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Soil, Land Use, Land Capability and Agricultural Potential Assessment for the Vlaklaagte Mining Permit application

Submitted by TerraAfrica Consult cc
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27 September 2020

Declaration of Specialist

Declaration of Independence

I, Mariné Pienaar, hereby declare that TerraAfrica Consult, an independent consulting firm, has no interest or personal gains in this project whatsoever, except receiving fair payment for rendering an independent professional service. I further declare that I was responsible for collecting data and compiling this report. All assumptions, assessments and recommendations are made in good faith and are considered to be correct to the best of my knowledge and the information available at this stage.

I, further confirm, that as a specialist, I shall –

a. Be independent;
b. Have expertise in undertaking specialist work as stipulated by GN 320 of the National Environmental Management Act 107 of 1998;
c. 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; and
d. 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.

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1. Introduction

Eco Elementum (Pty) Ltd appointed Terra Africa Consult to conduct the soil, land capability and agricultural potential assessment as part of the Basic Assessment (BA) process required in support of a mining permit application for coal mining. The applicant for the mining permit application is Trentra (Pty) Ltd. The are that will be affected by the infrastructure and operations associated with the proposed mining permit, is 4.9ha in extent. For the purpose of the site assessment and reporting, a 50m buffered area was allocated around the 5ha mining permit area and the total area assessed is 10.4ha (from here onwards referred to as the study area). For the purpose of reporting, this here is from here onwards referred to as the study area or project area.

The study area is located on the Remaining extent of the farm Vlaklaagte 45 IS. The property is approximately 15km northeast of Kriel and part of the eMalahleni Local Municipality that is situated within the Nkangala District Municipality in Mpumalanga province (Figure 1). The Exxaro Dorstfontein East Colliery is located around 3.8km south of the study area.

2. Terms of Reference

The terms of reference for the Soil, Land Capability and Agricultural Agro-Ecosystem Specialist Assessment that will be included in the Basic Assessment (BA) Report, is to ensure that the sensitivity of the site to the proposed infrastructure development 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 soil properties, land capability and food production potential of the site. The report includes mitigation and management measures to reduce the impacts as far as possible and to ensure sustainable soil management throughout the project cycle.

3. Scope of works

In order to meet the Terms of Reference, the following Scope of Works were applied for the assessment:

- Undertake a desktop study and site investigation to establish broad baseline soil conditions (from land type data), land capability and areas of environmental sensitivity at all the proposed alternative sites in order to rate their sensitivity to the proposed development.
- Undertake a soil survey of the areas that have been provided by the client.
- Describe soils in terms of soil form, texture, soil structure, effective depth, structure, soil colour and presence of carbonates.
- Classify and describe soils using the South African Soil Classification: A Natural and Anthropogenic System for South Africa (Soil Classification Working Group, 2018).

- Classify the land capabilities following the most suitable land capability classification system.
- Determine the agricultural potential of the site following the site survey as well as taking climatic considerations into account.
- Determine the agricultural income and employment opportunities associated with the current land uses.
- Identify and assess the potential impacts that the proposed project will have on soil and agricultural potential of the area.
- Recommend mitigation, management and monitoring measures to minimise impacts and/or optimise benefits associated with the proposed project.
- 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. Environmental legislation applicable to study

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

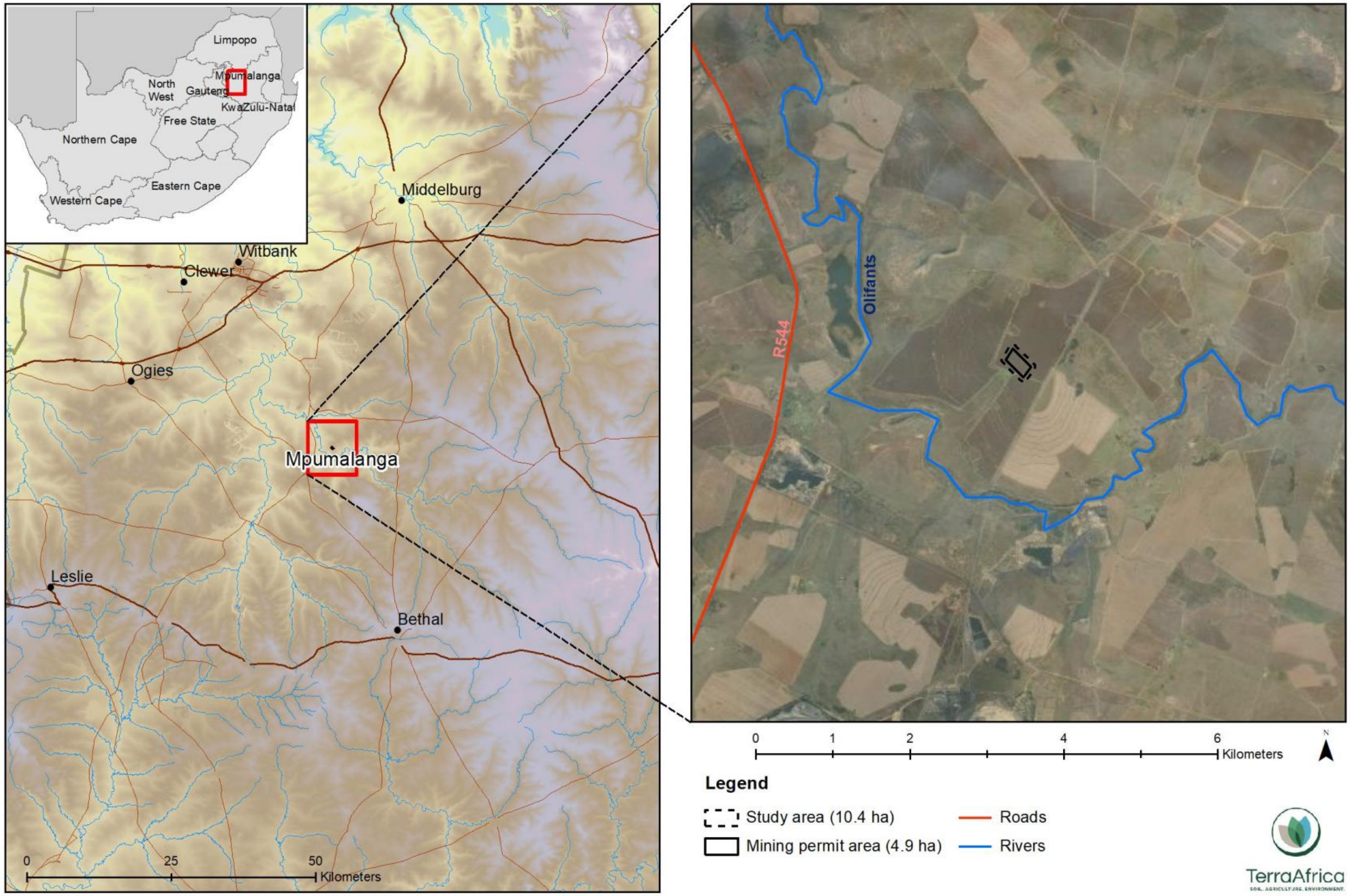

Figure 1: Locality map of the Vlaklaagte Mining Permit study area

5. 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.
- Soil profiles were observed at distances of 50m to 120m apart. While a denser sampling grid will provide even more detailed information on soil depth and the boundaries between different soil forms, the information gathered during the survey is considered sufficient to provide accurate depiction of the in situ soil form distribution.
- It is assumed that the results of the four samples analysed provide a good overview of the soil chemical properties of the study area. Although higher sampling density will be able to provide detailed soil chemical maps of the area, this was outside of the assessment's scope of works.

The following knowledge gaps have been identified:

- There are no historical results on the soil pollution status of the land that was surveyed. 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 1.5 m or refuse. 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.

6. Response to concerns raised by I&APs

Thus far, no concerns raised by I & APs during the Public Participation Process have been received or communicated to the report author by the EAP. Should any comments be received and made available during the public review period, it will be adequately addressed in this report or in an addendum letter.

7. Methodology

7.1 Desktop study

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

- Land type data for the site was obtained from the Institute for Soil Climate and Water (ISCW) of the Agricultural Research Council (ARC) (Land Type Survey Staff, 1972 – 2006). The land type data is presented at a scale of 1:250 000 and entails the division of land into land types, typical terrain cross sections for the land type and the presentation of dominant soil types for each of the identified terrain units (in the cross section).

- The 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 Vlaklaagte study area and surrounding area. This data provides an indication of the area's suitability for rainfed crop production, based on the combination of soil properties and climate.
- The long-term grazing capacity data of South Africa (DAFF, 2018) was analysed for the study area and surrounding area to determine what the potential of the area is for livestock farming.
- The Mpumalanga Field Crop Boundaries (DAFF, November 2019) was analysed to determine whether the proposed grid corridor 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, smallholdings and subsistence farming.

The most recent aerial photography of the area available from Google Earth was obtained. The aerial photography analysis was used to determine areas of existing impact; land uses within the project area as well as the larger landscape. It was also used as background imagery for the maps generated in ArcGIS 10.3.

7.2 Site survey

A soil survey was undertaken on 25 August 2020. The season in which the site visit took place has no influence on the results of the survey with regards to the identification of soil forms. The soil profiles were examined between 80 and 120 m apart. Soil profiles were observed to a maximum depth of 1,5 m or refuse, by using a hand-held bucket 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. Four soil samples were collected within the study area. The soil were stored in clean sampling bags, sealed and delivered to Eco Analytica Laboratory that is part of North West University. A digital camera was used to record photographic evidence of the soil properties as well as the current agricultural activities within and around the study area.

The soils are described using the third revised edition of the South African Soil Classification system namely Soil Classification: A Natural and Anthropogenic System for South Africa (Soil Classification Working Group, 2018). ArcGIS 10.3 was used to map the different soil units that illustrates the spatial distribution of the different soil forms.

7.3 Land capability classification

For the land capability classification, the soil properties as determined during the soil survey were used in combination with the land capability classification criteria that was developed by the South African Chamber of Mines and originally published in 1981 in the Guidelines for the rehabilitation of land disturbed by surface coal mining in South Africa. These criteria remained unaltered in the 2007 guidelines and are outlined in Table 1.

