SCIENTIFIC AQUATIC SERVICES

Reg No. 2003/078943/23
VAT Reg No. 4020235273
PO Box 751779
Gardenview
2047
Tel: 011 616 7893
Fax: 086 724 3132
Email: admin@sasenvgroup.co.za
www.sasenvironmental.co.za

SOIL, LAND USE AND LAND CAPABILITY ASSESSMENT AS PART OF THE ENVIRONMENTAL IMPACT ASSESSMENT AND AUTHORISATION PROCESS FOR THE PROPOSED EXPANSION OF BUSHVELD VAMETCO MINE OPERATIONS IN BRITS WITHIN THE JURISDICTION OF MADIBENG LOCAL MUNICIPALITY IN NORTH WEST PROVINCE

Prepared for

NSOVO ENVIRONMENTAL CONSULTING

October 2020

Prepared by: Scientific Aquatic Services
Report author : N.S. Sithole (Cand. Nat. Sci)
Report reviewers: B. Mzila
S. van Staden (Pr.Sci.Nat)
Report Reference: SAS 219184
Date: October 2020

EXECUTIVE SUMMARY

Scientific Aquatic Services (SAS) was appointed to conduct a soil, land use and land capability assessment as part of the Environmental Impact Assessment (EIA) and authorisation process for the proposed expansion of Bushveld Vametco mine operations in Brits within the jurisdiction of Madibeng Local Municipality in North West Province.

The survey was conducted in July 2019 which entailed evaluating physical soil characteristics, terrain quality and climatic conditions as well as current limitations to various land uses. The proposed project site will hereafter be referred to as the “study area”.

The climatic conditions associated with the study area and the surrounding area, have good yield potential for a moderate range of adapted crops but planting date options might be a significant limiting factor. This is attributable to the Mean Annual Precipitation (MAP), as some portions receive 400-601mm, while others receive 601-800mm per annum. As a result, the Climate Capability assignable to the study area is Class 4.

The dominant land uses within the study area are mining, grazing and wilderness. In addition, a small residential area within which subsistence farming is practiced was also observed to the west of the study area, however no commercial cultivated agriculture occurs within the immediate vicinity. Large scale irrigated commercial agriculture only occurs approximately 1.4 km west of the study area. The rest of the surrounding areas are comprised of residential and wilderness land uses.

Based on the field data collected and supporting desktop studies, the majority of the where the proposed mining development will occur can be broadly described as “unsuitable” to due to due to historic and current mining activities. The bulk of the proposed development is located within areas which have either been previously mined or disturbed to a degree that there have no bearing on agricultural production. In addition, the unimpacted soils in the immediate surrounding of the proposed mining development are not ideal for cultivation attributed to their physical characteristics which include:

- High clay content;
- Waterlogging conditions and
- Shallow effective depth which limits the root penetration of deep-rooted plants.

Out of the total surveyed area, only 13.29 % is deemed suitable for cultivation. The rest of the soils, at best, are suited for pastures and/or wildlife however can be cultivated under serious management interventions. It should be noted that no mining activities are planned on prime agricultural soils, therefore direct impact is not foreseen. Indirect impact is also deemed unlikely on these soils due to their proximity to the current and proposed mining activities. Below is a tabular presentation of the dominant soils, with relative description of soil horizons as well as associated land capability.

Table A: Dominant soil forms and their respective land capability

Soil form	Code	Diagnostic Horizon Sequence	Land Capability	Areal Extent (ha)	Sum of the Extent (ha)	Percentage (%)
Hutton	Hu	Orthic/ red pedal (thick)	Arable (Class I)	87.61	105.23	6.59
Shortlands	Sd	Orthic/ red structure (thick)		17.62		
Valsrivier	Va	Orthic/Pedocutanic (thick)	Arable (Class III)	24.04	107.12	6.70
Swartland	Sw	Orthic/Pedocutanic/Lithic		83.08		
Rensburg	Rg	Vertic/Gley	Grazing (Class V)	467.59	467.59	29.26
Arcadia/Rustenburg	Ar/Rs	Vertic A/Hard Rock; Vertic A/Lithic	Grazing (Class VI)	304.85	318.16	19.91
Mispah	Ms	Orthic/hardrock		13.31		
Cullinan	Cu	Anthropogenic Open Excavation Technosols	Wilderness (Class VIII)	73.65	523.83	32.78
Witbank	Wb	Unspecified		450.18		
TOTAL					**1521.93**	**95.24**

***Infrastructural areas 76.06ha (4.67%) were not included in the table above since they not considered in the land capability ratings**

The land capability of the identified soils forms ranged between Class I and VIII due to land use limitations related to anthropogenic activities and low soil workability potential of the dominant soils. The high clay content and wedge soil structure of related soils (i.e. Arcadia/Rustenburg, Rensburg) leads to poor internal drainage which then limits their land capability to marginal potential for arable land use under normal circumstances. These soils are therefore considered to have little contribution to regional and national agricultural production. However, small pockets of prime agricultural soils (i.e. Hutton and Shortlands) were also found within the study area. These soils are considered to have a significant potential contribution to the regional and national agricultural production grid. It should be noted that no mining activities are planned on prime agricultural soils, therefore direct impact is not foreseen. Indirect impact is also deemed unlikely on these soils due to their proximity to the current and proposed mining activities. The extent of the agriculturally important soils within the study area is limited to support viable commercial cultivated agriculture.

The overall potential loss of land capability is anticipated to be relatively low considering the dominant soil forms occurring within the study area due to the marginal agricultural potential of these soils. Furthermore, the surrounding climatic conditions are associated with a moderately restricted growing season due to high and/or low temperatures, frost and moisture stress. Suitable crops may be grown at risk of some yield loss as a result of the above-mentioned cultivation constraints under normal circumstances.

Due to historic and current mining activities, a loss of agricultural potential within the Witbank and Cullinan soils has occurred, reducing the land capability within these areas to wilderness land uses. Based on the international soil classification system these soil forms (Witbank and Cullinan) are classified as Anthrosols. Witbank and Cullinan soils are already in a deteriorated state and require rehabilitation. Overall, the relevant limiting factors within the study area for land capability, particularly for cultivated agricultural land use potential can be summarised as follows:

- Shallow effective rooting depth due to shallow indurated parent rock material of the Mispah soils. As such, these soils are not considered to contribute significantly to agricultural productivity;
- High clay contents of the Rustenburg/Arcadia soil forms which tightly binds water and soluble nutrients which reduces the potential of plant uptake promoting reduced yields and possible crop failures;
- Limited rooting depth due to periodic waterlogging of the Rensburg soil forms are associated with wetland features. Although these soils have little contribution to agriculture, these soils are protected by the National Water Act (Act 36 0f 1998) as they support and maintain the ecological integrity of the freshwater resources. Thus, preservation of these soils for conservation purposes takes precedence, according to the National Water Act, 1998 (Act No. 36 of 1998); and
- Lack of soil medium for plants and crop growth for the rocky outcrop, mine infrastructure, Cullinan, and Witbank (Anthrosols) soil types.

During the various phases of the proposed mining associated development, various impacts are anticipated. The anticipated impacts include soil erosion, soil compaction and soil contamination. Soil compaction is expected to be severe without mitigation measures in place due to the physical composition of Vertic soils as they contain high content of expanding clay (smectite group) minerals. All soil forms occurring within the study area have equal chance of being accidentally contaminated by various toxicants used during mining operation. These impacts mentioned above are expected to be moderate -negative without mitigation and low with mitigations.

If mitigation measures are implemented, the overall impact footprint of the proposed mining associated development will be reduced to acceptable levels from a land use and land capability point of view. The cumulative impact on land use will be the conversion of land into mining infrastructure areas resulting in the loss of potential grazing land and wilderness during the life of the mine.

The degraded areas within the footprint, with specific mention of historic and current mining activities, can be rehabilitated, in an integrated manner as part of the closure of the project and this project can therefore leave a positive legacy in the area. Thus, if integrated rehabilitation is undertaken, this project will potentially lead to a betterment of the environment post closure, thus allowing pre mining activities such as grazing and wilderness to commence. It is deemed essential that the proposed mitigation measures and recommendations presented in this report are appropriately implemented to minimise impact on soil resources. After the mitigation measures have been implemented the proposed mining development is deemed acceptable from a agricultural use and land capability point of view.

DOCUMENT GUIDE

No.	Requirement	Section in report
a)	Details of -	
(i)	The specialist who prepared the report	Appendix C
(ii)	The expertise of that specialist to compile a specialist report including a curriculum vitae	Appendix C
b)	A declaration that the specialist is independent	Appendix C
c)	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
cA)	An indication of the quality and age of base data used for the specialist report	Section 4
cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 4 and 5
d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 4
e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 4
f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternative	Section 5
g)	An identification of any areas to be avoided, including buffers	Section 5
h)	A map superimposing the activity including the associated structure and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	Section 4
i)	A description of any assumption made and any uncertainties or gaps in knowledge	Section 1.1
j)	A description of the findings and potential implication\s of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities	Section 4 and 5
k)	Any mitigation measures for inclusion in the EMPr	Section 5.2
l)	Any conditions for inclusion in the environmental authorisation	Section 4.1
m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	None
n)	A reasoned opinion -	
(i)	As to whether the proposed activity, activities or portions thereof should be authorised	Section 5 and 6
(iA)	Regarding the acceptability of the proposed activity or activities	Section 6
(ii)	If the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Section 4 and 5
o)	A description of any consultation process that was undertaken during the course of preparing the specialist report	None
p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	None
q)	Any other information requested by the competent authority	None

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

GLOSSARY OF TERMS

Albic	Grey colours, apedal to weak structure, few mottles (<10 %)
Alluvial soil:	A deposit of sand, mud, etc. formed by flowing water, or the sedimentary matter deposited thus within recent times, especially in the valleys of large rivers.
Catena	A sequence of soils of similar age, derived from similar parent material, and occurring under similar macroclimatic condition, but having different characteristics due to variation in relief and drainage.
Chromic:	Having within ≤150 cm of the soil surface, a subsurface layer ≥30 cm thick, that has a Munsell colour hue redder than 7.5YR, moist.
Ferralic:	Having a ferralic horizon starting ≤150 cm of the soil surface.
Ferralic horizon:	A subsurface horizon resulting from long and intense weathering, with a clay fraction that is dominated by low-activity clays and contains various amounts of resistant minerals such as Fe, Al, and/or Mn hydroxides.
Gleying:	A soil process resulting from prolonged soil saturation which is manifested by the presence of neutral grey, bluish or greenish colours in the soil matrix.
Hard Plinthic	Accumulative of vesicular Fe/Mn mottles, cemented
Hydrophytes:	Plants that are adaptable to waterlogged soils
Lithic	Dominantly weathering rock material, some soil will be present.
Mottles:	Soils with variegated colour patterns are described as being mottled, with the “background colour” referred to as the matrix and the spots or blotches of colour referred to as mottles.
Plinthic Catena	South African plinthic catena is characterised by a grading of soils from red through yellow to grey (bleached) soils down a slope. The colour sequence is ascribed to different Fe-minerals stable at increasing degrees of wetness
Red Apedal	Uniform red colouring, apedal to weak structure, no calcareous
Runoff	Surface runoff is defined as the water that finds its way into a surface stream channel without infiltration into the soil and may include overland flow, interflow and base flow.
Orthic	Maybe dark, chromic or bleached
Salinity:	High Sodium Adsorption Ratio (SAR) above 15% are indicative of saline soils. The dominance of Sodium (Na) cations in relation to other cations tends to cause soil dispersion (deflocculation), which increases susceptibility to erosion under intense rainfall events.
Sodicity:	High exchangeable sodium Percentage (ESP) values above 15% are indicative of sodic soils. Similarly, the soil dispersion.
Soil Map Unit	A description that defines the soil composition of a land, identified by a symbol and a boundary on a map
Soft Plinthic	Accumulation of vesicular Fe/Mn mottles (>10%), grey colours in or below horizon, apedal to weak structure
Witbank	Man-made soil deposit with no recognisable diagnostic soil horizons, including soil materials which have not undergone paedogenesis (soil formation) to an extent that would qualify them for inclusion in another diagnostic horizon

ACRONYMS

AGIS	Agricultural Geo-Referenced Information Systems
°C	Degrees Celsius.
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
ET	Evapotranspiration
IUSS	International Union of Soil Sciences
FAO	Food and Agriculture Organization
GIS	Geographic Information System
GPS	Global Positioning System
m	Meter
MAP	Mean Annual Precipitation
NWA	National Water Act
PSD	Particle Size Distribution
SACNASP	South African Council for Natural Scientific Professions
SAS	Scientific Aquatic Services
SOTER	Soil and Terrain

1. INTRODUCTION

Scientific Aquatic Services (SAS) was appointed to conduct a soil, land use and land capability assessment as part of the Environmental Impact Assessment (EIA) and authorisation process for the proposed expansion of Bushveld Vametco mine operations in Brits within the jurisdiction of Madibeng Local Municipality in North West Province. The proposed project site will hereafter be referred to as the “study area”.

The study area is situated in the Brits Magisterial District, approximately 7 km northeast of the town of Brits, 4,6km north of the R566 roadway and 13,5 km west of Soshanguve.

A soil, land use and land capability survey was conducted in July 2019 by a qualified soil scientist [Ndumiso S. Sithole]. The assessment entailed evaluating physical soil characteristics as well as current limitations to various land uses. The land use and land capability assessment was undertaken in fulfilment of the terms of reference summarised in the points below:

- Review and verify current land use in the vicinity of the study area with particular mention of agricultural uses;
- Record local topographic features of the landscape, as estimated slope gradient;
- Subsurface soil observations will be made by means of a manual hand auger in order to assess individual soil profiles;
- Identify master and diagnostic horizons to 1.5m below ground surface or to depth of refusal;
- Describe potential soil limitations/restrictions to land capability;
- Classify identified soils into soil forms according to the South African Soil Classification System (Soil Classification Working Group, 2018);
- Assess spatial distribution of various soil types within the study area;
- Compile soil, land use and land capability maps under current on-site conditions based on the field assessment data; and
- Impact assessment and mitigation measure development.

1.1 Project Description

Bushveld Vametco Holdings proposes expanding its mining operations to increase production capacity from 3000 to 5000 metric tons and eventually 10000 metric tons in the future. The project will take place within their authorised Mining Right (MR) area and will entail the following activities:

- The expansion of the existing slimes dam towards the east of the mine to cater for additional slimes waste;
- The expansion of the magnetite dump to the north and south of the mine;
- The construction of the two Pollution Control Dams (PCDs) for the proposed magnetite dump expansion and existing plant to accommodate the return or polluted water;
- Development of the new Return Water Dam (RWD) to accommodate return/polluted water from the proposed and existing slimes dams as well as to accommodate stormwater within the mine;
- Construction of a Barren Dam (BD) to store barren and mother liquor solution; and
- Development of a new Waste Rock Dump (WRD) to reduce load and haul distance and facilitate easy backfill.

