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, LAND CAPABILITY AND AGRICULTURAL POTENTIAL ASSESSMENT FOR THE PROPOSED BEESHOEK MINE EXPANSION PROJECT NEAR POSTMASBURG, NORTHERN CAPE

Prepared for

Envirogistics (Pty) Ltd

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Prepared by:	**Scientific Aquatic Services**
Report author :	**B. Mzila**
Report reviewers:	**S. van Staden (Pr.Sci.Nat)**
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EXECUTIVE SUMMARY

Scientific Aquatic Services (SAS) was appointed to conduct a soil, land use, land capability and land potential assessment for the proposed Beeshoek Mine expansion projects near Postmasburg, Northern Cape. The proposed expansion projects are split into five (5) projects and will collectively be referred to as the "focus area", unless referring to each individual project (i.e., project 1).

The aim of this study was to define the land use, land capability and land potential of the soil associated with the proposed projects in line with the Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983) which necessitates an Agricultural Potential assessment prior to land development, particularly for purposes other than agricultural land use. A soil, land use, land capability and land potential survey was conducted between in October 2020 and March 2021 to understand the potential of the land to support cultivated agriculture under rainfed conditions in line with the Conservation of Agricultural Resources Act No. 43 of 1983. The assessment entailed evaluating:

- Climatic conditions;
- Land scape setting and land use,
- Soil physical; and
- Other current limitations to various land use purposes.

Based on observation during the site assessment, the dominant land use within the focus area is wildlife/wilderness, access roads and services roads as well as existing expansion project. No cultivated commercial agricultural activities were observed within the focus area and the immediate vicinity.

The focus area traverses a Calcic and Anthropic catena with Coega/Knersvlakte, Mispah/Glenrosa being the dominant soil forms within the total investigated focus area. The remaining portions are occupied by Plooysburg/Vaalbos/Nkonkoni soil forms which occur in small patches within the focus area. These soils are considered ideal for cultivation due to:

- Good drainage characteristics;
- Sufficient depth for root growth;
- Sufficient moisture holding capacity; and
- Nutrient retention capacity to support the optimum growth and production.

The majority of the investigated focus area comprises extensively disturbed soils classified as Witbank/Cullinan formation which cover approximately 54.5%. These soils are considered as having poor physical characteristics which are not suitable for cultivated agricultural practices. The shallow soils of Coega/Knersvlakte (Cg) and Mispah/Glenrosa (Ms/Gs) formations collectively cover approximately 35.6% of the total investigated focus area. The occurrence of Hardrock/Lithic and Hard Carbonate material near and/or at the surface on these soil forms restricts root growth and creates conditions that are not conducive to the cultivation of most cultivated crops. Only 9.8% of the total investigated area is considered suitable for cultivated agricultural practices under intensive management practices (i.e. irrigation). Below is a tabular representation of the dominant soils, with relative description of soil horizons as well as associated land capability. Table **A** below presents the dominant soils, with their relative description of soil horizons as well as the associated land capability and land potential.

The findings of this assessment suggest that the relevant soil limiting factors within the focus area for land capability and land use potential include the following:

- Shallow effective rooting depth due to shallow indurated bedrock of the Mispah/Glenrosa, Coega/Knersvlakte soil forms. As such, these soils are not considered to contribute significantly to agricultural productivity;
- Seasonal waterlogging of the Kolke and Lepallane soil forms within the associated with the seasonal wetland features. 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, surface water areas and Witbank (Anthrosols) soil types.

Table A: Dominant soil forms and their respective land capability and land potential

Soil Forms	Code	Diagnostic Horizon Sequence	Land Capability	Land Potential	Areal Extent (ha)	Percentage (%)
Plooysburg	Py	Orthic/Red Apedal/Hard Carbonate or Hard Rock	Class (III)	Restricted potential	499.4	9.8
Vaalbos	Vb	Orthic/Red Apedal/Hard Rock				
Nkonkoni	Nk	Orthic/Red Apedal/ Lithic				
Kolke	Ko	Orthic/Soft Carbonate/Unconsolidated material with wetness	Grazing (Class V)	Vlei	3.2	0.1
Lepallane	Lp	Unconsolidated material with wetness				
Mispah	Ms	Orthic/Hard Rock	Grazing (Class VI)	Very Restricted potential	1802.0	35.6
Glenrosa	Gs	Orthic/Lithic				
Coega	Cg	Orthic/Hard Carbonate				
Knersvlakte	Kn	Orthic/Dorbank				
Witbank	Wb	Unspecified	Wilderness (Class VIII)	Very low potential	2757.6	54.5
Total					**5062.2**	**100**

The climatic conditions associated with the focus area and surroundings are characterised by severe climatic limitations with Mean Annual Precipitation ranging between 201-400mm per annum, thus making the focus area unsuitable for commercial cultivation under rainfed conditions due to high risk of plant desiccation and subsequent permanent wilting. From a land capability point of view, the proposed expansion project footprint is largely dominated by shallow soils with low agricultural potential soils with only minor areas comprising of High agricultural potential. At best, the Coega/Knersvlakte, Mispah/Glenrosa soil forms are suitable for marginal grazing. Although arable soils occur with the expansion project footprint (Plooysburg), given the climatic constraints of the area (Rainfall less than 400 mm) and lack of irrigation options, these soils are not likely to contribute substantially to national food production. Furthermore, high temperatures occurring in this area are also likely to cause crop wilting, thus affecting crop yield. Given these constraints the extent of the high productivity soils is not considered sufficient for viable cultivated commercial farming.

Livestock commercial farming is marginal for one (1) landowner for the proposed area extent to be affected by mining activities, due to the grazing capacity low grazing capacity for this area (14 Hectares per animal). Although the grazing capacity indicated in the existing database is 14ha/LSU, based on the field investigation considering the veld condition (i.e., sparsity and palatability of grass) and occurring soils the grazing capacity is anticipated to be lower than indicated. Therefore, this area it is not considered sufficient for viable commercial farming unless intensive management practices are implemented.

The proposed expansion projects will impact the soil resources in varying severities, with project 3 posing the highest impact significance due to its extent as well as the encroachment on high agricultural potential soils. Project 2 is anticipated to have the second highest impact while the remaining projects are anticipated to a limited impact since the majority of the development will occur on previously disturbed soils. Although there is occurrence of arable soils, low potential crop yields are foreseen for this area due to climatic constraints (i.e., limited rainfall) and lack of irrigation options. Nevertheless, protection of high agricultural resources (where feasible) is deemed imperative in efforts to conserve the finite agricultural resources in line with the CARA (CARA), 1983 (Act No. 43 of 1983).

The surrounding areas within which the proposed expansion project is to occur are dominated by Iron Ore mines, and no cultivated agricultural activities occur in the immediate vicinity. This is largely attributable to the dominance of rocky outcrops and shallow soils which are not ideal for cultivated agricultural production.

Therefore, based on the above-mentioned limiting factors, the proposed project is anticipated to lead to a relatively low cumulative loss of arable land and medium low cumulative loss of natural grasslands for grazing. Therefore, from a soil and land capability point of view, the addition to the cumulative impact footprint of the region is considered relatively minor.

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 1.1
cA)	An indication of the quality and age of base data used for the specialist report	Section 2
cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5
d)	The date of the site investigation	Section 1
e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 2
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 alternatives	Section 4
h)	Map of the pre-determined soil and land capability data	Section 3
i)	A description of any assumption made and any uncertainties	Section 1.2
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
k)	Any mitigation measures for inclusion in the EMPr	None
l)	Any conditions for inclusion in the environmental authorisation	None
m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	None
n)	A reasoned opinion -	Section 7
(i)	As to whether the proposed activity, activities or portions thereof should be authorised	None
(iA)	Regarding the acceptability of the proposed activity or activities	None
(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	None
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

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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.
Pedoturbation	Physical churning and turning of soil either by swelling and shrinking of clays, freezing and thawing or animal action
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, land capability and land potential assessment for the proposed Beeshoek Mine expansion projects near Postmasburg, Northern Cape. The proposed expansion projects are split into five (5) projects and will collectively be referred to as the "focus area", unless referring to each individual project (i.e., project 1).

The Beeshoek Mine is situated approximately 7 km west of the town of Postmasburg, and 70 km south of Kathu within the Tsantsabane Local Municipality and within the ZF Mgcawu District Municipality. Refer to Figure 1 and 2.

The aim of this study is to define the land capability and land potential of the soil associated with the proposed projects in line with the Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983) which necessitates an Agricultural Potential assessment prior to land development, particularly for purposes other than agricultural land use. Agricultural potential is directly correlated to Land Capability Class (LCC), measured on a scale of I to VIII, with classes I to III considered as prime agricultural soils, and classes V to VIII not suitable for cultivation. High potential agricultural land is defined as having "*the soil and terrain quality, growing season and adequate available moisture supply to sustain crop production when treated and managed according to best possible farming practices*" (Land Capability report, ARC, 2006).

1.1 Project Description

Assmang (Pty) Ltd is the holder of the new order rights in terms of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA) in respect of high-grade hematite iron ore deposits at Beeshoek on the farms Beesthoek and Olynfontein. The mining method currently entails an opencast mining operation, which consists of five (5) active opencast pits (Village Opencast Pit, HF Opencast Pit, BF Opencast Pit, East Opencast Pit, and BN Opencast Pit). Although other opencast pits are dormant at this time, these are continuously assessed in terms of their economic value. The current resources of the Mine are approximately 87 million tonnes with a reserve of about 26 million tonnes.

Beeshoek Mine can broadly be categorised as follows:

- Northern Mining Area ("North Mine"): This area comprises active as well as historical mining areas. Several small quarries and mine residue dumps of various categories are located within this area. The area also includes the existing iron ore beneficiation plant, tailings storage facility (slimes dam), as well as the North Opencast Pit (BN Opencast Pit);

- Main Offices, village (since demolished) and recreational area; and
- Southern Mining Area (“South Mine”): This area comprises large opencast pits and associated Waste Rock Dumps (WRDs). The Village Opencast Pit and associated WRD are the main activities in this area. This area also includes a crushing and screening area as pre-preparation of the Run of Mine (ROM) iron ore before being routed by overland conveyor to the Iron Ore Beneficiation Plant located at North Mine.

The purpose of the Beeshoek Mine project is to give effect to the Regulation 23 MPRDA requirements for the optimisation of the Mining Right, as well as the implementation of the best practical environmental management measures for the operation and management of the WRDs. Further to this, the proposed Beeshoek Low-Grade Beneficiation Optimisation Project is to allow Beeshoek Mine to optimise the mining process and reduce mineral waste on site (in line with the National Waste Management Hierarchy) by implementing two additional Beneficiation Projects, namely a new WHIMS Plant to rework the existing slimes from the Slimes Dam and a new Jig Plant to rework the existing low-grade stockpile (Discard Dump).

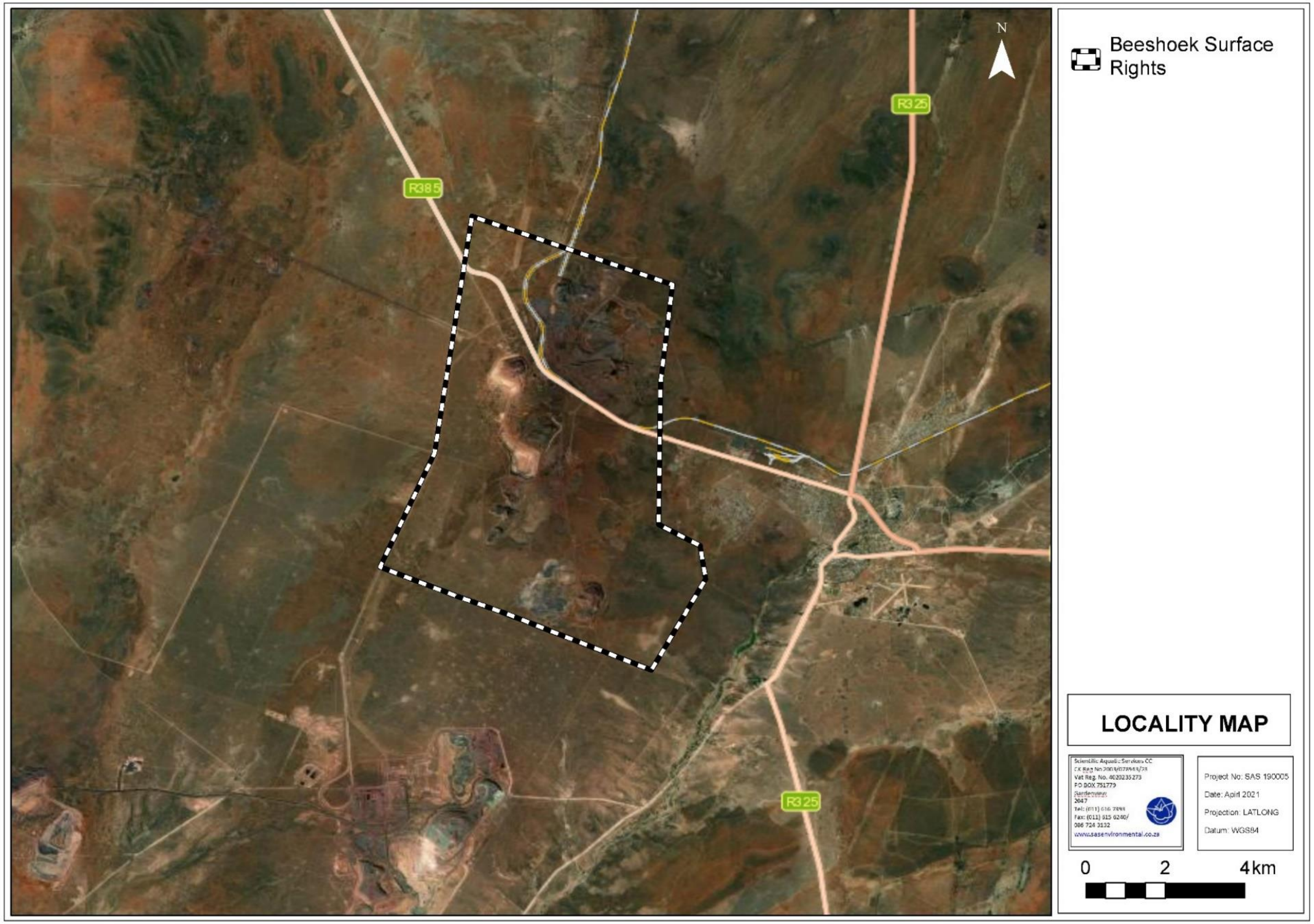

Figure 1: Digital satellite imagery depicting the locality of the focus area in relation to the surrounding areas.

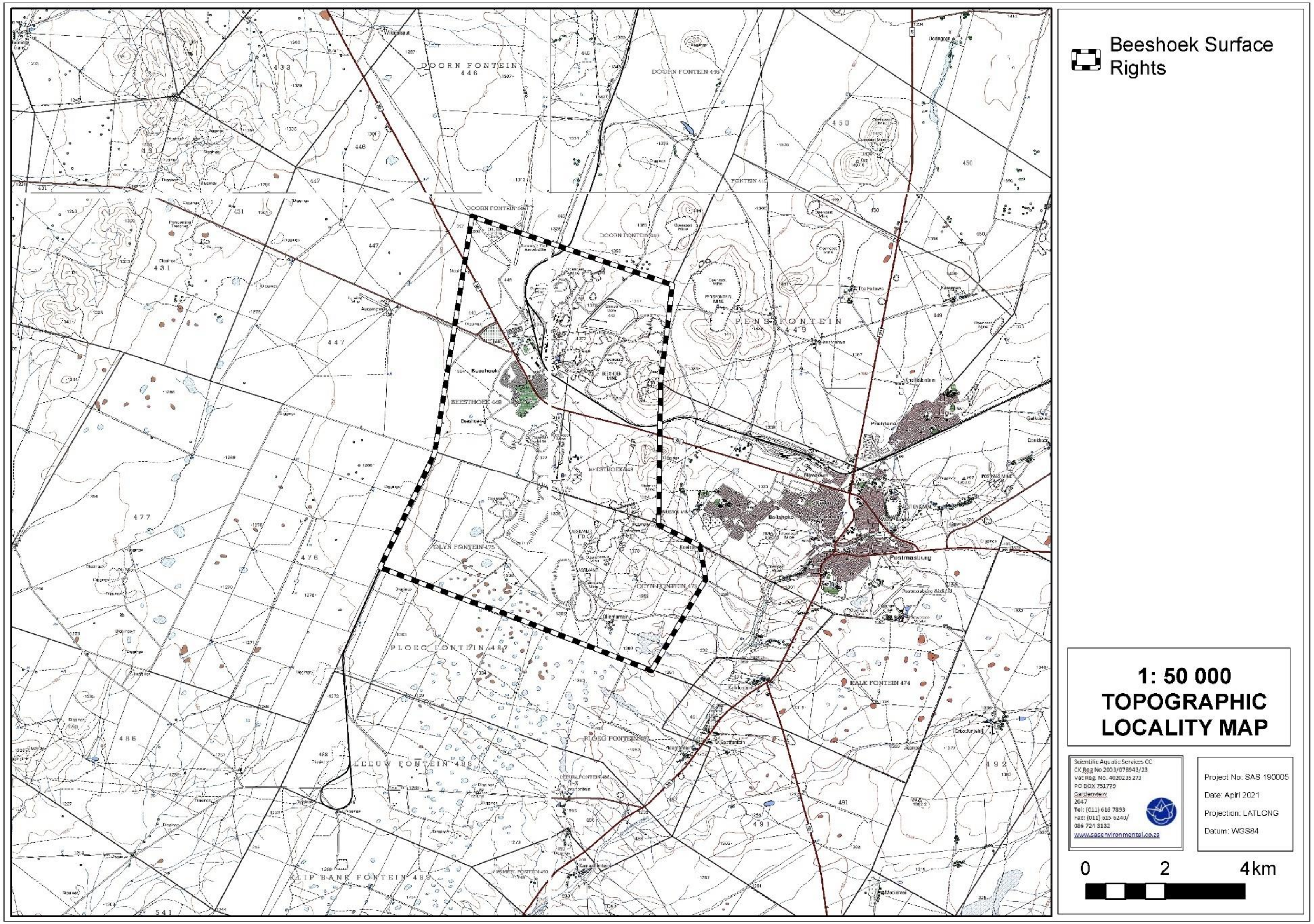

Figure 2: Location of the focus area depicted on a 1:50 000 topographical map in relation to surrounding area

Detailed descriptions of the proposed five (5) projects are provided below.

Project 1: Consolidation of Run of Mine (ROM) Stockpiles on South Mine (Figure 3).

In areas where individual ROM stockpiles are located (OM Stockpile, South Contaminated ROM 1 and Contaminated Dump 2), these will be consolidated to allow for further capacity and operational management – referred to as the "**Consolidated ROM Footprint**". The ROM stockpile area on South Mine will thus be demarcated as a combined ROM stockpile area for both on-grade, off-grade and BIS.

Specific details include:

- Overall Area: 35 ha.
- No clearance of vegetation is required; this area is located on the north-eastern perimeter of the West Pit Waste Rock Dump (WRD) in a legally disturbed area.
- Heights will not exceed 10 m.

