Proposed Sebilo Manganese Mine

Blasting Specialist Impact Assessment Study

April 2012

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Declaration by Authors

I, Claude Victor Bruce Cunningham, am the sole author of this report.

I have no have commercial interest in the operations of Sebilo. My only interest is in fair reward for time and expertise in compiling the report.

I am qualified as a Mining Engineer, but my expertise in the field of blasting impact on the environment arises principally from my training and experience gained as an Explosives Engineer, during employment in a technical role with African Explosives Limited (AEL) between 1974 and 2006, and since then as an independent consultant. I am an Adjunct Professor at the School of Mining, University of the Witwatersrand.

During employment with AEL I was frequently involved in blast designs to prevent either damage to various structures or disturbance to the public. This required that I was familiar with the authorities, the knowledge base and technologies related to avoiding damage from blasting, as well as potential environmental impact resulting from pollution.

The material for the compilation of this urgent preliminary report was forwarded to me by Jon Buckley: I have not visited the proposed mining site.

Executive Summary

The mine site is exceptionally isolated and devoid of public structures. Vibration and Airblast from blasting are therefore of minimal concern, but standards have been raised in the event that they become relevant

With the blast configuration envisaged (which can be improved), vibration levels of 12mm/s or above will be contained within a 500m radius of blasting, providing the timing is according to the laid down method. Airblast is dependent on the length and efficacy of stemming, and must be addressed by appropriate measures if it becomes an issue.

There is no reason to believe that cattle will be adversely affected by the blasting,

The following standards should be observed:

Flyrock: less than 500m from blast site (will be contained by measures to containAairblast).

Airblast: less than 128dB at inhabited structures.

Vibration: Less than 50mm/s at structures controlled by mine, less than 12 mm/s at structures of independent residents.

Any structures within 1 km should be visited with a view to determining whether an intervention is needed to pre-empt claims of damage. Such intervention would consist of communication combined with monitoring by seismograph.

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1. INTRODUCTION

On 11 April 2011 I was commissioned by Jon Buckley to provide an assessment of potential impact from blasting at the Sebilo mine.

1.1 Objectives

The Environmental consultant, Irene Lea, requested the following.

1. Develop conceptual blast design for a small open pit
2. Determine the likely noise and vibration levels associated with the air blast.
3. Determine the likely ground vibration levels associated with blasting.
4. Determine the radius of influence of blasting around the pit. This can be indicated as a line around the pit at the distance where the impacts of blasting are expected to be negligible.
5. Identify possible sensitive receptors within zone of influence of blasting, including the cattle on the farm Perth.
6. Identify the impacts that blasting may have on these sensitive receptors.
7. Develop a Blasting Standard Operating Procedure to be implemented at the operations, that will minimise the impacts associated with blasting.

1.2 Approach

Owing to the preliminary but urgent nature of the report, analysis is based on the following resources:

1. Map of Perth Mine layout, with surface installations and annual production zones (Figure 1)
2. Google Earth projection of the area showing the roads and current old workings (Figure 2)
3. An estimate of the mining/ blasting production design

The basic blast design is appropriate to the project, and has been taken as the basis for evaluating the vibration and Airblast impact on the area. This only required that assumptions be made in terms of the timing of the blasting.

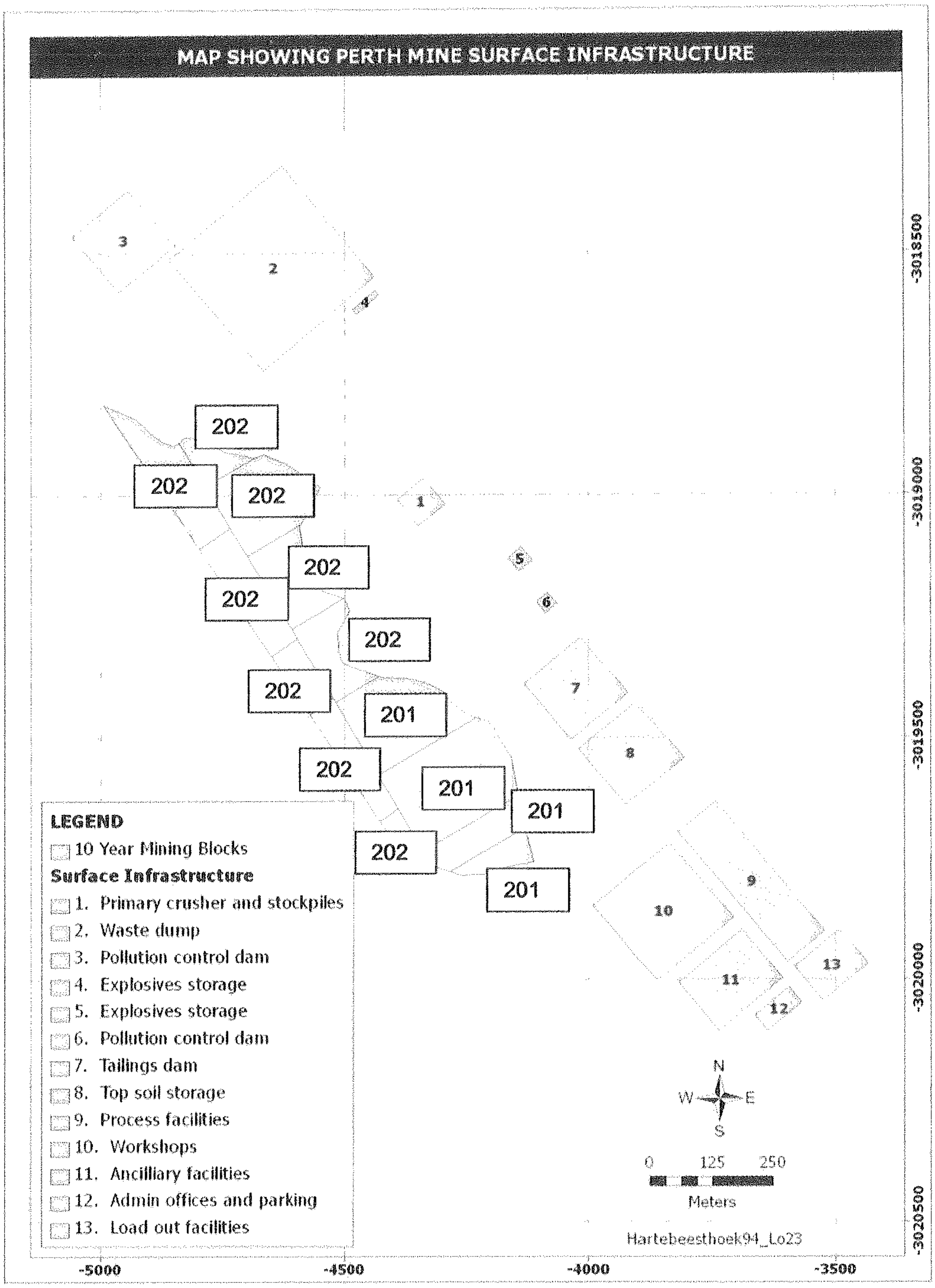


Figure 1: Mining Layout - production source from 2016 to 2026 indicated

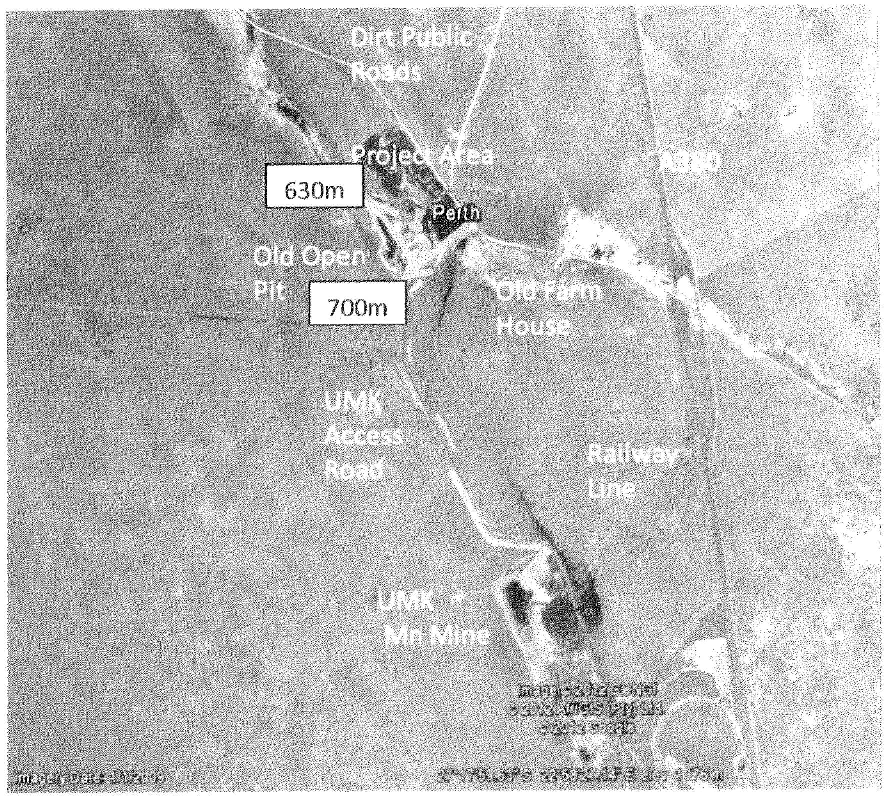


Figure 2: Area surrounding project, with arrows indicating dimensions around old pit

2. BLAST DESIGN

Table 1 shows the fundamental blast design assumed for this exercise. It is a worst case scenario, so while one can question some aspects, the purpose of the report is environmental aspects, so does not need to be altered at this stage.

Table 1: Blast Design Parameters

Parameter	Units	Ore	Waste
Bench height	m	5	12
Hole diameter	mm	165	165
Spacing	m	4	4
Burden	m	4	4
Sub drill	m	1	1.5
Hole depth	m	6	13.5
Explosive density	g/cm^3	1.25	
Explosive mass/metre	kg/m	26.73	26.73
Stemming length	m	3	3
Mass per hole	kg	80.19	280.67
Powder Factor	kg/m^3	1.00	1.46
PRODUCTION			
Penetration rate	m/hr	20	20
Avg penetration rate	m/min	0.33	0.33
Time per hole	min	18.2	40.9
In-situ SG	t/m^3	3.7	3.7
t/hole		296	710.4
t/min drilled		16.26	17.37
t/hr drilled		975.6	1,042.2
Working hours		12	12
t/day drilled		11,707	12,506
t required per day		1,678	10,506
Days production		14	14
On floor		23,492	147,084
Drilling days		2.01	11.76
NoHoles		79	207
No Rows		4	5
No lines		20	40
Explosives per blast	kg	6,361	58,090
Frequency	days	14	7

Arising from the table, one can plot the expected vibration levels around the pit, if the number of holes firing in any one instant are controlled.

Table 1 indicates the number of holes, rows and lines of holes to be blasted, and with this configuration, a typical blast timing layout has been assumed, using 25ms delays along the face, with 42ms delays, tied obliquely, to generate 67ms between rows, and starting from the centre of the face. Figure 3 shows the number of holes that can be estimated to be firing within the 8ms window counted to be additive for explosive mass firing per instant.

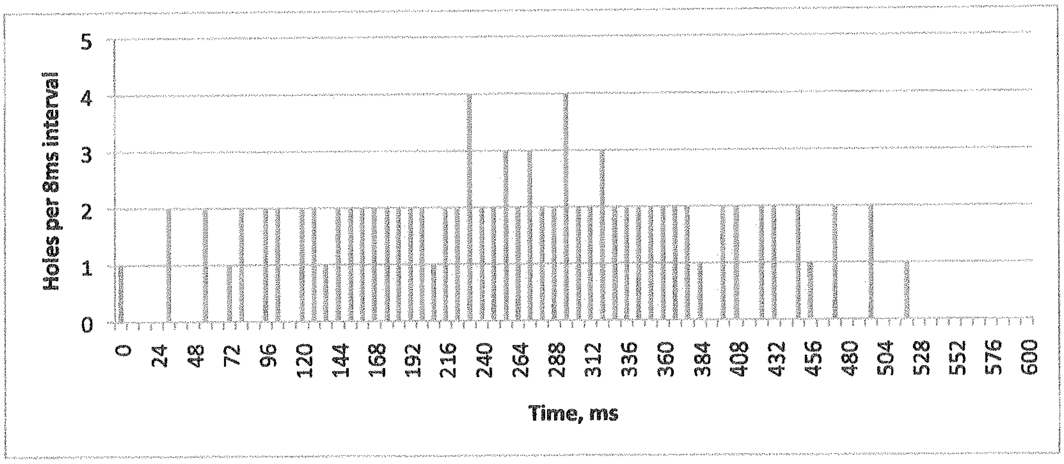


Figure 3: Holes firing per 8ms interval based on submitted blast design

The worst-case situation here is four holes per delay, so this is applied to the explosive charge per hole.

The equation used for vibration prediction is Equation 1, commonly used in South Africa, originally derived from the du Pont explosives handbook in the USA. Many other similar equations exist, and it is only possible to make any correction once blasting commences under the regime of this equation, by measuring actual, statistically valid measurements, and fitting modified curves for different parts of the pit.

⍰'=1143*⍰⍰.05−1.65 (Eq 1)

Where

V' = Predicted PPV, mm/s

D = Distance from blast, m

E = charge mass per delay period, within 8ms of any other shot, kg

Applying Equation 1 to the expected charge masses from the blast designs, figure 4 shows the anticipated vibration levels at various distances from the blasting site.