Sizes of the proposed activities

Proposed activity	Size (hectares)
Pollution Control Dam 1	: ± 3Ha
Pollution Control Dam 1	: ± 1Ha
Return Water Dam	: ± 5Ha
Barren Dam	: ± 3Ha
Waste Rock Dump	: ± 24Ha
Slimes dam extension	: ± 108Ha
Magnetite Dump North	: ± 17Ha
Magnetite Dump South	: ± 20Ha

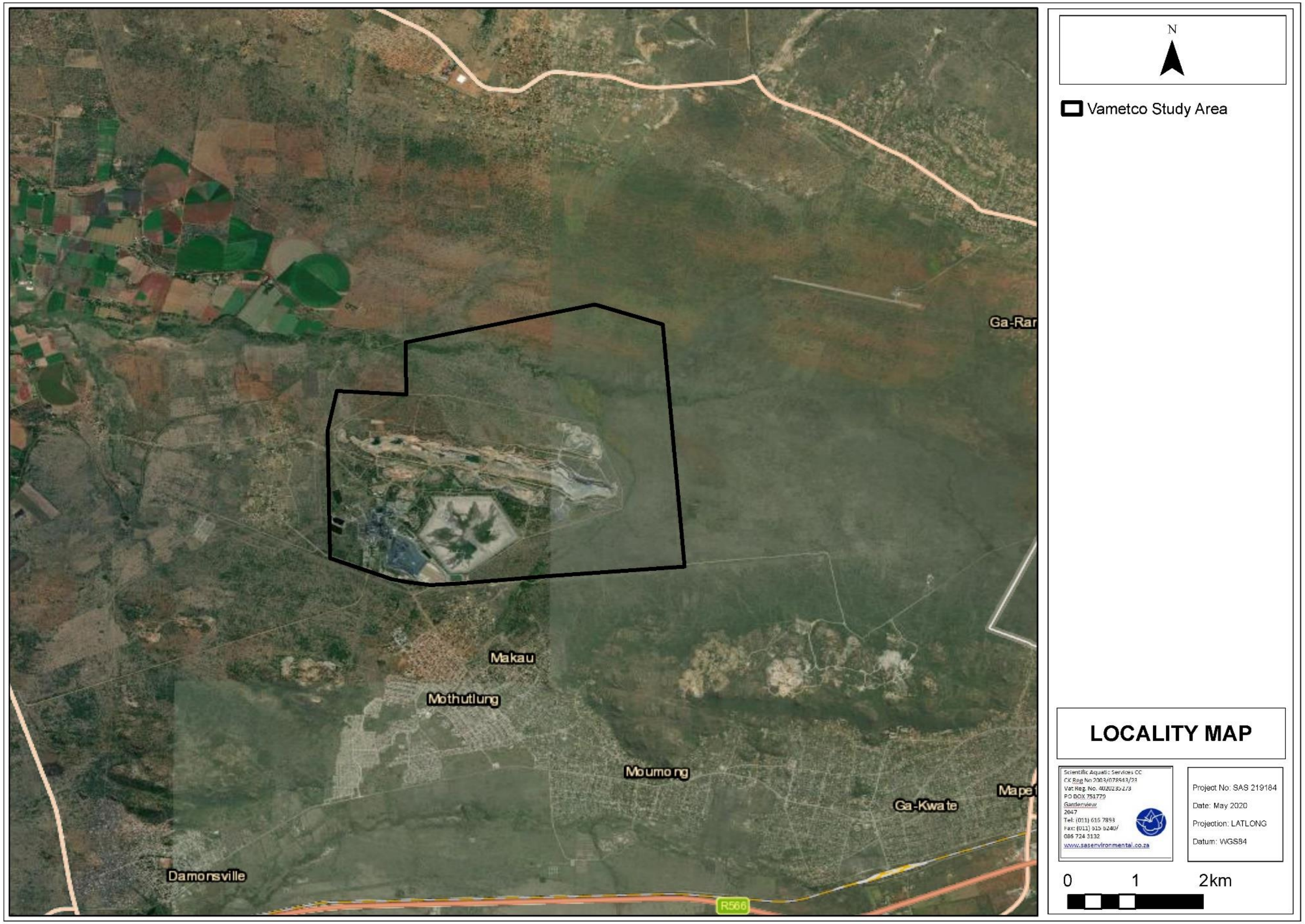


Figure 1: Digital Satellite image depicting the location of the study area in relation to surrounding areas.

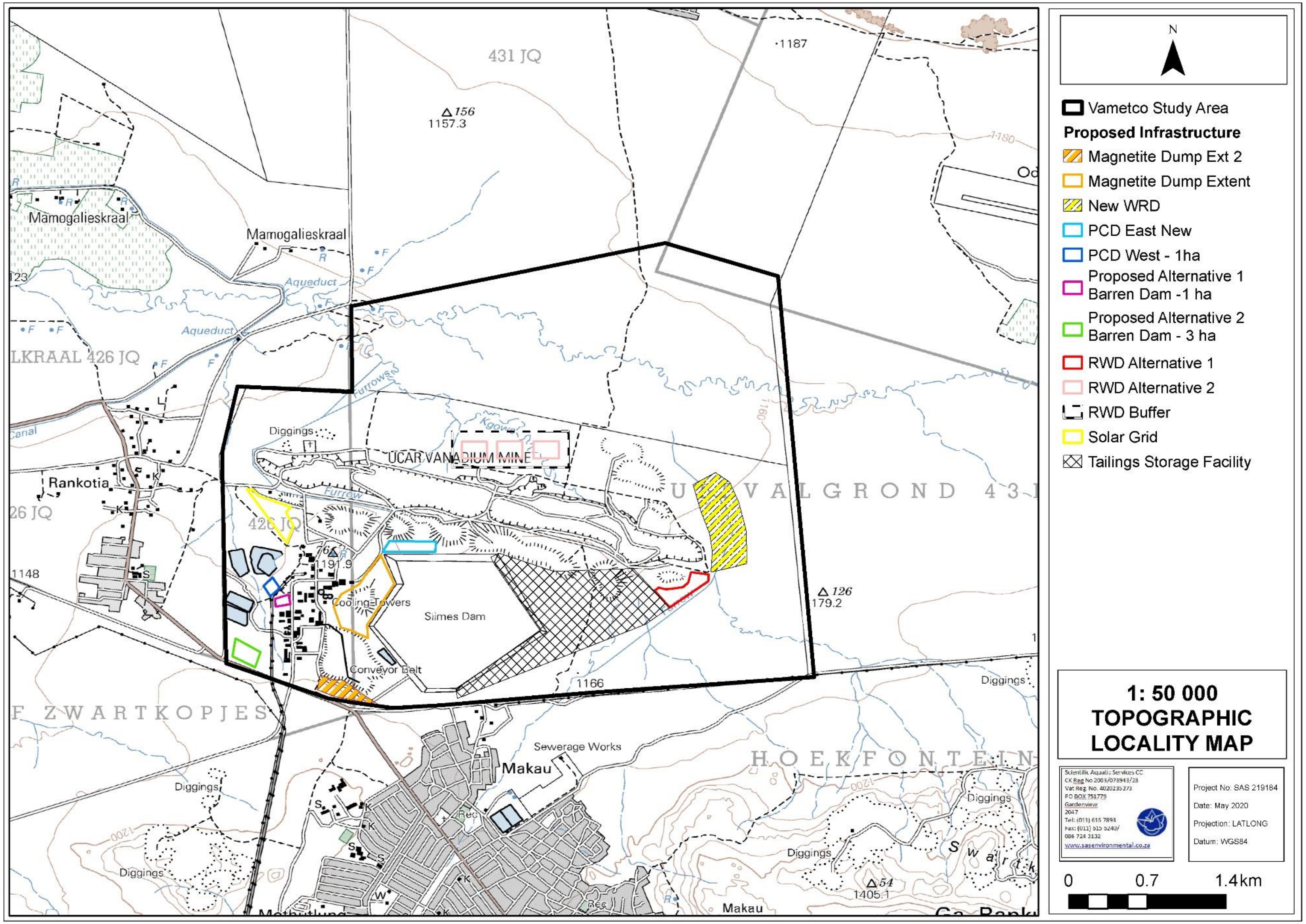


Figure 2: The study area depicted on a 1:50 000 topographical map in relation to the surrounding area.

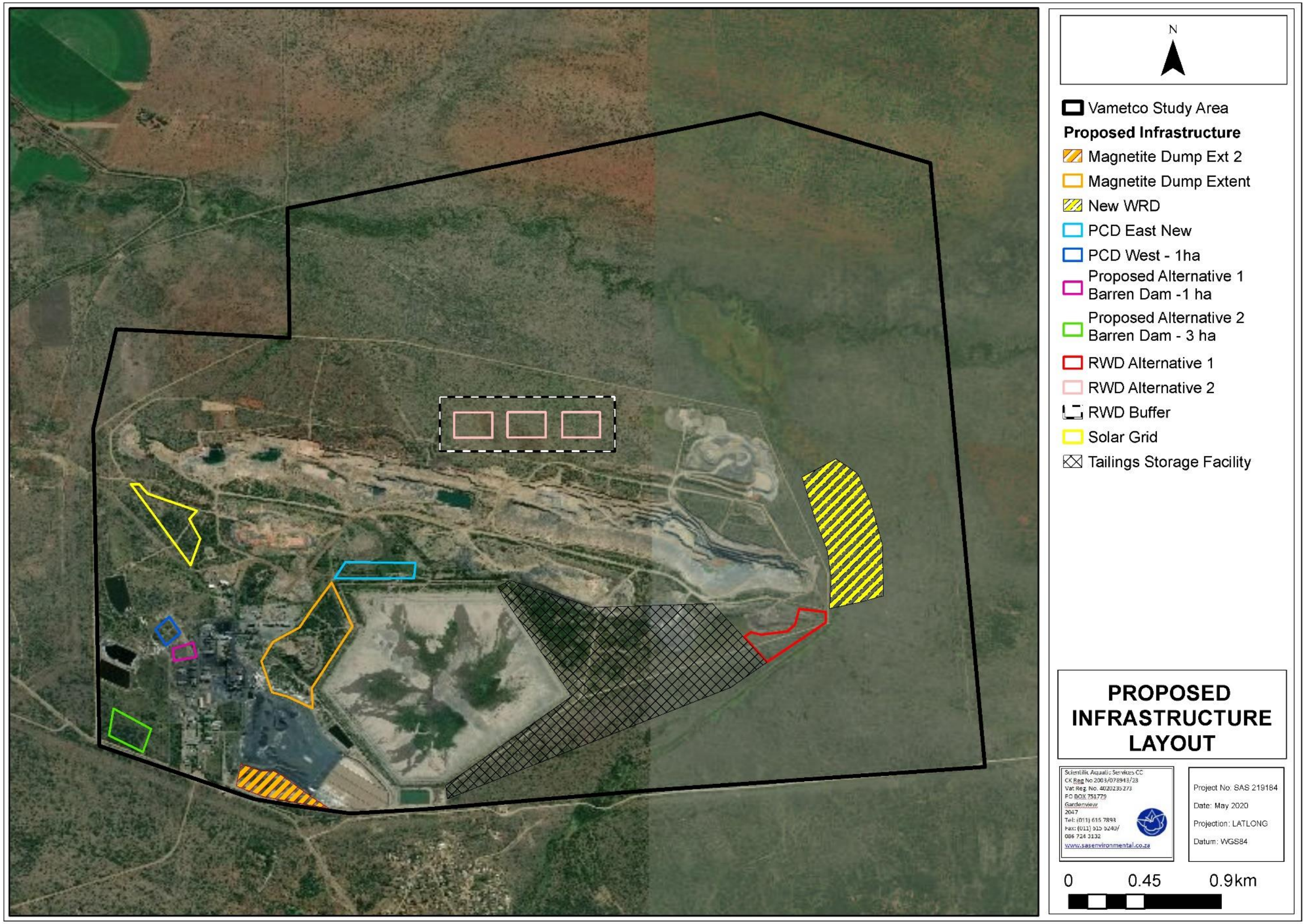


Figure 3: Proposed Layout of the Expansion Activities at the Vametco Alloy (Pty) Ltd. Mining and beneficiation Operations

1.2 Assumptions and Limitations

For the purpose of this assessment, the following assumptions are applicable:

- The soil survey conducted as part of the land capability assessment was restricted to the Vametco study area, which is considered adequate for the purpose of this investigation;
- Sampling by definition means that not all areas are assessed, and therefore some aspects of soil and land capability may have been overlooked in this assessment. It is however the opinion of the specialist that this assessment was carried out with sufficient sampling and in sufficient detail to enable the proponent, the Environmental Assessment Practitioner (EAP) and the regulating authorities to make an informed decision regarding the proposed Bushveld Vametco Alloys (Pty) Ltd Project;
- Land Capability was classified according to current soil restrictions; however it is virtually impossible to achieve 100% purity in soil mapping, the delineated soil map units could include other soil type(s) as the boundaries between the mapped soils are absolute but rather form a continuum and gradually change from one type to another. Soil mapping and the findings of this assessment were therefore inferred from extrapolations from individual observation points; and
- Soil fertility status was not considered a limitation, seeing as inherent nutrient deficiencies and/or toxicities would be rectified by appropriate liming and/or fertilization prior to cultivation.

2. METHOD OF ASSESSMENT

Prior to commencement of the field assessment, a background study, including a literature review, was conducted in order to determine the expected land and soil capability of the soils within the Vametco study area. Various data sources including but not limited to the Agricultural Geo-Referenced Information System (AGIS) and other sources as listed under references were used for the assessment.

A soil survey was conducted in July 2019, at which time the identified soils within the Vametco study area were classified according to the South African Soil Classification System (Soil Classification Working Group, 2018). The soil survey was restricted to the Vametco study area, however observation of the surrounding areas was made so as to cater for any edge effect that may occur during different phases of development. Subsurface soil observations were made using a manual hand auger in order to assess individual soil profiles, which entailed evaluating physical soil properties and prevailing limitations to various land uses. Soils with relatively equivalent potential (i.e. soils with relatively similar characteristics and limitations) were then assigned into predetermined Land Capability classes according to Scotney et al., 1987.

2.1 Land Capability Classification

Agricultural potential is directly correlated to Land Capability, as measured on a scale of (I) to (VIII), as presented in Table 1 below; with Classes I to III classified as prime agricultural land that is well suitable for annual cultivated crops. Class IV soils may be cultivated under certain circumstances and management practices, whereas Land Classes V to VIII are not considered to contribute significantly to provincial and/or national agricultural productivity. Furthermore, the climate capability is also measured on a scale of 1 to 8, as illustrated in Table 2 below. The land capability rating is therefore adjusted accordingly, depending on the prevailing climatic conditions as indicated by the respective climate capability rating.

Table 1: Land Capability Classification (Scotney et al., 1987)

Land Capability Group	Land Capability Class	Increased intensity of use									Limitations
Arable	I	W	F	LG	MG	IG	LC	MC	IC	VIC	No or few limitations. Very high arable potential. Very low erosion hazard
	II	W	F	LG	MG	IG	LC	MC	IC	-	Slight limitations. High arable potential. Low erosion hazard
	III	W	F	LG	MG	IG	LC	MC	-	-	Moderate limitations. Some erosion hazards
	IV	W	F	LG	MG	IG	LC	-	-	-	Severe limitations. Low arable potential. High erosion hazard.
Grazing	V	W	-	LG	MG	-	-	-	-	-	Water course and land with wetness limitations
	VI	W	F	LG	MG	-	-	-	-	-	Limitations preclude cultivation. Suitable for perennial vegetation
	VII	W	F	LG	-	-	-	-	-	-	Very severe limitations. Suitable only for natural vegetation
Wildlife	VIII	W	-	-	-	-	-	-	-	-	Extremely severe limitations. Not suitable for grazing or afforestation.

W - Wildlife **F - Forestry** **LG - Light grazing**
MG – Moderate grazing **IG - Intensive grazing** **LC - Light cultivation**
MC – Moderate cultivation **IC - Intensive cultivation.** **VIC – Very intensive cultivation**

Table 2: Climate Capability Classification (Scotney et al., 1987)

Climate Capability Class	Limitation Rating	Description
C1	None to slight	Local climate is favourable for good yield for a wide range of adapted crops throughout the year.
C2	Slight	Local climate is favourable for good yield for a wide range of adapted crops and a year-round growing season. Moisture stress and lower temperatures increase risk and decrease yields relative to C1.
C3	Slight to moderate	Slightly restricted growing season due to the occurrence of low temperatures and frost. Good yield potential for a moderate range of adapted crops.
C4	Moderate	Moderately restricted growing season due to low temperatures and severe frost. Good yield potential for a moderate range of adapted crops but planting date options more limited than C3.
C5	Moderate to severe	Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Suitable crops may be grown at risk of some yield loss.
C6	Severe	Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Limited suitable crops for which frequently experience yield loss.
C7	Severe to very severe	Severely restricted choice of crops due to heat, cold and/or moisture stress.
C8	Very severe	Very severely restricted choice of crops due to heat and moisture stress. Suitable crops at high risk of yield loss.

The anticipated impacts of the proposed open cast pits and related infrastructure on soil and land capability were assessed to inform the necessary mitigation measures. A detailed description of the land capability classification and impact assessment methodology is included in Appendix A for reference.

3. LEGISLATIVE REQUIREMENTS

The following legislative requirements were taken into consideration during the assessment. A detailed description of these legislative requirements is presented in Appendix B:

- National Environmental Management Act, (Act 107 of 1998) (NEMA);
- National Environmental Management: Waste Act (Act 59 of 2008);
- Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983) (CARA); and
- Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002) (MPRDA).

4. ASSESSMENT RESULTS

4.1 Desktop Assessment Results

The following data is applicable to the study area, according to various data sources including but not limited to the Agricultural Geo-referenced Information System (AGIS):

- The majority of the Vametco study area receives a Mean Annual Precipitation (MAP) ranging between 401 and 600mm per annum, the remaining southern portion of the study area receives a MAP ranging between 601 and 800mm per annum (Figure 4);

- According to the soil-terrain (SOTER) database and the 1:250 000 geological map of South Africa, the entire Vametco study area is underlain by Gabbro rock formations of the Lebowa geological group;
- The SOTER database indicates that the majority of the Vametco study area comprises calcic Vertisols (VRk), and a small north eastern portion of the Vametco study area comprises Ferric Luvisols (LVf) (Figure 5);
- According to the AGIS database, the Vametco study area has a moderate arable land potential (Class III);
- According to the AGIS Database, the livestock grazing capacity potential is estimated to be approximately 8 to 10 hectares per large animal unit for the western portion of the Vametco study area, the livestock grazing capacity of the remaining portion of the study area is transformed rangeland;
- The natural soil pH is estimated to range between 5.5 and 6.4, indicating that the soil pH is acidic, as interpolated from topsoil pH values obtained from the National Soil Profile Database (AGIS database); and
- According to the National Land Cover Database, the Vametco study area is dominated by various land cover types. However, the woodland/open bush is the most prominent land cover types as depicted on Figure 6.

