NHLABATHI MINERALS (PTY) LTD

RIETKOL MINING OPERATION

FINAL SCOPING REPORT APRIL 2018

PLAN OF STUDY - 2018

RIETKOL MINING OPERATION – NHLABATHI MINERALS (PTY) LTD

FINAL SCOPING REPORT: PLAN OF STUDY

APRIL 2018

Compiled by:

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1 SPECIALIST TEAM

1.1 ENVIRONMENTAL ASSESSMENT PRACTITIONER (EAP)

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Marietjie Eksteen is the Managing Director of the consulting firm Jacana Environmentals cc, an environmental consulting firm based in Polokwane. She is an environmental scientist with 27 years' experience, her main fields of expertise being water quality management, mine water management, environmental legal compliance and project management. Ms Eksteen is a registered Professional Environmental Scientist (Pr.Sci.Nat.) at the South African Council for Natural Scientific Professions – Registration No. 400090/02.

Since establishing Jacana Environmentals in 2006, she has been involved in a variety of mine-related environmental projects serving clients such as Coal of Africa Limited, BHP Billiton Energy Coal SA, Xstrata Coal SA and Optimum Coal. Prior to 2006 she was employed by Pulles Howard & De Lange Inc as an environmental consultant for 2 years. Before consulting, Ms Eksteen was employed by BHP Billiton as a mine environmental manager at their operations in Mpumalanga, as well as the Department of Water Affairs where she was appointed as a water quality specialist for the mining industry. Her career started off as a geophysicist at Genmin in 1990. Ms Eksteen obtained a Masters' degree in Exploration Geophysics (MSc) from the University of Pretoria in 1993.

1.2 SPECIALIST TEAM

The specialist team that has been appointed to assist Jacana Environmentals with the EIA is:

Soils, land use and capability	SAS Environmental Holdings (Pty) Ltd
Biodiversity / Aquatic systems	SAS Environmental Holdings (Pty) Ltd
Groundwater	Groundwater Complete
Air Quality	Royal Haskoning DHV
Ambient Noise	Royal Haskoning DHV
Blasting	Blast Management & Consulting
Traffic	AvzconS Civil Engineering Consultant
Heritage	R&R Cultural Resource Consultants
Visual	SAS Environmental Holdings (Pty) Ltd
Social Impact Assessment	Diphororo Development (Pty) Ltd
Hazard Identification and Risk Assessment (HIRA)	AirCheck Occupational Health, Environmental and Training Services cc
Macro-Economic Assessment	Mosaka Economic Consultants

The team members, with their qualifications and professional registrations and affiliations is presented in Table 1.

Table 1: Qualification and professional registrations and affiliations of EIA specialists

Aspect	Firm	Specialists	Qualification	Professional registrations and affiliations
Soils, land use & land capability	SAS Environmental Holdings	Sinethemba Mchunu	MSc (Soil Science)	Pr.Sci.Nat. – SACNASP Reg No. 100171/13. Member of the SA Soil Surveyors Organisation (SASSO), the Soil Science Society of SA (SSSSA), and the Land Rehabilitation Society of Southern Africa (LaRSSA).
		Braveman Mzila	BSc (Hons) Hydrology BSc (soil Science and Hydrology)	Member of the SA Soil Surveyors Organisation (SASSO), the Soil Science Society of SA (SSSSA), and the Land Rehabilitation Society of Southern Africa (LaRSSA).
		Stephen van Staden	BSc (Hons) Zoology MSc Environmental Management	Pr.Sci.Nat. - SACNASP Reg No. 400134/05. Registered by the SA RHP as an accredited aquatic biomonitoring specialist. Member of the Gauteng Wetland Forum and SA Soil Surveyors Association (SASSO). Cert. Tools for Wetland Assessment.
Biodiversity impact assessment	SAS Environmental Holdings	Stephen van Staden	BSc (Hons) Zoology MSc Environmental Management	Pr.Sci.Nat. - SACNASP Reg No. 400134/05. Registered by the SA RHP as an accredited aquatic biomonitoring specialist. Member of the Gauteng Wetland Forum and SA Soil Surveyors Association (SASSO). Cert. Tools for Wetland Assessment.
		Christopher Hooton	National Diploma: Nature Conservation B Tech Nature Conservation	Extensive experience in large mammal and carnivore research and management across south Africa and especially the Phinda Game reserve. Ecologist with focus on zoology.
		Emile van der Westhuizen	BSc Environmental Management and Botany BSc (Hons) Plant Science	Cand.Sci.Nat. - SACNASP Reg No. 100008/15. Extensive experience (more than 8 years) in botanical ecological assessments throughout Southern, Central, East and West Africa. Ecologist with focus on botany.
		Michelle Pretorius	BSc Landscape Architecture BSc Botany BSc (Hons) Plant Science	Pr.Sci.Nat. - SACNASP REG.NO: 400003/15. Botanical Society of South Africa (BotSoc). Member of the South African Council for the Landscape Architectural Profession (SACLAP).
Aquatic impact assessment	SAS Environmental Holdings	Stephen van Staden	BSc (Hons) Zoology MSc Environmental Management	Pr.Sci.Nat. - SACNASP Reg No. 400134/05. Registered by the SA RHP as an accredited aquatic biomonitoring specialist. Member of the Gauteng Wetland Forum and SA Soil Surveyors Association (SASSO). Cert. Tools for Wetland Assessment.

Aspect	Firm	Specialists	Qualification	Professional registrations and affiliations
		Kirsten Olsen	BSc (Hons) Environmental Science and Conservation	Member of the SA Society of Aquatic Scientists.
Groundwater impact assessment	Groundwater Complete	Gerhard Steenekamp	MSc Geohydrology / Hydrology	Pr.Sci.Nat. - SACNASP Reg No. 400385/04.
		Wiekus du Plessis	MSc Geohydrology	Pr.Sci.Nat. - SACNASP Reg No. 400148/15.
		Paul Naude	BSc (Hons) MSc (Mol. Phylogenetics)	Pr.Sci.Nat. - SACNASP Reg No. 400130/10.
Air quality and noise impact assessments	Royal Haskoning DHV	Vladimir Jovic	BSc (Hons) Urban and Regional Planning, University of Belgrade Serbia,1998 (SAQA accredited as Bachelors' degree in Town & Planning)	Pr.Sci.Nat. – SACNASP Reg No. 400054/17 Member Association of cleanrooms Member of Geo-Information Society of South Africa (GISSA) Member of South African Society for Atmospheric Sciences (SASAS)
Blasting and Vibration Study	Blasting Management & Consulting	Danie Zeeman	1985 - 1987 Diploma: Explosives Technology, Technicon Pretoria 1990 - 1992 BA Degree, University of Pretoria 1994 National Higher Diploma: Explosives Technology, Technicon Pretoria 2000 Advanced Certificate in Blasting, Technicon SA	International Society of Explosives Engineers.
Heritage and cultural impact assessment	R&R Cultural Resources	Frans Roodt Principal Investigator	BA Hons MA Archaeology Post Grad Dip. in Museology	Association of Southern African Professional Archaeologists (ASAPA) Member No. 120.
Visual Impact Assessment	SAS Environmental Holdings	Michelle Pretorius	BSc Landscape Architecture BSc Botany BSc (Hons) Plant Science	Pr.Sci.Nat. - SACNASP REG.NO: 400003/15. Botanical Society of South Africa (BotSoc). Member of the South African Council for the Landscape Architectural Profession (SACLAP).
Traffic Impact Assessment	Avzcons (Pty) Ltd	Awie van Zyl	BSc Eng. Civil	ECSA Reg. No: 920506
Macro-economic impact assessment	Mosaka Economic Consultants	William Mullins	BSc – Trained as Mathematician and Statistician. 16 years' experience as macro- and micro-economist. UED – 7 years teaching at Agricultural College.	Specialising in application of econometric models in analysing specific socio-economic impacts.
		Riekie Cloete	M.Com (Agricultural Economy)	Specialising in Cost-benefit Analyses and Macro-Economic Impact Modelling.
		Tefelo Majoro	B Com (Ed) MBA	She has over ten years of combined practical work experience, of which five are within the economic consulting environment. She is an Economist with a broad project experience in evaluating the financial and economic viability of investment

Aspect	Firm	Specialists	Qualification	Professional registrations and affiliations
				projects using econometric models such as Cost Benefit Analysis, Multi Criteria Decision Analysis and Social Accounting Matrix based Macro-Economic Analysis.
Social Impact Assessment	Diphororo Development	Lizinda Dickson	BA (Geography) BA (Hons) Environmental Management M Inst Agrar Environment and Society	International Association for Impact Assessment (IAIA).
		Carien Joubert	PhD Social and Behavioural Sciences	-
Hazard Identification and Risk Assessment (HIRA)	AirCheck	Piet Marais	MSc (Occupational Physiology)	Registered Occupational Hygienist (SAIOH).
		Lisa Roux	B Tech (Environmental Health)	Registered Occupational Hygienist (SAIOH).
		George Farmer	BSc (Hons) Biokinetics	Registered Occupational Hygiene Assistant (SAIOH).

2 SPECIALIST STUDIES METHODOLOGY

2.1 SOILS AND LAND CAPABILITY

Land capability and the potential impacts of the proposed silica mining activity will be evaluated in detail during the EIA phase of this assessment, as outlined in the sections below. In addition, individual impacts of the associated infrastructure (e.g. access roads and/or processing plant) will be assessed once the respective locations have been finalised, following consideration of all the relevant environmental aspects.

2.1.1 Land Capability Classification

Land Capability is measured on a scale of I to VIII, as presented in Table 2 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. The land capability rating is therefore adjusted accordingly, depending on the prevailing climatic conditions as indicated by the respective climate capability rating.

Table 2: Land Capability Classification

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

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

Table 3: Climate Capability Classification

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

2.1.2 Land Capability Impact Assessment

In South Africa, agricultural potential is generally restricted by climatic conditions, particularly water availability. However, even within similar climatic zones, various soil types have different land use capabilities attributed to their inherent characteristics. High potential agricultural land is defined as having the soil and terrain quality, growing season and adequate available moisture supply needed to produce sustained economically high crops yields when treated and managed according to best possible farming practices" (Land Capability report, 2006).

The capability of the identified soils will be classified according to the land capability classification method. The anticipated impacts of the proposed development on the identified soils and land capability will be evaluated according to the impact assessment methodology described below.

The identified impacts will be 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.

2.1.3 Mitigation Measure Development

The following points present the key concepts considered in the development of mitigation measures for the proposed construction.

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

2.2 BIODIVERSITY

2.2.1 Faunal Assessment

Prior to the faunal field assessment use will be made of topographical and aerial maps to identify "areas of faunal interest" regarded as representative of the different habitat units within the MRA area. Attention will also be given to data from national and provincial databases, such as the recent South African National Biodiversity Assessment (NBA) report of 2011 (which includes the recent BGIS dataset which has been compiled by South African National Biodiversity Institute (SANBI)). Special emphasis will be placed on habitat that may support faunal species of concern that are listed in the Limpopo Environmental Management Act (Act No 7 of 2003), NBA 2011 report and IUCN.

Thus, all relevant authorities and available databases will be consulted as far as possible regarding conservational species lists, as well as all the latest available literature utilised to gain a thorough understanding of the MRA area and its surrounding habitats. This information and further literature reviews will then be used to determine the potential biodiversity lists for the proposed development site and surrounding areas. This information incorporated (amongst others) data on vegetation types, faunal habitat suitability and biodiversity potential coupled to this information.

During the detailed field assessment, focus will be placed on the occurrence of RDL and/or protected faunal species which are known to occur in the area. Furthermore, a detailed inventory of faunal species encountered through direct observation and/or field signs and other trapping techniques will be compiled.

2.2.1.1 Mammals

Small mammals are unlikely to be directly observed in the field because of their nocturnal/crepuscular and cryptic nature. A simple and effective solution to this problem is to use Sherman traps. A Sherman trap is a small aluminium box with a spring-loaded door. Once the animal is inside the trap, it steps on a small plate that causes the door to snap shut, thereby capturing the individual. Trapping will take place within relatively undisturbed small mammal habitat identified throughout the mining and infrastructure footprint area. In the event of capturing a small mammal during the night, the animal would be photographed and then set free unharmed early the following morning. Traps will be baited with a universal mixture of oats, peanut butter, fish paste and syrup.

Medium and larger faunal species will be recorded during the field assessment with the use of visual identification as well as where spoor, call, or dung samples can be positively identified. Infrared camera traps will also be set which will record any faunal species which trigger the infrared sensors. In addition, species lists provided by local conservation authorities will be used to determine the potential biodiversity lists for the MRA area.

2.2.1.2 Avifauna

Field surveys will be undertaken using a pair of binoculars and bird call identification (vocalisation) practices. The Birdlife South Africa avifaunal database for EIA reports, local conservation authority databases, along with the Southern African Bird Atlas Project 2 (www.sabap2.org) data will be used to compare with birds identified during the field survey and to provide potential biodiversity lists. Habitat evaluation for RDL species and areas of avifaunal importance will be noted and consideration will be given to impacts on avifaunal ecology with specific mention of impacts on breeding/nesting suitability, foraging suitability, migratory species and migratory corridors.

2.2.1.3 Reptiles

Reptile species encountered during the assessment will be identified. Specific attention will be paid to priority areas which may provide habitat for RDL reptile species such as rocky outcrops. Species lists provided by local conservation authorities will be used to determine the potential biodiversity lists for the MRA area and the conservation status of each species listed will be determined.