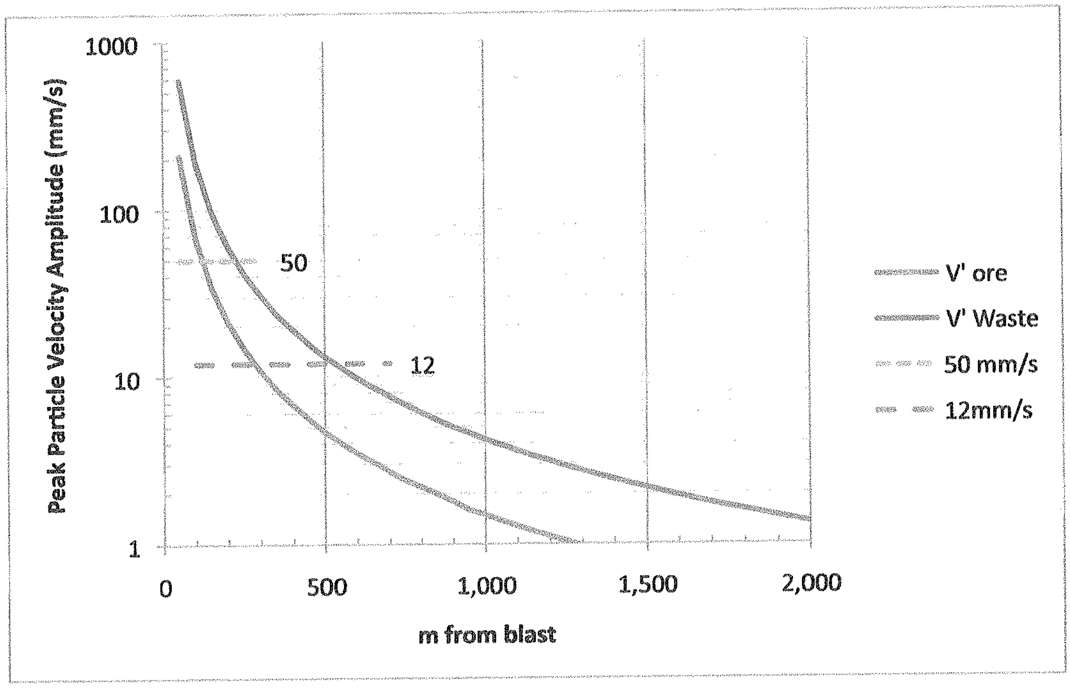


Figure 4: Calculated vibration amplitude for ore and waste

Figure 4 can be used to estimate the radii around the pit at which various vibration levels might be expected.

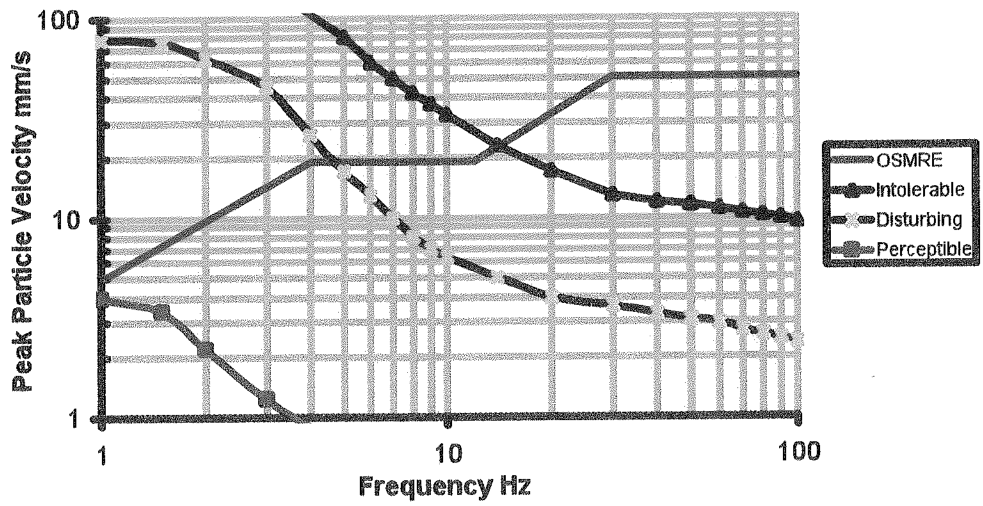
3. VIBRATION CRITERIA

As indicated, PPV (Peak Particle Velocity) is the parameter of choice for limiting blasting vibration. It is registered using specially configured and calibrated Blasting Seismographs which adhere to internationally accepted standards for recording blasting events.

There are no legislated criteria of vibration in South Africa, and the criteria used by various authorities tend to be corrupted by successive waves of arbitrary cuts in previous criteria, "to be on the safe side". If this process had been followed on the roads, we'd be restricted to 60 km/h on the motorways and 20 km/h in the towns. The setting of criteria therefore tends to be a political rather than a technical issue.

The frequency of the signal affects the likelihood of damage, and the US Office of Surface Mining and Reclamation Enforcement (OSMRE) works to a well-known "Z" curve, represented in figure 5.

OSMRE Ground Vibration and Criteria and Human Response



This curve was developed from research where US homes built with timber lath and plaster board (particularly vulnerable to cracking) were involved.

The Human response curves are based on research into the reaction of persons subjected to lengthy periods of vibration at different frequencies. For periods of less than a second, the response was much reduced. The time of day, ambient noise conditions and temperament of the people play a large role in these outcomes.

However, a PPV of 50mm/s has always been recognized as below the threshold at which cracking might be expected in brick buildings in reasonable repair, and 12 mm/s is recognized as being tolerable to people. These criteria are therefore indicated in figure 3, and indicate that for Waste blasts, which create the most disturbance, the vibration will be below 12mm/s at 500m beyond the blast boundaries.

Since few of the blasts will be at the final limits, this means that vibration levels will normally be far below the 12mm/s criterion. The old farmhouse is about 350m from the edge of the old pit, but is for the use as mine offices and later to be abandoned, so is not of concern.

In the case of cattle, the experience of the other mines in the area bear witness that this is really not an issue, any more than thunderstorms.

3.1 Airblast Criterion

In terms of Airblast, Table 2 shows the likely reactions from given Airblast levels. It is important to note that that cloud cover could concentrate sound downwards, so it is important to use good cover when blasting, as discussed in section 3. The decibel levels are for seismograph units having a lower frequency response of -3dB at 0.1Hz. The limit for any new public structures that might be built should be 128 dB. For other structures, 134 dB will be safe, but disturbing.

It is apposite to point out that the decibel scale is logarithmic, and that exceeding the limit is more serious than it might appear. Figure 6 shows that although a decibel level of 133 dB may not seem high, at 90 Pa it is almost double the pressure of 50 Pa (128 dB) limit. Increases above this multiply similarly.

Table 2: Human and structural response to concussion (airblast)

Level	Description
100 dB (2.0 Pa)	Scarcely noticeable
110 dB (6.3 Pa)	Rattling of loose windows/doors/ceiling panels
128 dB (50.2 Pa)	Public concern due to sudden and unexpected nature. May cause dogs to bark and disturb domestic animals
134 dB (100.2 Pa)	Good Highveld thunderstorm. Poorly mounted wall pictures, rattling of objects on shelves/display units, potential for these to fall.
170 dB (6300 Pa)	Will break well mounted windows, note not individual frames

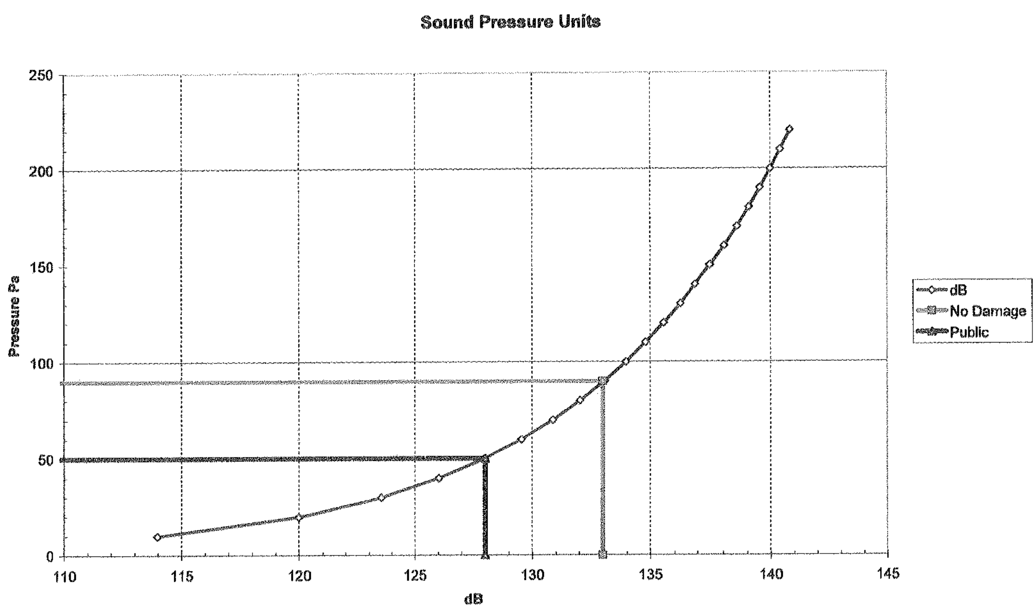


Figure 6: Airblast Units, showing pressures at dB limits.

The key to controlling Airblast is cover and control of charge height in the holes, and avoiding of secondary blasting. There is no dependable way of predicting Airblast from covered blasts, as it can be very quiet even very close up. It is therefore important to keep seismograph records with blasting records so that if the need arises, problems can be diagnosed and contained.

4. BLASTING STANDARD OPERATING PROCEDURE

The site is so remote that vibration and airblast concerns would seem only to apply to the premises of the mining operation, and really do not fall into this report.

The following remarks are relevant purely to environmental concerns which might arise, and are in addition to the normal mandatory steps required by law for safety.

1. Prior to any blast, a survey should be conducted to determine all properties within 500m of any part of the blast. The condition of these properties needs to be recorded and signed off by any persons who might later claim against blasting damage. Such persons should be warned of the blasting time and any concerns discussed.
2. If there are any structures within 1000m, discussions should be held to ascertain whether there might be any claims arising from blasting. Vibration/ Airblast readings should be undertaken in order to support such discussions. If it is apparent that monitoring will be wise, two seismographs should be operated at the mine by persons competent to do so, both so that there is a backup if one instrument is down, but also that more than one place can be monitored for each blast.
3. The location of the seismographs must be accurately recorded, and the fixation of the sensors in the ground or to structures must be appropriate to the conditions and expected vibration amplitude. Fixation method must be recorded.
4. Blasting records indicating the exact location of every blasthole, and the explosive mass delivered into it, as well as the timing layout, must be archived together with complete seismograph records (i.e. raw data files and printouts of vibration traces).

5. CONCLUSION

This report is intended as an initial assessment of the risks posed by blasting to the area. From the isolated nature of the mine and the medium scale of operations, there does not appear to be any obvious environmental threat. A radius of 500m around any blast zone will define vibrations of 12mm/s, which is well below any threat of damage, while 50mm/s is a realistic criterion for avoiding cracking to brick structures.

If any public /civil structures should become apparent, the airblast levels should be kept below 128 dB.

Air Quality Impact Assessment for the Sebilo Perth Manganese Mine

A Report for: Sebilo Resources (Pty) Ltd

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1 INTRODUCTION

1.1 Background

SSI Environmental was requested by Sebilo Resources (Pty) Ltd (Sebilo) to carry out an air quality impact assessment for a proposed Manganese mine and near the town of Hotazel in the Northern Cape Province (Figure 1). The project developed as a result of prospecting rights being obtained by Sebilo Resources (Pty) Ltd to assess the resource on the farm Perth 276 in the Kuruman District. The expected life of mine is approximately 13 years, in which time Manganese Ore will be produced both from open cast mining, as well as underground operations.

1.2 Scope of Work

This project aims to identify the potential air quality impacts associated with the construction, operation and eventual decommissioning of the proposed mine, and associated infrastructure, as well as provide guidance on possible mitigation measures to reduce environmental impacts.

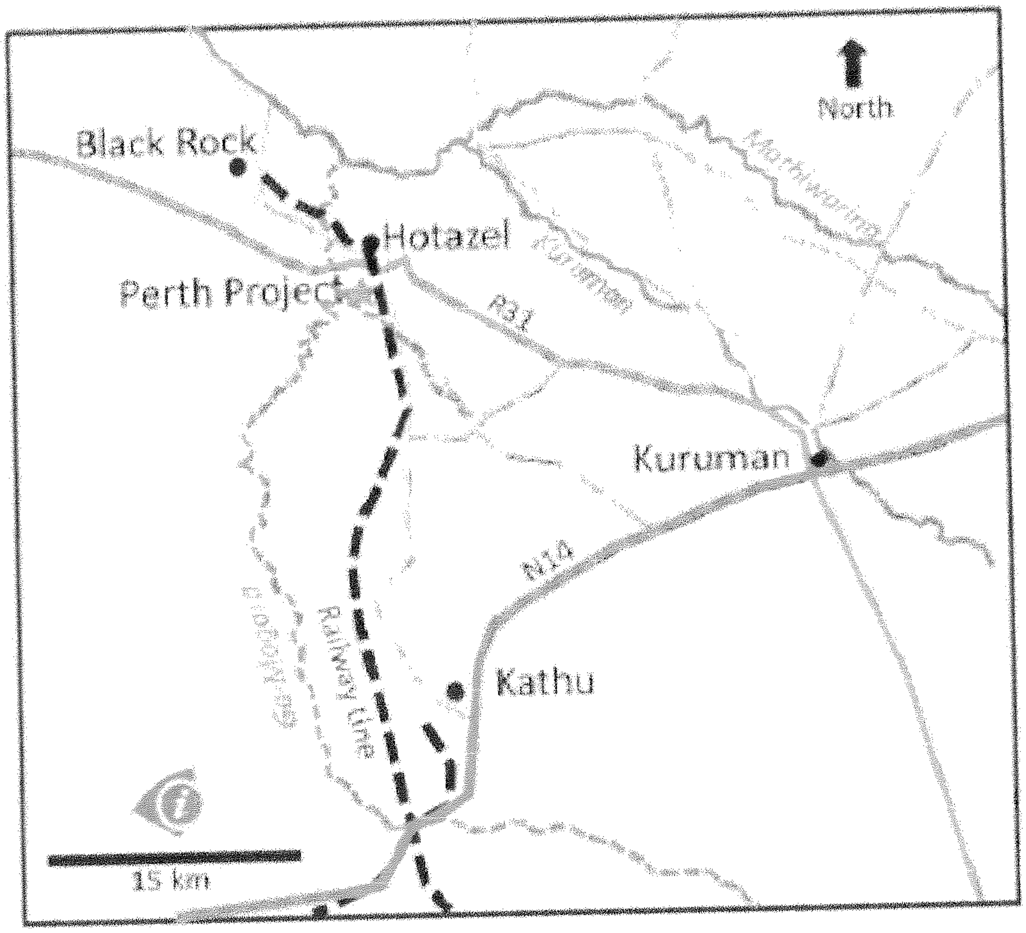


FIGURE 1: LOCALITY MAP SHOWING LOCATION OF THE MINE SITE IN RELATION TO LOCAL TOWNS (SOURCE: ILEH)

1.3 Project Team

Raylene Watson is currently employed as the Air Quality Unit Manager for Bohlweki-SSI Environmental in South Africa. Her key responsibilities are to manage the air quality unit and to promote Bohlweki-SSI Environmental as a Company within South Africa and the rest of Africa.

