analysed, ranging between 2.0 mg/kg and 7.0 mg/kg P. These low levels are common for undisturbed soil profiles in South Africa and higher levels are usually found in crop fields where phosphorus is supplemented with fertilizer or in forested areas where much the higher soil organic matter content is linked with higher P levels. Fertilizer recommendations for phosphorus are highly dependent on the clay content of the soil, with higher clay content requiring higher levels of P fertilization.

Although sodium is not considered an essential plant nutrient and can cause soil sodicity when present in very high concentrations, a number of C4 plants use sodium for the concentration of carbon dioxide, thereby aiding in maximum biomass yield in these plants (Subbarao et al., 2003). A wide range of sodium concentrations are present in soil on site, ranging from very low at 0.50 mg/kg to much higher concentrations of 350 mg/kg (as measured in sample KR02).

Table *10* below.

Soil texture within the proposed development area fall within one of four soil textural classes i.e. Sandy Loam, Sandy Clay Loam, Sandy Clay and Clay. The apedal horizons of the Vaalbos and Carolina soil forms have Sandy Loam texture while the soil forms with weakly to more strongly developed structure such as the Spioenberg Sandy Clay Loam to Sandy Clay texture. Soil forms with vertic topsoil such as the Rensburg and Rustenburg forms, have Clay texture.

10.3. Soil fertility parameters

The soil pH(KCl) values range between a strongly acidic value of 4.16 for sample KR09 to a slightly acidic value of 6.05 for sample KR02. None of the samples analysed have neutral to alkaline pH values. For the purpose of 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, the areas from which the samples were collected have not been used for crop production at least ten years and the soil pH analysis results are not considered problematic for livestock production.

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Table 10 Analysis results of the nutrient status of samples analysed

Sample no.	**pH(KCl)**	**Ca**	**Mg**	**K**	**Na**	**P**	**Sand**	**Silt**	**Clay**	**Soil texture**
		(mg/kg)					(% smaller than 2mm)			
KR01	4,72	2120,5	1113,5	140,5	48,5	4,2	56,5	12,4	31,1	Sandy Clay Loam
KR02	6,05	2907,5	1767,5	129,5	350,0	2,6	43,9	7,6	48,6	Clay
KR03	4,78	400,5	117,0	155,0	0,5	3,2	78,1	11,1	10,7	Sandy Loam
KR04	5,01	749,5	305,0	33,5	0,5	2,2	70,1	9,7	20,2	Sandy Clay Loam
KR05	4,54	721,0	209,5	160,5	0,5	2,8	66,9	9,1	24,0	Sandy Clay Loam
KR06	4,92	1050,0	335,0	83,0	0,5	2,1	56,5	9,7	33,8	Sandy Clay Loam

KR07	4,93	610,5	246,5	117,0	0,5	2,7	70,9	15,9	13,1	Sandy Loam
KR08	4,83	648,5	405,5	23,5	0,5	2,0	57,1	12,2	30,6	Sandy Clay Loam
KR09	4,16	382,5	128,5	179,0	0,5	3,1	76,6	6,7	16,7	Sandy Loam
KR10	5,80	1465,6	364,3	120,9	16,8	6,7	56,5	12,4	31,1	Sandy Loam
KR11	5,86	1406,9	397,4	81,5	17,2	7,0	70,9	17,6	11,4	Sandy Loam
KR12	4,93	1015,8	343,3	595,4	9,9	6,0	75,6	13,8	10,5	Sandy Loam
KR13	5,06	1302,8	545,7	83,5	18,8	4,5	65,6	20,3	14,1	Clay
KR14	4,77	1252,2	360,5	218,0	13,0	4,5	41,8	16,5	41,7	Sandy Clay Loam
KR15	5,37	2645,7	1340,6	142,7	89,1	5,0	57,4	17,6	25,0	Sandy Clay
KR16	4,97	2885,6	1072,4	211,6	290,7	5,6	51,6	12,6	35,8	Sandy Clay Loam
KR17	4,85	2035,1	1299,3	207,9	129,4	5,7	58,3	10,2	31,5	Sandy Loam

10.4. Land capability classification

Following the results of the soil classification survey as well as other site assessment observations such as the terrain and climate, the entire study area can be divided into eight different land capability classes (Figure 9). Within this area, the proposed development footprint consist of seven different land capability classes (Figure 10).

The land capability classes within the proposed development area include Moderate-High (Class 09), Moderate (Class 08), Low-Moderate (Class 07), Low (05), Low-Very Low (Class 04), Low-Very Low (Class 03) and Very low (Class 02). The area west of the existing Kareerand TSF largely consists of soil with Moderate-High land capability that could have been used for crop cultivation. This area consists largely of soil of the Vaalbos, Carolina and Lichtenburg forms. The small area with Oaklands soil profiles bordering on the Vaal River, also has Moderate-High land capability. An area south and south-east of the within the proposed development area consists of Shortland soil with Moderate land capability.