2.2.1.4 Amphibians

During the field assessment, visual identification along with other identification aids such as call identification will be used. Any habitat encountered that may provide suitable habitat for RDL amphibian species will be noted. Species lists provided by local conservation authorities will be used to determine the potential biodiversity lists for the MRA area and the conservation status of each species listed will be determined.

2.2.1.5 *Invertebrates, scorpions and spiders*

During the field assessment, visual identification and recording of invertebrate species will be conducted at specific priority areas, and if applicable, sweep nets will be used to capture and help identify invertebrate species. Any habitat encountered that may provide suitable habitat for RDL invertebrate species will be noted. Species lists provided by local conservation authorities will be used to determine the potential invertebrate biodiversity lists for the MRA area and the conservation status of each species listed will be determined.

2.2.1.6 *Red Data species assessment*

Given the restrictions of field assessments to identify all the faunal species that possibly occur on a particular property, the Red Data Sensitivity Index (RDSIS) has been developed to provide an indication of the potential red data faunal species that could reside in the area, while simultaneously providing a quantitative measure of the subject property's' value in terms of conserving faunal diversity. The RDSIS is based on the principles that when the knowledge of the specie's historical distribution is combined with a field assessment that identifies the degree to which the property supports a certain species habitat and food requirements, inferences can be made about the chances of that particular species residing on the property. Repeating this procedure for all the potential red data faunal species of the area and collating this information then provides a sensitivity measure of the property that has been investigated.

RDSIS Score	RDL faunal importance
0-20%	Low
21-40%	Low-Medium
41-60%	Medium
60-80%	High-Medium
81-100%	High

2.2.1.7 *Sensitivity mapping*

All results obtained during the literature review as well as field assessments will be used to map each habitat unit according to sensitivity. A Geographic Information System (GIS) will be used to project these features onto aerial photographs and topographic maps. The sensitivity map should guide the design and layout of the proposed mining development. The assessment will be undertaken in line with the requirements deemed necessary to address the envisaged risks associated with the proposed development.

2.2.2 Floral Assessment

2.2.2.1 General methodology

To accurately determine the desktop level Present Ecological State (PES) of the mining and infrastructure footprint area and capture comprehensive data with respect to floral taxa the following methodology will be used:

- Maps, aerial photographs and digital satellite images will be consulted to determine broad habitats, vegetation types and potentially sensitive sites.
- A literature review with respect to habitats, vegetation types and species distribution will be conducted.
- Relevant data bases that will be considered during the assessment of the MRA area include local conservation authority databases, South African National Biodiversity Institute (SANBI) Threatened Species Programme (TSP) and Pretoria Computer Information Systems (PRECIS) and the SANBI Biodiversity Geographic Information Systems (GIS) database (BGIS).

2.2.2.2 Field surveys

The overall vegetation survey will be conducted by first identifying different habitat units and then analysing the floral species composition. Vegetation analyses will be conducted within areas that are perceived to best represent the various plant communities. Species will be recorded and a species list will be compiled for each habitat unit.

2.2.2.3 Transects

All transects will be located within what may be considered to be representative of the vegetation types associated with the MRA area. Data will be collected along at 1m intervals and the plant species or biophysical feature falling closest to the assessment point will be identified. These data points will be developed along 100m long transect lines, making for 100 data points along a single transect. Species lists will be compiled and species composition analysed along the selected transect lines, where after the data will be analysed and the percentage contribution of the various floral species for each transect line will be calculated.

If the species composition is quantitatively determined and characteristics of all components of the floral community are taken into consideration, it is possible to determine the PES of the portion of land represented by an assessment point/ transect line. This section will summarise the dominant floral species identified within each transect with their associated habitats and optimal growth conditions.

2.2.2.4 Vegetation Index Score

The Vegetation Index Score (VIS) was designed to determine the ecological state of each habitat unit defined within an assessment site. This enables an accurate and consistent description of the PES concerning the subject property in question. The information gathered during these assessments also significantly contributes to sensitivity mapping, leading to a more truthful representation of ecological value and sensitive habitats.

Each defined management unit is assessed using separate data sheets and all the information gathered then contributes to the final VIS score. The VIS is derived using the following formulas:

VIS = [(EVC) + (SI x PVC) + (RIS)]

Where:

- EVC is extent of vegetation cover;
- SI is structural intactness;
- PVC is percentage cover of indigenous species and
- RIS is recruitment of indigenous species.

The final VIS scores for each habitat unit are then categorised as follows:

Vegetation Index Score	Assessment Class	Description
25	A	Unmodified, natural
20 to 24	B	Largely natural with few modifications.
15 to 20	C	Moderately modified
10 to 15	D	Largely modified
5 to 10	E	The loss of natural habitat extensive
<5	F	Modified completely

2.2.2.5 Red Data species assessment

Prior to the field visit, a record of Red Data Listed (RDL) floral species and their habitat requirements will be acquired from the Limpopo Environmental Management Amendment Act (No. 7 of 2003), databases for the area from local conservation authorities, the National Forest Act (Act 84 of 1998) and the South African National Biodiversity Institute (SANBI) for the relevant Quarter Degree Squares (QDS). Throughout the floral assessment, special attention will be paid to the identification of any of these RDL species as well as identification of suitable habitat that could potentially sustain these species.

The Probability of Occurrence (POC) for each floral species of concern will be determined using the following calculations where in the habitat requirements and habitat disturbance were considered. The accuracy of the calculation is based on the available knowledge about the species in question, with many of the species lacking in-depth habitat research. Therefore, it is important that the literature available is also considered during the calculation.

Each factor contributes an equal value to the calculation.

Literature availability						
	No Literature available					Literature available
Site score						
Score	0	1	2	3	4	5
Habitat availability						
	No Habitat available					Habitat available
Site score						
Score	0	1	2	3	4	5
Habitat disturbance						
	0	Very Low	Low	Moderately	High	Very High
Site score						
Score	5	4	3	2	1	0

[Literature availability + Habitat availability + Habitat disturbance] / 15 x 100 = POC%.

2.2.2.6 Sensitivity mapping

All sensitive features and or habitats (including localities of RDL/protected floral species, wetlands, rivers and ridges) will be mapped utilising a Geographical Positioning System (GPS) and a sensitivity map will be compiled. This sensitivity map will aim to guide the design of the proposed mining development in order to have the least ecological impact on the receiving environment.

2.3 SURFACE WATER ASSESSMENT

2.3.1 Wetland Assessment

2.3.1.1 Classification System for Wetlands and other Aquatic Ecosystems in SA (2013)

All wetland or riparian features encountered within the MRA area will be assessed using the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems, hereafter referred to as the “Classification System” (Ollis et. al., 2013). A summary on Levels 1 to 4 of the classification system are presented in the tables below.

Classification System for Inland Systems, up to Level 3

WETLAND / AQUATIC ECOSYSTEM CONTEXT		
LEVEL 1: SYSTEM TYPE	**LEVEL 2: REGIONAL SETTING**	**LEVEL 3: LANDSCAPE UNIT**
Inland Systems	DWA Level 1 Ecoregions OR NFEPA WetVeg Groups OR Other special framework	Valley Floor
		Slope
		Plain
		Bench (Hilltop / Saddle / Shelf)

Hydrogeomorphic (HGM) Units for the Inland System, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C

FUNCTIONAL UNIT		
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	B	C
River	Mountain headwater stream	Active channel
		Riparian zone
	Mountain stream	Active channel
		Riparian zone
	Transitional	Active channel
		Riparian zone
	Upper foothills	Active channel
		Riparian zone
	Lower foothills	Active channel
		Riparian zone
	Lowland river	Active channel
		Riparian zone
	Rejuvenated bedrock fall	Active channel
		Riparian zone
	Rejuvenated foothills	Active channel
		Riparian zone
	Upland floodplain	Active channel
		Riparian zone
Channelled valley-bottom wetland	(not applicable)	(not applicable)
Unchannelled valley-bottom wetland	(not applicable)	(not applicable)
Floodplain wetland	Floodplain depression	(not applicable)
	Floodplain flat	(not applicable)
Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)
Wetland flat	(not applicable)	(not applicable)

2.3.1.2 Level 1: Inland systems

From the classification system, Inland Systems are defined as aquatic ecosystems that have no existing connection to the ocean (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but which are inundated or saturated with water, either permanently or periodically. It is important to bear in mind, however, that certain Inland Systems may have had a historical connection to the ocean, which in some cases may have been relatively recent.

2.3.1.3 Level 2: Ecoregions & NFEPA Wetland Vegetation Groups

For Inland Systems, the regional spatial framework that has been included in Level 2 of the classification system is that of the DWA's Level 1 Ecoregions for aquatic ecosystems (Kleynhans et. al., 2005). There is a total of 31 Ecoregions across South Africa, including Lesotho and Swaziland. DWA Ecoregions have most commonly been used to categorise the regional setting for national and regional water resource management applications, especially in relation to rivers.

The Vegetation Map of South Africa, Swaziland and Lesotho (Mucina & Rutherford, 2006) groups' vegetation types across the country, according to Biomes, which are then divided into Bioregions. To categorise the regional setting for the wetland component of the NFEPA project, wetland vegetation groups (referred to as WetVeg Groups) were derived by further splitting Bioregions into smaller groups through expert input (Nel et al., 2011). There are currently 133 NFEPA WetVeg Groups. It is envisaged that these groups could be used as a special framework for the classification of wetlands in national- and regional-scale conservation planning and wetland management initiatives.

2.3.1.4 Level 3: Landscape Setting

At Level 3 of the classification system for Inland Systems, a distinction is made between four Landscape Units on the basis of the landscape setting (i.e. topographical position) within which an HGM Unit is situated, as follows (Ollis et. al., 2013):

- Slope: an included stretch of ground that is not part of a valley floor, which is typically located on the side of a mountain, hill or valley;
- Valley floor: The base of a valley, situated between two distinct valley side-slopes;
- Plain: an extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land; and
- Bench (hilltop/saddle/shelf): an area of mostly level or nearly level high ground (relative to the broad surroundings), including hilltops/crests (areas at the top of a mountain or hill

flanked by down-slopes in all directions), saddles (relatively high-lying areas flanked by down-slopes on two sides in one direction and up-slopes on two sides in an approximately perpendicular direction), and shelves/terraces/ledges (relatively high-lying, localised flat areas along a slope, representing a break in slope with an up-slope one side and a down-slope on the other side in the same direction).

2.3.1.5 Level 4: Hydrogeomorphic Units

Seven primary HGM Types are recognised for Inland Systems at Level 4A of the classification system, on the basis of hydrology and geomorphology (Ollis et. al., 2013), namely:

- River: a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water;
- Channelled valley-bottom wetland: a valley-bottom wetland with a river channel running through it;
- Unchannelled valley-bottom wetland: a valley-bottom wetland without a river channel running through it;
- Floodplain wetland: the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank;
- Depression: a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates;
- Wetland Flat: a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat; and
- Seep: a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.

The above terms have been used for the primary HGM Units in the classification system to try and ensure consistency with the wetland classification terms currently in common usage in South Africa. Similar terminology (but excluding categories for “channel”, “flat” and “valleyhead seep”) is used, for example, in the recently developed tools produced as part of the Wetland Management Series including WET-Health (Macfarlane et. al., 2008), WET-IHI (DWAF, 2007) and WET-EcoServices (Kotze et. al., 2009).

"The importance of a water resource, in ecological, social or economic terms, acts as a modifying or motivating determinant in the selection of the management class" (DWA, 1999). The assessment of the ecosystem services supplied by the identified wetlands will be conducted according to the guidelines as described by Kotze et al. (2009). An assessment will be undertaken that examines and rates the following services according to their degree of importance and the degree to which the service is provided:

- Flood attenuation;
- Stream flow regulation;
- Sediment trapping;
- Phosphate trapping;
- Nitrate removal;
- Toxicant removal;
- Erosion control;
- Carbon storage;
- Maintenance of biodiversity;
- Water supply for human use;
- Natural resources;
- Cultivated foods;
- Cultural significance;
- Tourism and recreation; and
- Education and research.

The characteristics are used to quantitatively determine the value, and by extension sensitivity, of the wetlands. Each characteristic will be scored to give the likelihood that the service is being provided. The scores for each service are then averaged to give an overall score to the wetland.

Classes for determining the likely extent to which a benefit is being supplied

Score	Rating of the likely extent to which the benefit is being supplied
<0.5	Low
0.6-1.2	Moderately low
1.3-2	Intermediate
2.1-3	Moderately high
>3	High

2.3.1.6 WET-Health

Healthy wetlands are known to provide important habitats for wildlife and to deliver a range of important goods and services to society. Management of these systems is therefore essential if these attributes are to be retained within an ever-changing landscape. The primary purpose of this assessment is to evaluate the eco-physical health of wetlands, and in so doing to promote their conservation and wise management.

2.3.1.6.1 Level of Evaluation

Two levels of assessment are provided by WET-Health:

- Level 1: Desktop evaluation, with limited field verification. This is generally applicable to situations where a large number of wetlands need to be assessed at a very low resolution; or
- Level 2: On-site evaluation. This involves structured sampling and data collection in a single wetland and its surrounding catchment.

