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Blast and Vibration Assessment Report Proposed Kalabasfontein Project	
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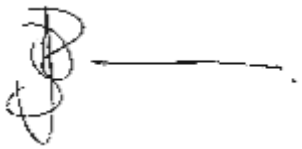
Signed:	
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ii. Study Team Qualifications And Background

The study team comprises J D Zeeman (as the member of Blast Management & Consulting) and Blast Management & Consulting employees. Blast Management & Consulting's main areas of concern are pre-blast consultation and monitoring, insitu monitoring, post-blast monitoring and consulting as well as specialised projects. Blast Management & Consulting has been active in the mining industry since 1997 and work has been done at various levels for mining companies in South Africa, Botswana, Namibia, Mozambique, Democratic Republic of Congo, Sierra Leone and Côte d'Ivoire.

J D Zeeman holds the following qualifications:

1985 - 1987 Diploma: Explosives Technology, Technikon Pretoria
1990 - 1992 BA Degree, University of Pretoria
1994 National Higher Diploma: Explosives Technology, Technikon Pretoria
1997 Project Management Certificate, Damelin College
2000 Advanced Certificate in Blasting, Technikon SA
Member: International Society of Explosive Engineers

iii. Independence Declaration

Blast Management & Consulting is an independent company. The work done for the report was performed in an objective manner and according to national and international standards, which means that the results and findings may not all be positive for the project applicant. Blast Management & Consulting has the required expertise to conduct such an investigation and draft

the specialist report relevant to the study. Blast Management & Consulting did not engage in any behaviour that could be result in a conflict of interest in undertaking this study.

iv. Legal Requirements

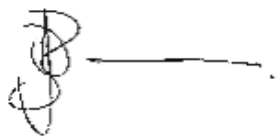
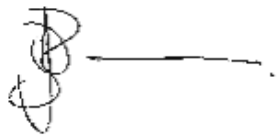
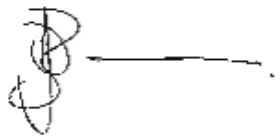
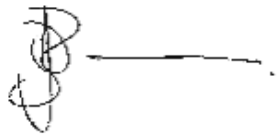
In terms of the NEMA 2014 EIA Regulations contained in GN R982 of 04 December 2014 all specialist studies must comply with Appendix 6 of the NEMA 2014 EIA Regulations (GN R982 of 04 December 2014). Table 1 show the requirements as indicated above.

Table 1: Legal Requirements for All Specialist Studies Conducted

GNR 326	Description	Section in the Report
Specialist Report		
Appendix 6 (a)	A specialist report prepared in terms of these Regulations must contain— details of— i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	Section i & Section 19
Appendix 6 (b)	A declaration that the specialist is independent in a form as may be specified by the competent authority;	Section vi
Appendix 6 (c)	An indication of the scope of, and the purpose for which, the report was prepared;	Section 3
Appendix 6 (cA)	An indication of the quality and age of base data used for the specialist report;	Section 4
Appendix 6 (cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 7
Appendix 6 (d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 6
Appendix 6 (e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 4
Appendix 6 (f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a, site plan identifying site alternatives;	Section 9, 10 & 11
Appendix 6 (g)	An identification of any areas to be avoided, including buffers;	Section 9
Appendix 6 (h)	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 9
Appendix 6 (i)	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 8
Appendix 6 (j)	A description of the findings and potential implications of such findings on the impact of the proposed activity **[including identified alternatives on the environment]** or activities;	Section 13, 14 and 15
Appendix 6 (k)	Any mitigation measures for inclusion in the EMPr;	Section 17.5
Appendix 6 (l)	Any conditions for inclusion in the environmental authorisation;	Section 16
Appendix 6 (m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 15
Appendix 6 (n)	A reasoned opinion— i. **[as to]** whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 18
Appendix 6 (o)	A description of any consultation process that was undertaken during the course of preparing the specialist report;	None
Appendix 6 (p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A

GNR 326	Description	Section in the Report
Appendix 6 (q)	Any other information requested by the competent authority.	None

v. Document Control:

Name & Company	Responsibility	Action	Date	Signature
C Zeeman Blast Management & Consulting	Document Preparation	Report Prepared	16/10/2018	
JD Zeeman Blast Management & Consulting	Consultant	Report Finalise	16/10/2018	
JD Zeeman Blast Management & Consulting	Consultant	Report Finalise & update on information	13/11/2018	
JD Zeeman Blast Management & Consulting	Consultant	Update of mapping for Powerline Alternative 2	6/03/2019	
JD Zeeman Blast Management & Consulting	Consultant	Update of mapping for Amended Powerline Route	9/04/2019	

vi. DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE: Blast and Vibration Assessment Report, Proposed Kalabasfontein Project

1. SPECIALIST INFORMATION

Specialist Company Name:	Blast Management & Consulting (PTY) Ltd			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	Level 2	Percentage Procurement recognition	125%
Specialist name:	Mr JD Zeeman			
Specialist Qualifications:	NHD Explosives Technology			
Professional affiliation/registration:	International Society of Explosives Engineers			
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2. DECLARATION BY THE SPECIALIST

I, JD Zeeman, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the Specialist:  _____

Name of Company: Blast Management & Consulting (PTY) Ltd

Date: 13/11/2018

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1 Executive Summary

The Kalabasfontein project area is situated in Mpumalanga, 20 kilometres north of Bethal and 20 kilometres east of Ga-Nala (Kriel). It is located to the east and south of the existing Forzando South 380MR and Forzando North 381MR respectively which fall within the Msukaligwa Local Municipality. The project area comprises two prospecting rights, 1035PR & 1170PR, which covers a total area of 1 547.8296ha over portions 7, 8, RE, 11 and 13 of the farm Kalabasfontein 232 IS. An additional ventilation shaft will also be required within the Forzando South mining area on either on Portion 7 or Portion 22 of the farm Uitgedacht 229 IS.

The Kalabasfontein project has an estimated LOM of 17 years with the project schedule and timeframe being based on the Forzando South equipment availabilities, efficiencies and both skilled and unskilled labour force. Mining in the Kalabasfontein project area is based on two Continuous Miner (CM) sections.

The access corridor to Kalabasfontein Reserves was identified during exploration drilling. Reserves will be mined through access from one of Forzando South Reserves block. This will eliminate intense preparation work of developing a new incline, as there will be infrastructure available at the face.

Currently, Forzando South mine is scheduled until 2037. However, the Kalabasfontein portion will be mined as soon as permission is granted, in order to ensure sustained production volumes and quantities from the 5 CM sections that are currently being mined. The mine will maintain its production rate of 2.2 Million tonnes (Mt) per annum. Commissioning of Kalabasfontein will not add to the production of Forzando South but will provide relocation areas for existing Forzando South sections. Since the Kalabasfontein project will be mined concurrently with Forzando South, production decline will be due to depletion of Reserves. In the second quarter of year 17 (2037), the first section will pull out and leave the one section to deplete the remaining Reserves.