The areas consisting moderately to strongly structured soil in the northern, eastern and southern sections of the proposed development area has Low land capability and is considered more suitable for grazing purposes. The areas where shallow rocky soil profiles are present is considered to have Low to Very Low land capability (Class 04) and livestock grazing is considered to be a more sustainable land use option in these areas. The areas where Low-Very Low (Class 03) and Very Low (Class 02) have been identified, is associated with the permanent responsive zones of the wetland areas south of the existing Kareerand TSF. These areas are not considered suitable for livestock grazing purposes as cattle grazing in these areas will result in trampling and the associated damage to the wetland vegetation.

10.5 Land use

The areas within the proposed development area that was indicated as old fields (Figure 5), have not been used for crop production at least the least ten years. This was confirmed by interrogating historical aerial imagery on Google Earth. Following the above-normal rainfall of the past summer season (2019-2020), the veld in the area identified as old crop fields is considered to be in good condition for livestock grazing and include patches of red grass (*Themeda triandra*) (Figure 11). The areas east and south of the existing Kareerand TSF are also used for livestock grazing.

During the last site assessment (30 May 2020), livestock grazing was observed in the area. Three groups of cattle were seen grazing the area and each group was herded by one person. The cattle groups consisted of mixed breeds and the breed mix seems to be dominated by the Brahman breed. Other livestock that was observed during this site visit including a small herd of Boer goats (Figure *12*) as well as a small group of sheep.

No signs of existing land degradation such as erosion gullies were found within the proposed new development area. However, during the last visit, evidence was found that solid waste dumping of household waste, is taking place next to the gravel road that enters the site from the northern boundary.