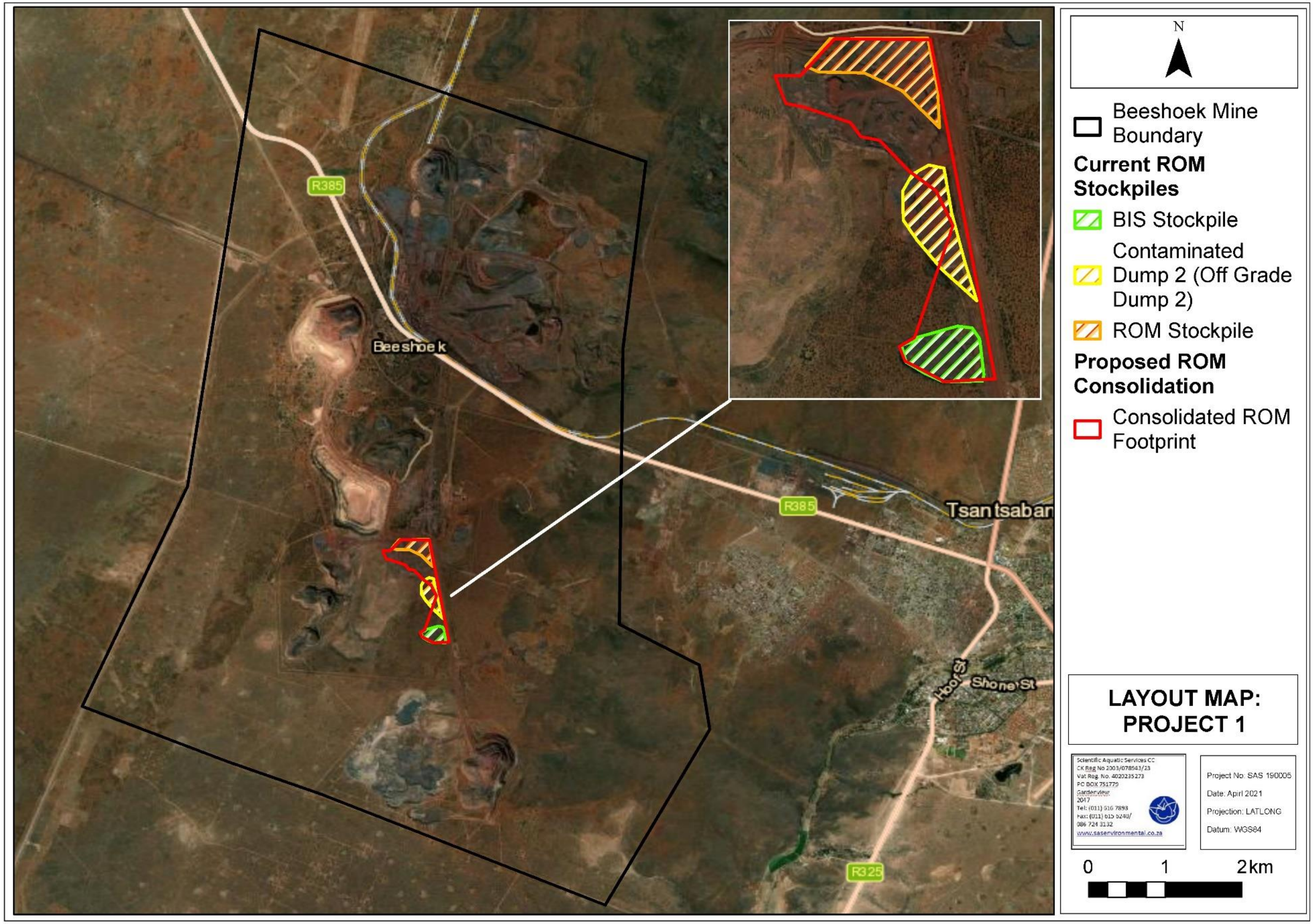

Figure 3: Layout map of Project 1

Project 2: Amendments to the design of existing Waste Rock Dumps (WRDs) in terms of the increase in heights, and allowance for final slope, which will result in extension of footprints (Figure 4).

The Beeshoek Mine proposes to increase the heights of several existing WRDs. The increase in the height will also require the increase in the footprint areas, to allow for the correct slope at closure. The below list of WRDs is targeted for height and footprint increase:

- **Village Waste Rock Dump (VP1):** Current area approximate 70 ha, to be increased with approximately 26 ha (final area 96 ha) to allow for final slope and footprint upon rehabilitation (area pending designs but will involve clearance of about 25 ha). Dimensions are as follows:
  - Footprint: 96 m
  - Height: 120 m, upon rehabilitation 70 ha.
- **GF Waste Rock Dump**: Current area approximately 48 ha, to be increased by about 6 ha (final area about 54 ha) to allow for final slope and footprint upon rehabilitation (area pending designs). Dimensions are as follows:
  - Footprint: 54 ha.
  - Height: 120 m, upon rehabilitation 97 ha.
- **East Pit Waste Rock Dump**: Current area approximately 144 ha, to be increased by about 26 ha (final area about 170 ha) to allow for final slope and footprint upon rehabilitation (area pending designs but will involve clearance more than 25 ha). Dimensions are as follows:
  - Footprint: 170 ha.
  - Height: 120 m, upon rehabilitation 114 ha.
- **West Pit Waste Rock Dump (VP2):** Current area approximately 80 ha, to be increased with about 55 ha (final area 135 ha) to allow for final slope and footprint upon rehabilitation (area pending designs but will likely involve clearance of about 35 ha). Dimensions are as follows:
  - Footprint: 135 ha.
  - Height: 110 m, upon rehabilitation 707 ha.
- **HF Waste Rock Dump (new dump on historic dump footprint):** Current area approximately 20 ha and used for BIS stockpiling, to be reused to allow for HF Pit waste rock disposal, as well as final slope and footprint upon rehabilitation (area pending designs). This area is located on an existing WRD footprint (no additional clearance therefore required). Dimensions are as follows:
  - Footprint: 20 ha.

- Height: 50 ha, upon rehabilitation 50 ha.

➢ **Discard Dump:** Current area approximately 28 ha, to be increased to about 60 ha. This area is located within the mining area, between WRDs, Slimes Dam and Opencast Pits, no clearance will be required. Dimensions are as follows:
  - Footprint: 60 ha.
  - Height: 50 m.

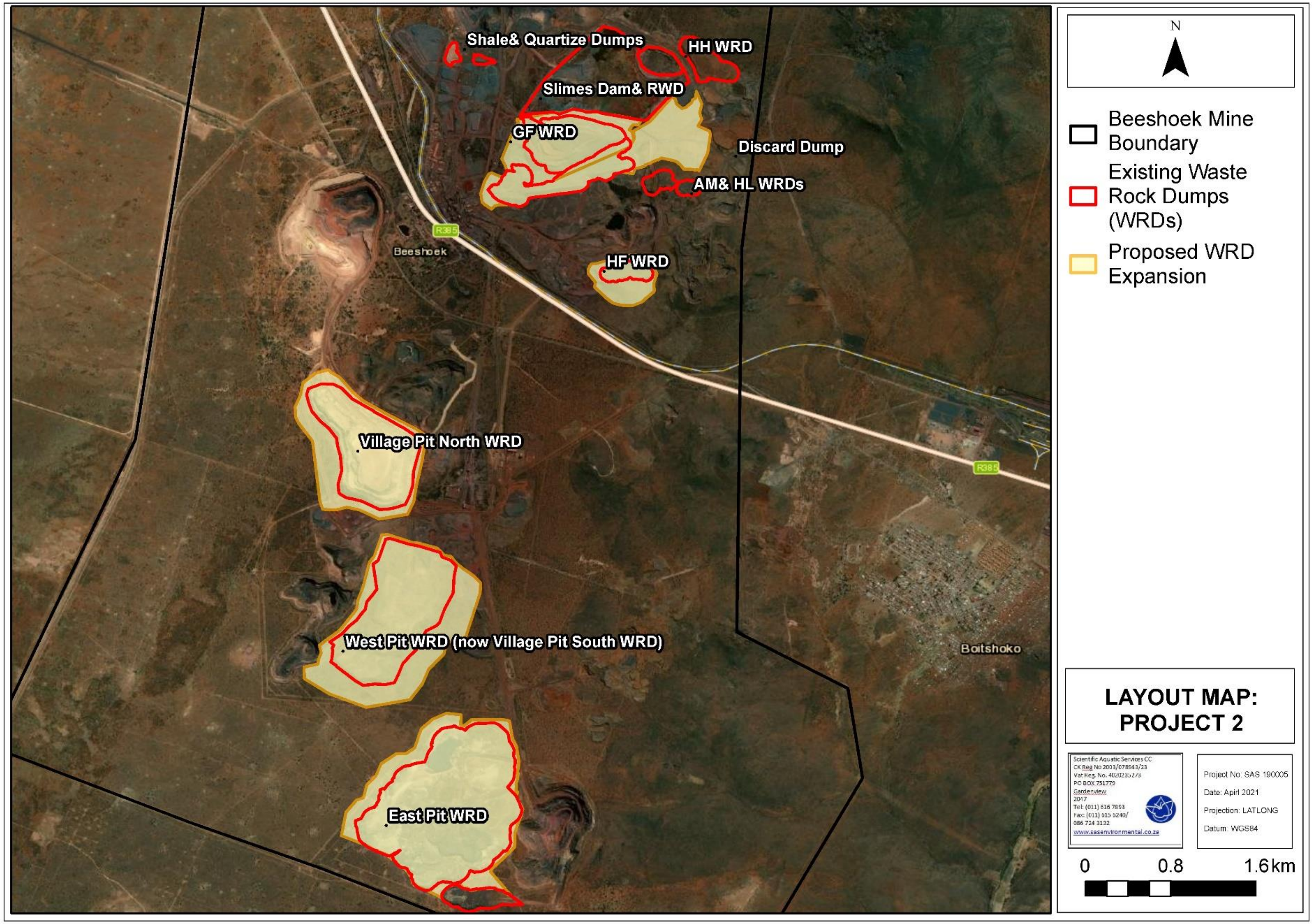

Figure 4: Layout map of Project 2

Project 3: Increase of Opencast footprint areas, as well as the undertaking of detrital mining for shallow iron ore reserves, including transportation routes (Haul roads) (Figure 5).

The mine would like to make use of the opportunity to increase the approved footprints of active pits, which will include:

- **BN Pit**
  - Depth: 162 m.
  - Area – 137 ha.
  - Planned to be expanded by 66 ha to approximately 137 ha.
  - Approximately 25 ha will require vegetation clearance.
- **Village Pit (VP North)** will be expanded by 203 ha in the future to 269 ha and will further include two satellite pits: **Pit East** and **Pit South**, each with and area of about 37 ha and 22 ha respectively. Clearance of vegetation will be required. Overall dimensions are as follows:
  - VP North Depth: 180 m.
  - VP East Depth: 160 m.
  - VP South Depth: 60 m.
  - Area: 436 ha.
- Village Exploration Block Area: To the west of the proposed Village Pit expansion area, an area for specific target exploration drilling has been demarcated. This area is about 170 ha in extent.
- **BF Pit Expansion** will be expanded from about 30 ha (comprising of 3 pits) to about 86 ha. Approximately 25 ha may require clearance.
  - Depth: 180 m.
  - Area: 86 ha.
- **East Pit**: will not result in an increase in the footprint but rather in the depth of mining within the mining shell. The depth of East Pit is planned at approximately 220 m.
  - Depth: 200 – 220 m.
  - Area: 50 ha.

Future Strategic Exploration Block Area[1]: Around the East Pit potential strategic iron ore resources have been identified. The area in question is about 976 ha.

[1] **Note in terms of the Future pit**: For this activity it is important to note that the future pit is in its planning phase, further exploration will be required in this area. Once the final designs for the mining schedule is available this will be submitted to the DMRE for approval. It will also be at this time that a detailed waste management strategy will be developed for the management of waste rock and overburden in this area. Once this information is available the necessary Waste Management License and Water Use License will be applied for from the DMRE and DWS respectively.

Various wetland systems are present within this area, as well as a potential recharge zone. Due to the presence of these sensitive ecosystems, strategic exploration drilling will be undertaken to determine the potential resources within this area. The drilling will be undertaken in terms of a management plan to ensure the least amount of disturbance to these systems.

- The Detrital Mining area of about 238 ha will be established – it should be noted that entire area will not be utilised, only where minerals are found economically viable. Clearance of vegetation will be required. Dimensions are as follows:
  - Depth: 20 - 40 m.
  - Area: 238 ha.

One additional haul road will be required:

- **Village Haul Road**: 1100 m (about 3.3 ha) with a width of 30 m. The road will be located in areas mostly disturbed with exiting mining activities or along exiting roads.

Backfilling of Opencast Pits

The 2004 Environmental Management Plan (EMP) clearly states that mine waste produced in the northern mining area will be used for the in-filling of available opencast pits areas. The Mine will backfill as far as practically possible as part of the ongoing development of the annual and long-term rehabilitation plans, but voids may remain where enviroberms will be established for safety.

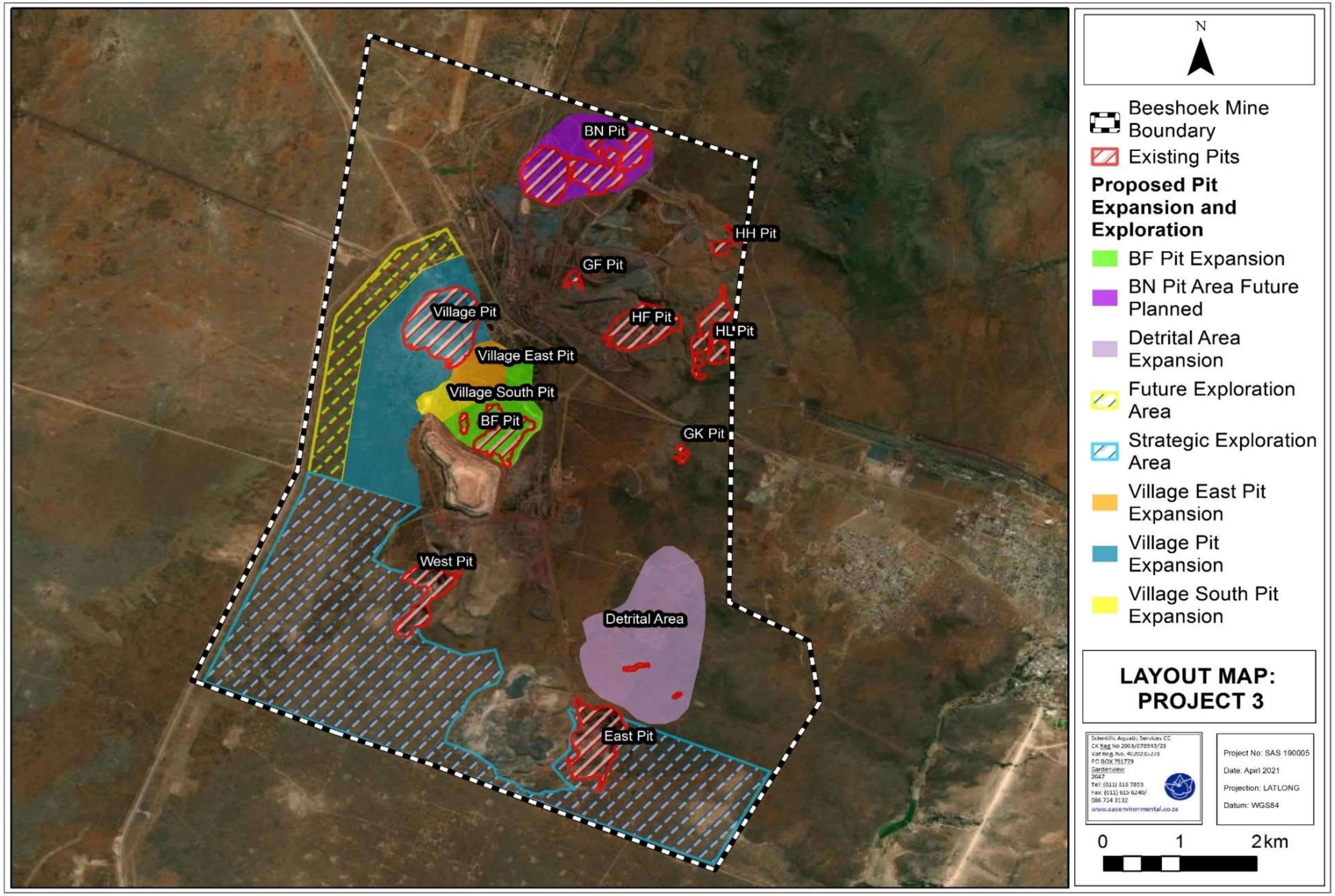

Figure 5: Layout map of Project 3

Project 4: Development of the Beneficiation Project which will comprise of a WHIMS Plant and Jig Plant at Beeshoek (Figure 6).

Beeshoek Mine has identified the opportunity to recover and economically beneficiate existing and arising low-grade resources. The intent being the construction, commissioning and bringing into production two additional beneficiation sections capable of processing ≈ 520 tph of material to produce ≈ 1 Mtpa of export quality sinter fines product.

The project includes the following footprints:

- WHIMS Plant: 13.2 ha;
- JIG Plant: Footprint: approximately 2.6 ha on already disturbed areas. Jig Plant Laydown Area: 2 ha on existing Discard Dump footprint;
- Staging Stockpile (WHIMS);
- Tailings Pipeline HDPE: 315 mm diameter at 750 m^3/hr (208.3l/s):
  - 1.1 km northern perimeter to Slimes Dam;
  - 1.4 km southern perimeter to Slimes Dam; and
  - Existing pipeline of 1.3 km to be rerouted directly to the WHIMS Plant.
- Jig Plant Road System:
  - Road 1: 240 m with a width of approx. 16 m.
  - Road 2: 700 m with a width of approx. 16 m.
  - Road 3: 280 m with a width of 16 m.
  - Road 4: 135 m with a width of about 30 m.
  - Decommissioning of existing haul road: about 800-1000 m length of about 30 m width.
- Overhead Powerline: 22 kV powerline of approx. 620 m;
- Underground electrical cable: 22 kV of approx. 380 m;
- Clearance (potentially 5.6 ha), note that the clearance associated with the road does not contribute to the listing activity for clearance.:
  - Road 1 – potential clearance of 0.1 ha (considered disturbed area).
  - WHIMS Laydown Area: approximately 1.5 ha.
  - WHIMS Plant footprint, including access road of 160 m: approximately 4 ha.
  - WHIMS Plant Central Process Water Dam: 0.4 ha, capacity less than 50 000 m^3.