She completed her Bachelor of Science Degree (BSc) in 1994 at the Rand Afrikaans University (now called University of Johannesburg), majoring in Botany and Zoology. Her BSc (Honours - Zoology) course was subsequently completed at the same institution (1995). She was awarded an NRF scholarship to undertake her Masters Studies in Ecotoxicology. This Thesis focused on the assessment of heavy metal bioaccumulation in fish, found in the Olifantsriver Catchment area (one of the main river systems in South Africa). Her Masters was completed in 1997, this work was used to supplement further studies, culminating in the completion of a Doctorate in 2000, which focused on the assessment of a Fish Health Assessment Index. Her Doctorate was awarded the Nights Awards by the Parasitological Association of South Africa for its contribution to the Field of Parasitology in 2001.

After completing her studies she worked as an air quality impact assessor at Airshed Planning Professional, where after 5 years of service she moved over to SSI to start up the air quality unit for Bohlweki-SSI Environmental. The air quality unit has now been in existence for 4 years, and has developed into a team of 4 individuals. During her work as an air quality specialist she has undertaken over 200 assessments focusing primarily on industrial related source impacts. Key studies undertaken focused on the assessment of impacts related to mining operations, smelters, landfill sites, sewage works, airports, harbour developments, residential developments and the expansion of road networks. Work has been undertaken in South Africa and further afield on the African Continent, including countries like, Angola, Mozambique, Zimbabwe, Zambia, Namibia, Democratic Republic of the Congo, Botswana and Mauritius.

Stuart Thompson is a senior environmental consultant for SSI Engineers and Environmental Consultants, and a specialist in the field of air quality assessments. Qualified as an Applied Environmental Scientist (BSc. Hons) and a Member of the South African Geophysical Association (SAGA) as well as the Society of South African Geographers (SSAG), Stuart has 7 years experience in the environmental field, including 5 years in the field of air quality. He has managed and contributed to a variety of project in South Africa, as well as further afield on the African continent, including Tanzania, Malawi, DRC, Mozambique, Mauritius, Swaziland, Zambia, Sierra Leone and Botswana on assessments ranging from large-scale commercial developments and Power Generation Projects to numerous mining operations. Stuart spent 6 months working with the SSI parent company DHV B.V. based in Amersfoort, Netherlands. During this time he worked on several projects for the European Union, as well as acting as a specialist technical advisor for a large scale environmental project in India.

1.4 Project Description

The Sebilo mining project aims to utilise a potential manganese ore reserve near the town of Hotazel in the Northern Cape Province, based on preliminary findings the reserve will result in a life of mine for approximately 13 years, starting in approximately 2015 producing 150 000 ROM Tons. This will be ramped up to 500 000 Tons at steady state in 2017, with depletion and termination expected in 2026.

2 APPLICABLE LEGISLATION

The information presented in the section which follows, details the local legislation within South Africa, as well as a list of international laws and conventions to which South Africa is a signatory.

2.1 South African legislative and standards frameworks

2.1.1 National Environmental Management: Air Quality Act 39 of 2004

The National Environmental Management: Air Quality Act (39 of 2004) represents a move to an air pollution control strategy that is based on receiving air quality management. It focuses on the adverse impacts of air pollution on the ambient environment and sets standards as the benchmark for air quality management performance. At the same time it sets emission standards to minimize the amount of pollution that enters the environment. The Act regulates the control of noxious and offensive gases emitted by industrial processes, the control of smoke and wind borne dust pollution, and emissions from diesel vehicles.

Multiple levels of standards provide the basis for both 'continued improvements' in air quality and for long term planning in air quality management. Although maximum levels of ambient concentrations should be set at a national level, more stringent ambient standards may be implemented by provincial and local authorities.

The control and management of all sources of air pollution relative to their contributions to ambient concentrations is required to ensure that improvements in air quality are secured in the timeliest, even handed and cost-effective way. The need to regulate diverse source types reinforces the need for varied management approaches ranging from command and control methods to voluntary measures.

The objectives of the Air Quality Act as stated in Chapter 1 are as follows:

- Give effect to everyone's right 'to an environment that is not harmful to their health and well-being' and
- Protect the environment by providing reasonable legislative and other measures that (i) prevent pollution and ecological degradation, (ii) promote conservation and (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

The National Framework is one of the significant functions detailed in Chapter 2 of the Air Quality Act. The Framework serves as a blueprint for air quality management and aims to achieve the air quality objectives as described in the preamble of the Air Quality Act.

Chapter 3 of the Air Quality Act covers institutional and planning matters, and is summarised as follows:

- The Minister may establish a National Air Quality Advisory Committee as a subcommittee of the National Environmental Advisory Forum established in terms of the National Environmental Management Act (NEMA);
- Air Quality Officers must be appointed at each level of Government (National, Provincial, Municipal);
- Each National Department or Province preparing an Environmental Implementation Plan or Environmental Management Plan in terms of NEMA must include an Air Quality Management Plan (AQMP). Each Municipality preparing an Integrated Development Plan must include an AQMP;
- The contents of the AQMPs are prescribed in detail; and
- Each organ of state is required to report on the implementation of its AQMP in the annual report submitted in terms of NEMA.

In Chapter 4 of the Air Quality Act, air quality management measures are outlined in terms of:

- The declaration of Priority Areas, where ambient air quality standards are being, or may be, exceeded;
- The listing of activities that result in atmospheric emissions and which have or may have a significant detrimental effect on the environment;
- The declaration of Controlled Emitters;
- The declaration of Controlled Fuels;
- Other measures to address substances contributing to air pollution, that may include the implementation of a Pollution Prevention Plan or an Atmospheric Impact Report; and
- The requirements for addressing dust, noise and offensive odours.

Licensing of Listed Activities through an Atmospheric Emission Licence is addressed in Chapter 5 of the Air Quality Act. On 31 March 2010, the Minister of Water and Environmental Affairs published the Listed Activities and Minimum Emission Standards. International air quality management is outlined in Chapter 6 and offences and penalties in Chapter 7.

2.1.2 National Ambient Air Quality Standards

The Air Quality Act makes provision for the setting and formulation of National ambient air quality standards for substances or mixtures of substances which present a threat to health, well-being or the environment. On 24 December 2009, the Minister of Water and Environmental Affairs established National ambient air quality standards (Table 2-1). These standards prescribe the allowable ambient concentrations of pollutants which are not to be exceeded during a specified time period in a defined area. If the air quality standards are exceeded, the ambient air quality is poor and the potential for health effects is greatest.

TABLE 1: NATIONAL STANDARDS (µG/M^3) WITH ALLOWABLE FREQUENCIES OF EXCEEDANCE FOR IMMEDIATE COMPLIANCE. THE VALUES INDICATED IN BLUE ARE EXPRESSED IN PPB.

Pollutant	Averaging Period	Concentration	Frequency of Exceedance
Sulphur dioxide SO_2	10-min average	500 (191)	526
	1-hr average	350 (134)	88

	24-hr average	125 (48)	4
	Annual average	50 (19)	0
Nitrogen dioxide NO_2	1-hr average	200 (106)	88
	Annual average	40 (21)	0
Carbon monoxide CO	1-hr average	30 000 (26 000)	88
	8-hourly running average	10 000 (8 700)	11
Ozone O_3	8-hourly running average	120 (61)	11
Particulate Matter PM10	24-hr average	120 75 (from 2015)	4
	Annual average	50 40 (from 2015)	0
Lead Pb	Annual average	0.5	0
Benzene C_6H_6	Annual average	10 (3.2) 5 (from 2015)	0

2.2 International guidelines and standards

2.2.1 United Nations Framework Convention on Climate Change (UNFCCC1)

The Convention entered into force on 21 March 1994. The Convention on Climate Change sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It recognizes that the climate system is a shared resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The Convention enjoys near universal membership, with 192 countries having ratified including South Africa.

Under the Convention, governments gather and share information on greenhouse gas emissions, national policies and best practices launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries and cooperate in preparing for adaptation to the impacts of climate change

2.2.2 Kyoto Protocol

[1]www.UNFCCC.org

The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change. The major feature of the Kyoto Protocol is that it sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions. This amounts to an average of five per cent against 1990 levels over the five-year period 2008-2012.

The Kyoto Protocol is generally seen as an important first step towards a truly global emission reduction regime that will stabilize GHG emissions, and provides the essential architecture for any future international agreement on climate change. The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005. 180 nations including South Africa have ratified the treaty to date. Under the Treaty, countries must meet their targets primarily through national measures. However, the Kyoto Protocol offers them an additional means of meeting their targets by way of three market-based mechanisms.

The Kyoto mechanisms are:

- Emissions trading – known as "the carbon market"
- the clean development mechanism (CDM)
- joint implementation (JI).

These mechanisms help stimulate green investment and help Parties meet their emission targets in a cost-effective way.

2.2.3 The Vienna Convention for the Protection of the Ozone Layer

The ultimate objective of the Convention is to protect human health and the environment against adverse effects resulting from human activities which modify or are likely to modify the ozone layer and urges the Parties to take appropriate measures in accordance with the provisions in the Convention and its Protocols which are in force for that party. To achieve the aforementioned objectives, the Parties, within their capabilities, are expected to: cooperate to better understand and assess the effects of human activities on the ozone layer and the effects of the modification of the ozone layer; adopt appropriate measures and cooperate in harmonizing appropriate policies to control the activities that are causing the modification of the ozone layer; cooperate in the formulation of agreed measures for the implementation of this Convention; and cooperate with competent international bodies to implement effectively this Convention and protocols to which they are party.

2.2.4 The Montreal Protocol on Substances that deplete the Ozone Layer

These protocol controls production of ozone depleting substances: The Montreal Protocol on Substances that Deplete Ozone Layer is a protocol under the Vienna Convention. The Protocol controls the production and consumption of the most commercially and environmentally significant ozone-depleting substances - those listed in the Annexes to the Protocol. One feature of the Montreal Protocol which makes it unique, is Article 6 that requires the control measures to be revised at least every four years (starting 1990), based on the review and assessment of latest available-information on scientific, environmental, technical and economic aspects of the depletion of the ozone layer. Based on reports of assessment panels appointed by the Parties and taking into consideration the needs and situation of the developing countries, the Protocol has already been adjusted and amended twice.

At present, 191 nations have become party to the Montreal Protocol. The Montreal Protocol on Substances that Deplete the Ozone Layer is an international treaty designed to protect the ozone layer by phasing out the production of a number of substances believed to be responsible for ozone depletion. The treaty was opened for signature on September 16, 1987 and entered into force on January 1, 1989 followed by a first meeting in Helsinki, May 1989. Since then, it has undergone seven revisions, in 1990 (London), 1991 (Nairobi), 1992 (Copenhagen), 1993 (Bangkok), 1995 (Vienna), 1997 (Montreal), and 1999 (Beijing).

2.2.5 The Stockholm Convention on Persistent Organic Pollutants (POPs)

The Stockholm Convention is an international legally binding agreement on persistent organic pollutants (POPs). In 1995, the Governing Council of the United Nations Environment Programme (UNEP) called for global action to be taken on POPs, which it defined as "chemical substances that persist in the environment, bio-accumulate through the food web, and pose a risk of causing adverse effects to human health and the environment".

Following this, the Intergovernmental Forum on Chemical Safety (IFCS) and the International Programme for Chemical Safety (IPCS) prepared an assessment of the 12 worst offenders. Known as the Dirty Dozen, this list includes eight organo-chlorine pesticides: aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, mirex and toxaphene; two industrial chemicals: hexachlorobenzene (HCB) and the polychlorinated biphenyl (PCB) group; and two groups of industrial by-products: dioxins and furans.

The negotiations for the Stockholm Convention on Persistent Organic Pollutants were completed on May 23rd 2001 in Stockholm, Sweden. The convention entered into force on May 17th, 2004 with ratification by an initial 128 parties and 151 signatories. Co-signatories agreed to outlaw nine of the "dirty dozen" chemicals, limit the use of DDT to malaria control, and curtail inadvertent production of dioxins and furans. Parties to the convention have agreed to a process by which persistent toxic compounds can be reviewed and added to the convention, if they meet certain criteria for persistence and trans boundary threat. Several other substances are being considered for inclusion in the Convention. These are: hexabromobiphenyl, octaBDE, pentaBDE, pentachlorobenzene, short-chained chlorinated paraffin's, lindane, α- and β-hexachlorocyclohexane, dicofol, endosulfan, chlordecone and PFOS.

The Convention sets out several objectives including:

- The elimination from commerce of identified POPs and others that may be identified in the future;
- encouraging the transition in commerce to safer alternatives;
- identifying additional POPs;
- the clean-up of old stockpiles and equipment containing POPs; and
- encouraging all stakeholders to work towards a POP-free environment.

2.2.6 International Concerns Around mercury

There are international initiatives to address mercury but to date no international policy has been developed. A recent programme backed by the United Nations (UN) that aims to reduce the health and environmental impacts of mercury includes a two-year period of voluntary action to reduce emissions and an evaluation to determine whether an international treaty is necessary. It aims to develop partnerships between government, industry and other key groups to reduce emissions.