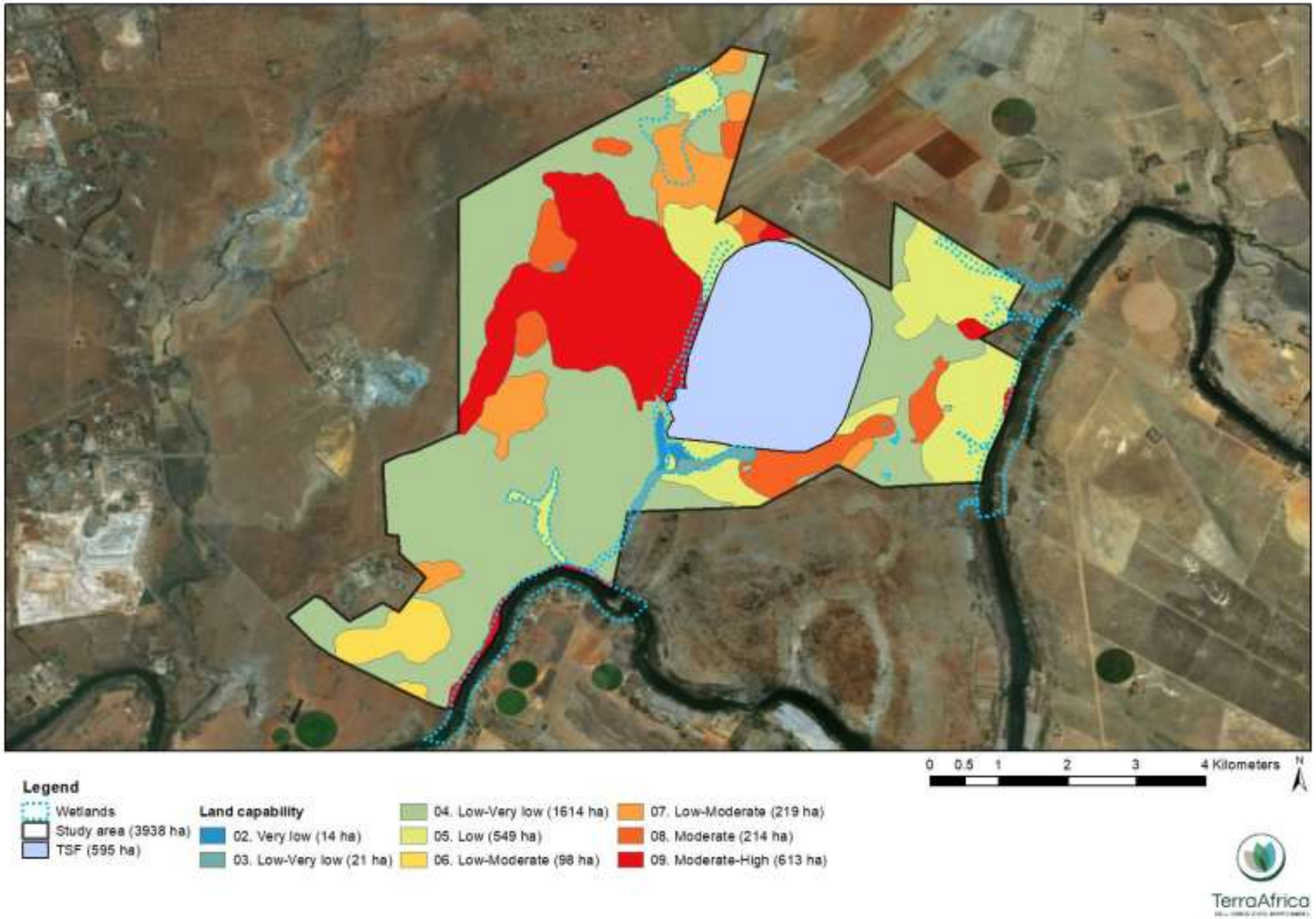

Figure 9 Land capability classification of the entire study area

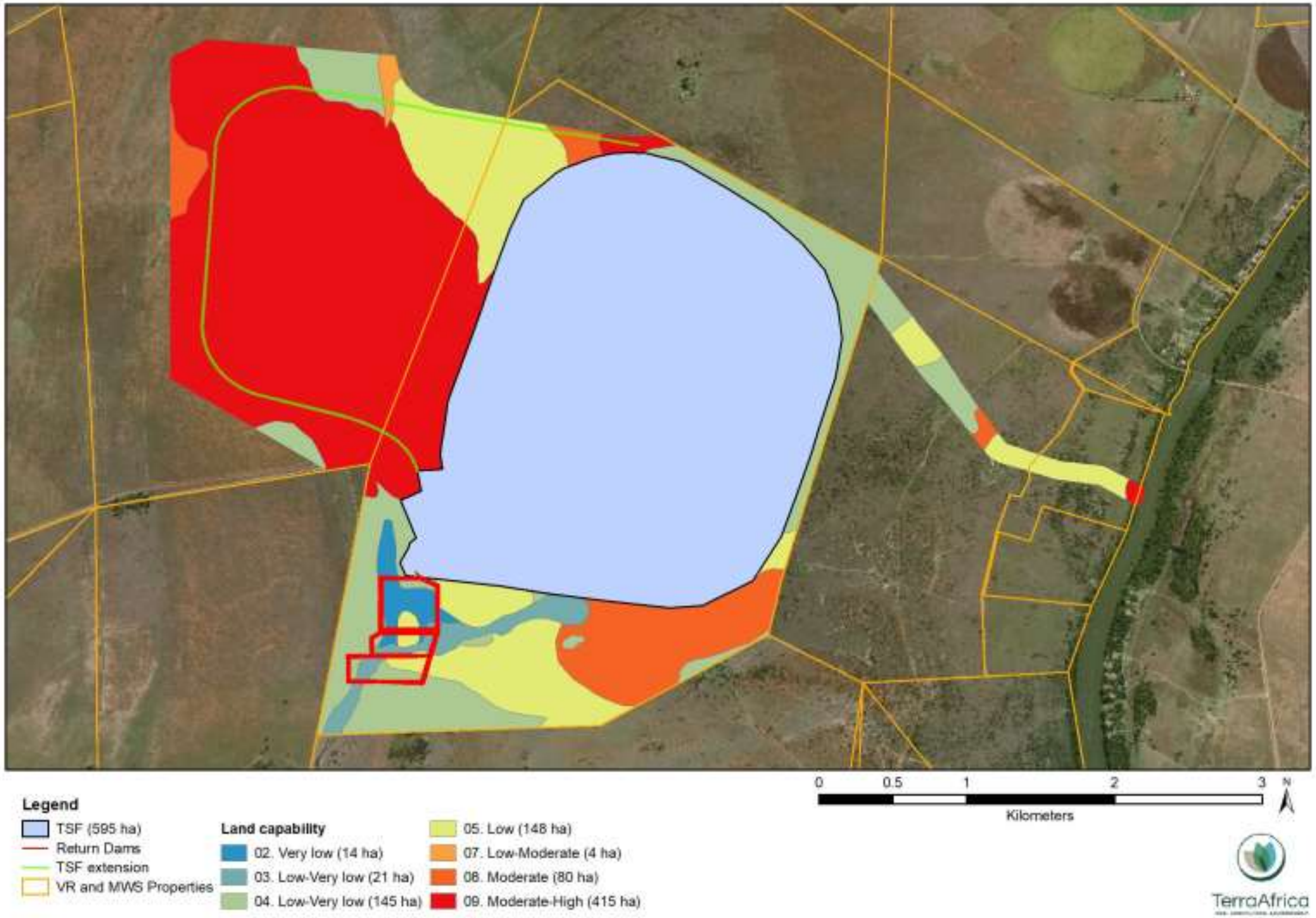

Figure 10 Land capability map of the proposed development area

Figure 11 Photographic evidence of the current veld conditions of the area west of the existing Kareerand TSF

Figure 12 Evidence of the small group of Boer goats grazing on site

Figure 13 Photographic evidence of domestic waste dumping along the gravel road that enters the site from the northern boundary

10.6. Gross agricultural income from the area of the proposed Kareerand TSF Expansion footprint

Although some areas of the land that will be affected by the proposed Kareerand TSF expansion, do have arable land capability, it has not been used for crop production within the last ten years. The properties to be affected is communal land that is leased to Chemwes for the operation of the existing waste facility. The area that was outside of the fence of the current TSF footprint, is used for cattle grazing by the community who owns the land.
The potential gross income that can be generated from the land annually, was calculated by using the long-term average grazing capacity of the area that will be affected by the proposed project. The following assumptions have been made in the calculations:

- The construction of the new fence around the new TSF expansion will exclude any cattle farming activities from the fenced-off area. Although a smaller area of land will be permanently changed by the infrastructure, it is assumed that no cattle grazing will be allowed within the boundary fence. The area where the existing TSF infrastructure is present, is excluded from the calculations as these areas have not been used for grazing the past five years. The area considered a loss to production from the onset of the construction period is:
    - Proposed fenced-off area (1 368.8 ha) minus the area already affected (594.7 ha) = area where cattle forage will no longer be available (792.1 ha)
- At a long-term average grazing capacity of 6 hectare per Large Stock Unit (/ha/LSU) (DAFF, 2018), the area of 792.1 ha, provide forage to 132 head of cattle.
- The herd is considered to have a 80% weaning rate which is considered an optimistic figure and does not take any potential losses from stock theft into consideration. This allows for the sale of around 106 weaners per annum.

- The average weight of a Brahman weaner is estimated at 220 kg and the average auction price for live weight (or "hoof weight") in 2019, was R30/kg.

The total gross income that was generated by livestock farming in the area the past year, is therefore estimated to be R699 600.00.

Following the requirements of GN320, the potential gross income loss from agricultural activities in the area for the next five years, must also be considered. For this estimation, it was assumed that there will be a price increase of 6% per annum for live weight of cattle. Should the proposed project be authorised, livestock farming can still continue in 2020 as the construction phase of the project will only commence in 2021. The estimates for the next six years as well as the total gross income lost from agricultural production, is presented in the table below.

Table 11 Gross income forecast for the proposed project area

Year	**Price of live weight (R/kg)**	**Gross annual income (R)**
2020	31.80	R741 576.00
2021	33.71	R786 117.20
2022	35.73	R833 223.60
2023	37.87	R883 128.40
2024	40.14	R936 064.80
2025	42.55	R992 226.00
Total gross income from livestock production between 2021 and 2025		**R4 430 760.00**

10.7. Agricultural employment

With the guidance of the socio-economic specialist of the project, the potential agricultural employment figures were calculated using two different models. The ratios used in the calculations are based on the information in provided in the Provincial GDP Statistics for 2010 to 2019 (Statistics South Africa, 2020). The one model considers livestock farming on the proposed project area as a community based project that can provide salaries and wages to approximately 7 people. The second model considers the livestock farming as a commercial project run by an entrepreneur. Following the assumptions of this model as outlined in Table 12, a commercial project will provide employment to 2 people.

Table 12 Potential agricultural employment of the area that will be affected by the proposed development

Component	**Community based project**	**Commercial project run by entrepreneur**
Gross income (2019 base year) (Rand per annum)	699,600	699,600
% value added	42%	42%
% salaries and wages (community project)	100%	28%
Salaries and wage component (Rand per annum)	293,832	82,273

Minimum wages in South Africa (Rand per hour)	20	20
Minimum wages (Rand per year) based on 8 hour working day; 20 working days per month for 12 months	38,400	38,400
Unskilled labour supported by income (number)	7.7	2.1

11. IMPACT ASSESSMENT

The impacts on soil and agricultural agro-ecosystems are confined to that within the area of direct impact. Any impacts on the nearby agricultural crop fields such as the pivot irrigation fields, will be caused by migration of contaminants from the direct area of impact either via air or water or as a result of radiation. The possible risk to the sensitive receptors on nearby farms, have been addressed in the following reports:

- Kareerand Expansion Project: Human Health Risk and Impact Assessment by EnviroSim (May 2020)
- Kareerand TSF Expansion Project: Radiological Public Impact Assessment by Aquisim Consulting (Pty) Ltd (May, 2020)
- Air Quality Specialist Report for Mine Waste Solutions Kareerand Extension Project by Airshed (2020)
- Hydrogeological Assessment for the Kareerand TSF & Expansion Project by GCS (2020)

The following sub-sections will describe and rate the impacts that are anticipated on the in-situ soil profiles that will be affected within the proposed project footprint. The impacts on the food production potential of the land as well as the associated agricultural employment, are also rated below. The impact rating is conducted separately for each of the proposed project phases.

11.1. Construction phase

11.1.1 Loss of current land capability in areas where infrastructure will be constructed

According following the land capability classification described in Section 10.5 above, the areas that will be affected by the TSF expansion area as well as the RWDs, access roads and the solution trench have Moderate (Class 08) to Moderate-High (Class 09) land capability. Smaller areas with Low Moderate (Class 07) and Low (Class 05) land capability, is also considered to be present.

Once construction commences and soil is stripped, the current land capability of all areas where the surface infrastructure will be constructed, will be lost. The largest feature of the project is the TSF expansion footprint of 380ha. As the TSF will become a permanent feature of the landscape, the area that will be affected, can't be rehabilitated to the original land capability.