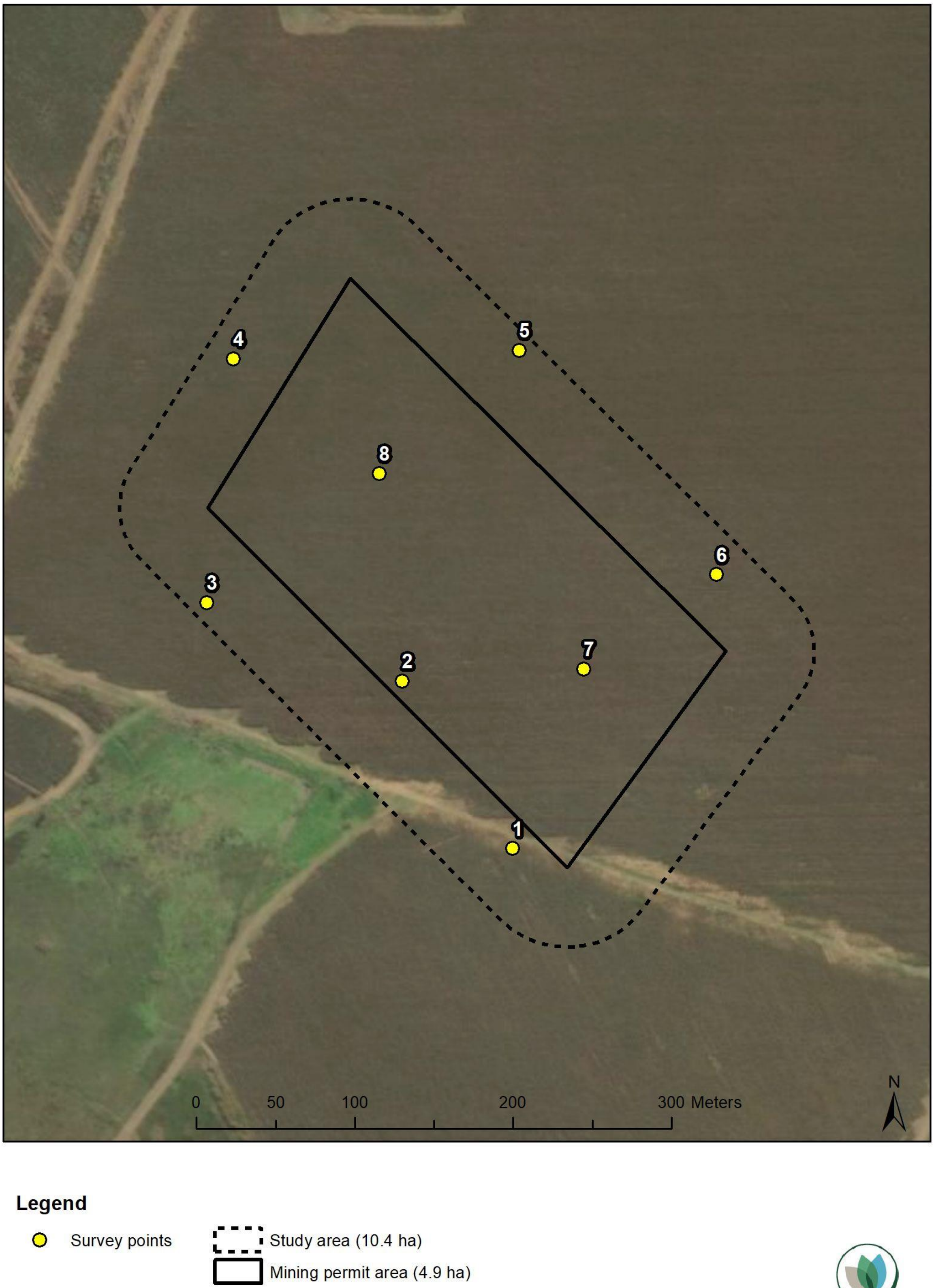

Figure 2 Locality of soil survey points within the Vlaklaagte Mining Permit study area

The Chamber of Mines pre-mining land capability system differs from the rating system that was used to categorise the DAFF land capability raster data. According to the Chamber of Mines classification system, the capability of land are divided into four major classes that includes wetland land capability but ignores different grades of suitability for agricultural production. To illustrate the agricultural capability of the land, the boundaries of the Vlaklaagte study area were superimposed on the DAFF land capability data.

The new system developed by DAFF consists of fifteen land capability classes where 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) is considered to have arable land capability with the potential for high yields increasing with the number of the land capability class.

Table 1: Pre-Mining Land Capability Requirements

Criteria for Wetland	• Land with organic soils or • A horizon that is gleyed throughout more than 50 % of its volume and is significantly thick, occurring within 750mm of the surface.
Criteria for Arable Land	• Land, which does not qualify as a wetland, • The soil is readily permeable to the roots of common cultivated plants to a depth of 750mm, • The soil has a pH value of between 4,0 and 8.4, • The soil has a low salinity and SAR, • The soil has a permeability of at least 1,5-mm per hour in the upper 500-mm of soil • The soil has less than 10 % (by volume) rocks or pedocrete fragments larger than 100-mm in diameter in the upper 750-mm, • Has a slope (in %) and erodibility factor (K) such that their product is <2.0, • Occurs under a climatic regime, which facilitates crop yields that are at least equal to the current national average for these crops, or is currently being irrigated successfully.
Criteria for Grazing Land	• Land, which does not qualify as wetland or arable land, • Has soil, or soil-like material, permeable to roots of native plants, that is more than 250-mm thick and contains less than 50 % by volume of rocks or pedocrete fragments larger than 100-mm, • Supports, or is capable of supporting, a stand of native or introduced grass species, or other forage plants, utilizable by domesticated livestock or game animals on a commercial basis.
Criteria for Wilderness Land	• Land, which does not qualify as wetland, arable land or grazing land.

7.4. Agricultural income and employment

From analysis of desktop data, it was found that the area to be directly impacted upon by the TSF expansion, is used for extensive livestock farming. The largest part of the road servitude is covered by the tar road and only the areas next to the road have vegetation that can be used for grazing. 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. The formula that was used to calculate the estimated agricultural income and associated employment opportunities of the areas that will likely be affected, are discussed together with the results.

7.5 Impact assessment methodology

The methodology that was used will be discussed in the relevant report section.

8. Results of Environmental Screening Tool

One of the requirements for Agricultural Assessments stipulated in GN320, states that the report must include:

"*A map showing the proposed development footprint (including supporting infrastructure) with a 50 m buffered development envelope, overlaid on the agricultural sensitivity map generated by the screening tool*"

A screening report was generated for the study area using the National Environmental Screening Tool (www.screening.environment.gov.za). The report was generated by Eco Elementum on 24 April 2020. The map was extracted from the report by capturing the image for the Agricultural Combined Sensitivity (Figure 3).
The map that was extracted from this report for the Agricultural Combined Sensitivity, shows both the mining permit area of approximately 5ha as well as the surrounding area.

According to **Error! Reference source not found.**, the mining permit area and surrounding buffered area consist of land with high agricultural sensitivity. This is likely because the area is part of a larger unit of crop fields where summer grains and other crops are produced.

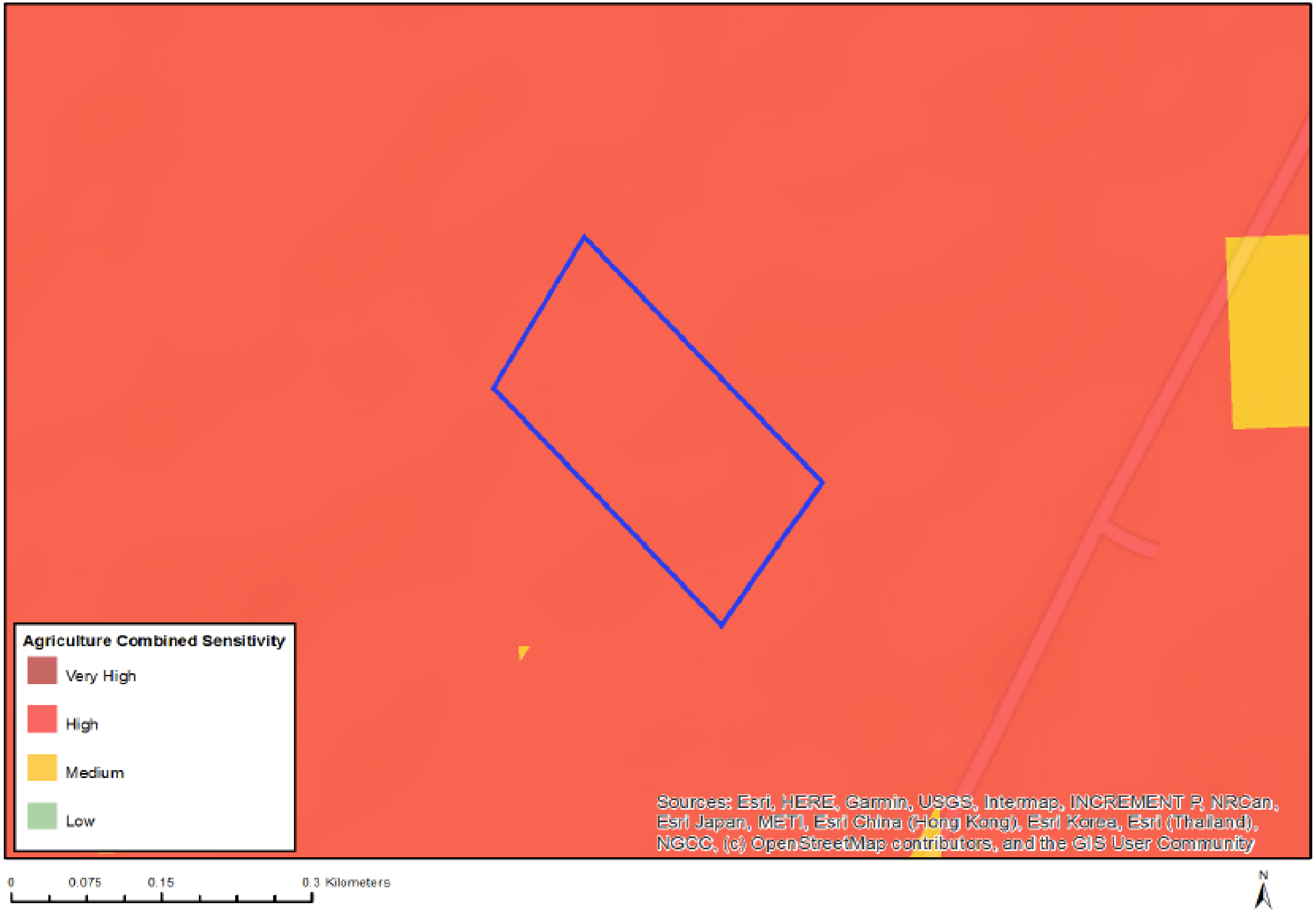

Figure 3 Agricultural Combined Sensitivity Map (Environmental Screening Tool)