2.3.1.6.2 Framework for the Assessment

A set of three modules has been synthesised from the set of processes, interactions and interventions that take place in wetland systems and their catchments: hydrology (water inputs, distribution and retention, and outputs), geomorphology (sediment inputs, retention and outputs) and vegetation (transformation and presence of introduced alien species).

2.3.1.6.3 Units of Assessment

Central to WET-Health is the characterisation of HGM Units, which have been defined based on geomorphic setting (e.g. hillslope or valley-bottom; whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated) and pattern of water flow through the wetland unit (diffusely or channelled) as described under the Classification System for Wetlands and other Aquatic Ecosystems above.

2.3.1.6.4 Quantification of Present State of a wetland

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present State score. This takes the form of assessing the spatial extent of the impact of individual activities and then separately assessing the intensity of the impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact. The impact scores, and Present State categories are provided in the table below.

Impact scores and categories of Present State used by WET-Health for describing the integrity of wetlands

Impact category	Description	Impact score range	Present State category
None	Unmodified, natural	0-0.9	A
Small	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1-1.9	B
Moderate	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact.	2-3.9	C
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	D
Serious	The change in ecosystem processes and loss of natural habitat and biota is great, but some remaining natural habitat features are still recognisable.	6-7.9	E
Critical	Modifications have reached a critical level and the ecosystem processes have been completely modified with an almost complete loss of natural habitat and biota.	8-10	F

2.3.1.7 Ecological Importance and Sensitivity (EIS)

The method used for the EIS determination is adapted from the method as provided by DWA (1999) for wetlands. The method takes into consideration PES scores obtained for WET-Health as well as function and service provision to enable the assessor to determine the most representative EIS category for the wetland feature or group being assessed.

A series of determinants for the EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The mean of the determinants is used to assign the EIS category as listed in the table below.

Descriptions of the EIS Categories

EIS Category	Range of Mean	Recommended Ecological Management Class
Very high Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications.	>3 and <=4	A
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications.	>2 and <=3	B

EIS Category	Range of Mean	Recommended Ecological Management Class
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications.	>1 and <=2	C
Low/marginal Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications.	>0 and <=1	D

2.3.1.8 Recommended Ecological Category (REC)

"A high management class relates to the flow that will ensure a high degree of sustainability and a low risk of ecosystem failure. A low management class will ensure marginal maintenance of sustainability but carries a higher risk of ecosystem failure" (DWA, 1999).

The REC will be based on the results obtained from the PES, reference conditions and EIS of the aquatic resource (sections above), and is followed by realistic recommendations, mitigation, and rehabilitation measures to achieve the desired REC.

A wetland may receive the same class for the PES as the REC if the wetland is deemed in good condition, and therefore must stay in good condition. Otherwise, an appropriate REC should be assigned in order to prevent any further degradation as well as enhance the PES of the wetland feature.

Description of REC classes

Class	Description
A	Unmodified, natural
B	Largely natural with few modifications
C	Moderately modified
D	Largely modified

2.3.1.9 Wetland Delineation

For the purposes of this investigation, a wetland is defined in the National Water Act (1998) as "land which is transitional between terrestrial and aquatic systems where the water table is at or near the surface, or the land is periodically covered with shallow water, and which in normal circumstances supports or would support vegetation typically adapted to life in saturated soil".

The wetland zone delineation will be done according to the method presented in the DWAF (2005) document “A practical field procedure for identification and delineation of wetlands and riparian areas. An updated draft version of this report is also available and will therefore also considered during the wetland delineation (DWAF, 2008). The foundation of the method is based on the fact that wetlands and riparian zones have several distinguishing factors including the following:

- The position in the landscape, which will help identify those parts of the landscape where wetlands are more likely to occur;
- The type of soil form (i.e. the type of soil according to a standard soil classification system), since wetlands are associated with certain soil types;
- The presence of wetland vegetation species; and
- The presence of redoxymorphic soil feature, which are morphological signatures that appear in soils with prolonged periods of saturation.

By observing the evidence of these features in the form of indicators, wetlands and riparian zones can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (DWAF, 2005 and 2008).

Riparian and wetland zones can be divided into three zones (DWAF, 2005). The permanent zone of wetness is nearly always saturated. The seasonal zone is saturated for a significant periods of wetness (at least three months of saturation per annum) and the temporary zone surrounds the seasonal zone and is only saturated for a short period of saturation (typically less than three months of saturation per annum), but is saturated for a sufficient period, under normal circumstances, to allow for the formation of hydromorphic soils and the growth of wetland vegetation. The object of this study will be to identify the outer boundary of the temporary zone and then to identify a suitable buffer zone around the wetland area.

2.3.2 Water Quality Assessment

The proposed EIA will include another water quality assessment which will build upon, and incorporate, this scoping report. It is proposed that the plan of study for the EIA include the following aspects:

- Two additional water quality sampling runs at RK01-03, with two monthly intervals between each run;
- The water quality variables assessed for each sampling event will be identical to those presented in this scoping report, which encompass:

- pH;
- Electrical conductivity;
- Total dissolved solid concentration;
- Temperature;
- Suspended solid concentration;
- Sulphate concentration;
- Nitrate concentration;
- Silica concentration;
- Ortho-phosphate;
- Free and saline ammonia concentration;
- Ammonium concentration, and;
- Mass spectroscopy of all metal constituents.

The data for each sampling event will be compared with the identical standards presented in this report, namely:

- South African Water Quality Guidelines for aquatic ecosystems, recreation, agricultural use and drinking water (DWAF 1996);
- The General and Special Limits for the discharge of wastewater into a watercourse (DWAF 1999), and;
- The resource quality objectives for the Upper Olifants River catchment (OREWA) (DWAF 2001). Please note as none of the aquatic resources assessed has riverine characteristics OREWA will only considered as a tentative guideline for management of resources within the greater catchment.

The data from the three sampling events will be used in combination to determine a water quality baseline for each of the monitoring points. This will enable a more reliable water quality baseline to be established for each of the monitoring points incorporating seasonal and temporal changes associated with each ecosystem;

The baseline water quality data will be used in conjunction with the proposed mine plan to assess the potential impacts that the proposed silica mine might have upon the aquatic resources identified;

2.3.3 Development of mitigation measures

Mitigatory actions will be developed in order to prevent or lessen the severity of each potential impact upon the water quality of the aquatic resources.

For sufficient consideration of all environmental impacts, impacts will be assessed using a common, defensible method that will enable comparisons to be made between risks/impacts. The method will also clearly define the process and rationale upon which risks/impacts have been assessed to authorities, stakeholders and the EAP.

Risks/Impacts will be for all stages of the project cycle including:

- Pre-construction;
- Construction;
- Operation, and;
- Decommissioning and closure.

Particular attention will be paid to describing any residual impacts that will occur after rehabilitation.

The following points present the key concepts that will be considered in the development of mitigation measures for the construction and operation of the proposed silica mine:

- Avoidance or prevention of impact;
- Minimisation of impact;
- Rehabilitation;
- Offsetting;
- Measures and actions to address negative impacts will favour avoidance and prevention over minimisation, mitigation or compensation;
- Desired outcomes will be defined, and developed in such a way as to be measurable events with performance indicators, targets and acceptable criteria that can be tracked over defined periods, wherever possible.

Recommendations will include specific management measures applicable to each of the aquatic resources assessed as well as general management measures which apply to the proposed mining operations in general.

2.4 GROUNDWATER ASSESSMENT

The proposed silica mining area is situated among the Modder East Orchards Agricultural Holdings where the land use is mostly small-scale agricultural practices. In terms of groundwater the site is situated on dolomitic karst terrain with some significant groundwater abstraction for irrigation in the wider area. It is therefore necessary to ensure that extra care is taken to accurately define the natural (baseline) groundwater conditions, aquifer types and characteristics present and then apply such knowledge to estimate potential impacts associated with the proposed mining and processing activities.

2.4.1 Task Items and Plan of Study

The task items and terms of reference (ToR) have been developed for similar authorization studies. Virtually all aspects of groundwater are covered, and the specialist study results can be used for various environmental and related authorizations, including EIA's, EMP's or Water Use License (WUL) applications.

The scope of work and methodology of the groundwater study are summarized below:

- Desk top study and key field data collection:
  - Initial data collection and hydrocensus;
  - Measure water levels and qualities; and
  - Record groundwater uses and users.
- Site Investigation:
  - Incorporation of hydraulic data gathered by Client for the geological and geotechnical investigation;
  - Assessment of existing boreholes around the site;
  - Installation open borehole monitoring network using existing boreholes;
  - Aquifer testing of boreholes to obtain aquifer parameters; and
  - Groundwater sampling for hydrochemical analysis.
- Data evaluation and holistic interpretation of all data types.
- Postulation of a conceptual hydrogeological model.
- Compilation of numerical model.
- Flow and mass transport calculations, groundwater balance, mine water balance, stage curve development, etc.
- Post-closure pit lake model.
- Evaluation and reporting.

The different tasks or aspects of the study as listed above are detailed below in tabular format.

Terms of reference		Comment
Task 1 – Desk top study and initial site-specific data collection **The primary objective of the site visit and initial data collection is to review all existing relevant data with a view to identifying significant information gaps and expand or adapt the scope of work accordingly.**		
1	Review of all available groundwater specific data.	Groundwater data will be assessed from internet, National Groundwater Archive and other public domain sources.

Terms of reference		Comment
2	Review of aerial photo and satellite image interpretation.	Aerial photos are reviewed and used, mostly from the latest Google Earth Professional software. Satellite imagery will also be used.
3	Review of geological and structural interpretation by Client.	Yes.
4	Review of geophysical interpretation (if available).	N/A.
5	Identification of hydrogeological units.	Will be conducted after collation and review of above info, regional geology and pump tests.
6	Review of water quality analysis	Inorganic macro element and indicator metals will be conducted and reviewed.
7	Borehole census of regional boreholes	Census (groundwater resources, users and uses) will be conducted on and around the proposed mining areas.
8	Adherence to best practice guidelines of sampling and analysis	Sampling methodology, sample custody and analysis provided in Para 2.2.4.
9	Generation of a conceptual hydrogeological model.	A conceptual geohydrological model will be postulated based on knowledge gained from the interpreted data.
10	Determination of areas of insufficient knowledge	Knowledge gaps will be shown and discussed if located.
Task 2 - Site Investigation Activities		
1	Hydraulic testing of boreholes – aquifer parameters and ongoing monitoring.	Boreholes will not be drilled but existing user boreholes will be used for testing of aquifer characteristics and ongoing monitoring.
2	Geochemical sampling	Geochemical sampling and testing will not be conducted. The mined mineral is silica (quartz) which is chemically totally inert.
3	Data analysis	Analysis of data will be conducted with applicable software and techniques. Aquifer tests will be analysed with Aqtesolv and the FC-Method. Groundwater levels, gradients and quality trends will be interpreted with the Windows Interpretation System for the Hydrogeologist (WISH) software supported by Surfer for contouring.
4	Construction of a numerical model	A numerical flow model will be compiled with the Modflow code (PM-PRO package). The conceptual model will determine whether a 2-dimendional or 3-dimensional grid will be constructed. The mass transport will be conducted with the MT3D code.
5	Specialist report	The report will contain all the aspects of the baseline study and modeling described above.
Task 3 - Gathering of hydraulic conductivity data		
1	Hydraulic conductivity tests	Boreholes near the project area will be pump-tested to determine hydraulic conductivity of the aquifer(s) in the area.
Task 4 - Installation of Monitoring Boreholes		
1	Monitoring boreholes	No monitoring boreholes will be drilled as part of the study. Monitoring boreholes will be recommended for drilling as part of the impact assessment and management plan.
Task 5 - Water Sampling		
1	Sampling and analysis	Water sampling and analysis will be conducted and assessed for all the smallholdings surrounding the project area.
2	Ongoing monitoring	A monitoring protocol will be recommended in the report for ongoing future sampling, analysis and interpretation.
Task 6 - Data Analysis and Conceptual Model		
1	Data analysis	All the information collected during the field campaign will be evaluated. Analysis of data will be conducted with applicable software and techniques. Aquifer tests will be analysed with Aqtesolv and the FC-Method. Groundwater levels, gradients and quality trends will be interpreted with the Windows Interpretation System for the Hydrogeologist (WISH) software supported by Surfer contouring etc.
2	Conceptual model	The conceptual model will be postulated based on the aquifer test results and all other interpreted data including identification, distribution and characterization of the hydrogeological units.
Task 7 - Numerical Modelling of Mine Site		
1	Construction of a numerical model	A numerical finite difference flow model will be compiled with the Modflow code (PM-PRO package). The conceptual model will determine whether a 2-

Terms of reference		Comment
		dimendional or 3-dimensional grid will be constructed. The mass transport will be conducted with the MT3D code.
2	Model calibration	The model will be calibrated using available data and will then be used to run sensitivity analyses and simulate different dewatering scenarios. The objective of the modelling will be to determine the impact of mining and beneficiation on the environment. All activities with potential impact on the groundwater regime will be incorporated, e.g. opencast pits, underground mines, plant, discard, tailings, RWD, workshops, sewage plant, storm water facilities etc.
Task 8 - Water Balance Predictions		
1	Groundwater model and environmental groundwater balance.	The groundwater model will mostly be used for impact simulation on groundwater quality and quantity. Analytical calculations will be used for recharge and seepage calculations or for post closure pit lake behavior. This includes stages curves, void volumes, time-to-fill, potential for decant, rate of decant and positions.
Task 9 – Reporting		
1	Report	All the results will be presented in a report that will incorporate the description of all the fieldwork performed, the collected data and the way in which that data was used. The numerical model description, the calibration process, the simulated scenarios and the results of the simulations will be presented, along with likely recharge rates and pollution plume movement (if any).