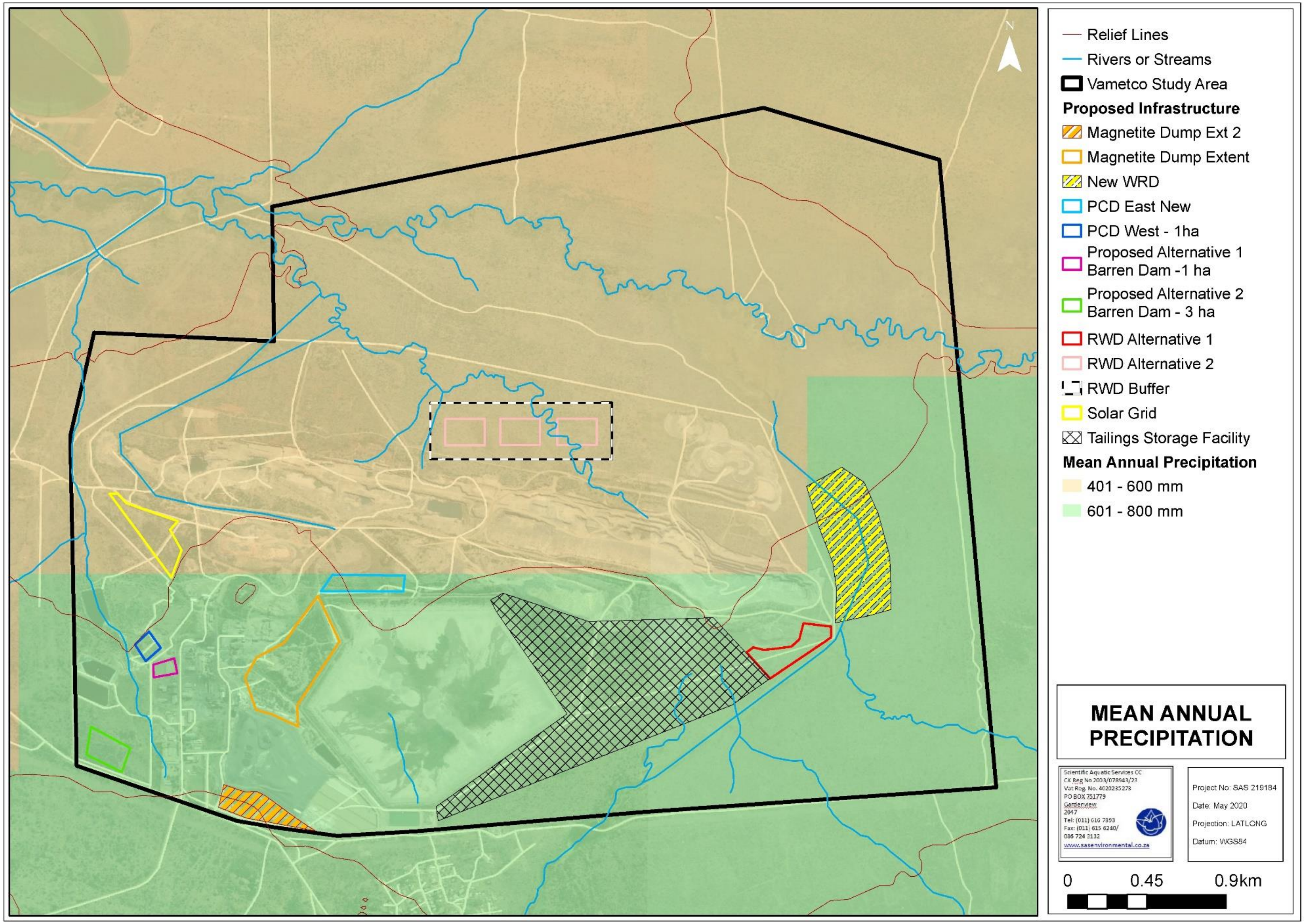


Figure 4: Mean Annual Precipitation (MAP) associated with the Vametco study area and surrounding area.

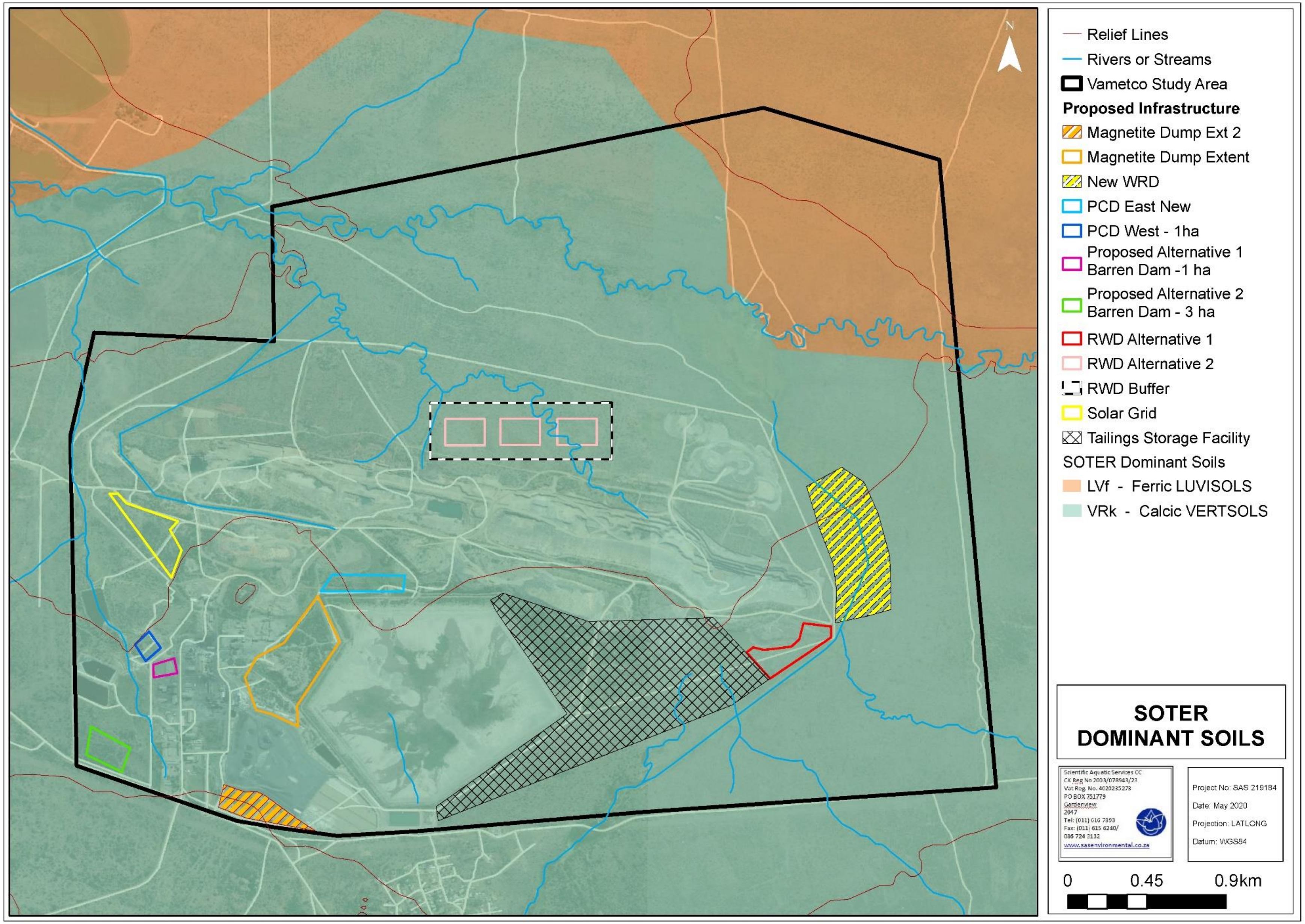


Figure 5: Dominant soils associated with the Vametco study area and surrounding area, according to the SOTER Database.

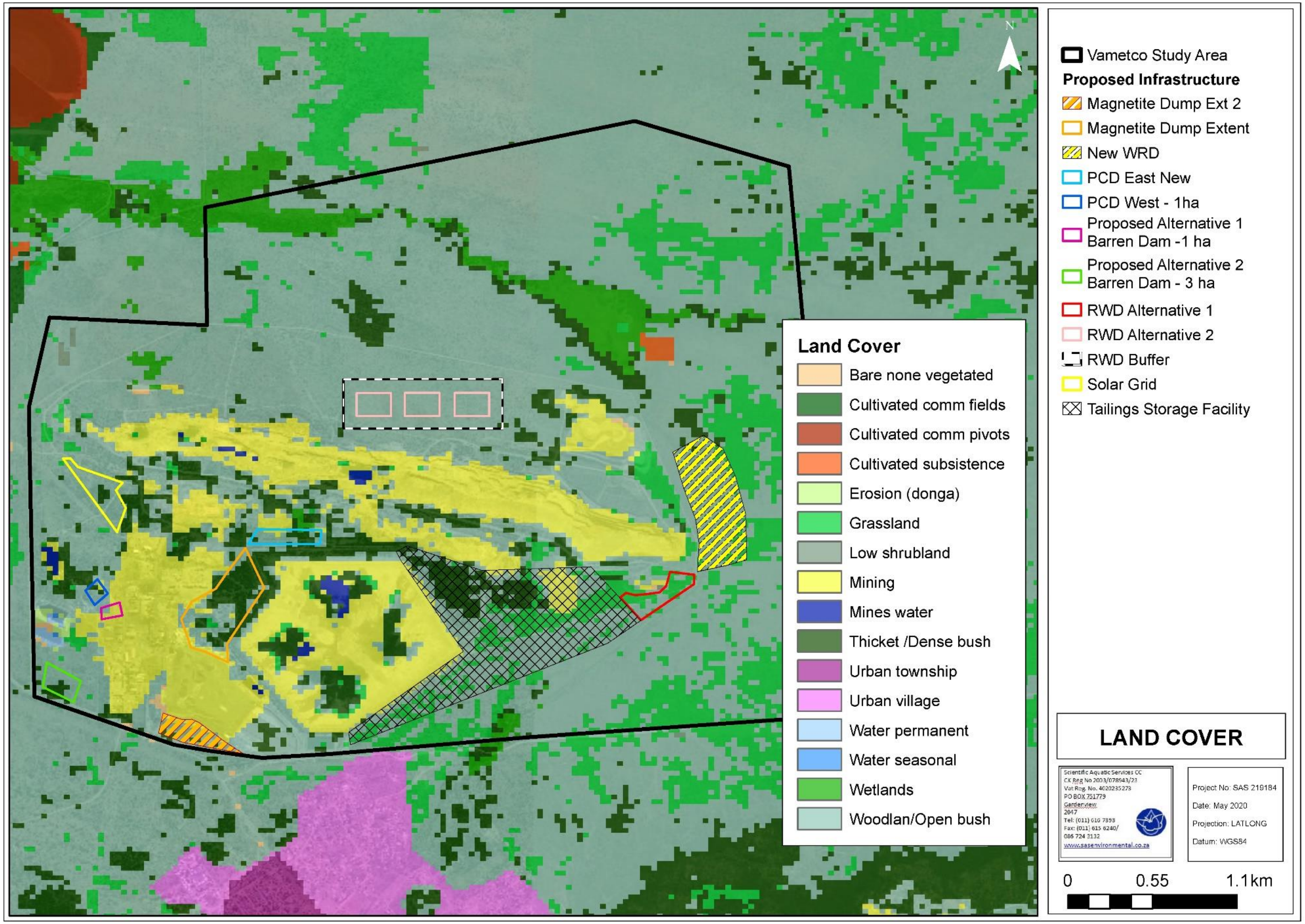


Figure 6: Land cover associated with the Vametco study area and surrounding area, according to the National Land Cover (2014).

4.2 *In-situ Assessment Results*

4.2.1 Current Land Use Impacts

Based on observations during the site assessment, the dominant land uses within the study area are mining, grazing and wilderness. In addition, a small residential area which practiced subsistence farming was also observed to the west of the study area, however no commercial cultivated agriculture occurs within the immediate vicinity. Large scale irrigated commercial agriculture only occurs approximately 1.4 km west of the study area. The rest of the surrounding areas is comprised of residential and wilderness. Current land uses are presented in Figure **7 and 8** below.

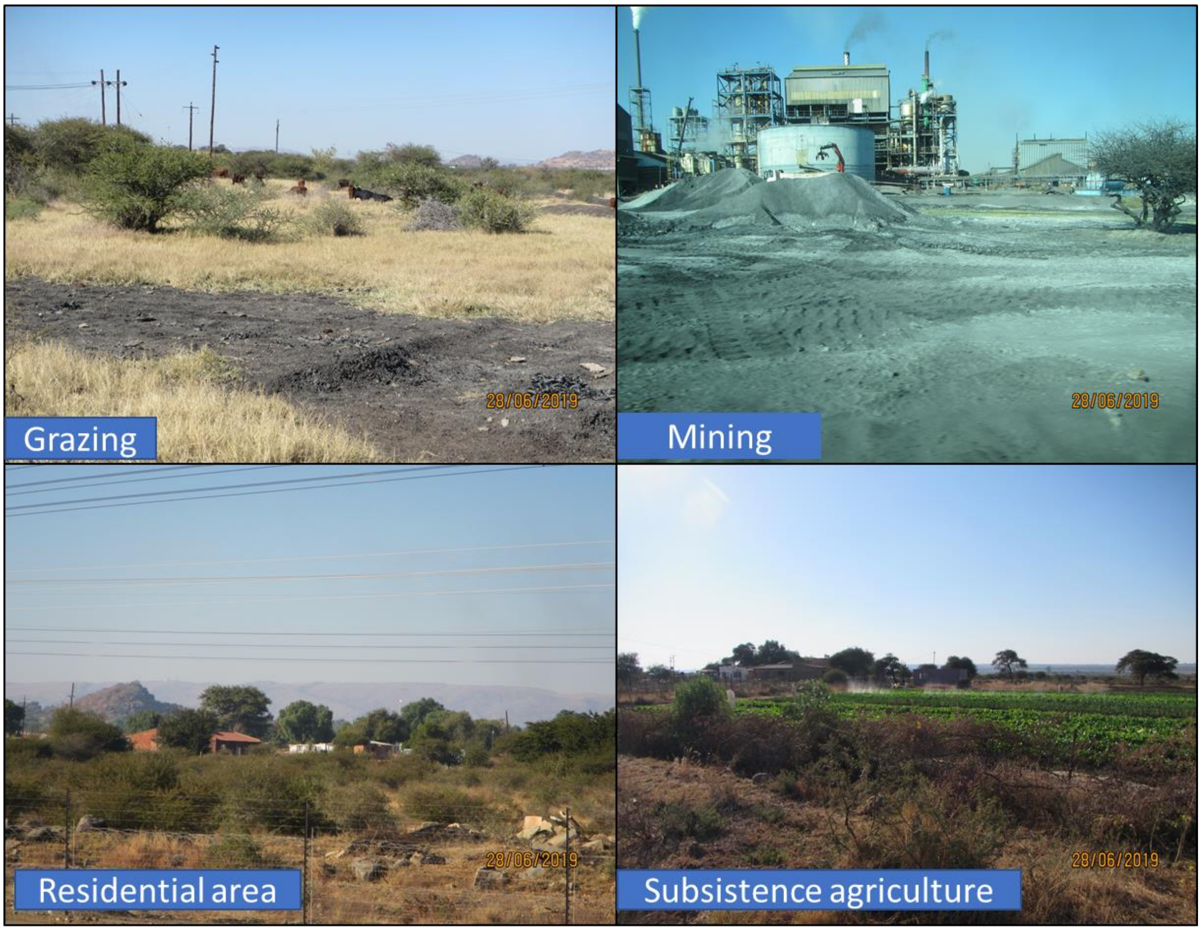


Figure 7: Photographs illustrating the dominant land use within the study area.

