ZIMPANDE
RESEARCH COLLABORATIVE

Soil, Landuse and Land Capability Assessment

FOR THE PROPOSED EXPANSION OF TWO WASTE ROCK DUMPS WITHIN THARISA MINE NEAR MARIKANA, NORTH WEST PROVINCE.

Prepared for:	SLR Consulting (Pty) Ltd
Report author:	B. Mzila
Report reviewers:	S. van Staden (Pr.Sci.Nat) T. Setsipane
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Website: http://www.sasenvironmental.co.za

EXECUTIVE SUMMARY

The Zimpande Research Collaborative (ZRC) was appointed to conduct a soil, land use and land capability assessment for the proposed expansion of the two existing Waste Rock Dumps (WRDs) as part of the Environmental Authorisation (EA) processes. The WRDs footprint area will henceforth be referred to as the "Study Area".

The objective of this study was to evaluate:

- Climatic conditions within the context of agricultural productivity and constraints;
- Landscape setting and land use,
- Soil physical properties; and
- Other current limitations to various land use purposes.

The climatic conditions associated with the study area and surroundings are characterised by climatic limitations with the Mean Annual Precipitation ranging between 401 – 600 mm per annum. The surrounding areas under these climatic conditions have a moderately restricted growing season due to low temperatures, frost and/or moisture stress. Limited suitable crops for which frequently experience yield loss. Therefore, crops under rainfed conditions should be cultivated with caution, and management practices may be required to maximise the yield.

Based on the observations during the site assessment, the dominant land uses within the proposed WRD footprint areas are mining related activities. No agricultural activities were observed in the immediate vicinity of the footprint areas.

The entire footprint area of the East Above Ground WRD is located in a disturbed area as a result of the ongoing open pit mining and waste rock dumping activities. Whereas a significant portion of the West Above Ground WRD footprint area has also been subjected to significant disturbance as a result of similar mining and related activities. The soil form associated with the disturbed areas was classified as a Witbank soil form while the excavated areas where no soil exist were classified as Cullinan soil form. The remaining patches of natural soils within the West Above Ground footprint area were classified as Acardia (black turf) soil form.

The Witbank soil form is considered to be of very low agricultural potential due to the soils having been subjected to physical disturbance because of human interventions. Such interventions include transportation and deposition of the earth material containing soil. As a result, these soils are unable to support agricultural production considering that they are currently in a degraded state unless significant amelioration and rehabilitation takes place. Whereas the Cullinan soil form is characterised by voids with no soil layer, and thus the agricultural potential thereof is very low.

The remaining soils of Arcadia and Sepane soils are associated with poor physical properties induced by high clay content and very strong structure, waterlogging during heavy rainfall and thus rendering the soil conditions unfavourable for most cultivated crops. Nonetheless, should the soils be cultivated, intensive management practices would to be implemented.

Table A: Dominant soil forms and their respective land capability

Soil Form	Land capability	Land Potential	Area (ha)	Percentage (%)
Acardia	Grazing (Class V)	Moderate Potential (L4)	2.65	1.61
Sepane			1.33	0.81
Witbank	Wilderness (Class VIII)	Very Low Potential (L8)	99.17	60.28
Cullinan			59.39	36.10
Total enclosed			**164.5**	**100**

***Infrastructural areas of 1.96 ha (1.20%) were not included in the table above since they not considered in the land capability ratings.**

From a soil and land capability point of view, the cumulative loss of agricultural land capability is considered limited since the dominant soils within each footprint area are disturbed as a result of the ongoing mining and related activities and the soil are not considered ideal to support agricultural activities. In addition, the proposed footprint areas are surrounded by active mining related activities as well as wilderness areas and are isolated from any large-scale agricultural activities in the area. If use of the natural soils within the footprint is made for closure of the mine, the significance of the impact will be further reduced.

From a soil, land use and land capability point of view, this project regarded as being of low impact significance due to the inherent soil constraints of the area and the severe disturbance of the majority of the soils on site. However, mitigation measures and recommendations outlined in this document need to be strongly considered and implemented accordingly in efforts to conserve soil resources in the post mining landscape.

DOCUMENT GUIDE

Table A: Document guide according to the amended 2017 EIA Regulations (No. R. 326)

No.	Requirement	Section in report
a)	Details of -	
(i)	The specialist who prepared the report	Appendix B
(ii)	The expertise of that specialist to compile a specialist report including a curriculum vitae	Appendix B
b)	A declaration that the specialist is independent	Appendix B
c)	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
cA)	An indication of the quality and age of base data used for the specialist report	Section 3
cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 4 and 5
d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 3
e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 3
f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternative	Section 4
g)	An identification of any areas to be avoided, including buffers	Section 4
h)	A map superimposing the activity including the associated structure and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	Section 4
i)	A description of any assumption made and any uncertainties or gaps in knowledge	Section 1.1
j)	A description of the findings and potential implication\s of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities	Section 4 and 5
k)	Any mitigation measures for inclusion in the EMPr	Section 5.2
l)	Any conditions for inclusion in the environmental authorisation	Section 4.1
m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	None
n)	A reasoned opinion -	
(i)	As to whether the proposed activity, activities or portions thereof should be authorised	Section 5 and 6
(iA)	Regarding the acceptability of the proposed activity or activities	Section 6
(ii)	If the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Section 4 and 5
o)	A description of any consultation process that was undertaken during the course of preparing the specialist report	None
p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	None
q)	Any other information requested by the competent authority	None

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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.
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

ACRONYMS

AGIS	Agricultural Geo-Referenced Information Systems
°C	Degrees Celsius.
CARA	Conservation of Agricultural Resources Act
CEC	Cation Exchange Capacity
DEA	Department of Environmental Affairs
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
PPA	Proposed Project Area
SACNASP	South African Council for Natural Scientific Professions
SAS	Scientific Aquatic Services
SOTER	Soil and Terrain
ZRC	Zimpande Research Collaborative

1. INTRODUCTION

The Zimpande Research Collaborative (ZRC) was appointed to conduct a soil, land use and land capability assessment for the proposed expansion of the two existing Waste Rock Dumps (WRDs) as part of the Environmental Authorisation (EA) processes. The WRDs footprint area will henceforth be referred to as the “Study Area”.

Tharisa Mine is located north of the N4 highway with both WRDs located east and west of the Marikana road within the North West Province. The towns of Marikana and Lapologang are located approximately 3km to the north and west of the study area respectively. Refer to Figure 1 and Figure 2 for the locality of the study area.

The proposed expansion of the existing WRDs and associated surface infrastructure and services project are located in soils, classified on a regional scale, which may potentially support agricultural practice and food production. Thus, it is imperative to understand the surrounding soils, land uses and land capability as well as the land potential to ensure that the proposed WRDs expansion related development takes into consideration the high potential agricultural land parallel with the Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983). High agricultural potential land is a scarce non-renewable resource, which necessitates an Agricultural Potential assessment prior to land development, particularly for purposes other than agricultural land use, as per Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983).

1.1 Project Description

Tharisa Minerals (Pty) Ltd (Tharisa) is an opencast mining operation that produces chrome and platinum group metal (PGMs) concentrates. The mine has been operational since 2008. The opencast mine is located on farms 342 JQ and Elandsdrift 467 JQ, south of the Marikana Town, in the North West Province.

Mining is undertaken in two mining sections, namely the East Mine and West Mine, using conventional open pit truck and shovel methods. The two mining sections are separated by the perennial Sterkstroom River and the D1325 (Marikana Road). Waste rock from the open pit areas is stockpiled on Waste Rock Dumps (WRDs) and some in-pit dumping of waste rock has taken place at the East Mine. Key existing mine infrastructure includes haul roads, run-of-mine, a concentrator complex, various product stockpiles, topsoil stockpiles, WRDs, tailings storage facilities (TSFs) and supporting infrastructure such as offices, workshops, change house and access control facilities.

Tharisa holds the following environmental authorisations (EAs) and licenses:

- A Mining Right (MR) (Reference No.: 358 MR) issued by the Department of Minerals and Energy (DME) (currently the Department of Mineral Resources and Energy (DMRE)) on 19 September 2008 and amended in July 2011;
- An approved EMPr (Reference No.: NW 30/5/1/2/3/2/1/358EM) issued by the DME (currently the DMRE) on 19 September 2008;
- An EA (Ref No.: NWP/EIA/159/2007) issued by the Northwest Department of Agriculture, Conservation and Environment (DACE) (currently the North West Department of Economic Development, Environment, Conservation and Tourism (DEDECT) on 23 October 2009;
- An EA (Ref No.: 14/12/16/3/3/2/408) issued by the Department of Environmental Affairs on 15 November 2012;
- An EA (Ref No.: NWP/EIA/50/2011) issued by the Northwest DACE (currently the DEDECT) on 29 April 2015;
- An addendum to the EIA and EMPr (Ref No.: NW/30/5/1/2/3/2/1/358EM) issued by the Department of Mineral Resources (DMR) (currently the DMRE) on 24 June 2015;
- An addendum to the EIA and EMPr (Ref No.: NW/30/5/1/2/3/2/1/358EM) issued by the DMR (currently the DMRE) on 14 Aug 2020 - Waste Water Treatment Plant;
- An addendum to the EIA and EMPr (Ref No.: NW/30/5/1/2/3/2/1/358EM) issued by the DMR (currently the DMRE) on 08 Aug 2021 – Fuel & Waste storage capacity increase;
- A Section 24G EA (Ref No.: NW/30/5/1/2/3/2/1/358EM) issued by the DMRE on 10 AUG 2021; and
- An amended Integrated Water Use Licence (IWUL) ((Licence No. 03/A21K/ABCGIJ/1468) issued by the Department of Water and Sanitation (DWS) in November 2020.

As part of its on-going mine planning, Tharisa has identified the need for additional waste rock storage on site (referred to as the Proposed Project). In this regard, Tharisa is making an application to the Department of Mineral Resources and Energy (DMRE) for an integrated EA and update of the mine’s current EMPr. The following activities are now proposed:

- The expansion of the existing and approved Far West WRD 1 by a footprint of 109 ha. The expanded area will be referred to as the West Above Ground (OG) WRD. Portions of the West OG WRD will be located on backfilled areas of the West Pit; and
- The establishment of a waste rock dump (referred to as the East OG WRD) on backfilled portions of the East Pit. The proposed East OG WRD will cover an area of approximately 72 ha.

1.1.1 Description of Proposed Project

Overview of Proposed Project

The nature of the pits at Tharisa is such that there is continually more waste rock generated than capacity available in the worked-out areas of the pits and the balance must be dumped on surface WRDs. Additional waste rock handling and storage capacity is therefore required to accommodate the waste rock from the open pit operations. As part of its on-going mine planning, Tharisa has identified the need for additional WRD storage on site. In this regard, Tharisa is making application to the DMRE for an integrated EA and update of the mine's EMPr and is proposing the following:

- The expansion of the existing and approved Far West WRD 1 by a footprint of 109 ha. The expanded area will be referred to as the West Above Ground (OG) WRD. Portions of the West OG WRD will be located on backfilled areas of the West Pit; and
- The establishment of a waste rock dump (referred to as the East OG WRD) on backfilled portions of the East Pit. The proposed East OG WRD will cover an area of approximately 72 ha.

1.1.2 Description of Activities

Overview of Existing Mining and Processing Operations

Information in the following section was sourced from the approved 2008 EIA and EMPr (Metago, 2008) and 2014 EIA and EMPr (SLR, 2014).

The mining method at Tharisa comprises a standard open pit truck and shovel method. Access to the mining face is by means of haul roads and boxcuts with ramps. Steady state open pit dimensions will differ between the east and west sections because of the varying dip of the target ore body. In the western section, the dimensions are expected to be 360 m wide, 1 km in length along the outcrop with a final high wall averaging at approximately 180 m. On the eastern section, the dimensions are expected to be 580 m wide, 1 km in length along the outcrop with a final high wall averaging at approximately 180 m. The general mining direction is north.