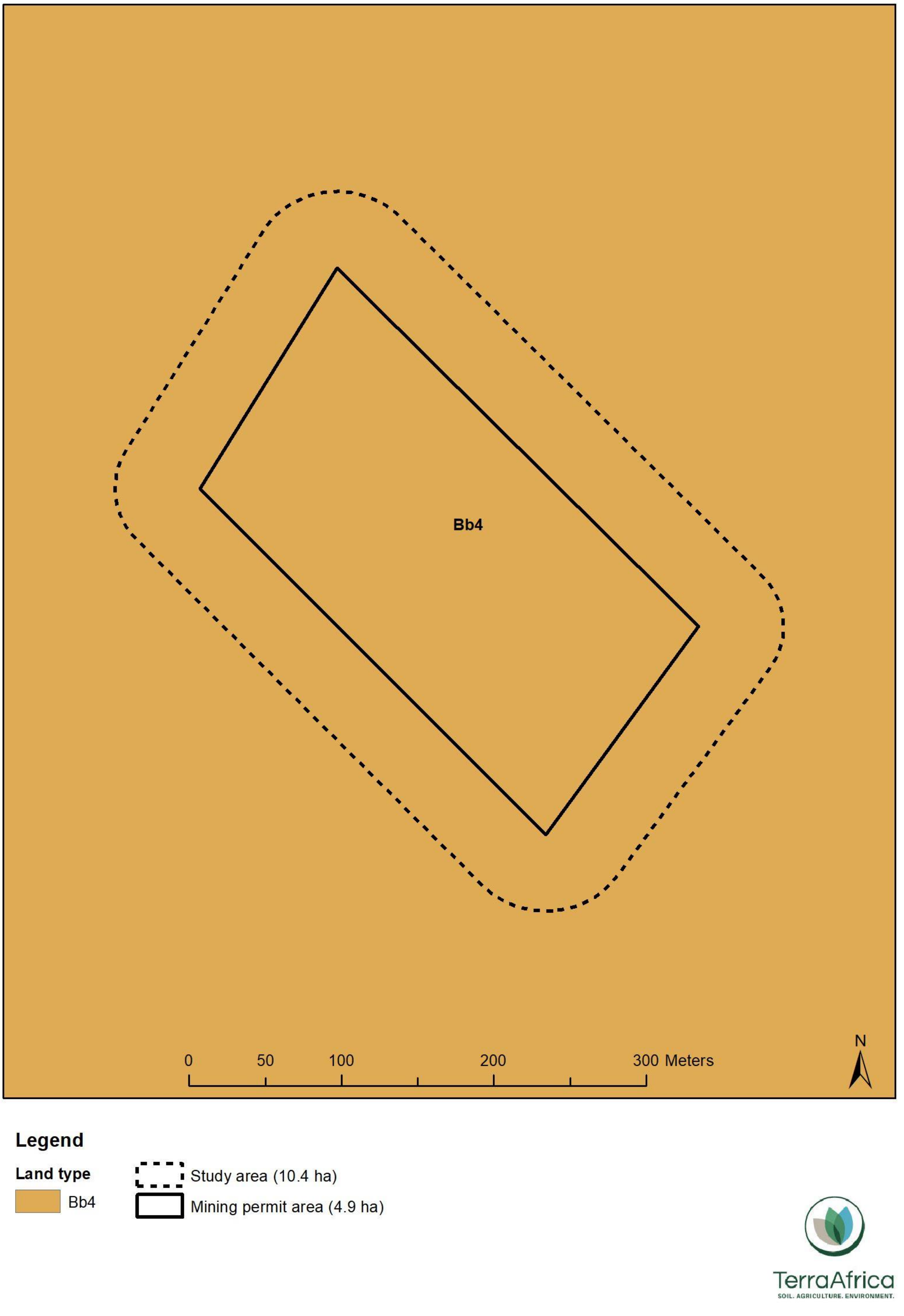

Figure 4 Land type map of the Vlaklaagte study area and surrounding area

9. Baseline conditions

9.1 Land types

The entire mining permit area as well as the surrounding area consist of one land type i.e. Land Type Bb4. The crest and upper mid-slope positions (Terrain unit 1) covers approximately 30% of the total area that consist of Land Type Bb4. The slope of this position ranges between 0 and 5%. The dominant soil forms that may be found in these positions are Avalon, Glencoe, Westleigh, Longlands, Rensburg and Hutton forms. The mid-slope areas (Terrain unit 3) consist of a similar mixture of soil forms and the estimated slope of these areas are 3 to 8%.

The toe-slopes (Terrain unit 4) and valley bottom positions (Terrain unit 5) consist of soil of the Rensburg, Katspruit, Kroonstad, Arcadia and Swartland forms. The toe-slopes and valley bottoms are almost flat, with slope ranging between 0 to 3% and 0 to 1%, respectively. The different terrain forms of Land Type Bb4 are illustrated in Figure 5 and the complete land type data sheet is attached as Appendix 1.

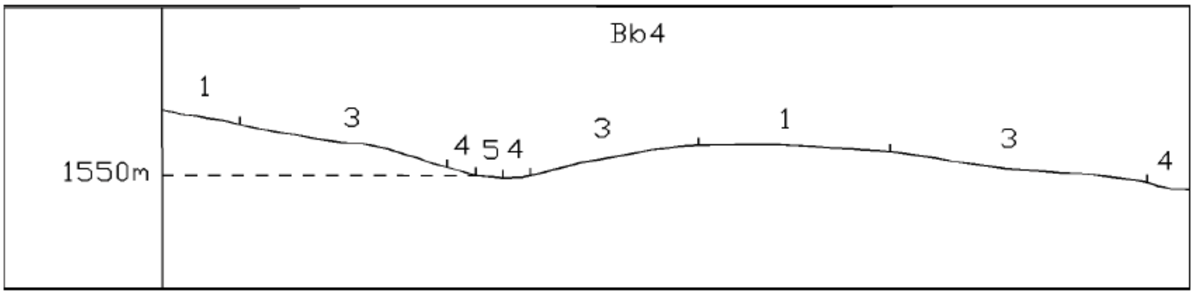

Figure 5 Depiction of the terrain units of Land Type Bb4

9.2 Soil forms

Four different soil forms are present within the study area. The positions of these soil forms in the landscape are depicted in Figure 6. Approximately 5.3 ha of the study area consists of the Dresden form. The Dresden form has shallow effective soil depth (between 0.35 and 0.4m) and is underlain by hard plinthite. No significant mottling or other signs of wetness were detected in the orthic horizon above the plinthic material.

The Wasbank soil form (0.7ha of the study area) is present in a slight depression south of the Dresden form. This soil form consists of a bleached, sandy albic horizon that is limited in depth by hard plinthite. Signs of mottling were already present at soil depths of 0.25m and mottling increase with depth of the profile. The albic horizon was moist and there was an increase in wetness with soil depth.

Other soil forms within the study area are the Pinedene form (3.2ha) and the Glencoe form (1.2ha). Both these soil forms consist of orthic topsoil horizons overlying yellow-brown apedal subsoil horizons. The Pinedene form is underlain by gleyic material at around 1.3m deep while the Glencoe form is underlain by hard plinthite.