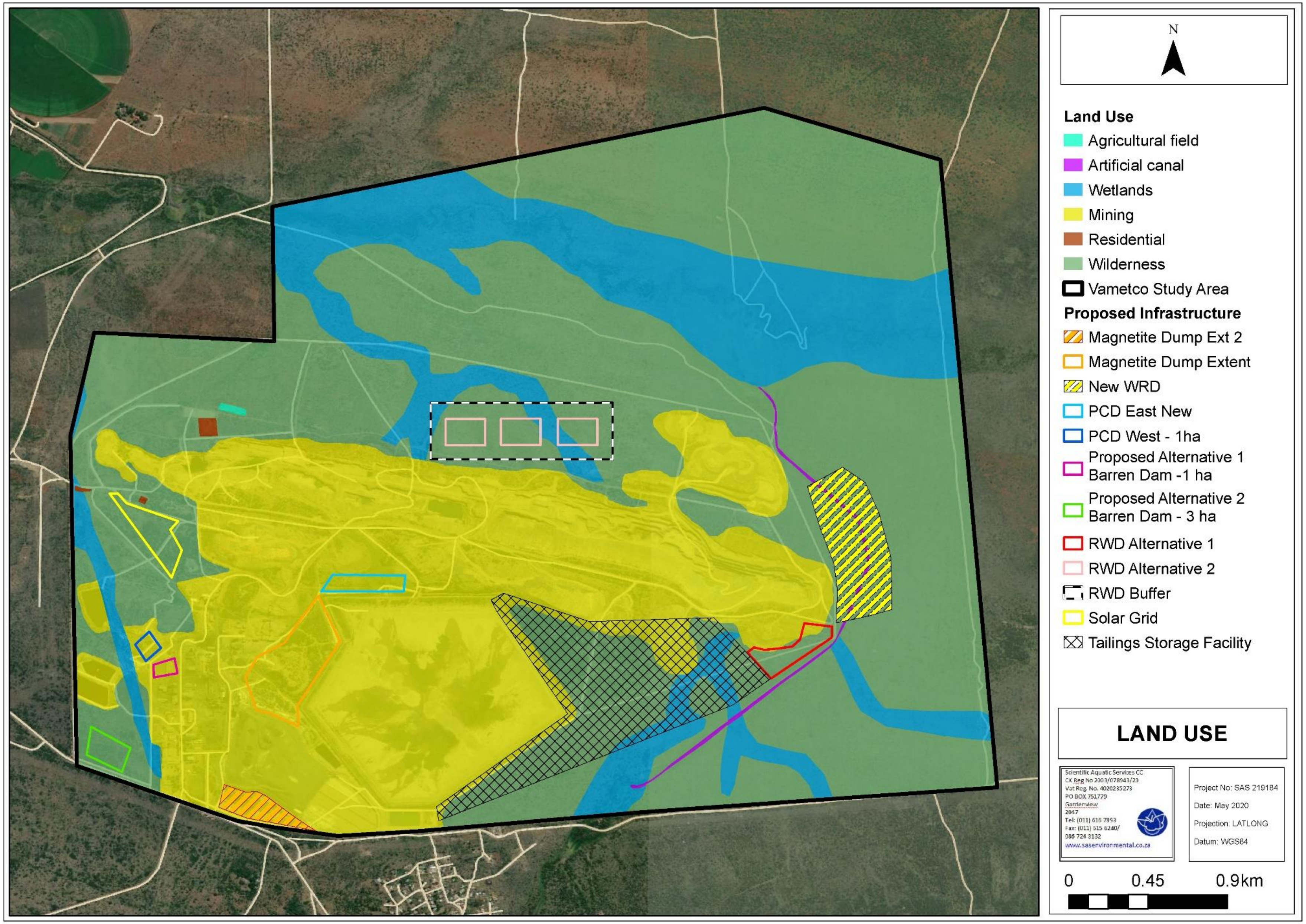


Figure 8: Map depicting current land use overlain by proposed mining operation within the study area.

4.2.2 Dominant Soil Forms

The study area largely traverses a Vertic and Anthropic catena with Rensburg, Rustenburg/Acardia, and Witbank soil forms being the dominant soil forms within the total surveyed landscapes, occupying 29.26%, 19.91%, and 28.71% respectively. Vertic soils such as Rensburg, Rustenburg/Acardia have some limiting factors for cultivation under normal circumstances such as:

- Waterlogging conditions;
- High clay content; and
- Shallow effective depth which limit the root penetration of deep-rooted plants.

These soils typically have a high fertility status however require serious management intervention measures to obtain high yields. At best, these soils are suited for pastures and/ or wildlife. Witbank and Cullinan soils have been extensively disturbed such that no recognizable diagnostic soil morphological characteristics could be identified, corresponding to *Anthrosols* in the international soil classification terminology.

Duplex soils (i.e. Swartland and Valsrivier) and Oxidic soils (i.e. Hutton and Shortland) were also found to be occurring on various patches of the total surveyed landscape, occupying 6.70% and 6.59% respectively. The remainder of the study area is comprised of mining related infrastructure which occupies approximately 4.76% of the total study area. **Table 3** below presents the dominant soil forms and their respective diagnostic horizon sequence.

Table 3: Dominant soil forms within the study area

Soil Form	Code	Diagnostic Horizon Sequence
Rensburg	Rg	Vertic/Gley
Rustenburg	Rs	Vertic A/Hard Rock
Arcadia	Ar	Vertic A/Lithic
Mispah	Ms	Orthic/hardrock
Shortlands	Sd	Orthic/ red structure (thick)
Hutton	Hu	Orthic/ red pedal (thick)
Valsrivier	Va	Orthic/Pedocutanic (thick)
Swartland	Sw	Orthic/Pedocutanic//Lithic
Cullinan	Cu	Anthropogenic Open Excavation Technosols
Witbank	Wb	Unspecified

***Infrastructural areas were not included in the table above since they not considered in the land capability ratings**

The spatial distribution of the identified soils are depicted in **Figure 9** below**.**

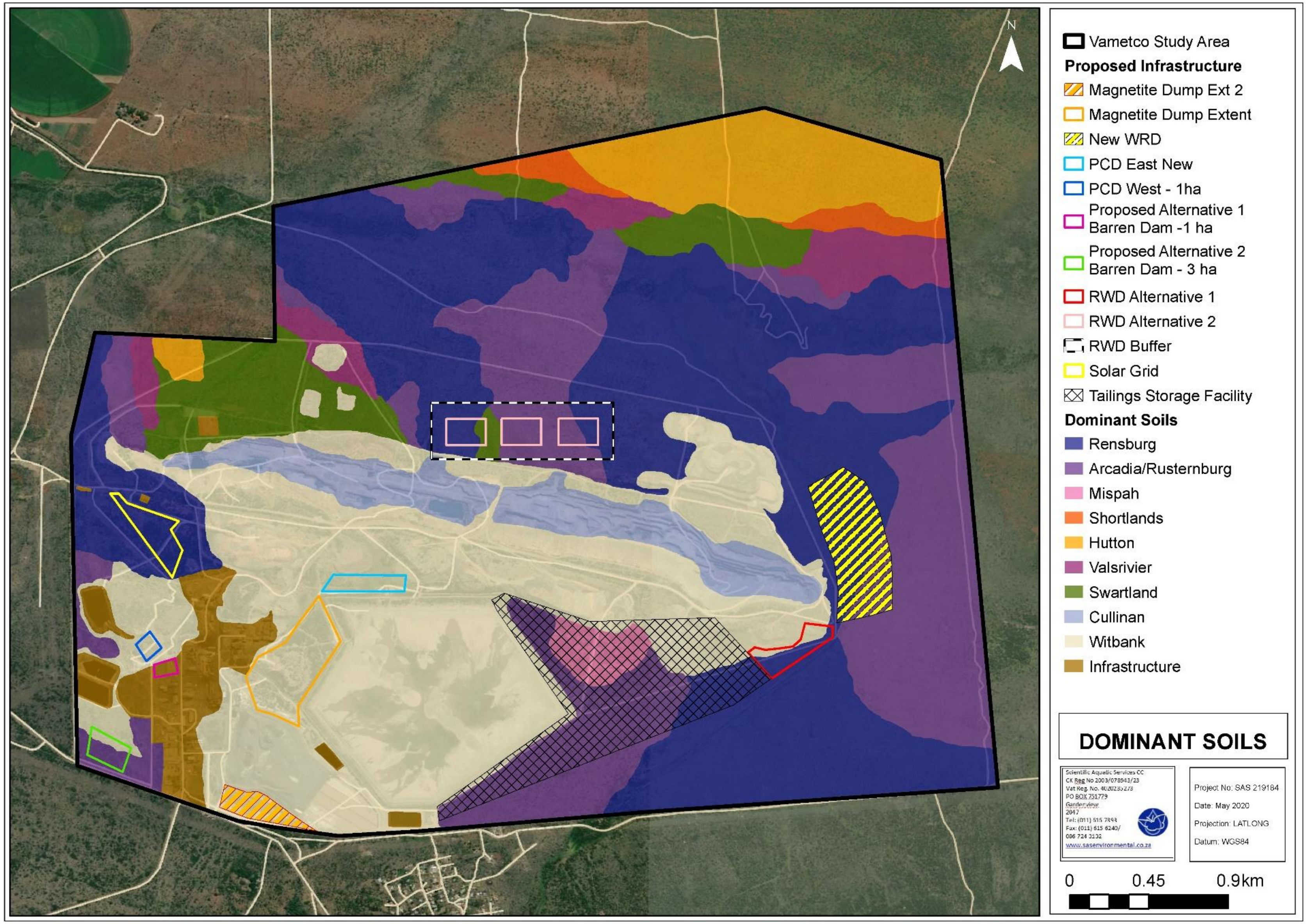


Figure 9: Map depicting current land use overlain by proposed mining operation within the study area

4.2.3 Land Capability Classification

Typically, agricultural land capability in South Africa is limited by climatic conditions, particularly water availability. However, even within similar climatic zones different soil types typically have different land use capabilities attributed to their inherent characteristics. High potential agricultural land is defined as having the soil and terrain quality, growing season and adequate available moisture supply required to produce sustained economically high crops yields when treated and managed according to best possible farming practices (Scotney et al., 1987). For the purpose of this assessment, land capability was inferred in consideration of observed limitations to land use due to physical soil properties and prevailing climatic conditions. Climate Capability (measured on a scale of 1 to 8) was therefore considered in the agricultural potential classification.

The study area falls within Climate Capability **Class 4** at best, as the majority of the study areas receive Mean Annual Precipitation (MAP) as some portion receive **401-600mm**, while others receive **601-800mm per annum**. The climatic conditions associated with the study area have good yield potential for a moderate range of adapted crops however planting date options more limited.

The identified soils within the study area were classified into different land capability classes based on arability and limitation. The land capability limitations for the identified soils are discussed in comprehensive “dashboard style” summary tables presented Table 5 to 9 below. Land capability maps are presented in **Figure 10**.

Table 4: Land capability of soil forms within the study area

Soil form	Land Capability	Areal Extent (ha)	sum of the Extent (ha)	Percentage (%)
Hutton	Arable (Class I)	87.61	105.23	6.59
Shortlands		17.62		
Valsrivier	Arable (Class III)	24.04	107.12	6.70
Swartland		83.08		
Rensburg	Grazing (Class V)	467.59	467.59	29.26
Arcadia/Rustenburg	Grazing (Class VI)	304.85	318.16	19.91
Mispah		13.31		
Cullinan	Wilderness (Class VIII)	73.65	523.83	32.78
Witbank		450.18		
Total soil material			**1521.93**	**95.24**

***Infrastructural areas 76.06ha (4.67%) were not included in the table above since they not considered in the land capability ratings**

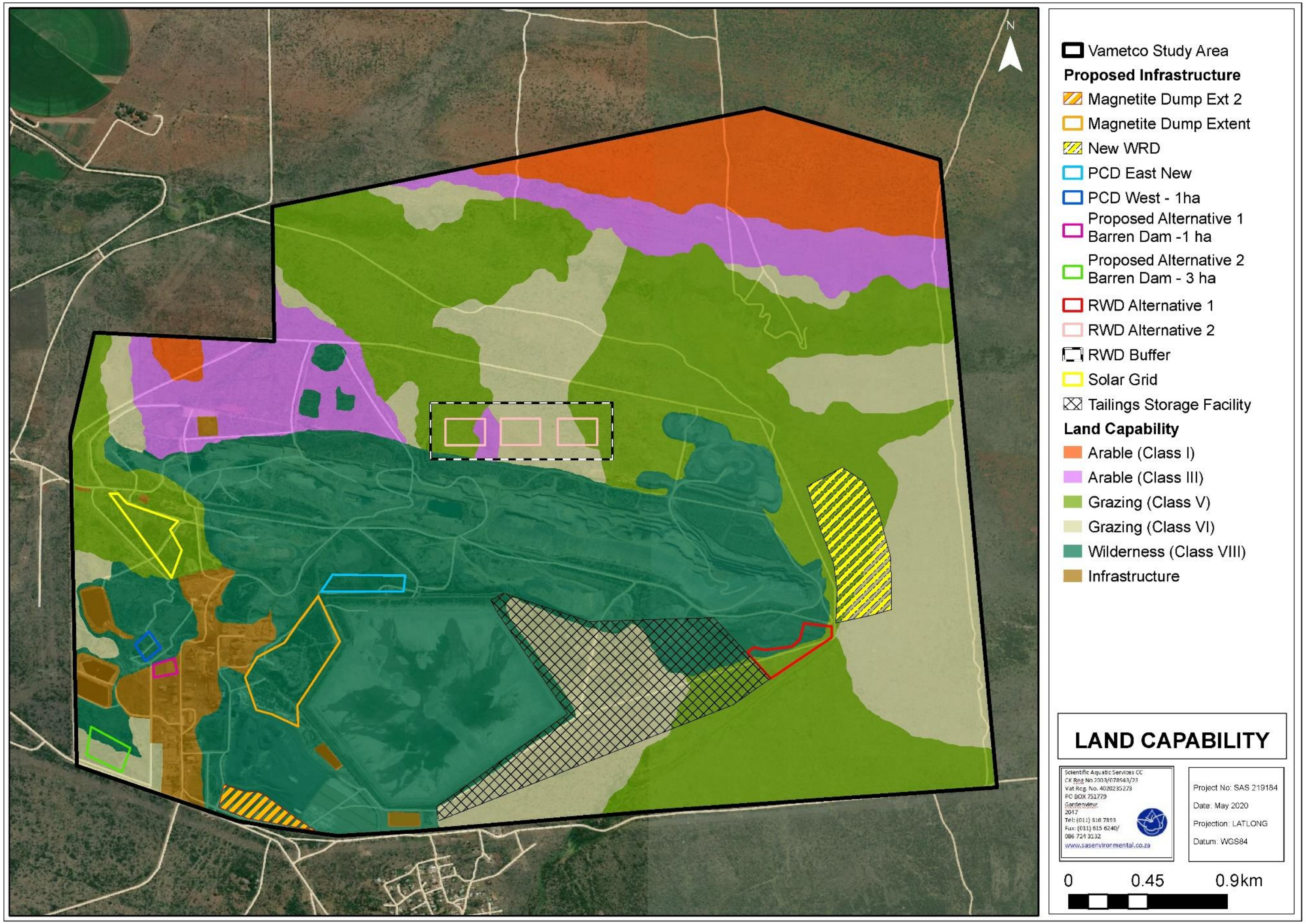


Figure 10: Map depicting land capability classes of soils associated with the mining footprints within the study area.

Table 5: Summary discussion of the Arable (Class I) land capability class.