As the Kalabasfontein project will use the existing Forzando South and Forzando North infrastructure, it is envisaged that additional infrastructure requirements will be minimal. Anticipated demand for water, power and the on-site infrastructure requirements is detailed in the mine works programme (MWP).

Bord and pillar mining using CM's was selected as the primary extraction method. In bord and pillar mining, parallel roads are developed in the development direction.

The Kalabasfontein Project was reviewed on impact assessment phase. Points of interest were identified for possible influence. Various installations were identified within close proximity of the

mining surface area. The possible influences and level of influence were investigated and based on the type of mining no specific negative influences on the surface areas were identified. The underground operation with mechanical mining is expected to have no significant influence on surface regarding ground vibration.

2 Introduction

Blast Management & Consulting was contracted as part of the Environmental Impact Assessment (EIA) team to perform an initial review of possible impacts with regards to blasting operations in the proposed Kalabasfontein Project. Blast Management & Consulting as a company concentrates on the monitoring, prediction, analysis, audit and consulting on all aspects of blasting operations. Specifically, are aspects such as ground vibration, air blast, fly rock, fumes and other influences evaluated.

3 Scope of Work

The following scope of work is suggested and reported.

- Introduction
- Legislative Requirements
- Existing Status
- Source And Receiving Environment
- Anticipated Impacts
- Influence From Blasting Operations
- Mining Method
- Impact Assessment
- Environmental Impact Assessment
- Mitigation Measures
- Recommendations

4 Methodology

The detailed plan of study consists of the following sections:

- Baseline influence: There are no blasting activities currently being done or no operations yet.
- Identifying surface structures/ installations that are found within reason from the project site. A list of Point of Interests (POI's) were created that will be used for the evaluation.
- Site evaluation: This entails an evaluation of the planned mining, drilling and blasting operations and the possible influences from the blasting operations. The possible environmental or social impacts were addressed in the detailed EIA phase investigation.

5 Legislative requirements

The following acts and guidelines contain references that will applicable to the study. There are currently no direct legislation with regards to ground vibration and air blast levels in South Africa. Aspects on control of blast impacts, vibration and air blast are not directly addressed in these acts

but are supporting documents to the process of evaluating the possible influences. The short fall of direct legislation is supported by international standards and other guidelines with experience.
The following acts and supporting detail is considered:

- 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 Blast Management & Consulting based on experienced and knowledge.

6 Existing Status

The Kalabasfontein project area is situated in Mpumalanga, 20 kilometres north of Bethal and 20 kilometres east of Ga-Nala (Kriel). It is located to the east and south of the existing Forzando South 380MR and Forzando North 381MR respectively which fall within the Msukaligwa Local Municipality. The project area comprises two prospecting rights, 1035PR & 1170PR, which covers a total area of 1 547.8296ha over portions 7, 8, RE, 11 and 13 of the farm Kalabasfontein 232 IS. An additional ventilation shaft will also be required within the Forzando South mining area on either on Portion 7 or Portion 22 of the farm Uitgedacht 229 IS.
Figure 1 shows the Locality map of Kalabasfontein project area and new Ventilation shafts localities.

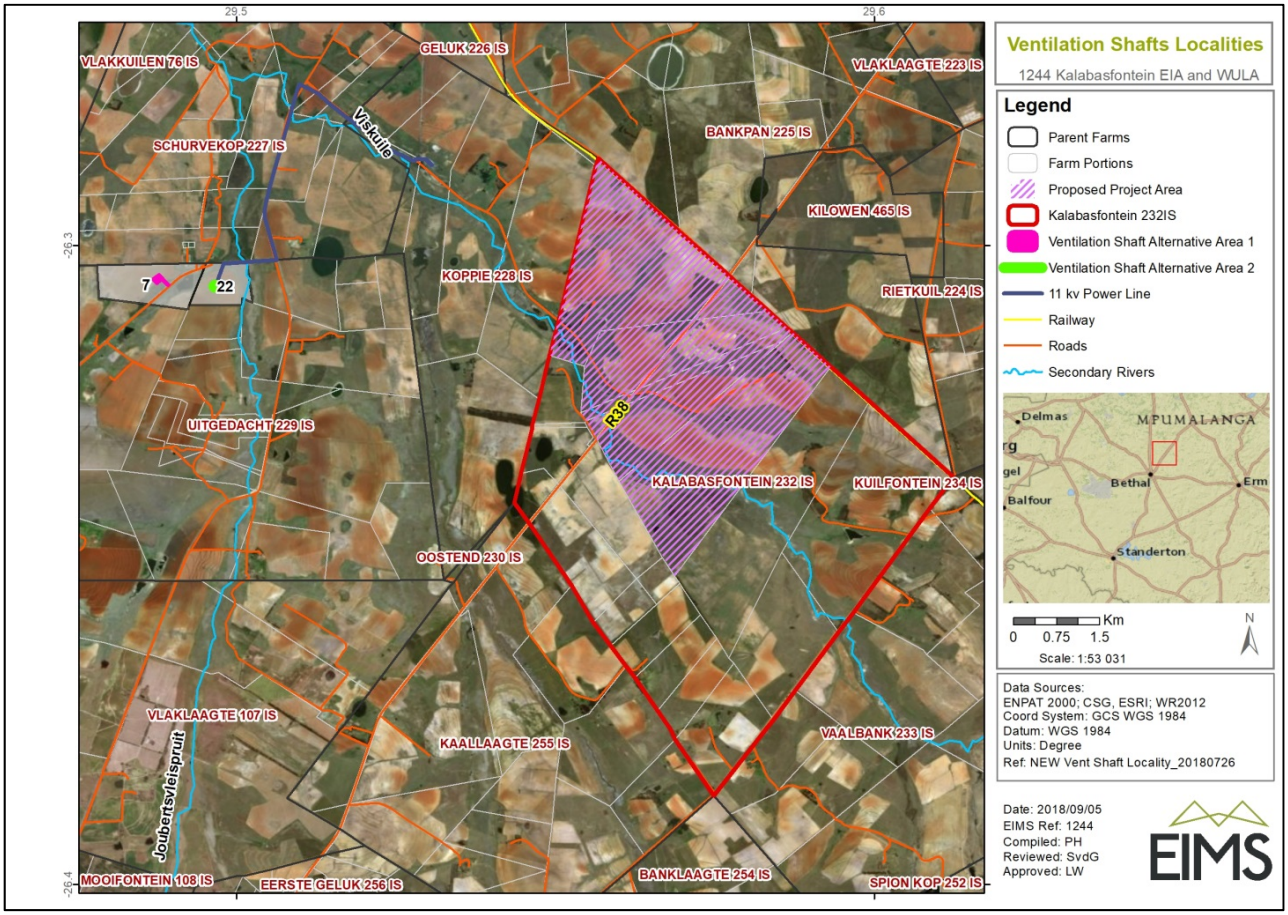

Figure 1: Locality map of Kalabasfontein project area and new Ventilation shafts localities

7 Site Investigation

The investigation and evaluation are not season specific. The operations are not season specific.