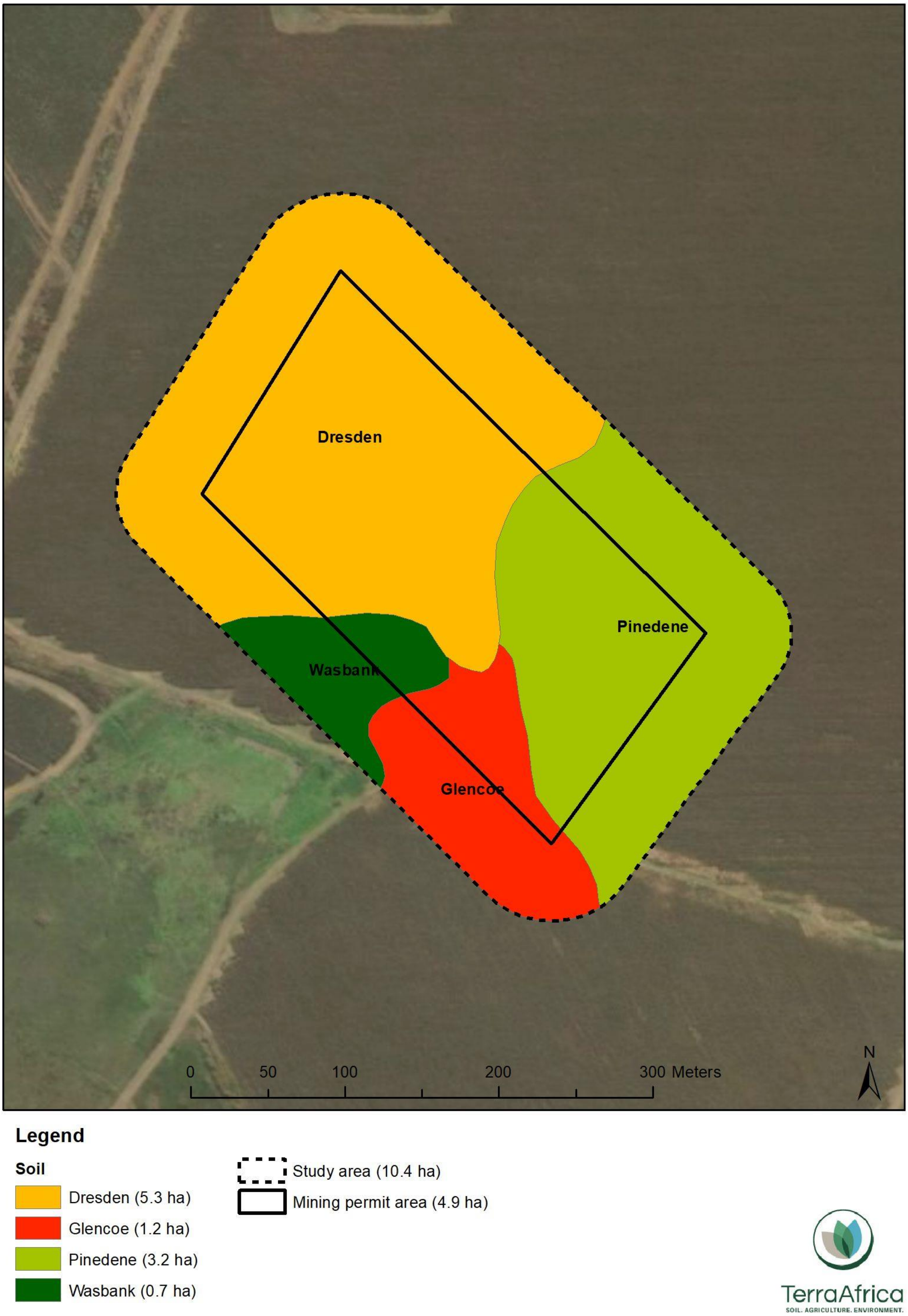

Figure 6 Soil map of the Vlaklaagte mining permit study area

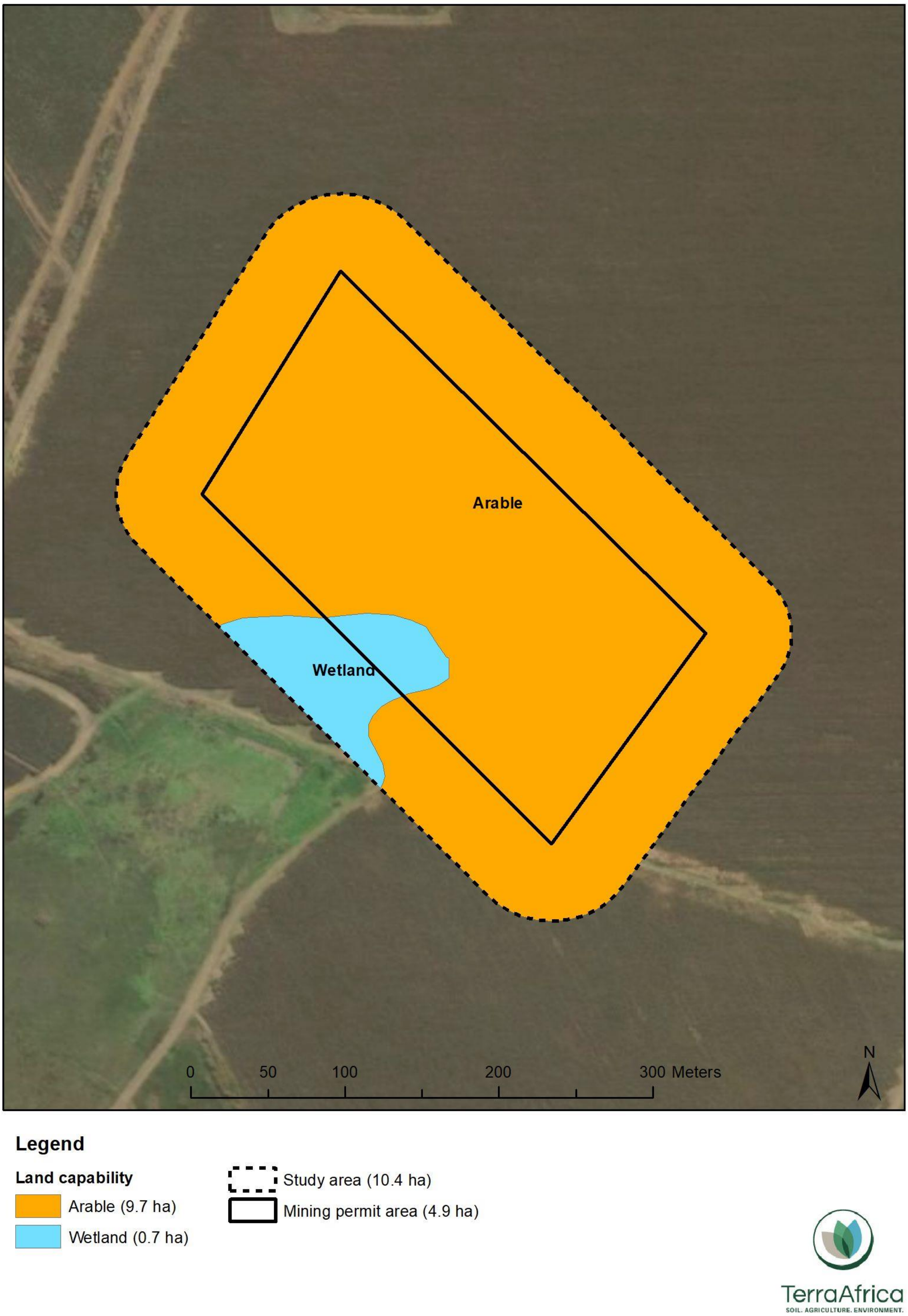

Figure 7: Land capability classes of the Vlaklaagte study area and surrounding area (Chamber of Mines classification system)

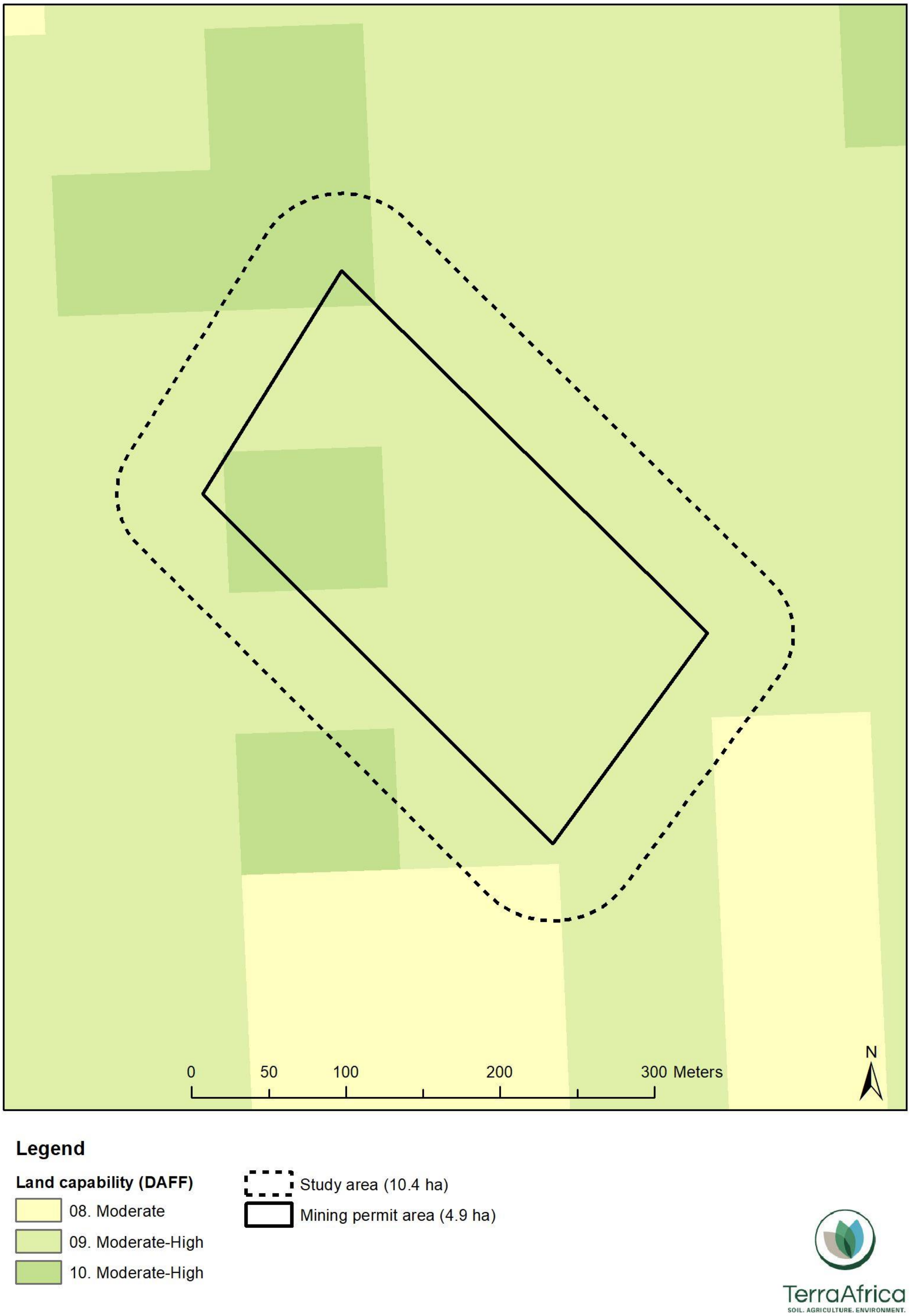

Figure 8 Land capability classes of the Vlaklaagte study area and surrounding area according to the DAFF land capability raster data (DAFF, 2017)

9.3 Soil chemical composition

The soil pH(KCl) values range between a strongly acidic value of 4.31 for sample Sample 4 to a slightly acidic value of 6.04 for Sample 1. 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.

The calcium levels range between 133.3 to 374.9 mg/kg and is considered sufficient to slightly deficient for crop production. The magnesium levels range between 22.3 and 70.6 mg/kg and the potassium values between 20.0 and 69.8 mg/kg. Both the magnesium and potassium levels may be slightly deficient for crop production. However, all of these elements can be supplemented through fertilizer application.

The plant-available phosphorus levels are low in all samples analysed, ranging between 4.0 mg/kg and 24.1 mg/kg P. For the purpose of crop production, phosphorus levels can be amended through pH correction and addition of phosphate fertilizers. 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). Sodium concentrations in all the soil samples are low to very low, ranging between 0.5 and 3.9 mg/kg. The organic carbon content of the soils range between 0.10 and 0.76%.

9.4 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

Table 2 below.

Soil texture within the proposed development area fall within one of two soil textural classes i.e. Sand or Sandy Loam. While the orthic topsoil horizons of the Dresden, Wasbank and Glencoe forms are sandy, there is clay particle accumulation in the yellow-brown apedal subsoil of the Pinedene soil.

Table 2 Soil texture analysis results

Sample	> 2mm	Sand	Silt	Clay	Texture class
no.	(%)	(% < 2mm)			

1	0,2	93,5	1,2	5,3	Sand
2	0,2	93,3	1,3	5,5	Sand
3	9,4	92,7	1,4	5,9	Sand
4	36,9	82,2	5,6	12,2	Sandy Loam

9.5 Land capabilities

The land capability of an area is the combination of the inherent soil properties and the climatic conditions as well as other landscape properties such as slope and drainage patterns that may inhibit agricultural land use or result in the development of specific land functionality such as wetlands. Land capability affects the socio-economic aspects of human settlements and determine the livelihood possibilities of an area. Baseline land capabilities are also used as a benchmark for rehabilitation of land in the case of project decommissioning.

Following the classification system of the South African Chamber of Mines, the area can be divided into two main land capability classes. The largest portion of the study area consist of land with arable land capability and is suitable for both rain-fed and irrigated crop production. This land capability class includes the Dresden, Glencoe and Pinedene forms. In drier parts of the country, the Dresden form would have been more suitable for grazing.

The second land capability class is land with wetland land capability (0.7 ha of the study area) and consist of the Wasbank form. This area is currently under cultivation of grain crops. However, hydric indicators are clearly visible within the first 0.5m from the surface.

The analysis of the DAFF land capability raster data shows good correlation with the Chamber of Mines classification. According to this data (Figure 8), the study area largely consist of land with Moderate-High (Classes 09 and 10) land capability. A few smaller pockets have Moderate (Class 08) land capability.

10. Sensitivity analysis

Following the analysis of the baseline properties of the project site, it can be classified as having high sensitivity to the proposed project from the perspective of soil, land capability, land use and agricultural potential (Figure **9**). Both the areas with wetland and arable land capability is considered highly sensitive to the activities of opencast coal mining and it is unlikely that the original functionality of the land will be returned.