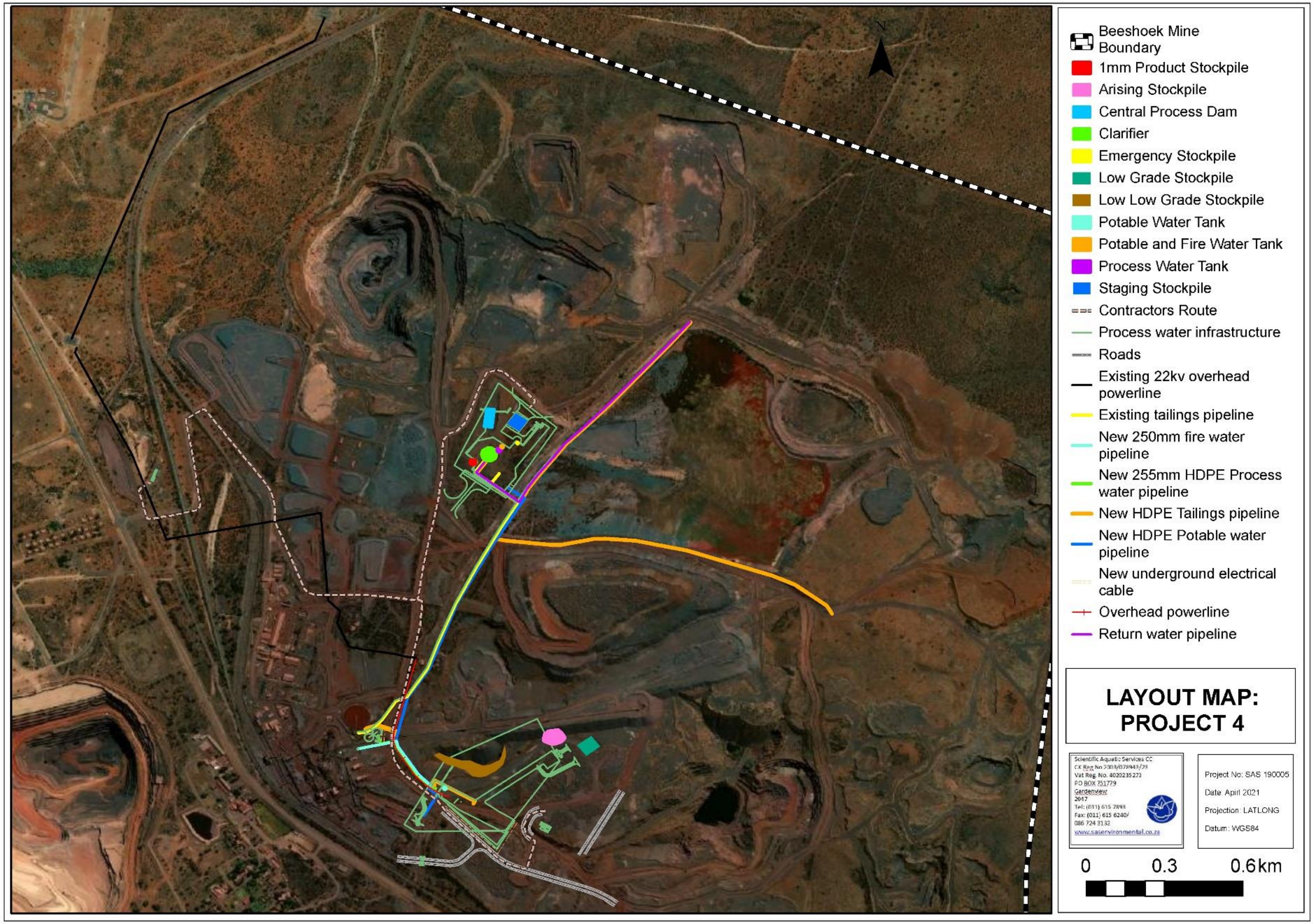

Figure 6: Layout map of Project 4

Project 5: Water Management (Figure 6).

The Beeshoek Mine will also establish additional water storage tanks on site which will include:

- An additional storage tank for clean water at the current D300 tank on South Mine. The current intended capacity is about 250 m3.
- A new additional storage tank near the existing BN Tank of 500 m^3. The purpose is to provide sufficient storage space for water from the approved in-pit dewatering activities;
- Four 10 m^3 plastic tanks at the existing clarifier, thickener area. To allow for the storage of water in the water balance system of the mine to capacitate the plant process to start up without delay;
- One 2000 m^3 process water tank adjacent to the existing Clarifier connected with a "balancing pipe". To allow for the storage of water in the water balance system of the mine to capacitate the plant process to start up without delay;
- Existing Dam: Steel Dam 250 m^3 with capacity to store process water and allow for the storage of top-up water; and
- Existing Dam: Zinc Dam: 90 m^3 with capacity to store input water where required.

Ancillary infrastructure: Topsoil stockpiles

With the expansion of area, soil layers will be stripped and place on the existing topsoil stockpiles near the detrital area, this will be dependent on the outcomes of the specialist studies.

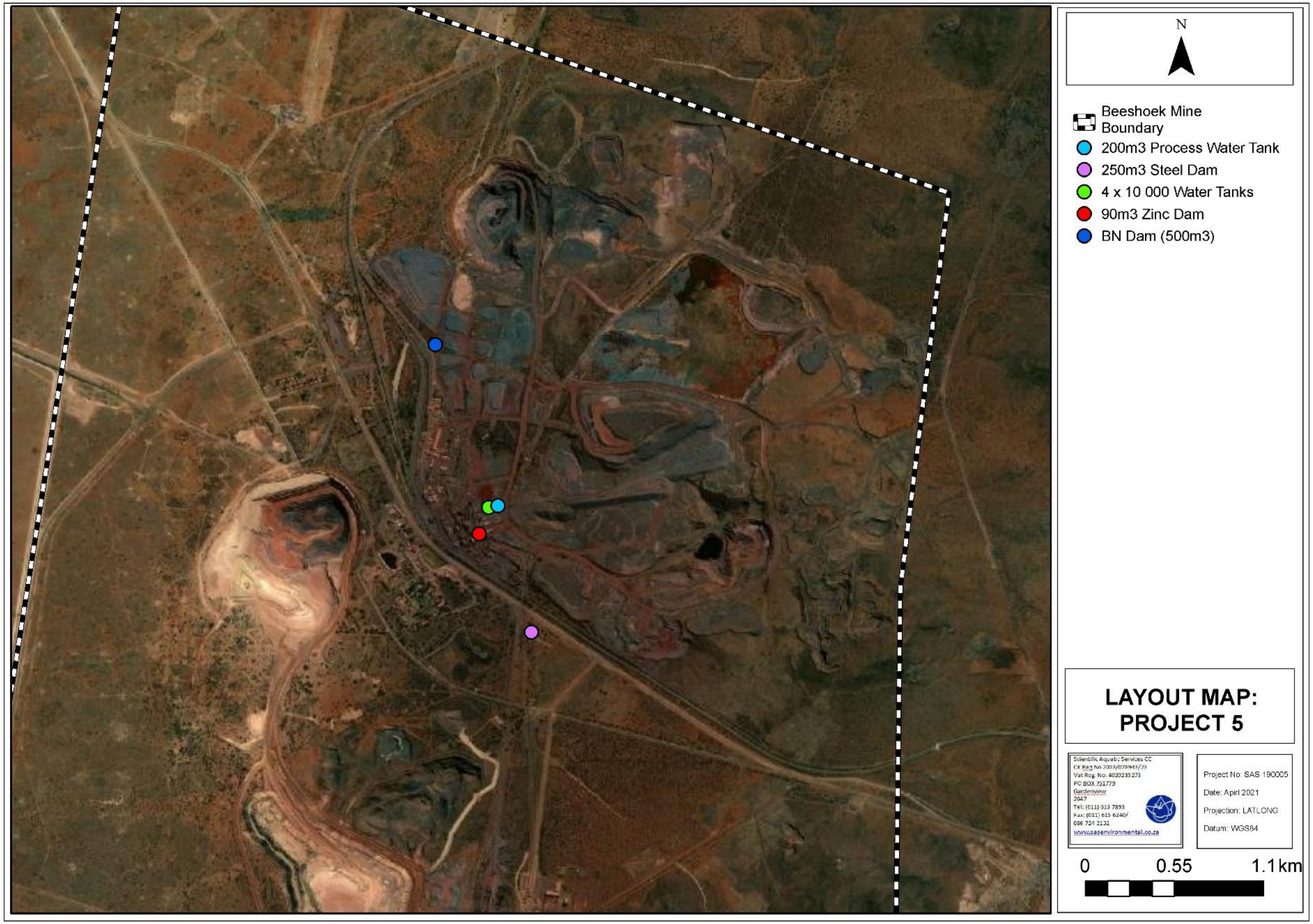

Figure 7: Project 5 - Water Management.

A soil land use and land capability and land potential survey was conducted in October 2020 and March 2021. The assessment entailed evaluating physical properties and current limitations to various land use purposes. Subsurface soil observations were made using a manual hand auger to assess individual soil sampling points.

1.2 Terms of Reference and Scope of Work

The soil and land capability assessment entailed the following aspects:

- A desktop review of existing soil and climatic database, to establish broad baseline conditions and sensitive agricultural areas;
- Assess spatial distribution of various soil forms within the focus area;
- Identify restrictive soil properties on land capability under prevailing conditions;
- Compile various maps depicting the on-site conditions, current land uses, soil forms and land capability based on desktop review of existing data;
- Conduction a soil classification survey within the focus area;
- Subsurface soil observations and sampling undertaken by means of a manual bucket hand auger;
- Classify the dominant soil forms according to the South African Soil Classification System (Soil Classification Working Group, 2018);
- Develop maps depicting the dominant soil forms, land capability and land potential based on the field investigation;
- Compile a report presenting the results of the desktop study and a description of the findings during the field assessment; and
- Provide high level recommended mitigation measures and management practices, including areas of increased land capability to avoid and implement in order to comply with applicable articles of legislation.

1.3 Assumptions and Limitations

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

- 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. However, it is the opinion of the professional 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 mining activities;

- Land Capability and land potential was classified according to current soil restrictions, with respect to prevailing climatic conditions on site; 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 not 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;
- Since soils occur in a continuum with infinite variances, it is often problematic to classify any given soils as one form, or another. for this reason, the classifications presented in this report are based on the "best fit" to the soil classification system of South Africa; 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 fertilisation prior to cultivation.

2. METHOD OF ASSESSMENT

2.1 Literature and Database Review

A desktop study was compiled from various data sources including but not limited to the Agricultural Geo-referenced Information System (AGIS) and other sources as listed under references.

2.2 Desktop Screening

Prior to commencement of the field assessment, a background study, including a literature review, was conducted to collect the pre-determined soil and land capability data in the vicinity of the investigated area. Soil patterns as well as land capability data within the focus area was reviewed on the Agricultural Geo-referenced Information System (AGIS) and/or Agricultural Research Council Institute for Soil Climate and Water (ARC-ISCW) databases.

2.3 Soil Classification and Sampling

A soil survey was conducted in October 2020 and March 2021 by a qualified soil specialist, at which time the identified soils within the focus area were classified into soil forms according to the South African Soil Classification System (Soil Classification Working Group,2018):

- Subsurface soil observations and sampling were made by means of a manual bucket hand auger;
- Dominant soil forms were classified according to the South African Soil Classification System (Soil Classification Working Group, 2018);
- Assessed survey and sampling points were recorded on a Global Positioning System (GPS);
- Physical soil properties were described including the following parameters:
  - Terrain morphological unit (landscape position) description;
  - Diagnostic soil horizons and their respective sequence;
  - Depth of identified soil horizons;
  - Soil form classification name(s);
  - Observed land capability limitations of the identified soil forms; and
  - Depth to saturation (water table), if encountered.
- Uniform soil patterns were grouped into map units, according to observed limitations; and
- Soil data was analysed to assess the contamination risk / impacts under current conditions.

It was also the objective of the assessment to provide recommended mitigation measures and management practices to implement in order to comply with applicable articles of legislation.

2.4 Land Capability Classification

Agricultural potential is directly related 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. Whereas, Class IV soils may be cultivated under certain circumstances and management practices, whereas Land Classes V to VIII are not suitable to cultivation. Furthermore, the climate capability is also measured on a scale of C1 to C8, as illustrated in Table 1 below. The land capability rating is therefore adjusted accordingly, depending on the prevailing climatic conditions as indicated by the respective climate capability rating. The anticipated impacts of the proposed land use on soil and land capability were assessed to inform the necessary mitigation measures.

Table 1: Land Capability Classification (Smith,2006)

Land Capability Class	Increased Intensity of Use									Land Capability Groups
I	W	F	LG	MG	IG	LC	MC	IC	VIC	Arable land
II	W	F	LG	MG	IG	LC	MC	IC		
III	W	F	LG	MG	IG	LC	MC	IC		
IV	W	F	LG	MG	IG	LC				
V	W		LG	MG						Grazing land
VI	W	F	LG	MG						
VII	W	F	LG							
VIII	W									Wildlife

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

Climate Capability Class	Limitation Rating	Description
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 land potential assessment entails the combination of climatic, slope and soil condition characteristics to determine the agricultural land potential of the investigated area. The classification of land potential and knowledge of the geographical distribution within an area of interest. This is of importance for making an informed decision about land use. Table 3 below presents the land potential classes, whilst Table 4 presents description thereof, according to Guy and Smith (1998).

Table 3: Table of Land Potential Classes (Guy and Smith, 1998)

Land Capability Class	Climate Capability Class							
	C1	C2	C3	C4	C5	C6	C7	C8
I	L1	L1	L2	L2	L3	L3	L4	L4
II	L1	L2	L2	L3	L3	L4	L4	L5
III	L2	L2	L3	L3	L4	L4	L5	L6
IV	L2	L3	L3	L4	L4	L5	L5	L6
V	Vlei	Vlei	Vlei	Vlei	Vlei	Vlei	Vlei	Vlei
VI	L4	L4	L5	L5	L5	L6	L6	L7
VII	L5	L5	L6	L6	L7	L7	L7	L8
VIII	L6	L6	L7	L7	L8	L8	L8	L8

Table 4: The Land Capability Classes Description (Guy and Smith, 1998)

Land Potential	Description of Land Potential Class
L1	**Very high potential:** No limitations. Appropriate contour protection must be implemented and inspected.
L2	**High potential:** Very infrequent and/or minor limitations due to soil, slope, temperatures or rainfall. Appropriate contour protection must be implemented and inspected.
L3	**Good potential:** Infrequent and/or moderate limitations due to soil, slope, temperatures or rainfall. Appropriate contour protection must be implemented and inspected.
L4	**Moderate potential:** Moderately regular and/or severe to moderate limitations due to soil, slope, temperature or rainfall. Appropriate permission is required before ploughing virgin land.
L5	**Restricted potential:** Regular and/or moderate to severe limitations due to soil, slope, temperature or rainfall.
L6	**Very restricted potential:** Regular and/or severe limitations due to soil, slope, temperature or rainfall. Non-arable.
L7	**Low potential:** Severe limitations due to soil, slope, temperature or rainfall. Non-arable.
L8	**Very low potential:** Very severe limitations due to soil, slope, temperature or rainfall. Non-arable.

3. DESKTOP ASSESSMENT RESULTS

The following data is applicable to the focus area, according to various data sources reviewed as part of the desktop assessment:

- According to the screening tool (agricultural theme), majority of the focus area has a low agricultural sensitivity, while some patches are deemed to be of medium and high agricultural sensitivity. Refer to Figure 4;
- The Mean Annual Precipitation (MAP) is estimated to range between 201 and 400mm per annum, which is considered low to support cultivation under rainfed conditions;
- According to the Geology 2001 layer, the entire focus area is underlain by Sedimentary, Dolomite and Tillite rock formations, while the lithology is comprised of clastic sedimentary rocks, and limestone and carbonate rocks, as depicted in Figure 9 and 10 respectively;
- The natural soil pH is estimated to be range between 6.5 and 7.4, indicating that the soils range between slightly acidic and neutral, as interpolated from topsoil pH values obtained from the National Soil Profile Database (AGIS database);
- According to the Soils 2001 Layer the focus area is largely situated within an area where the soils are classified as red-yellow apedal freely drained soils with a high base status and less than 300mm depth. The remaining areas comprise rocky areas with miscellaneous soils, as depicted in Figure 12. This implies that most of the soils are not ideal for cultivation for most crops due to limited soil depth;
- The desktop assessment indicates that the focus area has a very low land capability and is considered non-arable;
- Most of the focus area is considered suitable for marginal livestock grazing (Class VII). According to the AGIS database, while the remaining portions are only capable of supporting wilderness land capability. Refer to Figure 13 and 14;
- The livestock grazing capacity potential is estimated to be approximately 14 hectares per large animal unit, which is not considered viable for (Morgenthal et al., 2005);
- Predicted soil loss is very low for the entire focus area;
- The entire study is located on a Plain Landform setting; and
- The soils within the focus area have a low to moderate water or wind erosion hazard, and the area is generally level to gently sloping land. The soils therefore have low to very high erodibility.