The mineral processing operation comprises a concentrator complex. The concentrator complex caters for two streams, namely PGM's and chrome, to accommodate the different characteristics of the ore seams that are mined. The target production figures for the plants are approximately 40 000 tonnes of PGM concentrate per year; and approximately 1.5 million tonnes of chrome concentrate per year.

1.1.3 Description and Location of Activity

This Section provides details of the project location and properties. A description of the properties on which the Tharisa Mine and Proposed Project are located is provided in Table 1 below.

Table 1: Description of the property.

Description	Details
Farm name	• Existing mining operations - 342 JQ and Elandsdrift 467 JQ. • Proposed Project - 342 JQ, within boundary of existing Mining Right Area.
Application area (ha)	• The existing Mining Right Area covers an area of approximately 5 516 ha. • The total application area is approximately 181 ha. Of the total application area approximately 1 ha will be located on undisturbed mining areas. The remaining application area will be located within existing disturbed areas.
Magisterial district	The Proposed Project is located within Bojanala District Municipality, the Rustenburg Magisterial District and the Rustenburg Local Municipality.
Distance and direction from nearest town	Tharisa Mine is located approximately 4 km to the south of Marikana Town, in the North West Province.
Distance and direction from nearest communities	• Bokamoso community settlement located east of the Tharisa mine. • Mmaditlhokwa is located immediately north of the West Pit. • Lapologang is located 480 m south of the West Pit. • Private landowners (Buffelspoort) are located approximately 450 m south of the N4.
Co-ordinates	The co-ordinates of the relevant project components are: West OG WRD: 25°43'35.29"S 27°27'17.56"E | 25°43'45.41"S 27°28'35.84"E East OG WRD: 25°44'11.20"S 27°29'22.47"E | 25°44'3.75"S 27°30'40.99"E
Water catchment and management area	• Crocodile River Basin: lower Sterkstroom of the Upper Crocodile Sub-Water Management Area (Sub-WMA). • A21K quaternary catchment.

Table 2: Activity and Extent

Main project activity	Aerial extent of the activity (ha)
Extension of a previously approved WRD (West OG WRD)	Approximately 109 ha (108 ha within a disturbed area)
Extension of a previously approved WRD (West OG WRD)	Approximately 109 ha
Establishing waste rock over backfilled portions of the East (East OG WRD)	Approximately 72 ha
Extension of a previously approved WRD (West OG WRD)	Approximately 109 ha
Establishing waste rock over backfilled portions of the East (East OG WRD)	Approximately 72 ha
Extension of a previously approved WRD (West OG WRD)	Approximately 109 ha
Establishing waste rock over backfilled portions of the East (East OG WRD)	Approximately 72 ha

1.1.4 Design of the proposed WRD's

The management of residue stockpiles and deposits must be undertaken in accordance with Regulations regarding the Planning and Management of Residue Stockpiles and Residue Deposits (GN 632 of 2015, as amended). In this regard, the design features of the proposed WRD's are presented in Table 3. The detailed design report and drawings of the proposed WRD's will be provided as part of the EIA and EMPr phase.

Table 3: Design features of the WRDs.

Feature	Detail
Physical dimensions	**Height:** Approximately 70 m (applies to all proposed WRD's) **Bench height:** Approximately 15 m **Footprint:** West OG WRD: Approximately 109 ha; and East OG WRD: Approximately 72 ha. **Maximum storage capacity:** West OG WRD: Approximately 35.31 million m^3; and East OG WRD: Approximately 26.26 million m^3.
Chemical properties	The waste rock material comprises pyroxenite, anorthosite and norite. The geochemical work undertaken for waste rock samples at Tharisa indicate that the waste rock is non-acid generating and based on leachate tests chemicals of concern that are likely to leach from the WRD's when compared to water quality standards include: Elevated concentrations of Al, Chromium (Cr), Iron (Fe), Manganese (Mn), Lead (Pb).
Waste rock transport and deposition	Excess open pit waste rock loaded onto mine dump trucks and transported to WRDs. Waste rock access ramps constructed with a maximum gradient of 1V:7H (8°) for mine dump trucks. Waste rock is then dumped and spread / flattened with a bulldozer.
Control of seepage and dirty water run-off	The control of seepage from the toe of the WRDs as well as run-off from the side slopes will be achieved by the construction of a series of toe paddocks and secondary toe paddock cross walls around the perimeter of the WRDs, from where it will seep into the unsaturated soil or evaporate.
Diversion of clean water	Stormwater diversion trenches will be established to divert clean surface run-off from the surrounding area away from the WRD in order to prevent the contamination of clean water.
Topsoil stripping	Topsoil in WRD footprint areas will be stripped and stockpiled in accordance with the topsoil conservation guide. A stripping depth of 500 mm has been recommended by the soils study. Stripping and stockpiling of topsoil will be done in advance of dumping.
Lining	A Class D liner is required.
Side slopes	Average slope: 1V:3H
Access and access control	A 4m wide waste rock road will be constructed around the perimeter of each dump for routine inspections and maintenance. A perimeter fence around each WRD is planned.
Monitoring	Monitoring of seepage water retained in the perimeter toe paddocks and of boreholes around the perimeter of each WRD.
Dust control	Operational Phase: Watering of roads for dust suppression. Post Operational Phase: No measures necessary due to the coarse particle size distribution.
Closure	The WRD should be shaped to ensure the area is free draining (i.e no ponding of water on the top surface post closure). The WRD side slopes to be confirmed through on-going field trails. The WRD should be capped with a minimum of 300 mm soil/growth medium material. The capping thickness should be confirmed through on-going field trails.

Feature		Detail
		No active groundwater protection measures are envisaged during closure given the relatively low pollution potential of the residual waste rock material. In the event that water quality monitoring around any WRD indicates that the WRDs are causing pollution, additional management measures will be investigated in consultation with a qualified specialist.
Rehabilitation	Revegetation	The WRD is to be revegetated using a mix of indigenous grasses (i.e. dry seeding) and trees/shrubs (i.e. hand planting of seedlings). The vegetation species will be confirmed through ongoing field trials.
	Erosion control	The erosion management measures and/or mitigation measures to be confirmed through ongoing field trials.
	Maintenance and aftercare	Maintenance and aftercare period to be confirmed through ongoing field trials.
	Rehabilitation success criteria	Rehabilitation success will be determined by monitoring trends in soil nutrient levels, soil microbial levels, vegetation cover and vegetation biodiversity levels and comparing data and temporal trends in the data to numerical targets.

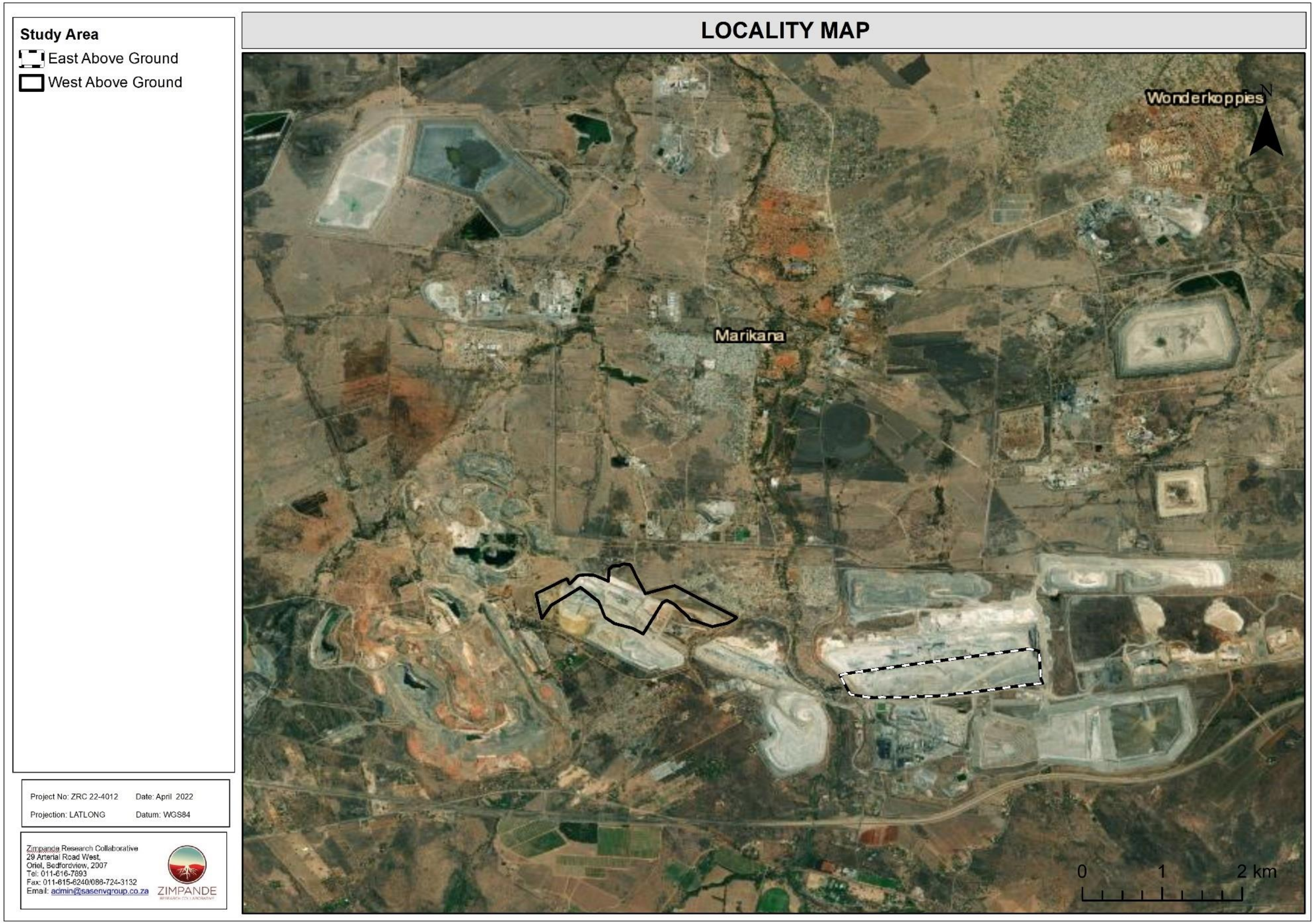

Figure 1: Digital satellite imagery depicting the locality of the study area in relation to the surrounding areas.