THEME: Loss of current land capability of the areas where infrastructure will be constructed		
	Without mitigation	**With mitigation / enhancement**
Status	Negative (-)	Negative (-)
Severity	4	3
Spatial Scale	1	1
Duration	5	5
Frequency of activity	5	5
Frequency of impact	5	5
Legal Issues	5	5
Detection	1	1
Impact rating	High (160) -	Medium (144) -

Mitigation:

- The mitigation measures are limited as the project infrastructure is considered to become a permanent feature of the landscape.
- The project infrastructure footprint should be kept to the project layout as provided by the client.
- The properties around the boundaries of the proposed Kareerand TSF Expansion should be actively managed to avoid the degradation of the current land capability through overgrazing and soil erosion.

Cumulative impacts:

- Other mining activities in the area not related to the Kareerand TSF Expansion
- Expansion of settlement areas into areas with arable and grazing land capability when work opportunities created by the Kareerand TSF result in a population influx of migrant workers in search of employment opportunities.

Residual impacts:

- The progressive loss of areas grazing and arable land capability that can be used for livestock grazing, game farming as well as other agricultural enterprises.

11.1.2 Loss of agricultural production income and agricultural employment

Following the calculations and assumptions as outlined in Sections 10.6 and 10.7 above, the first five years of the proposed Kareerand TSF Expansion project, will result in a loss of R4 430 760.00 agricultural gross income over the five years. This income that will be lost from livestock farming in the area that will be fenced off, can provide employment either to 2 people (in the case of a commercial entrepreneurial project) or to 7 people when the model of a community based project is considered.

THEME: Loss of agricultural production and agricultural-related employment within the fenced-off area		
	Without mitigation	**With mitigation / enhancement**
Status	Negative (-)	Negative (-)
Severity	4	3
Spatial Scale	1	1
Duration	5	5
Frequency of activity	5	5
Frequency of impact	4	4
Legal Issues	1	1
Detection	2	2
Impact rating	Medium (120) -	Medium (108) -

Mitigation: • The project infrastructure footprint should be kept to the project layout as provided by the client. • MWS can investigate to introduce alternative agricultural projects in the area
Cumulative impacts: • Other mining activities in the area not related to the Kareerand TSF Expansion
Residual impacts: • A reduction of the volume of food produced within the district municipality

11.1.3 Loss of soil ecosystem services and soil fertility in areas where topsoil are stripped

Prior to construction, the available topsoil (a combination of all soil horizons above the underlying material such as fractured rock, solid rock or hard plinthite) will be removed and stored largely in at the topsoil bund wall that will be used for future rehabilitation of the TSF.

The soil in the affected area provides the following ecosystem services:

- It provides soil nutrients that supports the vegetation growth of the area;
- The hydropedology of the in-situ soil profiles of the entire landscape contributes to both underground and surface water volumes. The soil also has a water purification function, especially in wetland areas such as the area where the RWDs will be constructed.
- It provides physical support to plants, animals and microorganisms by anchoring plant roots, providing shelter for animals and a nutrient matrix for microorganisms.

Once the soil is stripped and transported from its original position, it becomes a new matrix with different physical and biological properties as a result of mixing of the soil horizons and storing it in large stockpiles.

THEME: Loss of soil ecosystem services and soil fertility in areas where topsoil are stripped		
	Without mitigation	**With mitigation / enhancement**
Status	Negative (-)	Negative (-)
Severity	4	4
Spatial Scale	1	1
Duration	5	5
Frequency of activity	5	5
Frequency of impact	5	5
Legal Issues	1	1
Detection	3	3
Impact rating	Medium (140) -	Medium (140) -
Mitigation: • The mitigation measures are limited as the topsoil removed will either be used for rehabilitation of the outside of the TSF wall and topsoil bund wall. • The project infrastructure footprint should be kept to the project layout as provided by the client and not spread outside of the fenced-off area. • Topsoil, whether present in stockpiles or as part of the topsoil bund wall, should be protected against wind and water erosion until vegetation has established on the exposed topsoil surfaces. • If natural revegetation does not occur, natural vegetation should be established on the topsoil stockpiles.		
Cumulative impacts:		

• Other mining activities in the area not related to the Kareerand TSF Expansion that impact on soil ecosystem services and soil fertility.
Residual impacts: • The progressive loss of soil ecosystem services, result in the progressive degradation of soil quality and the services provided such as water and nutrient cycling.

11.1.4 Soil contamination with hydrocarbons and solid waste

The following construction activities can result in the pollution of soil with hydrocarbons and/or solid waste:

- Petroleum hydrocarbon (present in oil and diesel) spills by machinery and vehicles during earthworks and the mechanical removal of vegetation during site clearing.
- 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 and operational workers.
- Spills from fuel storage tanks during construction.
- Polluted water from wash bays and workshops during the construction phase.
- Accidental spills of other hazardous chemicals used and stored on site.
- Pollution from concrete mixing.