2.4.2 Groundwater Impact Assessment

The knowledge gained from the baseline and site assessment will be applied in the impact assessment. The potential impacts will be rated according to a rating matrix with clearly defined criteria that allows, as far as possible, a comparable and objective evaluation of potential impacts by various specialists.

The source – pathway – receptor principle will be used in evaluation of groundwater related impacts foreseen by the proposed project:

- Potential sources include most activities proposed for the project where coal or carbonaceous material is mined, handled, stored, disposed of or where water comes into contact with such material.
- The pathway in this instance encompasses the entire groundwater regime and the study will focus on characterizing this entity.
- Receptors mainly include existing groundwater users such as humans (for domestic use, livestock water and gardening or irrigation), animals, plants and the receiving surface water environment through groundwater base flow or spring discharge.

Where impacts are indicated by the study, interaction will be required between ourselves and the other specialists on the project such as surface water specialists, bio-diversity, soil and social/heritage specialists.

The infrastructure and activities for which groundwater specialist inputs are required can be summarized as follows:

- Opencast pit;
- Crusher;
- Screening and washing facility;
- Supporting infrastructure such as workshops (maintenance), offices, laydown area, etc.;
- Storm water control and other dirty water retaining facilities;
- Overburden, waste rock and ROM stockpiles; and
- Haul roads.

2.4.3 Specific Focus Areas

In the Rietkol area there will be focus on a number of aspects that are of particular importance due to dolomite aquifer sensitivity and proximity to other users:

2.4.3.1 Existing groundwater users

Smallholdings in the area are using boreholes for domestic and agricultural purposes (irrigation, greenhouses and livestock watering). The study will thus focus on determining if any such boreholes will be affected.

2.4.3.2 Base flow, pans, wetlands, springs

The same as the above applies to the receiving surface water environment, be it in the form of base flow to rivers or spring discharge or groundwater daylighting in wetlands. The potential effect on the groundwater quality and availability will be evaluated in the study.

2.4.3.3 Underground cave

An underground, water-filled cave occurs approximately 2.5 km north of the Rietkol MRA area. Any potential impacts on the cave will be discussed.

2.4.4 Sampling Protocol and Methodology

Groundwater sampling, sample custody, quality assurance and analysis will be conducted according to the DWA best practice guidelines for water monitoring and will also conform to other national and international standards such as the USA and Australian EPA's.

2.4.4.1 Water Quality Sampling

- Various surface and groundwater samples are to be taken for the project.
- All fieldwork is conducted based on the protocols and specifications, and code of practice contained in the SABS ISO 5667:1-15. These international standards address all aspects from the program design, sampling methods as well as sample preservation and many other aspects. Applicable standards include:
  - ISO 5667-1: 2006 Part 1: Guidance on the design of sampling programs and sampling techniques
  - ISO 5667-3: 2003 Part 3: Guidance on preservation and handling of samples
  - ISO 5667-6: 2005 Part 6: Guidance on sampling of rivers and streams
  - ISO 5667-11: 1993 Part 11: Guidance on sampling of groundwater
  - DWAF Best Practice Guidelines Series G3: General Guidelines for Water Monitoring Systems
- In certain cases, adhering to the norms as set out in the above SABS standards may not be possible due to certain practicalities.
- Observations during sampling are of critical importance during the evaluation of the water quality results. We therefore employ highly qualified personnel to conduct the fieldwork as well as the evaluation component of the program.
- We make use of sampling and monitoring specialists who developed a custom-made data sheet in accordance with SABS ISO guidelines 5667-1 to 5667-3, to assist the field scientist in recording the physical and environmental information of the sampling locality. This information is needed to interpret water quality especially if the water quality results obtained by the laboratory indicate sudden changes at a specific locality. These sheets typically include the following information:
  - Location, name and details of the sample site
  - Method of collection
  - Name of collector
  - Nature of pre-treatment, if any
  - Preservative or stabilizer added, if any
  - Flow status or dam level
  - Water level of boreholes
  - Other data gathered at this point

2.4.4.2 *Water Quality Analysis*

- The samples will be preserved and submitted to the Clean Stream Scientific Services (CSSS) laboratory in Pretoria. CSSS offers state of the art technology to deliver fast and accurate results. The software installed to manage the laboratory, has been designed for a turnaround from receiving the sample to verifying the results and reporting within 14 working days.
- Our hydrochemical and microbiological laboratory is a SANAS Accredited Testing Laboratory, No T0374 governed by ISO17025:2005. The accreditation schedules for the chemical and microbiological disciplines can be viewed upon request. This analytical laboratory takes part in the SANAS accredited SABS Proficiency Testing Scheme (PTS0003) for hydrochemical analyses as well as the SANAS Accredited Rand Water Proficiency Testing Scheme for microbiological laboratories (PTS0002).
- The laboratory offers the following types of analyses:
    - Physical–chemical analyses
    - Inorganic analyses – major anions/cations
    - Full metal scan analyses
    - Hydrocarbon analyses
    - Microbiological analyses
    - Waste water analyses
    - Drinking water analyses
    - Environmental health analyses
    - Dust deposition analyses.

2.5 AIR QUALITY IMPACT ASSESSMENT

The assessment which will be carried out is a level 2 assessment which is in line with the objective of the study. Level 2 assessments are used for air quality impact assessment where:

- The distribution of pollutant concentration and disposition are required in time and space;
- The respective dispersion modelling can be treated by a steady state Gaussian plume model with first order chemical transformation.
- Emissions assessed are from sources where the greatest impacts are in the order of a few kilometres (less than 50 km) downwind.

The model which will be used in the impact assessment is AERMOD, a state-of-the-art Planetary Boundary Layer (PBL) air dispersion model, was developed by the American Meteorological Society and USEPA Regulatory Model Improvement Committee (AERMIC). AERMOD is a steady-state plume dispersion model for stimulating transport and dispersion from point, area or volume sources based on an up to date characterization of the atmospheric boundary layer. AERMOD utilizes a similar input and output structure to ISCST3 and shares many of the same features, as well as offering additional features. AERMOD fully incorporates the PRIME building downwash algorithms, advanced depositional parameters, local terrain effects, and advanced meteorological turbulence calculations.

The AERMOD atmospheric dispersion modelling system is an integrated system that includes three modules:

- Steady-state dispersion model designed for short-range (up to 50 km) dispersion of air pollutant emissions from stationary industrial sources.
- A meteorological data pre-processor (AERMET) for surface meteorological data, upper air soundings, and optionally, data from on-site instrument towers. It then calculates atmospheric parameters needed by the dispersion model, such as atmospheric turbulence characteristics, mixing heights, friction velocity, Monin-Obukov length and surface heat flux.
- A terrain pre-processor (AERMAP) which provides a physical relationship between terrain features and the behaviour of air pollution plumes. It generates location and height data for each receptor location. It also provides information that allows the dispersion model to simulate the effects of air flowing over hills or splitting to flow around hills.

AERMOD incorporates AERMET which uses a standard meteorological measurements and surface parameters representative of the modelling domain to compute boundary layer parameters used to estimate profiles of wind, turbulence and temperature used by AERMOD (DEA, 2014).

- The emissions inventory will need to be developed to determine the emission generated from each source. The inventory will be developed based on the process taking place on site and on associated sources characteristics provided by the client. Nuisance dust and particulate emission will be assessed as the main pollutants of concern. The calculated emission rates and source characteristics of each area source will input into AERMOD view dispersion model to predict the off-site air quality impacts.
- The emissions in relation to each identified sensitive receptor will assessed.
- A thorough review of the existing baseline condition was carried out in the scoping phase.
- Once dispersion modelling is carried out, comparisons will be made to the South African National Ambient Air Quality Standards.
- Impact results will be presented in the forms of Isopleths plots which reflect the gridded contours of zones of impact at various distances from the contributing source. The dispersion patterns which will be generated by the contours will be a representation of the maximum predicted ground level concentration for the period being assessed.
- Information gaps within the air quality assessment will be identified.
- Consolidation of a draft and then final impact report will be done which assesses the air quality impacts associated with the mining operations.

2.6 ENVIRONMENTAL NOISE IMPACT ASSESSMENT

The general procedure used to determine the noise impact will be guided by the requirements of the Code of Practice SANS 10328:2008: Methods for Environmental Noise Impact Assessments. The level of investigation will be the equivalent of an EIA. A comprehensive assessment of all noise impact descriptors (standards) will be undertaken. The noise impact criteria used specifically will take into account those as specified in the South African National Standard SANS 10103:2008, The Measurement and Rating of Environmental Noise with Respect to Annoyance and Speech Communication as well as those in the National Noise Control Regulations. The investigation will include the following:

- Determination of the existing situation (prior to development).
- Identification of the noise sensitive receptors in close proximity to the mine and transport routes.
- Determination of the situation during the construction phase and the operational phase.
- Assessment of the change in noise climate and impact.
- Identification of mitigation measures.

The full impact assessment will take into account the data provided in this report. The following input data can be used in the modelling of the different scenarios.

- Scenario 01: Baseline;
- Scenario 02: Construction Phase – Earth Clearing;
- Scenario 03: Construction Phase – Construction of plant and pit establishment;
- Scenario 04: Operational Phase – Active mining (open pit);
- Scenario 05: Operational Phase – Project associated traffic and materials handling; and
- Scenario 06: Cumulative result.

Scenarios testing the effectiveness of the proposed mitigation measure will also be included in the scenario list. This will help in selecting the best available option of mitigation.

The meteorological data to use in the CadnaA software is, for annual assessments, an average temperature of 20°C and 50% humidity, as per the integrated temperature and humidity options provided by CadnaA. As with any modelling project, it is advised to incorporate the terrain profile of the study area in the modelling software. The terrain of the region will be changed, due to the waste rock dump, and this should be included in the modelling.

All calculated model results must be compared to the project specific guidelines. The cumulative impact should also be calculated (considering the baseline noise level and new additional noise from this project).

Based on experience these proposed scenarios should be investigated to assess the full impact of the project:

- Baseline Noise Climate – utilising the existing noise sources' sound power levels to replicate the noise levels as measured at the different locations in the study area;
- Construction Phase – Earth clearing – the noise model replicating the typical conditions that would occur during the earth clearing and levelling stage of construction;
- Construction phase – Pit establishment – the noise associated with the establishment and construction of mine- pits or shafts;
- Operational Phase – Cumulative plant and mining noise – the noise associated with day-to-day operation of the mine; and
- Mitigated Scenario – Construction and Operational mitigation measures to investigate.

The purpose of the environmental noise impact investigation will be to determine and quantify the noise (unwanted sound) impact on the environment and identified noise sensitive receptors surrounding the planned Rietkol Project and the access road to the new mine.

The results of the measurements and calculations shall be used to evaluate the noise impacts associated with the Rietkol Project and a risk score will be awarded to the environmental impact. The rating of the environmental impact shall be used to recommend mitigation measures for the risk.

2.7 BLASTING IMPACT ASSESSMENT

BM&C has been appointed to perform a Blast and Vibration Study for the proposed Rietkol Project to determine the possible effects of blasting operations in terms of Ground vibration, Air blast, Fly rock and Noxious fumes.

2.7.1 Scope of Work

A detailed study will be prepared on evaluating the possible influences from blasting operations at the project. The data will be presented in a formal report and arranged according to the following sections of aspects that will be evaluated.

Consideration will be given to the following:

- Ground vibration prediction and modelling;
- Ground vibration and human perception;
- Vibration impacts on animals, including domestic animals (cattle, chickens, pigs, etc.);
- Vibration impact on national and provincial roads;
- Vibration that may impact on adjacent communities;
- Damage of houses and consequent devaluation;
- Vibration impact on water boreholes;
- Air blast expected from future blasting operations;
- Fly-rock expected; and
- Noxious fumes.

Safe Blasting Procedures will be developed for the project to mitigate the potential impacts.

2.7.2 Legislative requirements

The following acts contain references that will applicable to the study. Aspects on control of blast impacts, vibration and air blast are addressed in these acts:

- Explosives Act No. 26 of 1956 and its amendments GNR.1604 of 8 September 1972.
- Environment Conservation Act No. 73 of 1989.
- Mineral and Petroleum Resources Development Act No. 28 of 2002 and amendments GNR.527 of 23 April 2004.
- Mine Health and Safety Act No. 29 of 1996 and amendments GNR.93 of 15 January 1997.
- Ground vibration and air blast is also evaluated according to the USBM (United States Bureau of Mines) guidelines for safe blasting.
- Ground vibration and air blast is also evaluated according to guidelines as used by BM&C based on experienced and knowledge.

2.7.3 Plan of study

The objective is to outline the expected environmental effects that blasting operations could have on the surrounding environment. The study will investigate the related levels and possible influences of expected ground vibration, air blast, fly rock and noxious fumes on the area of 3500m surrounding the blast areas.