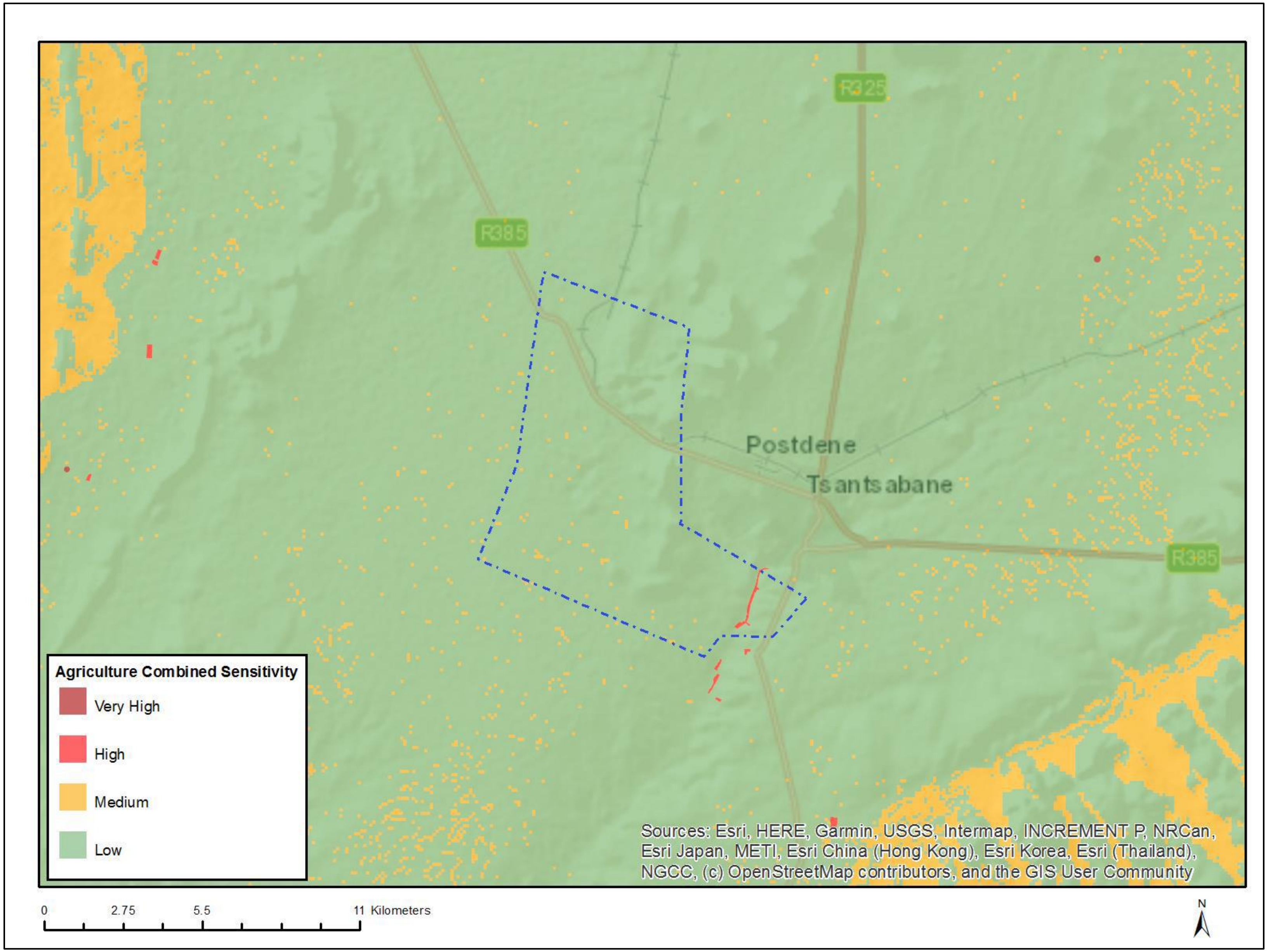

Figure 8: Screen tool – Agricultural Theme

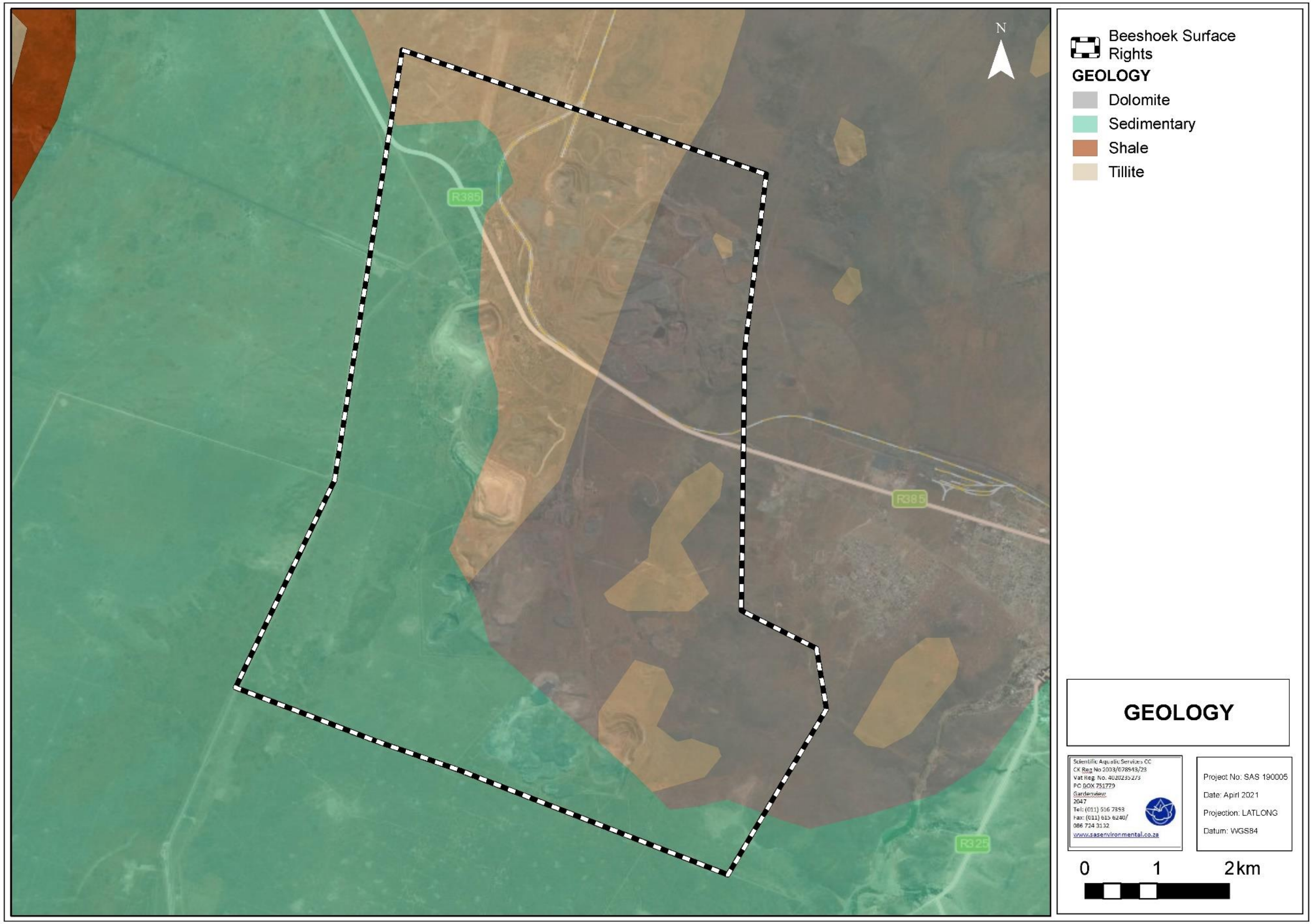

Figure 9: Geology associated with the focus area.

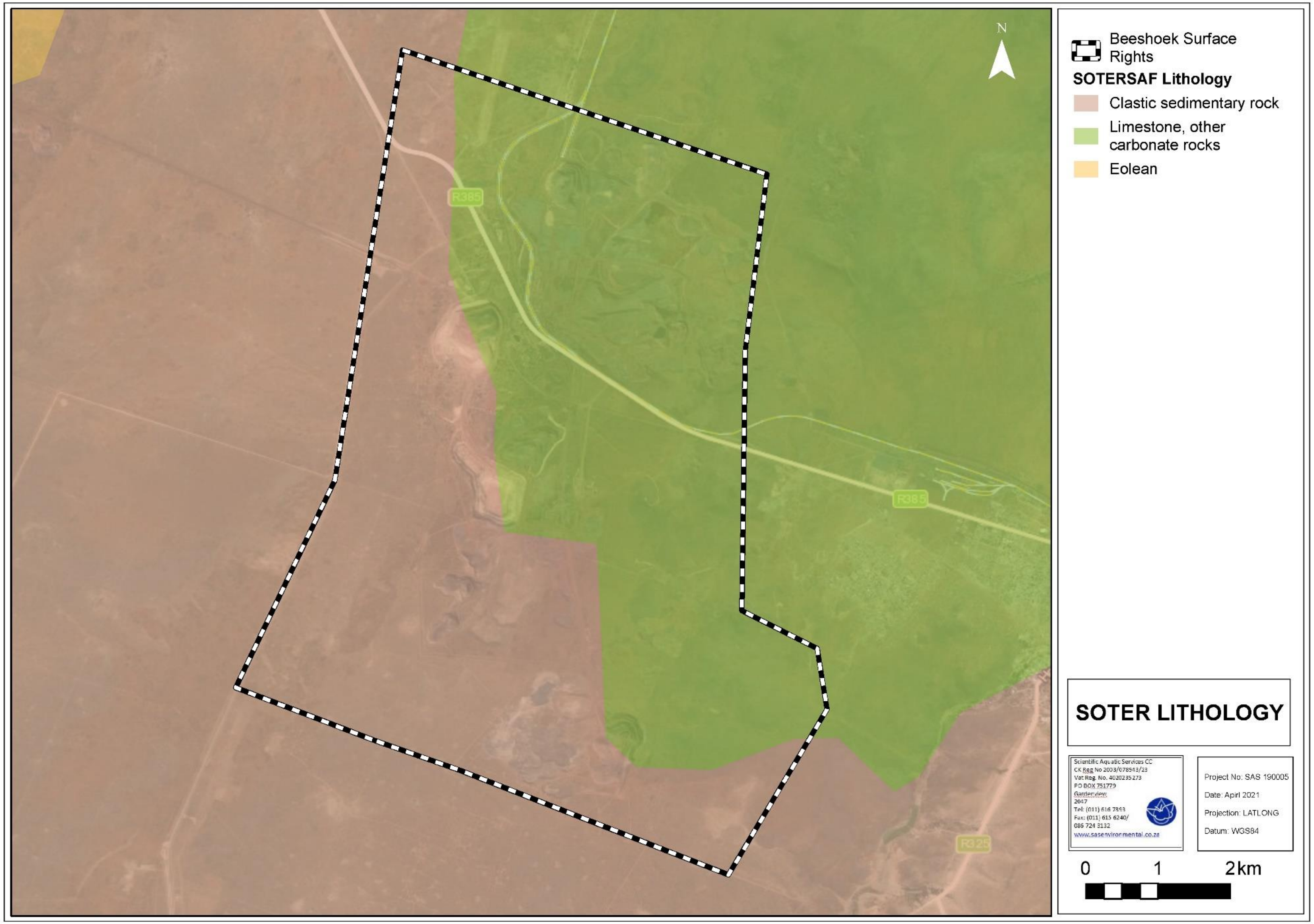

Figure 10: Lithology of the area associated with the focus area according to the SOTER Database.

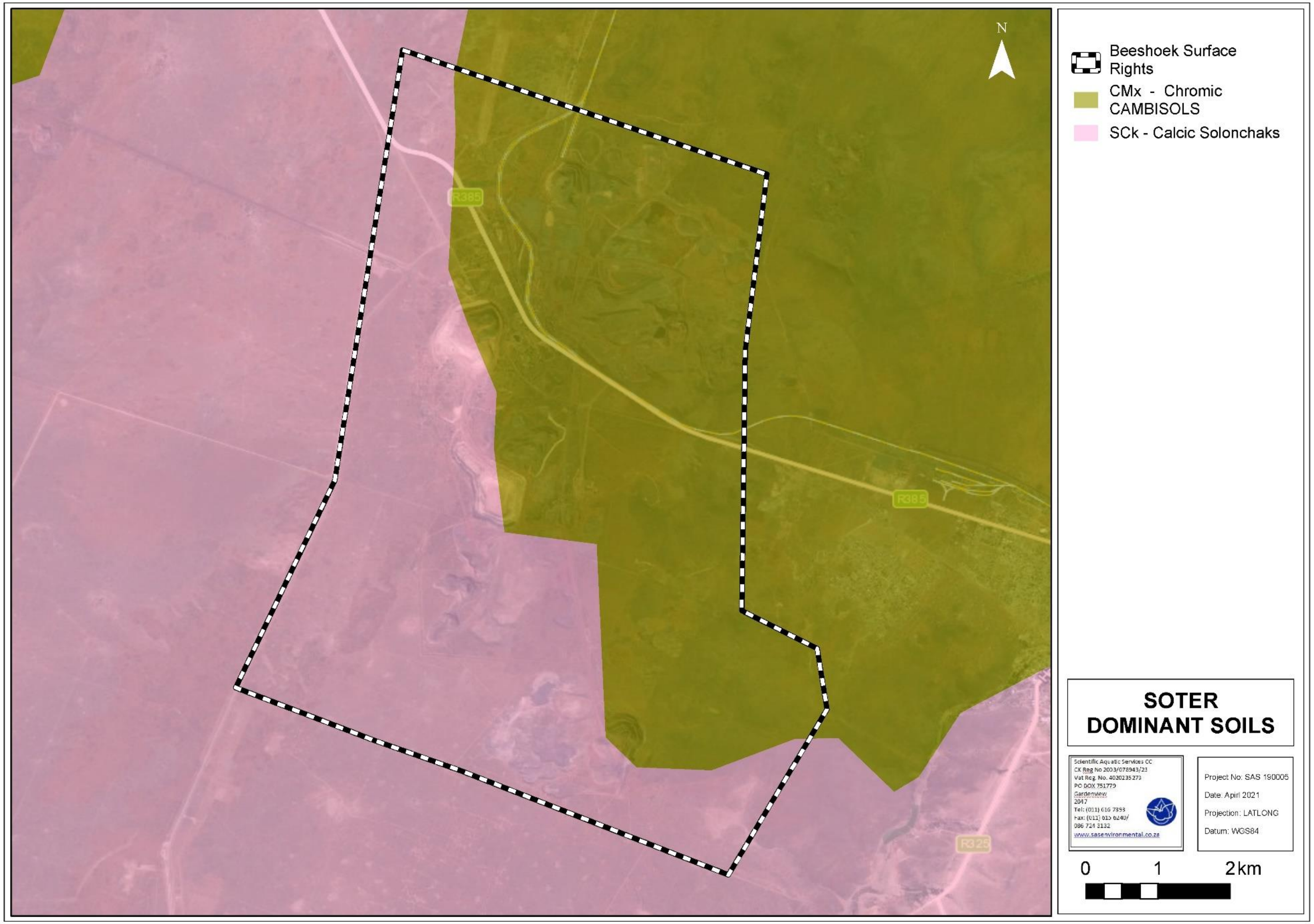

Figure 11: Dominant soils associated with the focus area according to the SOTER Database.

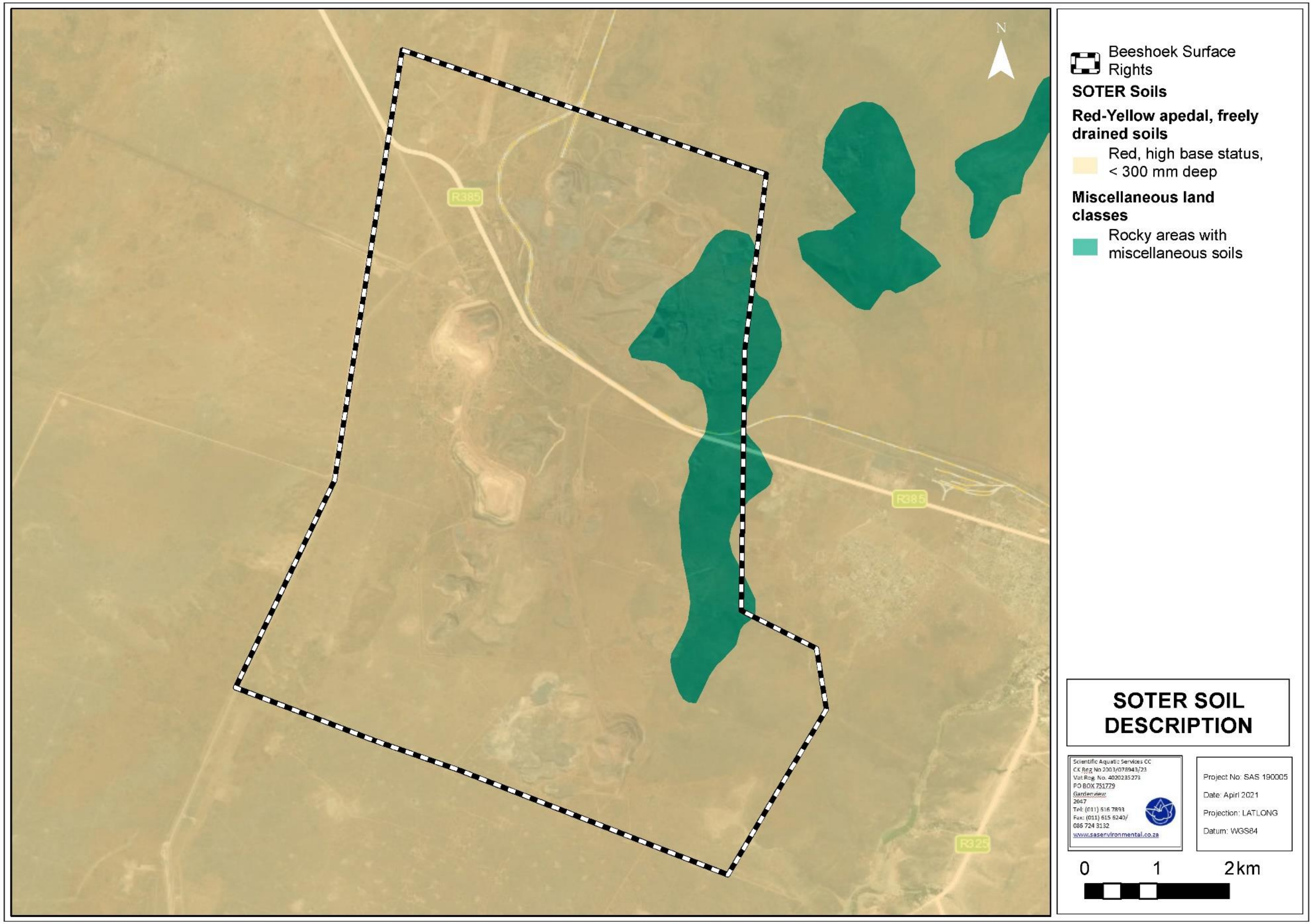

Figure 12: Soil description associated with the focus area according to the SOTER Database.

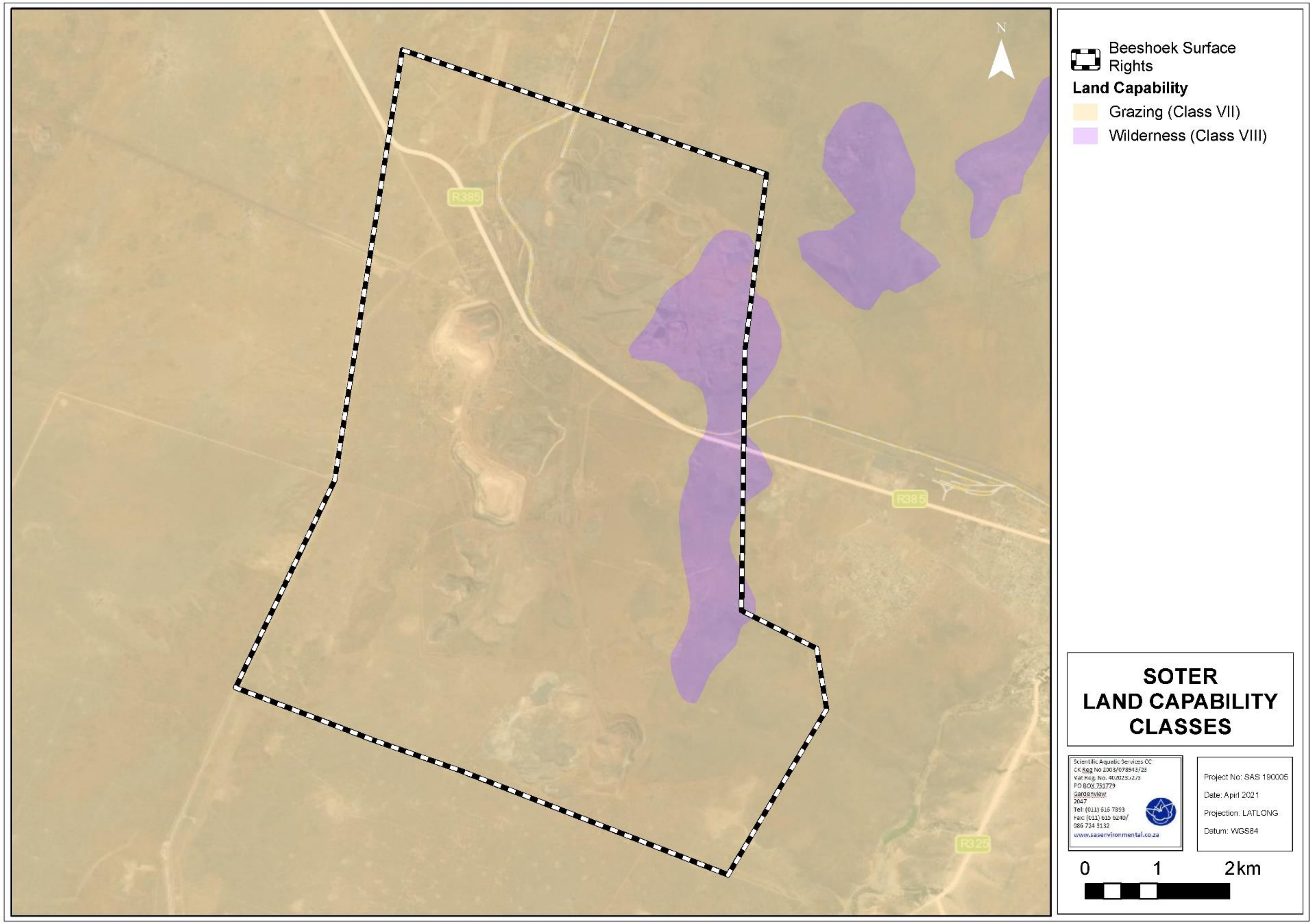

Figure 13: Soil description associated with the focus area according to the SOTER Database.