2.2.7 Equator Principles

The Environmental Assessment report required needs to addresses baseline environmental and social conditions, requirements under host country laws and regulations, applicable international treaties and agreements, sustainable development and use of renewable natural resources, protection of human health, cultural properties, and biodiversity, including endangered species and sensitive ecosystems, use of dangerous substances, major hazards, occupational health and safety, fire prevention and life safety, socio-economic impacts, land acquisition and land use, involuntary resettlement, impacts on indigenous peoples and communities, cumulative impacts of existing projects, the proposed project, and anticipated future projects, participation of affected parties in the design, review and implementation of the project, consideration of feasible environmentally and socially preferable alternatives, efficient production, delivery and use of energy, pollution prevention and waste minimization, pollution controls (liquid effluents and air emissions) and solid and chemical waste management.

2.2.8 International Finance Corporation

The International Finance Corporation (IFC) recommends the following in regards to air pollution. "Emissions do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standards by applying national legislation standards, or in their absence, the current World Health Organization (WHO) Air Quality Guidelines (AQGs0 or other internationally recognized sources. ...As a general rule, this Guideline suggests 25 percent of the applicable air quality standards to allow additional, future sustainable development in the same airshed." However also includes that the "25 percent increment rule itself is too strict to be applied universally on all guidelines, to be noted that the immission figures vary greatly between different guidelines and therefore a universal increment rule will lead in most cases to big unnecessary problems without enhancing the environment.",

3 BASELINE ENVIRONMENT

3.1 Description of Environment

3.1.1 Regional and Local Climate and Atmospheric Dispersion Potential

The nature of the local climate will determine what will happen to pollution when it is released into the atmosphere (Tyson & Preston-Whyte, 2000). Pollution levels fluctuate daily and hourly, in response to changes in atmospheric stability and variations in mixing depth. Similarly, atmospheric circulation patterns will have an effect on the rate of transport and dispersion of pollution.

The release of atmospheric pollutants into a large volume of air results in the dilution of those pollutants. This is best achieved during conditions of free convection and when the mixing layer is deep (unstable atmospheric conditions). These conditions occur most frequently in summer during the daytime. This dilution effect can however be inhibited under stable atmospheric conditions in the boundary layer (shallow mixing layer). Most surface pollution is thus trapped under a surface inversion (Tyson & Preston-Whyte, 2000).

Inversion occurs under conditions of stability when a layer of warm air lies directly above a layer of cool air. This layer prevents a pollutant from diffusing freely upward, resulting in an increased pollutant concentration at or close to the earth's surface. Surface inversions develop under conditions of clear, calm and dry conditions and often occur at night and during winter (Tyson & Preston-Whyte, 2000). Radiative loss during the night results in the development of a cold layer of air close to the earth's surface. These surface inversions are however, usually destroyed as soon as the sun rises and warm the earth's surface. With the absence of surface inversions, the pollutants are able to diffuse freely upward; this upward motion may however be prevented by the presence of an elevated inversion (Tyson & Preston-Whyte, 2000).

Elevated inversions occur commonly in high pressure areas. Sinking air warms adiabatically to temperatures in excess of those in the mixed boundary layer. The interface between the upper, gently subsiding air is marked by an absolutely stable layer or an elevated subsidence inversion. This type of elevated inversions is most common over Southern Africa (Tyson & Preston-Whyte, 2000).

The study area is situated in a semi-arid zone in the Northern Cape The area is characterized by cold, dry winters (May to August) and hot summers (October to March), with April and September being transition months.

3.1.2 Temperature

Site specific meteorological data was obtained from Lakes Environmental MM5 model, due to the distance to the Olifantshoek weather station. Temperatures for the Olifantshoek station range between -5°C and 38°C.

Table 2: AVERAGE TEMPERATURE DATA FOR OLIFANTSHOEK OBTAINED FROM THE SOUTH AFRICAN WEATHER SERVICE

Month	Temperature (° C)		
	Maximum	Minimum	Average
January	38	2	25.1
February	37.7	9.9	25.3
March	36.4	4.9	20.7
April	31.3	1	18.2
May	28.3	-4.7	13.6
June	24.1	-2.7	10.2
July	25.4	-4.9	9.2
August	29.9	-3.9	12.9
September	34.5	-1.4	17.0
October	35.2	0	20.5
November	36.8	7.4	22.8
December	36.9	11.5	24.8

3.1.3 Winds

From the wind rose (Figure 2), it is noted that the dominant wind is from the north easterly sector. Due to the distances from reporting monitoring stations as well as the complexity of the terrain in the area, all meteorological data used for modelling purposes was obtained from the Lakes Environmental MM5 Model. The average wind speed from this direction is between 3.6 to 5.7 m/s, but the winds from a more northern direction may exceed 5.7 m/s. Calm periods for this region are less than 4% of the time period. The wind from the west, and south west occur less than 6% of the time, when the wind can reach speeds of up to 5.7 m/s.

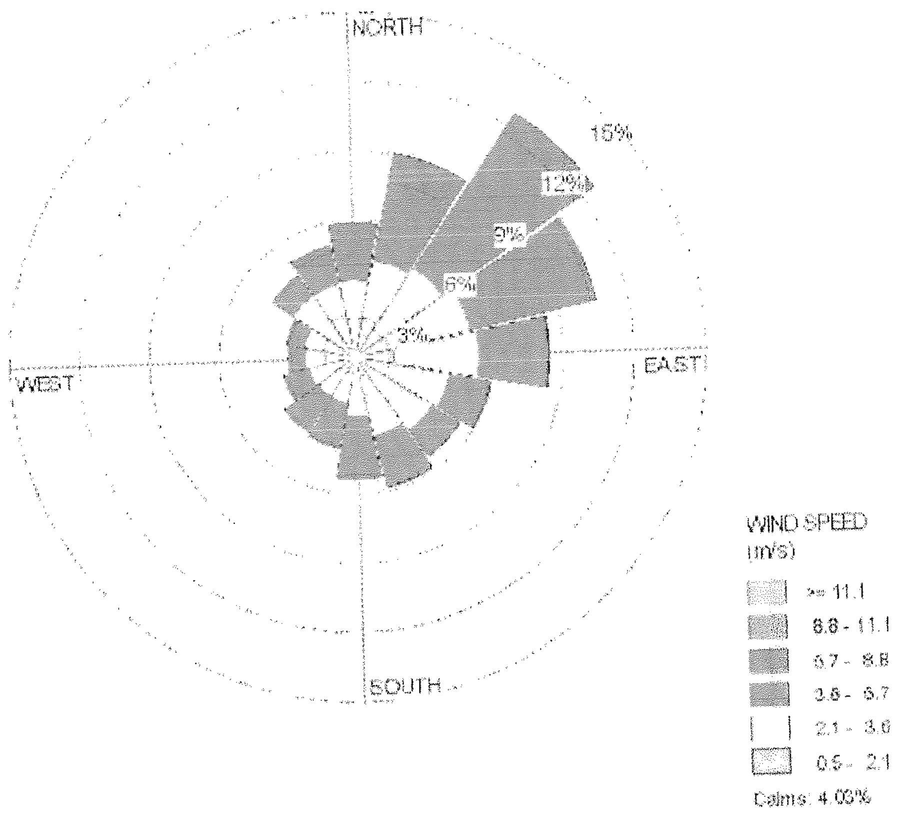


FIGURE 2: WIND ROSE FOR THE SEBILO SITE FOR THE PERIOD FROM 2007 TO 2011

Note: Wind roses comprise 16 spokes which represent the directions from which winds blew during the period. The colours reflect the different categories of wind speeds. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories. The resultant vector represents the mean wind direction.

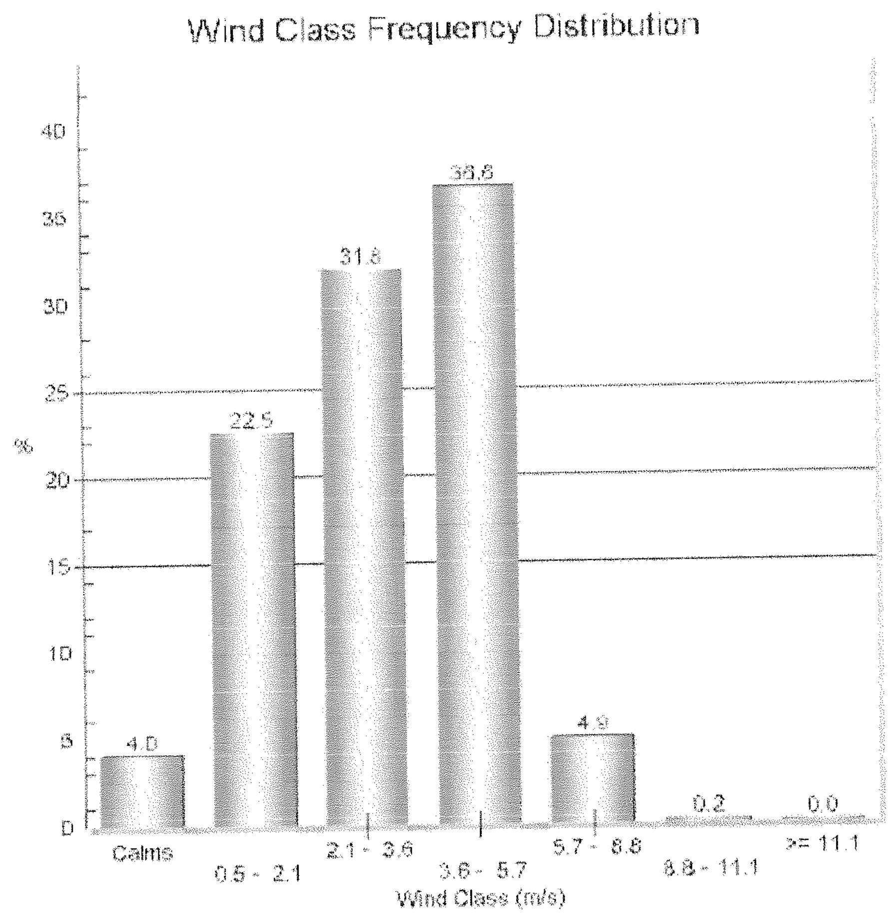


FIGURE 3: WIND CLASS FREQUENCY DISTRIBUTION AND STABILITY CLASSES FOR THE SEBILO SITE FOR THE PERIOD 2007 TO 2011

3.2 Other Polluting Sources in the Area

A detailed emissions inventory for the Kuruman area is currently not available. Based on site visits and 1:50 000 topographical maps; the following sources of air pollution have however been identified. These are important to consider in terms of assessing the cumulative impact potential on air quality in the region:

* Agricultural activities;
* Vehicle entrainment and exhaust gas emissions;
* Veld Fires; and
* Domestic Fuel Burning

A qualitative discussion on each of these source types is provided in the subsections which follow.

3.2.1 Agriculture

Agricultural activity can be considered a significant contributor to particulate emissions, although tilling, harvesting and other activities associated with field preparation are seasonally based.

The main focus internationally with respect to emissions generated due to agricultural activity is related to animal husbandry, with special reference to malodours generated as a result of the feeding and cleaning of animals. Mixed farming is practised in the area. The farming includes maize, wheat, grain sorghum, sunflower seed, dry beans and soybeans. Vegetables are produced under irrigation. The types of livestock assessed included pigs, sheep, goats, chickens and cattle as a result of subsistence agriculture. Emissions assessed are predominantly odorous pollutants include ammonia and hydrogen sulphide (USEPA, 1996) however due to the relatively low stocking rates, it is unlikely that these sources will contribute significantly to the cumulative pollution load of the area.

3.2.2 Vehicles

The force of the wheels of vehicles travelling on unpaved roadways causes the pulverisation of surface material. Particles are lifted and dropped from the rotating wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed. The quantity of dust emissions from unpaved roads varies linearly with the volume of traffic (USEPA, 1996). Due to the nature of both mining and agricultural activity, road networks can often be of a temporary nature, and are thus unpaved. An extensive unpaved road network exists in the area.

Due to the high degree of transport of product from the site expected during mining operations, exhaust tailpipe emissions from vehicles is a significant source of particulate emissions. Exhaust fumes contain nitrogen, oxygen, carbon monoxide, water vapour, sulphur dioxide, nitrogen oxide, volatile hydrocarbons and polyaromatic hydrocarbons (PAHs) and their derivatives, acetylaldehyde, benzene and formaldehyde, carbon particles, sulphates, aldehydes, alkanes, and alkenes.

3.2.3 Veld Fires

A veld fire is a large-scale natural combustion process that consumes various ages, sizes, and types of flora growing outdoors in a geographical area. Consequently, veld fires are potential sources of large amounts of air pollutants that should be considered when attempting to relate emissions to air quality. The size and intensity, even the occurrence, of veld fires depend directly on such variables as meteorological conditions, the species of vegetation involved and their moisture content, and the weight of consumable fuel per hectare (available fuel loading).

Once a fire begins, the dry combustible material is consumed first. If the energy released is large and of sufficient duration, the drying of green, live material occurs, with subsequent burning of this material as well. Under suitable environmental and fuel conditions, this process may initiate a chain reaction that results in a widespread conflagration. It has been hypothesized, but not proven, that the nature and amounts of air pollutant emissions are directly related to the intensity and direction (relative to the wind) of the veld fire, and are indirectly related to the rate at which the fire spreads. The factors that affect the rate of spread are (1) weather (wind velocity, ambient temperature, relative humidity); (2) fuels (fuel type, fuel bed array, moisture content, fuel size); and (3) topography (slope and profile). However, logistical problems (such as size of the burning area) and difficulties in safely situating personnel and equipment close to the fire have prevented the collection of any reliable emissions data on actual veld fires, so that it is not possible to verify or disprove the hypothesis.

The major pollutants from veld burning are particulate matter, carbon monoxide, and volatile organics. Nitrogen oxides are emitted at rates of from 1 to 4 g/kg burned, depending on combustion temperatures. Emissions of sulphur oxides are negligible (USEPA, 1996). A study of biomass burning in the African savannah estimated that the annual flux of particulate carbon into the atmosphere is estimated to be of the order of 8 Tg C, which rivals particulate carbon emissions from anthropogenic activities in temperate regions (Cachier *et al*, 1995).