The receiving environment will be classed into three areas:

- 0 to 500 m which is considered the most critical. In most blasting operations this area is considered the unsafe zone and is normally cleared of all people and animals when blasting is done in a mining environment.
- Lesser sensitive is the 500 m to 1500 m reference area. 1500m is considered range by BM&C as range where influence may be lesser but still requires active monitoring.

- The lowest critical area is the 1500 m plus to approximately 3500 m. In this area the effects have more possibility of upsetting people than causing damage to structures.

The specific levels of influence to be considered contributing to damage of structures/installations in the area cannot be determined at this stage. The geology and expected drilling and blasting operations to be done with the possible influence with regards to the human perceptions of ground vibration and air blast will be considered. Humans are sensitive to even very low-level effects of ground vibration and air blast. To take this into consideration an area of 3500m is identified as area that could observe influence. This is in view that people will experience ground vibration levels as low as 0.75mm/s.

The objective is to outline the expected environmental effects that blasting operations could have on the surrounding environment. The study will investigate the related levels and possible influences of expected ground vibration, air blast, fly rock on the surrounding area.

To complete impact assessment, the following is required to be done:

- Conduct a site visit for determining location of structures and structure profile: Determine typical structures and installations that are found in within the influence radius form the operation.
- Obtain all relevant data and information on proposed blasting methods and methodology.
- The process then consists of modelling the expected impact based on planned drilling and blasting information for the operation. Various accepted mathematical equations are applied to determine the attenuation of ground vibration, air blast and fly rock. These values are then calculated over distance from site and shown as amplitude level contours. Overlay of these contours with the location of the various receptors then give indication of the possible impact and expected result of potential impact. Evaluation of each receptor according to the predicted levels will indicate level of possible influence and required mitigation if necessary. The possible environmental or social impacts are then addressed in the detailed EIA phase investigation.
- Prepare a report that provides the discussion and outcomes of all evaluations.
- Present the outcomes to interested and affected parties if required.

2.8 TRAFFIC IMPACT ASSESSMENT

Understanding the demands placed on the community's transportation network by the project is an important dimension of assessing the overall impacts of the proposed Rietkol Project. All development generates traffic, and it may generate enough traffic to create congestion and to create a need for further investment in infrastructure. Traffic congestion results in a number of problems, including economic costs due to delayed travel times, air pollution and accidents. The traffic impact analysis will assess the effects that the project will have on the transportation network in the project area, as well as the impact on community safety.

The traffic impact study will help to:

- Forecast additional traffic associated with the Rietkol Project.
- Determine the improvements that are necessary to accommodate the project.
- Identify potential impacts of the proposed development which may influence the project decision.
- Allow the community to assess the impacts that the project will have.
- Recommend mitigate measures for the negative impacts created by the project.
- Develop a safety management system to reduce the potential impacts on the community.

The following activities will be conducted and included in the final impact report:

- Gathering of required information
    - Primary data: Traffic counts, road status
    - Secondary data: Traffic counts
- Conduct detail traffic analyses and impact assessment
    - Trip Generation Analysis
    - Trip Distribution
- Identify appropriate measures to mitigate the impacts
- Develop traffic safety management plan
- Develop safety awareness programmes for the community, if required

2.9 VISUAL IMPACT ASSESSMENT

2.9.1 Key Observation Points

As part of the final Visual Impact Assessment (VIA) report, the preliminary Key Observation Points (KOPs) will be refined and finalised. Conceptual visual simulations will be rendered and illustrated from key locations and will be presented as the development is envisioned in its pre-mitigated and post-mitigated state.

Preliminary Key Observation Points (KOPs), to be refined as part of the final report, were identified based on prominent viewpoints, where uninterrupted views of the proposed development may occur and at points where positive viewshed areas intersect with potential receptors, were the exception of the KOP within the town of Delmas (Figure 1). The majority of KOPs were also selected within 5km of the proposed project, as receptors beyond this distance are unlikely to be significantly affected.

The final KOP analysis will be conducted by investigating the visual influence of proposed structures as per the available site layout. Major routes, such as the N12 and the R50, which carry increased amounts of traffic, as well as local roads, will also be considered during the assessment.

2.9.2 Line of Sight Analysis

A line of sight and elevation profile analysis will be conducted through drawing of a graphic line between two points on a surface that shows where along the line the view is obstructed. Emphasis will be placed on confirming whether the proposed mining infrastructure will be visible from the larger settlements located within 10km of the MRA area, including the town of Delmas and from prominent roads (N12, R50 and R555).

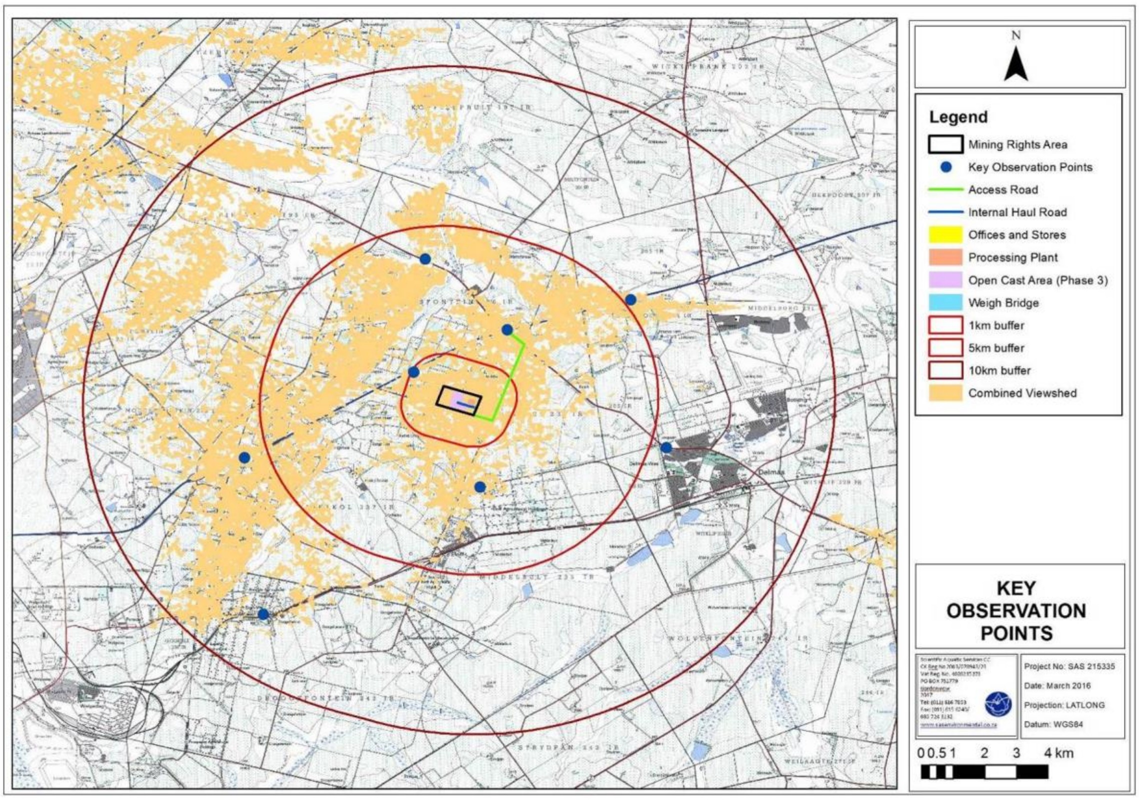


Figure 1: Location of preliminary Key Observation Points (KOPs), indicated in blue

2.9.3 Description of Potential Impacts Associated with the Proposed Mining Operation

Several potential risks to the receiving environment that may occur because of the proposed mining project, have been identified and are presented below:

- The proposed project may impact on the existing landscape and visual character of the region and Sense of Place associated with the MRA area and its immediate surroundings. The character of the landscape in the region of the MRA is currently dominated by gently undulating topography interspersed with cultivated fields, alien tree stands and low-density development, with the vegetation comprising open grassland vegetation, typical of the region. The MRA area itself and it immediate vicinity have not previously been exposed to mining activities and the overall character of the landscape is therefore at risk to be altered by the proposed mining activities. It is however important to note that some light industrial activities are currently present in the region;
- The altered visual environment during the various development phases of the proposed mining project may lead to high levels of visual intrusion on the MRA area, some incompatibility with the surrounding land uses as well as high levels of visual contrast. This in turn will negatively impact on the existing medium to high VAC (the ability of an area to visually absorb development);
- The proposed mining project may impact on visual exposure and visibility, which relates directly to the perception of sensitive visual receptors towards the project. Sensitive visual receptors have been determined to primarily comprise of residents living within 5km of the proposed project and local roads users. Direct visual exposure will take place as a result of mining infrastructure being visible to residents of the various settlements in the immediate vicinity of the MRA area, as well as indirectly through fugitive dust generated by construction and operation related activities, such as construction vehicles driving on dirt roads, as well as blasting and earthworks activities. Temporary stockpiles associated with opencast mining and the upgrading of access roads will also alter the visual environment. In addition to physical mining infrastructure, impacts from clearing of vegetation, potential erosion as a result of bare soils and alteration of local topography will also create contrast in the landscape and will be highly visible to receptors; and
- Lighting associated with the proposed project may be visible during both day and night but is more likely to have an adverse visual impact during the night-time. Lighting from operational activities may be visible for significant distances and indirect lighting impacts may reduce the night sky quality at locations some distance from the light sources.

Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Cumulative visual impacts resulting from landscape modifications as a result of the proposed project in conjunction with further planned mining activity within the region is likely to be of high significance, even more so due to the fact that no existing mining activities is currently present within the MRA and its immediate surrounds. Should the proposed project be approved, it is furthermore possible that other mines in the region will also be authorised to proceed, which will significantly increase the cumulative impact of mining activity in the area. The cumulative impact of additional traffic on the local and regional roads will also occur and affect the sense of place of the larger region.

It is possible that some surface infrastructure, including opencast areas may remain present post-closure and that rehabilitation and revegetation of the project footprint may not be successful. This will lead to a permanent visual impact in the area that may be significant, due to the extent and height of mining infrastructure.

2.9.4 Impact Assessment Report

The following box explains the inputs, which must form part of each level of assessment as outlined by the methodology of assessment determination presented in the section above (Oberholzer, 2005):

Level 1 input:

Identification of issues, and site visit;

Brief comment on visual influence of the project and an indication of the expected impacts / benefits.

Level 2 input:

Identification of issues raised in scoping phase, and site visit;

Description of the receiving environment and the proposed project;

Establishment of Receptor Site area and receptors;

Brief indication of potential visual impacts, and possible mitigation measures.

Level 3 assessment:

Identification of issues raised in scoping phase, and site visit;

Description of the receiving environment and the proposed project;

Establishment of Receptor Site area, view corridors, viewpoints and receptors;

2.9.5 Mitigation Measure Development

The following points present the key concepts considered in the development of mitigation measures for the proposed mining development.

- Mitigation and performance improvement measures and actions that address the risks and impacts 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; and
- Desired outcomes are defined and have been developed in such a way as to be measurable events with performance indicators, targets and acceptable criteria that can be tracked over defined periods, with estimates of the resources (including human resource and training requirements) and responsibilities for implementation.

2.9.5.1 Possible Mitigation Measures

Recommendations and management measures will be developed to address and mitigate potential impacts on the visual and aesthetic environment associated with Rietkol project. These recommendations will include general management measures, which apply to the proposed development as a whole, including general housekeeping guidelines relating to the proposed project and including management measures to limit visual impacts from dust, vehicle movement and lighting type and placement. as well as recommendations on infrastructure appearance and specific management measures applicable to individual infrastructure components in terms of screening potential.

Mitigation measures will also be developed to address issues during all project phases throughout the life of the operation from planning, through to construction and operation to after care and maintenance. Rehabilitation requirements will also be considered.

2.9.5.2 Monitoring

A visual monitoring programme, to ensure that mitigation measures regarding visual impacts are implemented and maintained, must be designed for implementation throughout all development phases. This programme would largely be based on visual reconnaissance at ground level and it must be noted that the monitoring plan must be continually updated and refined for site-specific requirements. Aspects to be included in such a monitoring plan will be developed and outlined.

2.10 PALAEONTOLOGICAL IMPACT ASSESSMENT

The Phase 1 HIA concluded that there are no objections regarding the development from a heritage point of view, provided the mitigation measures are implemented. No further work was proposed by the heritage specialist.

The South African Heritage Resources Agency (SAHRA) indicated that they require a field based Palaeontological Impact Assessment to be conducted by a professional palaeontologist. The area falls in the BLUE category of SAHRA's Palaeontological Sensitivity Map because of the under-lying Vryheid formation. Blue is low in sensitivity and no palaeontological studies are required; however, a protocol for finds is required. As a result of their comments, a palaeontological study will be conducted, to the level proposed by the professional palaeontologist.

2.11 SOCIAL IMPACT ASSESSMENT

2.11.1 Introduction

A social impact assessment will be performed to determine the expected impacts on the social environment. The social impact assessment will consider all variables that might impact on the community.

2.11.2 Field Research

Further field research will be conducted and interviews with landowners and other stakeholders in the region.

2.11.2.1 Observations

Direct observation, such as site visits or photographic records, are descriptive records developed by outside or participant observers. It captures free-form impressions, going beyond limitations of previously defined categories and interactions are observed in a natural setting.

Observations will also be done during the Public Participation Phase to note area of particular interest or concern.