8 Assumptions and Limitations

The following assumptions have been made:

- The planned operation is underground and mechanical miners will be used. This leaves that no continuous drilling and blasting operations will be done.
- It is assumed that dykes and sills will be encountered and will require blasting. The frequency and occurrence are expected to be low and insignificant on the surface areas.
- The work done is based on the author's knowledge and information provided by the project applicant.

9 Source and Receiving Environment

The receiving environment is considered the area expected to be influenced directly adjacent to the Kalabasfontein Project Area. Figure 2 shows the location of the Kalabasfontein Project Area and the anticipated receiving environment around the mining area, indicated as the Study area.

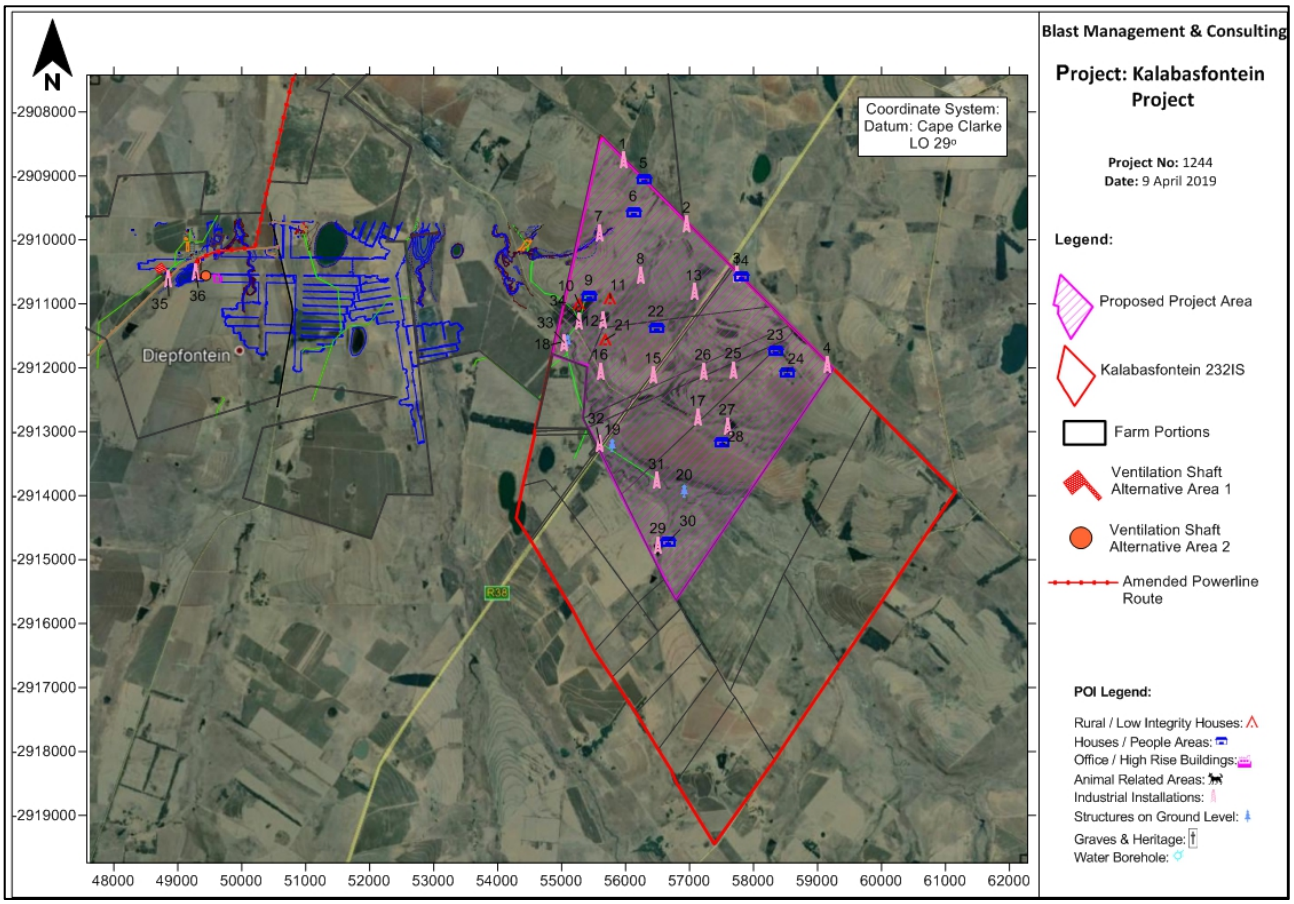

Figure 2: Study Area

10 Anticipated Impacts

In blasting operations, the primary objective is break rock, ore material or mineral in expected fragmented sizes that can be mechanically excavated or removed. The blasting operation has the potential to yield secondary effects such as ground vibration, air blast, fly rock and fumes. These aspects may have a negative impact on the surrounding areas depending on the levels generated.

The operation planned is an underground operation. There are no surface influences pertaining to air blast and fly rock associated with underground mining operations. Only ground vibration may be applicable if drilling and blast is done.

The typical potential impacts considered can be described as follows:

Ground vibration: Levels greater than recommended limits may be damaging to structures. Different structures will also have different permitted levels. Ground vibration may cause damage if levels exceed the structures safe limit. People may also experience ground vibration as perceptible at very low levels and normally react negatively to the experience of ground vibration.

Considering the possible impacts given above where blasting operations are to be done the level of anticipated impact needs to be defined. The level of impact will also give guideline to the level of mitigation or management of the impacts. Management of the impacts could include the following aspects as indicated in Table 2 below. Detail of management and mitigation will be discussed in the report where applicable:

Table 2: Anticipated impact and possible management

Anticipated Impact	Mitigation / Management
Ground Vibration	Blast Design.
	Reduce charge mass per delay,
	Change drilling configuration,
	Alternative blasting,
	Change initiation systems,

The objective is to outline the expected environmental effects when blasting operations are done and could have on the surrounding environment. The study investigates the related levels and possible influences of expected ground vibration on the area of 3500m[1] surrounding the blast areas.

In a blasting operations environment the receiving environment is classed into three areas. The areas are defined by the type of operation and the expected levels of influence generated. In an opencast environment the range of influence is expected to be rather large up to 3500 m primarily or in some cases even further. In an underground blasting environment, the possible influence is reduced significantly due to type and size of blasting conducted. This range of influence may extend to the immediate area above underground workings and a small distance around the underground area.

In an underground mining where blasting is done the following ranges may be applicable:

- Immediate surface area is considered the most critical. Due to Kalabasfontein being an underground mine only ground vibration will be considered. The levels of ground vibration will be very dependent on the drilling and blasting parameters applied.
- Lesser sensitive is the area adjacent to the underground operations and this may vary in range, but generally no more than 500 m[2]. In this case a 250 m boundary is considered.

[1] Determined by Blast Management & Consulting from Experience

[2] Estimated from experience by Blast Management & Consulting

This range is considered by Blast Management & Consulting as a range where influence may be less than damaging levels but still requires active monitoring.