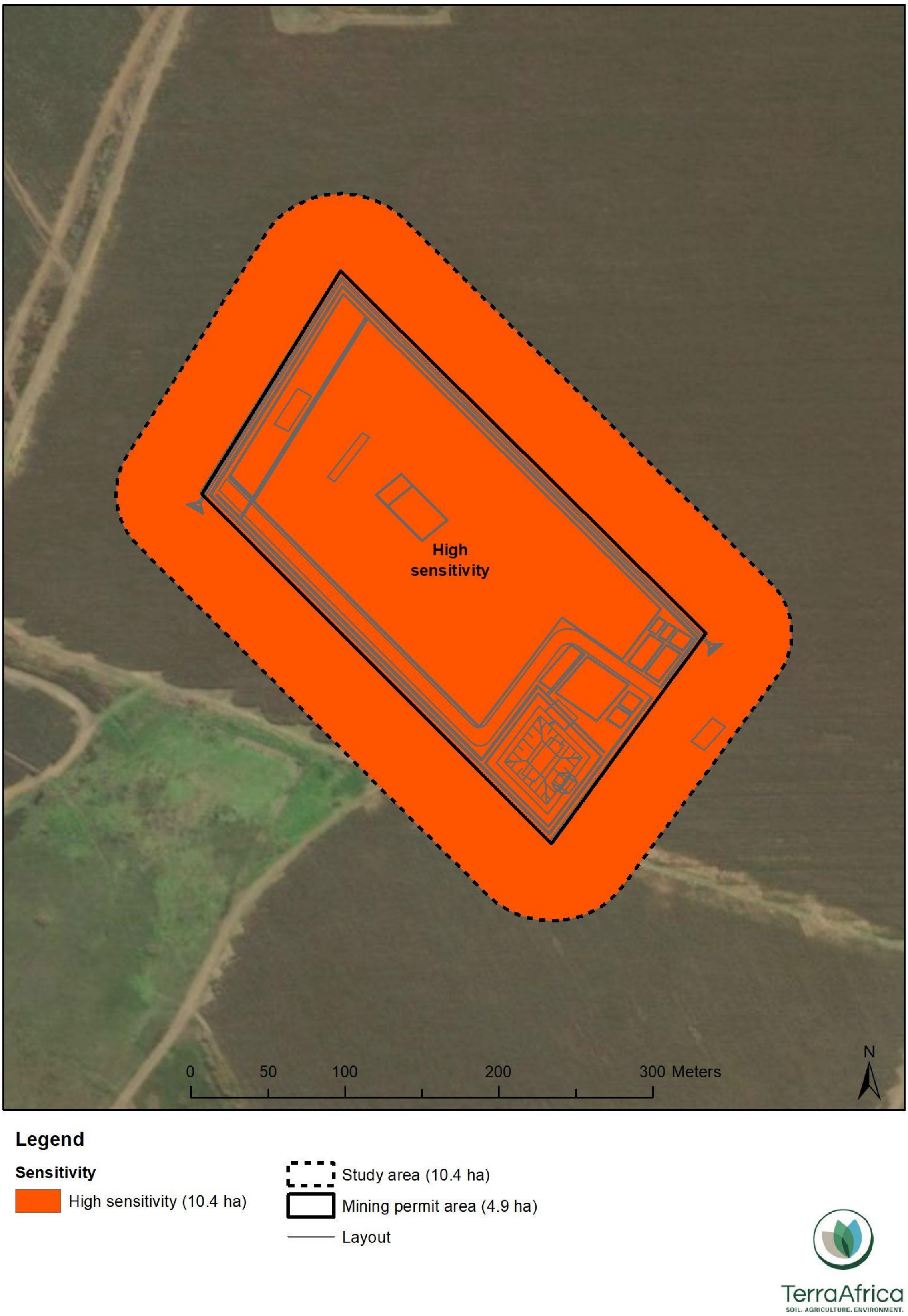

Figure 9 Sensitivity of the Vlaklaagte study area to the proposed infrastructure construction and operations

11. Impact Assessment

11.1 Project description

The proposed coal mining activities associated with the Vlaklaagte Mining permit application, will include the following activities and infrastructure:

- Box cut opencast mining with a roll over rehabilitation sequence;
- Hauling, access road, haul road,
- Mobile offices;
- Mobile sanitation and change house;
- Mobile fuel storage;
- Pollution control facility/dam(s);
- Clean and dirty water separation system;
- Topsoil, subsoil, overburden, stockpiles;
- Weighbridge;

The main activities associated with the project includes the following:

- Vegetation clearance in areas to be impacted upon as well as a buffer zone around it where trucks and equipment will move
- Stripping of the topsoil and overburden layers in order to access the coal resource
- Deposition of topsoil along a berm that will cover the soil surface underneath

The impacts caused by the activities will be discussed below and the rating of the impacts presented as a summarised table.

11.2 Impact assessment methodology

Table **3** presents a summary of the scoring system that was used to rate the impacts of the project and their significance on the soil and agricultural properties of the Vlaklaagte Mining Permit area.

Table 3 Summary of impact assessment score parameters

Intensity (Magnitude)		**ASSIGNED QUANTITATIVE SCORE**
The intensity of the impact is considered by examining whether the impact is destructive or benign, whether it has a significant, moderate or insignificant		
(L)OW	The impact alters the affected environment in such a way that the natural processes or functions are not affected.	**1**
(M)EDIUM	The affected environment is altered, but functions and processes continue, albeit in a modified way.	**3**
(H)IGH	Function or process of the affected environment is disturbed to the extent where it temporarily or permanently ceases.	**5**

Duration		
The lifetime of the impact, that is measure in relation to the lifetime of the proposed development.		
(S)HORT TERM	The impact will either disappear with mitigation or will be mitigated through a natural process in a period shorter than that of the construction phase.	**1**
(SM) SHORT - MEDIUM TERM	The impact will be relevant through to the end of a construction phase.	**2**
(M)MEDIUM	The impact will last up to the end of the development phases, where after it will be entirely negated.	**3**
(L)ONG TERM	The impact will continue or last for the entire operational lifetime (i.e. exceed 20years) of the development, but will be mitigated by direct human action or by natural processes thereafter.	**4**
(P)ERMANENT	This is the only class of impact, which will be non-transitory. Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact is transient.	**5**
Spatial Scale/Extent		
Classification of the physical and spatial aspect of the impact		
(F)OOTPRINT	The impacted area extends only as far as the activity, such as footprint occurring within the total site area.	**1**
(S)ITE	The impact could affect the whole, or a significant portion of the site.	**2**
(R)EGIONAL	The impact could affect the area including the neighbouring Farms, the transport routes and the adjoining towns.	**3**
(N)ATIONAL	The impact could have an effect that expands throughout the country (South Africa).	**4**
(I)NTERNATIONAL	Where the impact has international ramifications that extend beyond the boundaries of South Africa.	**5**
Probability		
This describes the likelihood of the impact actually occurring. The impact may occur for any length of time during the life cycle of the activity. The classes are rated as follows:		
(I)MPROBABLE	The possibility of the Impact occurring is none, due to the circumstances or design. The chance of this Impact occurring is zero (0%)	**1**
(P)OSSIBLE	The possibility of the Impact occurring is very low, due either to the circumstances or design. The chance of this Impact occurring is defined as 25% or less	**2**
(L)IKELY	There is a possibility that the impact will occur to the extent that provisions must therefore be made. The chances of Impact occurring is defined as 50%	**3**
(H)IGHLY LIKELY	It is most likely that the Impacts will occur at some stage of the development. Plans must be drawn up before carrying out the activity. The chances of this impact occurring is defined as 75 %.	**4**
(D)EFINITE	The impact will take place regardless of any prevention plans, and only mitigation actions or contingency plans to contain the effect can be relied on. The chance of this impact occurring is defined as 100 %.	**5**
Weighting Factor		
Subjective score assigned by Impact Assessor to give the relative importance of a particular environmental component based on project knowledge and previous experience. Simply, such a weighting factor is indicative of the importance of the impact in terms of the potential effect that it could have on the surrounding environment. Therefore, the aspects considered to have a relatively high value will score a relatively higher weighting than that which is of lower importance		
(L)OW		**1**
LOW- MEDIUM		**2**
MEDIUM (M)		**3**

MEDIUM-HIGH		4
HIGH (H)		5
Mitigation Measures and Mitigation Efficiency		
Determination of significance refers to the foreseeable significance of the impact after the successful implementation of the necessary mitigation measures		
Mitigation measures were recommended to enhance benefits and minimise negative impacts and address the following: Mitigation objectives: what level of mitigation must be aimed at: For each identified impact, the specialist must provide mitigation objectives (tolerance limits) which would result in measurable reduction in impact. Where limited knowledge or expertise exists on such tolerance limits, the specialist must make "educated guesses" based on professional experience; Recommended mitigation measures: For each impact the specialist must recommend practicable mitigation actions that can measurably affect the significance rating. The specialist must also identify management actions, which could enhance the condition of the environment. Where no mitigation is considered feasible, this must be stated and reasons provided; Effectiveness of mitigation measures: The specialist must provide quantifiable standards (performance criteria) for reviewing or tracking the effectiveness of the proposed mitigation actions, where possible; and Recommended monitoring and evaluation programme: The specialist is required to recommend an appropriate monitoring and review programme, which can track the efficacy of the mitigation objectives. Each environmental impact is to be assessed before and after mitigation measures have been implemented. The management objectives, design standards, etc., which, if achieved, can eliminate, minimise or enhance potential impacts or benefits. National standards or criteria are examples, which can be stated as mitigation objectives.		
LOW	The impact will be mitigated to the point where it is of limited importance	**0,20**
LOW - MEDIUM	The impact is of importance, however, through the implementation of the correct mitigation measures such potential impacts can be reduced to acceptable levels	**0,40**
MEDIUM	Notwithstanding the successful implementation of the mitigation measures, to reduce the negative impacts to acceptable levels, the negative impact will remain of significance. However, taken within the overall context of the project, the persistent impact does not constitute a fatal flaw	**0,60**
MEDIUM - HIGH	The impact is of major importance but through the implementation of the correct mitigation measures, the negative impacts will be reduced to acceptable levels	**0,80**
HIGH	The impact is of major importance. Mitigation of the impact is not possible on a cost-effective basis. The impact is regarded as high importance and taken within the overall context of the project, is regarded as a fatal flaw. An impact regarded as high significance, after mitigation could render the entire development option or entire project proposal unacceptable.	**1,00**

Extent	Duration	Intensity	Probability	Weighting Factor (WF)	Significance Rating (SR)	Mitigation Efficiency (ME)	Significance Following Mitigation (SFM)
Footprint 1	Short term 1	Low 1	Probable 1	Low 1	Low 0-19	High 0,2	Low 0-19
Site 2	Short to medium 2		Possible 2	Low to medium 2	Low to medium 20-39	Medium to high 0,4	Low to medium 20-39
Regional 3	Medium term 3	Medium 3	Likely 3	Medium 3	Medium 40-59	Medium 0,6	Medium 40-59
National 4	Long term 4		Highly Likely 4	Medium to high 4	Medium to high 60-79	Low to medium 0,8	Medium to high 60-79
International 5	Permanent 5	High 5	Definite 5	High 5	High 80-100	Low 1,0	High 80-100

11.2 Discussion of impacts, mitigation measures and best practice guidelines

11.2.1 Soil compaction

Soil compaction will take place due to unnatural load and increased traffic by construction vehicles in the area that will change soil structure. Soil compaction generally reduces the amount of water that plants can take up. This is because compaction crushes many of the macropores and large micropores into smaller pores, and the bulk density increases. As the soil particles are forced closer together, soil strength increases and limits root penetration. Compaction also results in aggravation of run-off erosion as compaction reduces the water infiltration rate.