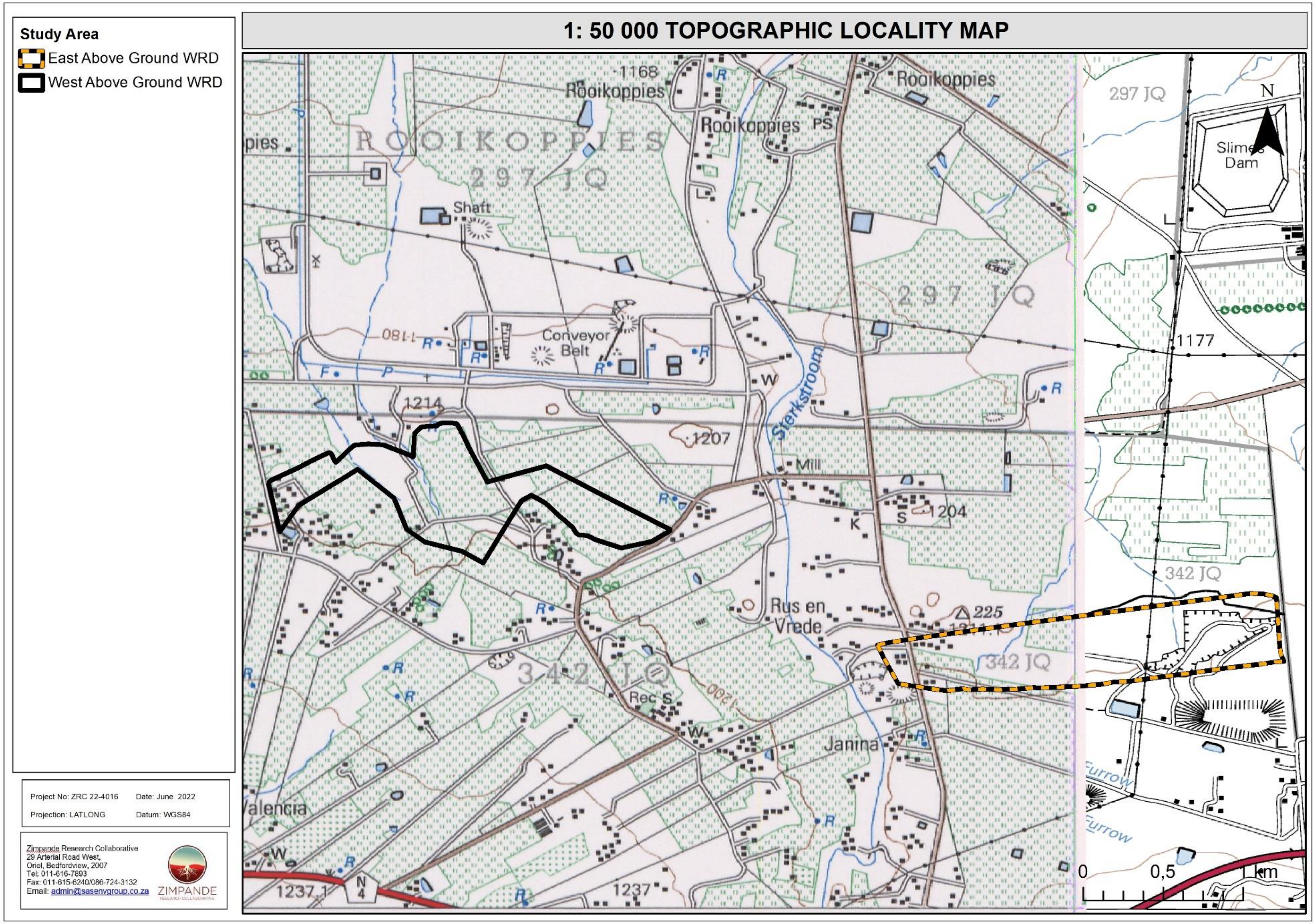

Figure 2: Location of the study area depicted on a 1:50 000 topographical map in relation to surrounding area.

1.2 Terms of Reference and Scope of Work

The soil, land use, land capability and agricultural potential assessment which formed part of the Environmental Authorisation process entailed the following aspects:

- As part of the desktop study various data sets were consulted which includes but not limited to Soil and Terrain dataset (SOTER) to review the geology, landform and land capability to establish broad baseline conditions and sensitivity of proposed project area both on environmental and agricultural perspective;
- Compile various maps depicting the on-site conditions based on desktop review of existing data;
- Classification of the climatic conditions occurring within the s;
- Conduct a soil classification survey within the proposed development footprint;
- Assess the spatial distribution of various soil types within the proposed project area and classify the dominant soil types according to the South African Soil Classification System: A Natural and Anthropogenic System for South Africa (Soil Classification Working Group, 2018);
- Identify restrictive soil properties on land capability under prevailing conditions;
- Identify and assess the potential impacts in relation to the proposed development using pre-defined impact assessment methodology; and
- Compile soil, land use and land capability report under current on-site conditions based on the field finding data.

1.3 Assumptions and Limitations

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

- The soil survey conducted as part of the land capability assessment was confined within the study area outline. However consideration of the immediately adjacent areas was given; and
- 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.

2. METHOD OF ASSESSMENT

2.1 Literature and Database Review

A background study, including a literature review, was conducted prior to the commencement of the field assessment to collect the pre-determined soil, land use and land capability data in the vicinity of the investigated proposed project area. Various data sources including but not limited to the Agricultural Geo-Referenced Information System (AGIS) and other sources as listed under references were utilized to fulfil the objectives for the assessment.

2.2 Soil Classification and Sampling

A soil survey was conducted in May 2022, at which time the identified soils within the proposed project area classified into soil forms according to the Soil Classification System: A Natural and Anthropogenic System for South Africa Soil Classification System (2018). This survey period is deemed appropriate since seasonality does not have an effect on the soil characteristics. 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.

2.3 Land Capability Classification

Agricultural potential is directly related to Land Capability, as measured on a scale of I to VIII, as presented in Table 4 below; with Classes I to III classified as prime agricultural land that is well suited for annual cultivated crops, whereas, Class IV soils may be cultivated under certain circumstances and specific or intensive management practices, and 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 5 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 4: 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 5: Climate Capability Classification (Scotney et al., 1987)

Climate Capability Class	Rainfall Range (mm)	Limitation Rating	Description
C1	>1000	None to slight	Local climate is favourable for good yield for a wide range of adapted crops throughout the year.
C2	900-1000	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	800 -900	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	700-800	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	600-700	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	400-600	Severe	Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Limited suitable crops for which frequently experience yield loss.
C7	200 -400	Severe to very severe	Severely restricted choice of crops due to heat, cold and/or moisture stress.
C8	0 - 200	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 agricultural land potential and knowledge of the geographical distribution of agricultural viable land within an area of interest. This is of importance for making an informed decision about land use. Table 6 below presents the land potential classes, whilst Table 7 presents a description thereof, according to Guy and Smith (1998).

Table 6: The Land Capability Classes Description (adapted from 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	(L3) Wetland	(L3) Wetland	(L4) Wetland	(L4) Wetland	(L5) Wetland	(L5) Wetland	(L6) Wetland	(L6) Wetland
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 7: 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 study area, according to various data sources including but not limited to the Agricultural Geo-referenced Information System (AGIS):

**It is important to note that although all data sources used provide useful and often verifiable, high-quality data, the various databases used do not always provide an entirely accurate indication of the actual site characteristics associated with the investigation area at the scale required to inform an environmental process. However, this information is useful as background information to the study and, if desktop results are considered with the outcome of the soil and land capability assessment, sufficient decision making can take place.*

Table 8: Desktop based soil background information sourced from various databases.

Parameters	Description
Mean Annual precipitation (MAP)	601 - 800 mm per annum. This rainfall is deemed adequate for a variety of cultivated crops with a moderate yield potential.
Mean Annual Evaporation (MAE)	2001 - 2200 mm per annum. The high evaporation rates pose risks to plant yield due possible plant permanent wilting resulting in plant desiccation and lack of adequate soil moisture.
Geology	Norite formation.
Landform type	Plain Landform This means the terrain is suitable to allow agricultural activities.
Soil pH	Slightly acidic to acidic with pH range of 5.5 - 6.4. This means that most nutrients will not be available for plant uptake.
The Soil and Terrain (SOTER) soil classification	Entire eastern WRD site is characterised by Calcic Vertisols, Majority of the western WRD site is dominated by so Calcic Vertisols and the remaining eastern portion is characterised by Rhodic Lixisols (Figure 3)
Desktop land capability	Very low capability under the Wilderness Class VIII.
Clay Content	Entire eastern WRD site above 35% Majority of western WRD site above 35% and remaining eastern portion between 15% and 35% (Figure 4)
Grazing Capacity	Transformed rangeland This grazing capacity is not suitable to support grazing land use.
Water Retaining Capacity of the soil	Good with no risk of waterlogging.
Alkalinity and Sodicity of the soils	The soils are neither alkaline or sodic, this indicates soils are not affected by high concentration of salts
Probability of soil loss	Low
Soil Water Retaining Characteristics	Scarce or Absent
Department of Environmental Affairs (DEA) screening tool	Western WRD is High Sensitivity (Figure 5) Eastern WRD is Medium Sensitivity (Figure 6)

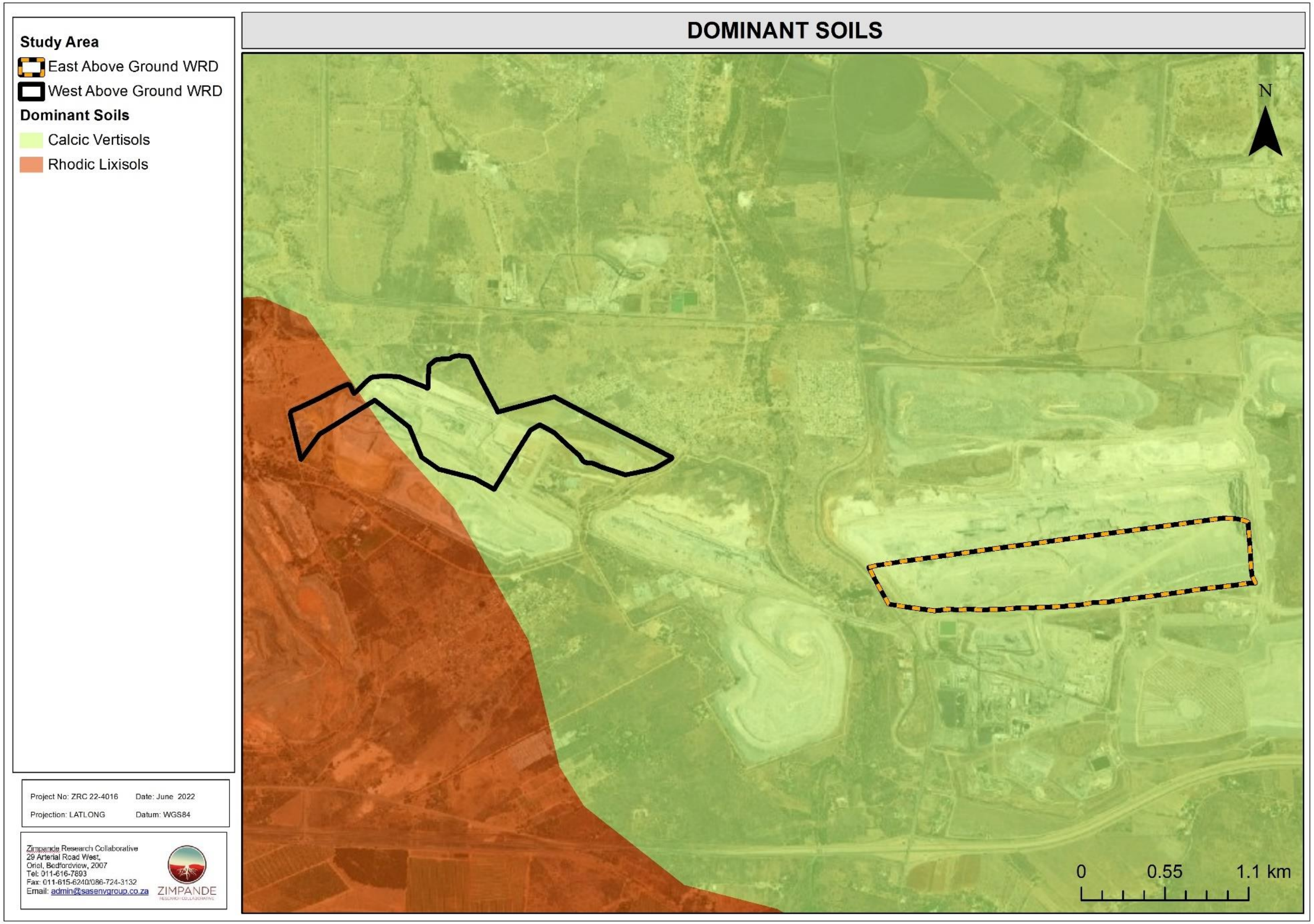

Figure 3: Dominant soils associated with the study area.