THEME: Soil contamination with hydrocarbons and solid waste		
	Without mitigation	**With mitigation / enhancement**
Status	Negative (-)	Negative (-)
Severity	3	2
Spatial Scale	1	1
Duration	4	2
Frequency of activity	4	3
Frequency of impact	4	3
Legal Issues	5	5
Detection	3	3
Impact rating	Medium (128) -	Medium (70) -
Mitigation: • High level maintenance must be undertaken on all vehicles and construction/maintenance 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 should be available on site and should be serviced regularly; • Waste disposal at the construction site and during operation 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.		

Cumulative impacts:
• None
Residual impacts:
• None

11.2. Operational phase

11.2.1 Soil pollution from pumping of waste slurry through pipelines to the Kareerand TSF complex for processing

Pipelines are prone to wear-and-tear and mechanical errors, resulting in either leakage or instants spills of the slurry from the affected areas onto the soil surface. As the soil surface underneath the pipeline will not be covered with any protective material, the slurry will seep into the soil surface, carrying trace elements and other pollutants with it.

THEME: Soil pollution from pumping of waste slurry through pipelines to the Kareerand TSF complex for processing		
	Without mitigation	**With mitigation / enhancement**
Status	Negative (-)	Negative (-)
Severity	4	2
Spatial Scale	3	1
Duration	5	3
Frequency of activity	4	2
Frequency of impact	4	3
Legal Issues	5	5
Detection	3	3
Impact rating	High (192) -	Medium (78) -

Mitigation:

- Regular maintenance of the pipelines are required to prevent waste leaks and spill events.
- All pipelines must be checked regularly in order to detect any if there are any leaks of waste product.
- Should any leaks or waste spillage from the pipelines be detected, the soil directly affected by the spill as well as in a radius of 20m around the spill area, must be assessed by a soil pollution expert.
- Any soil pollution assessment following on a leak or spill from the pipelines, should be accompanied by recommendations with proven soil remediation techniques.
- The volumes of soil polluted by any leaks and spills from the pipelines should be remediated directly after it was detected to avoid migration of pollutants into the groundwater or air as emission particles.

Cumulative impacts:

- Any existing soil contamination as a result of previous spills and leaks from the existing pipeline network.
- Sabotage of the pipelines by artisanal miners in search of gold-containing material that they can process.
- Other mining activities in the area not related to the Kareerand TSF Expansion.

Residual impacts:

- Gradual or sudden enrichment of soil with soil contaminants will result in bio-accumulation of the contaminants in vegetation and increased contamination levels of groundwater, surface water and air. This has negative human and environmental health impacts.

11.2.2 Soil pollution from storage of processed mine tailings waste in the proposed expanded TSF

While the project layout design aims to minimise the soil pollution risk from the proposed new TSF expansion, soil pollution can still occur. Sources of soil pollution from the project include an increase in dust fallout that contain contaminant particles, failure of the TSF lining to prevent any seepage into underlying and nearby areas and failure of dirty water management systems to contain polluted water in the case of an extreme weather event resulting in floods.

THEME: Soil pollution from storage of processed mine tailings waste in the proposed expanded TSF		
	Without mitigation	**With mitigation / enhancement**
Status	Negative (-)	Negative (-)
Severity	4	2
Spatial Scale	3	1
Duration	5	3
Frequency of activity	4	2
Frequency of impact	4	3
Legal Issues	5	5
Detection	3	3
Impact rating	High (192) -	Medium (78) -

Mitigation:

- An assessment of the current soil contamination status of the area around the proposed Kareerand TSF Expansion, must be conducted prior to the construction phase.
- This assessment must inform a detailed soil contamination monitoring plan for the operational phase that include bi-annual monitoring of the comprehensive range of contaminants that are present in the processed tailings waste as well as any other soil contaminant that are the by-product of operations at the Kareerand TSF.
- An increase in soil contamination levels detected, must be addressed through soil remediation.
- All areas that had undergone soil remediation must continually be monitored to ensure that the soil remediation measures were effective.

Cumulative impacts:

- Other mining activities in the area not related to the Kareerand TSF Expansion.
- Any existing soil contamination present as a result of the site being part of a larger gold mining area.
- Extreme weather events such as major floods and windstorms that increase the distance and severity of contaminant transport from the TSF.

Residual impacts:

- Gradual or sudden enrichment of soil with soil contaminants will result in bio-accumulation of the contaminants in vegetation and increased contamination levels of groundwater, surface water and air. This has negative human and environmental health impacts.

11.2.3 Soil contamination with hydrocarbons and solid waste

During the operational phase, soil can be polluted with spills from vehicles transporting workers and equipment to and from site as well as on site. Soil can also be contaminated through the generation of domestic waste by workers.

THEME: Soil contamination with hydrocarbons and solid waste		
	Without mitigation	**With mitigation / enhancement**
Status	Negative (-)	Negative (-)
Severity	3	2
Spatial Scale	1	1
Duration	4	2
Frequency of activity	4	3
Frequency of impact	4	3
Legal Issues	5	5
Detection	3	3
Impact rating	Medium (128) -	Medium (70) -

Mitigation:

- High level maintenance must be undertaken on all vehicles and construction/maintenance 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 should be available on site and should be serviced regularly;
- Waste disposal at the construction site and during operation 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.