3.2.4 Domestic Fuel Burning

It is anticipated that low income households in the area surrounding the site are likely to use coal and wood for space heating and/ or cooking purpose. The problems facing Sebilo around the impact of air pollution generated indoors as a result of the use of coal and wood are not unique. Similar problems are reported around the world in poor communities which either lack access to electricity or lack the means to fully utilise the available supply of electricity (Van Horen et al. 1992).

Globally, almost 3 billion people rely on biomass (wood, charcoal, crop residues, and dung) and coal as their primary source of domestic energy. Exposure to indoor air pollution (IAP) from the combustion of solid fuels is an important cause of morbidity and mortality in developing countries. Biomass and coal smoke contain a large number of pollutants and known health hazards, including particulate matter, carbon monoxide, nitrogen dioxide, sulphur oxides (mainly from coal), formaldehyde, and polycyclic organic matter, including carcinogens such as benzo[*a*]pyrene (Ezzati and Kammen, 2002).

Exposure to indoor air pollution (IAP) from the combustion of solid fuels has been implicated, with varying degrees of evidence, as a causal agent of several diseases in developing countries, including acute respiratory infections (ARI) and otitis media (middle ear infection), chronic obstructive pulmonary disease (COPD), lung cancer (from coal smoke), asthma, cancer of the nasopharynx and larynx, tuberculosis, perinatal conditions and low birth weight, and diseases of the eye such as cataract and blindness (Ezzati and Kammen, 2002).

Monitoring of pollution and personal exposures in biomass-burning households has shown concentrations are many times higher than those in industrialized countries. The latest Mozambique Air Quality Objectives, for instance, required the monthly average concentration of PM_{10} (particulate matter < 10 µm in diameter) to be < 200 µg/m^3 (annual average < 100 µg/m^3). In contrast, a typical 24-hr average concentration of PM_{10} in homes using biofuels may range from 200 to 5000 µg/m^3 or more throughout the year, depending on the type of fuel, stove, and housing. Concentration levels, of course, depend on where and when monitoring takes place, because significant temporal and spatial variations may occur within a house. Field measurements, for example, recorded peak concentrations of ≳ 50000 µg/m^3 in the immediate vicinity of the fire, with concentrations falling significantly with increasing distance from the fire. Overall, it has been estimated that approximately 80% of total global exposure to airborne particulate matter occurs indoors in developing nations. Levels of CO and other pollutants also often exceed international guidelines (Ezzati and Kammen, 2002).

3.3 Standards and guidelines

The main pollutant of concern which may poses a health risk to surrounding sensitive receptors and possible communities during the current investigation is particulate matter. Particulate matter is a collective name for fine solid or liquid particles added to the atmosphere by processes at the earth's surface. Particulate matter includes dust, smoke, soot, pollen and soil particles (Kemp, 1998). An overview is provided of the available local regulations and standards (SANS), and then for comparison, international guidelines and standards prescribed for inhalable particulate and nuisance dust exposure, these include the World Bank (WB), European Union (EU), United Kingdom (UK), World Health Organisation (WHO), and the United States Environmental Protection Agency (USEPA).

3.3.1 Inhalable Particulates

Particulate matter (PM) has been linked to a range of serious respiratory and cardiovascular health problems. The key effects associated with exposure to ambient particulate matter include: premature mortality, aggravation of respiratory and cardiovascular disease, aggravated asthma, acute respiratory symptoms, chronic bronchitis, decreased lung function, and increased risk of myocardial infarction (USEPA, 1996).

PM represents a broad class of chemically and physically diverse substances. Particles can be described by size, formation mechanism, origin, chemical composition, atmospheric behaviour and method of measurement. The concentration of particles in the air varies across space and time, and is related to the source of the particles and the transformations that occur in the atmosphere (USEPA, 1996).

PM can be principally characterised as discrete particles spanning several orders of magnitude in size, with inhalable particles falling into the following general size fractions (USEPA, 1996):

- PM10 (generally defined as all particles equal to and less than 10 microns in aerodynamic diameter; particles larger than this are not generally deposited in the lung);
- PM2.5, also known as fine fraction particles (generally defined as those particles with an aerodynamic diameter of 2.5 microns or less)
- PM10-2.5, also known as coarse fraction particles (generally defined as those particles with an aerodynamic diameter greater than 2.5 microns, but equal to or less than a nominal 10 microns); and
- Ultra fine particles generally defined as those less than 0.1 microns.

Fine and coarse particles are distinct in terms of the emission sources, formation processes, chemical composition, atmospheric residence times, transport distances and other parameters. Fine particles are directly emitted from combustion sources and are also formed secondarily from gaseous precursors such as sulphur dioxide, nitrogen oxides, or organic compounds. Fine particles are generally composed of sulphate, nitrate, chloride and ammonium compounds, organic and elemental carbon, and metals. Combustion of coal, oil, diesel, gasoline, and wood, as well as high temperature process sources such as smelters and steel mills, produce emissions that contribute to fine particle formation. Fine particles can remain in the atmosphere for days to weeks and travel through the atmosphere hundreds to thousands of kilometres, while most coarse particles typically deposit to the earth within minutes to hours and within tens of kilometres from the emission source. Some scientists have postulated that ultra fine particles, by virtue of their small size and large surface area to mass ratio may be especially toxic. There are studies which suggest that these particles may leave the lung and travel through the blood to other organs, including the heart.

Coarse particles are typically mechanically generated by crushing or grinding and are often dominated by resuspended dusts and crustal material from paved or unpaved roads or from construction, farming, and mining activities (USEPA, 1996).

Table 3 outlines the local and international health risk criteria used for the assessment of inhalable particulate matter (PM10). Guidelines and standards are provided for a 24-hour exposure and annual average exposure period respectively.

TABLE 3: AVAILABLE LOCAL AND INTERNATIONAL STANDARDS USED FOR THE EVALUATION OF INHALABLE PARTICULATE MATTER (PM10).

Origin	24-Hour Exposure ($\mu g/m^3$)	Annual Average Exposure ($\mu g/m^3$)	Number of Exceedances Allowed per year
RSA[1]	120[1]	50[1]	4 daily exceedances
RSA[2]	75[2]	40[2]	0 daily exceedances
Australia	50		5 daily exceedances
World Bank[3]	500	100	NA
EU[4]	50	20	7 daily exceedances
US-EPA[5]	150	50[6]	1 daily exceedance
UK[7]	50	40	35 daily exceedances
WHO[8] [9] [10]	50	20	NA

Notes: (1) Standard laid out in the National Environment Management: Air Quality Act. No. 39 of 2004:

(2) Compliance by 1 January 2015

(3) World Bank Air Quality Standards summary obtainable at URL

(4) European Union Air Quality Standards summary obtainable at URL

(5) United States Environmental Protection Agencies National Air quality Standards obtainable at URL

(6) To attain this standard, the 3-year average of the weighted annual mean PM_{10} concentration at each monitor within an area must not exceed 50 $\mu g/m^3$.

(7) United Kingdom Air Quality Standards and objectives obtainable at URL

(8) WHO = World Health Organisation

(9) Guidance on the concentrations at which increasing, and specified mortality responses due to PM are expected based on current scientific insights (WHO, 2005).

(10) Air quality guideline

3.3.2 Nuisance Dust

Nuisance dust is known to result in the soiling of materials and has the potential to reduce visibility. Atmospheric particulates change the spectral transmission, thus diminishing visibility by scattering light. The scattering efficiency of such particulates is dependent upon the mass concentration and size distribution of the particulates. Various costs are associated with the loss of visibility, including: the need for artificial illumination and heating; delays, disruption and accidents involving traffic; vegetation growth reduction associated with reduced photosynthesis; and commercial losses associated with aesthetics. The soiling of building and materials due to dust frequently gives rise to damages and costs related to the increased need for washing, cleaning and repainting. Dustfall may also impact negatively on sensitive industries, e.g. bakeries or textile industries. Certain elements in dust may damage materials. For instance it was found that sulphur and chlorine if present in dust may cause damage to copper (Maeda *et al.*, 2001).

The physical smothering of the leaf surface of plants by dust particles causes reduced light transmission, affecting photosynthetic processes resulting in growth reduction (Thompson et al., 1984; Pyatt and Haywood, 1989; Farmer, 1993).

Increases in the temperature of particle-covered leaves result in a positive impact on respiration and a negative impact on photosynthesis and productivity (Eller, 1977). The physical obstruction of the stomata has been observed to reduce stomatal resistance, resulting in the potential for higher uptake of pollutant gases, and it may also affect the exchange of water vapour (CEPA/FPAC Working Group, 1999). Particle accumulation on leaf surfaces may cause plants to become more susceptible to other stresses such as disease (CEPA/FPAC Working Group, 1999). A review of the effects of cement dust on trees showed that the dust caused physical damage to the leaves, reduced fruit setting and generally reduced growth (Farmer, 1993). Several studies in Europe and the United States have indicated that a decline in species diversity may be linked to declining air quality around urban and industrial areas (Gunnarsson, 1988; Hallingbäck, 1992; Vá ňa, 1992; Van Zanten, 1992; Finizio *et al.*, 1998; Jones & Paine, 2006; Motiejūnaitė, in press; Otnyukova, in press). Currently in South Africa on two studies are currently underway, the first is to determine the potential impacts of Sulphur and Nitrogen from power stations, on the forestry industry in the lowveld of Mpumalanga, with the second being a study between the Kruger Park and Foskor to determine impacts associated with phosphate contamination at the Phalaborwa Mine. Neither of these studies have to date yielded publishable results..

Air pollution is a recognized health hazard for man and domestic animals (Newman *et al.*, 1979). Air pollutants have had a worldwide effect on both wild birds and wild mammals, often causing marked decreases in local animal populations (Newman *et al.*, 1979). The major effects of industrial air pollution on wildlife include direct mortality, debilitating industrial-related injury and disease, physiological stress, anaemia, and bioaccumulation. Some air pollutants have caused a change in the distribution of certain wildlife species.

South Africa is one of the only countries who have issued guideline limits for the evaluation of nuisance dust levels. A four banding system has traditionally been used which describes the dust deposition as resulting in a slight, moderate, heavy or very heavy nuisance impact. These criteria are summarised as follows:

Slight	: < 250 mg/m²/day
Moderate	: > 250 mg/m²/day < 500 mg/m²/day
Heavy	: > 500 mg/m²/day < 1200 mg/m²/day
Very Heavy	: > 1200 mg/m²/day

The South African Department of Mineral Resources (DMR) use the 1 200 mg/m²/day threshold level as an action level. In the event that on-site dustfall exceeds this threshold, the specific causes of high dustfall should be investigated and remedial steps taken.

"Slight" dustfall is barely visible to the naked eye. "Heavy" dustfall indicates a fine layer of dust on a surface, with "very heavy" dustfall being easily visible should a surface not be cleaned for a few days. Dustfall levels of > 2000 mg/m²/day constitute a layer of dust thick enough to allow a person to "write" words in the dust with their fingers. Local experience, gained from the assessment of impacts due to dust from mine tailings dams in Gauteng, has shown that complaints from the public will be activated by repeated dustfall in excess of ~2000 mg/m²/day. Dustfall in excess of 5000 mg/m²/day impacting on residential or industrial areas generally provoke prompt and angry complaints.

The main limitation in using this type of classification system is that it is purely descriptive and does not provide and indication as to what action needs to be taken to remediate the problem. The South African Bureau of Standards in their SANS 1929:2005 publication, "Ambient air quality – limits for common pollutants", provides additional criteria which can be used for the evaluation of fallout dust deposition. A four banded scale has been provided, with target, action and alert thresholds indicated. Permissible margins of tolerances are outlined with possible exceptions noted. Table 4 and Table 5 detail these evaluation criteria.

TABLE 4: FOUR BAND SCALE EVALUATION CRITERIA FOR DUST DEPOSITION (SANS, 2005).

Band Number	**Band Description**	**Dustfall rate, D (mg/m²/day, 30-day average)**	**Comment**
1	Residential	D < 600	Permissible for residential and light commercial
2	Industrial	600 < D < 1200	Permissible for heavy commercial and industrial
3	Action	1200 < D < 2400	Requires investigation and remediation if two sequential months lie in this band, or more than three occur in a year
4	Alert	2400 < D	Immediate action and remediation required following the first incidence of the dustfall rate being exceeded. Incidence reported to be submitted to the relevant authority.

TABLE 5: TARGET, ACTION AND ALERT THRESHOLDS FOR DUST DEPOSITION (SANS, 2005).

Level	**Dustfall rate, D (mg/m²/day, 30-day average)**	**Averaging Period**	**Permitted Frequency of Exceeding dustfall rate**

Target	300	Annual	
Action residential	600	30 days	Three within any year no two sequential months
Action industrial	1200	30 days	Three within any year not sequential months
Alert threshold	2400	30 days	None. First incidence of dust fall rate being exceeded requires remediation and compulsory report to the relevant authorities.

An enterprise may submit a request to the authorities to operate within band 3 (action band), as specified in Table 4, for a limited period, provided that this is essential in terms of the practical operation of the enterprise and provided that and appropriate control technology is applied for the duration. No margin of tolerance will be granted for operations that result in dustfall rates which fall within band 4 (alert band) as specified in Table 5 (SANS, 2005).

Dustfalls that exceed the specified rates but that can be shown to be the result of some extreme weather or geological event shall be discounted for the purpose of enforcement and control. Such an event might typically result in excessive dustfall rates across an entire metropolitan region, and not be localised to a particular operation. Natural seasonal variations, for example, the naturally windy months each year, will not be considered extreme events for this definition (SANS, 2005).

3.4 Sensitive Receptors

The residential, educational and recreational land uses are considered to be sensitive receptors. For this study, the position of houses/dwellings on the farms was taken off 1:50 000 topographical cadastral maps and verified as far as possible using Google Earth and site visits. Even though the latest editions were used, the relevant maps out of date and there may be new dwellings and/or some of the existing shown buildings may be derelict.