Soil compaction will be an impact during all the entire construction phase, operational phase and decommissioning phase. While it may still be present at the closure phase, mitigation and management measures should aim to alleviate the compaction before roll-over rehabilitation commences.

The effect of this will largely be within the site boundary and is highly likely to occur frequently due to the constant movement of vehicles as well as the weight of the topsoil berm overlying the in situ soil profiles underneath.

The main mitigation measure for minimising the negative impact of compaction is to limit the areas affected by construction activities. Limiting heavy vehicle access to haul roads and construction areas only is especially important. Deep ripping is recommended to alleviate compaction before revegetation, especially if there is an attempt to restore the agricultural potential of the land.

<u>Best practice measures:</u>

- Where possible, rather use tracked vehicles than vehicles with wheels due to their lower point loading and slip.
- Vehicle speed should be maintained in order to reduce the duration of applied pressure, thereby minimizing compaction.
- During construction, construction vehicles should preferably be parked in areas already affected by compaction. If temporary parking areas are created, it should be for a very short period (one to two weeks) before being moved to another area.

11.2.2 Destruction of soil nutrient cycles

Earthworks will include clearing of vegetation from the surface, stripping topsoil (soil excavation) and stockpiling in order to access the coal resource. The removal of vegetation from the surface and the stripping of topsoil in areas where necessary, negatively affects the nutrient cycles of topsoil horizon and results in loss of soil fertility. Disruption of soil nutrient cycles are considered reversible when the activities causing the impact is short-term (less than six months). However, in the case of the new open pit void, it may take longer than six months before roll-over rehabilitation of an area can commence. The impact is localised to the surface footprint (19,3 ha) where topsoil will be removed as well as the 3 ha of soil underneath the berm that will be sterilised by the layer of soil above it.

Best practice measures:

- The topsoil berm conserved for land rehabilitation practices should be vegetated with indigenous plants or seeds as found in the surrounding area as quickly as possible in order to maintain soil nutrient cycles in the stored soil.
- Ensure all topsoil stockpiles are clearly and permanently demarcated and located in defined no-go areas. As the mining will last over several months (or years) it is important to have well defined maps of stockpile locations that correlate with these demarcated areas as re-vegetated stockpiles may easily be mistaken for something else.
- Topsoil should never be used for other purposes such as filling material for roads, ramps etc.

11.2.3 Soil chemical pollution

The use of vehicles that can result in oil and fuel spills on site as well as waste generation by mine workers can result in possible chemical soil pollution. In addition to this, dust suppression can result in soil pollution, especially when the water used contains additives to aid the dust suppression or the water used is of marginal quality.

Best practice measures:

- Losses of fuel and lubricants from oil sumps and steering racks of vehicles and equipment used during construction should be contained using a drip tray filled with absorbent material.
- Vehicles and equipment should be parked in demarcated areas where vehicles can regularly be checked for oil leaks during the construction activities.
- Waste disposal at the construction sites should be avoided wherever possible by segregating, trucking out, and recycling waste;

11.2.4 Soil erosion

Soil erosion is anticipated as a result of vegetation clearance that will leave the soil surface exposed. Topsoil stockpiles are also susceptible to erosion, especially when not covered by any vegetation. Soil erosion results in the loss of the nutrient-rich upper layers of the soil. Soil erosion can only be prevented for once it has occurred, it is a permanent impact as soil particles transported away from the landscape by wind and water energy, cannot be recovered. Although there are off-site indirect impacts associated with soil erosion, the impact is mainly considered to be local.

Best practice measures:

- Stripping of vegetation should be conducted just prior to mining activities and not earlier than required
- Using drainage control measures and culverts to manage the natural flow of surface runoff around the topsoil berm.
- Soil stockpile surfaces must be vegetated as quickly as possible after the stockpiling was done.
- Should vegetation establishment on stockpiles be too slow to prevent soil erosion, geotextiles should be used to stabilise the surfaces and prevent soil erosion.

11.2.4 Loss of land capability

Once vegetation clearance and stripping of topsoil commences, the in situ soil profiles are disturbed and the inherent soil fertility associated with the original horizon organisation is lost. While several research and rehabilitation projects have aimed to re-establish the arable potential of the land, it has not been proven yet that the rainfed agricultural potential of the land can be restored. Roll-over rehabilitation should still aim though to get the land as productive as possible. Similarly, the functioning of the hydric soils present along the southwestern boundary (where the Wasbank soil form is located), will be lost once soil in this area is stripped and stockpiled. This will result in the loss of the wetland land capability of the area.

Table 4 Summary of impacts of the proposed Vlaklaagte coal mining permit (assessed before and after mitigation)

Activity	Aspect	Impact	Phase	Extent	Severity	Durations	Probability	Weighting Factor	+/-	Significance without mitigation		+/-	Mitigation efficiency	Significance with mitigation	
Surface clearing and preparation	Removal of vegetation	Soil erosion from exposed soil surfaces	Construction	2	5	5	4	5	Negative	80	High	Negative	0,8	64	Med-High
Surface clearing and preparation	Removal of topsoil and subsoil horizons above the overburden and coal seam	Removal of both topsoil and subsoil horizons increase the risk of groundwater pollution	Construction	3	5	4	4	5	Negative	80	High	Negative	0,6	48	Med
Hydrocarbon spills	Vehicles and equipment moving over the soil surface	Pollution of soil with hydrocarbons	Construction	3	5	4	3	5	Negative	75	Med-High	Negative	0,4	30	Low-Med
Surface clearing and preparation	Removal of topsoil and subsoil horizons above the overburden and coal seam	Loss of pre-mining land capabilities	Construction	2	5	5	5	5	Negative	85	High	Negative	1	85	High
Roll over mining	Earth moving and transport of ROM continues	Soil surfaces are increasingly compacted by vehicle and equipment movement	Operation	2	3	5	5	4	Negative	60	Med-High	Negative	0,8	48	Med

Roll over mining	Storage of stripped soil horizons in stockpiles	Soil erosion on soil stockpiles	Operation	2	5	5	4	5	Negative	80	High	Negative	0,6	48	Med
Pit dewatering and dust control	Contaminated water are released on soil surfaces	Soil contamination with a range of pollutants	Operation	2	3	4	4	4	Negative	52	Med	Negative	0,4	20,8	Low-Med
Heavy machinery and vehicle movement	Vehicles and equipment moving over the soil surface	Compaction of surfaces will increase surface water run-off	Rehabilitation	1	3	4	4	3	Negative	36	Low-Med	Negative	1	36	Low-Med
Resurfacing of areas with available topsoil	Covering rehabilitated areas with a layer of topsoil	Bare soil surfaces are at risk of soil erosion until vegetation cover has sufficiently established	Rehabilitation	2	5	4	4	3	Negative	45	Med	Negative	0,6	27	Low-Med

Table 5 Summary of mitigation and management measures for each of the impacts of the proposed Vlaklaagte coal mining permit

Impact	Phase	Mitigation measures	Action Plan	Mitigation and management objective	Mitigation and management Goals
Soil erosion from exposed soil surfaces	Construction	Keep vegetation removal limited to footprint and use geo-textiles and other erosion control structures to limit soil erosion	Regularly monitor areas where vegetation has been removed to detect early signs of soil erosion. In the case that soil erosion are detected, immediately implement preventative measures such as re-vegetation and/or make use of geotextiles to prevent any further erosion.	The area must have no to minimal signs of erosion that gullies that forms in areas where vegetation has been removed from the soil surface.	To minimise the areas where soil surfaces will be exposed to soil erosion
Removal of both topsoil and subsoil horizons increase the risk of groundwater pollution	Construction	Limit areas where soil horizons are removed to that which are essential for the construction of infrastructure	Implement a well-designed Stormwater Management Plan that will direct polluted water into Pollution Control Dams. Restict the removal of topsoil and subsoil to areas where it is essential for the construction of mine infrastructure	Regularly monitor the quality of groundwater in boreholes around the areas of impact.	To minimise the areas where soil surfaces will be exposed to soil erosion
Pollution of soil with hydrocarbons	Construction	Do regular checks on vehicles and equipment that are used during the construction phase to ensure that oil leakage and fuel spillage are minimised	Inspect vehicles and equipment on a weekly base during the construction phase. Any spills and leakages detected on site must be cleaned up immediately	The soil hydrocarbon levels must be monitored and remain below the values as indicated in the Framework for the Management of Contaminated Land	To avoid the contamination of soil resources on site and around the site with hydrocarbons
Loss of pre-mining land capabilities	Construction	Mitigation measures will not be able to return the original land capabilities	The destruction of the current land capabilities are immediate and no action plans will result in a reduction of this impact.	Not efficient	Not efficient
Soil surfaces are increasingly compacted by vehicle and equipment movement	Operation	Vehicle and equipment should only move around on haul roads and park in designated areas	Parking areas and haul roads must be clearly demarcated. Any vehicle and equipment movement outside of these areas must be prohibited.	To restrict areas of additional soil compaction during the operational phase	To prevent extensive soil compaction in Vlaklaagte mining permit areas

Soil erosion on soil stockpiles	Operation	The slope of the topsoils stockpiles must not be more than 15% in order to limit erosion from the stockpiles.	Regularly monitor areas where vegetation has been removed to detect early signs of soil erosion. In the case that soil erosion are detected, immediately implement preventative measures such as re-vegetation and/or make use of geotextiles to prevent any further erosion.	The area must have no to minimal signs of erosion that gullies that forms in areas where vegetation has been removed from the soil surface.	To minimise the areas where soil surfaces will be exposed to soil erosion
Soil contamination with a range of pollutants	Operation	Manage dirty and polluted water on site through storage and treatment with suitable infrastructure such as pollution control dams.	Conduct soil quality monitoring on a biannual base in all areas that are likely affected by contaminated water within the Vlaklaagte permit area.	The soil salinity and anionic salt levels (sulphates, nitrates and phosphates) must be monitored and remain below the values as indicated in the Framework for the Management of Contaminated Land	To avoid the contamination of soil resources on site and around the site with hydrocarbons
Compaction of surfaces will increase surface water run-off	Rehabilitation	Prepare the rehabilitated areas properly to promote quick vegetation re-establishment.	Monitor all areas where rehabilitation took place to determine where erosion gullies are present. In the case of measurable erosion, stabilise the areas with geo-textiles and vegetation immediately.	To prevent soil erosion from rehabilitated surfaces.	To prevent soil losses through erosion from the Vlaklaagte permit area

11.3 Cumulative impacts of the Vlaklaagte mining permit

The region within which the Vlaklaagte study area falls, have already experienced significant transformations from agriculture as the main land use, to coal mining and power generation that are dotted across the entire area. The Vlaklaagte mining project will result in the accumulation of the following impacts in the larger area:

- Increased risk of soil erosion
- Increased risk of soil compaction
- More areas where possible soil pollution can occur
- An additional area where soil nutrient cycles will be disturbed
- The increased destruction of the arable and wetland land capability in an area where rainfed crop production areas are increasingly reduced by coal mining activities.