Land Capability: Arable (Class I)			
			
Terrain Morphological Unit (TMU)	Relatively flat landscapes of < 1% slope gradient	**Photograph notes**	View of the identified Shortlands/Hutton soil forms
Soil Form(s)	Shortlands and Hutton	**Areal Extent**	105.23ha; which constitutes 6.59% of the study area
Physical Limitations	None; these soils have sufficient depth for most cultivated crops and rapid drainage characteristics. However, the excessively drained nature of these soils may be problematic for cultivated crops.	**Land Capability** The identified Shortlands and Hutton soil forms are considered to be prime agricultural soils of high (Class I) land capability, suitable to arable agricultural land use. Therefore, these soils are considered to contribute significantly to provincial and/or national agricultural productivity if used for crop cultivation, and are essentially also well-suited for other less intensive land uses such as grazing, forestry, etc. However, emphasis is directed to their agricultural crop productivity due to the scarcity of such soil resources on a national scale and food security concerns.	
Overall impact significance prior to mitigation	L	The overall impact of the proposed mining operation activities on land capability is anticipated to be low (L), before and after the implementation of mitigation measures. The proposed mining operation is to be located within the historically disturbed areas, and no loss in land capability is foreseen.	**Business case, Conclusion and Mitigation Requirements:** The proposed mining operation will largely occur on disturbance soils (Witbank soil form). The loss of high agricultural productive soils is not anticipated due to the proximity of these soils to the proposed mining development. The extent of the agricultural important soils within the study area is limited to support viable commercial cultivated agriculture.
Overall impact significance post mitigation	L		

Table 6: Summary discussion of the Arable (Class III) land capability class

Land Capability: Arable (Class III)				
				
Terrain Morphological Unit (TMU)	Relatively flat landscapes of < 1% slope gradient		**Photograph notes**	View of the identified Valsrivier and Swartland soil forms
Soil Form(s)	Valsrivier and Swartland		**Areal Extent**	107.12ha; which constitutes 6.70% of the study area
Physical Limitations	The limitations on these soils are related to the physical soil particle composition (soil structure) that might impact the plant rooting depth and soil water movement within the soil profile through voids.		**Land Capability** The identified Valsrivier and Swartland soil forms are considered to be high potential agricultural soils of moderate land capability (Class III), suitable to arable agricultural land use. These soils are considered to have significant contribution to provincial and/or national agricultural productivity land uses such as grazing, forestry etc.	
Overall impact significance prior to mitigation	L	The overall impact of the proposed mining operation on the land capability of these soils is anticipated to be low (L), as no proposed mining operation is to take place on these soil forms.	**Business case, Conclusion and Mitigation Requirements:** Similar to the Shortland/Hutton soils, these soils are not associated with the proposed mining activities. Thus, both direct and indirect impacts are not foreseen.	
Overall impact significance post mitigation	L			

Table 7: Summary discussion of the Grazing (Class V) land capability class

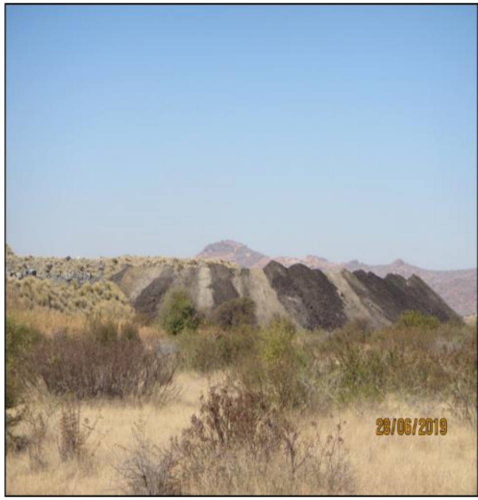
Land Capability: Grazing (Class V)			
			
Terrain Morphological Unit (TMU)	Gently sloping landscapes of < 0.5% slope gradient	**Photograph notes**	View of the identified Rensburg soil forms
Soil Form(s)	Rensburg soil form	**Areal Extent**	467.59ha; which constitutes 29.26% of the study area
Physical Limitations	Plant roots development and water infiltration are largely impeded by the clayey, slowly permeable G horizon occurring at shallow depths of less than 50 cm. Prolonged saturation of these soils are typically induce anoxic (oxygen deficiency) conditions which hamper root development of most arable crops. These soils, at most are suitable for rice paddies.	**Land Capability** The Rensburg soil forms were classified as Class V land capability due to land use limitations related to prolonged waterlogging which leads to internal drainage of the underlying G horizon. The prolonged waterlogging of these soils limits their land use largely to grazing, wilderness and habitats for various plant species that are inherently tolerant and/or obligate to anoxic conditions. These soils are therefore not considered to contribute significantly to provincial and/or national agricultural productivity.	
Overall impact significance prior to mitigation	**M**	The overall impact of the proposed mining operation on the land capability of these soils is anticipated to be medium without mitigation and relatively low with mitigation due to their inherently poor land capability. However, on the contrary, the ecological functionality of these soils as an essential medium for supporting wetland habitats is considered to be highly significant, and therefore, the recommendations and management measures of the wetland assessment report should be considered and implemented to ensure ongoing functionality as well as goods and services provision of the watercourses in the region.	**Business case, Conclusion and Mitigation Requirements:** Although not considered of significant agricultural productivity, these soils are considered to be of significant ecological conservation as they are characteristically unique to wetland habitats; and as such the recommendations and management measures of the wetland assessment report conducted as part of the environmental assessment and authorisation process take precedence. It is highly likely that these soils will be affected by the proposed mining activities, as they occur within the boundaries of the proposed mining operation.
Overall impact significance post mitigation	**L**		

Table 8: Summary discussion of the Grazing (Class VI) land capability class

Land Capability: Grazing (Class VI)			
			
Terrain Morphological Unit (TMU)	Relatively flat landscapes of < 1% slope gradient	**Photograph notes**	View of the identified Rustenburg/Acardia and Mispah soil form
Soil Form(s)	Rustenburg (Rs)/Arcadia (Ar) and Mispah (Ms)	**Areal Extent**	318.16ha; which constitutes 19.91% of the study area
Physical Limitations	Vertic A horizon inherently have some serious management constraints attributed to excessive stickiness when wet and hardening when dry due to high smectitic (expandable) clay minerals and high plasticity index values (>32 PI).Mispah soil form have shallow effective rooting depth due to the occurrence of a rocky layer at relatively shallow depth, which hinders penetration of plant roots	**Land Capability** The identified Rustenburg/Arcadia and Mispah soil form is considered to be of poor (Class VI) land capability, which is generally not considered suitable for arable agricultural land use under normal circumstances, unless significant management interventions are applied. The inherently high natural fertility status of these soils is considered to be of significant value for grazing purposes. Traditionally Rustenburg/Arcadia soil form are ploughed for subsistence farming for shallow rooted arable crops such as vegetables under resource-poor circumstances due to their limiting factors such as high clay content which tightly holds soil water such that it is not readily available for plant uptake. Thus, require intensive management practices.	
Overall impact significance prior to mitigation	**M**	The overall impact of the proposed mining operation on the land capability of these soils is anticipated to be moderate (M) before mitigation due to their relatively poor land capability which may still of importance for grazing and will be effectively reduced to a low (L) level by implementing the proposed mitigation. From a soil, land use and land capability point of view, it is important that the proposed development is limited within the borders of the proposed layout to prevent excessive loss of potential grazing land.	**Business case, Conclusion and Mitigation Requirements:** The susceptibility of these soils to shrink under dry conditions and expand under moist conditions should also be considered and avoided where possible as this may cause undesired damage to the structural integrity of the surface infrastructure. These soils are highly sensitive to long-term stockpiling and their structural integrity is anticipated to deteriorate during stockpiling while awaiting use for rehabilitation. The development may proceed within these soils with rehabilitation plan in place which will aim to reinstate these soils back to their natural condition as close as possible for potential grazing opportunity as well as wildlife and wilderness post closure.
Overall impact significance post mitigation	**L**		

Table 9: Summary discussion of the Wildlife/ Wilderness (Class VIII) land capability class

<table>
<tr><td colspan="3">Land Capability: Wildlife/ Wilderness (Class VIII)

</td><td colspan="2">

</td></tr>
<tr><td>Terrain Morphological Unit (TMU)</td><td colspan="2">Not applicable; highly disturbed areas</td><td>Photograph notes</td><td>View of the identified Witbank/Cullinan soil forms</td></tr>
<tr><td>Soil Form(s)</td><td colspan="2">Witbank and Cullinan (Anthrosols)</td><td>Areal Extent</td><td>523.83ha; which constitutes 32.78% of the study area</td></tr>
<tr><td>Physical Limitations</td><td colspan="2">Comprises extensively disturbed areas due to anthropogenic activities to an extent that no recognizable diagnostic soil horizon properties could be identified. These soils pose various limitations in support of agriculture, primarily the absence of soil as a growth medium for arable agriculture.</td><td colspan="2">Land Capability
These identified Witbank soils have very poor land capability (Class VIII) due to disturbances attributable to anthropogenic activities, particularly in the vicinity of the study area. This land capability class also include areas where the original soil has been buried and/or extensively modified by anthropogenic activities. These soils are not considered to make a significant contribution to agricultural productivity even on a local or regional scale.</td></tr>
<tr><td>Overall impact significance prior to mitigation</td><td>L</td><td rowspan="2">The overall impact of the proposed mining related activities on the land capability of these soils is anticipated to be low (L) and can be effectively managed by implementing the general house-keeping mitigatory measures and minimisation of edge effects. A significant opportunity exists to rehabilitate this area and improve the future land capability and ecological support provided by these currently affected areas.</td><td colspan="2" rowspan="2">Business case, Conclusion and Mitigation Requirements:
The current state of these soils requires rehabilitation already and development should be targeted in these areas to minimise impact on the natural soils of the area. As such these areas should rather be rehabilitated holistically at the rehabilitation and closure so as to ensure that the soils are returned to a more natural condition for potential grazing opportunity as well as wildlife and wilderness areas.</td></tr>
<tr><td>Overall impact significance post mitigation</td><td>L</td></tr>
</table>

5. IMPACT ASSESSMENT AND MITIGATION MEASURES

The soils are anticipated to be exposed to erosion, compaction, dust emission, and potential soil contamination impacts during the proposed mining associated development. These impacts may persist for the duration of the operational phase if not mitigated adequately. The extension of the existing TSF as well as the construction of the new return water dam (RWD), will result in a loss of soils only suitable for grazing. These site-specific mitigation measures have been developed to ensure that the impact of significance is reduced to acceptable levels. The anticipated activities for different phases of development have been summarised and are presented in Tables 10 below.

5.1 Activities

The impact assessment rating is applicable to the following activities:

Table 10: Summary of the anticipated activities associated with the proposed mining associated development.

Phase	Activities
Planning	- Land and footprint clearing; - Topsoil stripping and stockpiling; - Establishment of surface infrastructure; and - Waste Management.
Mining associated infrastructure	- Operation of the proposed mining associated infrastructure; - Transportation (Load out area, roads); - Operation of infrastructure; and - Waste Management.
Closure	- Rehabilitation of mining area; - Dismantling and decommissioning of infrastructure and buildings, including product stockpiles; - Earth moving, shaping and ripping of ground; - Waste Management; and - Revegetation of disturbed areas.

5.1.1 Soil Erosion

The significance of soil erosion is largely dependent on land use and soil management and is generally accelerated by anthropogenic activities. In the absence of detailed South African guidelines on erosion classification, the erosion potential and interpretation are based on field observations as well as observed soil profile characteristics. Typically, soils with high clay content have a high-water retention capacity, thus less prone to erosion in comparison to sandy textured soils. Given the above soils in the study area are likely to be at limited risk of erosion.

The proposed mining operation is located on a relatively flat terrain, which decreases the erosion hazard. While the identified soils display low susceptibility to erosion under current conditions, their susceptibility to erosion is likely to increase once the land is cleared for construction activities, and the soils will inevitably be exposed to wind and stormwater.

Aspect and activities register

Pre-Construction	Construction	Operational	Decommissioning and Closure
Potential poor planning leading to excessive placement of infrastructure outside of the demarcated infrastructure areas.	Site preparation and associated disturbances to soils, leading to increased runoff, erosion and loss of land capability as the soil are unvegetated.	Minimal disturbances of soils the nearby soils, resulting in detachment of soil particles, reduced soil quality and risk of erosion, attributed to the proposed mining activities.	Ineffective rehabilitation may lead to further loosening and detachment of soil particles and risk of erosion.
	Stockpiling of topsoil material on sloping areas leading to increased runoff and erosion.	Ineffective rehabilitation may lead to terrestrial habitat transformation, which will ultimately lead to lower soil quality.	Decommissioning activities may lead to habitat transformation and increased alien plant species proliferation, and potential changing the nutrient status of the soils in the greater area.

Impact assessment results for the proposed mining associated development, which include site preparation for the extension of the existing TSF and magnetite dump, and Construction of two new PCDs and return water dam (RWD).

Issue	Corrective Measures	Impact rating criteria					Significance
		Nature	Extent	Duration	magnitude	Probability	
Soil Erosion and Dust Emission	No	Negative	2	4	8	5	**70 (High)**
	Yes	Negative	2	2	5	3	**27 (Low)**

Corrective Action

- Any disturbance of high potential agricultural soils must be actively avoided, should this be not feasible, the footprint of the proposed mining areas should be clearly demarcated to restrict the planned activities within infrastructure footprint as far as possible, thus minimising edge effects and reducing the extent and overall significance of impact;
- An adequate storm water management plan must be carefully designed and implemented in order to avoid erosion of topsoil on adjacent arable soils throughout all the mining phases. In this regard, special mention is made of:
  - Sheet runoff from cleared areas, paved surfaces and access roads needs to be curtailed;
  - Runoff from paved surfaces should be slowed down by the strategic placement of berms; and
  - All overburden stockpiles and waste stockpiles must have berms and/catchment paddocks at their toe to contain runoff of the facilities;
- If possible, commencement of construction activities can be scheduled to coincide with low rainfall conditions when the erosive runoffs and wind are anticipated to be low;
- As the footprints of the proposed development are unvegetated it is best to be regularly dampened with water to suppress dust during the construction phase, especially when strong wind conditions are predicted according to the local weather forecast;
- Bare soils adjacent to the infrastructural areas can be vegetated with an indigenous grass mix, if necessary, to re-establish a protective cover, to minimise soil erosion and dust emission; and
- Erosion control is regarded critical as the majority of the soils are susceptible to erosion, as they have finer particles, due their sandy texture and continuous tillage practises taking place.

5.1.2 Soil Compaction

Heavy equipment traffic during construction activities is anticipated to cause significant soil compaction. The severity of this impact is anticipated to be significant for the identified soil forms due to the high clay content of these soils. However, such impact is not anticipated to be severe on Witbank soil form as it has been already disturbed.

Aspects and activities register

Pre-Construction	Construction	Operational	Decommissioning and Closure
Potential poor planning leading to excessive or unnecessary placement of infrastructure, laydown areas on compaction prone soil resources	Topsoil stockpiling on to high clay content soils such as wetland soils, leading to compaction of underlying soil material	Ongoing disturbances to soils, resulting from mining and related activities, leading to further soil compaction and subsequent impact on soil structure	Disturbance of soils as part of demolition activities and backfilling.
	Earthworks on the soil surface leading to increased soil compaction and crusting of topsoil.	Ineffective application of the recommended mitigation measures may lead to significant soil transformation leading to lower infiltration rate, and consequently increased surface runoff.	Decommissioning activities may lead to further soil compaction and increased runoff.
	Potential frequent movement of excavation machines within and in close proximity to the freshwater resources, leading to excessive compaction, potential soil surface crusting and sealing.	Further movement of construction equipment/machinery leading to further soil compaction.	Ineffective rehabilitation may lead to significant soil transformation leading to lower infiltration rate, and consequently increased surface runoff and reduced land capability.

Impact assessment results for the proposed mining associated development, which include site preparation for the extension of the existing TSF and magnetite dump, and Construction of two new PCDs and return water dam (RWD).

Issue	Corrective Measures	Impact rating criteria					Significance
		Nature	Extent	Duration	magnitude	Probability	
Soil Erosion	No	Negative	2	4	8	5	**70 (High)**
	Yes	Negative	2	2	5	3	**27 (Low)**
Corrective Action	➢ All vehicular traffic should be restricted to the existing service roads and the selected road servitude as far as practically possible; to avoid unnecessary compaction of the surrounding soils; ➢ Direct surface disturbance of the identified high clay content/wetland (i.e., Rensburg, Arcadia and Rustenburg etc.) soils should be limited within demarcated areas where possible to minimise the intensity of compaction due to the susceptibility of these soils to prolonged waterlogging conditions (inundation); ➢ Compacted soils adjacent to the mining project foot prints and associated infrastructure footprint can be lightly ripped to at least 25 cm below ground surface to alleviate compaction prior to re-vegetation, and ➢ Compaction of soil can be mitigated by ripping the footprint and introducing both organic and inorganic fertilizers.						

5.1.3 Potential Soil Contamination

Contamination sources are mostly unpredictable and often occur as incidental spills or leak for construction developments. Thus, all the identified soils are considered equally predisposed to potential contamination. The significance of soil contamination is considered to be moderate before mitigation and low after mitigation for all identified soils, largely depending on the nature, volume and/or concentration of the contaminant of concern as well as the rate at which contaminants are transported by water into the soil. Therefore, strict contamination and waste management protocols as well as activity specific Environmental Management Programme (EMP) and monitoring guidelines should be adhered to during all phases of development.

Aspects and activities register

Pre-Construction	Construction	Operational	Decommissioning and Closure
Potential poor planning leading to excessive or unnecessary placement of infrastructure high potential agricultural soils	Spillage of petroleum hydrocarbons during construction of new facilities	Ongoing disturbances to soils, resulting in increased leaching of soil nutrients and risk of erosion, attributed to mining activities.	Contamination of soils during demolition activities and backfilling.
Potential inadequate design of infrastructure leading to risks of contamination of soils and freshwater due to seepages and runoff.	Soil contamination through leakages of hydrocarbons resulting from constructing machinery	Seepage and runoff from mining infrastructure (e.g. overburden) to the surrounding soils.	Decommissioning activities may lead to soil transformation and increased alien plant species proliferation, which will ultimately alter the chemical composition of the soil.
	Potential indiscriminate disposal of hazardous and non-hazardous waste, including waste material spills and refuse deposits into the	Increased seepage and potential increase in concentrations of contaminant concentration in the soil.	Potential contamination from the decommissioning of mining infrastructure.
			Ineffective rehabilitation may lead to decant which can affect soil chemistry

Impact assessment results for the proposed mining associated development, which include site preparation for the extension of the existing TSF and magnetite dump, and Construction of two new PCDs and return water dam (RWD).