The proposed mine is located to the south of Hotazel (Figure 1). The surrounding areas are predominately farming based and therefore the farms, homesteads and crops being produced, can be classified as a sensitive. Nearby villages include Gasese, Magobeng, Tsineng and Maipeing.

4 ASSESSMENT OF ENVIRONMENT LIKELY TO BE AFFECTED

The impact assessment phase of this investigation assesses the impact the construction and operational phase of the proposed mine will have on the surrounding areas.

This Section of the report outlines the predicted increase in impacts with the introduction of the mine and associated operations. To clearly detail the predicted impacts in ambient inhalable particulate ground level concentrations, only operational emissions were included in this evaluation. The construction and decommissioning phases of the operation can only qualitatively be addressed due to the variability and unpredictable nature of the construction operations on site.

4.1 Methodology

Dispersion modelling was undertaken using the US-EPA approved Aermod Dispersion Model. This model is based on the Gaussian plume equation and is capable of providing ground level concentration estimates of various averaging times, for any number of meteorological and emission source configurations (point, area and volume sources for gaseous or particulate emissions).

The AERMOD View model is used extensively to assess pollution concentrations and deposition from a wide variety of sources. AERMOD View is a true, native Microsoft Windows application and runs in Windows 2000/XP and NT4 (Service Pack 6).

The AERMOD (dispersion model used during the current investigation, is a steady state Gaussian plume model which can be used to assess pollutant concentrations and /or deposition fluxes from a wide variety of sources associated with an industrial source complex. Some of the modelling capabilities are summarised as follows:

- AERMOD may be used to model primary pollutants and continuous releases of toxic hazardous waste pollutants;
- AERMOD model can handle multiple sources, including point, volume, area and open pit source types. Line sources may also be modelled as a string of volume sources or as elongated area sources;
- Source emission rates can be treated as constant or may be varied by month, season, hour of day, or other periods of variation, for a single source or for a group of sources;
- The model can account for the effects aerodynamic downwash due to nearby buildings on point source emissions;
- The model contains algorithms for modelling the effects of settling and removal (through dry deposition) of large particulates and for modelling the effects of precipitation scavenging from gases or particulates;
- Receptor locations can be specified as gridded and/or discrete receptors in a Cartesian or polar coordinate system;
- AERMOD incorporates the COMPLEX1 screen model dispersion algorithms for receptors in complex terrain;
- The model uses real-time meteorological data to account for the atmospheric conditions that affect the distribution of air pollution impact on the modelling area; and
- Output results are provided for concentration, total deposition, dry deposition, and/or wet deposition flux.

Input data to the AERMOD model includes: source and receptor data, meteorological parameters, and terrain data. The meteorological data includes: wind velocity and direction, ambient temperature, mixing height and stability class.

The uncertainty of the AERMOD model predictions is considered to be equal to 2, thus it is possible for the results to be over predicting by double or under predicting by half, it is therefore recommended that monitoring be carried out at the proposed more during operation to confirm the modelled results, to ensure legal standards are maintained.

4.2 Detailed Project Description

The Sebilo mining project aims to utilise a potential manganese ore reserve near the town of Hotazel in the Northern Cape Province, based on preliminary findings the reserve will result in a life of mine for approximately 13 years, starting in approximately 2015 producing 150 000 ROM Tons. This will be ramped up to 500 000 Tons at steady state in 2017, with depletion and termination expected in 2026.

. The Primary Project will consist of the following:

- Open pits
- Processing Plant
- Stockpile areas
- Engineering and Support infrastructure
- Roads and rail link

4.3 Input parameters

The emissions inventory details below provide information as to the input parameters which were used for the modelling runs. The base information for this inventory was provided by the client, and assumed correct, and used directly in the model or used within calculations based on the US-EPA AP42 emission factor guidelines.

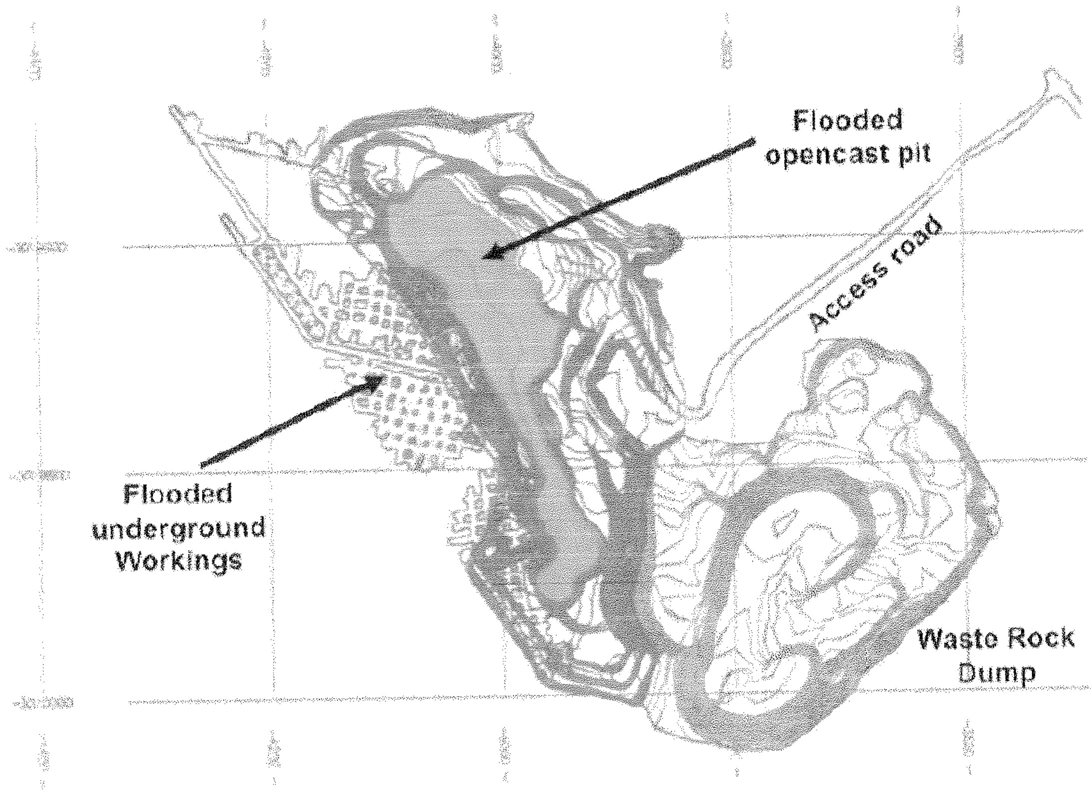


FIGURE 4: BASIC PLANT DIAGRAM FOR THE MINERALPROCESSING

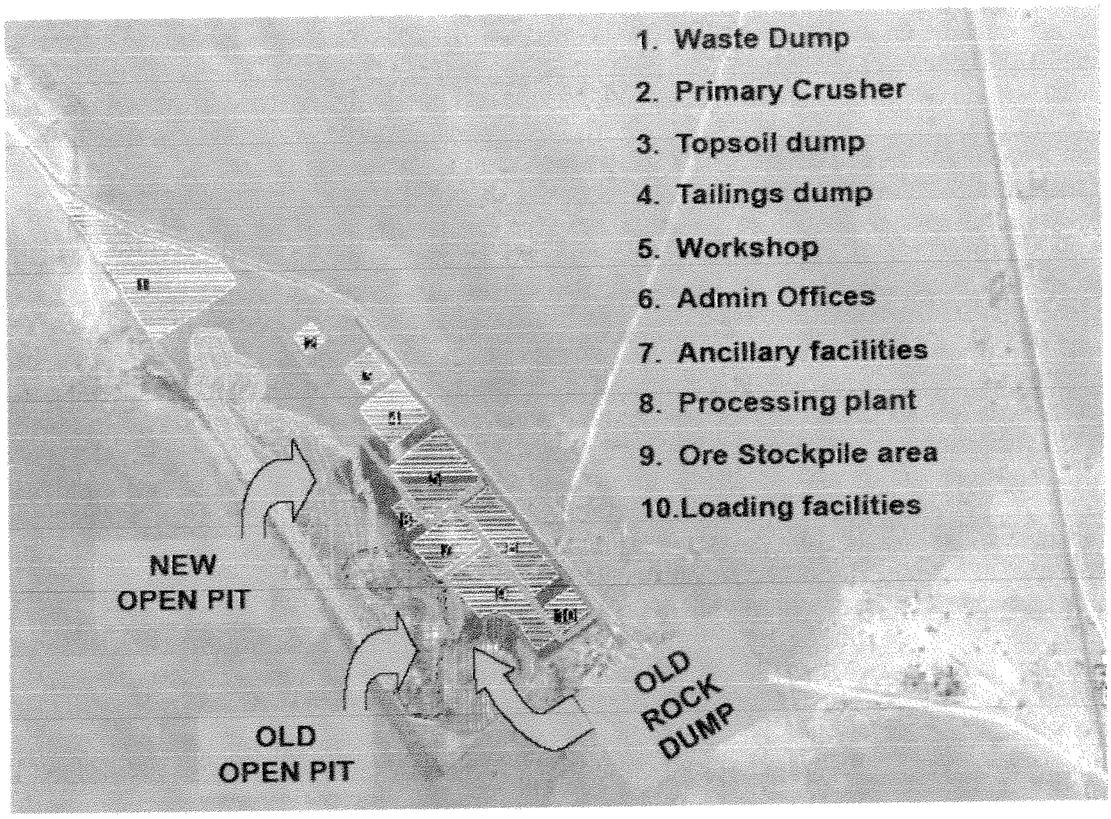


FIGURE 5: SITE INFRASTRUCTURE LAYOUT PLAN

TABLE 6: PROVIDED DETAILS FOR RAIL AND ROAD TRANSPORTATION

	Type	Length	Width	Area m^2	Emission Rate $g/s/m^2$
Roads	Access	6,200.0	10	62,000	1.02812E-5
	Internal haul roads	2,700.0	25	67,500	1.02812E-5
	Mining Haul Roads	1,900.0	16	30,400	1.02812E-5
	Total	10,800.0			
Rail	Access and train loading	3,200.0	6	19,200	

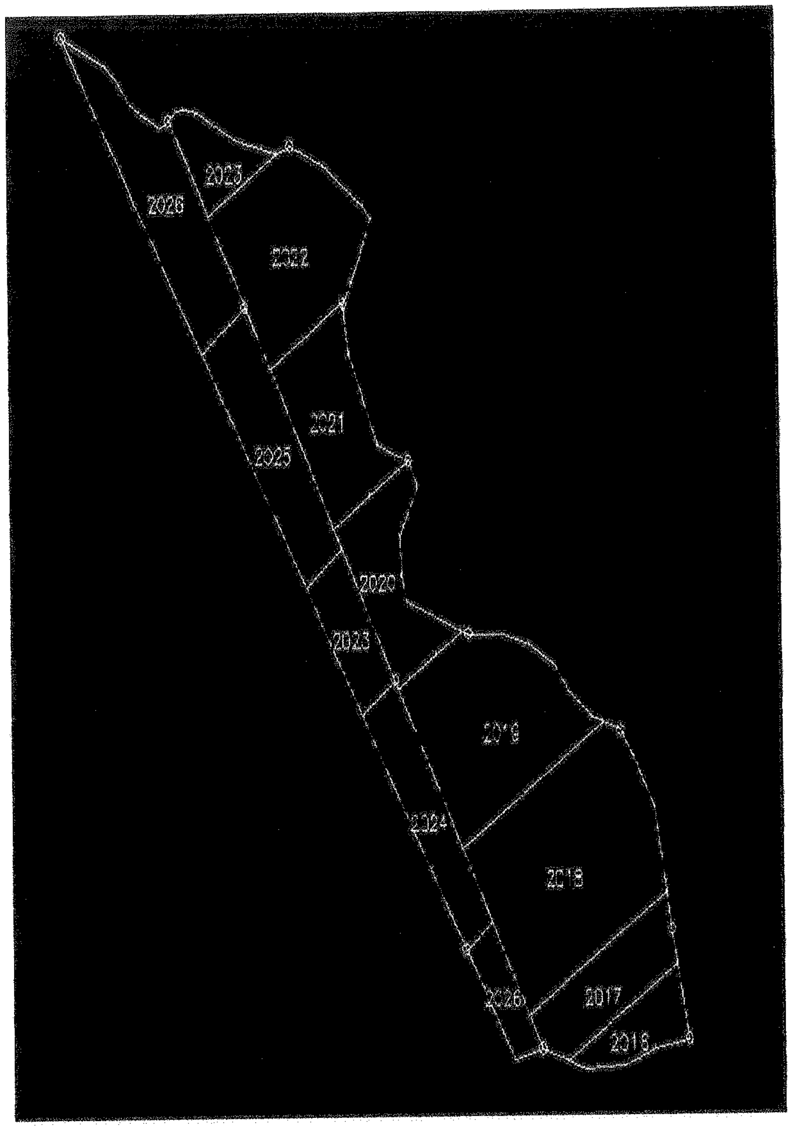


FIGURE 6: DIAGRAM OF MINE SCHEDULE

TABLE 7: TECHNICAL DETAIL REQUIRED FOR DISPERSION MODELLING

Bulldozing	0.586626731g/s
Throughput (i.e. amount of material bulldozed in tons per day)	Approx 1,800tpd
Number of hours operating per day, days per annum.	9 hours 298 days per year
Amount of hours stand time (or rest time) per day	15 hours
Grading	0.115419789g/s
Description of activity	Grading of haul roads
Number of hours operating per day and days per annum.	9 hours 298 days per year
Drilling	1.999E-04 g/s/m^2
Description of activity (i.e. overburden etc)	13 days drilling @12 hours per day