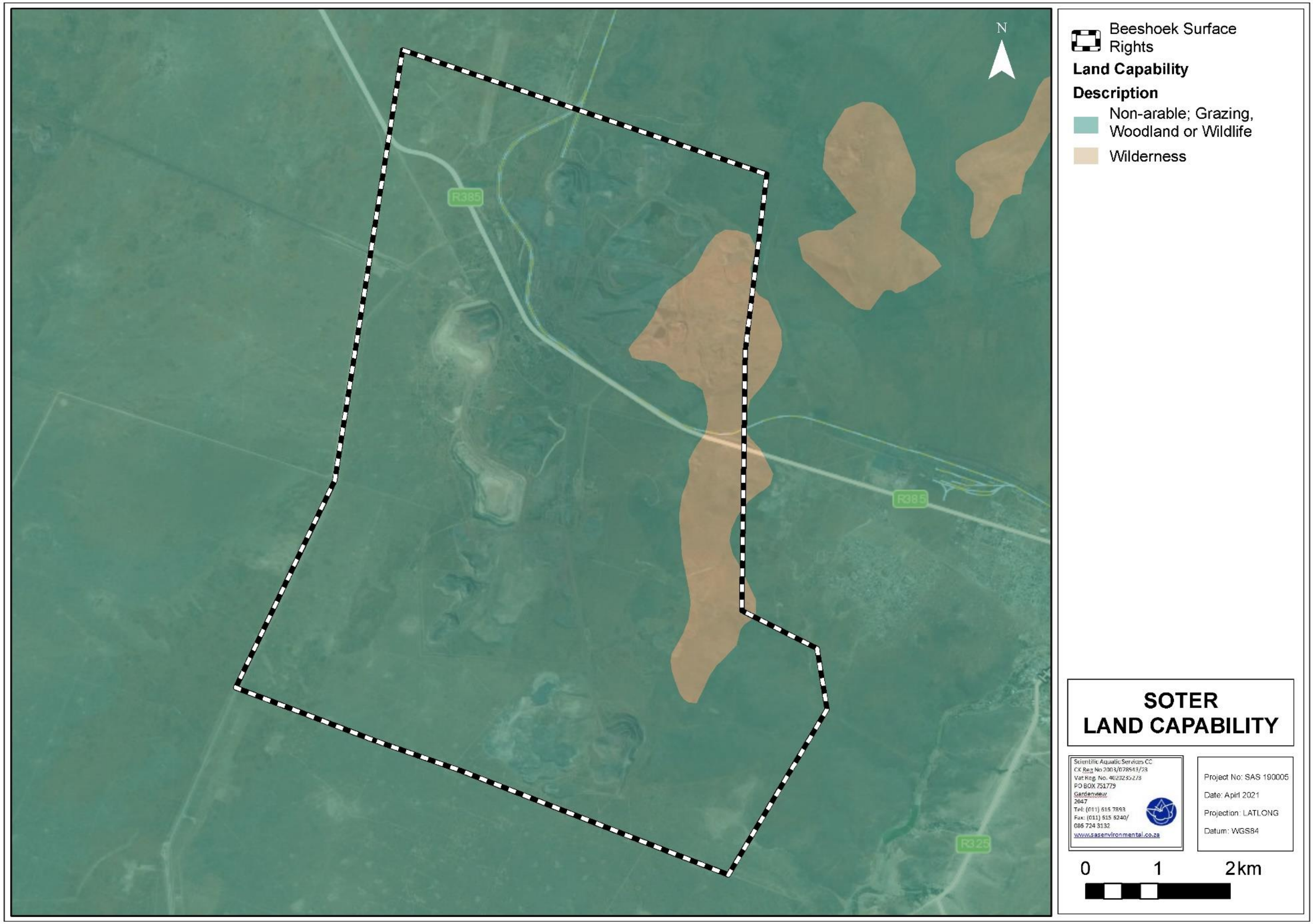

Figure 14: Soil description associated with the focus area according to the SOTER Database.

4. FIELD ASSESSMENT RESULTS

4.1 Current Land Use

Based on observation during the site assessment, the dominant land use within the focus area is wildlife/wilderness, access roads and services roads as well as existing expansion project. No cultivated commercial agricultural activities were observed within the focus area and the immediate vicinity. Current land use examples are presented in Figure 7 and 8 below.

Current Land Use

Figure 15: Photographic presentation of the dominant land uses associated with the focus area and surrounding areas.

4.2 Dominant Soil Forms

The focus area traverses a Calcic and Anthropic topo catena Coega/Knersvlakte, Mispah/Glenrosa, Plooysburg and Witbank soil forms being the dominant soil forms within the total investigated focus area. Arable soils (i.e., Vaalbos/Nkonkoni) only constitute of approximately 9.8% (499.4 ha) which occurs in small patches within the investigated focus area. These soils are considered ideal for cultivation due to:

- Good drainage characteristics;
- Sufficient depth for root growth;
- Sufficient moisture holding capacity; and
- Nutrient retention capacity to support the optimum growth and production.

Shallow soils of Coega/Knersvlakte (Cg) and Mispah/Glenrosa (Ms/Gs) formations collectively cover approximately 82.2% of the total investigated focus area and can be considered as having poor physical characteristics ideal in supporting cultivation agricultural practices. This is attributed to the occurrence of Hardrock/Lithic and Hard Carbonate material near and/or at the surface which restricts root growth and development. This creates conditions that are not conducive to the cultivation of most cultivated crops. Some portions of the focus area are comprised of extensively disturbed soils classified as Witbank formation (16.6%). Below is a tabular representation of the dominant soils, with relative description of soil horizons as well as associated land capability. **Table 5** below present the dominant soil forms and their respective diagnostic horizon sequence.

Table 5: Dominant soil forms within the focus area

Soil Forms	Code	Diagnostic Horizon Sequence
Plooysburg	Py	Orthic/Red Apedal/Hard Carbonate or Hard Rock
Vaalbos	Vb	Orthic/Red Apedal/Hard Rock
Nkonkoni	Nk	Orthic/Red Apedal/ Lithic
Kolke	Ko	Orthic/Soft Carbonate/Unconsolidated material with wetness
Lepallane	Lp	Unconsolidated material with wetness
Mispah	Ms	Orthic/Hard Rock
Glenrosa	Gs	Orthic/Lithic
Coega	Cg	Orthic/Hard Carbonate
Knersvlakte	Kn	Orthic/Dorbank
Witbank	Wb	Unspecified

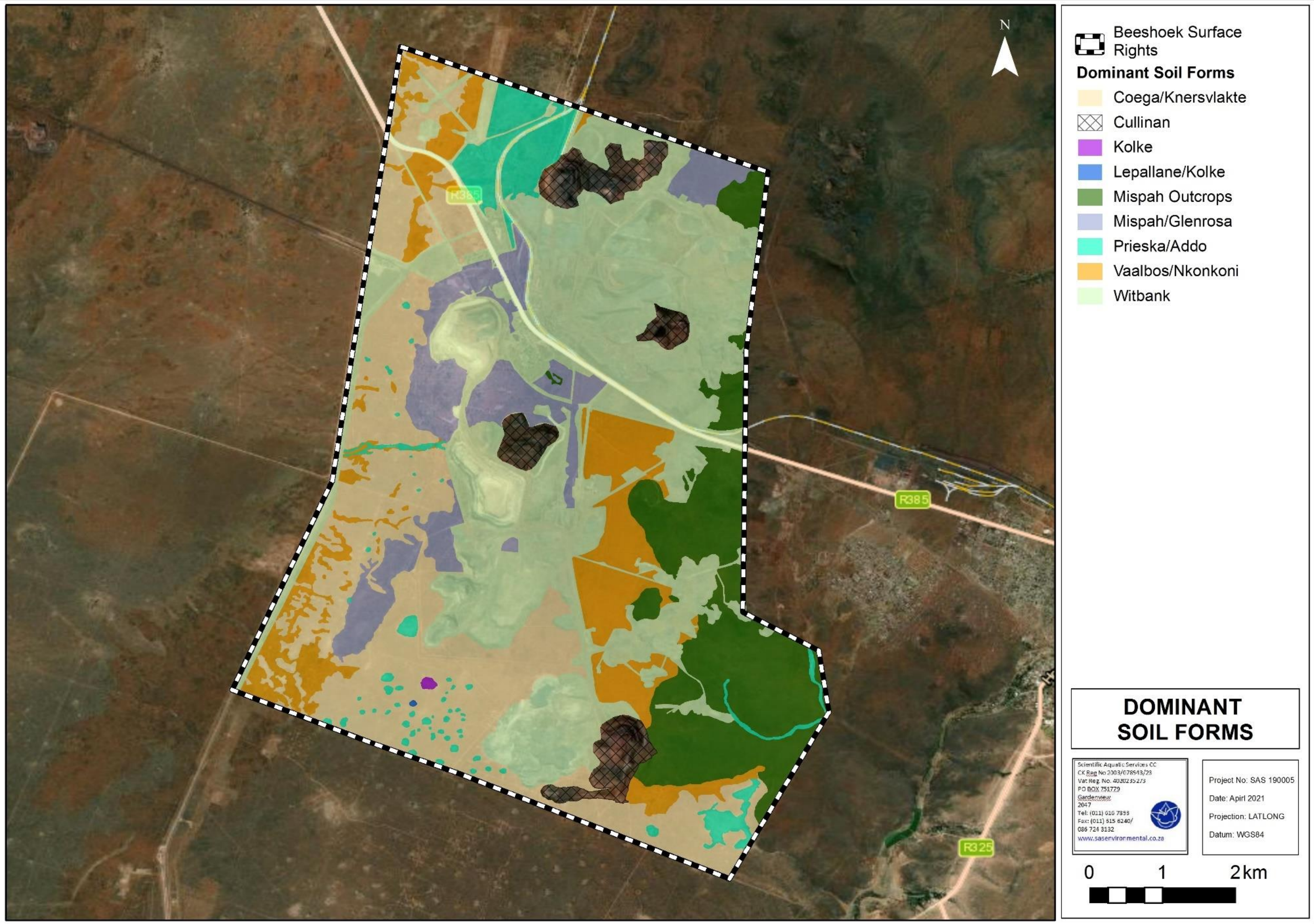

Figure 16: Soil map depicting identified soil forms within the focus area

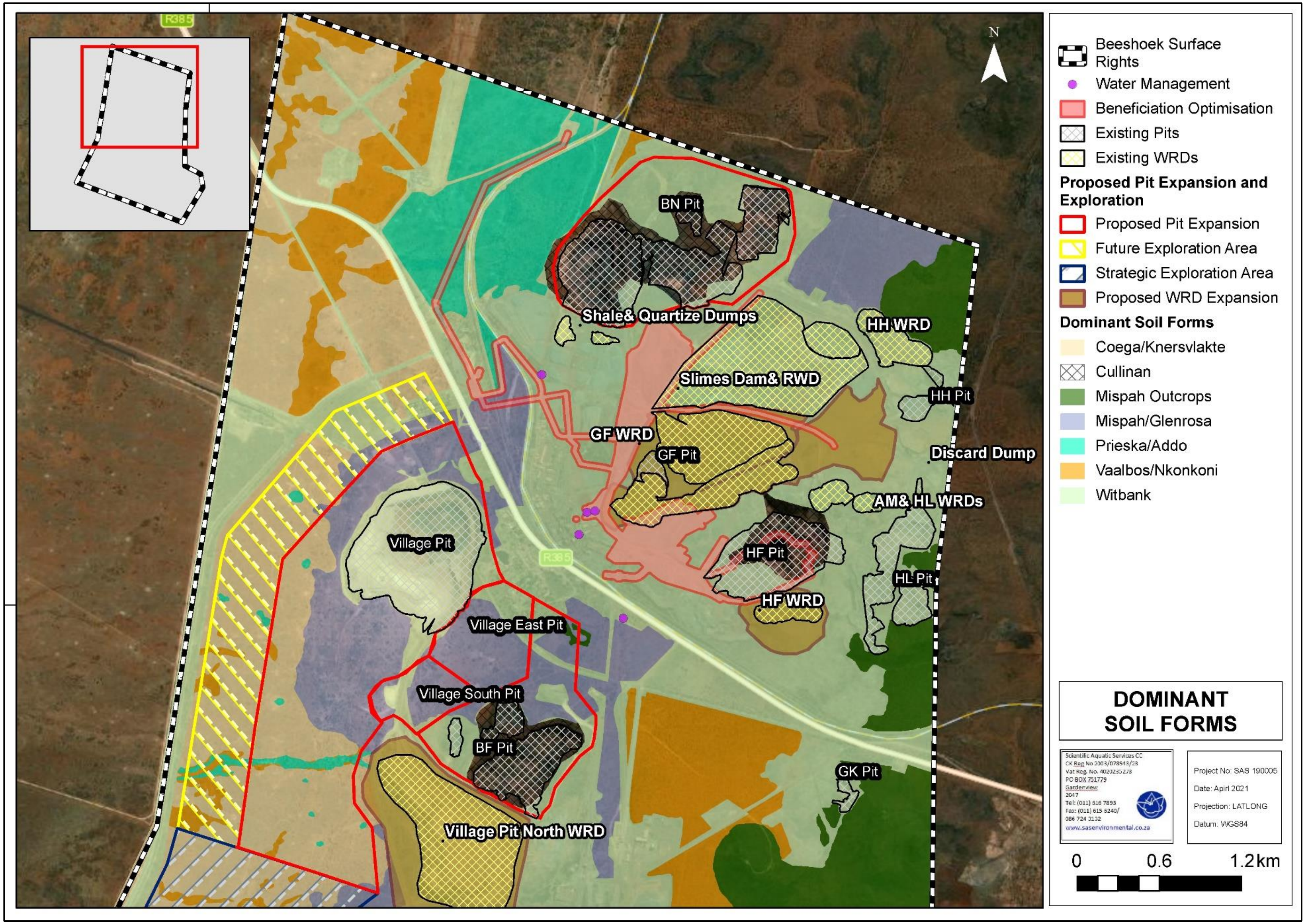

Figure 17: Soil map depicting identified soil forms in the northern overlain by the simplified layout of the proposed projects

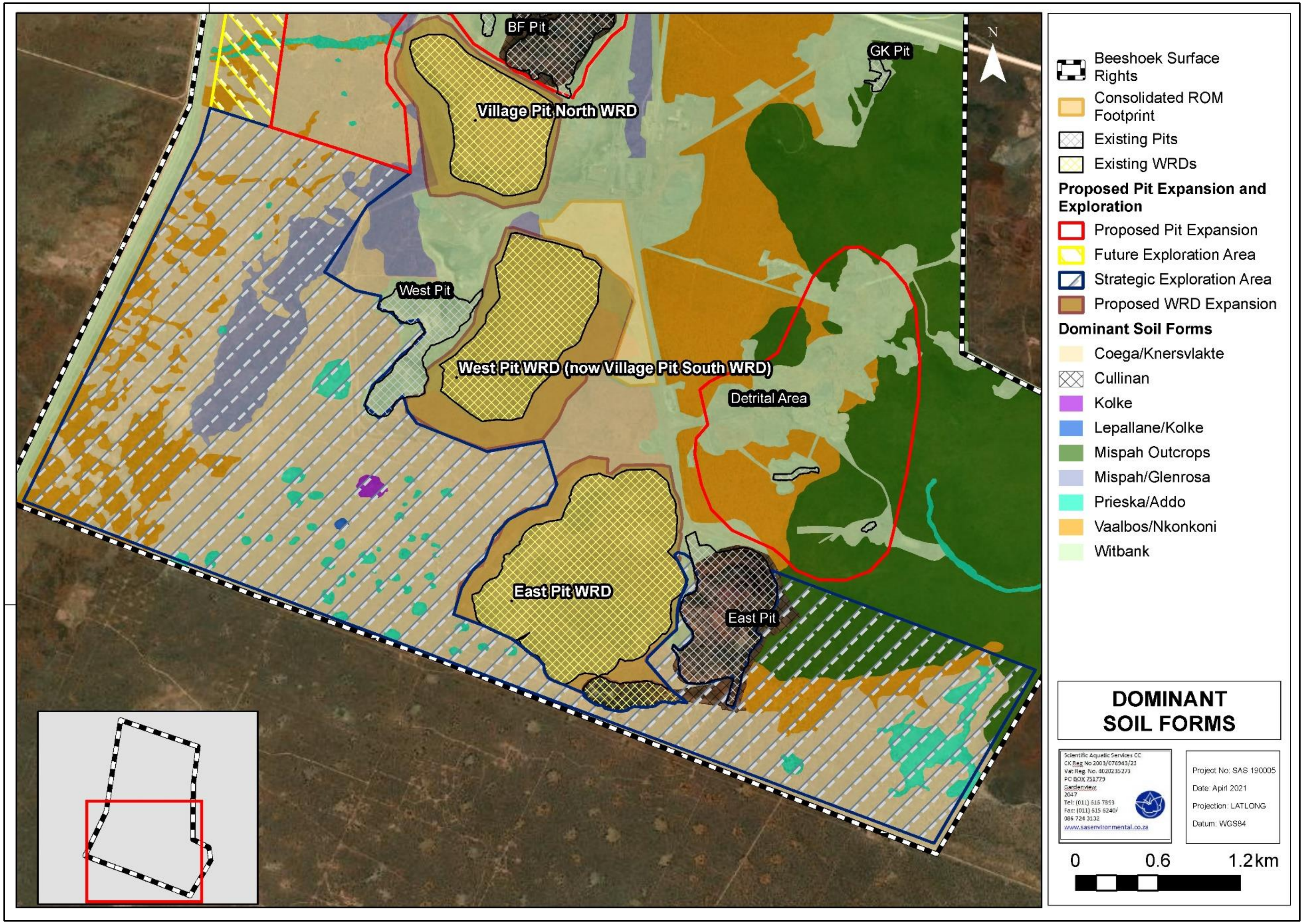

Figure 18: Soil map depicting identified soil forms in the southern portion, overlain by the simplified layout of the proposed projects

4.3 Land Capability and Land Potential Classification

Agricultural land capability in South Africa is commonly restricted by climatic conditions, with specific mention to water availability (Rainfall). Even within similar climatic zones, different soil forms 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 needed to produce sustained economically high crops yields when treated and managed according to best possible farming practices (Scotney *et al*., 1987). For this assessment, land capability and land potential were 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 focus area falls into Climate Capability Class 6 due to high temperatures and moisture stress, with limited suitable crops which experience frequent yield loss throughout the year.