- The lowest critical or low sensitivity area is the area beyond 500 m. In this area the effects are expected to be none.

Indicated in Figure 3 is the planned mining area and two locations identified as possible positions for the single vent shaft that is to be constructed. Various points of interest to be considered were identified and are also indicated in the figure. These points are locations of possible receptors.

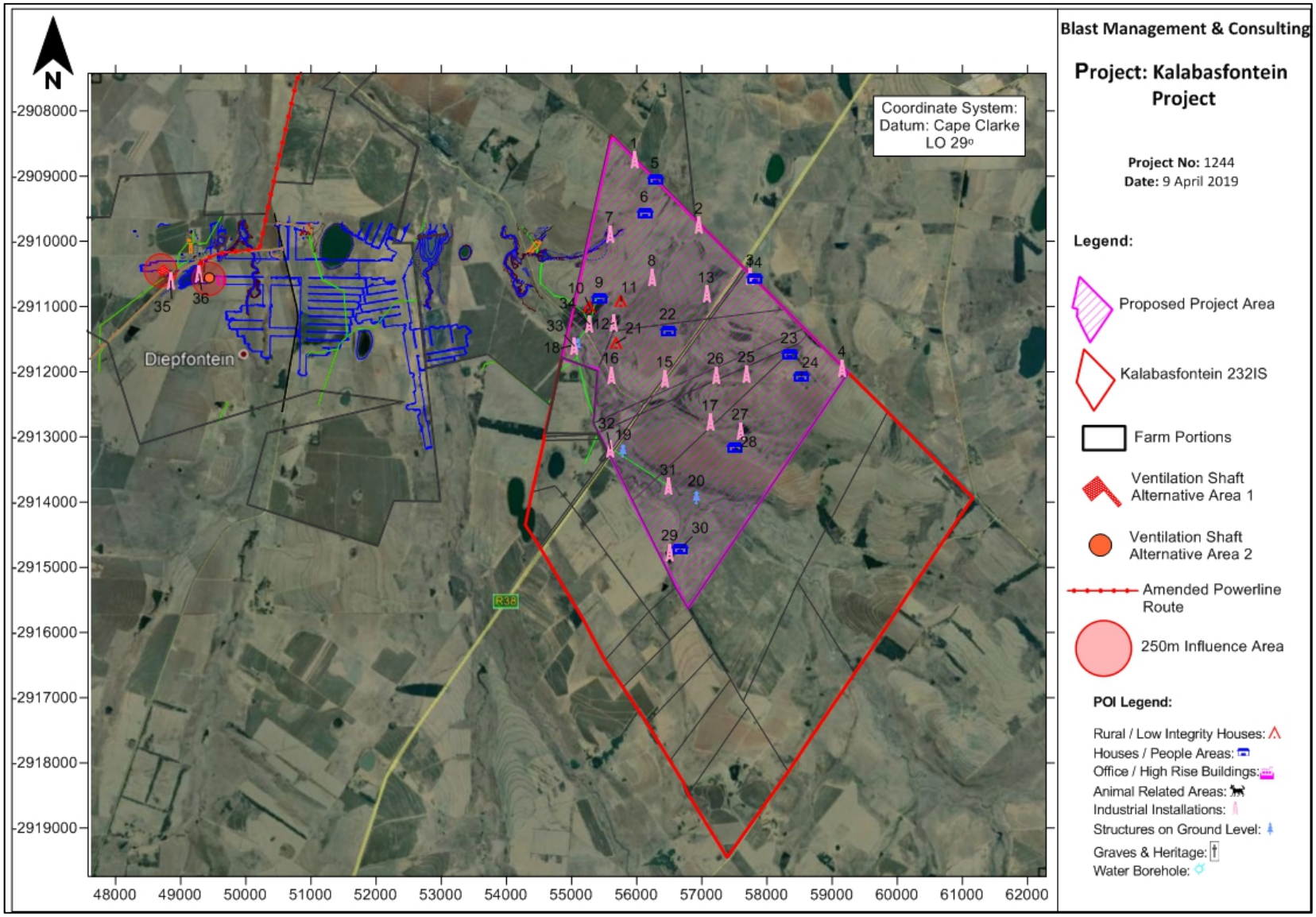

Figure 3: Study Area with POI and ranges from the project area

Table 3: Identified points of interest

Tag	Description	Y	X
1	Railway Line	-55962.36	2908752.25
2	Railway Line	-56958.50	2909750.78
3	Railway Line	-57748.56	2910541.39
4	Railway Line	-59160.17	2911946.55
5	Structure	-56286.89	2909054.24
6	Structure	-56121.85	2909572.35
7	Dam	-55587.50	2909888.17
8	Dam	-56239.00	2910550.67
9	Farm Buildings/Structures/Grain Silo's	-55429.27	2910885.33
10	Informal Housing	-55273.45	2911006.66
11	Informal Housing	-55762.81	2910915.16
12	Dam	-55651.52	2911253.34
13	Dam	-57072.95	2910810.82
14	Structure	-57809.29	2910580.80
15	R38 Road	-56430.80	2912107.91
16	Road	-55605.72	2912051.23
17	Road	-57128.82	2912775.85
18	Viskuile River	-55089.33	2911576.35
19	Viskuile River	-55796.60	2913201.68
20	Viskuile River	-56925.36	2913914.06
21	Informal Housing	-55681.71	2911561.56
22	Structure	-56483.50	2911375.11
23	Structures	-58345.07	2911742.09
24	Farm Buildings/Structures	-58524.01	2912067.98
25	Dam	-57687.67	2912031.43
26	Dam	-57216.83	2912052.04
27	Dam	-57595.72	2912913.77
28	Structures	-57508.95	2913163.98
29	Dam	-56510.06	2914767.96
30	Structures	-56664.27	2914719.42
31	Power lines/Pylons	-56493.77	2913762.97
32	Power lines/Pylons	-55595.36	2913179.71
33	Power lines/Pylons	-55042.37	2911603.98
34	Power lines/Pylons	-55279.48	2911269.82
35	Road	-48844.51	2910607.60
36	Dam	-49284.29	2910507.05

11 Influence from Blasting Operations

Blasting operations are required to break rock for excavation to access the targeted ore material. Explosives in blast holes provide the required energy to conduct the work. Ground vibration, air blast and fly rock result from the blasting process. Based on the regulations of the different acts consulted and international accepted standards these effects are required to be within certain

limits. The following sections provide guidelines on these limits. As indicated there are no specific South African ground vibration and air blast limit standards.