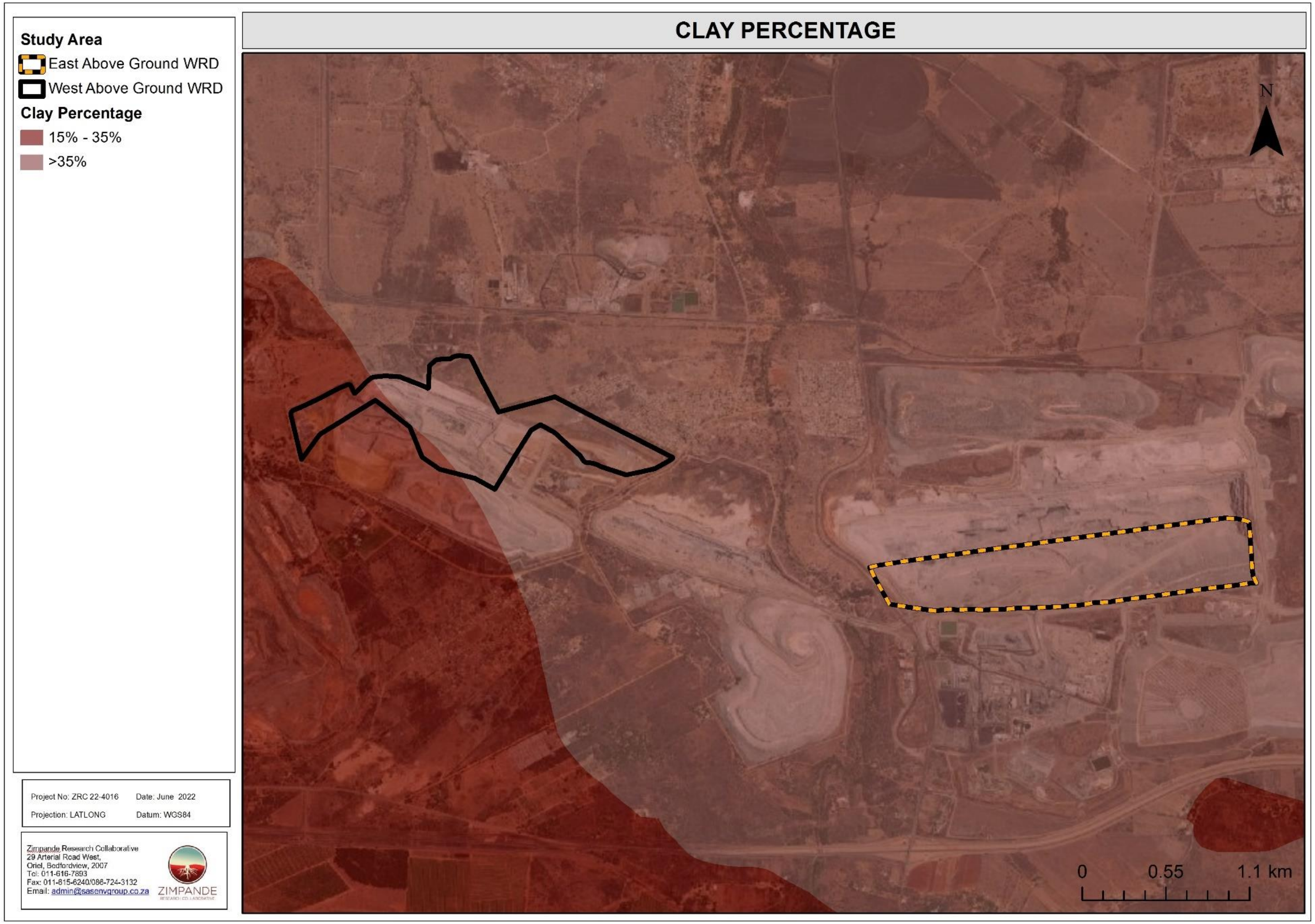

Figure 4: Clay Percentage associated with the soils occurring within the study area.

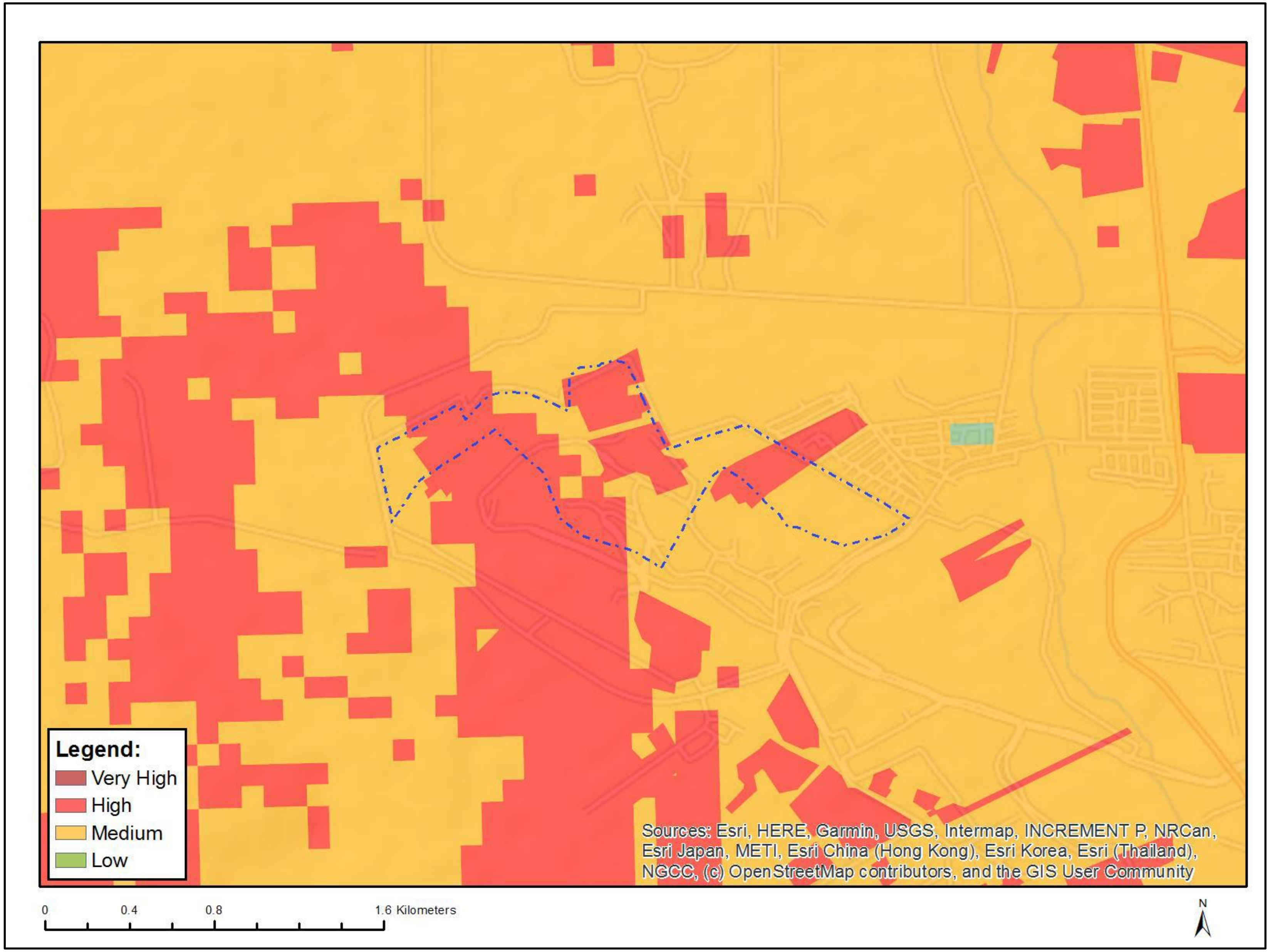

Figure 5: Screening tool analysis associated with the Western WRD.

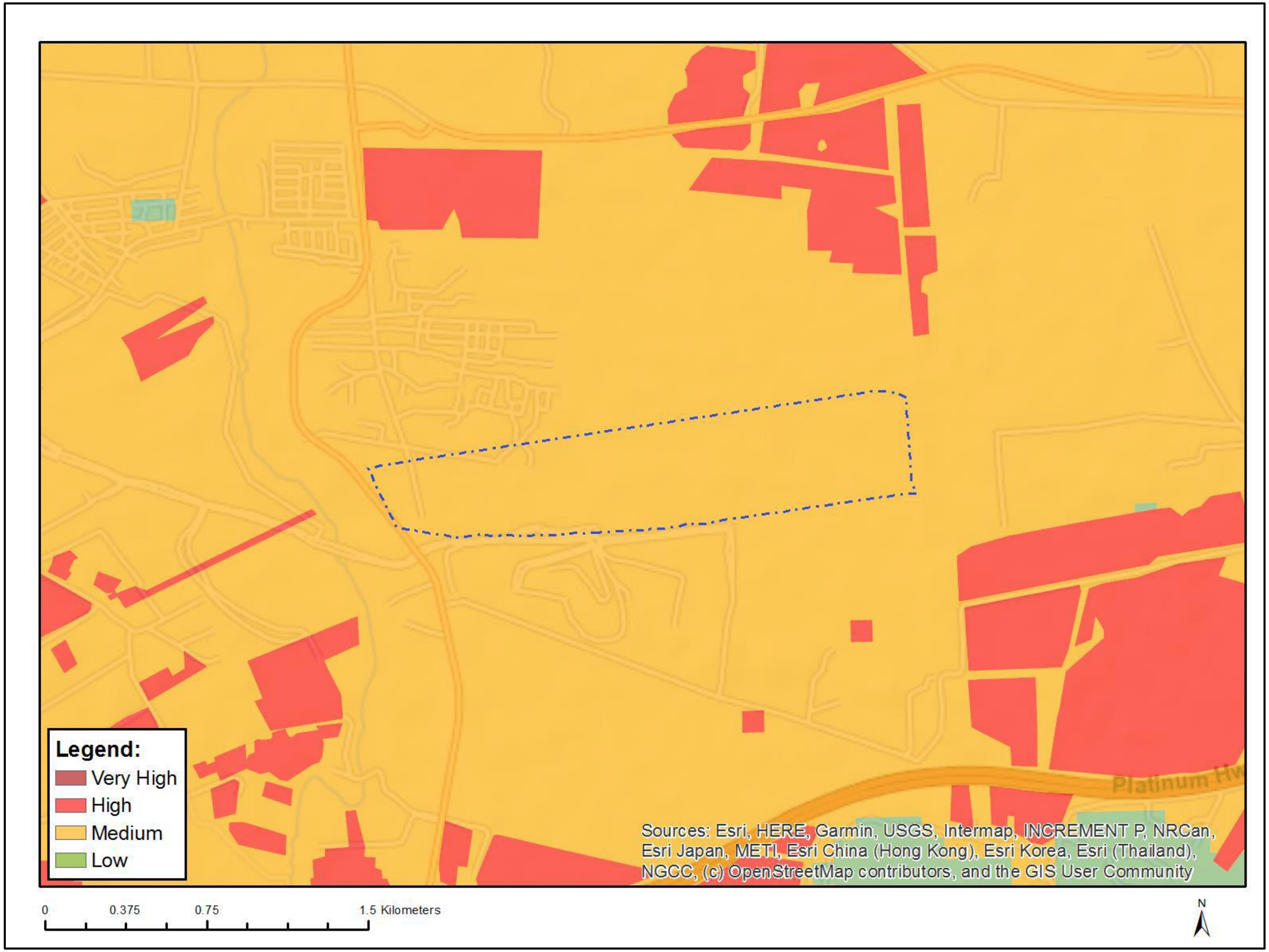

Figure 6: Screening tool analysis associated with the Eastern WRD.

4. ASSESSMENT RESULTS

4.1 Current Land Use

Based on the observations during the site assessment, the dominant land uses within the proposed WRD footprint areas are mining related activities. No agricultural activities were observed in the immediate vicinity of the footprint areas. Refer to Figure 7 for some of the current land uses associated with the footprint areas.