The identified soils were classified into land capability and land potential classes using the Camp et. al, and Guy and Smith Classification system (Camp et.al., 1987, Guy and Smith,1998), as presented from **Figure 19 to Figure 24** below. The identified land capability limitation for the identified soils are discussed in comprehensive “dashboard style” summary tables presented from **Table 6 to 9** below. The dashboard reports aim to present all the pertinent information in a concise and visually appealing fashion.

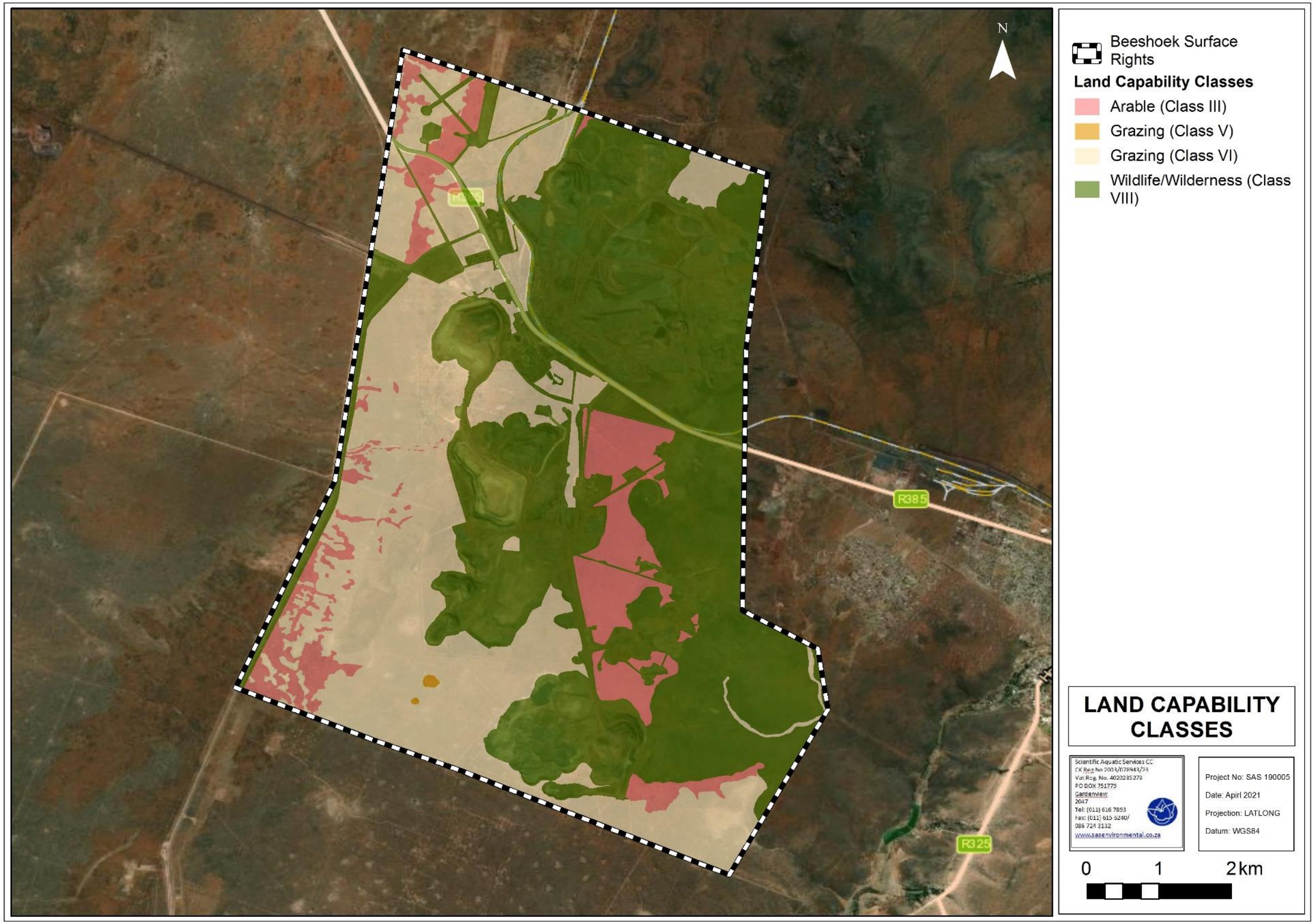

Figure 19: Map depicting land capability classes of soils occurring within the focus area.

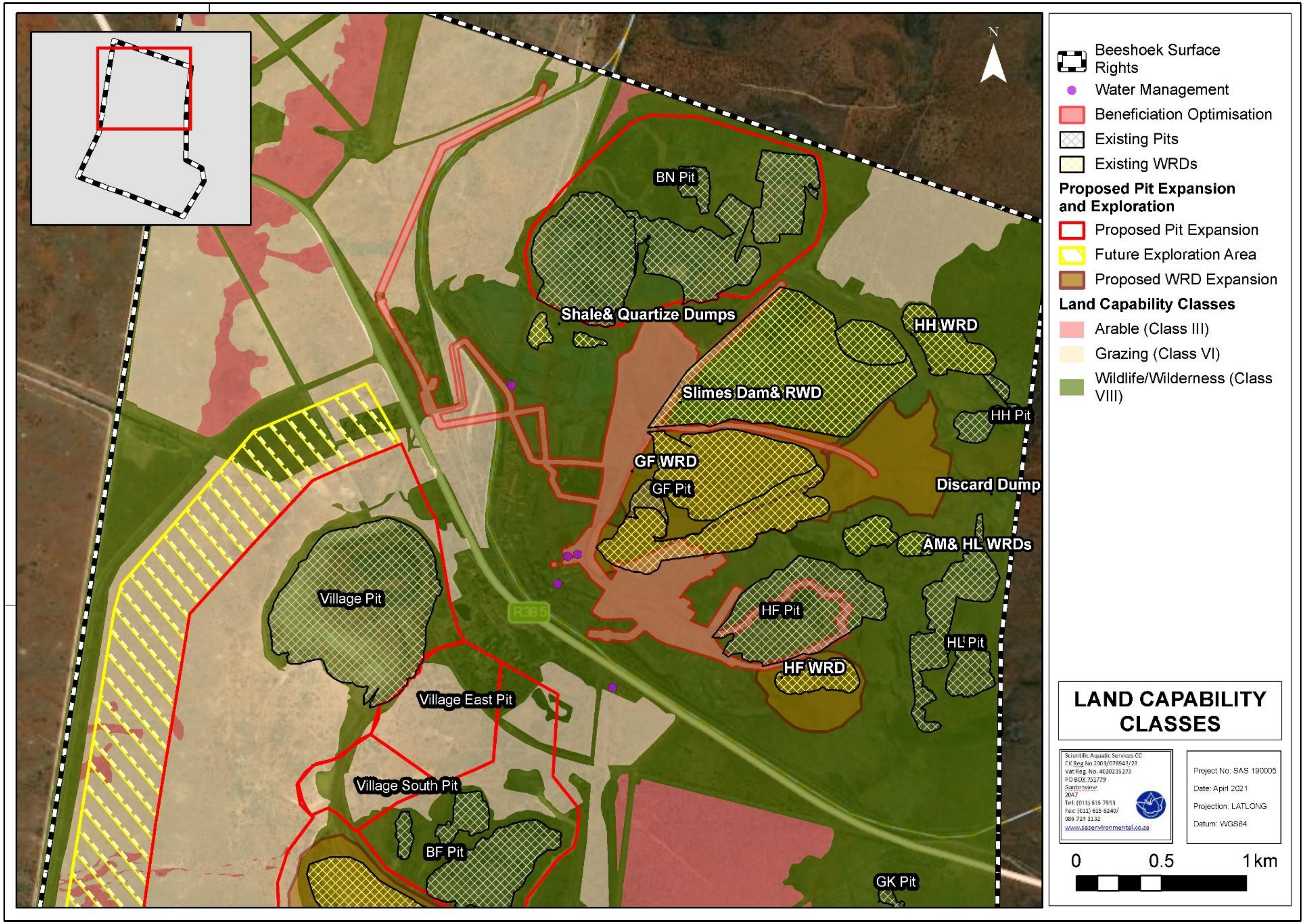

Figure 20: Map depicting land capability classes of soils overlain by the simplified layout of the proposed projects

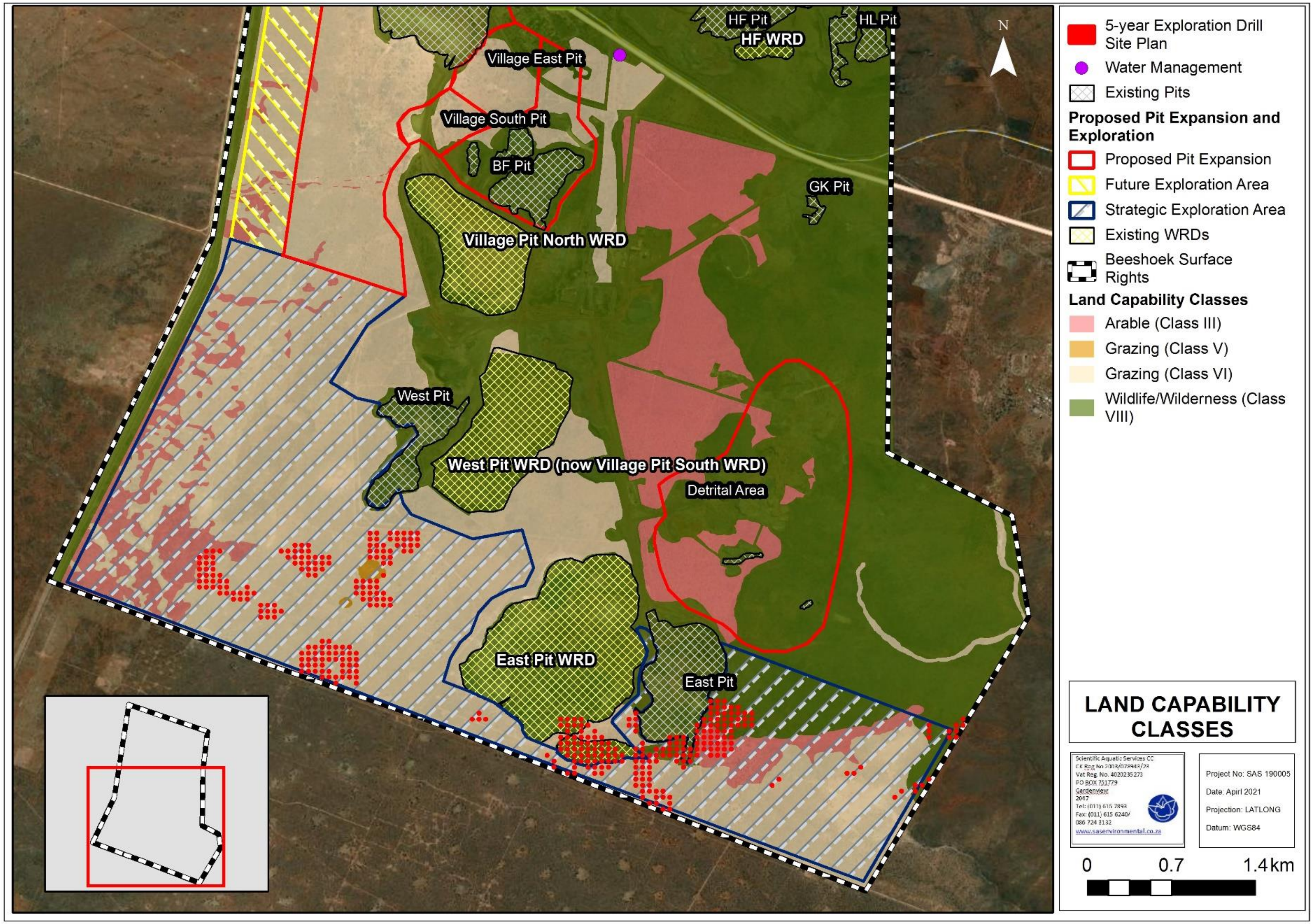

Figure 21: Map depicting land capability classes of soils overlain by the simplified layout of the proposed projects

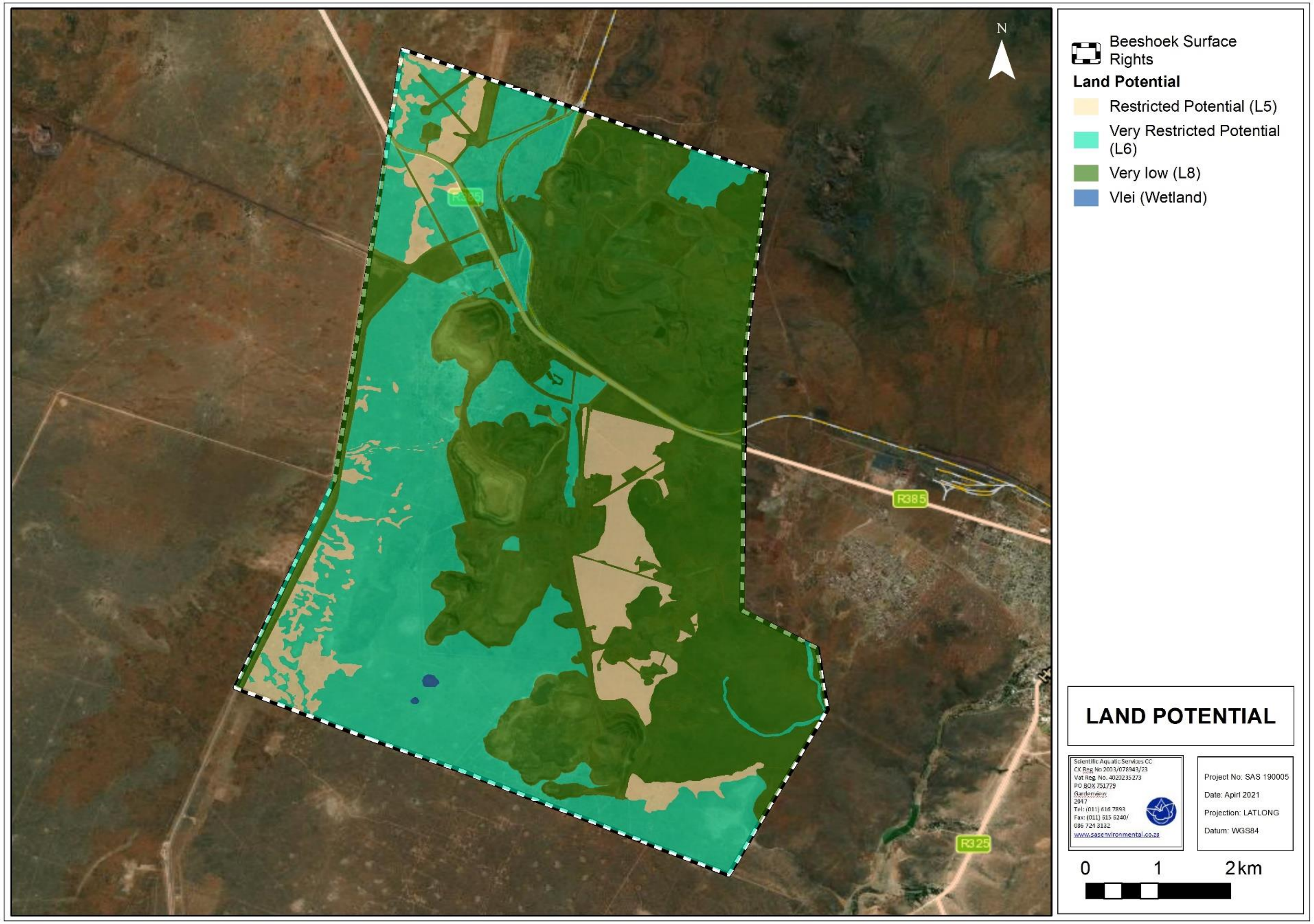

Figure 22: Map depicting land potential classes of soils occurring within the focus area.

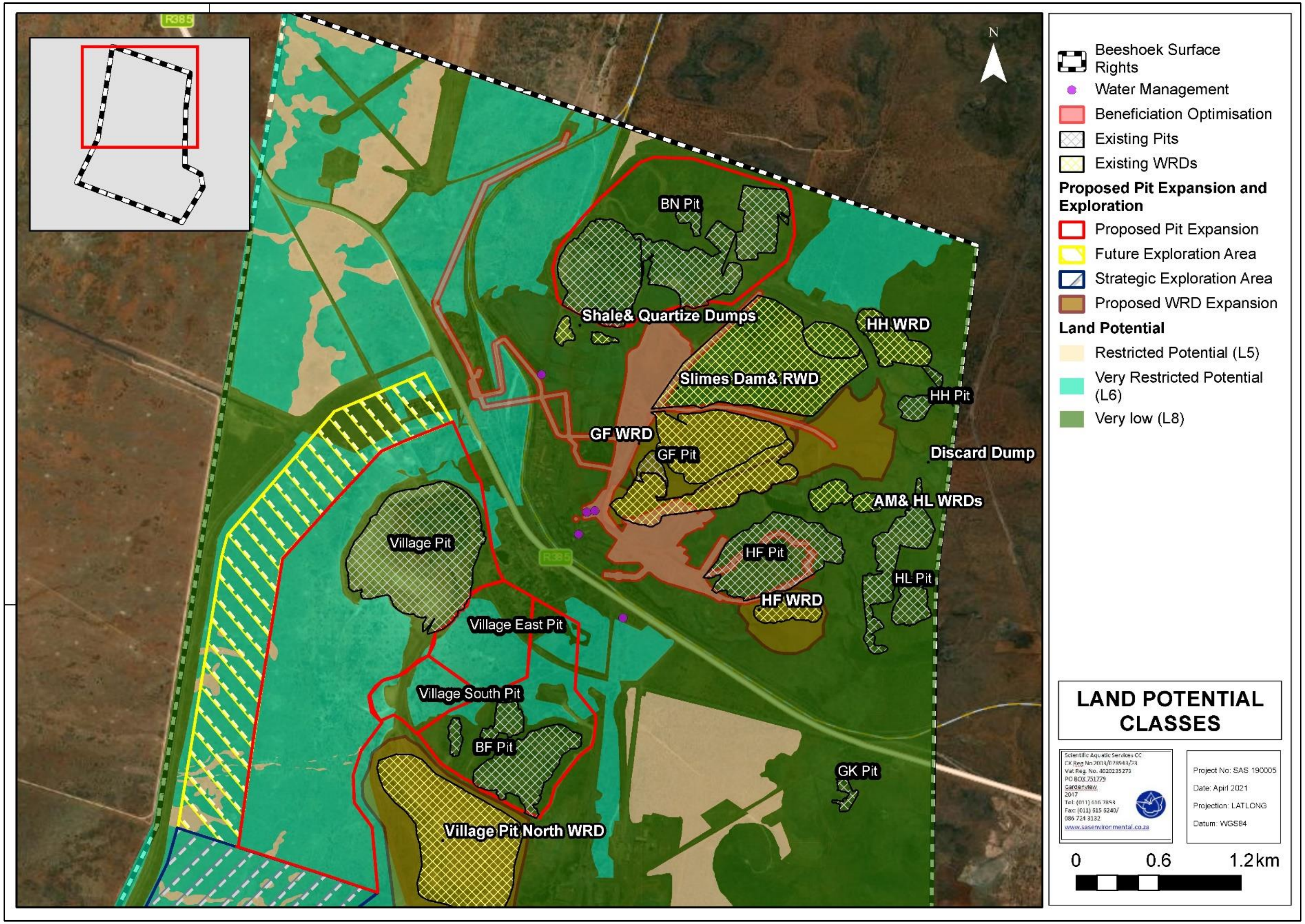

Figure 23: A zoomed map depicting land potential classes for the northern portion, overlain by the simplified layout of the proposed projects