Issue	Corrective Measures	Impact rating criteria					Significance
		Nature	Extent	Duration	magnitude	Probability	
Soil Contamination	No	Negative	2	5	10	5	**85** (**high**)
	Yes	Negative	2	2	4	2	**16** (**Low**)
Corrective Action	➢ Contamination prevention measures should be addressed in the Environmental Management Programme (EMPr) for the proposed development, and this should be implemented and made available and accessible at all times to the contractors and construction crew conducting the works on site for reference; ➢ A spill prevention and emergency spill response plan should be compiled to guide the construction works; ➢ An emergency response contingency plan should be put in place to address clean-up measures should a spill and/or a leak occur; and ➢ Mining vehicles/equipment should be regularly checked for leakages to avoid soil contamination by hydrocarbons.						

5.1.4 Loss of Agricultural Land Capability

The overall potential loss of land capability impacts is anticipated to be relatively low for the soil forms occurring within the study area, due to the marginal agricultural potential of these soils and the fact that large portions of the study area. The limitations on Witbank soils (Anthrosols) can be attributed to mining, which has subsequently led to loss of agricultural potential of these soils. Whereas Rustenburg/Arcadia soil forms are limited by high clay content which tightly holds water and soluble nutrients such that it is unavailable for plant uptake thus leading to crop failure and reduced yields.

The operational phase of the proposed study area will have a long-term residual loss in land capability attributed to the surface area that will virtually be inaccessible for potential grazing opportunities. Additional permanent land capability losses may occur where the proposed infrastructure is not rehabilitated following mine closure.

The land capability impacts are anticipated to be limited to the immediate vicinity of the developed areas during the operational phase, provided that all the recommended mitigation and management measures are implemented accordingly during all phases of development, as evaluated on the impact rating table below.

Aspects and activities register

Pre-Construction	Construction	Operational	Decommissioning and Closure
Potential poor planning leading to excessive or unnecessary placement of infrastructure high potential agricultural soils	Site preparation, and associated disturbances to soils, leading to increased nutrient leaching, runoff and erosion and consequent sedimentation	Ongoing disturbances to soils, resulting in increased leaching of soil nutrients and risk of erosion, attributed to mining activities	Compaction and contamination of soils during demolition activities and backfilling
Potential inadequate design of infrastructure leading to risks of contamination of soils due to seepages and runoff	Loss of topsoil as a growth medium due to the proposed mining activities and inadequate rehabilitation efforts	Soil surface crusting and sealing of exposed soils, particularly arable soils	Decommissioning activities may lead to soil transformation and increased alien plant species proliferation, which will ultimately alter the chemical composition and nutrient status of the soil
	Potential indiscriminate disposal of hazardous and non-hazardous waste, including waste material spills and refuse deposits into the soil.	Ongoing disturbance as a result of maintenance activities, leading to the altering of quality and nutrient status of the soil	Disturbance of soils as part of demolition activities as well as backfilling, which may lead to the formation of Witbank soils (Anthrosols) which reduce long term land capability.

Impact assessment results for the proposed mining associated development, which include site preparation for the extension of the existing TSF and magnetite dump, and Construction of two new PCDs and return water dam (RWD).

Issue	Corrective Measures	Impact rating criteria					Significance
		Nature	Extent	Duration	magnitude	Probability	
Loss of Agricultural Land	No	Negative	2	2	4	2	**16 (Low)**
	Yes	Negative	2	2	4	2	**16 (Low)**
Corrective Action	➢ Unnecessary disturbances of the potentially arable soils outside the demarcated areas can be avoided where possible to minimise loss of agricultural land use; ➢ During the decommissioning phase the footprint should be thoroughly cleaned, and all building material should be removed to a suitable disposal facility; ➢ The footprint should be ripped at 25 cm to alleviate compaction as part of rehabilitation; ➢ Stored topsoil should be replaced (if any) and the footprint graded to a smooth surface; ➢ The landscape should be backfilled and reprofiled to mimic the natural topography for potential agricultural activities and grazing opportunities post mining. If possible, ensure a continuation of the pre-mining surface drainage pattern; ➢ The soil layers should be put back in the reverse order of stripping (e.g. subsoil fist then followed by topsoil); ➢ It is recommended that soil quality assessments (through laboratory analysis) be conducted prior to establishing vegetation on the rehabilitated; ➢ The analytical data should be evaluated by a suitably qualified expert, and soil fertility or soil acidity problems should be corrected prior to vegetation establishment; ➢ Slopes of the backfilled surfaces should change gradually since abrupt changes in slope gradient increase the susceptibility for erosion initiation; and ➢ The footprint should be re-vegetated with a grass seed mixture as soon as possible, preferably in spring and early summer to stabilise the soil and prevent soil loss during the rainy season.						

5.1.5 Cumulative Impacts

Surrounding land use can be broadly defined as not ideal for commercial crop cultivation under natural conditions. The soils associated with the proposed development are not considered prime agricultural potential soils due to various limitations such as high clay content, waterlogging issues, shrinking and swelling properties of these soil which might cause significant damage on plant roots. It is anticipated that the proposed activities associated with mining will have a relatively low impact on cumulative loss of arable soils.

If mitigation measures are implemented, the overall impact footprint of the proposed mining associated development will be reduced to acceptable levels. The cumulative impact on land use will be the conversion of land into mining infrastructure areas resulting in the permanent loss of potential grazing land during the life of the mine. The degraded areas within the footprint, with specific mention of the waste material dumped on site, can be rehabilitated, in an in integrated manner, as part of the closure of the project and this project can therefore leave a positive legacy in the area. If the adequate closure and rehabilitation does not occur, the overall impact associated with the proposed development will be at permanent and long term and detrimental to the functioning of the local environment.

5.2 Integrated Mitigation Measures

Based on the findings of the soil, land use and land capability assessment, mitigation measures have been developed to minimise the impact on the soil resources of the area, should the proposed project proceed:

5.2.1 Soil Erosion and Management

Below are the proposed mitigation measures to better manage soil erosion during all phases of the proposed mining operation:

- The footprint of the proposed miming activities infrastructure area should be clearly demarcated to restrict vegetation clearing activities within the infrastructure footprint;
- Clearing of vegetation should take place in a phased manner as to keep bare soil areas as small as possible to limit the erosion potential;
- Moisture control will be necessary on large bare areas during dry season construction, in order to reduce the frequency and amount of dust suspended in the ambient air;
- The mine should implement adequate dust suppression techniques to limit dust release;
- All disturbed areas adjacent to the infrastructural areas can be re-vegetated with an indigenous grass mix, if necessary, to re-establish a protective cover, to minimise soil erosion and dust emission;
- Temporary erosion control measures may be used to protect the disturbed soils during the construction phase until adequate vegetation has established.

5.2.2 Sedimentation and Soil Compaction management

Below are the proposed mitigation measures to better manage sedimentation and soil compaction impacts during all phases of the proposed mining operation:

- All vehicular traffic should be restricted to the existing service roads and the selected road servitude as far as practically possible;
- Vegetation clearance and commencement of construction activities can be scheduled to coincide with low rainfall conditions when soil moisture is anticipated to be relatively low, such that the soils are less prone to compaction; and
- Compacted soils adjacent to the mine associated infrastructure footprint can be lightly ripped to at least 25 cm below ground surface to alleviate compaction prior to re-vegetation.

5.3 Soil Contamination Management

Below are the proposed mitigation measures to better manage soil contamination impacts during all phases of the proposed mining operation:

- Regular monitoring of site activities and machinery must be undertaken to identify spills or leaks;
- Withdraw equipment for maintenance if change in emission characteristics is noticeable;
- Contamination prevention measures should be addressed in the Environmental Management Programme (EMP) for the proposed mining development, and this should be implemented and made available and accessible at all times to the contractors and construction crew conducting the works on site for reference;
- A spill prevention and emergency spill response plan, as well as dust suppression, fire prevention plans should also be compiled to guide the construction works;
- An emergency response contingency plan should be put in place to address clean-up measures should a spill and/or a leak occur, as well as preventative measures to prevent ingress; and
- Spill kits (such as spill-sorb or a similar type product) must be kept on site and used to clean up hydrocarbon spills in the event that they should occur.

5.4 Waste Management

Below are the proposed mitigation measures to better manage compaction generated waste during all phases of the proposed mining operation:

- Burying of any waste including rubble, domestic waste, empty containers on the site should be strictly prohibited and all construction rubble waste must be removed to an approved disposal site;
- All construction rubble waste must be removed to an approved disposal facility; and
- Contractors and construction crew conducting the works on site should be informed about approved waste disposal facilities.

5.5 Loss of Natural Topography, Soil Depth, Soil Volume and Drainage Pattern Management

Below are the proposed mitigation measures to better manage associated impacts on loss of natural topography and soil medium during all phases of the proposed mining operation:

- Infrastructure sites should be accessed through existing road network, where feasible to avoid unnecessary excavation;

- Temporary berms can be constructed, if necessary, around stockpile areas whilst vegetation cover has not established to avoid soil loss through erosion;
- The recovered soils should be re-used to rehabilitate the mine footprint following mine closure;
- Soil resources of similar characteristics must be imported back to the site to compensate for soil loss that will occur during activities associated with mining: and
- The landscape should be reprofiled so as to mimic the natural topography, in a manner that allows water to freely drain to the downgradient receiving environment post closure to avoid water ponding which will subsequently lead to water logging conditions.

5.6 Stockpile and Stripping Management

Below are the proposed mitigation measures to better manage soil stripping and stockpiling activities during all phases of the proposed mining operation:

- Excavation and long-term stockpiling of soil should be limited within the demarcated areas as far as practically possible;
- Separate stripping, stockpiling and replacing of soil horizons (separating soft material from the rock) in the original natural sequence to combat hardsetting and compaction, and maintain soil fertility;
- Stockpile should not exceed three (3) meters in height and should be treated with temporary soil stabilization and erosion control measures;
- Stockpiles should be revegetated to establish a vegetation cover as an erosion control measure. These stockpiles should also be kept alien vegetation free at all times to prevent loss of soil quality;
- Ensure all stockpiles (especially topsoil) are clearly and permanently demarcated and located in defined no-go areas;
- Restrict the amount of mechanical handling, as each handling event increases that compaction level and the changes to the soil structure. Wherever possible, the ‘cut and cover’ technique (where the stripped soils is immediately placed in an area already prepared for rehabilitation, thus avoiding stockpiling) should be used, and
- Use of heavy machinery such as bulldozers should be avoided as far as possible;
- Soil stripping should be done in conjunction with a soil specialist and careful consultation of the pre-mining soil survey is essential. This will ensure optimal soil availability and avoid excessive mixing of soil due to over-stripping, as well as loss of available cover soil due to under-stripping. Such consultation is recommended for the whole soil handling process, from stripping through stockpiling to final rehabilitation;

- Separate stockpiling of different soil to obtain the highest post-mining land capability. For instance, stockpile Rustenburg, Arcadia, and Rensburg together, and Witbank separately;
- Separate stripping, stockpiling and replacing of soil horizons [A (softs) and B (rock material)] in the original natural sequence to combat hardsetting and compaction, and maintain soil fertility;
- Stockpile height should be restricted to that which can deposited without additional traversing by machinery. A Maximum height of 3 m is therefore proposed, and the stockpile should be treated with temporary soil stabilisation methods; such as the application of organic matter to promote soil aggregate formation, leading to increased infiltration rate, thereby reducing soil erosion. Also, the use of lime to stabilise soil pH levels;
- Soil erosion should be controlled on stockpiles by having control measures to reduce erosion risk such as erosion control blankets, soil binders, revegetation, contours, diversion banks and spillways;
- Temporary berms should be constructed around stockpile areas whilst vegetation cover has not established to avoid soil loss through erosion;
- Stockpiled soils should be stored for a maximum of 3-5 years. In addition, concurrent rehabilitation should strongly be considered to reduce the duration of stockpile storage to ensure that the quality of stored soil material does not deteriorate excessively; especially with regard to leaching and acidification;
- The topsoil stockpile should be vegetated and while vegetating, measures will be needed to contain erosion of the stockpile during rain events.
- The recovered soils should be re-used to rehabilitate the mine footprint following mine closure;
- During rehabilitation replace soil to appropriate soil depths in the correct order (i.e. hard rock first, overlain by softs), and cover areas to achieve an appropriate topographic aspect and altitude so as to achieve a free draining landscape that is as close as possible the pre-mining land capability rating as possible; and
- A short-term fertilizer application program should be based on the soil chemical status after levelling and should consists of a pre-seeding lime and fertilizer application, an application with the seeding process as well as a maintenance application after rehabilitation until the area can be declared as self-sustaining by an appropriately qualified soil scientist.

5.7 Estimation of Available Topsoil (soft material) for Rehabilitation

This section aims to provide indication of the available soft material (soil medium) for rehabilitation phase. It should be noted the volumes of soil provided below are estimated, hence the calculations were based on the average depth of the occurring soils. The following approach was used:

$$\textbf{Soil Volume} = \textbf{Area} \times \textbf{Average Depth}$$

Table 11: Estimation of available soft material for soil forms associated with the proposed mining operation and related infrastructure.

Soil form	Average depth (m)	Area (m^2)	Volume (m^3)	Level of confidence (%)
Hutton				
Shortlands	1.35	1052300	1420605	65
Valsrivier				
Swartland	0.9	1071200	964080	60
Rensburg	0.65	4675900	3039335	70
Arcadia/Rustenburg				
Mispah	0.55	3181600	1749880	75
	Total	**9981000**	**7173900**	**67.5**

***The average depth of soils associated with properties was extrapolated from depths of the surrounding soils. Thus, a high level of uncertainty in terms of the available soft material (soil medium) exists.**

5.8 Loss of Land Capability Management

- During the decommissioning phase the footprint should be thoroughly cleared, and all mine residue as well as building material should be removed to a suitable disposal facility;
- The footprint should be ripped to alleviate compaction;
- Stored topsoil should be replaced (if any) and the footprint graded to a smooth free draining surface that does not lead to concentration of flow in areas that would lead to erosion;
- The landscape should be backfilled and reprofiled to mimic the natural topography for potential agricultural activities and grazing opportunities post mining. If possible, ensure a continuation of the pre-mining surface drainage pattern;
- Slopes of the backfilled surface should change gradually since abrupt changes in slope gradient increase the susceptibility for erosion nodes to form;
- The soil fertility status should be determined by soil chemical analysis after levelling (before seeding/re-vegetation. Soil amelioration should be undertaken in consideration of soil analyses as recommended by a soil specialist, to correct the pH and nutritional status before revegetation; and
- The footprint should be re-vegetated with a grass seed mixture as soon as possible, preferably in spring and early summer to stabilise the soil and prevent soil loss during

the rainy season. The species used should be selected by an appropriately qualified ecologist or rehabilitation specialist.

6. CONCLUSION

Based on the field data collected and supporting desktop studies, the majority of the where the proposed mining development will occur can be broadly described as "unsuitable" to due to due to historic and current mining activities. The bulk of the proposed development is located within areas which have either been previously mined or disturbed to a degree that they have no bearing on agricultural production. In addition, the unimpacted soils in the immediate surrounding of the proposed mining development are not ideal for cultivation attributed to their physical characteristics which include:

- High clay content;
- Waterlogging conditions and
- Shallow effective depth which limits the root penetration of deep-rooted plants.

Out of the total surveyed area, only 13.29 % is deemed suitable for cultivation. The rest of the soils, at best, are suited for pastures and/or wildlife however can be cultivated with extensive management interventions. It should be noted that no mining activities are planned on prime agricultural soils, therefore direct impact is not foreseen. Indirect impact is also deemed unlikely on these soils due to their proximity to the current and proposed mining activities.

The overall potential loss of land capability is anticipated to be relatively low considering the dominant soil forms occurring within the study area due to the marginal agricultural potential of these soils. Furthermore, the surrounding climatic conditions are associated with a moderately restricted growing season due to high and/or low temperatures, frost and moisture stress. Suitable crops may be grown at risk of some yield loss as a result of the above-mentioned cultivation constraints under normal circumstances.