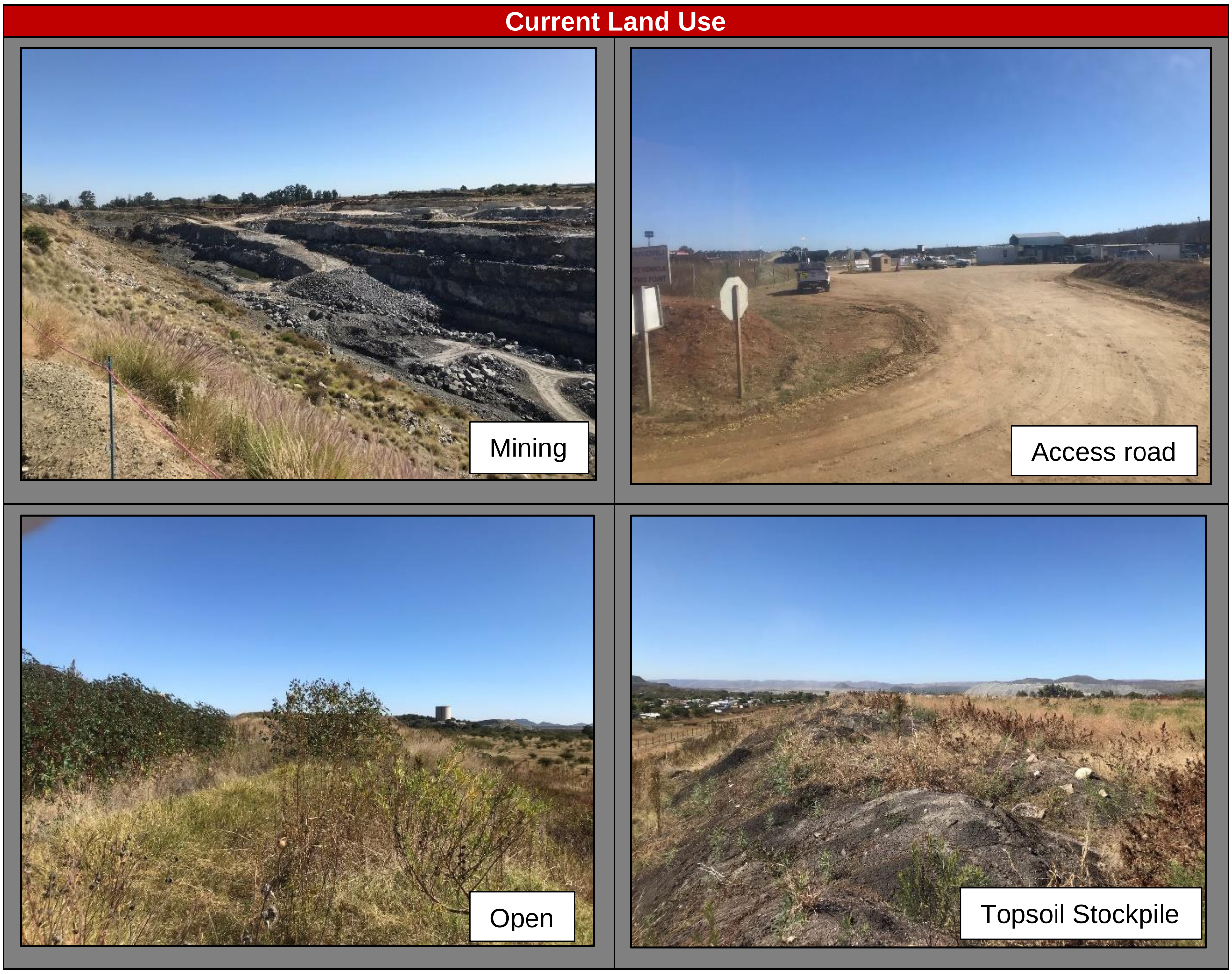

Figure 7: Photographs illustrating the dominant land use associated with the proposed footprint area and surrounding areas.

4.2 Dominant Soil Forms

The entire footprint area of the East Above Ground WRD is located in a disturbed area as a result of the ongoing open pit mining and waste rock dumping activities. Whereas a significant portion of the West Above Ground WRD footprint area has also been subjected to significant disturbance as a result of similar mining activities. The soil form associated with the disturbed areas was classified as a Witbank soil form while the excavated areas where no soil exist were classified as Cullinan soil form. The remaining patches of natural soils within the West Above Ground footprint area were classified as Acardia (black turf) soil form.

The Witbank soil form is considered to be of very low agricultural potential due to the soils having been subjected to physical disturbance because of human interventions. Such interventions include transportation and deposition of the earth material containing soil. As a result, these soils are unable to support agricultural production unless significant amelioration and rehabilitation takes place. Whereas the Cullinan soil form is characterised by voids with no soil layer, and thus the agricultural potential thereof is very low.

The remaining soils of Arcadia and Sepane soils are associated with poor physical properties induced by high clay content and very strong structure, waterlogging during heavy rainfall and thus rendering the soil conditions unfavourable for most cultivated crops. Nonetheless, should the soils be cultivated, intensive management practices would to be implemented.

Figure 8 and Table 9 below represents the soil forms identified within the study area as well as their diagnostic horizons respectively.

Table 9: Dominant soil forms within the study area.

Soil Form	Code	Diagnostic Horizon Sequence
Arcadia	Ar	Vertic/Lithic
Sepane	Se	Orthic/Pedocutanic/Gleyic
Cullinan	Cu	N/A (Open Pit)
Witbank	Wb	Transported Technosols

Figure 8: Dominant soils forms within the study area.

4.3 Land Capability Classification

Agricultural land capability in South Africa is generally restricted by climatic conditions, with specific mention to water availability (rainfall). Even within similar climatic zones, different soil types typically have different land use capabilities attributed to their inherent characteristics. High potential agricultural land is defined as having the soil and terrain quality, growing season and adequate available moisture supply needed to produce sustained economically high crop yields when treated and managed according to best possible farming practices (Scotney et al., 1987).

For this assessment, land capability was inferred in consideration of observed limitations to land use due to physical soil properties and prevailing climatic conditions. Climate Capability (measured on a scale of 1 to 8) was therefore considered in the agricultural potential classification. The study area falls into Climate Capability Class 4 due a good yield potential for a moderate range of adapted crops but planting date options more limited than C3..

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 on Figures **9** and **10** illustrates the Land Potential associated with the study area when incorporating other factors such as climate, slope and soil conditions together. The identified land capability limitations for the identified soils are discussed in comprehensive "dashboard style" summary tables presented from Tables **11** and **12** below. The dashboard reports aim to present all the pertinent information in a concise and visually appealing fashion. **Table 10** below presents the dominant soil forms and their respective land capability, agricultural potential as well as areal extent expressed as hectares as well as percentages

Table 10: Identified soil forms within the proposed footprint area and their respective land capability.

Soil Form	Land capability	Land Potential	Area (ha)	Percentage (%)
Acardia	Grazing (Class V)	Moderate Potential (L4)	2.65	1.61
Sepane			1.33	0.81
Witbank	Wilderness (Class VIII)	Very Low Potential (L8)	99.17	60.28
Cullinan			59.39	36.10
Total enclosed			**164.5**	**100**

***Infrastructural areas of 1.96 ha (1.20%) were not included in the table above since they not considered in the land capability ratings.**

Figure 9: Map depicting Land capability of soils occurring within the proposed footprint areas.

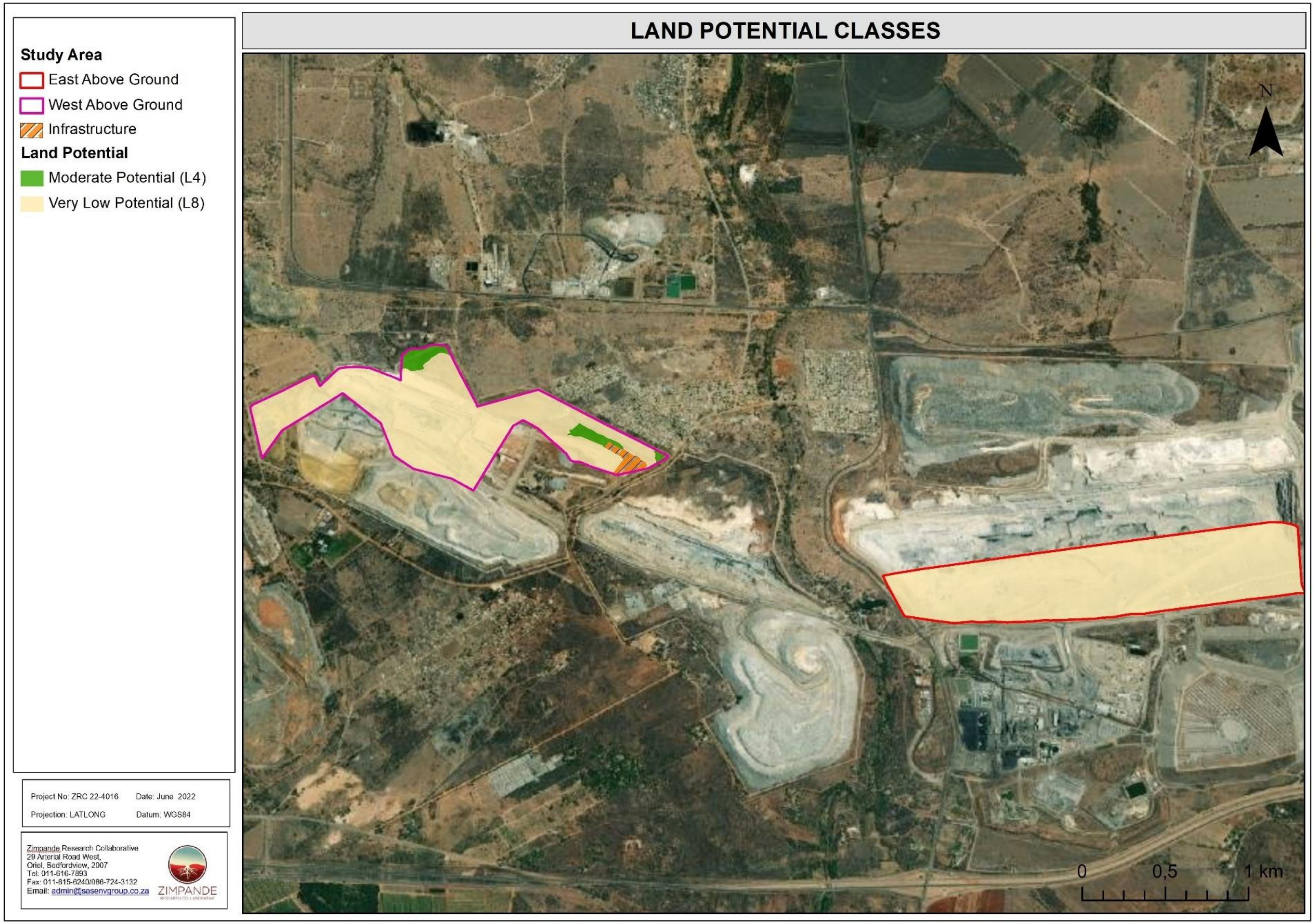

Figure 10: Map depicting land potential of soils occurring within the proposed footprint area.

Table 11: Summary discussion of the Grazing (Class V) land capability class

<table>
<tr><th colspan="5">Land Capability: Grazing (Class V) and Restricted land potential</th></tr>
<tr><td colspan="5">  </td></tr>
<tr><td>Terrain Morphological Unit (TMU)</td><td colspan="2">Relatively flat landscapes of < 0.2% slope gradient</td><td>Photograph notes</td><td>View of the vertic and pedocutanic horizons associated with the Arcadia and Sepane soil forms occurring within the soil profile of the identified soil forms.</td></tr>
<tr><td>Soil Form(s)</td><td colspan="2">Acardia</td><td>Area Extent</td><td>3.98 ha (2.42%)</td></tr>
<tr><td>Physical Limitations</td><td colspan="2">Arcadia and Sepane are characterized by high clay content in the subsoil and strong structure and thus limiting rooting depth and also prone to waterlogging during high rainfall events.</td><td colspan="2" rowspan="2">Land Capability
The identified soil forms are of (Class V) land capability, Land has very serious permanent limitations that restrict the choice of alternative crops or the intensity of crop production to a great extent.</td></tr>
<tr><td>Land Potential</td><td colspan="2">L5 (Restricted Potential): Regular and/or moderate to severe limitations due to soil type characterised by high clay content, low temperatures and low rainfall without any supplementary irrigation schemes.</td></tr>
<tr><td>Overall impact significance prior to mitigation</td><td>L</td><td rowspan="2">The overall impact of the proposed WRDs, internal haul roads and associated developments on land capability and land potential is anticipated to be Low (L) without mitigation measures and Very Low (VL) with mitigation measures in place. Due to the inherently low land potential of the identified dominant soil forms and the very small footprint within the study area. These sols that have not historically been affected also occur in a patchy form throughout the mining landscape and no single unit is large enough to contribute in any significant way to agricultural production unless holistic closure and rehabilitation of the entire mine takes place.</td><td colspan="2" rowspan="2">Business case, Conclusion and Mitigation Requirements:
The identified soils are generally not considered significant in terms of agricultural productivity. Should agricultural production be considered intense management practices have to be applied, which are usually costly and not economical based on the expected yields from these soils. This is exacerbated by the climate of the area. Also, these soils only account for 2.65 ha (1.61%) for the Arcadia and 1.33 ha (0.81%) of the study area and are interspersed within the active mining area and thus rendering the impact on agricultural productivity insignificant. The proposed developments are viable on these soils considering the agricultural potential of these soils. Mitigation measures should this put in place to minimise further disruption of other adjacent soils which can potentially be used for grazing, rangeland and wildlife and to provide soil for use in closure of the mine.</td></tr>
<tr><td>Overall impact significance post mitigation</td><td>VL</td></tr>
</table>

Table 12: Summary discussion of the Wilderness (Class VII) land capability class.