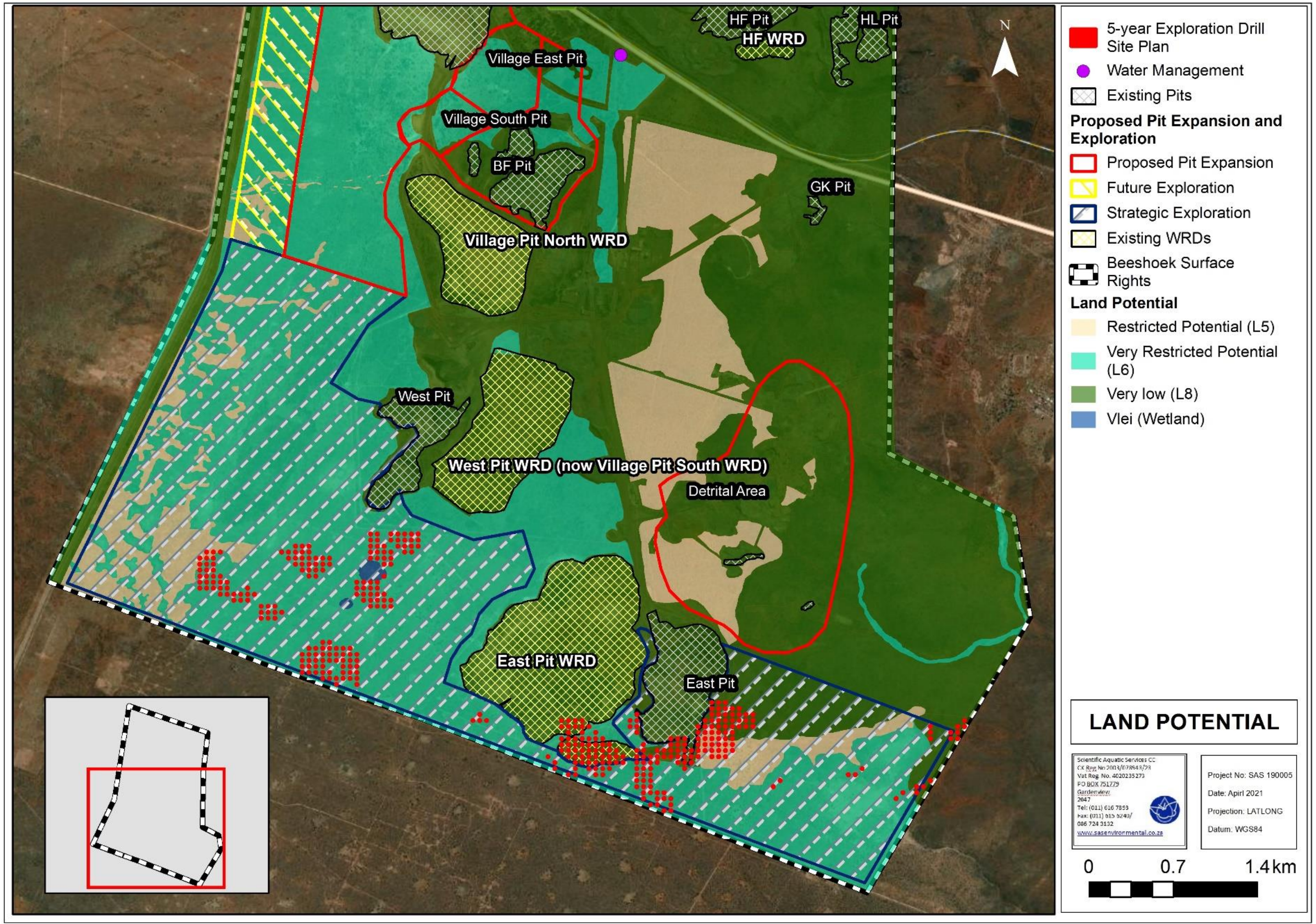

Figure 24: A zoomed map depicting land potential classes for the southern portion map depicting land potential classes overlain by the simplified layout of the proposed projects

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

<table>
<tr><th colspan="4">Land Capability: Arable (Class III) and Moderate land potential class</th></tr>
<tr><td colspan="4">  </td></tr>
<tr><td>Terrain Morphological Unit (TMU)</td><td>Relatively flat terrain</td><td>Photograph notes</td><td>View of the Red Apedal diagnostic horizon</td></tr>
<tr><td>Soil Form(s)</td><td>Vaalbos and Plooysburg</td><td>Area Extent</td><td>499.4 ha which constitutes 9.8% of the total investigated area</td></tr>
<tr><td>Physical Limitations</td><td>These soils have sufficient depth for most cultivated crops and rapid drainage characteristics (well-drained). However, the occurrence of impeding layers (layer of refusal), such as Hard Rock and Hard Carbonate may be the limiting factor for deep-rooted plants in some areas.</td><td colspan="2">Land Capability
The identified Plooysburg soil forms are considered high potential agricultural soils, with high land capability (Class III) and moderate land potential. These soils are suitable for arable agricultural land use with minimal management interventions. Therefore, they potentially contribute 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 etc. However, emphasis is directed to their agricultural crop productivity due to the scarcity of such soil resources on national scale and food security concerns.</td></tr>
<tr><th colspan="4">Business case and Conclusion</th></tr>
<tr><td colspan="4">The identified soils are considered prime agricultural soils suitable for arable crops. These soils can yield profit returns under prudent crop selection and conservation soil management practices. However, the prevailing local climatic conditions severely restricts the choice of crop cultivation under rainfed agriculture. Lack of irrigation options further disqualify this area for commercial cultivated agriculture although ideal soils occur. Site-specific striping and stockpiling management measures must be implemented during all phases of any future development with the focus area to ensure that soils are stripped accordingly, and high potential soils are not mixed with low potential soils to try and reinstate which can be used for optimal support of grazing post mining.</td></tr>
</table>

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

Land Capability: Grazing Class V			
			
Terrain Morphological Unit (TMU)	Relatively flat to gently sloping landscape of < 2% slope gradient	**Photograph notes**	View of the morphology of the identified Kolke and Lepallane forms
Soil Form(s)	Kolke and Lepallane	**Area Extent**	3.2 ha; which constitutes 0.1% of the total investigated area
Diagnostic Horizon Sequence	0-35 cm: Orthic A 35 - 70 cm: soft carbonation	**Land Capability** The identified Kolke and Lepallane soil forms are considered to be of limited grazing (class V) land capability and are not considered as prime agricultural soils. Theses soils, at best, are associated with seasonal wetlands as well as livestock grazing. Therefore, these soils are considered to make a substantial contribution to extensive commercial cattle farming.	
Physical Limitations	These soils were found to be associated with a wetland feature located in the southern section of the proposed focus area. The land capability class in which these soils were assigned to is associated with water course or land with wetness limitations. Refer to land capability description above. These soils might be suitable for some crops, however, are not ideal for crop production since they are associated with wetland features and episodically saturated soils.		
Business case, Conclusion and Mitigation Requirements:			
Should the proposed infrastructure encroach on these soils, rehabilitation would be a requirement for these soils as they can be of significant use from an extensive commercial cattle farming point of view. In this instance, these soils are associated with a pan depression which enjoys protection from the National Water Act No. 36 of 1996 and the National Environmental Management Act No. 36 of 1996. These sites can be rehabilitated holistically at closure of the proposed mine.			

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

Land Capability: Grazing (Class VI) and Restricted land potential			
  			
Terrain Morphological Unit (TMU)	Relatively flat to gently sloping landscape of < 2% slope gradient	**Photograph notes**	View of the morphology of the identified Glenrosa/Mispah and Coega/Knersvlakte soil forms
Soil Form(s)	Mispah/Glenrosa and Coega/Knersvlakte	**Area Extent**	1802.0 ha; which constitutes 35.6% of the total investigated area
Physical Limitations	Shallow effective rooting depth is the primary limitation of the land capability of the Glenrosa/Mispah and Coega/Knersvlakte soil forms, which is due to the occurrence of a Lithic/Hard Rock and Hard Carbonate at relatively shallow depth, which would hinder penetration of plant roots.	**Land Capability** The identified Glenrosa/Mispah and Coega/Knersvlakte soil forms are considered to be of poor land capability (class VII) and restricted land potential. These soils are not suitable for arable agricultural land use attributable to the occurrence of parent material at shallow depths which inhibits root penetration. These soils are, at best, suitable for natural pastures for light livestock grazing. The contribution of these soils to the local, regional and national food production grid is limited. However, livestock farming under managed grazing interventions may be of significant contribution to the food security of the country.	
Business case and Conclusion			
These soils only support shallow rooted crops due to their shallow nature which hinders root growth, leading to stunted growth to most crops. These soils, at best, are suited for grazing and/or wilderness practices. The impact to the land capability and land potential of these soils is anticipated range between moderate and low. However, implementation of rehabilitation interventions and the integrated measures to manage any potential impacts such as soil erosion, contamination, and compaction.			

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

Land Capability: Wildlife/Wilderness (Class VIII) and Very low land potential			
  			
Terrain Morphological Unit (TMU)	Not applicable; Significantly disturbed areas	**Photograph notes**	View of the identified Witbank soil forms
Soil Form(s)	Witbank and Cullinan (Anthrosols)	**Area Extent**	2757.6 ha; which constitutes 54.5% of the total investigated area
Physical Limitations	Comprises of significantly disturbed areas due from anthropogenic activities to an extent that no recognisable diagnostic soil horizon properties could be identified. These soils included existing gravel/dirt roads and open excavation as observed during the site assessment. These soils are characterised by various limitations, primarily the absence of soil as a growth medium for arable agriculture.	**Land Capability** These identified soils (Witbank and Cullinan) have very poor land capability (Class VIII) and very low land potential, attributed to historic and ongoing mining activities. In addition, some of these soils have been subjected to long term compaction, erosion and chemical soil composition alteration. These soils are therefore not considered to make a significant contribution to agricultural productivity even on a local scale.	
Business case and Conclusion			
The current state of these soils requires major rehabilitation already and currently have no agricultural production potential. These areas can therefore be rehabilitated holistically at closure phase of any future development that may occur within the focus area.			

5. IMPACT ASSESSMENT

This section aims to present potential impact which will likely occur, particularly during site preparation in the pre-construction phase for the proposed Beeshoek Mine expansion and consolidation which is divided into five projects, namely:

- **Project 1**: Consolidation of Run of Mine (ROM) Stockpiles on South Mine.
- **Project 2**: Amendments to the design of existing Waste Rock Dumps (WRDs) in terms of the increase in heights, and allowance for final slope, which will result in extension of footprints.
- **Project 3**: Increase of Opencast footprint areas, as well as the undertaking of detrital mining for shallow iron ore reserves, including transportation routes (Haul roads).
- **Project 4**: Development of the Beneficiation Project which will comprise of a WHIMS Plant and Jig Plant at Beeshoek.
- **Project 5**: Water Management.

The soils will be impacted once vegetation has been cleared which will result to various impact including, but not limited to:

- **Soil erosion** - The soils will become more vulnerable to erosion once the vegetation is cleared for construction activities, and the soils will inevitably be exposed to wind and some surface runoff during intensive rainfall events;
- **Soil compaction** - Heavy equipment traffic during construction activities is anticipated to cause soil compaction, particularly for soils where the layer of refusal or bedrock its occurrence is not at/ near surface;
- **Potential Soil Contamination** - The soils will be equally predisposed to potential contamination, as contamination sources are generally unpredictable and often occur as incidental spills or leak for construction developments; and

  Loss of Agricultural Land Capability and Land Potential - The focus area comprises patches of arable soils which will likely be impacted during the proposed development. Although the prevailing climatic conditions (MAP ranges between 201 and 400 mm per annum) are the main limiting factor for these soils for cultivated agriculture under rainfed conditions, protection of these soils where feasible is deemed necessary. If arable soils are avoided, and development largely occurs on soils suitable for grazing and wilderness the overall impact on agricultural resources will be reduced to very low impact.

5.1 Expansion project and Associated Activities

The potential impact triggers at various phases of the proposed development are presented in Table 10 below.

Table 10: Summary of the anticipated Activities for the proposed expansion project development

Phase	Activities and associated impacts on soils and land capability
Preconstruction and construction	- Vegetation clearing within the proposed expansion projects; - Soil erosion on cleared areas; and - Soil compaction from frequent traffic of construction vehicles.
Operational	- Operation of expansion projects - Increased soil erosion, compaction, and spillage of hydrocarbons
Decommissioning and closure	- Demolishing and decommissioning the expansion project and associated infrastructure; - Reshaping of the landscape and reinstatement of the natural topography; and - Rehabilitation of the impacted areas in the vicinity of the expansion project footprint.
Post-closure	- Resumption of former land use activities; and - Potential latent impact on soil chemistry.

5.1.1 Impact: Soil erosion

Shallow, and sandy textured soils have a low water retention capacity and are typically more susceptible to erosion in comparison to clay textured soils, which in contrast are less susceptible to erosion. However, the parameters determining the extent and severity of soil erosion are highly complex, with water and wind as the main geomorphic agents, and soil erosion is largely dependent on land use and soil management and is generally accelerated by human activities such as tillage practices.

Most of the proposed activities are located on a relatively flat and gently sloping terrain, consisting of rocky Coega/Knersvlakte and Mispah/Glenrosa soils with very shallow to no soils. The identified soils will become more vulnerable to erosion once the vegetation is cleared for construction activities, and the soils will inevitably be exposed to wind and some surface runoff during intensive rainfall events. This will most likely lead to:

- Loss of soil;
- Reduced soil fertility status of soils and subsequently loss of valuable arable land; and
- Possible pollution and sedimentation of nearby watercourses consequently affecting the water quality for livestock.

The significance of this impact the various projects is presented in the tables below. The impacts can be reduced if mitigation measure outlined in this document are adhered to, as illustrated 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 clearing and removal of vegetation	Site clearing, the removal of vegetation, and associated disturbances to soils, leading to increased runoff, erosion subsequent loss of land capability	Constant disturbances of soils, resulting in detachment of soil particles, reduced soil quality and risk of erosion, attributed to mining activities.	Potential ineffective rehabilitation may lead to further loosening and detachment of soil particles and risk of erosion.
		Ongoing disturbances to soils, resulting in increased sedimentation and risk of erosion, arising from mining activities.	Decommissioning activities may lead to habitat transformation and increased alien plant species proliferation, and potential changing the nutrient status of the soils.

Impact assessment results for Project 1,4 and 5

Unmanaged								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	4	2	3	2	2	6	7	42 (Low)
Operational phase	4	2	3	2	2	6	7	42 (Low)
Decommissioning and Closure	4	2	3	2	2	6	7	42 (Low)
Managed								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	2	2	2	1	2	4	5	20 (Very Low)
Operational phase	2	2	2	1	2	4	5	20 (Very Low)
Decommissioning and Closure	2	2	2	1	2	4	5	20 (Very Low)

Impact assessment results for Project 2 and 3

Unmanaged								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	4	3	2	2	4	7	8	56 (Medium-Low)
Operational phase	4	3	2	2	4	7	8	56 (Medium-Low)
Decommissioning and Closure	4	3	2	2	4	7	8	56 (Medium-Low)
Managed								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	3	3	1	2	2	6	5	30 (Low)
Operational phase	3	3	1	1	2	6	5	30 (Low)
Decommissioning and Closure	3	3	1	1	2	6	5	30 (Low)

5.1.2 Impact: Soil compaction

Heavy equipment traffic during construction activities is anticipated to cause significant soil compaction. The severity of this impact is anticipated to be moderate for soils such as the Vaalbos/Nkonkoni soil due to loamy sand texture. Whereas soils with a relatively shallow bedrock and lithocutanic character (partly weathered rock material) such as the Coega/Knersvlakte and Glenrosa/Mispah soil forms are anticipated to be less impaired due to the resistance offered by the underlying bedrock. Soil compaction will potentially lead to:

- Increased bulk density and soil strength, reduced aeration and lower infiltration rate;
- Consequently, it lowers crop performance via stunted aboveground growth coupled with reduced root growth;
- Destroyed soil structure, leading to large with fewer natural voids with a high possibility of soil crusting. This situation may lead to stunted, drought-stressed plants due restricted water and nutrient uptake, which results in reduced crop yields; and
- Soil biodiversity is also influenced by reduced soil aeration. Severe soil compaction may cause reduced microbial biomass. Soil compaction may not influence the quantity, but the distribution of macro fauna that is vital for soil structure including earthworms due to reduction in large pores.

Aspects and activities register

Pre-Construction	Construction	Operational	Decommissioning and Closure
Potential poor planning leading to excessive or unnecessary placement of infrastructure in soils highly prone to compaction.	Potential movement of construction equipment/machinery leading to soil compaction.	Movement of service vehicles on gravel services roads leading to further soil compaction.	Disturbance of soils as part of demolition activities and backfilling.
	Unnecessary placement of construction material in soils which are prone to compaction.		Potential ineffective rehabilitation may lead to significant soil compaction, resulting in lower infiltration rate, and consequently increased surface runoff.

Impact assessment results for Project 1,4 and 5

Unmanaged								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	3	2	2	2	4	5	8	40 (Low)
Operational phase	3	2	2	2	4	5	8	40 (Low)
Decommissioning and Closure	3	2	2	2	4	5	8	40 (Low)
Managed								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	2	2	1	1	2	4	4	16 (Very Low)
Operational phase	2	2	1	1	3	4	4	16 (Very Low)
Decommissioning and Closure	2	2	1	1	2	4	4	16 (Very Low)

Impact assessment results for Project 2 and 3

Unmanaged								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	3	3	3	2	4	6	9	54 Medium-low)
Operational phase	3	3	3	2	4	6	9	54 (Medium-low)
Decommissioning and Closure	3	3	3	2	4	6	9	54 (Medium-low)

Managed								
Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	2	3	3	1	2	5	6	30 (Very Low)
Operational phase	2	3	3	1	2	5	6	30 (Very Low)
Decommissioning and Closure	2	3	3	1	2	5	6	30 (Very Low)

5.1.3 Impact: Potential Soil Contamination

All the identified soils are considered equally predisposed to potential contamination, as contamination sources are generally unpredictable and often occur as incidental spills or leak for construction developments. The impact significance of soil contamination is largely dependent on the nature, volume and/or concentration of the contaminant of concern. If the management protocols are not well managed this will more likely lead to:

- Contaminants leaching into the soil and thus potentially rendering the soil sterile. reducing the yield potential of soils; and
- Potential reduction of water quality used for irrigation and for livestock use.

Aspects and activities register

Pre-Construction	Construction	Operational	Decommissioning and Closure
Potential inadequate design of infrastructure leading to risks of contamination of soils due to seepages and runoff.	Potential leakages in construction equipment/machinery leading to contamination.	Seepage and runoff from mining infrastructure (e.g. overburden) to high potential agricultural soils within the footprint.	Contamination of soils during demolition activities and backfilling.
		Potential leakages in construction equipment/machinery leading to contamination.	Potential ineffective rehabilitation may lead to decant which can affect soil chemistry.