Cumulative impacts:

- None

Residual impacts:

- None

11.2.4 Soil compaction of topsoil bund wall and access roads

Regular traffic of vehicles and equipment result in soil compaction. Soil compaction affects the soil porosity, thereby decreasing the water infiltration rate of soil. Compacted soil surfaces are prone to soil erosion after rainfall events as the slower infiltration rate cause higher stormwater runoff rates. The decreased ability of soil to absorb rainwater, has a negative impact on the soil biological composition and can affect the long-term ability of stored topsoil to be used for site rehabilitation.

THEME: Soil compaction of topsoil bund wall and access roads		
	Without mitigation	**With mitigation / enhancement**
Status	Negative (-)	Negative (-)
Severity	4	4
Spatial Scale	2	1

Duration	5	5
Frequency of activity	5	5
Frequency of impact	5	5
Legal Issues	1	1
Detection	3	3
Impact rating	Medium (154) -	Medium (140) -

Mitigation:

- Restrict traffic and vehicle movement to access roads.
- Demarcate parking areas and monitor that vehicles and equipment are not parked outside of these areas.

Cumulative impacts:

- None

Residual impacts:

- None

11.3. Decommissioning phase

During the decommissioning phase, the infrastructure that will not remain permanent features of the landscape, will be removed. This includes the decommissioning of the fence line and the slurry pipelines. The removal of the infrastructure will result in vehicles and equipment moving around in these areas to collect the materials for transport to waste dump areas.

11.3.1 Soil compaction of in areas where infrastructure will be removed

It is anticipated that vehicles and other equipment will traverse the area during the infrastructure removal. This will result in soil compaction that causes reduced water infiltration that increases the risk of surface water runoff and soil erosion.

THEME: Soil compaction of topsoil bund wall and access roads		
	Without mitigation	**With mitigation / enhancement**
Status	Negative (-)	Negative (-)
Severity	4	4
Spatial Scale	2	1
Duration	5	5
Frequency of activity	5	5
Frequency of impact	5	5
Legal Issues	1	1
Detection	3	3
Impact rating	Medium (154) -	Medium (140) -

Mitigation:

- Restrict traffic and vehicle movement to access roads.
- Demarcate parking areas and monitor that vehicles and equipment are not parked outside of these areas.

Cumulative impacts:

- None

Residual impacts:

- None

11.3.2 Soil contamination with hydrocarbons and solid waste

During the decommissioning phase, soil can be polluted with spills from vehicles that are used for the removal of infrastructure from site. The infrastructure removal will also generate solid waste that may cause soil pollution.

THEME: Soil contamination with hydrocarbons and solid waste		
	Without mitigation	**With mitigation / enhancement**
Status	Negative (-)	Negative (-)
Severity	3	2
Spatial Scale	1	1
Duration	4	2
Frequency of activity	4	3
Frequency of impact	4	3
Legal Issues	5	5
Detection	3	3
Impact rating	Medium (128) -	Medium (70) -

Mitigation:

- High level maintenance must be undertaken on all vehicles and construction/maintenance machinery to prevent hydrocarbon spills;
- Impermeable and bunded surfaces must be used for storage tanks and to park vehicles on;
- 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 should be available on site and should be serviced regularly;
- Waste disposal in the areas where infrastructure are removed must be avoided by transporting the waste to designated waste sites.
- 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.

Cumulative impacts:

- None

Residual impacts:

- None

11.3.3 Increase in areas available for livestock grazing

Once the fence around the proposed project area is removed during the decommissioning phase, the areas not affected by permanent infrastructure such as the expanded TSF, will again become available for livestock farming.

THEME: Loss of agricultural production and agricultural-related employment within the fenced-off area		
	Without mitigation	**With mitigation / enhancement**
Status	Positive (+)	Positive (+)
Severity	2	2
Spatial Scale	1	1
Duration	5	5

Frequency of activity	5	5
Frequency of impact	4	5
Legal Issues	1	1
Detection	1	1
Impact rating	Medium (88) +	Medium (96) +

Mitigation:

- Ensure that the area around the permanent infrastructure is considered safe for livestock grazing.
- Fence off any areas that may pose a physical and/or chemical health risk to livestock as well as the people that will be herding the livestock.

Cumulative impacts:

- Any areas that may additionally become available for livestock grazing in the larger region around the Kareerand TSF Expansion

Residual impacts:

- None

12. ACCEPTABILITY STATEMENT

The proposed Kareerand TSF Expansion Project falls within an area where gold mining has been a main industry for several decades. The current agricultural production of the proposed development area is limited to livestock grazing with cattle, goats and sheep. It was calculated that the area currently provides agricultural employment to between 2 and 7 people. Although old crop fields are present within the proposed development area, it has not been used for crop cultivation the last decade.