11.1 Ground Vibration Limitations on Structures

Ground vibration is measured in velocity with units of millimetres per second (mm/s). Ground vibration can also be reported in units of acceleration or displacement if required. Different types of structures have different tolerances to ground vibration. A steel structure or a concrete structure will have a higher resistance to vibrations than a well-built brick and mortar house. A brick and mortar house will be more resistant to vibrations than a poorly constructed or a traditional built mud house. Different limits are then applicable to the different types of structures. Limitations on ground vibration take the form of maximum allowable levels or intensity for different installations or structures. Ground vibration limits are also dependent on the frequency of the ground vibration. Frequency is the rate at which the vibration oscillates. Faster oscillation is synonymous with a higher frequency and lower oscillation is synonymous with a lower frequency. Lower frequencies are less acceptable than higher frequencies because structures have a low natural frequency. Significant ground vibration at low frequencies could cause increased structure vibrations due to the natural low frequency of the structure and this may lead to crack formation or damages to occur.

Currently, the United States Bureau of Mines (USBM) criteria for safe blasting are applied as the industry standard where private structures are of concern. Ground vibration amplitude and frequency is recorded and analysed. The data is then evaluated accordingly. The USBM graph is used for plotting of data and evaluating the data. Figure 4 below provides a graphic representation of the USBM analysis for safe ground vibration levels. The USBM graph is divided mainly into two parts. The red lines in the Figure 4 are the USBM criteria:

- Analysed data displayed in the bottom half of the graph shows safe ground vibration levels; and
- Analysed data displayed in the top half of the graph shows potentially unsafe ground vibration levels.

Added to the USBM graph is a blue line and green dotted line that represents 6 mm/s and 12.5 mm/s which are additional criteria that are used by BM&C. 6 mm/s is used for traditional built rural structures and 12.5 mm/s is used for structures that are considered being of lesser structural integrity than brick and mortar structures built according to building regulations.

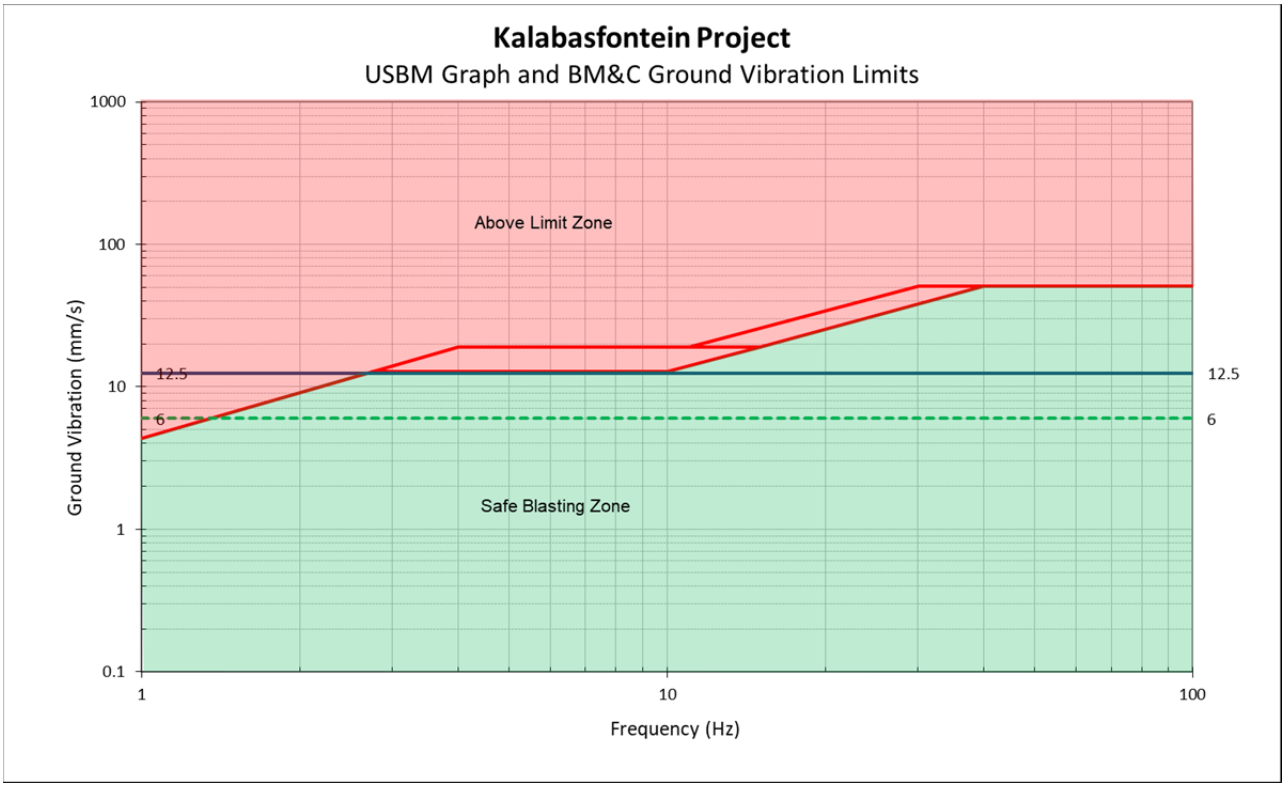

Figure 4: USBM Analysis Graph

Additional limitations that should be considered were determined through research and prescribed by the various institutions; these are as follows:

- National roads/tar roads: 150 mm/s
- Steel pipelines: 50 mm/s (Rand Water Board)
- Electrical lines: 75 mm/s (Eskom)
- Sasol Pipe Lines: 25 mms/s (Sasol)
- Railways: 150 mm/s
- Concrete less than 3 days old: 5 mm/s
- Concrete after 10 days: 200 mm/s
- Sensitive plant equipment: 12 mm/s or 25 mm/s, depending on type. (Some switches could trip at levels of less than 25 mm/s.)
- Water wells: 50 mm/s

Considering the above limitations, BM&C work is based on the following:

- USBM criteria for safe blasting.
- The additional limits provided above.
- Consideration of private structures in the area of influence.

- Should structures be in poor condition the basic limit of 25 mm/s is halved to 12.5 mm/s or when structures are in very poor condition limits will be restricted to 6 mm/s. It is a standard accepted method to reduce the limit allowed with poorer condition of structures.
- Traditional built mud houses are limited to 6 mm/s. The 6 mm/s limit is used due to unknowns on how these structures will react to blasting. There is also no specific scientific data available that would indicate otherwise.
- Input from other consultants in the field locally and internationally.

11.2 Ground Vibration Limitations and Human Perceptions

A further aspect of ground vibration and frequency of vibration that must be considered is human perceptions. It should be realized that the legal limit set for structures is significantly greater than the comfort zone of human beings. Humans and animals are sensitive to ground vibration and the vibration of structures. Research has shown that humans will respond to different levels of ground vibration at different frequencies.

Ground vibration is experienced at different levels; BM&C considers only the levels that are experienced as “Perceptible”, “Unpleasant” and “Intolerable”. This is indicative of the human being’s perceptions of ground vibration and clearly indicates that humans are sensitive to ground vibration and humans perceive ground vibration levels of 4.5 mm/s as unpleasant (See Figure 5). This guideline helps with managing ground vibration and the complaints that could be received due to blast induced ground vibration.
Indicated on Figure 5 is a blue solid line that indicates a ground vibration level of 12.5 mm/s and a green dotted line that indicates a ground vibration level of 6 mm/s. These are levels that are used in evaluation.