Impact assessment results for Project 1,4 and 5

Unmanaged								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	3	1	3	2	2	4	7	28 (Medium-low)
Operational phase	3	1	3	2	4	4	7	28 (Medium-low)

Unmanaged								
Decommissioning and Closure	3	1	3	2	2	4	7	28 (Medium-low
Managed								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	2	1	1	1	2	3	4	12 (Very Low)
Operational phase	2	1	1	1	3	3	4	12 (Very Low)
Decommissioning and Closure	2	1	1	1	2	3	4	12 (Very Low)

Impact assessment results for Project 2 and 3

Unmanaged								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	4	3	2	2	4	7	8	63 (Medium-Low)
Operational phase	4	3	2	2	4	7	8	63 (Medium-Low)
Decommissioning and Closure	4	3	2	1	4	7	8	63 (Medium-Low)
Managed								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	3	3	1	1	2	6	4	24 (Very Low)
Operational phase	3	3	1	1	2	6	4	24 (Very Low)
Decommissioning and Closure	3	3	1	1	2	6	4	24 (Very Low)

5.1.4 Impact: Loss of Agricultural Land Capability

The proposed expansion projects will impact the soil resources in varying severities, with project 3 posing the highest impact significance due to its extent in size as well as the encroachment on high agricultural potential soils. Project 2 is anticipated to have the second highest impact while the remaining projects are anticipated to a limited impact since majority of the development will occur on previously disturbed soils. Although there is occurrence of arable soils, low crop yields are foreseen for this area due to climatic constraints (i.e., limited rainfall) and lack of irrigation options. Nevertheless, protection of high agricultural resources (where feasible) is deemed imperative in efforts to conserve the limited agricultural resources in line with the CARA (CARA), 1983 (Act No. 43 of 1983).

Aspects and activities register

Pre-Construction	Construction	Operational	Decommissioning and Closure
Potential poor planning leading to excessive or unnecessary placement of	Site clearing, the removal of vegetation, and associated disturbances to soils, leading to increased nutrient	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	Potential indiscriminate disposal of hazardous and non-hazardous waste, including waste material spills and refuse deposits into the soil.	Potential increase in concentrations of contaminant concentration in the soil.	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.
		Ongoing disturbance as a result of maintenance activities, leading to altered terrestrial vegetation community structures, and consequently altering the 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 Project 1,4 and 5

Unmanaged								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	2	2	2	2	4	4	8	32 (Low)
Operational phase	2	2	2	2	4	4	8	32 (Low)
Decommissioning and Closure	2	2	2	2	4	4	8	32 (Low)
Managed								
Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	1	1	1	1	3	3	5	15 (Low)
Operational phase	1	1	1	1	3	3	5	15 (Low)
Decommissioning and Closure	1	1	1	1	3	3	5	15 (Very Low)

Impact assessment results for Project 2

Unmanaged								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	5	3	2	2	4	8	7	63 (Medium-Low)
Operational phase	5	3	2	2	4	8	7	63 (Medium-Low)
Decommissioning and Closure	5	3	2	1	4	8	7	63 (Medium-Low)
Managed								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	3	2	2	1	2	5	5	25 (Very Low)
Operational phase	3	2	2	1	2	5	5	25 (Very Low)
Decommissioning and Closure	3	2	2	1	2	5	5	25 (Very Low)

Impact assessment results for Project 3

Unmanaged								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	5	2	5	2	4	7	11	77 (Medium-high)
Operational phase	5	2	5	2	4	7	11	72 (Medium-high)
Decommissioning and Closure	5	2	5	2	4	7	11	72 (Medium-high)
Managed								
Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	3	2	4	1	2	5	8	40 (Low)
Operational phase	3	2	4	1	2	5	8	40 (Low)
Decommissioning and Closure	3	2	4	1	2	5	8	40 (Low)

5.1.5 Cumulative impacts

The surrounding areas within which the proposed expansion project is to occur are dominated by Iron Ore mines, and no cultivated agricultural activities occur in the immediate vicinity. This is largely attributable to the dominance of rocky outcrops and shallow soils which are not ideal for cultivated agricultural production. In addition, lack of rainfall as well as limited irrigation options further disqualifies the area from being ideal for agricultural production. Therefore, based on the above-mentioned limiting factors, the proposed project is anticipated to contribute n a relatively limited manner to the cumulative loss of arable land and medium low cumulative loss of natural grasslands for grazing. Therefore, from a soil and land capability point of view, the addition to the cumulative impact footprint of the region is considered relatively minor and insignificant on a provincial or national scale.

6. IMPACT STATEMENT ON EXPLORATION ACTIVITIES

The majority of the soils that will be subjected to exploration activities are shallow (i.e., Coega/Knersvlakte. Mispah/Glenrosa) and not suitable for cultivation. Even though grazing can still occur in the soils, the grazing capacity is low (14ha/LSU) and as such it is not considered sufficient for viable commercial farming unless intensive management practices are implemented. From a soil, land use and land capability point of view, the overall impact significance of the proposed exploration activities is anticipated to be low after mitigation measures have been implemented during all phases of development.

7. SUMMARY OF 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

Stockpile and Stripping Management

- Excavation and long-term stockpiling of soil should be limited within the demarcated areas;
- 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 deep soils such Vaalbos and Nkonkoni, separate stripping, stockpiling and replacing of soil horizons [A (0-30 cm) and B (30-60 cm)] in the original natural sequence to combat hard setting and compaction, and maintain soil fertility;
- Stockpile height should be restricted to that which can deposited without equipment being located on the stockpile;
- 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;
- 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;
- Stockpiled soils should be stored for a maximum of 5 years. 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.
- Temporary berms can be installed, 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;
- During rehabilitation replace soil to appropriate soil depths in the correct order, and cover areas to achieve an appropriate topographic aspect and attitude 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 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 for 2 to 3

years after rehabilitation or until the area can be declared as self-sustaining by an appropriately qualified soil scientist.

Soil Erosion and Dust Emission Management

- The footprint of the proposed infrastructure area must 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 wet suppression techniques to limit dust release;
- Regulated speed limits of 40km/hr must be maintained on gravel roads to minimize dust generation; and
- All disturbed areas adjacent to the expansion project 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.

Soil Compaction management

- All vehicular traffic should be restricted to the existing service roads and the selected road servitude as far as practically possible; and
- Compacted soils adjacent to the mining and associated infrastructure footprint should be lightly ripped to at least 25 cm below ground surface to alleviate compaction prior to re-vegetation.

Soil Contamination Management

- Regular monitoring of site activities and machinery must be undertaken to identify spills or leaks;
- A spill prevention and emergency spill response plan, as well as dust suppression, and fire prevention plans must be developed and be implemented;
- Withdraw equipment for maintenance if change in emission characteristics is noticeable;
- 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; and

- 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.

Loss of Land Capability Management

- Due to the extent of the proposed expansion projects, mining (i.e., opencast pits excavation) should done in a phased manner and concurrent rehabilitation should occur as far as practically possible. This will allow the post closure landuses to potentially commence on the rehabilitated portions.
- Direct surface disturbance of the identified arable soils can be avoided where possible to minimise loss of arable soils;
- 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 to alleviate compaction;
- Stored topsoil should be replaced and the footprint graded to a smooth surface;
- The topsoil should be ameliorated according to soil chemical analysis; and
- Revegetate with an indigenous grass mix, to re-establish a natural protective cover, in order to minimise soil erosion and allow preconstruction activities to take place (grazing and wildlife).

8. CONCLUSION

Scientific Aquatic Services (SAS) was appointed to conduct a soil, land use, land capability and land potential assessment for the proposed Beeshoek Mine expansion projects near Postmasburg, Northern Cape. The proposed expansion projects are split into five (5) projects and will collectively be referred to as the “focus area”, unless referring to each individual project (i.e., project 1).

The aim of this study was to define the land capability and land potential of the soil associated with the proposed projects in line with the Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983) which necessitates an Agricultural Potential assessment prior to land development, particularly for purposes other than agricultural land use. A soil, land use, land capability and land potential survey was conducted between in October 2020 and March 2021 to understand the potential of the land to support cultivated agriculture under rainfed conditions in line with the Conservation of Agricultural Resources Act No. 43 of 1983. The assessment entailed evaluating:

- Climatic conditions;
- Land scape setting,
- Soil physical; and
- Other current limitations to various land use purposes.

The proposed expansion projects will impact the soil resources in varying severities, with project 3 posing the highest impact significance due to its extent as well as the encroachment on high agricultural potential soils. Project 2 is anticipated to have the second highest impact while the remaining projects are anticipated to a limited impact since the majority of the development will occur on previously disturbed soils. Although there is occurrence of arable soils, low potential crop yields are foreseen for this area due to climatic constraints (i.e., limited rainfall) and lack of irrigation options. Nevertheless, protection of high agricultural resources (where feasible) is deemed imperative in efforts to conserve the finite agricultural resources in line with the CARA (CARA), 1983 (Act No. 43 of 1983).

The surrounding areas within which the proposed expansion project is to occur are dominated by Iron Ore mines, and no cultivated agricultural activities occur in the immediate vicinity. This is largely attributable to the dominance of rocky outcrops and shallow soils which are not ideal for cultivated agricultural production.

Therefore, based on the above-mentioned limiting factors, the proposed project is anticipated to have a relatively low cumulative loss of arable land and medium low cumulative loss of natural grasslands for grazing. Therefore, from a soil and land capability point of view, the addition to the cumulative impact footprint of the region is considered relatively minor.

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APPENDIX A: METHOD OF ASSESSMENT

Desktop Screening

Prior to commencement of the field assessment, a background study, including a literature review, was conducted to collect the pre-determined soil and land capability data in the vicinity of the investigated focus 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.

Soil Classification and Sampling

A soil survey was conducted in October 2020 and March 2021 by a qualified soil specialist, at which time the identified soils within the infrastructure areas and associated access roads were classified into soil forms according to the Soil Classification Working Group for South Africa (2018). 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.

Land Capability Classification

Agricultural potential is directly related to Land Capability, as measured on a scale of I to VIII, as presented in Table **A1** below; with Classes I to III classified as prime agricultural land that is well suitable for annual cultivated crops. Whereas, Class IV soils may be cultivated under certain circumstances and management practices, whereas Land Classes V to VIII are not suitable to cultivation. Furthermore, the climate capability is also measured on a scale of 1 to 8, as illustrated in Table 3 below. The land capability rating is therefore adjusted accordingly, depending on the prevailing climatic conditions as indicated by the respective climate capability rating. The anticipated impacts of the proposed land use on soil and land capability were assessed in order to inform the necessary mitigation measures.

Table A1: Land Capability Classification (Smith,2006)

Land Capability Class	Increased Intensity of Use									Land Capability Groups
I	W	F	LG	MG	IG	LC	MC	IC	VIC	**Arable land**
II	W	F	LG	MG	IG	LC	MC	IC		
III	W	F	LG	MG	IG	LC	MC	IC		
IV	W	F	LG	MG	IG	LC				
V	W		LG	MG						**Grazing land**
VI	W	F	LG	MG						
VII	W	F	LG							
VIII	W									**Wildlife**
W- Wildlife			MG- Moderate grazing				MC- Moderate cultivation			
F- Forestry			IG- Intensive grazing				IC- Intensive cultivation			
LG- Light grazing			LC- Light 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.
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 land potential assessment entails the combination of climatic, slope and soil condition characteristics to determine the agricultural land potential of the investigated area. The classification of land potential and knowledge of the geographical distribution within an area of interest. This is of importance for making an informed decision about land use. **Table A3** below presents the land potential classes, whilst Table 4 presents description thereof, according to Guy and Smith (1998).

Table A3: Land Potential Classes (Guy and Smith, 1998)

Land Capability Class	Climate Capability Class							
	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**
I	L1	L1	L2	L2	L3	L3	L4	L4
II	L1	L2	L2	L3	L3	L4	L4	L5
III	L2	L2	L3	L3	L4	L4	L5	L6
IV	L2	L3	L3	L4	L4	L5	L5	L6
V	Vlei	Vlei	Vlei	Vlei	Vlei	Vlei	Vlei	Vlei
VI	L4	L4	L5	L5	L5	L6	L6	L7
VII	L5	L5	L6	L6	L7	L7	L7	L8
VIII	L6	L6	L7	L7	L8	L8	L8	L8

Impact Assessment Methodology

In order for the Environmental Assessment Practitioner (EAP) to allow for sufficient consideration of all environmental impacts, 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 infrastructure that is possessed by an organisation.
- An **environmental aspect** is an 'element of an organizations activities, products and services which can interact with the environment'[2]. 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 C1. 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 necessary[3].

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. 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 1998 (Act No. 108 of 1998) 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.

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

[3] Some risks/impacts that have low significance will however still require mitigation.

Table C1: Criteria for assessing significance of impacts

LIKELIHOOD DESCRIPTORS

Probability of impact	RATING
Highly unlikely	1
Possible	2
Likely	3
Highly likely	4
Definite	5
Sensitivity of receiving environment	**RATING**
Ecology not sensitive/important	1
Ecology with limited sensitivity/importance	2
Ecology moderately sensitive/ /important	3
Ecology highly sensitive /important	4
Ecology critically sensitive /important	5

CONSEQUENCE DESCRIPTORS

Severity of impact	RATING
Insignificant / ecosystem structure and function unchanged	1
Small / ecosystem structure and function largely unchanged	2
Significant / ecosystem structure and function moderately altered	3
Great / harmful/ ecosystem structure and function largely altered	4
Disastrous / ecosystem structure and function seriously to critically altered	5
Spatial scope of impact	**RATING**
Activity specific/ < 5 ha impacted / Linear developments affected < 100m	1
Development specific/ within the site boundary / < 100ha impacted / Linear developments affected < 100m	2
Local area/ within 1 km of the site boundary / < 500ha impacted / Linear developments affected < 1000m	3
Regional within 5 km of the site boundary / < 2000ha impacted / Linear developments affected < 3000m	4
Entire habitat unit / Entire system/ > 2000ha impacted / Linear developments affected > 3000m	5
Duration of impact	**RATING**
One day to one month	1
One month to one year	2
One year to five years	3
Life of operation or less than 20 years	4
Permanent	5

Table C2: Significance Rating Matrix.

LIKELIHOOD (Frequency of activity + Frequency of impact)	CONSEQUENCE (Severity + Spatial Scope + Duration)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90
	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105
	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
	9	18	27	36	45	54	63	72	81	90	99	108	117	126	135
	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150

Table C3: Positive/Negative Mitigation Ratings.

Significance Rating	Value	Negative Impact Management Recommendation	Positive Impact Management Recommendation
Very high	126-150	Critically consider the viability of proposed projects Improve current management of existing projects significantly and immediately	Maintain current management
High	101-125	Comprehensively consider the viability of proposed projects Improve current management of existing projects significantly	Maintain current management
Medium-high	76-100	Consider the viability of proposed projects Improve current management of existing projects	3Maintain current management
Medium-low	51-75	Actively seek mechanisms to minimise impacts in line with the mitigation hierarchy	Maintain current management and/or proposed project criteria and strive for continuous improvement
Low	26-50	Where deemed necessary seek mechanisms to minimise impacts in line with the mitigation hierarchy	Maintain current management and/or proposed project criteria and strive for continuous improvement
Very low	1-25	Maintain current management and/or proposed project criteria and strive for continuous improvement	Maintain current management and/or proposed project criteria and strive for continuous improvement

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 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 all stages of the project cycle including:
  - Pre-construction;
  - Construction; and
  - Operation.
    - 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

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[4] 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.*

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.

[4] *Mitigation measures should address both positive and negative impacts*

APPENDIX B: DETAILS, EXPERTISE AND CURRICULUM VITAE OF SPECIALISTS

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

Stephen van Staden MSc (Environmental Management) (University of Johannesburg)

Braveman Mzila BSc (Hons) Environmental Hydrology University of KwaZulu-Natal

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

Company of Specialist:	Zimpande Research Collaborative		
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

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Signature of the Specialist

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

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

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Group CEO, Water Resource discipline lead, Managing member, Ecologist, Aquatic Ecologist
Joined SAS Environmental Group of Companies	2003 (year of establishment)

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 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
Legal liability training course (Legricon Pty Ltd)	2018
Hazard identification and risk assessment training course (Legricon Pty Ltd)	2013

Short Courses

Certificate – Department of Environmental Science in Legal context of Environmental Management, Compliance and Enforcement (UNISA)	2009
Introduction to Project Management - Online course by the University of Adelaide	2016
Integrated Water Resource Management, the National Water Act, and Water Use Authorisations, focusing on WULAs and IWWMPs	2017

AREAS 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 Leona
Central Africa – Democratic Republic of the Congo

KEY SPECIALIST DISCIPLINES

Biodiversity Assessments

- Floral Assessments
- Biodiversity Actions Plan (BAP)
- Biodiversity Management Plan (BMP)
- Alien and Invasive Control Plan (AICP)
- Ecological Scan
- Terrestrial Monitoring
- Protected Tree and Floral Marking and Reporting
- Biodiversity Offset Plan

Freshwater Assessments

- Desktop Freshwater Delineation
- Freshwater Verification Assessment
- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination
- Rehabilitation Assessment / Planning
- Maintenance and Management Plans
- Plant species and Landscape Plan
- Freshwater Offset Plan
- Hydropedological Assessment
- Pit Closure Analysis

Aquatic Ecological Assessment and Water Quality Studies

- Habitat Assessment Indices (IHAS, HRC, IHIA & RHAM)
- Aquatic Macro-Invertebrates (SASS5 & MIRAI)
- Fish Assemblage Integrity Index (FRAI)
- Fish Health Assessments
- Riparian Vegetation Integrity (VEGRAI)
- Toxicological Analysis
- Water quality Monitoring
- Screening Test
- Riverine Rehabilitation Plans

Soil and Land Capability Assessment

- Soil and Land Capability Assessment
- Soil Monitoring
- Soil Mapping

Visual Impact Assessment

- Visual Baseline and Impact Assessments
- Visual Impact Peer Review Assessments
- View Shed Analyses
- Visual Modelling

Legislative Requirements, Processes and Assessments

- Water Use Applications (Water Use Licence Applications / General Authorisations)
- Environmental and Water Use Audits
- Freshwater Resource Management and Monitoring as part of EMPR and WUL conditions

SAS ENVIRONMENTAL GROUP OF COMPANIES – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF BRAVEMAN MZILA

PERSONAL DETAILS

Position in Company	Wetland Ecologist and Soil Scientist
Joined SAS Environmental Group of Companies	2017

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Member of the South African Soil Science Society (SASSO)

Member of the Gauteng Wetland Forum (GWF)

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, Mpumalanga, Free State, North West, Limpopo, Northern Cape, Eastern Cape, KwaZulu-Natal

KEY SPECIALIST DISCIPLINES

Hydropedological Assessments:

- Soil Survey
- Soil Delineation
- Hydrological hillslope classification
- Hydropedological loss Quantification
- Hydropedological impact assessment
- Scientific buffer determination

Soil, Land use, Land Capability and Agricultural Potential Studies

- Soil Desktop assessment
- Soil classification
- Agricultural potential
- Agricultural Impact Assessments