Overall, the relevant limiting factors within the study area for land capability, particularly for cultivated agricultural land use potential can be summarised as follows:

- Shallow effective rooting depth due to shallow indurated parent rock material of the Mispah soils. As such, these soils are not considered to contribute significantly to agricultural productivity;
- High clay contents of the Rustenburg/Arcadia soil forms which tightly binds water and soluble nutrients which reduces the potential of plant uptake promoting reduced yields and possible crop failures;
- Limited rooting depth due to periodic waterlogging of the Rensburg soil forms are associated with wetland features. Although these soils have little contribution to agriculture, these soils are protected by the National Water Act (Act 36 0f 1998) as they support and maintain the ecological integrity of the freshwater resources. Thus,

preservation of these soils for conservation purposes takes precedence, according to the National Water Act, 1998 (Act No. 36 of 1998); and

- Lack of soil medium for plants and crop growth for the rocky outcrop, mine infrastructure, Cullinan and Witbank (Anthrosols) soil types.

During the various phases of the proposed mining associated development, various impacts are anticipated. The anticipated impacts include soil erosion, soil compaction and soil contamination. Soil compaction is expected to be severe without mitigation measures in place due to the physical composition of Vertic soils as they contain high content of expanding clay (smectite group) minerals. All soil forms occurring within the study area have equal chance of being accidentally contaminated by various toxicants used during mining operation. These impacts mentioned above are expected to be moderate -negative without mitigation and low with mitigations.

If mitigation measures are implemented, the overall impact footprint of the proposed mining associated development will be reduced to acceptable levels from a land use and land capability point of view. The cumulative impact on land use will be the conversion of land into mining infrastructure areas resulting in the loss of potential grazing land and wilderness during the life of the mine.

The degraded areas within the footprint, with specific mention of historic and current mining activities, can be rehabilitated, in an integrated manner as part of the closure of the project and this project can therefore leave a positive legacy in the area. Thus, if integrated rehabilitation is undertaken, this project will potentially lead to a betterment of the environment post closure, thus allowing pre mining activities such as grazing and wilderness to commence. It is deemed essential that the proposed mitigation measures and recommendations presented in this report are appropriately implemented to minimise impact on soil resources. After the mitigation measures have been implemented the proposed mining development is deemed acceptable from a soil and land capability point of view.

7. REFERENCES

Agricultural Geo-referenced Information System (AGIS) database. www.agis.agric.za

Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983).

Department of Agriculture, Forestry and Fisheries. Agricultural Geo-referenced Information system (AGIS). Grazing Capacity Maps (1993).

Department of Mines (1970). 1:250 000 Geological Map Series (sheet no. 2730) of the Republic of South Africa (RSA) and the Kingdoms of Lesotho and Swaziland. Department of Mines (1970).

International Union of Soil Sciences (IUSS) Working Group (2014). World Reference Base (WRB) for Soil Resources 2014. International soil classification system for naming soils and creating legends for soil maps. World Soil Resources Reports No. 106. FAO, Rome

Lubbe, W. 2019. Bushveld Vametco: Wetland and Riparian Impact Assessment. WaterMakers.

Morgenthal, T.L., Newby, T., Smith, H.J.C., and Pretorius, D.J. (2004*). Developing and refinement of a grazing capacity map for South Africa using NOAA (AVHRR) satellite derived data*. Report GW/A/2004/66. ARC Institute for Soil, Climate and Water, Pretoria.

National Department of Agriculture, 2002. Development and Application of a Land Capability Classification System for South Africa

Soil Classification Working Group, 2018. Soil classification. A Natural and Anthropogenic System for South Africa. Mem. agric. nat. Resource. S. Afr. No. 15. Dept. Agric. Dev., Pretoria.

APPENDIX A: ASSESSMENT METHODOLOGY

Land Capability Classification

Agricultural potential is directly related to Land Capability, as measured on a scale from I to VIII, as presented in Table A1 below. Classes I to III are classified as prime agricultural land that is well suitable for annual cultivated crops. Class IV soils may be cultivated under certain circumstances and management practices, whereas Land Classes V to VIII are not suitable for cultivation. Furthermore, the climate capability is also measured on a scale from 1 to 8, as illustrated in Table A2 below. Therefore, the land capability rating is adjusted, depending on the prevailing climatic conditions as indicated by the respective climate capability rating.

Table A1: Land Capability Classification (Scotney et al., 1987).

Land Capability Group	Land Capability Class	Increased intensity of use									Limitations
Arable	I	W	F	LG	MG	IG	LC	MC	IC	VIC	No or few limitations. Very high arable potential. Very low erosion hazard
	II	W	F	LG	MG	IG	LC	MC	IC	-	Slight limitations. High arable potential. Low erosion hazard
	III	W	F	LG	MG	IG	LC	MC	-	-	Moderate limitations. Some erosion hazards
	IV	W	F	LG	MG	IG	LC	-	-	-	Severe limitations. Low arable potential. High erosion hazard.
Grazing	V	W	-	LG	MG	-	-	-	-	-	Water course and land with wetness limitations
	VI	W	F	LG	MG	-	-	-	-	-	Limitations preclude cultivation. Suitable for perennial vegetation
	VII	W	F	LG	-	-	-	-	-	-	Very severe limitations. Suitable only for natural vegetation
Wildlife	VIII	W	-	-	-	-	-	-	-	-	Extremely severe limitations. Not suitable for grazing or afforestation.

W - Wildlife
F - Forestry
LG - Light grazing
MG – Moderate grazing
IG - Intensive grazing
LC - Light cultivation
MC - Moderate cultivation
IC - Intensive cultivation.
VIC – Very intensive cultivation

Table A2: Climate Capability Classification (Scotney et al., 1987).

Climate Capability Class	Limitation Rating	Description
C1	None to slight	Local climate is favourable for good yield for a wide range of adapted crops throughout the year.
C2	Slight	Local climate is favourable for good yield for a wide range of adapted crops and a year round growing season. Moisture stress and lower temperatures increase risk and decrease yields relative to C1.
C3	Slight to moderate	Slightly restricted growing season due to the occurrence of low temperatures and frost. Good yield potential for a moderate range of adapted crops.
C4	Moderate	Moderately restricted growing season due to low temperatures and severe frost. Good yield potential for a moderate range of adapted crops but planting date options more limited than C3.
C5	Moderate to severe	Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Suitable crops may be grown at risk of some yield loss.
C6	Severe	Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Limited suitable crops for which frequently experience yield loss.

Climate Capability Class	Limitation Rating	Description
C7	Severe to very severe	Severely restricted choice of crops due to heat, cold and/or moisture stress.
C8	Very severe	Very severely restricted choice of crops due to heat and moisture stress. Suitable crops at high risk of yield loss.

Impact Assessment Methodology

The identified impacts were assessed using a common, defensible method of assessing significance that will enable comparisons to be made between risks/impacts and will enable authorities, stakeholders and the client to understand the process and rationale upon which risks/impacts have been assessed. The method to be used for assessing risks/impacts is outlined in the sections below.

The first stage of risk/impact assessment is the identification of environmental activities, aspects and impacts. This is supported by the identification of receptors and resources, which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. The definitions used in the impact assessment are presented below.

- An **activity** is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructures that are possessed by an organisation.
- An **environmental aspect** is an 'element of an organizations activities, products and services which can interact with the environment'[1]. The interaction of an aspect with the environment may result in an impact.
- **Environmental risks/impacts** are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity, for example, disturbance due to noise and health effects due to poorer air quality. In the case where the impact is on human health or wellbeing, this should be stated. Similarly, where the receptor is not anthropogenic, then it should, where possible, be stipulated what the receptor is.
- **Receptors** can comprise, but are not limited to, people or human-made systems, such as local residents, communities and social infrastructure, as well as components of the biophysical environment such as wetlands, flora and riverine systems.
- **Resources** include components of the biophysical environment.
- **Frequency of activity** refers to how often the proposed activity will take place.
- **Frequency of impact** refers to the frequency with which a stressor (aspect) will impact on the receptor.
- **Severity** refers to the degree of change to the receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards.
- **Spatial extent** refers to the geographical scale of the impact.
- **Duration** refers to the length of time over which the stressor will cause a change in the resource or receptor.

The significance of the impact is then assessed by rating each variable numerically according to the defined criteria. Refer to the table below. The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The severity, spatial scope and duration of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity and the frequency of the impact together comprise the likelihood of the impact occurring and can obtain a maximum value of 10. The values for likelihood and consequence of the impact are then read off a significance rating matrix and are used to determine whether mitigation is necessary2.

The assessment of significance is undertaken twice. Initial, significance is based on only natural and existing mitigation measures (including built-in engineering designs). The subsequent assessment takes into account the recommended management measures required to mitigate the impacts.

[6] *The definition has been aligned with that used in the ISO 14001 Standard.*

[2] *Some risks/impacts that have low significance will however still require mitigation*

Measures such as demolishing infrastructure, and reinstatement and rehabilitation of land, are considered post-mitigation.

The model outcome of the impacts was then assessed in terms of impact certainty and consideration of available information. The Precautionary Principle is applied in line with South Africa's National Environmental Management Act (No. 108 of 1997) in instances of uncertainty or lack of information, by increasing assigned ratings or adjusting final model outcomes. In certain instances where a variable or outcome requires rational adjustment due to model limitations, the model outcomes have been adjusted.

Status of Impact

The impacts are assessed as either having a:
Negative effect (i.e. at a `cost' to the environment),
Positive effect (i.e. a `benefit' to the environment), or
Neutral effect on the environment.

Extent of the Impact

Site (site only),	**1**
Local (site boundary and immediate surrounds),	**2**
Regional,	**3**
National, or	**4**
International.	**5**

Duration of the Impact

The length that the impact will last for is described as either:

Immediate (<1 year)	1
Short term (1-5 years),	2
Medium term (5-15 years),	3
Long term (ceases after the operational life span of the project),	4
Permanent.	5

Probability of Occurrence

The likelihood of the impact actually occurring is indicated as either:

None (the impact will not occur),	0
Improbable (probability very low due to design or experience)	1
Low probability (unlikely to occur),	2
Medium probability (distinct probability that the impact will occur),	3
High probability (most likely to occur), or	4
Definite	5

Significance of the Impact

Based on the information contained in the points above, the potential impacts are assigned a significance rating (**S**). This rating is formulated by adding the sum of the numbers assigned to extent (**E**), duration (**D**) and magnitude (**M**) and multiplying this sum by the probability (**P**) of the impact.
S= (E+D+M) P

The significance ratings are given below

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

The following points were considered when undertaking the assessment:

- Risks and impacts were analysed in the context of the *project's area of influence* encompassing:
  - Primary project site and related facilities that the client and its contractors develop or controls;
  - Areas potentially impacted by cumulative impacts for further planned development of the project, any existing project or condition and other project-related developments; and
  - Areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location.
- Risks/Impacts were assessed for prospecting activities and decommissioning and rehabilitation;
- If applicable, transboundary or global effects were assessed;
- Individuals or groups who may be differentially or disproportionately affected by the project because of their *disadvantaged* or *vulnerable* status were assessed.
- Particular attention was paid to describing any residual impacts that will occur after rehabilitation.

Mitigation measure development

According to the DEA *et al.,* (2013) "Rich biodiversity underpins the diverse ecosystems that deliver ecosystem services that are of benefit to people, including the provision of basic services and goods such as clean air, water, food, medicine and fibre; as well as more complex services that regulate and mitigate our climate, protect people and other life forms from natural disaster and provide people with a rich heritage of nature-based cultural traditions. Intact ecological infrastructure contributes significant savings through, for example, the regulation of natural hazards such as storm surges and flooding by which is attenuated by wetlands".

According to the DEA *et al.,* (2013) Ecosystem services can be divided into 4 main categories:

- Provisioning services are the harvestable goods or products obtained from ecosystems such as food, timber, fibre, medicine, and fresh water;
- Cultural services are the non-material benefits such as heritage landscapes and seascapes, recreation, ecotourism, spiritual values and aesthetic enjoyment;
- Regulating services are the benefits obtained from an ecosystem's control of natural processes, such as climate, disease, erosion, water flows, and pollination, as well as protection from natural hazards; and
- Supporting services are the natural processes such as nutrient cycling, soil formation and primary production that maintain the other services.

Loss of biodiversity puts aspects of the economy, wellbeing and quality of life at risk, and reduces socio-economic options for future generations. This is of particular concern for the poor in rural areas who have limited assets and are more dependent on common property resources for their livelihoods. The importance of maintaining biodiversity and intact ecosystems for ensuring on-going provision of ecosystem services, and the consequences of ecosystem change for human well-being, were detailed in a global assessment entitled the Millennium Ecosystem Assessment (MEA, 2005), which established a scientific basis for the need for action to enhance management and conservation of biodiversity.

Sustainable development is enshrined in South Africa's Constitution and laws. The need to sustain biodiversity is directly or indirectly referred to in a number of Acts, not least the National Environmental

Management: Biodiversity Act (No. 10 of 2004) (hereafter referred to as the Biodiversity Act) and is fundamental to the notion of sustainable development. In addition, International guidelines and commitments as well as national policies and strategies are important in creating a shared vision for sustainable development in South Africa (DEA *et al.,* 2013).

The primary environmental objective of the Mineral and Petroleum Resources Development Act (MPRDA) is to give effect to the environmental right contained in the South African Constitution. Furthermore, Section 37(2) of the MPRDA states that "any prospecting or mining operation must be conducted in accordance with generally accepted principles of sustainable development by integrating social, economic and environmental factors into the planning and implementation of prospecting and mining projects in order to ensure that exploitation of mineral resources serves present and future generations".

Pressures on biodiversity are numerous and increasing. According to the DEA *et al.,* (2013) Loss of natural habitat is the single biggest cause of biodiversity loss in South Africa and much of the world. The most severe transformation of habitat arises from the direct conversion of natural habitat for human requirements, including[3]:

- Cultivation and grazing activities;
- Rural and urban development;
- Industrial and mining activities, and
- Infrastructure development.

Impacts on biodiversity can largely take place in four ways (DEA *et al.,* 2013):

- **Direct impacts:** are impacts directly related to the project including project aspects such as site clearing, water abstraction and discharge of water from riverine resources;
- **Indirect impacts:** are impacts associated with a project that may occur within the zone of influence in a project such as surrounding terrestrial areas and downstream areas on water courses;
- **Induced impacts:** are impacts directly attributable to the project but are expected to occur due to the activities of the project. Factors included here are urban sprawl and the development of associated industries; and
- **Cumulative impacts:** can be defined as the sum of the impact of a project as well as the impacts from past, existing and reasonably foreseeable future projects that would affect the same biodiversity resources. Examples include numerous mining operations within the same drainage catchment or numerous residential developments within the same habitat for faunal or floral species.

Given the limited resources available for biodiversity management and conservation, as well as the need for development, efforts to conserve biodiversity need to be strategic, focused and supportive of sustainable development. This is a fundamental principle underpinning South Africa's approach to the management and conservation of its biodiversity and has resulted the definition of a clear mitigation strategy for biodiversity impacts.

'Mitigation' is a broad term that covers all components of the 'mitigation hierarchy' defined hereunder. It involves selecting and implementing measures – amongst others – to conserve biodiversity and to protect, the users of biodiversity and other affected stakeholders from potentially adverse impacts as a result of mining or any other land use. The aim is to prevent adverse impacts from occurring or, where this is unavoidable, to limit their significance to an acceptable level. Offsetting of impacts is considered to be the last option in the mitigation hierarchy for any project.

The mitigation hierarchy in general consists of the following in order of which impacts should be mitigated (DEA *et al.,* 2013):

- **Avoid/prevent impact:** can be done through utilising alternative sites, technology and scale of projects to prevent impacts. In some cases if impacts are expected to be too high the "no project" option should also be considered, especially where it is expected that the lower levels of mitigation will not be adequate to limit environmental damage and eco-service provision to suitable levels;

[3] Limpopo Province Environment Outlook. A Report on the State of the Environment, 2002. Chapter 4.