Generally, people also assume that any vibration of a structure - windows or roofs rattling - will cause damage to the structure. Air blast is one of the causes of vibration of a structure and is the cause of nine out of ten complaints.

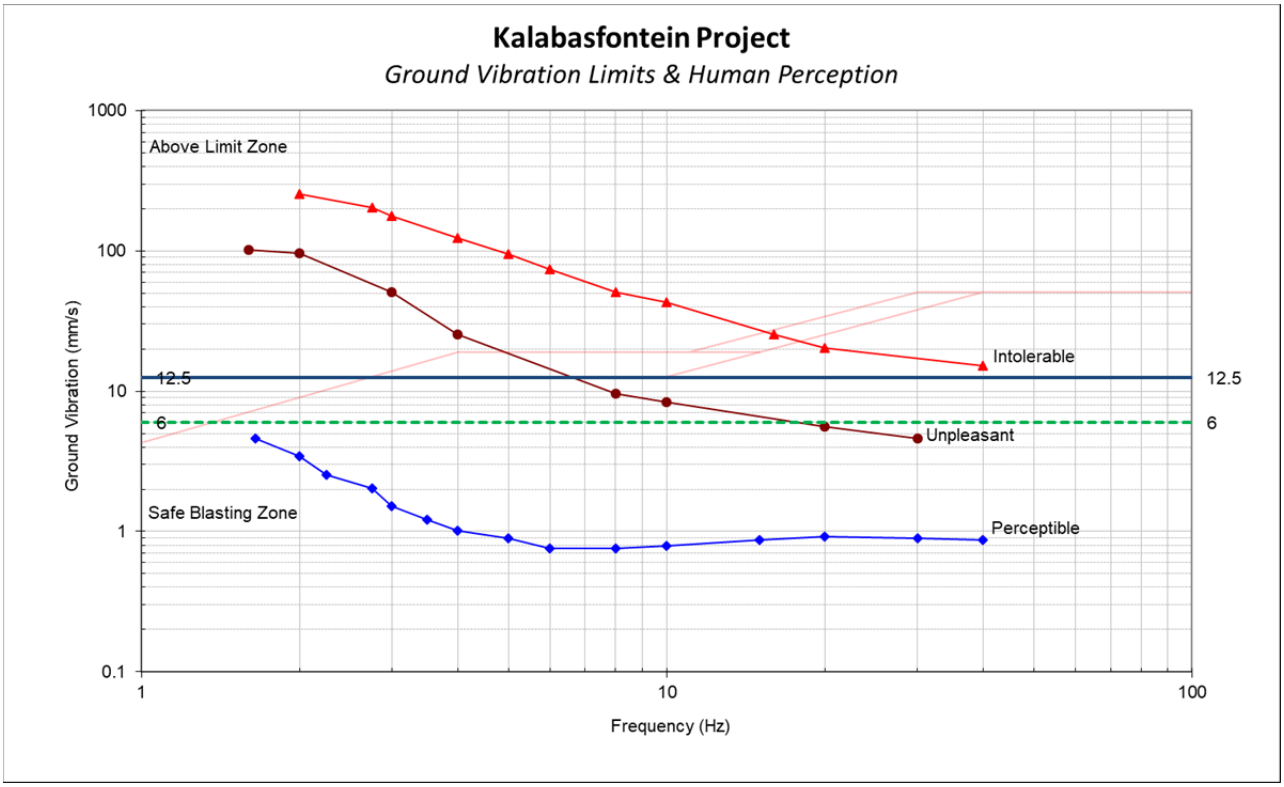

Figure 5: USBM Analysis with Human Perception

12 Mining Method

The Kalabasfontein project has an estimated LOM of 17 years with the project schedule and timeframe being based on the Forzando South equipment availabilities, efficiencies and both skilled and unskilled labour force. Mining in the Kalabasfontein project area is based on two Continuous Miner (CM) sections. As the Kalabasfontein project will use the existing Forzando South and Forzando North infrastructure, it is envisaged that additional infrastructure requirements will be minimal. Bord and pillar mining using CM's was selected as the primary extraction method.

The Kalabasfontein mine will be a non-drilling and blasting operation. The occurrence of dykes and sills are expected to be blasted but the frequency will be low. The exact locations and specific blasting required is unknown and not possible to define specific influence. Blasting is expected to be small with insignificant or no influence on surface.

13 Construction Phase Impact assessment

No blasting operations are anticipated as part of the construction phase. No specific impact is expected regarding ground vibration. The vent shaft will be a raise bore drilling operation, thus no blasting operations to be conducted.

14 Operational Phase Impact Assessment

During the operational phase the mine operations will be conducted mechanically. No drilling and blasting are anticipated as part of the operational phase. Mechanical continuous miners do not generate ground vibration levels of any significant level that could attribute to a measurable level on surface. The occurrence of dykes and sills are expected to be blasted but the frequency will be low. The exact locations and specific blasting required is unknown and not possible to define specific influence. Blasting is expected to be small with insignificant or no influence on surface. There will be no ground vibration generated that requires impact evaluation. No specific impact is expected regarding ground vibration on the surface areas.

15 Closure Phase Impact Assessment

During the closure phase no mining, drilling and blasting operations are expected. It is uncertain if any blasting will be done for demolition. If any demolition blasting will be required it will be reviewed as civil blasting and addressed accordingly.

16 Alternatives (Comparison and Recommendation)

No specific alternative mining methods are currently under discussion or considered for drilling and blasting.

17 Environmental Impact Assessment

The impact rating process is designed to provide a numerical rating of the various environmental impacts identified by use of the Input-Output model. As discussed above, it has to be stressed that the purpose of the EIA process is not to provide an incontrovertible rating of the significance of various aspects, but rather to provide a structured, traceable and defendable methodology of rating the relative significance of impacts in a specific context. This will give the project applicant a greater understanding of the impacts of his project and the issues which need to be addressed by mitigation. It will also give the regulators information on which to base their decisions.

Details of the impact assessment methodology used to determine the significance of physical, bio-physical and socio-economic impacts are provided below.

17.1 Method of Assessing Impacts

The impact assessment methodology is guided by the requirements of the NEMA EIA Regulations (2010). The broad approach to the significance rating methodology is to determine the environmental risk (ER) by considering the consequence (C) of each impact (comprising Nature,

Extent, Duration, Magnitude, and Reversibility) and relate this to the probability/likelihood (P) of the impact occurring. This determines the environmental risk. In addition other factors, including cumulative impacts, public concern, and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the ER to determine the overall significance (S).

17.2 Determination of Environmental Risk

The significance (S) of an impact is determined by applying a prioritisation factor (PF) to the environmental risk (ER).

The environmental risk is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and reversibility (R) applicable to the specific impact.

For the purpose of this methodology the consequence of the impact is represented by:

$$\boldsymbol{C = \frac{E + D + M + R}{4} \times N}$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in Table 4.