From the perspective of soil conservation and sustainable land use, the project will have a negative impact wherever the activities result in surface disturbance, cause soil contamination and exclude livestock grazing from the area. It is anticipated that these impacts will either have or medium risk that can be mitigated to medium risk. It is also anticipated that removal of the outside boundary fence during the decommissioning phase, will have a medium positive impact on returning some land to the community for livestock grazing.

The project description of the proposed project indicates several precautionary measures to reduce the impacts such as a stormwater diversion trench to divert clean water away from possibly contaminated areas to the Vaal River, the lining of the proposed new TSF area as well as the storage of topsoil in a bund wall around the TSF for the purpose of future rehabilitation. Other mitigation measures that must be included are the limitation of the project footprint to as small as possible as well the continual monitoring of any soil contamination sources such as vehicles and equipment and the spillage of the solid waste in the project area.

Considering all the above, it is my professional opinion that authorisation of the proposed project is an acceptable land use change in the area.

13. REFERENCE LIST

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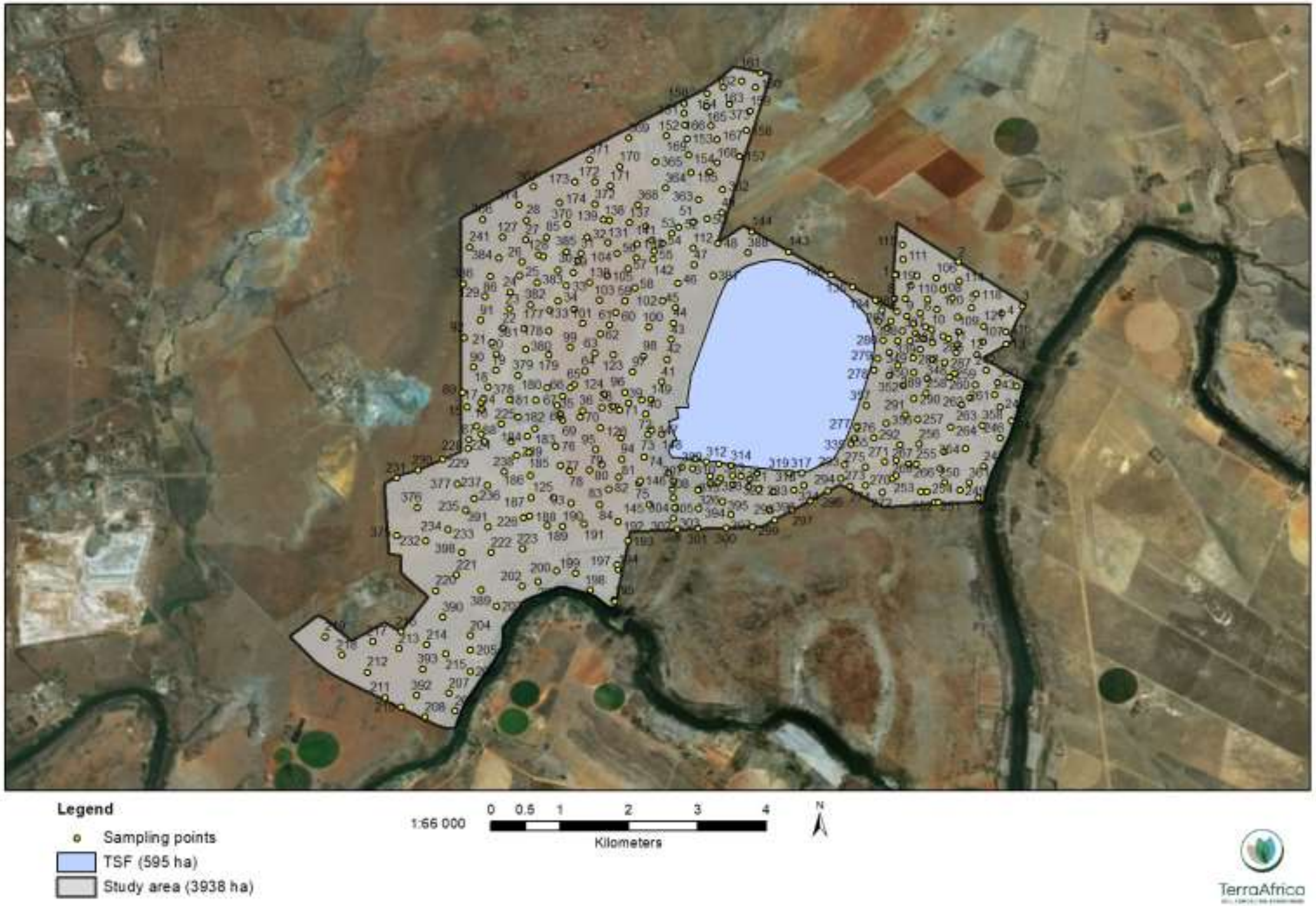
APPENDIX 1 – LOCALITY OF SOIL SURVEY POINTS WITHIN THE ENTIRE STUDY AREA



APPENDIX 2 – CURRICULUM VITAE OF SPECIALIST

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South Africa

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

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

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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