<table>
<tr><th colspan="6">Land Capability: Wildlife/Wilderness (Class VIII) and Low land potential</th></tr>
<tr><td colspan="6">  </td></tr>
<tr><td>Terrain Morphological Unit (TMU)</td><td colspan="2">Not applicable; highly disturbed areas</td><td>Photograph notes</td><td colspan="2">View of the identified Witbank and Cullinan soil forms</td></tr>
<tr><td>Soil Form(s)</td><td colspan="2">Witbank (Anthrosols) and Cullinan (Open void)</td><td>Area Extent</td><td colspan="2"></td></tr>
<tr><td>Physical Limitations</td><td colspan="2">Comprises significantly disturbed areas due to open pit and water rock dumping activities to an extent that no recognisable diagnostic soil horizon properties could be identified. These soils are characterised by various limitations, primarily the absence of the A horizon as a growth medium.</td><td colspan="3" rowspan="2">Land Capability
These identified Witbank and Cullinan soils have very poor (Class VIII) land capability and Low land potential class attributed the ongoing mining activities. This land capability class also includes areas where the original soil has been buried and/or extensively modified by mining and related activities. These soils are not considered to make contribution to agricultural productivity even on a local scale.</td></tr>
<tr><td>Land Potential</td><td colspan="2">L8 (Very Low potential): Severe limitations due to the disturbed nature of soils thus rendering them non-arable.</td></tr>
<tr><td>Overall impact significance prior to mitigation</td><td>VL</td><td rowspan="2">The overall impact of the proposed WRDs, internal haul roads and associated developments and related activities on the land capability of these physically disturbed soils due to human intervention is anticipated to be low due to their very poor land capability and Low land potential.</td><td colspan="3" rowspan="2">Business case, Conclusion and Mitigation Requirements:
The current state of these soils is not suitable for agricultural activities, except for wilderness due to unsuitability of the landscape as well as the impact on the soil resources as a result of mining. The WRDs is not anticipated to cause a loss of agricultural resources. These soils will need to be rehabilitated upon closure of the greater mining landscape to suit the post closure land use.</td></tr>
<tr><td>Overall impact significance post mitigation</td><td>VL</td></tr>
</table>

5. IMPACT ASSESSMENT AND MITIGATION MEASURES

This section presents the significance of potential impacts on the identified soil resources associated with the proposed developments. In addition, it also indicates the required mitigatory measures needed to minimise the perceived impacts associated with the proposed development and presents an assessment of the significance of the impacts taking into consideration the available mitigatory measures and assuming that they are fully implemented. The description of the impact significance and ratings are presented on Table 13 and Table 14.

Table 13: Description of the impact significance in relation to the to the proposed activities and developments within the proposed footprint areas.

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
Very High	Potential fatal flaw unless mitigated to lower significance.
High	It must have an influence on the decision. Substantial mitigation will be required.
Medium	It should have an influence on the decision. Mitigation will be required.
Low	Unlikely that it will have a real influence on the decision. Limited mitigation is likely required.
Very Low	It will not have an influence on the decision. Does not require any mitigation
Insignificant	Inconsequential, not requiring any consideration.

Table 14: Description of terms used in the impact assessment rating for the proposed activities and developments within the proposed footprint areas.

PART A: DEFINITIONS AND CRITERIA*		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of intensity, spatial extent and duration**
Criteria for ranking of the INTENSITY of environmental impacts	**VH**	Severe change, disturbance or degradation. Associated with severe consequences. May result in severe illness, injury or death. Targets, limits and thresholds of concern continually exceeded. Substantial intervention will be required. Vigorous/widespread community mobilization against project can be expected. May result in legal action if impact occurs.
	H	Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place.
	M	Moderate change, disturbance or discomfort. Associated with real but not substantial consequences. Targets, limits and thresholds of concern may occasionally be exceeded. Likely to require some intervention. Occasional complaints can be expected.
	L	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.
	VL	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.

	VL+	Negligible change or improvement. Almost no benefits. Change not measurable/will remain in the current range.
	L+	Minor change or improvement. Minor benefits. Change not measurable/will remain in the current range. Few people will experience benefits.
	M+	Moderate change or improvement. Real but not substantial benefits. Will be within or marginally better than the current conditions. Small number of people will experience benefits.
	H+	Prominent change or improvement. Real and substantial benefits. Will be better than current conditions. Many people will experience benefits. General community support.
	VH+	Substantial, large-scale change or improvement. Considerable and widespread benefit. Will be much better than the current conditions. Favourable publicity and/or widespread support expected.
Criteria for ranking the DURATION of impacts	**VL**	Very short, always less than a year. Quickly reversible
	L	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.
	M	Medium-term, 5 to 10 years.
	H	Long term, between 10 and 20 years. (Likely to cease at the end of the operational life of the activity)
	VH	Very long, permanent, +20 years (Irreversible. Beyond closure)
Criteria for ranking the EXTENT of impacts	**VL**	A part of the site/property.
	L	Whole site.
	M	Beyond the site boundary, affecting immediate neighbours
	H	Local area, extending far beyond site boundary.
	VH	Regional/National

5.1 Activities

The proposed activities will entail the construction of the WRDs and associated developments. The soils are anticipated to be exposed to erosion, dust emission, and potential soil contamination impacts during the construction phase of the proposed project area; and these impacts may persist for the duration of the operational phase if not mitigated adequately. The activities associated with the proposed developments are presented on Table 15. The impact assessment rating is applicable to the following activities:

Table 15: Activities associated with proposed footprint areas during different phases.

Phase	Activities
Construction	Clearing of the footprint area associated for the proposed developments.
	Soil striping.
	Construction of WRDs
Operational	Operation of the WRDS and related activities.
Closure and Rehabilitation	Cessation of WRD activities
	Capping and revegetation of WRDs

5.1.1 Soil Erosion

Soil erosion is largely dependent on land use and soil management and is generally accelerated by anthropogenic activities. In the absence of detailed South African guidelines on erosion classification, the erosion potential and interpretation are based on field observations as well as observed soil profile characteristics. In general, soils with high clay content (i.e., Arcadia and Sepane) have a high-water retention capacity, thus less prone to erosion.

The proposed WRD footprint areas are already comprised open void (pit) and waste rock material with limited natural soil. The soil erosion impact is therefore anticipated to be Low (L) during all phases. However, mitigation measures will be required to further reduce the impacts. The post mitigation measures the impact is anticipated to be Very Low (VL). Refer to Table 16, 17 and 18 for the different impact significance ratings on soil erosion before and after mitigation during all phases of development.

Aspects and activities register

Construction	Operational	Decommissioning
Site clearing, removal of vegetation, and associated disturbances to soils, leading to, increased runoff, erosion, and consequent loss of land	Constant disturbances of soils, resulting in risk of erosion	Pre-Decommissioning planning and removal of all plant equipment
Potential frequent movement of digging machinery within lose and exposed soils, leading to excessive erosion		Closure of the proposed development leading to further disturbance of soils.

Construction Phase

Table 16: Summary of the impact significance on soil erosion for the proposed footprint areas during the construction phase.

Issue: Soil erosion		
Phases: Construction		
Criteria	Without Mitigation	With Mitigation
Intensity	Moderate change or disturbance (M)	Minor change or disturbance (L)
Duration	Short-term (L)	Short-term (L)
Extent	Part of site (VL)	Part of site (VL)
Consequence	Low (L)	Low (L)
Probability	Probable (H)	Conceivable (L)
Significance	Low (L)	Very Low (VL)
Nature of cumulative impacts	Cumulative impacts from the proposed developments within the Proposed Footprint Areas are anticipated to be of Low significance without mitigation measures.	
Degree to which impact can be reversed	The impact can be fully reversed once the construction period is completed, and management measures are put in place and adhered to.	

Issue: Soil erosion	
Degree to which impact may cause irreplaceable loss of resources	Low
Residual impacts	The residual impact is considered to be Very Low due to the proposed footprint areas being dominated by Witbank and Cullinan soil forms and being in close proximity to active mining area.

Operational Phase

Table 17: Summary of the impact significance on soil erosion for the proposed footprint areas during the operational phase.

Issue: Soil erosion		
Phases: Operational		
Criteria	Without Mitigation	With Mitigation
Intensity	Moderate change or disturbance (M)	Minor change or disturbance (L)
Duration	Medium term (L)	Medium-term (M)
Extent	Part of site (VL)	Part of site (VL)
Consequence	Low (L)	Low (L)
Probability	Probable (H)	Possible (M)
Significance	Low (L)	Very Low (VL)
Nature of cumulative impacts	Cumulative impacts from the proposed developments within the Proposed Footprint Areas are anticipated to be of Low significance without mitigation measures	
Degree to which impact can be reversed	Low during operational phase.	
Degree to which impact may cause irreplaceable loss of resources	Low because the majority of the soils are disturbed already.	
Residual impacts	The residual impact is considered to be Very Low due to the proposed footprint areas being dominated by Witbank and Cullinan soil forms and being in close proximity to active mining area.	

Closure and Rehabilitation Phase

Table 18: Summary of the impact significance on soil erosion for the proposed footprint areas during the decommissioning phase.

Issue: Soil erosion		
Phases: Decommissioning		
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Minor change or disturbance (L)	Minor change or disturbance (L)
Duration	Long-term (L)	Long-term (L)
Extent	Part of site (VL)	Part of site (VL)
Consequence	Low (L)	Low (L)
Probability	Probable (H)	Conceivable (L)
Significance	Low (L)	Very Low (VL)

Issue: Soil erosion	
Nature of cumulative impacts	Cumulative impacts from the proposed developments within the Proposed Footprint Areas are anticipated to be of Low significance.
Degree to which impact can be reversed	The impact can be reversed to a degree once the mining activities cease and the impacted areas have been rehabilitated.
Degree to which impact may cause irreplaceable loss of resources	Very Low
Residual impacts	The residual impact is considered to be Very Low due to the proposed footprint areas being dominated by Witbank and Cullinan soil forms and being in close proximity to active mining area.

5.1.2 Potential Soil Compaction

The severity of impact on soil compaction is anticipated to be low for the disturbed soils (i.e., Witbank and Cullinan) and high for the natural soils due to their high clay content. The impact significance can however be reduced significantly, should the proposed activities be restricted to access roads, vehicle hard stand areas and equipment and machinery laydown areas. Soil compaction will potentially lead to:

- Increased bulk density and soil strength, reduced aeration and lower infiltration rate
- Destroyed soil structure, causing it to become more massive with fewer natural voids with a high possibility of soil crusting.
- 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.

Refer to Table 19, 20 and 21 for the different impact significance ratings on soil compaction before and after mitigation during all phases of development.

Aspects and activities register.