Table 4: Criteria for Determining Impact Consequence

Aspect	Score	Definition
Nature	- 1	Likely to result in a negative/ detrimental impact
	+1	Likely to result in a positive/ beneficial impact
Extent	1	Activity (i.e. limited to the area applicable to the specific activity)
	2	Site (i.e. within the development property boundary),
	3	Local (i.e. the area within 5 km of the site),
	4	Regional (i.e. extends between 5 and 50 km from the site
	5	Provincial / National (i.e. extends beyond 50 km from the site)
Duration	1	Immediate (<1 year)
	2	Short term (1-5 years),
	3	Medium term (6-15 years),
	4	Long term (the impact will cease after the operational life span of the project),
	5	Permanent (no mitigation measure of natural process will reduce the impact after construction).
Magnitude/ Intensity	1	Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes

Aspect	Score	Definition
		are not affected),
	2	Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected),
	3	Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way),
	4	High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease), or
	5	Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease).
Reversibility	1	Impact is reversible without any time and cost.
	2	Impact is reversible without incurring significant time and cost.
	3	Impact is reversible only by incurring significant time and cost.
	4	Impact is reversible only by incurring prohibitively high time and cost.
	5	Irreversible Impact

Once the C has been determined the ER is determined in accordance with the standard risk assessment relationship by multiplying the C and the P. Probability is rated/scored as per Table 5.

Table 5: Probability Scoring

Probability	1	Improbable (the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <25%),
	2	Low probability (there is a possibility that the impact will occur; >25% and <50%),
	3	Medium probability (the impact may occur; >50% and <75%),
	4	High probability (it is most likely that the impact will occur- > 75% probability), or
	5	Definite (the impact will occur),

The result is a qualitative representation of relative ER associated with the impact. ER is therefore calculated as follows:

$$\boldsymbol{ER = C\ x\ P}$$

Table 6: Determination of Environmental Risk

Consequence						
	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5
		Probability				

The outcome of the environmental risk assessment will result in a range of scores, ranging from 1 through to 25. These ER scores are then grouped into respective classes as described in Table 7.

Table 7: Significance Classes

Environmental Risk Score	
Value	**Description**
< 9	Low (i.e. where this impact is unlikely to be a significant environmental risk),
≥9; <17	Medium (i.e. where the impact could have a significant environmental risk),
≥ 17	High (i.e. where the impact will have a significant environmental risk).

The impact ER will be determined for each impact without relevant management and mitigation measures (pre-mitigation), as well as post implementation of relevant management and mitigation measures (post-mitigation). This allows for a prediction in the degree to which the impact can be managed/mitigated.

17.3 Impact Prioritisation:

In accordance with the requirements of Regulation 31 (2)(l) of the EIA Regulations (GNR 543), and further to the assessment criteria presented in the Section above it is necessary to assess each potentially significant impact in terms of:

- Cumulative impacts; and
- The degree to which the impact may cause irreplaceable loss of resources.

In addition it is important that the public opinion and sentiment regarding a prospective development and consequent potential impacts is considered in the decision making process.

In an effort to ensure that these factors are considered, an impact prioritisation factor (PF) will be applied to each impact ER (post-mitigation). This prioritisation factor does not aim to detract from

the risk ratings but rather to focus the attention of the decision-making authority on the higher priority/significance issues and impacts. The PF will be applied to the ER score based on the assumption that relevant suggested management/mitigation impacts are implemented.

Table 8: Criteria for Determining Prioritisation

Public response (PR)	Low (1)	Issue not raised in public response.
	Medium (2)	Issue has received a meaningful and justifiable public response.
	High (3)	Issue has received an intense meaningful and justifiable public response.
Cumulative Impact (CI)	Low (1)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.
	Medium (2)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.
	High (3)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change.
Irreplaceable loss of resources (LR)	Low (1)	Where the impact is unlikely to result in irreplaceable loss of resources.
	Medium (2)	Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.
	High (3)	Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criteria represented in Table 8. The impact priority is therefore determined as follows:

$$\boldsymbol{Priority = PR + CI + LR}$$

The result is a priority score which ranges from 3 to 9 and a consequent PF ranging from 1 to 2 (Refer to Table 9).

Table 9: Determination of Prioritisation Factor

Priority	Ranking	Prioritisation Factor
3	Low	1
4	Medium	1.17
5	Medium	1.33
6	Medium	1.5
7	Medium	1.67
8	Medium	1.83
9	High	2

In order to determine the final impact significance the PF is multiplied by the ER of the post mitigation scoring. The ultimate aim of the PF is to be able to increase the post mitigation environmental risk rating by a full ranking class, if all the priority attributes are high (i.e. if an impact comes out with a medium environmental risk after the conventional impact rating, but there is significant cumulative impact potential, significant public response, and significant potential for irreplaceable loss of resources, then the net result would be to upscale the impact to a high significance).

Table 10: Final Environmental Significance Rating

Environmental Significance Rating	
Value	**Description**
< 10	Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
≥10 <20	Medium (i.e. where the impact could influence the decision to develop in the area),
≥ 20	High (i.e. where the impact must have an influence on the decision process to develop in the area).

17.4 Assessment Outcomes:

Table 11: Risk Assessment Outcome for Aspect "A"

A. Ground vibration Impact on houses -	
Impact Name	**Ground vibration Impact on houses**
Alternative	**0**
Phase	**Operation**

Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	1	1
Extent of Impact	2	2	Reversibility of Impact	1	1
Duration of Impact	4	4	Probability	2	2
Environmental Risk (Pre-mitigation)					-4.00
Mitigation Measures					
None Required					
Environmental Risk (Post-mitigation)					-4.00
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikley that the impact will result in spatial and temporal cummulative change.					
Degree of potential irreplaceable loss of resources					3
The impact may result in the irreplacable loss of resources of high value (services and/or functions).					
Prioritisation Factor					1.33
Final Significance					-5.33

Table 12: Risk Assessment Outcome for Aspect "B"

B. Ground vibration impact on Eskom, Railway, Roads and other surface infrastructure -

Impact Name	**Ground vibration impact on Eskom, Railway, Roads and other surface infrastructure**				
Alternative	**0**				
Phase	**Operation**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	1	1
Extent of Impact	2	2	Reversibility of Impact	1	1
Duration of Impact	4	4	Probability	2	2
Environmental Risk (Pre-mitigation)					-4.00
Mitigation Measures					
None Required					
Environmental Risk (Post-mitigation)					-4.00
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikley that the impact will result in spatial and temporal cummulative change.					
Degree of potential irreplaceable loss of resources					1
The impact is unlikely to result in irreplaceable loss of resources.					