12. Soil Management Plan

12.1 Overarching Strategy

This Soil Management Plan (SMP) aims to ensure a proactive approach to the effective management of anticipated project impacts. It prescribes procedures and protocols that is considered international best practice and that takes the Voluntary Soil Guidelines of the FAO (FAO, 2017) into consideration. It covers all phases of the operations from construction, operation, decommissioning to closure. Measures are presented that will eliminate, offset or reduce adverse environmental impacts, prevent excessive deterioration of the soil resource and sedimentation through erosion of sensitive receptors like waterways and wetlands within the operation's area of influence.

The purpose of the management plan is to set out a clear set of actions and responsibilities for the control of impacts affecting the soil, land use and land capability within the operations' Area of Influence (AoI). It is a living document that will be amended and updated as circumstances change and knowledge is gained.

The objectives of the management plan are to:

- Prevent adverse impacts from occurring or to keep impacts that do occur within acceptable levels.
- Identify the mitigation measures, actions and procedures to reduce the impacts of targeted parameters.
- Outline the requirements for an inclusive monitoring programme, specifying environmental indicators to monitor the effectiveness of the mitigation measures.
- Define the roles and responsibilities for implementing the management plan.

12.2 Design Control Measures

The design control measures stipulated below are to ensure the protection of soils:

12.2.1 Minimise mining infrastructure footprint

- Keep to the existing pre-construction project layout and design to minimise the area to be occupied by project infrastructure to be as small as practically possible.
- All footprint areas should be clearly defined and demarcated and edge effects beyond these areas should also be clearly defined. Access to areas outside of the demarcated areas should be treated as no-go areas

- Restrict the activities of construction workers and employees to the planned areas. Instructions must be included in contracts that will restrict construction work and construction workers to clearly defined limits of the construction site. Compliance to these conditions must be monitored.
- Photo records of preconstruction areas should be collected to use as a reference during the entire project cycle.

12.2.2 Stripping and stockpiling of topsoil

- Delineate areas to be stripped and place soil stockpiles outside of sensitive areas. Construction activities should remain within the delineated areas and not proceed outside of this.
- When stripping with excavators and dump trucks, the excavator should only operate on the topsoil layer and the dump trucks must only operate on the basal/non-soil layer and their wheels must not run on soil layers.
- Soil stripping operations should not start until the required soil moisture levels are reached. If significant rainfall occurs during operations the stripping must be suspended.
- The operation must follow a detailed stripping plan showing soil units to be stripped, haul routes and the phasing of vehicle movements.
- Wherever possible, stripping and replacing of soils should be done in a single action. This is both to reduce compaction and also to increase the viability of the seed bank contained in the stripped surface soil horizons.
- Locate all topsoil stockpiles in areas where they will not have to be relocated prior to replacement for final rehabilitation.
- To minimise compaction associated with stockpile creation, it is recommended that the height of stockpiles be restricted between 4 – 5 metres maximum. For extra stability and erosion protection, the stockpiles may be benched.
- Ensure all topsoil stockpiles are clearly and permanently demarcated and located in defined no-go areas. As the mining, will last over several years it is important to have well defined maps of stockpile locations that correlate with these demarcated areas as re-vegetated stockpiles may easily be mistaken for something else.
- These topsoil stockpiles should be maintained for rehabilitation purposes and topsoil should never be used as a filling material for roads, etc.
- Prevent the contamination of topsoil stockpiles by prohibiting dumping of waste next to or on the stockpiles, Contamination can also be caused by dust from product stockpiles, or dust suppression with contaminated water.

12.2.3 Management of terrain stability to minimise erosion potential

- Stripping of topsoil should not be conducted earlier than required (maintain vegetation cover for as long as possible) in order to prevent the erosion (water and wind) of organic matter, clay and silt.
- Reduce slope gradients as far as possible along road cuts and disturbed areas to gradients at or below the angle of repose of those disturbed surfaces,
- Use drainage control measures and culverts to manage the natural flow of surface runoff.
- Soil stockpiles must be sampled, ameliorated (if necessary) and re-vegetated as soon after construction as possible. This is to limit raindrop and wind energy, as well as to slow and trap runoff, and thereby reducing soil erosion.

12.2.4 Management of access and haulage roads

- Existing established roads should be used wherever possible to minimise footprint and soil compaction.
- Where possible, roads that will carry heavy-duty traffic should be designed in areas previously disturbed rather than clearing new areas.
- The moisture content of access road surface layers must be maintained through routine spraying or the use of an appropriate dust suppressant.
- Access roads should be designed with a camber to avoid ponding and to encourage drainage to side drains. Where necessary, culverts should be installed to permit free drainage of existing water courses.
- The side drains of the roads should be protected with sediment traps and/or gabions to reduce the erosive velocity of water during storm events.
- Geo-membrane lining can be used where necessary to prevent erosion.

12.2.5 Prevention of soil contamination

- Losses of fuel, lubricants and hydraulic fluids from vehicles and equipment should be contained using drip trays filled with absorbent material.
- Use biodegradable drilling fluids, use lined sumps for collection of drilling fluids, recover drilling muds and treat them off-site, and securely store dried waste mud by burying it in a purpose-built containment area.
- Avoid waste disposal at the site wherever possible by segregating, trucking out and recycling waste.
- Contain potentially contaminating fluids and other waste.
- Clean up areas of spillage of potentially contaminating liquids and solids.

12.2.6 Revegetation / rehabilitation

- Develop a rehabilitation and revegetation plan that includes the management of soil. Apply this plan to all revegetation and rehabilitation activities throughout the project lifecycle.
- Revegetate earthworks and exposed areas/soil stockpiles, with non-invasive vegetation, to stabilise surfaces as soon as practicable.
- Collect photo records of soil rehabilitation measures
- Cover berms and soil stockpiles effectively with non-invasive vegetation or clad with hessian, mulches or tackifiers where it is not possible to re-vegetate as soon as possible.
- Minimise the height of topsoil stockpiles to 5m wherever possible.
- Cover and seed completed long-term stockpiles as soon as is practicable in order to stabilise surfaces.

12.3 Monitoring

Monitoring of the soil management plan should include the monitoring of relevant mitigation measures. The objectives of the monitoring of soil resource management is to:

- Assess compliance with mitigation and control measures within the main impact zone of the operations.
- Facilitate the measurement of progress against environmental targets within the main impact zone of the operations.
- Track progress of pollution control measure implementation within the main impact zone of the operations.
- Inform the management, regulator and I&APs, as required, of the extent of different impacts on soil resources occurring in the vicinity of the operations.

The environmental targets should be reviewed annually or when triggered by changes in soil quality regulations.

i. Monitoring Locations

Monitoring should be done everywhere within the impact zone of the construction and operational activities of the Vlaklaagte project with special attention to the following areas:

- Where active earthworks are taking place
- Topsoil stockpiles.

- Along established and new access roads to monitor compaction, pollution and erosion.
- At areas with high possibility of pollution like storage areas and parking areas and around temporary fuel depots
- At the edges of development footprints
- Where land rehabilitation was done

ii. Monitoring Methodologies

a) Weather

Since soil moisture levels are critical during soil stripping operations to minimise compaction, the stripping must be suspended if significant rainfall occurs. It is therefore important to monitor the amount and intensity of precipitation. Prior to work commencing a weather forecast should be considered for potential rainfall interruptions.

b) Observations

Monitoring of the following activities should be done to ensure that best management practices are followed:

- Adhere topsoil stripping guidelines and have qualified supervision. This practice should be monitored daily.
- Minimise soil erosion through stockpile maintenance and rehabilitate finished areas following construction. Manage the physical, chemical and biological properties of stockpiled soils. Rehabilitate finished areas following construction. These practices should be monitored weekly by the ECO.
- During the construction and decommissioning phases contractors and employees must be monitored to stay within predetermined boundaries. This practice should be monitored daily by the ECO.
- Prevent soil contamination from spills of hazardous materials. (Daily monitoring). Ensure pollution sources are isolated through clean and dirty water separation. (Weekly monitoring).

iii. Monitoring records

All monitoring records required under this management plan must be kept on file either by management of the construction site or the SHEQ Department for a period of not less than five years following measurement and copies of these be made available to the funding institutions of the project.

iv. Response to short term episodes and cumulative impacts

The procedures to manage short term episodic events are:

- Significant rainfall:
    - Stripping of topsoil must be suspended and
    - where the soil profile has been disturbed it should be removed to base level.
- Accidental spill of hazardous material:
    - Contaminated soil should be placed in a sealed container and treated off-site;
    - and the cause of the spill should be remedied.
- Erosion of disturbed soils:
    - Cover bare soil with geotextiles until revegetation has stabilised the soil.

v. Analytical Parameters

It is recommended an annual soil monitoring be conducted for at least the first five years of the project lifecycle. The prescribed analytical parameters for soils below will ensure measurement and quantification of the following potential irregularities:

- Acidification (low pH) – increase solubility and mobility of heavy metals
- Alkalinisation (high pH) – hydrolysis of sodium.
- Sodification (if sodium in the soil solution exceeds 15% of the total cation exchange capacity it causes dispersion anomalies which increase the erodibility of the soil)
- Salinisation (if soil electrical conductivity (EC) is higher than 450 mSm^{-1} it has a detrimental effect on plant growth)
- Eutrophication (excess nitrates and phosphorous in the soil solution)
- Toxicity (maximum concentrations of elements for environmental receptors.
- Erosion (gully formation and loss of sediment due to lack of erosion control measures and chemical pollution causing dispersion)
- Compaction (increase in bulk density >1.750 kg/m^3)

vi. Inspections and Reporting

Visual inspections must be undertaken at fixed intervals by an ECO, trained and appointed by the site manager. Daily and weekly visual inspections will be carried out as part of the area monitoring of activities. As part of the visual inspection of the soil the nominated person will:

- Record all inspections of the routes around the site, the site entrance and the haul routes used on the site and any subsequent action on an observation sheet.