2.11.2.2 Interviews / Surveys

The following further interviews will be conducted:

- Municipal Stakeholders
- Additional landowners and Agricultural Organisations
- NGO's and CBO's

Interviews are conversations in which questions are asked by the interviewer to obtain information from the interviewee. Benefits of interviews are that it allows for detailed, qualitative insights into interviewees' perspectives and if using a less structured approach increases chance of identifying factors not previously incorporated into assessment. The potential drawbacks includes that it must account for biases of the interviewer and interviewee and it can be time-consuming; and it may not be feasible if perspectives are needed from a large group. Seeing that the footprint of the project is medium sized it is anticipated that this approach will be effective to gain information if coupled with direct observations and collection of external data.

2.11.2.3 Information from other specialist studies and stakeholder consultation process

The review of information from other specialist studies may support the integration of direct physical impacts with the secondary socio-economic impacts that occur.

2.11.3 Social Impact Assessment

Social impact analysis will amongst others be done for expected changes in the social environment to:

- Demographic processes
- Socio-economic processes
- Geographic processes
- Institutional and legal processes
- Emancipatory and empowerment processes
- Socio-cultural processes
- Biophysical processes

The objectives of the mitigation measures are:

- To describe an action plan to achieve the mitigation measures identified during the impact assessment
- To make recommendations on a monitoring programme to review the success of the mitigation measures and to provide information to the relevant decision-makers.
- The potential significance of every environmental impact identified is determined by using a ranking scale, based on the terminology from the DEA guideline document.

The report will serve to verbalise and quantify possible impacts and its significance in a coherent and descriptive manner.

2.11.4 Social Management Plans

As part of the Environmental Management Plan it is recommended that Social Management Plans be compiled which will serve as a mitigation policy and management plan for the impacts on the social environment.

2.12 ECONOMIC IMPACT ASSESSMENT

The approach and contribution of this study to the greater study is to determine the current economic activities and compare the current land use to the proposed mining activities. In the process the possible impact of the proposed Rietkol Mining Project on the surrounding properties will be determined and the economic feasibility of the proposed mine established.

2.12.1 Approach

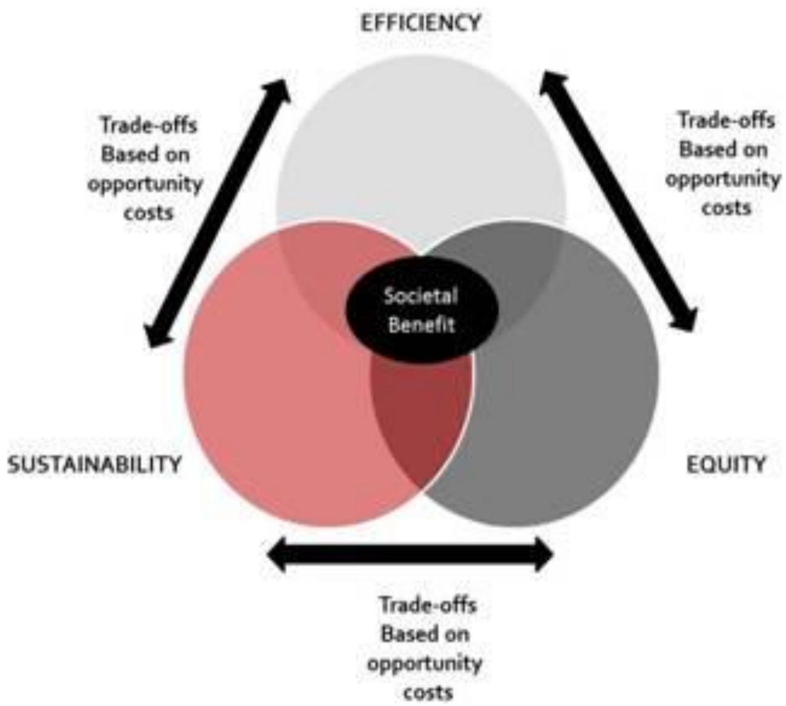
The areas subjected to and immediately adjacent to the mining development in the Rietkol Mining Project area that might be directly impacted upon will be visited where possible, or the land owners will be contacted to obtain certain information required for the study. The approach is to utilise the collected site-specific data to determine the comparative feasibility of the project and also the possible impact on local activities.

A macro and micro-economic study aimed at determining the economic and socio-economic indicators will be done to assist in identifying the best alternative land use option in a resource economic re-evaluation.

The basic function of this specialist study is to determine whether the Rietkol Mining Project will enhance net societal welfare as it is using a non-renewable resource to stimulate economic growth. The proposed approach is to establish the current economic baseline in the study area to determine the deviation brought about by the proposed mining project. This can be compared to measuring temperature changes with a thermometer. The zero baseline of water is established at freezing point at sea-level (in the Celsius scale) and the deviation is measured in terms of the difference from zero in positive and negative degrees. In the economic analysis the baseline is established as the current activities and the deviation is measured from this baseline.

At a broad level, investigating impacts on overall welfare requires considering the efficiency, equity and sustainability of the project. Keeping these principles in mind, the core concept applied by the economist when considering trade-offs is “opportunity cost” - the net benefit that would have been yielded by the next best alternative (for example, if farming is the next best alternative for a piece of land, then the foregone benefit associated with it will be the opportunity cost of any other land use). It is vital information when decision makers are to understand the trade-offs involved in projects. A key part of considering opportunity costs is commonly to highlight the impacts of doing nothing i.e. the “no-go alternative” or also referred to as the “economic baseline”. The economic baseline is established and is used to evaluate possible positive or negative impacts by the proposed mine on the current activities. It must be emphasized that in effect the economic baseline includes socio-economic, social and environmental issues.

The figure below illustrates how efficiency, equity and sustainability combine to impact on societal welfare and how trade-offs need to be made between these issues, taking cognizance of opportunity costs.



The principle of efficiency raises the issue of whether alternative forms of a project would constitute a more efficient use of resources.

The equity principle requires the consideration of whether the project results in outcomes that can be considered “fair”. Investigating the distribution of impacts is required to clearly indicate what is impacted on, in what way and for what period.

Sustainability related issues include a consideration of whether the project is likely to be economically viable over the long term and whether it will be ecologically sustainable. Risks to the long-term success of the project, including factors such as changing interest and exchange rates, become important here.

The economic study will, for the MRA area, consider the associated infrastructure, which includes the:

- Evaluation of economic trade-offs between:
  - Agricultural (i.e. livestock and cultivated agriculture where applicable) land use activities;
  - Bio-experience (where applicable) land use activities; and
  - Community use (i.e. rural settlements and communal land use if the current land restitution process is successful).
- Assess the influence of the planned development (i.e. resource use restrictions, and especially rights to use and benefit from resources) on the magnitude and adaptability of land use activities and livelihood systems. One issue is that mining is not a renewable resource and care must be taken that after the mining activities are stopped, the majority of the land will again be available for agricultural activities.
- Assess the vulnerability of land use activities to the possible emergence of plant and animal diseases.

The key issues that will be considered and addressed by the specialist can be summarised as follows:

- Environmental and social externalities that are not accounted for in financial costs and benefits but must be addressed in terms of economic costs and benefits.
- The economic sustainability of the project over the medium term.
- Degree of compatibility with economic development planning in the area (i.e. does the project compliment economic and spatial plans).
- Linkage effects that allow a project to generate added benefits in the form or employment, incomes, increased production.
- Macro-economic risks (i.e. whether the project has the potential to impact on exchange rates, balance of payments, interest rates or local factor and product prices).

The Macro-Economic Impact Assessment includes:

- The possible impact on current economic activities, the population and the environment, by establishing the baseline of current activities to determine possible deviations from the baseline. This will be performed in current monetary units and converted to economic parameters like Gross Domestic Product (GDP) or if preferred Gross Value Added (GVA) and socio-economic parameters, namely; Employment and Payments to Households. The nature and magnitude of the possible economic impacts on the agricultural sector emanating from the proposed Rietkol Mining Project will thus be determined. As such a comparison of the impacts (probably negative) that the project will have on the agricultural sector will be weighed against the positive economic development that the project will bring to the region, as is essential in projects of this nature.

- The determination whether the project is economically viable. It will be necessary to determine whether the benefits associated with the project actually outweigh the possible costs/negative impacts. This determination includes the impact on the environment as well as on the social quality of life.

Should the proposed mining activities have negative effects on the current land use, possibly identified by the specialist reports, alternatives for irrigation farming, dry land maize production, vegetable production, floriculture, red meat production or poultry (egg and meat) production on farms surrounding the Rietkol Mining Project area, such effects will also be taken into account.

2.12.2 Area Definition

To evaluate the impact of the mine, the study will focus on two areas, namely:

- MRA area - The MRA area of the Rietkol Mining Project comprising of 16 AHs and Rietkol 237 IR (RE/31/237 and Portion 71/237) that will be directly impacted upon by the mining activities. This area will be purchased from the landowners and the current farming activities will cease. The existing rural residences will either be used by the mine for offices or be demolished.
- Buffer Area - A 1 km demarcated area surrounding the proposed MRA area of the Rietkol Mining Project that may be impacted upon. In this area primary data collection will be undertaken to calculate the economic impact of the proposed project. As the proposed mining activities are considered to be a more “clean” operation than, for example a coal mine or some other mining operations, the extended area is a significantly smaller area than normally applied for a new mining operation. However, the expected increase in the truck traffic transporting the mining product could have a negative effect on current activities.

2.12.3 Methodology

The methodology for the study will include a number of actions, namely: data collection and the application of econometric models to determine economic viability, risk analyses and macro-economic impact analyses (local impacts, a Cost Benefit Analysis [CBA] and a Macro-Economic Impact Analysis).

- A macro-economic and micro-economic modelling approach will be used in the calculation of the different parameters to test the impact of the mine and determine the economic sustainability.

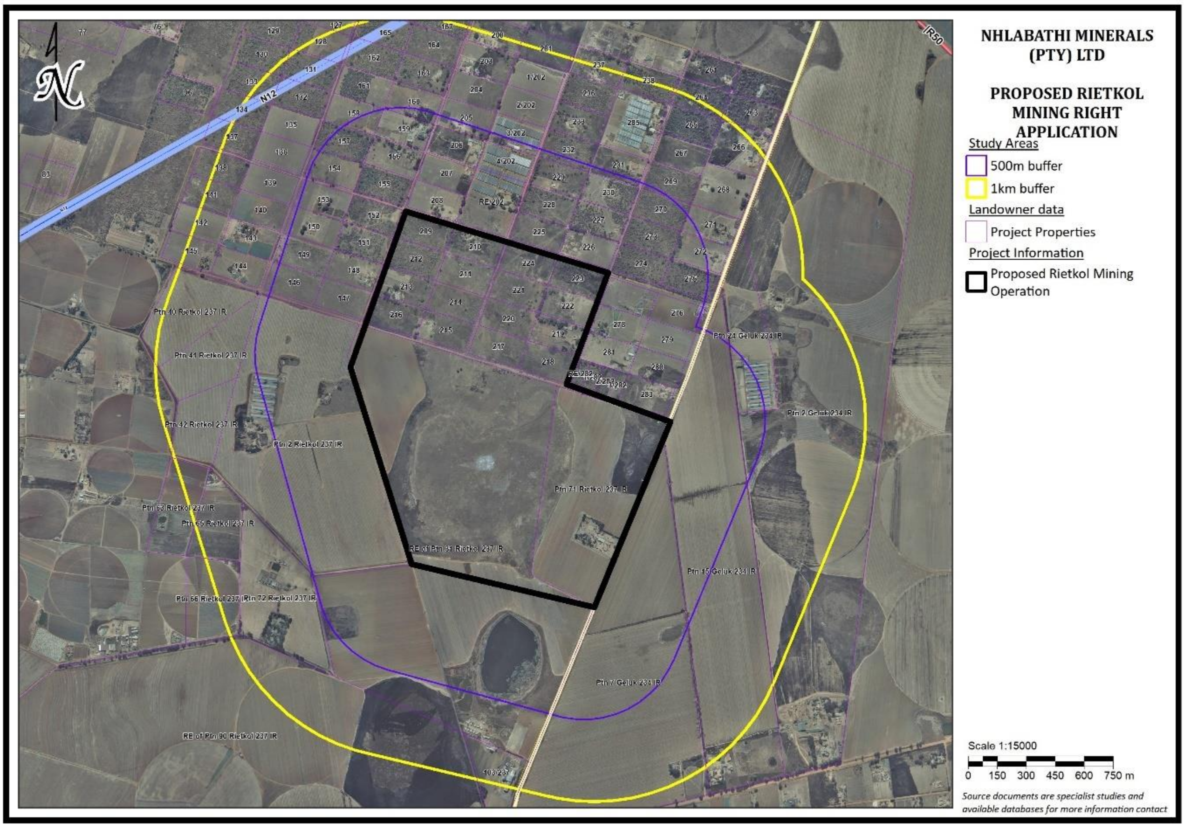


Figure 2: Socio-economic Focus Areas

- The economic sustainability will be determined by the construction of a detailed economic CBA.
- The macro-economic impact of the project on the Mpumalanga Province and South Africa will be calculated using an econometric model based on the Mpumalanga and South Africa SAMs.
- Three economic evaluation methodologies will be applied to contribute to the final decision on the mining application:

- Possible impact on local economic activities. A macro-economic approach will be used to determine and express the magnitude of the present economic activities and the possible impact of the planned mining activities.
- Economic Viability. A CBA approach to determine medium to long term economic viability compared to current land use.
- A SAM based econometric model approach to estimate the macro-economic impact on the National Economy and the Mpumalanga Provincial Economy.