Number of drills per source per day	One
Drilling grid	4m x 4m
Dust control measures and efficiencies (%)	Dust collectors 80% efficient
Blasting Ore	1.222E-04g/s/m^2
Number of blasts per source per week	Blasting every two weeks
Blast length and width (or drill grid)	Approx L 162m W 17m D 13m
Horizontal surface area being blasted	2,750m^2
Time of day when blasting takes place	Lunch time 12H00
Explosives mixture used during blasting	Emulsion blend RD 1.25 g/cc and 53t per blast
Dust control measures and efficiencies (%)	Stemming only
Conveyor transfer points	2.93393 TPA
Throughput (i.e. amount transferred (t/hr))	220 tph
Moisture content of material transferred (%)	Estimate 8%
Number of hours operating per day, days per annum.	Operates at 9 hours per day 298 days per year
Amount of hours stand time (or rest time) per day	15 hours
Dust control measures (e.g. covered, wet suppression, hoods) and efficiencies (%)	Dust suppression at PRC and PF using sprays. Wet screening also employed est efficiency 80%
Tipping Ore	4.06994 TPA
Description of activity	Loading trucks at working faces, tipping at PRC, loading into trucks at PRC, tipping at PF stockpile, loading into plant receiving bin
	Plant conveyor discharging onto stockpiles, FEL loading silo conveyor to train loading silo
	Loading train from silo
Throughput (i.e. amount transferred (t/hr))	220 tph processing
Moisture content of material transferred (%)	8%
Number of hours operating per day, days per annum.	Operates at 9 hours per day 298 days per year
Amount of hours stand time (or rest time) per day	15 hours
Dust control measures (e.g. covered, wet suppression, hoods) and efficiencies (%)	Mist spray at silo conveyor loading point est efficiency of 80%
Loading and offloading haul trucks	4.06994 TPA
Throughput (i.e. amount transferred (t/hr))	1,800 tph
Number of hours operating per day, days per annum.	Operates at 9 hours per day 298 days per year
Control measures in place and their efficiencies (%)	Impact sprinklers 70%
Loading and offloading train	4.06994 TPA
Throughput (i.e. amount transferred (t/hr))	2,200 tph when loading train of 6,550 tonnes capacity in 3 hours
Moisture content of material transferred (%)	8%
Silt content of the material transferred (%)	Fines approximately 6%
Number of hours operating per day, days per annum.	Load train in 3 hours, 7 trains per month
Capacity and type of truck used for transportation	104 rail trucks x 63 tonnes

Loading and offloading mechanism (e.g. conveyer, loader)	Loading with conveyor via silo
Control measures in place and their efficiencies (%)	Water misting at conveyor loading point estimated efficency of 80%
Storage piles, discard dumps and tailings	
Description of source (i.e. coal, overburden, etc)	Top soil
o Surface area (m^2)	22500
o Height (m)	21
o Volume (m^3)	0.5million (m)
Description of source (i.e. coal, overburden, etc)	Overburden
o Surface area (m^2)	90000
o Height (m)	31
o Volume (m^3)	2.8m
Description of source (i.e. coal, overburden, etc)	RoM Stockpiles
o Surface area (m^2)	900
o Height (m)	12
o Volume (m^3)	0.01m
Description of source (i.e. coal, overburden, etc)	Saleable Stockpiles
o Surface area (m^2)	400
o Height (m)	12
o Volume (m^3)	0.005m
Description of source (i.e. coal, overburden, etc)	Tailings
o Surface area (m^2)	22500
o Height (m)	6
o Volume (m^3)	0.12m
Open Pits	
o Depth (m)	70 m
o Surface area (m^2)	600,000
o Volume (m^3)	42,000,000
Stack/Vent parameters for underground mining activities	Two 200kw fans will be located in the open pit bottom projecting out of the high wall
Stack/vent dimensions:	2m x 2m
stack height (m)	In Open pit
stack diameter (inner)	1.5
volumetric flow (m^3/hr) or exit velocity (m/s)	Approx 200 m^3/s or 100 per fan
gas exit temperature	Estimated at 32 degrees
o Control equipment in place or proposed.	NA
Beneficiation Plant	
Crushing	
Throughput (i.e. amount transferred (t/hr))	220tph

Operational hours per annum or per day	9
Screening	
Description of Activity	Double screens (wet type)
Throughput (i.e. amount transferred (t/hr))	220tph
Operational hours per annum or per day	9

4.4 Potential impacts

4.4.1 Construction Phase

During the construction assessment phase it is expected that, the main sources of impact will result due to the construction of access haul roads, the plant area and the clearing of the existing face with open pit mining. These predicted impacts cannot accurately be quantified, primarily due to the lack of information related to scheduling and positioning of construction related activities on a day to day basis. A qualitative description of the impacts has been provided. This will involve the identification of possible sources of emissions and the provision of details related to their impacts.

Construction is commonly of a temporary nature with a definite beginning and end. Construction usually consists of a series of different operations, each with its own duration and potential for dust generation. Dust emission will vary from day to day depending on the phase of construction, the level of activity, and the prevailing meteorological conditions (USEPA, 1996).

The following possible sources of fugitive dust have been identified as activities which could potentially generate dust during construction operations at the mine:

1. Product Transport
    - Scraping;
    - Debris handling;
    - Debris stockpiles; and
    - Truck transport and dumping of debris.

2. Concentrator Plant and Rail Loading
    - Clearing of area for infrastructure;
    - Debris handling;
    - Debris stockpiles; and
    - Truck transport and dumping of debris.

3. Opencast Mining
    - Removal of overburden; and
    - Haul Roads (scraping etc).

4.4.1.1 Creation and Grading of Access Roads

Access roads are constructed by the removal of overlying topsoil, whereby the exposed surface is graded to provide a smooth compacted surface for vehicles to drive on. Material removed is often stored in temporary piles close to the road edge, which allows for easy access once the road is no longer in use, whereby the material stored in these piles can be re-covered for rehabilitation purposes. Often however, these unused haul roads are left as is in the event that sections of them could be reused at a later stage.

A large amount of dust emissions are generated by vehicle traffic over these temporary unpaved roads (USEPA, 1996). Substantial secondary emissions may be emitted from material moved out from the site during grading and deposited adjacent to roads (USEPA, 1996). Passing traffic can thus re-suspend the deposited material. To avoid these impacts material storage piles deposited adjacent to the road edge should be vegetated, with watering of the pile prior to the establishment of sufficient vegetation cover. Piles deposited on the verges during continued grading along these routes should also be treated using wet or chemical suppressants depending on the nature and extent of their impacts.

A positive correlation exists between the amount of dust generated (during vehicle entrainment) and the silt content of the soil as well as the speed and size of construction vehicles. Additionally, the higher the moisture content of the soil the lower the amount of dust generated.

The periodic watering of these road sections will aid in the reduction of dust generated from these sources. Cognisance should be taken to increase the watering rate during high wind days and during the summer months when the rate of evaporation increases.

4.4.1.2 Preparation of areas identified for the construction of the plant and supporting infrastructure.

Removal of material usually takes place with a bulldozer, extracted material is then stored in piles for later use during rehabilitation procedures. Fugitive dust is generated during the extraction and removal of overlying material, as well as from wind blown dust generated from cleared land and exposed material stockpiles. Dust problems can also be generated during the transportation of the extracted material, usually by truck, to the stock piles. This dust can take the form of entrainment from the vehicle itself or due to dust blown from the back of the trucks during transportation.

To avoid the generation of unnecessary dust, material drop height should be reduced and material storage piles should be protected from wind erosion. This can take the form of wind breaks, water sprays or vegetation of piles. All stockpiles should be damped down, especially during dry weather.

It should be noted that emissions generated by wind are also dependent on the frequency of disturbance of the erodable surface. Each time material is added to or removed from a storage pile or surface, the potential for erosion by wind is restored. Any crusting of the surface binds the erodable material (USEPA, 1996). Dust created during the transportation can be limited by watering the road sections that are being used and by either wetting the material being transported or covering the back of the trucks, to limit the wind blown dust from the load.

4.4.1.3 *Preparation of the open pit mining areas*

Open pit mining usually starts with the set up of the initial box cut, as there has been previous mining activities, this will mainly involve opening and clearing the mine face. This will involve the removal of topsoil, and overburden by front end loader with the drilling and blasting of the overlying rock required in order to gain access to the mineral bearing ore. Bulldozing, drilling and blasting operations can result in the liberation of significant quantities of dust to atmosphere.

Dust liberated during bulldozing activity can be reduced by increasing the moisture content of the material being removed. An attempt should be made to coincide blasting operations with winds blowing away from the communities directly south of the site, as well as periods when poor atmospheric dispersion are expected i.e. early morning and late evening.

The removed topsoil will have to be transported to a designated collection point from where it can be recovered later during site rehabilitation. The removal of this material for storage should be done along designated haul roads which are properly maintained (watering), to reduce the amount of vehicle entrained dust which can be kicked up during these activities. Likewise, waste rock removed from the pit will have to be discarded at a dedicated waste rock pile. In addition to the use of dedicated, treated haul roads, the material transported can be wet or covered to limit the wind blown dust being released from the load.

4.4.1.4 *Overview of potential Impacts*

The following components of the environment may be impacted upon during the construction phase:

- ambient air quality;
- local residents and neighbouring communities;
- employees;
- the aesthetic environment; and
- possibly fauna and flora

The impact on air quality and air pollution of fugitive dust is dependent on the quantity and drift potential of the dust particles (USEPA, 1996). Large particles settle out near the source causing a local nuisance problem. Fine particles can be dispersed over much greater distances. Fugitive dust may have significant adverse impacts such as reduced visibility, soiling of buildings and materials, reduced growth and production in vegetation and may affect sensitive areas and aesthetics. Fugitive dust can also adversely affect human health. It is important to note that impacts will be of a temporary nature, only occurring during the construction period.

4.4.2 Operational Phase

This section will aim to deal with the potential air quality impacts which could result due to the proposed operations. Details regarding the source characteristics will be obtained from site layout plans and process specific information provided and a questionnaire filled in by the client. The sources likely to be included in this assessment can be categorised as follows:

- Material Processing (Crushing and Screening, Storage Piles);
- Opencast mining (Drilling and Blasting, Tipping, Bulldozing)
- Underground mining operations; and
- Product Transport (Haul Road and Rail)

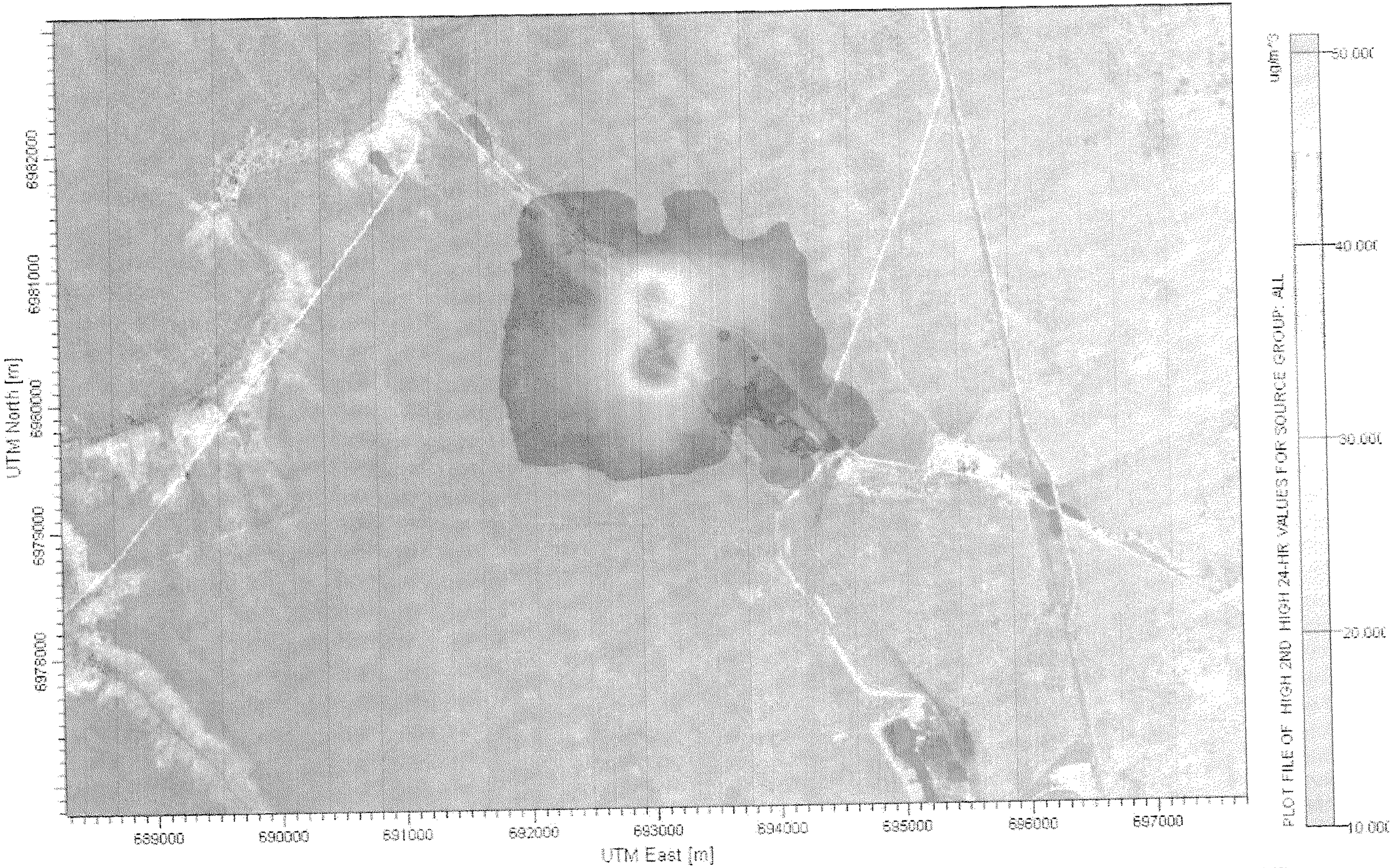


FIGURE 7: PREDICTED IMPACTS ASSOCIATED WITH ALL OPERATIONS FOR A 24 HOUR AVERAGING PERIOD (STANDARD 120µG/M³)