Construction	Operational	Decommissioning
Site clearing and associated disturbances to soils, leading to, increased runoff, soil compaction and consequent loss of land capability in cleared areas.	Constant disturbances of soils, resulting in risk of compaction.	Pre-Decommissioning planning and removal of all plant equipment potentially leading to further compaction of soils.
Potential frequent movement of digging machinery and construction vehicles within lose and exposed soils, leading to excessive soil compaction.		Closure of the proposed development potentially leading to further compaction of soils.

Construction Phase

Table 19: Summary of the impact significance on soil compaction for the proposed footprint areas during the construction phase.

Issue: Soil erosion.		
Phases: Construction		
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Moderate change or disturbance (M)	Minor change or disturbance (L)
Duration	Short-term (L)	Short-term (L)
Extent	Part of site (VL)	Part of site (VL)
Consequence	Medium (M)	Low (L)
Probability	Probable (H)	Conceivable (L)
Significance	Low (L)	Very Low (VL)
Nature of cumulative impacts	Cumulative impacts from the proposed developments within the Proposed Footprint Areas are anticipated to be of Low significance without mitigation measures.	
Degree to which impact can be reversed	The impact can be fully reversed once the construction period is completed, and management measures are put in place and adhered to .	
Degree to which impact may cause irreplaceable loss of resources	Low	
Residual impacts	The residual impact is considered to be VERY LOW due to the proposed footprint areas being dominated by Witbank and Cullinan soil forms and being within an active mining area.	

Operational Phase

Table 20: Summary of the impact significance on soil compaction for the proposed footprint areas during the operational phase.

Issue: Soil compaction		
Phases: Operational		
Criteria	Without Mitigation	With Mitigation
Intensity	Moderate change or disturbance (M)	Minor change or disturbance (L)
Duration	Long-term (M)	Long-term (M)
Extent	Part of site (VL)	Part of site (VL)
Consequence	Medium (M)	Low (L)
Probability	Probable (H)	Conceivable (L)
Significance	Medium (M)	Very Low (VL)
Nature of cumulative impacts	Cumulative impacts from the proposed developments within the proposed footprint areas are anticipated to be of Medium significance without mitigation measures.	
Degree to which impact can be reversed	Low during operational phase.	
Degree to which impact may cause irreplaceable loss of resources	Low because the majority of the soils are disturbed already.	

Issue: Soil compaction	
Residual impacts	The residual impact is considered to be VERY LOW due to the proposed footprint areas being dominated by Witbank and Cullinan soil forms and being in close proximity to active mining area.

Closure and Rehabilitation Phase

Table 21: Summary of the impact significance on soil compaction for the proposed footprint areas during the closure and rehabilitation phase.

Issue: Soil Compaction		
Phases: Decommissioning and Closure Phases		
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Minor change or disturbance (L)	Minor change or disturbance (L)
Duration	Long-term (H)	Long-term (H)
Extent	Part of site (VL)	Part of site (VL)
Consequence	Low (L)	Low (L)
Probability	Probable (H)	Conceivable (L)
Significance	Low (L)	Very Low (VL)
Nature of cumulative impacts	Cumulative impacts from the mining activities within the proposed footprint areas are anticipated to be of Low significance.	
Degree to which impact can be reversed	The impact can be reversed to a large degree once the mining activities cease and the impacted areas have been rehabilitated.	
Degree to which impact may cause irreplaceable loss of resources	Very Low	
Residual impacts	The residual impact is considered to be VERY LOW due to the proposed footprint areas being dominated by Witbank and Cullinan soil forms and being in close proximity to active mining area.	

5.1.3 Potential Soil Contamination

Contamination sources are mostly unpredictable and often occur as incidental spills or leaks during both the construction and operational phase. Thus, all the identified soils are considered equally predisposed to potential contamination. The significance of contamination is largely dependent on the nature, volume and/or concentration of the contaminant of concern as well as the rate at which contaminants are transported by water in the soil. Therefore, strict waste management protocols as well as product stockpile management and activity specific Environmental Management Programme (EMP) and monitoring guidelines should be adhered to during the construction and operational activities. 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.

The soil contamination impact is therefore anticipated to be Medium during the pre-construction, construction and operational phases. Hence it should have an influence on the decision and mitigation measures will be required. Post mitigation measures the significant impacts are anticipated to be Very Low during the construction, operational and rehabilitation phases. Refer to Table 19, 20 and 21 for the different impact significance ratings on soil contamination before and after mitigation during all phases of development.

Aspects and activities register.

Construction	Operational	Decommissioning
Spillage of petroleum hydrocarbons during construction of associated infrastructure.	Leaching of hydrocarbons chemicals into the soils, leading to alteration of the soil chemical status as well as contamination of ground water.	Pre-Decommissioning planning and removal of all plant equipment.
Disposal of hazardous and non-hazardous waste, including waste material spills and refuse deposits into the soil.	Disposal of hazardous and non-hazardous waste, including waste material spills and refuse deposits into the soil.	Closure of the proposed development.

Construction Phase

Table 22: Summary of the impact significance on soil contamination for the proposed footprint areas during the construction phase.

Issue: Soil Contamination		
Phases: Construction		
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Moderate change or disturbance (M)	Minor change or disturbance (L)
Duration	Short-term (L)	Short-term (L)
Extent	Part of site (VL)	Part of site (VL)
Consequence	Low (L)	Low (L)
Probability	Probable (H)	Conceivable (L)
Significance	Low (L)	Very Low (VL)
Nature of cumulative impacts	Cumulative impacts from the proposed developments within the proposed footprint areas are anticipated to be of Low significance without mitigation measures.	
Degree to which impact can be reversed	The impact can be fully reversed once the construction period is completed, and management measures are put in place and adhered to	
Degree to which impact may cause irreplaceable loss of resources	Low	
Residual impacts	The residual impact is considered to be VERY LOW due to the proposed footprint areas being dominated by Witbank and Cullinan soil forms and being in close proximity to active mining area.	

Operational Phase

Table 23: Summary of the impact significance on soil contamination for the proposed footprint areas during the operational phase.

Issue: Soil Contamination		
Phases: Operational		
Criteria	Without Mitigation	With Mitigation
Intensity	Moderate change or disturbance (M)	Minor change or disturbance (L)
Duration	Short-term (L)	Short-term (L)
Extent	Part of site (VL)	Part of site (VL)
Consequence	Medium (L)	Low (L)
Probability	Probable (H)	Conceivable (L)
Significance	Low (L)	Very Low (VL)
Nature of cumulative impacts	Cumulative impacts from the proposed developments within the proposed footprint areas are anticipated to be of Medium significance without mitigation measures.	
Degree to which impact can be reversed	Low during operational phase	
Degree to which impact may cause irreplaceable loss of resources	Low because the majority of the soils are disturbed already.	
Residual impacts	The residual impact is considered to be VERY LOW due to the proposed footprint areas being dominated by Witbank and Cullinan soil forms and being in close proximity to active mining area.	

Decommissioning Phase

Table 24: Summary of the impact significance on soil contamination for the proposed footprint areas during the decommissioning phase.

Issue: Soil Contamination		
Phases: Decommissioning and Closure Phases		
Criteria	Without Mitigation	With Mitigation
Intensity	Minor change or disturbance (L)	Minor change or disturbance (L)
Duration	Long-term (H)	Long-term (H)
Extent	Part of site (VL)	Part of site (VL)
Consequence	Low (L)	Low (L)
Probability	Probable (H)	Conceivable (L)
Significance	Low (L)	Very Low
Nature of cumulative impacts	Cumulative impacts from the proposed developments within the proposed footprint areas are anticipated to be of Low significance.	
Degree to which impact can be reversed	The impact can be reversed to a large degree once the mining activities cease, and the impacted areas have been rehabilitated.	

Issue: Soil Contamination	
Degree to which impact may cause irreplaceable loss of resources	Very Low
Residual impacts	The residual impact is VERY LOW due to the proposed footprint areas being dominated by Witbank and Cullinan soil forms and being in close proximity to active mining area.

5.1.4 Loss of Agricultural Land Capability

The impact on soil land capability is anticipated to be Low without mitigation and Very Low with mitigation. However, mitigation measure are deemed necessary, particularly for the conservation of topsoil for use during the closure and rehabilitation phase to meet the post closure landuse objectives. Refer to Table 23, 24 and 25 for the different impact significance ratings on loss of agricultural land capability before and after mitigation during all phases of development.

Construction Phase

Table 25: Summary of the impact significance on soil contamination for the proposed footprint areas during the construction phase.

Issue: Loss of agricultural land capability		
Phases: Construction		
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Moderate change or disturbance (M)	Minor change or disturbance (L)
Duration	Short-term (L)	Short-term (L)
Extent	Part of site (VL)	Part of site (VL)
Consequence	Low (L)	Low (L)
Probability	Probable (H)	Conceivable (L)
Significance	Low (L)	Very Low (VL)
Nature of cumulative impacts	Cumulative impacts from the proposed developments within the Proposed Footprint Areas are anticipated to be of Low significance without mitigation measures.	
Degree to which impact can be reversed	The impact can be fully reversed once the construction period is completed, and management measures are put in place and adhered to	
Degree to which impact may cause irreplaceable loss of resources	Low	
Residual impacts	The residual impact is considered to be VERY LOW due to the proposed footprint areas being dominated by Witbank and Cullinan soil forms and being in close proximity to active mining area.	

Operational Phase

Table 26: Summary of the impact significance on soil contamination for the proposed footprint areas during the operational phase.

Issue: Loss of agricultural land capability		
Phases: Operational		
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Moderate change or disturbance (M)	Minor change or disturbance (L)
Duration	Short-term (L)	Short-term (L)
Extent	Part of site (VL)	Part of site (VL)
Consequence	Low (L)	Low (L)
Probability	Probable (H)	Conceivable (L)
Significance	Low (L)	Very Low (VL)
Nature of cumulative impacts	Cumulative impacts from the proposed developments within the proposed footprint areas are anticipated to be of Medium significance without mitigation measures.	
Degree to which impact can be reversed	Low during operational phase	
Degree to which impact may cause irreplaceable loss of resources	Low because the majority of the soils are disturbed already.	
Residual impacts	The residual impact is considered to be VERY LOW due to the proposed footprint areas being dominated by Witbank soil and Cullinan forms and being in close proximity to active mining area.	

Decommissioning Phase

Table 27: Summary of the impact significance on soil contamination for the proposed footprint areas during the decommissioning phase.

Issue: Loss of agricultural land capability		
Phases: Decommissioning and Closure Phases		
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Minor change or disturbance (L)	Minor change or disturbance (L)
Duration	Long-term (H)	Long-term (H)
Extent	Part of site (VL)	Part of site (VL)
Consequence	Low (L)	Low (L)
Probability	Probable (H)	Conceivable (L)
Significance	Low	Very Low
Nature of cumulative impacts	Cumulative impacts from the proposed developments within the proposed footprint areas are anticipated to be of Low significance.	
Degree to which impact can be reversed	The impact can be reversed to a large degree once the mining activities cease and the impacted areas have been rehabilitated.	

Issue: Loss of agricultural land capability	
Degree to which impact may cause irreplaceable loss of resources	Very Low
Residual impacts	The residual impact is considered to be VERY LOW due to the proposed footprint areas being dominated by Witbank and Cullinan soil forms and being in close proximity to active mining area.

5.1.4 Cumulative Impact

From a soil and land capability point of view, the cumulative loss agricultural land capability is considered limited since the dominant soils within each footprint area are disturbed as a result of the ongoing mining activities and the soil are not considered ideal to support agricultural activities. In addition, the proposed footprint areas are surrounded by active mining related activities as well as wilderness areas and are isolated from any large-scale agricultural activities in the area. If use of the natural soils within the footprint is made for closure of the mine, the significance of the impact will be further reduced.

5.2 Integrated Mitigation Measures

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

5.2.1 Soil Erosion

- Temporary erosion control measures around the topsoil stockpile areas should be used to protect the disturbed soils during the rehabilitation until adequate vegetation has established;
- Bare soils within the access roads can be regularly dampened with water to suppress dust during the construction phase, especially when strong wind conditions are predicted according to the local weather forecast;
- The footprint of the proposed development and construction activities should be clearly demarcated to restrict vegetation clearing activities within the infrastructure footprint as far as practically possible; and
- All disturbed areas adjacent to the proposed development areas should be re-vegetated with an indigenous grass mix, if necessary, to re-establish a protective cover, to minimise soil erosion and dust emission.