Prioritisation Factor	1.00
Final Significance	-4.00

Table 13: Risk Assessment Outcome for Aspect "C"

C. Air blast Impact on surface infrastructure -					
Impact Name	**Air blast Impact on surface infrastructure**				
Alternative	**0**				
Phase	**Operation**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	1	1
Extent of Impact	2	2	Reversibility of Impact	1	1
Duration of Impact	4	4	Probability	1	1
Environmental Risk (Pre-mitigation)					-2.00
Mitigation Measures					
None Required					
Environmental Risk (Post-mitigation)					-2.00
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikley that the impact will result in spatial and temporal cummulative change.					
Degree of potential irreplaceable loss of resources					3
The impact may result in the irreplacable loss of resources of high value (services and/or functions).					
Prioritisation Factor					1.33
Final Significance					-2.67

Table 14: Risk Assessment Outcome for Aspect "D"

D. Fly rock impact on surface infrastructure -					
Impact Name	**Fly rock impact on surface infrastructure**				
Alternative	**0**				
Phase	**Operation**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	1	1
Extent of Impact	2	2	Reversibility of Impact	1	1
Duration of Impact	4	4	Probability	1	1
Environmental Risk (Pre-mitigation)					-2.00
Mitigation Measures					
None Required					

Environmental Risk (Post-mitigation)	-2.00
Degree of confidence in impact prediction:	High
Impact Prioritisation	
Public Response	1
Low: Issue not raised in public responses	
Cumulative Impacts	1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikley that the impact will result in spatial and temporal cummulative change.	
Degree of potential irreplaceable loss of resources	2
The impact may result in the irreplaceable loss (cannot be replaced or subsitituted) of resources but the value (services and/or functions) of these resources is limited.	
Prioritisation Factor	1.17
Final Significance	-2.33

Table 15: Risk Assessment Outcome for Aspect "E"

E. Vibration from drilling on raise bore for vent shafts -					
Impact Name	**Vibration from drilling on raise bore for vent shafs**				
Alternative	**0**				
Phase	**Construction**				
Environmental Risk					
Attribute	**Pre-mitigation**	**Post-mitigation**	**Attribute**	**Pre-mitigation**	**Post-mitigation**
Nature of Impact	-1	-1	Magnitude of Impact	1	1
Extent of Impact	2	2	Reversibility of Impact	1	1
Duration of Impact	2	2	Probability	1	1
Environmental Risk (Pre-mitigation)					-1.50
Mitigation Measures					
None Required					
Environmental Risk (Post-mitigation)					-1.50
Degree of confidence in impact prediction:					High
Impact Prioritisation					
Public Response					1
Low: Issue not raised in public responses					
Cumulative Impacts					1
Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikley that the impact will result in spatial and temporal cummulative change.					
Degree of potential irreplaceable loss of resources					3
The impact may result in the irreplacable loss of resources of high value (services and/or functions).					
Prioritisation Factor					1.33
Final Significance					-2.00

17.5 Mitigation Measures

No mitigation measures are required.

15 Monitoring

No specific monitoring is required for ground vibration.

16 Recommendations

No additional recommendations can be made.

17 Knowledge Gaps

The data provided by the project applicant and information gathered was sufficient to conduct this study. Surface surroundings change continuously and this should be considered. This report may need to be reviewed and updated if necessary. This report is based on data provided and internationally accepted methods and methodology used for calculations and predictions where applicable

18 Project opinion

In view of the evaluation and planned operations there is no significant influence expected on surface from the planned project. There is no reason to believe that the project will have a negative influence for the aspects evaluated. There is no reason to believe that the project cannot continue based on the aspects evaluated.

18 Conclusion

The Kalabasfontein Project was reviewed on impact assessment phase. Points of interest were identified for possible influence. Various installations were identified within close proximity of the mining surface area. The possible influences and level of influence were investigated and based on the type of mining no specific negative influences on the surface areas were identified. The underground operation with mechanical mining is expected to have no significant influence on surface regarding ground vibration.

19 Curriculum Vitae of Author

J D Zeeman was a member of the Permanent Force - SA Ammunition Core for period January 1983 to January 1990. During this period, work involved testing at SANDF Ammunition Depots and

Proofing ranges. Work entailed munitions maintenance, proofing and lot acceptance of ammunition.
From July 1992 to December 1995, Mr Zeeman worked at AECI Explosives Ltd. Initial work involved testing science on small scale laboratory work and large-scale field work. Later, work entailed managing various testing facilities and testing projects. Due to restructuring of the Technical Department, Mr Zeeman was retrenched but fortunately was able to take up an appointment with AECI Explosives Ltd.'s Pumpable Emulsion Explosives Group for underground applications.
From December 1995 to June 1997 Mr Zeeman provided technical support to the Underground Bulk Systems Technology business unit and performed project management on new products.
Mr Zeeman started Blast Management & Consulting in June 1997. The main areas of focus are Pre-blast monitoring, Insitu monitoring, Post-blast monitoring and specialized projects.

Mr Zeeman holds the following qualifications:

1985 - 1987	Diploma: Explosives Technology, Technikon Pretoria
1990 - 1992	BA Degree, University of Pretoria
1994	National Higher Diploma: Explosives Technology, Technikon Pretoria
1997	Project Management Certificate: Damelin College
2000	Advanced Certificate in Blasting, Technikon SA

Member: International Society of Explosives Engineers

Blast Management & Consulting has been active in the mining industry since 1997, with work being done at various levels for all the major mining companies in South Africa. Some of the projects in which BM&C has been involved include:
Iso-Seismic Surveys for Kriel Colliery in conjunction with Bauer & Crosby Pty Ltd.; Iso-Seismic surveys for Impala Platinum Limited; Iso-Seismic surveys for Kromdraai Opencast Mine; Photographic Surveys for Kriel Colliery; Photographic Surveys for Goedehoop Colliery; Photographic Surveys for Aquarius Kroondal Platinum – Klipfontein Village; Photographic Surveys for Aquarius – Everest South Project; Photographic Surveys for Kromdraai Opencast Mine; Photographic inspections for various other companies, including Landau Colliery, Platinum Joint Venture – three mini-pit areas; Continuous ground vibration and air blast monitoring for various coal mines; Full auditing and control with consultation on blast preparation, blasting and resultant effects for clients, e.g. Anglo Platinum Ltd, Kroondal Platinum Mine, Lonmin Platinum, Blast Monitoring Platinum Joint Venture – New Rustenburg N4 road; Monitoring of ground vibration induced on surface in underground mining environment; Monitoring and management of blasting in close relation to water pipelines in opencast mining environment; Specialized testing of explosives characteristics; Supply and service of seismographs and VOD measurement equipment and accessories; Assistance in protection of ancient mining works for Rhino Minerals (Pty) Ltd.; Planning, design, auditing and monitoring of blasting in new quarry on new road project, Sterkspruit, with Africon, B&E International and Group 5 Roads; Structure Inspections and

Reporting for Lonmin Platinum Mine Limpopo Pandora Joint Venture 180 houses – whole village; Structure Inspections and Reporting for Lonmin Platinum Mine Limpopo Section - 1000 houses / structures.

BM&C have installed a world class calibration facility for seismographs, which is accredited by Instantel, Ontario Canada as an accredited Instantel facility. The projects listed above are only part of the capability and professional work that is done by BM&C.

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