- The current activities are identified, and the monetary value of the different activities estimated in the project area in 2017 prices. This is then converted to four macro-economic indicators which is used to estimate the projected possible impact of the proposed mine.

A Macro-Economic Impact Model (MEIM) is used to convert the monetary values of the different activities to macro-economic indicators. The MEIM is based on the Mpumalanga SAM, which has been converted to an econometric model to be used in the project area. The MEIM will be adapted to accommodate each of the identified project areas and will be populated with the baseline, site-specific data.

The magnitude of the current activities in the project area has been calculated according to the methods as explained. In later sections the current economic activities are expressed in terms of the following economic and socio-economic parameters as provided by the Macro-Economic Model:

- Economic Parameters
  - GDP – Direct and Indirect/Induced Impacts; and
  - Capital Utilisation.
- Socio-economic parameters
  - Employment – Direct and Indirect/Induced Impacts; and
  - Payments to Households – Low Income and Medium/High Income.

The possible impacts of the proposed mining of Silica and associated minerals on the current economic activities will be estimated and converted to the macro-economic parameters to reflect the impacts.

The SAM will be used to synthesise appropriate multipliers to be used in the MEIM to calculate the macro-economic impact of the different activities.

All economic models incorporate a number of "multipliers" which form the nucleus of the modelling system. The nature and extent of the impact of a change in a specific economic quantity, e.g. exports, on that of another economic quantity or quantities, e.g. production output or employment, is determined by a “multiplier”. A multiplier summarises the total impact that can be expected from a change in a given economic activity.

The change in economic activity resulting from the change in one factor of production, such as water resources, is measured by different multipliers. Four multipliers are commonly used to assess the impacts of an initial increase in production resulting from an increase in sales, usually called final demand in multiplier analysis. The four multipliers are: (1) output, (2) employment; (3) income; and (4) value added.

Sectorial multipliers are calculated using information contained in the applicable Provincial Social Accounting Matrix (SAM) and the National SAM as well as data obtained from the South African Reserve Bank and Statistics South Africa. These inverse matrices capture all the direct and indirect relationships among the inputs and outputs of the various entities included in the applicable provincial SAM.

Direct GDP, labour and capital multipliers for each sector are calculated using the following formula:

- GDP multiplier = Value Added / Production
- Labour multiplier = Employment / Production
- Capital multiplier = Capital stock / Production

These multipliers will be incorporated into the MEIM and used to calculate the macro-economic impacts. By using a SAM for the applicable region, the above multipliers can be calculated. The multipliers that will be used in this study to determine the economic impacts are as follows:

- Economic growth, i.e. the impact on GDP.
- Employment creation, i.e. the impact on labour requirements.
- Income distribution, i.e. the impact on low income, poor households and total households.

2.13 HAZARDOUS IDENTIFICATION AND RISK ASSESSMENT

A Hazard Identification and Risk Assessment (HIRA) will be conducted for the Rietkol Project, to:

- Identify and assess the health hazards that may be presented to employees and members of the public within the impact zone of a proposed silica mine; and
- Recommend appropriate measures to mitigate any adverse impacts and risks before the commissioning of the mine and associated works.

The HIRA will focus on the potential occupational and environmental health risks that may be presented by each individual component, as well as by the sum total of the components functioning as a silica mine, during the construction and operational phases of the mine.

The HIRA shall involve the structured identification and assessment of potential health hazards that may be presented to employees, as well as citizens of the community within the impact zone of the proposed silica mine near Delmas in the Victor Khanye Local Municipal area, Nkangala District.

2.13.1 Methodology

The method that will be followed involves the following steps:

- Desk top study of relevant literature to list / extract health risks that were documented during similar projects, locally and internationally. Health risks that are relevant to the proposed silica mine shall be assessed as part of this project.
- Analysis of specialist and environmental modelling reports on the various environmental studies, such as, inter alia, air quality, water quality and noise impacts that are conducted as part of the Environmental Impact assessment to establish the extent to which the proposed silica mine may impact on the health of employees and members of the community.
- Evaluation of employee and environmental exposure to Respirable Dust and Crystalline Silica at a similar / existing silica mine near Delmas. Samples shall be collected and analysed in accordance with MDHS 14/4 and NIOSH Method 7602.
- Experience of the author(s) drawn from actual surveys / data regarding the health hazards that may be presented by similar silica mines.

During the Occupational and Environmental Risk Assessment three variables of the potential health hazard will be quantified, namely consequence, frequency and probability.

Collectively, these variables will reflect the degree of employee / public exposure and used to calculate the Risk Score.

- Consequence is the severity of the health effect posed by the health hazard in question. The selected consequence index describes a typical example of a potential health effect presented by a hazard (eg. cancer) and is adopted irrespective of existing control measures or conditions.
- Frequency relates to both the duration and number of exposures to the specific health hazard, for example five 10-minute exposures per day, continuous 8-hour exposure throughout a shift, or once a month for 2 hours.

- Probability is the likelihood that the health effect presented by the hazard will follow through or materialise. The probability relies on a number of factors, the most important being the existing measures that control employee / public exposure.

A Risk Score for each exposure shall be mathematically calculated to establish the extent of exposure, i.e. Risk Score (RS) = Consequence (C) x Frequency (F) x Probability (P).

The Risk Score indicates the priority of the health hazard, namely Very Low, Low, Moderate, High, or Very High Risk.

Table 4 and Table 5 provide the algorithms used to calculate the Risk Score.

Table 4: Indices for consequence (C), frequency (F) and probability (P)

	Consequence (C) Description	**Frequency (C) Description**	**Probability (P) Description**
10	Death – highly serious, extremely toxic and life threatening; non-reversible effects from exposure characterized by acute lethal toxicity (H_2S, HF, simple and chemical asphyxiants) and Group 4 Hazardous Biological Agents.	Hazard present during 7 – 8 hrs of an 8 hr shift, 10 – 12 hrs of a 12 hr shift	Inevitable (100 % chance)
9	Permanent partial incapacity & unemployable – non-reversible chronic cumulative systemic effects; known human carcinogens (OSHA, IARC and NTP listed); reproductive hazards; characterized by incapacitating and poisonous nature (Asbestos, Benzene, Vinyl Chloride).	Hazard present during 4 – 7 hrs of an 8 hr shift, 6 – 10 hrs of a 12 hr shift	Almost certain (90 % chance)
8	Serious but not immediately / acutely life threatening – non-reversible consequences from exposure characterized by acute systemic effects (ie respiratory, CNS, kidneys, liver, heart); chronic systemic effects; suspect carcinogen, mutagen / teratogen. Group 3 Hazardous Biological Agents.	Hazard present ± 4 hrs of an 8 hr shift, ± 6 hrs of a 12 hr shift	Very likely (80 % chance)
7	Permanent partial incapacity with / without work absence – may cause temporary reversible and irreversible health effects; can cause considerable discomfort ie noise induced hearing loss.	Hazard present 2 – 4 hrs of an 8 hr shift, 3 – 6 hours of a 12 hr shift	Probable (70 % chance)
6	Serious but not life threatening effects from exposure characterized by marked irritation, occupational asthma. Group 2 Hazardous Biological Agents, acids and bases.	Hazard present 1 – 2 hrs of an 8 hr shift, 1.5 – 3 hrs of a 12 hr shift	More than even chance (60 % chance)
5	Temporary incapacity with / without work absence – reversible health condition with subsequent complete recovery after extended period of absence. Cumulative trauma disorders / injury reoccurrence (ie carpal tunnel syndrome).	Hazard present < 1 hr of an 8 hr shift, < 1.5 hrs of a 12 hr shift	Even chance (50 % chance)
4	Reversible health condition with subsequent complete recovery after short leave of absence – can cause readily reversible tissue damage that disappears when exposure stops (ie dermatitis, etc).	Hazard arises a few times per week (± 4 hrs of an 8 hr shift, ± 6 hrs of a 12 hr shift)	Less than even chance (30 % - 40 % chance)
3	Minor temporary or reversible effects from excess exposure characterized by mild to moderate irritants, volatile organic compounds, or odorous materials – can cause discomfort (ie nuisance noise, nuisance dust). Group 1 Hazardous Biological Agents.	Hazard arises once a week (± 2 – 4 hrs of an 8 hr shift, 3 – 6 hrs of a 12 hr shift)	Unusual sequence/coincidence (10 % - 20 % chance)
2	Minor health effects with no lost time and complete recovery.	Hazard arises every 2nd week, once a month or infrequently	Improbable (1 % - 10 % chance)
1	No incapacity expected under normal working conditions.	Hazard arises quarterly, once a year or very rarely	Practically impossible (<1% chance)

Table 5: Risk Score (RS) and actions

Risk Score	**Action**
Very low (≥1 - < 30)	No action is required and no documentary records need to be kept.
Low (≥30 - < 120)	No additional controls required. Consideration may be given to a more cost-effective solution or improvement that imposes no additional cost burden.
Moderate (≥120 - < 340)	Efforts should be made to reduce risk, but costs or prevention should be carefully limited. Risk reduction measures should be implemented within a defined period. Where the moderate risk is associated with extremely harmful consequences, further assessment may be necessary to establish more precisely the likelihood of harm as a basis for determining the need to improved control measures. Occupational Hygiene Monitoring and Medical Surveillance are required and regular revision of controls should be done.

Risk Score	Action
High **(≥340 - < 730)**	Work should not be started until the risk has been reduced. Considerable resources may have to be allocated to reduce the risk. Occupational Hygiene Monitoring and Medical Surveillance are required and regular revision of controls should be done.
Very high **(≥730 - ≤1000)**	Work should not be started or continued until the risk has been reduced. If it is not possible to reduce the risk even with unlimited resources, work has to remain suspended.

2.13.2 Standards and Criteria

2.13.2.1 Occupational Exposure Impacts

The Mine Health and Safety Act (29 of 1999) requires that every manager shall assess and respond to risk. Furthermore, every employer must:

- Ensure that the occupational exposure to health hazards of employees is maintained below the limits set out in Schedule 22.9(2) (a) and (b).
- Establish and maintain a system of occupational hygiene measurements, as contemplated in section 12, of all working places where the following hazard limits prevail: Airborne pollutants, thermal stress and noise.
- The competent person engaged by the employer in terms of section 12(1) must, as part of the compliance with section 12(2)(b), report to the employer on:
    - The occupational hygiene risk assessment, with specific reference to planning, design, implementation and management of occupational hygiene at the mine;
    - The occupational hygiene hazards that may cause illness or adverse health effects to persons, assess the results in terms of the implementation of control systems and the management thereof, and recommend remedial actions to the employer.

In addition to the above, applicable SANS Codes and International Standards of good Occupational Hygiene practise may be used.

2.13.2.2 Public Exposure Impacts

Various acts, regulations and local authority by-laws govern environmental pollution in South Africa. However, where local standards are not available, international guidelines may be used as a terms of reference.

The most important environmental standards relating to this assessment are provided below.

- Mineral and Petroleum Resources Development Act (49 of 2008).
- National Environmental Management Amendment Act (62 of 2008).

- National Environmental Management: Air Quality Amendment Act (20 of 2014).
- National Water Amended Act (45 of 1999).
- Provincial and local authority regulations, by-laws and standards.

In addition to the above, applicable SANS Codes and International Standards of good Environmental practice may be used

2.13.3 Identification of Potential Health Risks

A systematic procedure will be followed during which the potential exposure to environmental and occupational factors of each occupational category and the general public living in the impact zone , will be identified .The potential health risk impact related to the proposed silica mine will be assessed by examining the process.

2.13.3.1 Occupational exposure impacts during Silica Mine operations

- Crystalline silica dust exposure.
- Airborne pollutants, other than crystalline silica dust, e.g.:
  - Nitrogen gases.
  - Methane gas (CH_4).
  - Carbon monoxide (CO).
  - Diesel particulate matter.
- Noise.
- Vibration.
- Environmental elements, eg. lighting, ventilation, temperature extremes.
- Shift Work.
- Ergonomic Stressors.

2.13.3.2 Public exposure and impact during mine operations

- Crystalline silica dust exposure, PM_{10} and $PM_{2,5}$
- Airborne pollutants, other than crystalline silica dust, e.g.:
  - Nitrogen gases.
  - Methane gas (CH_4)
  - Carbon monoxide (CO).
  - Diesel particulate matter.
- Noise.

- Blasting shock and vibration.
- Water.
- Social Environment.
- Economic and other benefits.
- Aesthetic impact, visual (sense of place).
- Community structure and culture.
    - Population density and infrastructure.
    - Major economic activities.
    - Developmental diseases, eg. HIV, TB

2.13.3.3 Deliverables / Outcomes

A HIRA report containing the following deliverables / outcomes will be produced:

- Identification of Occupational and Public Exposure Risks pertaining to activities and / or tasks.
- Job categorization regarding potential exposure to Occupational Exposure Risks.
- Rating of Occupational and Public Exposure Risks to determine Risk Acceptability.
- Control measures to mitigate Occupational and Public Exposure Risks.
- Outline Proposed Occupational Hygiene Monitoring and Medical Surveillance Programmes.
- Outline Proposed Environmental Monitoring and Community Medical Surveillance Programmes.
- Outline Proposed Information and Training.