- Increase the frequency of site inspections when activities with a high potential to produce compaction, chemical pollution or erosion are being carried out, such as during construction, earthworks activities or during prolonged windy conditions or rain storms.

- The soil chemical monitoring report should include measurements of the following elements and parameters:

    - pH(H_2O) and pH(KCl)

    - Cation exchange capacity (CEC) and exchangeable cations (K, Ca, Mg, Na)

- Phosphorus (Bray 1)
- Electrical conductivity (EC) and sulphate, nitrate and boron
- Heavy metals (use different reagents for the determination of the different fractions).
- Lime requirement of soil

12.4 Soil management during the decommissioning phase

At decommissioning any excavated areas will be backfilled and covered with a layer of topsoil. Some re-grading and re-contouring will be carried out. Soil management in the decommissioning phase will include the following:

12.4.1 Management and supervision of decommissioning teams

The activities of decommissioning contractors or employees will be restricted to the planned areas. Instructions must be included in contracts that will restrict decommissioning workers to the areas demarcated for decommissioning. In addition, compliance to these instructions must be monitored.

12.4.2 Infrastructure removal

All buildings, structures and foundations not part of the post-closure land use plan must be demolished and removed from site.

12.4.3 Site preparation

Once the site has been cleared of infrastructure and potential contamination, the slope must be re-graded (sloped) in order to approximate the pre-project aspect and contours. The previous infrastructure footprint area must be ripped a number of times in order to reduce soil compaction. The area must then be covered with topsoil material from the stockpiles.

12.4.4 Seeding and re-vegetation

Once the land has been prepared, seeding and re-vegetation will contribute to establishing a vegetative cover on disturbed soil as a means to control erosion and to restore disturbed areas to beneficial uses as quickly as possible. The vegetative cover reduces erosion potential, slows down runoff velocities, physically binds soil with roots and reduces water loss through evapotranspiration. Indigenous species will be used for the re-vegetation, the exact species will be chosen based on research available and then experience as the further areas are re-vegetated.

12.4.5 Prevention of soil contamination

During the decommissioning phase, chemical soil pollution should be minimised as follows: Losses of fuel and lubricants from the oil sumps of vehicles and equipment should be contained using a drip tray with plastic sheeting and filled with absorbent material;

- Using biodegradable hydraulic fluids, using lined sumps for collection of hydraulic fluids and recovering contaminated soils and treating them off-site;
- Avoiding waste disposal at the site wherever possible, by segregating, trucking out, and recycling waste;
- Containing potentially contaminating fluids and other wastes; and
- Cleaning up areas of spillage of potentially contaminating liquids and solids.

12.5 Soil management during the closure phase

During the closure phase activities include the maintenance and aftercare of final rehabilitated land. In this regard, frequent visual observations should be undertaken to confirm if vegetation has re-established and if any erosion gullies have developed. In the event that vegetation has not re-established and erosion gullies have developed, remedial action should be taken.

13 Consideration of alternatives

No layout alternatives were provided for consideration.

14 Acceptability statement

The proposed Vlaklaagte Colliery will impact on soil with moderate-high to high moderate arable agricultural potential. The impacts associated with the project includes soil erosion, soil compaction, soil chemical pollution, destruction of soil nutrient cycles and the loss of the arable and wetland land capability. Since the impacts are mainly localised, the implementation of strict soil management measures are important to limit the extent of the damage.

It is therefore my professional opinion that the project will cause significant damage to the existing food production activities in the fields and is not desirable from the perspective of conservation of agricultural resources and soil with hydromorphic properties that contribute to water flow of the wetlands in the larger area around the site.

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Appendix 1 – Land Type Data Sheet of Land Type Bb4

LAND TYPE / *LANDTIPE*...................... : Bb4

CLIMATE ZONE / *KLIMAATSONE* .... : 24S

Area / *Oppervlakte* .... : 234720 ha

Estimated area unavailable for agriculture

Beraamde oppervlakte onbeskikbaar vir landbou : 15000 ha

Occurrence (maps) and areas / *Voorkoms (kaarte) en oppervlakte :*

2528 Pretoria (11990 ha) 2628 East Rand (222730 ha)

Inventory by / *Inventaris deur :*

J L Schoeman

Modal Profiles / *Modale profiele :*

P128 P129 P131 P157

Terrain unit / *Terreineenheid* .... :	1	3	4	5
% of land type /*% van landtipe* .... :	30	60	5	5
Area / *Oppervlakte (ha)* .... :	70416	140832	11736	11736
Slope / *Helling (%)* .... :	0 - 5	3 - 8	0 - 3	0 - 1
Slope length / *Hellingslengte (m)* .... :	500 - 1000	500 - 1500	100 - 200	50 - 500
Slope shape / *Hellingsvorm* .... :	Y	Y-X	X	X
MB0, MB1 (ha) .... :	49291	126749	11736	11736
MB2 - MB4 (ha) .... :	21125	14083	0	0

Soil series or land classes *Grondseries of landklasse*	**Depth** ***Diepte*** **(mm)**	**MB**	**ha**	**%**	**ha**	**%**	**ha**	**%**	**ha**	**%**	**Total** ***Totaal*** **ha**	**%**	**Clay content %** ***Klei-inhoud %*** **A**	**E**	**B21**	**Hor**	**Texture** ***Tekstuur*** **Class / *Klas***	**Depth limiting material** ***Diepte-beperkende materiaal***
Avalon Av26, Ruston Av16	800-1200	0	14083	20	56333	40					70416	30.0	15-20		15-35	B	fi/meSaLm-SaClLm	sp
Msinga Hu26, Hutton Hu16	900-1200+	0	10562	15	14083	10					24646	10.5	15-25		15-35	B	fi/meSaLm-SaClLm	so,hp
Bergville Av27, Bezuidenhout Av37	700-1000	0	7042	10	14083	10					21125	9.0	25-30		35-45	B	fi/meSaCl	sp
Glencoe Gc26, Appam Gc16	700-1000	0	7042	10	14083	10					21125	9.0	15-20		15-25	B	fi/meSaLm-SaClLm	hp
Klipfontein Ms11	200-400	3	7042	10	7042	5					14083	6.0	10-20			A	Lmfi/meSa-SaLm	hp
Sibasa We13	300-500	0	3521	5	7042	5	587	5			11149	4.8	15-25		35-45	A	fi/meSaLm-SaClLm	sp
Trevanian Gs17, Williamson Gs16	300-500	1	3521	5	7042	5					10562	4.5	10-25			A	Lmfi/meSa-SaClLm	lc
Mispah Ms10	200-400	3	3521	5	7042	5					10562	4.5	10-25			A	Lmfi/meSa-SaLm	R
Klipstapel Gc13, Strathrae Gc23, Dunbar Gc24	700-1000	0	3521	5	7042	5					10562	4.5	10-15		10-15	B	Lmfi/meSa-SaLm	hp
Longlands Lo21, Waaisand Lo11	700-1000	0			7042	5	3521	30			10562	4.5	10-15	10-15	30-40	A	Lmfi/meSa-SaLm	sp
Phoenix Rg10, Rensburg Rg20	400-500	0							5868	50	5868	2.5	40-60			A	SaCl-Cl	gc
Uitvlugt Es34, Enkeldoorn Es33	300-500	0					1760	15	2347	20	4108	1.8	10-20	10-15	40-50	A	Lmfi/meSa-SaLm	pr
Killarney Ka20	300-400	0							3521	30	3521	1.5	15-30			A	fi/meSaLm-SaClLm	gc
Arniston Va31, Lindley Va41	400-500	0					2934	25			2934	1.3	25-30		35-45	A	fi/meSaClLm	vp
Mngazi Ar10, Gelykvlakte Ar20	300-600	0					1174	10			1174	0.5	40-60			A	SaCl-Cl	so,lc
Sterkspruit Ss26, Rosehill Sw30	300-400	0					1174	10			1174	0.5	10-20		35-45	A	Lmfi/meSa-SaLm	pr
Mkambati Kd14, Kroonstad Kd13	500-700	0					587	5			587	0.3	10-15	10-15	35-45	A	Lmfi/meSa-SaLm	gc
Pans/Panne		4	10562	15							10562	4.5						

Appendix 2 – Soil chemical analysis results

NOORDWES UNIVERSITEIT
ECO-ANALYTICA

Eco Analytica
Posbus 19140
NOORDBRUG 2522
Tel: 018-285 2732/3/4

TERRA AFRICA (VLAKLAAGTE)

2020/11/09 **Voedingstatus**

Monster no.	Ca	Mg	K	Na	P	pH(KCl)	EC
	(mg/kg)						(mS/m)
1	374,9	70,6	55,8	3,9	18,1	6,04	44
2	141,9	22,3	20,0	1,7	4,6	5,13	16
3	335,5	70,3	69,8	0,5	24,1	6,02	20
4	133,3	26,0	40,6	1,4	4,0	4,31	15

Uitruilbare katione

Monster no.	Ca	Mg	K	Na	S-waarde	Walkley Black
	(cmol(+)/kg)					%C
1	1,87	0,58	0,14	0,02	2,61	0,76
2	0,71	0,18	0,05	0,01	0,95	0,10
3	1,67	0,58	0,18	0,00	2,43	0,56
4	0,67	0,21	0,10	0,01	0,99	0,20

2020/11/09 **Particle Size Distribution**

Sample no.	**> 2mm (%)**	**Sand**	**Silt**	**Clay**
		(% < 2mm)		
1	0,2	93,5	1,2	5,3
2	0,2	93,3	1,3	5,5
3	9,4	92,7	1,4	5,9
4	36,9	82,2	5,6	12,2

"HANDBOOK OF STANDARD SOIL TESTING METHODS FOR ADVISORY PURPOSES"

UITRUILBARE KATIONE: 1 M NH_4-asetaat pH=7
KUK: 1 M NH_4-asetaat pH=7
FOSFAAT: Bray 1 - Ekstrak
pH H_2O/KCl: 1:2,5 - Ekstrak
EG: Versadigde Ekstrak

Ten einde betroubaarheid van analises te verseker, neem Eco-Analytica deel aan die volgende instan
International Soil-Analytical Exchange (ISE), Wageningen, Nederland
Geen verantwoordelikheid word egter deur Noordwes Universiteit aanvaar vir enige verliese wat uit

Appendix 3 – Curriculum Vitae of Specialist

+2782-828-3587

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linkedin.com/in/marinepienaar

Wolmaransstad,
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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