- **Minimise impact:** can be done through utilisation of alternatives that will ensure that impacts on biodiversity and ecoservices provision are reduced. Impact minimisation is considered an essential part of any development project;
- **Rehabilitate impact:** is applicable to areas where impact avoidance and minimisation are unavoidable where an attempt to re-instate impacted areas and return them to conditions which are ecologically similar to the pre-project condition or an agreed post project land use, for example arable land. Rehabilitation can however not be considered as the primary mitigation tool as even with significant resources and effort rehabilitation that usually does not lead to adequate replication of the diversity and complexity of the natural system. Rehabilitation often only restores ecological function to some degree to avoid ongoing negative impacts and to minimise aesthetic damage to the setting of a project. Practical rehabilitation should consist of the following phases in best practice:
  - **Structural rehabilitation** which includes physical rehabilitation of areas by means of earthworks, potential stabilisation of areas as well as any other activities required to develop a long terms sustainable ecological structure;
  - **Functional rehabilitation** which focuses on ensuring that the ecological functionality of the ecological resources on the study area supports the intended post closure land use. In this regard special mention is made of the need to ensure the continued functioning and integrity of wetland and riverine areas throughout and after the rehabilitation phase;
  - **Biodiversity reinstatement** which focuses on ensuring that a reasonable level of biodiversity is re-instated to a level that supports the local post closure land uses. In this regard special mention is made of re-instating vegetation to levels which will allow the natural climax vegetation community of community suitable for supporting the intended post closure land use; and
  - **Species reinstatement** which focuses on the re-introduction of any ecologically important species which may be important for socio-cultural reasons, ecosystem functioning reasons and for conservation reasons. Species re-instatement need only occur if deemed necessary.
- **Offset impact:** refers to compensating for latent or unavoidable negative impacts on biodiversity. Offsetting should take place to address any impacts deemed to be unacceptable which cannot be mitigated through the other mechanisms in the mitigation hierarchy. The objective of biodiversity offsets should be to ensure no net loss of biodiversity. Biodiversity offsets can be considered to be a last resort to compensate for residual negative impacts on biodiversity.

The significance of residual impacts should be identified on a regional as well as national scale when considering biodiversity conservation initiatives. If the residual impacts lead to irreversible loss or irreplaceable biodiversity the residual impacts should be considered to be of *very high significance* and when residual impacts are considered to be of *very high significance*, offset initiatives are not considered an appropriate way to deal with the magnitude and/or significance of the biodiversity loss. In the case of residual impacts determined to have *medium to high significance*, an offset initiative may be investigated. If the residual biodiversity impacts are considered of low significance no biodiversity offset is required.[4]

In light of the above discussion the following points present the key concepts considered in the development of mitigation measures for the proposed development.

- Mitigation and performance improvement measures and actions that address the risks and impacts[5] are identified and described in as much detail as possible.
- Measures and actions to address negative impacts will favour avoidance and prevention over minimisation, mitigation or compensation.
- Desired outcomes are defined, and have been developed in such a way as to be measurable events with performance indicators, targets and acceptable criteria that can be tracked over defined periods, with estimates of the resources (including human resource and training requirements) and responsibilities for implementation wherever possible.

[4] Provincial Guideline on Biodiversity Offsets, Western Cape, 2007.

[5] Mitigation measures should address both positive and negative impacts

Recommendations

Recommendations were developed to address and mitigate impacts associated with the proposed development. These recommendations also include general management measures which apply to the proposed development as a whole. Mitigation measures have been developed to address issues in all phases throughout the life of the operation from planning, through to construction and operation

APPENDIX B: LEGISLATION

LEGISLATIVE REQUIREMENTS

National Environmental Management Act, 1998 (Act No.107 of 1998) (NEMA)	The National Environmental Management Act,1998 (Act No. 107 of 1998) (NEMA) and the associated Regulations as amended in 2017, states that prior to any development taking place within the environment, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment Report (BAR) process or the Environmental Impact Assessment (EIA) process depending on the scale of the impact. Provincial regulations must also be considered.
Mineral and Petroleum Resources Development Act, 2002 (Act No.28 of 2002) (MPRDA)	The obtaining of a New Order Mining Right (NOMR) is governed by the MPRDA. The MPRDA requires the applicant to apply to the DMR for a NOMR which triggers a process of compliance with the various applicable sections of the MPRDA. The NOMR process requires environmental authorisation in terms of the MPRDA Regulations and specifically requires the preparation of a Scoping Report, an EIA, an Environmental Management Programme (EMP), and a Public Participation Process (PPP).
National Environmental Management: Waste Act, 2008 (Act No.59 of 2008) (NEMWA)	NEMWA, which reforms the law regulating waste management in order to protect the health and the environment by providing reasonable measures for the prevention of pollution; provides for national norms and standards for regulating the management of waste by all spheres of government, and provides for the licensing and control of waste management activities
Conservation of Agricultural Resources Act, 1983 (Act No.43 of 1983) (CARA)	The Conservation of Agricultural Resources Act 1983 (Act No. 43 of 1983) promote the protection, management and conservation of soil resources during various land uses, by providing reasonable measures in prevention of losses and quality degradation of soil continuum. Especially, the valuable arable soils which are regarded as scarce resource and have significant contribution in supporting the local, provincial and national agricultural sector in sustaining the food security of South Africa.

APPENDIX C: DETAILS, EXPERTISE AND CURRICULUM VITAE OF SPECIALISTS

1. (a) (i) Details of the specialist who prepared the report

Ndumiso Sithole	BSc (Environmental Hydrology and Soil Science) (University of KwaZulu Natal)
Braveman Mzila	BSc (Hons) Environmental Hydrology (University of KwaZulu-Natal)
Stephen van Staden	MSc (Environmental Management) (University of Johannesburg)

1. (a). (ii) The expertise of that specialist to compile a specialist report including a curriculum vitae

Company of Specialist:	Scientific Terrestrial Services		
Name / Contact person:	Stephen van Staden		
Postal address:	29 Arterial Road West, Oriel, Bedfordview		
Postal code:	2007	Cell:	083 415 2356
Telephone:	011 616 7893	Fax:	011 615 6240/ 086 724 3132
E-mail:	stephen@sasenvgroup.co.za		
Qualifications	MSc (Environmental Management) (University of Johannesburg) BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg) BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)		
Registration / Associations	Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP) Accredited River Health practitioner by the South African River Health Program (RHP) Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum		

1. (b) A declaration that the specialist is independent in a form as may be specified by the competent authority

I, Stephen van Staden, declare that -

- I act as the independent specialist in this application;
- I will 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 applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct

----

Signature of the Project Manager

I, Ndumiso Sithole, declare that -

- I act as the independent specialist in this application;
- I will 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 applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct

----
Signature of the Specialist

I, Braveman Mzila, declare that -

- I act as the independent specialist in this application;
- I will 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 applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct

----
Signature of the Specialist

SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALISTS CONSULTANT INFORMATION
CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Managing member, Ecologist with focus on Freshwater Ecology
Date of Birth	13 July 1979
Nationality	South African
Languages	English, Afrikaans
Joined SAS	2003 (year of establishment)
Other Business	Trustee of the Serenity Property Trust and emerald Management Trust

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP);
Accredited River Health practitioner by the South African River Health Program (RHP);
Member of the South African Soil Surveyors Association (SASSO);
Member of the Gauteng Wetland Forum;
Member of International Association of Impact Assessors (IAIA) South Africa;
Member of the Land Rehabilitation Society of South Africa (LaRSSA)

EDUCATION

Qualifications

MSc (Environmental Management) (University of Johannesburg)	2003
BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg)	2001
BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)	2000
Tools for wetland Assessment short course Rhodes University	2016

COUNTRIES OF WORK EXPERIENCE

South Africa – All Provinces
Southern Africa – Lesotho, Botswana, Mozambique, Zimbabwe Zambia
Eastern Africa – Tanzania Mauritius
West Africa – Ghana, Liberia, Angola, Guinea Bissau, Nigeria, Sierra Leone
Central Africa – Democratic Republic of the Congo

PROJECT EXPERIENCE (Over 2500 projects executed with varying degrees of involvement)

1 Mining Coal, Chrome, PGM's, Mineral Sands, Gold, Phosphate, river sand, clay, fluorspar
2 Linear developments
3 Energy Transmission, telecommunication, pipelines, roads
4 Minerals beneficiation
5 Renewable energy (wind and solar)
6 Commercial development
7 Residential development
8 Agriculture
9 Industrial/chemical

REFERENCES

- Terry Calmeyer (Former Chairperson of IAIA SA)
  Director: ILISO Consulting Environmental Management (Pty) Ltd

Tel: +27 (0) 11 465 2163
Email: terryc@icem.co.za

- Alex Pheiffer
  African Environmental Management Operations Manager
  SLR Consulting
  Tel: +27 11 467 0945
  Email: apheiffer@slrconsulting.com

- Marietjie Eksteen
  Managing Director: Jacana Environmental
  Tel: 015 291 4015

Yours faithfully

STEPHEN VAN STADEN

SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF BRAVEMAN MZILA

PERSONAL DETAILS

Position in Company	Junior Wetland Ecologist and Soil Scientist
Date of Birth	03 January 1991
Nationality	South African
Languages	IsiZulu, English
Joined SAS	2017

EDUCATION

Qualifications

BSc (Hons) Environmental Hydrology (University of KwaZulu-Natal)	2013
BSc Hydrology and Soil Science (University of KwaZulu-Natal))	2012

COUNTRIES OF WORK EXPERIENCE

South Africa – Gauteng, KwaZulu-Natal, Eastern Cape, Northern Cape, North West, Limpopo, Western Cape, Mpumalanga, Free State.

SELECTED PROJECT EXAMPLES

Freshwater Ecological Assessments

- Freshwater ecological assessment as part of the water use authorisation relating to stormwater damage of a tributary of the Sandspruit, Norwood, Gauteng province.
- Wetland verification as part of the environmental assessment and authorization process for the proposed development in Crowthorne extension 67, Gauteng province.
- Freshwater assessment as part of the section 24g rectification process for unauthorised construction related activities that took place on erf 411, Ruimsig extension 9, Gauteng province
- Baseline aquatic and freshwater assessment as part of the environmental assessment and authorisation process for the N11 Ring Road, Mokopane, Limpopo Province
- Wetland Resource Scoping Assessment as Part of The Environmental Assessment and Authorisation Process for The Kitwe TSF Reclamation Project, Kitwe, Zambia
- Wetland delineation as part of the environmental assessment and authorization process for the proposed development in Boden Road, Benoni, Ekurhuleni Metropolitan Municipality, Gauteng Province.

Soil, Land Use and Land Capability Assessments

- Soil, Land Use and Land Capability Assessment as Part of The Environmental Assessment and Authorisation Process for The Proposed Dwarsrivier Expansion Project, Limpopo Province
- Alternatives Analysis as Part of The Environmental Assessment and Authorisation Process for The Proposed Development of a New Tailings Storage Facility at The Dwars River Chrome Mine, Limpopo Province
- Soil Land Use and Land Capability Assessment as Part of The Environmental Impact Assessment Process for The Proposed Anglo Platinum Der Brochen Expansion Project, Limpopo Province

- Soil, Land Use and Land Capability Assessment as Part of The Environmental Assessment and Authorisation Process for The Proposed Underground Expansion Activities at The Amandelbult Platinum Mine Complex, Thabazimbi, Limpopo Province
- Soil, Land Use and Land Capability Assessment as Part of The Environmental Assessment and Authorisation Process for The Proposed Borrow Pits Prior To The Construction of Alternative Haul Roads for Borrow Pits Near Emalahleni (Witbank) In the Mpumalanga Province
- Soil, Land Use and Land Capability Assessment as Part of The Environmental Assessment and Authorisation Process the Proposed Transvaal Gold Mining Estates (TGME) Development Project: Gold Mining Project (GMP) – Pre-Mined Residue (PMR) And Hard Rock Mining (HRM) Near Pilgrim's Rest (Project 10167), Mpumalanga Province
- Soil, Land Use and Land Capability Assessment as part of the environmental assessment and authorisation process for the proposed Witfontein Railway Siding Project Near Bethal, Mpumalanga Province
- Soil, Land Use and Land Capability Assessment as part of the environmental assessment and authorisation process for the proposed Heuningkranz Mine, Postmasburg, Northern Cape Province
- Soil, Land Use and Land Capability Assessment as Part of The Environmental Assessment and Authorisation Process for The Proposed Kanakies Mining Project, Near Loeriesfontein, Northern Cape
- Soil, Land Use and Land Capability Assessment as Part of The Environmental Impact Assessment Process for The Mining Right Application for The Proposed Opencast and Underground Mining Activities of Gold for The West Wits Project, North of Soweto, Gauteng Province

Hydropedological Wetland Impact Assessments

- Hydropedological Assessment as Part of The Water Use Authorisation Process for The Proposed Welstand Colliery, Near Kriel, Mpumalanga Province;
- Hydropedological Assessment as Part of the Environmental Assessment and Authorisation Process for the proposed Vandyksdrift Central Dewatering Project
- Hydropedological Assessment for the Proposed Evander Gold Elikhulu Tailings Storage Facility (TSF) Expansion, Mpumalanga Province
- Hydropedological Assessment as part of the environmental assessment and authorisation process for the proposed Palmietkuilen Mine, Springs, Gauteng Province
- Hydropedological Assessment as part of the environmental assessment and authorisation process for the
- proposed Uitkomst Colliery Mine expansion, Newcastle, KwaZulu-Natal Province
- Hydropedological Assessment for The Proposed Khutala Water Treatment Plant and Kendal 5 Seam Underground Mine Dewatering at Khutala Colliery, Near Ogies, Mpumalanga Province
- Hydropedological Assessment as Part of The Water Use Authorisation Process for The Proposed Welgemeend Mining Project, Near Kriel, Mpumalanga Province
- Hydropedological Assessment Process for The Proposed Kebrafield Colliery Near Delmas Within the Mpumalanga Province
- Hydropedological Assessment as Part of The Environmental Impact Assessment and Authorisation Process for The Proposed Royal Sheba Mining Project, Near Barberton, Mpumalanga Province
- Hydropedological Assessment as Part of The Environmental Impact Assessment and Authorisation Process for The Proposed Rietvlei Mining Project, Near Middleburg, Mpumalanga Province
- Hydropedological Assessment as Part of The Environmental Impact Assessment and Authorisation Process for The Proposed Dorstfontein West Expansion Project, Near Kriel, Mpumalanga Province

Soil Rehabilitation Assessments

- Soil rehabilitation plan, a water resource assessment and develop a management plan in support of the water use license for the Driefontein operations, Carletonville, Gauteng

SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALISTS CONSULTANT INFORMATION
CURRICULUM VITAE OF NDUMISO SITHOLE

PERSONAL DETAILS

Position in Company	Junior Wetland Ecologist and Soil Scientist
Date of Birth	21 February 1992
Nationality	South African
Languages	IsiZulu and English
Joined SAS	2019

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Candidate Natural Scientist with the South African Council for Natural Scientific Professions (SACNASP);

Member of the South African Wetland Society (SAWS);

Member of International Association for Impact Assessment (IAIAsa).

EDUCATION

Qualifications

BSc (Hons) Environmental Monitoring and Modelling (University of South Africa)	(In-Progress)
BSc Hydrology and Soil Science (University of KwaZulu Natal)	2014

COUNTRIES OF WORK EXPERIENCE

South Africa – KwaZulu Natal, Mpumalanga, North West, Limpopo, Gauteng and Northern Cape

SELECTED PROJECT EXAMPLES

Soil, Land Use and Land Capability Assessments

- Soil, Land Use and Land Capability Assessment as part of the environmental assessment and authorisation process for the proposed, Royal Sheba Mine Mpumalanga Province
- Soil, Land Use and Land Capability Assessment as part of the environmental assessment and authorisation process for the proposed Theta Hill Mining Project, Mpumalanga Province
- Soil, Land Use and Land Capability Assessment as Part of The Environmental Assessment and Authorisation Process for The Proposed Dorsfontein west Mining Project, Mpumalanga Province
- Soil, Land Use and Land Capability Assessment as Part of the Environmental Assessment and Authorisation Process for the Proposed Biespruit Mining Project, Limpopo Province.
- Soil, Land Use and Land Capability Assessment as part of the Environmental Assessment and Authorisation Process for the proposed Fine Chrome Recovery Plant project, Limpopo Province.
- Soil, Land Use and Land Capability Assessment as Part of the Environmental Assessment and Authorisation process for the proposed development at Doornfontein Mining project, Northern Cape
- Soil, Land Use and Land Capability Assessment as Part of the Environmental Assessment and Authorisation process for the proposed development at Mamantwan Mining project, Northern Cape

- Soil, Land Use and Land Capability Assessment as Part of the Environmental Assessment and Authorisation process for the proposed coal washing bay, Nasonti Mine, Mpumalanga.

Freshwater Ecological Assessment

- Wetland verification as part of the environmental assessment and authorization process for the proposed development Rhenostersruit, North West province.
- Wetland Monitoring as part of water use license requirement Rietvlei Mine, Mpumalanga province
- Wetland verification as part of the environmental assessment and authorization process for the proposed alluvial diamonds mine, EJ Diamonds, North West province.
- Wetland identification, delineation and impact assessment as part of the environmental assessment and authorization process for the proposed Welgeemend coal mining, Mpumalanga province.
- Wetland identification, delineation and impact assessment as part of the environmental assessment and authorisation process for the proposed future development, Assmung processing plant, KwaZulu Natal.
- Wetland identification delineation and impact assessment as part of the environmental assessment and authorisation process for the proposed opencast coal mining project, Mpumalanga.