The above mentioned will assist in the development of the following:

- Risk Register development.
- Risk acceptability determination.
- Information for major or principal hazard plan.
- Information for operational guidelines.
- Information for maintenance plans or guidelines.
- Hardware design review.
- Review of change management plan.
- Information for drafting of SOPs.
- Informal risk awareness on day-to-day tasks.

2.14 PUBLIC PARTICIPATION PLAN

2.14.1 Objectives of Public Participation

The fundamental objectives of the public participation process are as follow:

- Meet legal and formal requirements;
- Identify public concerns and values;
- Improve decision-making. Public involvement can often produce better "technical decisions" than a strictly technically oriented decision process;
- Establish and maintain good relationships with Interested and Affected Parties (IAPs);
- Provision and sharing of information throughout the process;
- Find and build common ground and move from extremes; and
- Stimulate two-way engagement on specific issues. In many cases, not all IAPs wish to be involved in every issue of the project all of the time. Most IAPs are partially involved, and therefore prefer to be only included in key elements of the process.

2.14.2 Principles of Public Participation

The public participation process should endeavour to embrace the following principles:

- Inclusive involvement of stakeholders and IAPs.
- Integration of public issues/knowledge and technical assessments.
- Mutual respect for each other's knowledge, abilities and inputs.
- Consideration of alternatives.
- Flexibility of the public participation process to adapt to different circumstances.
- Transparency of the process and information availability.
- Accountability of commitments made.
- Accessibility to information.
- Efficiency of the Public Participation Plan.
- Suitability of scale of involvement.
- Feedback to and from stakeholders.

2.14.3 Methods of Public Participation

The following methods will be utilised throughout the Public Participation process:

- Background Information Documents, Information Flyers, and Posters

- Advertisements and Notices;
- Authority meetings;
- Landowner and occupant meetings;
- Public Meetings and/or Open Days;
- Community Forums and Group Presentations;
- One-on-One interviews / engagements
- Electronic and email correspondence; and
- Other Methods.

2.14.4 Scoping Phase

2.14.4.1 Focus Group Meetings

The following focus group meetings were held:

- Combined Authority and District and Local Municipality
- Landowners & Neighbouring Landowners
- Land Occupants

2.14.4.2 Comments and Responses on the Draft Scoping Report

A comments and response report was be compiled from all the comments received in meetings and written submissions on the draft Scoping Report. This report is included in the final Scoping Report.

2.14.4.3 Notification of the Final Scoping Report

Registered IAPs will be notified of the availability of the final Scoping Report.

2.14.5 Environmental Impact Assessment Phase

2.14.5.1 EIA Results Information Dissemination

The draft EIA report will be distributed amongst all registered IAPs and more specifically the affected communities neighbouring the mine development.

2.14.5.2 Public Open Day

A Public Open Day will be held where all IAPs will be provided with an opportunity to raise concerns, make comments and/or suggestions to the Environmental Assessment Practitioner and the Applicant. The meeting will be held within the Municipal area.

2.14.6 Availability of the EIR/EMPr Report

The draft EIR/EMPr report will be made available for 30 calendar days. Notification will be sent to all registered IAPs on where copies of the report can be accessed. Hard copies of the reports will be submitted to relevant Authorities and will also be placed in the Public Places. The report will be available for download or a Compact Disc can be posted on request. Provision will be made to facilitate access to the report by communities.

2.14.7 Comments and Responses

All comments received during the Scoping and EIR/EMPr phase will be included in the Comments and Response reports for the project and process. Responses to questions and comments will be provided in these reports, where relevant inputs will be incorporated into the EIR/EMPr report.

2.15 RISK ASSESSMENT METHODOLOGY

2.15.1 Impact Significance

2.15.1.1 Nature and Status

The 'nature' of the impact describes what is being affected and how. The 'status' is based on whether the impact is positive, negative or neutral.

2.15.1.2 Spatial Extent

'Spatial Extent' defines the spatial or geographical scale of the impact.

Category	Rate	Descriptor
Site	1	Site of the proposed development
Local	2	Limited to site and/or immediate surrounds
District	3	Victor Khanye Local Municipal Area
Region	4	Nkangalai District Municipal Area
Provincial	5	Mpumalanga Province
National	6	South Africa
International	7	Beyond South African borders

2.15.1.3 Duration

'Duration' gives the temporal scale of the impact.

Category	Rate	Descriptor
Temporary	1	0 – 1 years
Short term	2	1 – 5 years
Medium term	3	5 – 15 years
Long term	4	Where the impact will cease after the operational life of the activity either because of natural process or by human intervention
Permanent	5	Where mitigation either by natural processes or by human intervention will not occur in such a way or in such a time span that the impact can be considered as transient

2.15.1.4 Probability

The 'probability' describes the likelihood of the impact actually occurring.

Category	Rate	Descriptor
Rare	1	Where the impact may occur in exceptional circumstances only
Improbable	2	Where the possibility of the impact materialising is very low either because of design or historic experience
Probable	3	Where there is a distinct possibility that the impact will occur
Highly probable	4	Where it is most likely that the impact will occur
Definite	5	Where the impact will occur regardless of any prevention measures

2.15.1.5 Intensity

'Intensity' defines whether the impact is destructive or benign, in other words the level of impact on the environment.

Category	Rate	Descriptor
Insignificant	1	Where the impact affects the environment is such a way that natural, cultural and social functions and processes are not affected. Localised impact and a small percentage of the population is affected
Low	2	Where the impact affects the environment is such a way that natural, cultural and social functions and processes are affected to a limited extent
Medium	3	Where the affected environment is altered in terms of natural, cultural and social functions and processes continue albeit in a modified way
High	4	Where natural, cultural or social functions or processes are altered to the extent that they will temporarily or permanently cease
Very High	5	Where natural, cultural or social functions or processes are altered to the extent that they will permanently cease and it is not possible to mitigate or remedy the impact

2.15.1.6 Ranking, Weighting and Scaling

The weight of significance defines the level or limit at which point an impact changes from low to medium significance, or medium to high significance. The purpose of assigning such weights serves to highlight those aspects that are considered the most critical to the various stakeholders and ensure that the element of bias is taken into account. These weights are often determined by current societal values or alternatively by scientific evidence (norms, etc.) that define what would be acceptable or unacceptable to society and may be expressed in the form of legislated standards, guidelines or objectives.

The weighting factor provides a means whereby the impact assessor can successfully deal with the complexities that exist between the different impacts and associated aspect criteria.

Spatial Extent	**Duration**	**Intensity / Severity**	**Probability**	**Weighting factor**	**Significance Rating (SR - WOM) Pre-mitigation**	**Mitigation Efficiency (ME)**	**Significance Rating (SR-WM) Post Mitigation**
Site (1)	Short term (1)	Insignificant (1)	Rare (1)	Low (1)	Low (0 – 19)	High (0.2)	Low (0 – 19)
Local (2) District (3)	Short to Medium term (2)	Minor (2)	Unlikely (2)	Low to Medium (2)	Low to Medium (20 – 39)	Medium to High (0.4)	Low to Medium (20 – 39)
Regional (4)	Medium term (3)	Medium (3)	Possible (3)	Medium (3)	Medium (40 – 59)	Medium (0.6)	Medium (40 – 59)
Provincial (5) National (6)	Long term (4)	High (4)	Likely (4)	Medium to High (4)	Medium to High (60 – 79)	Low to Medium (0.8)	Medium to High (60 – 79)
International (7)	Permanent (5)	Very high (5)	Almost certain (5)	High (5)	High (80 – 110)	Low (1.0)	High (80 – 110)

2.15.1.7 Impact significance without mitigation (WOM)

Following the assignment of the necessary weights to the respective aspects, criteria are summed and multiplied by their assigned weightings, resulting in a value for each impact (prior to the implementation of mitigation measures).

Equation 1:
Significance Rating (WOM) = (Extent + Intensity + Duration + Probability) x Weighting Factor

2.15.1.8 Effect of Significance on Decision-makings

Significance is determined through a synthesis of impact characteristics as described in the above paragraphs. It provides an indication of the importance of the impact in terms of both tangible and intangible characteristics. The significance of the impact “without mitigation” is the prime determinant of the nature and degree of mitigation required.

Rating	Rate	Descriptor
Negligible	0	The impact is non-existent or insignificant, is of no or little importance to decision making.
Low	1-19	The impact is limited in extent, even if the intensity is major; the probability of occurrence is low and the impact will not have a significant influence on decision-making and is unlikely to require management intervention bearing significant costs.
Low to Medium	20 – 39	The impact is of importance, however, through the implementation of the correct mitigation measures such potential impacts can be reduced to acceptable levels. The impact and proposed mitigation measures can be considered in the decision-making process
Medium	40 – 59	The impact is significant to one or more affected stakeholder, and its intensity will be medium or high; but can be avoided or mitigated and therefore reduced to acceptable levels. The impact and mitigation proposed should have an influence on the decision.
Medium to High	60 -79	The impact is of major importance but through the implementation of the correct mitigation measures, the negative impacts will be reduced to acceptable levels.
High	80 – 110	The impact could render development options controversial or the entire project unacceptable if it cannot be reduced to acceptable levels; and/or the cost of management intervention will be a significant factor and must influence decision-making.

2.15.2 Mitigation

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

The mitigation hierarchy in general consists of the following in order of which impacts should be mitigated:

- Avoid/prevent impact: can be done through utilising alternative sites, technology and scale of projects to prevent impacts. In some cases, if impacts are expected to be too high, the "no project" option should also be considered, especially where it is expected that the lower levels of mitigation will not be adequate to limit environmental damage and eco-service provision to suitable levels.
- Minimise (reduce) impact: can be done through utilisation of alternatives that will ensure that impacts on biodiversity and eco-services provision are reduced. Impact minimisation is considered an essential part of any development project.
- Rehabilitate (restore) impact is applicable to areas where impact avoidance and minimisation are unavoidable where an attempt to re-instate impacted areas and return them to conditions which are ecologically similar to the pre-project condition or an agreed post project land use, for example arable land. Rehabilitation can however not be considered as the primary

mitigation toll as even with significant resources and effort rehabilitation that usually does not lead to adequate replication of the diversity and complexity of the natural system. Rehabilitation often only restores ecological function to some degree to avoid ongoing negative impacts and to minimise aesthetic damage to the setting of a project. Practical rehabilitation should consist of the following phases in best practice:

- Structural rehabilitation which includes physical rehabilitation of areas by means of earthworks, potential stabilisation of areas as well as any other activities required to develop a long terms sustainable ecological structure;
- Functional rehabilitation, which focuses on ensuring that the ecological functionality of the ecological resources on the subject property supports the intended post-closure land use. In this regard, special mention is made of the need to ensure the continued functioning and integrity of wetland and riverine areas throughout and after the rehabilitation phase;
- Biodiversity reinstatement that focuses on ensuring that a reasonable level of biodiversity is re-instated to a level that supports the local post-closure land uses. In this regard, special mention is made of re-instating vegetation to levels which will allow the natural climax vegetation community of community suitable for supporting the intended post-closure land use; and
- Species reinstatement that focuses on the re-introduction of any ecologically important species, which may be important for socio-cultural reasons, ecosystem functioning reasons and for conservation reasons. Species re-instatement need only occur if deemed necessary.

* Offset impact: refers to compensating for latent or unavoidable negative impacts on biodiversity. Offsetting should take place to address any impacts deemed unacceptable which cannot be mitigated through the other mechanisms in the mitigation hierarchy. The objective of biodiversity offsets should be to ensure no net loss of biodiversity. Biodiversity offsets can be considered a last resort to compensate for residual negative impacts on biodiversity.

According to the DMR (2013) “Closure” refers to the process for ensuring that mining operations are closed in an environmentally responsible manner, usually with the dual objectives of ensuring sustainable post-mining land uses and remedying negative impacts on biodiversity and ecosystem services.

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

2.15.2.1 Impact significance with mitigation measures (WM)

In order to gain a comprehensive understanding of the overall significance of the impact, after implementation of the mitigation measures, it is necessary to re-evaluate the impact.

2.15.2.2 Mitigation Efficiency (ME)

The most effective means of deriving a quantitative value of mitigated impacts is to assign each significance rating value (WOM) a mitigation effectiveness (ME) rating. The allocation of such a rating is a measure of the efficiency and effectiveness, as identified through professional experience and empirical evidence of how effectively the proposed mitigation measures will manage the impact. Thus, the lower the assigned value the greater the effectiveness of the proposed mitigation measures and subsequently, the lower the impacts with mitigation.

Equation 2: Significance Rating (WM) = Significance Rating (WOM) x Mitigation Efficiency (ME)

Mitigation Efficiency is rated out of 1 as follows:

Category	Rate	Descriptor
Not Efficient (Low)	1	Mitigation cannot make a difference to the impact
Low to Medium	0.8	Mitigation will minimize impact slightly
Medium	0.6	Mitigation will minimize impact to such an extent that it becomes within acceptable standards
Medium to High	0.4	Mitigation will minimize impact to such an extent that it is below acceptable standards
High	0.2	Mitigation will minimize impact to such an extent that it becomes insignificant

2.15.2.3 Significance Following Mitigation (SFM)

The significance of the impact after the mitigation measures are taken into consideration. The efficiency of the mitigation measure determines the significance of the impact. The level of impact is therefore seen in its entirety with all considerations taken into account.