5.2.2 Soil compaction Management

- Compacted soils adjacent to the proposed developments during construction should be lightly ripped to at least 25 cm below ground surface to alleviate compaction; and
- Decommissioning activities should be scheduled to coincide with low rainfall conditions when soil moisture is anticipated to be relatively low, such that the soils are less prone to compaction.

5.2.3 Soil Contamination Management

- The construction of toe paddocks and secondary toe paddock cross walls around the perimeter of the WRDs should be installed to limit seepage;
- WRDs should be lined in accordance with the proposed design features to limit possible seepage and the subsequent soil contamination;
- 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;
- A spill prevention and emergency spill response plan, as well as dust suppression, and fire prevention plans should also be compiled to guide the construction works; and
- An emergency response contingency plan should be put in place to address clean-up measures should a spill and/or a leak occur, as well as preventative measures to prevent contamination.

5.2.4 Loss of Land Capability Management

- Topsoil material should be stripped and stockpiled in areas demarcated as “No Go Areas”;
- A stripping depth of 500 mm has been recommended by the previous soil studies and this should be adhered to as far as possible;
- Close supervision and monitoring of the stripping process is required to ensure that soils are stripped correctly;.
- Revegetate the disturbed soils with an indigenous grass mix, to re-establish a protective cover, in order to minimise soil erosion and dust emissions; and
- The footprint areas should be lightly ripped to alleviate compaction.

5.3 Stockpile Management

- 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;
- Stockpile height should be restricted to that which can deposited without additional traversing by machinery. Stockpiles should be treated with temporary soil stabilisation methods, such as the application of organic matter to promote soil aggregate formation, leading to increased infiltration rate, thereby reducing soil erosion. Also, the use of lime to stabilise soil pH levels;
- Soil erosion should be controlled on stockpiles by having control measures to reduce erosion risk such as erosion control blankets, soil binders, revegetation, contours, diversion banks and spillways;
- Stockpiled soils should be stored for a maximum of 3-5 years to ensure that the soil quality does not deteriorate. In addition, concurrent rehabilitation must 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;
- 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.

5.4 Estimation of Available Topsoil (soft material) for Rehabilitation

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

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

Table 28: Estimation of available soft material for soils to be directly impacted by the proposed open cast pits

Land capability	Area (m2)	Average Depth (m)	Volume (m3)	Level of confidence (%)
Acardia	26500	0.6	15 900	80
Sepane	13300	0.6	7 980	80
Witbank	991700	N/A	N/A	60
Cullinan	593900	N/A	N/A	80
Total			**23 880**	**75**

6 CONCLUSION

The Zimpande Research Collaborative (ZRC) was appointed to conduct a soil, land use and land capability assessment for the proposed expansion of the two existing Waste Rock Dumps (WRDs) as part of the Environmental Authorisation (EA) processes. The WRDs footprint area will henceforth be referred to as the “Study Area”.

The objective of this study was to evaluate:

- Climatic conditions within the context of agricultural productivity and constraints;
- Landscape setting and land use,
- Soil physical; and
- Other current limitations to various land use purposes.

The entire footprint area of the East Above Ground WRD is located in a disturbed area as a result of the ongoing open pit mining and waste rock dumping activities. Whereas a significant portion of the West Above Ground WRD footprint area has also been subjected to significant disturbance as a result of similar mining activities. The soil form associated with the disturbed areas was classified as a Witbank soil form while the excavated areas where no soil exist were classified as Cullinan soil form. The remaining patches of natural soils within the West Above Ground footprint area were classified as Acardia (black turf) soil form, and are not considered ideal for cultivation unless intensive management practices are implemented.

From a soil and land capability point of view, the cumulative loss is considered limited since the dominant soils within each footprint area are disturbed as a result of the ongoing mining activities and the soil are not considered ideal to support agricultural activities. In addition, the proposed footprint areas are surrounded by active mining related activities as well as wilderness areas and are isolated from any large-scale agricultural activities in the area. If use of the natural soils within the footprint is made for closure of the mine, the significance of the impact will be further reduced.

From a soil, land use and land capability point of view, this project regarded as being of low impact significance due to the inherent soil constraints of the area and the severe disturbance of the majority of the soils on site. However, mitigation measures and recommendations outlined in this document need to be strongly considered and implemented accordingly in efforts to conserve soil resources in the post mining landscape.

REFERENCES

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

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

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

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

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

Land Type Survey Staff, 1976-2006. Land type Survey Database. ARC-ISCW, Pretoria.

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

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

Scotney, D.M., Ellis, F., Nott, R.W., Taylor, K.P., Van Niekerk, B.J., Verster, E. & Wood, P.C., 1987. A system of soil and land capability classification for agriculture in the SA TBVC states. Dept. Agric., Pretoria.

Smith, B. , 2006. The Farming Handbook. Netherlands & South Africa: University of KwaZulu Natal Press & CTA.

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

APPENDIX A: ASSESSMENT METHODOLOGY

Desktop Screening

Prior to commencement of the field assessment, a background study, including a literature review, was conducted in order to collect the pre-determined soil and land capability data in the vicinity of the investigated 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 May 2022 by a qualified soil specialist, at which time the identified soils within the proposed project area 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 **A2** 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	Rainfall Range (mm)	Limitation Rating	Description
C1	>1000	None to slight	Local climate is favourable for good yield for a wide range of adapted crops throughout the year.
C2	900-1000	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	800 -900	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	700-800	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	600-700	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	400-600	Severe	Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Limited suitable crops for which frequently experience yield loss.
C7	200 -400	Severe to very severe	Severely restricted choice of crops due to heat, cold and/or moisture stress.
C8	0 - 200	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 A4 presents description thereof, according to Guy and Smith (1998).

Table A3: The Land Capability Classes Description (adapted from 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	(L3) Wetland	(L3) Wetland	(L4) Wetland	(L4) Wetland	(L5) Wetland	(L5) Wetland	(L6) Wetland	(L6) Wetland
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 A4: 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.

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

The significance of the impact is then assessed by rating each variable according to the defined criteria. Refer to the Table A1. The purpose of the rating is to develop a clear understanding of influences and

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

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[2].

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 considers 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.

Table A1: Criteria and definitions for assessing significance of impacts

LIKELIHOOD DESCRIPTORS

PART A: DEFINITIONS AND CRITERIA*		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of intensity, spatial extent and duration**
Criteria for ranking of the INTENSITY of environmental impacts	**VH**	Severe change, disturbance or degradation. Associated with severe consequences. May result in severe illness, injury or death. Targets, limits and thresholds of concern continually exceeded. Substantial intervention will be required. Vigorous/widespread community mobilization against project can be expected. May result in legal action if impact occurs.
	H	Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place.
	M	Moderate change, disturbance or discomfort. Associated with real but not substantial consequences. Targets, limits and thresholds of concern may occasionally be exceeded. Likely to require some intervention. Occasional complaints can be expected.
	L	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.
	VL	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.
	VL+	Negligible change or improvement. Almost no benefits. Change not measurable/will remain in the current range.
	L+	Minor change or improvement. Minor benefits. Change not measurable/will remain in the current range. Few people will experience benefits.
	M+	Moderate change or improvement. Real but not substantial benefits. Will be within or marginally better than the current conditions. Small number of people will experience benefits.
	H+	Prominent change or improvement. Real and substantial benefits. Will be better than current conditions. Many people will experience benefits. General community support.

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

	VH+	Substantial, large-scale change or improvement. Considerable and widespread benefit. Will be much better than the current conditions. Favourable publicity and/or widespread support expected.
Criteria for ranking the DURATION of impacts	VL	Very short, always less than a year. Quickly reversible
	L	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.
	M	Medium-term, 5 to 10 years.
	H	Long term, between 10 and 20 years. (Likely to cease at the end of the operational life of the activity)
	VH	Very long, permanent, +20 years (Irreversible. Beyond closure)
Criteria for ranking the EXTENT of impacts	VL	A part of the site/property.
	L	Whole site.
	M	Beyond the site boundary, affecting immediate neighbours
	H	Local area, extending far beyond site boundary.
	VH	Regional/National

CONSEQUENCE DESCRIPTORS

Table A2: Determining Consequence and Significance

PART B: DETERMINING CONSEQUENCE							
INTENSITY = VL							
DURATION	Very long	VH	Low	Low	Medium	Medium	High
	Long term	H	Low	Low	Low	Medium	Medium
	Medium term	M	Very Low	Low	Low	Low	Medium
	Short term	L	Very low	Very Low	Low	Low	Low
	Very short	VL	Very low	Very Low	Very Low	Low	Low
INTENSITY = L							
DURATION	Very long	VH	Medium	Medium	Medium	High	High
	Long term	H	Low	Medium	Medium	Medium	High
	Medium term	M	Low	Low	Medium	Medium	Medium
	Short term	L	Low	Low	Low	Medium	Medium
	Very short	VL	Very low	Low	Low	Low	Medium
INTENSITY = M							
DURATION	Very long	VH	Medium	High	High	High	Very High
	Long term	H	Medium	Medium	Medium	High	High
	Medium term	M	Medium	Medium	Medium	High	High
	Short term	L	Low	Medium	Medium	Medium	High
	Very short	VL	Low	Low	Low	Medium	Medium
INTENSITY = H							
DURATION	Very long	VH	High	High	High	Very High	Very High
	Long term	H	Medium	High	High	High	Very High
	Medium term	M	Medium	Medium	High	High	High
	Short term	L	Medium	Medium	Medium	High	High
	Very short	VL	Low	Medium	Medium	Medium	High
INTENSITY = VH							
DURATION	Very long	VH	High	High	Very High	Very High	Very High
	Long term	H	High	High	High	Very High	Very High
	Medium term	M	Medium	High	High	High	Very High
	Short term	L	Medium	Medium	High	High	High
	Very short	VL	Low	Medium	Medium	High	High

			VL	L	M	H	VH
			A part of the site/ property	Whole site	Beyond the site, affecting neighbours	Extending far beyond site but localised	Regional/ National
			EXTENT				
PART C: DETERMINING SIGNIFICANCE							
PROBABILITY (of exposure to impacts)	Definite/ Continuous	VH	Very Low	Low	Medium	High	Very High
	Probable	H	Very Low	Low	Medium	High	Very High
	Possible/ frequent	M	Very Low	Very Low	Low	Medium	High
	Conceivable	L	Insignificant	Very Low	Low	Medium	High
	Unlikely/ improbable	VL	Insignificant	Insignificant	Very Low	Low	Medium
			VL	L	M	H	VVH
			CONSEQUENCE				

Table A3: Significance Rating and Interpretation

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
Very High	Potential fatal flaw unless mitigated to lower significance.
High	It must have an influence on the decision. Substantial mitigation will be required.
Medium	It should have an influence on the decision. Mitigation will be required.
Low	Unlikely that it will have a real influence on the decision. Limited mitigation is likely required.
Very Low	It will not have an influence on the decision. Does not require any mitigation
Insignificant	Inconsequential, not requiring any consideration.

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[3] 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.

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.

[3] *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

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

I, Tshiamo Setsipane, 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

SAS ENVIRONMENTAL GROUP OF COMPANIES (SEGC) –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF TSHIAMO SETSIPANE

PERSONAL DETAILS

Position in Company	Soil Scientist/ Hydropedologist
Joined SAS Environmental Group of Companies	2020

MEMBERSHIP IN PROFESSIONAL SOCIETIES

South African Council for Natural Scientist Professions (SACNASP)

EDUCATION

Qualifications

M.Sc. (Agric) Soil Science (*Cum Laude*)	(University of the Free State)	2019
B.Sc. (Agric) Honours Soil Science	(University of the Free State)	2014
B.Sc. (Agric) Soil Science & Agrometeorology	(University of the Free State)	2013

COUNTRIES OF WORK EXPERIENCE

South Africa – Kwa-Zulu Natal, Northern Cape, Mpumalanga and Free State

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