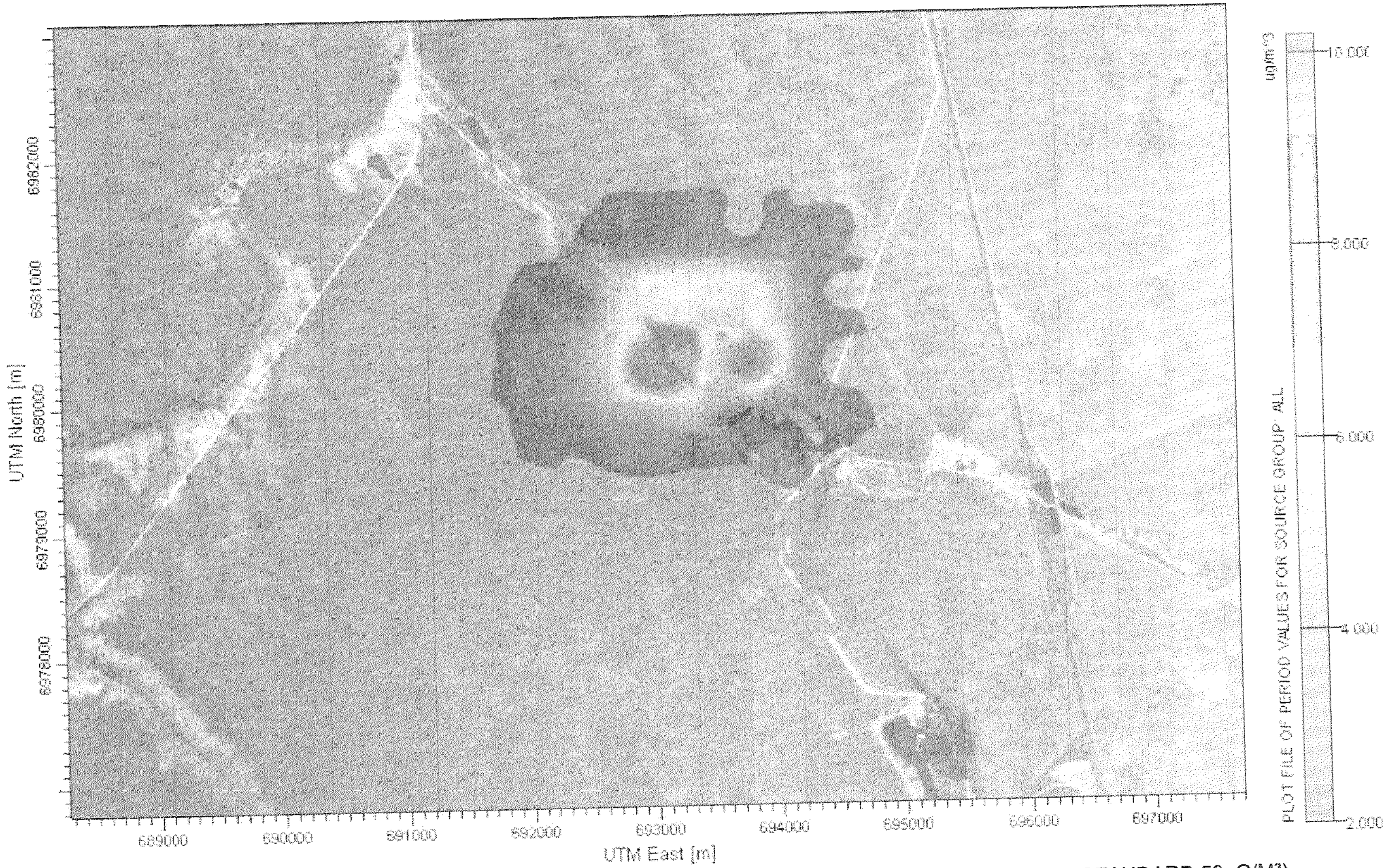


FIGURE 8: PREDICTED IMPACTS ASSOCIATED WITH ALL OPERATIONS FOR AN ANNUAL AVERAGING PERIOD (STANDARD 50µG/M³)

TABLE 8: TABLE INDICATING MAXIMUM PREDICTED ONSITE CONCENTRATIONS

	24 Hour (µg/m³)	Annual (µg/m³)
All Operations	55.98	12.59
National Standard	120	50

Note: Onsite concentrations are determined based on the maximum predicted concentration. The South African Air Quality Standards are based on a site boundary figure and not necessarily on a maximum predicted figure

Figure 7 provides an indication of the impacts proposed for all operations on site, this is a cumulative impact to determine the overall potential impact. For the 24 hour averaging period the maximum predicted concentration is 55.98 µg/m³ at the source, and a predicted impact of 53.00 µg/m³ at the edge of the mine lease area, this is just below the National Standard set at 120 µg/m³. Figure 8 provide the predicted concentrations over an annual averaging period, where the National Standard is set at 50 µg/m³ with the maximum predicted concentration being 12.59 µg/m³, and a maximum offsite concentration of 12.10, as indicated in Table 8. These results are based on a mitigation plan which is currently being proposed by the mine. These mitigation measures include:

- Conveyor Transfer Points - Dust suppression at PRC and PF using sprays. Wet screening also employed estimated efficiency 80%
- Tipping - Mist spray at silo conveyor loading point estimated efficiency of 80%
- Tipping - Wet suppression using impact sprinklers 70%
- Haul loading - Impact sprinklers 70%
- Rail Loading - Water misting at conveyor loading point estimated efficiency of 80%
- Haul Trucks - Watering down truck 70%
- Drilling - Dust collectors 80% efficient

By including these measures into the design and implementation of the mine plan, the dust levels on site are predicted to be below the South African Standards.

4.4.3 Decommissioning Phase

The decommissioning phase is associated with activities related to the demolition of infrastructure and the rehabilitation of disturbed areas. The total rehabilitation will ensure that the total area will be a free draining covered with topsoil and grassed. The following activities are associated with the decommissioning phase (US-EPA, 1996):

- Existing buildings and structures demolished, rubble removed and the area levelled;
- Remaining exposed excavated areas filled and levelled using overburden recovered from stockpiles;
- Stockpiles and tailings impoundments to be smoothed and contoured;
- Topsoil replaced using topsoil recovered from stockpiles; and
- Land and permanent waste piles prepared for revegetation.

Possible sources of fugitive dust emission during the closure and post-closure phase include:

- Smoothing of stockpiles by bulldozer;
- Grading of sites;
- Transport and dumping of overburden for filling;
- Infrastructure demolition;
- Infrastructure rubble piles;
- Transport and dumping of building rubble;
- Transport and dumping of topsoil; and
- Preparation of soil for revegetation – ploughing and addition of fertiliser, compost etc.

Exposed soil is often prone to erosion by water. The erodability of soil depends on the amount of rainfall and its intensity, soil type and structure, slope of the terrain and the amount of vegetation cover (Brady, 1974). Revegetation of exposed areas for long-term dust and water erosion control is commonly used and is the most cost-effective option. Plant roots bind the soil, and vegetation cover breaks the impact of falling raindrops, thus preventing wind and water erosion. Plants used for revegetation should be indigenous to the area, hardy, fast-growing, nitrogen-fixing, provide high plant cover, be adapted to growing on exposed and disturbed soil (pioneer plants) and should easily be propagated by seed or cuttings.

4.5 Proposed mitigation

4.5.1 Construction Phase

Due to the lack of quantitative dust emissions data for the site, it is recommended that the precautionary principle be followed and dust control measures be implemented. Recommendations for the control of fugitive dust emissions are given in Table 9. Wet suppression with water is the least expensive of the possible control measures but is temporary in nature.

TABLE 9: RECOMMENDATIONS FOR THE CONTROL OF FUGITIVE DUST EMISSIONS DURING THE CONSTRUCTION PHASE (USEPA, 1996).

Emission Source	Recommended Control Methods
Debris handling and debris piles	Wind speed reduction
	Wet suppression [1]
Truck transport [2]	Wet suppression
	Paving
	Chemical stabilisation [3]
Bulldozers	Wet suppression
Pan scrapers	Wet suppression of travel routes
Cut/fill material handling	Wind speed reduction
	Wet suppression
Cut/fill haulage	Wet suppression
	Paving
	Chemical stabilisation
General construction	Wind speed reduction
	Wet suppression
	Early paving of permanent roads

Note: [1] Dust control plans should contain precautions against watering programs that confound trackout problems.

[2] Loads could be covered to avoid loss of material in transport, especially if material is transported offsite.

(3) Chemical stabilisation is usually cost-effective for relatively long-term or semi-permanent unpaved roads.

Water may be combined with a surfactant as wetting agent. Surfactants increase the surface tension of water, reducing the quantity of water required. Chemical stabilisation is of longer duration but is not cost effective for small-scale operations. Dustex represents an example of a product, which is commercially available and widely used by mines and quarries. The Dustex product binds with the aggregate used to build on-site roads. (USEPA, 1996).

Dust and mud should be controlled at vehicle exit and entry points to prevent the dispersion of dust and mud beyond the site boundary. Facilities for the washing of vehicles could be provided at the entry and exit points. A speed limit of 40 km/hr should be set for all vehicles travelling over exposed areas or near stockpiles. Traffic over exposed areas should be kept to a minimum (USEPA, 1996).

All stockpiles should be maintained for as short a time as possible and should be enclosed by wind breaking enclosures of similar height to the stockpile Examples of wind breaks include the planting of trees around stockpiles, which will also aid in the visible impacts of the mine. Synthetic screening materials are also available for installation at the base of the stockpiles, as well as on the stockpile slopes to increase surface roughness and reduce wind speeds. Stockpiles should be situated away from the site boundary, water courses and nearby receptors and should take into account the predominant wind direction. For the Sebilo site, stockpiles are located in very close proximity to the mine, to reduce overall footprint, as well as ensure increased distances to sensitive receptors

During the transfer of material to piles, drop heights should be minimised to control the dispersion of materials being transferred (USEPA, 1996).

Additional preventative techniques include the reduction of the dust source extent and adjusting work processes to reduce the amount of dust generation (USEPA, 1996).

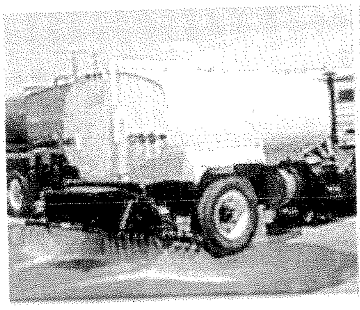
4.5.2 Operational Phase

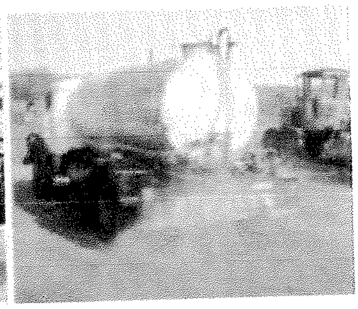
Based on the results presented the following recommendations are outlined:

- Fallout monitoring should be included to assess the level of nuisance dust associated with both mining and process related operations. Sampling of fallout should be undertaken within the neighbouring farming and community areas as well as on-site.

Due to emissions being generated from roads and storage piles it is recommended that all piles should be maintained for as short a time as possible and a water spray system should be operated at any stockpiles it is also recommended that wind breaks be used in close proximity of storage piles in order to reduce the potential erosive forces of the wind. During the transfer of material to piles, drop heights should be minimised to control the dispersion of materials being transferred (USEPA, 1996).

Water may be combined with a surfactant as wetting agent to increase the control efficiency if pit infow water is insufficient for adequate control of dust. Surfactants increase the surface tension of water, reducing the quantity of water required. Chemical stabilisation is of longer duration but is not cost effective for small-scale operations. Dustex represents an example of a product, which is commercially available and widely used by mines and quarries. The Dustex product binds with the aggregate used to build on-site roads. (USEPA, 1996). Nozzles fitted on a spread bar behind trucks for a controlled spray opposed to a wide splash set-up shown in picture below.





The predominant source of emissions expected from this proposed site is as a result of the crushing and screening operations as part of the mineral processing. It is recommended that dust suppression systems be fitted to these, either in the form of water sprays, or if sufficient water is not available at the site, then a bag filter or cyclone system, in order to reduce the potential emissions. These mitigation measures also need to be fitted to the Rapid Load-out station, and if possible include the installation of dust hoods over the rail cars during loading.

4.5.3 Decommissioning Phase

Revegetation of exposed areas for long-term dust and water erosion control is commonly used and is the most cost-effective option. Plant roots bind the soil, and vegetation cover breaks the impact of falling raindrops, thus preventing wind and water erosion. Plants used for revegetation should be indigenous to the area, hardy, fast-growing, nitrogen-fixing, provide high plant cover, be adapted to growing on exposed and disturbed soil (pioneer plants) and should easily be propagated by seed or cuttings.

4.5.4 Post-Closure Phase

Revegetation of exposed areas for long-term dust and water erosion control is commonly used and is the most cost-effective option. Plant roots bind the soil, and vegetation cover breaks the impact of falling raindrops, thus preventing wind and water erosion. Plants used for revegetation should be indigenous to the area, hardy, fast-growing, nitrogen-fixing, provide high plant cover, be adapted to growing on exposed and disturbed soil (pioneer plants) and should easily be propagated by seed or cuttings.

4.6 Significance Rating

In line with the MPRDA, each impact identified for the proposed project must be ranked based on the categories detailed below to determine the overall impacts associated with the proposed project.

CONSEQUENCE	**Nature / Intensity / Severity of Impact:**		
	Low	Impacts affect the environmental in such a way that natural, cultural and/or social functions and processes are not affected.	1
	Medium	Impacts affect the environment in such a way that natural, cultural and/or social functions and processes are altered	3
	High	Impacts affect the environment in such a way that natural, cultural and/or social functions and processes will temporarily or permanently cease.	5
	Spatial extent of impact:		
	On-site	Impact occurs on-site.	1
	Local	Impact occurs within 5km radium of the site.	2
	Regional	Impact occurs within a 100km radius of the site	3
	National	Impact occurs within South Africa	4
	International	Impact occurs internationally	5
	Duration of Impact:		
	Short-term	Through dilution and dispersion, the impact reduces to insignificant within 1 week.	1
	Medium-term	Through dilution and dispersion, the impact reduces to insignificant within the life of the mine.	2
	Long-term	The impact will cease after the operational life of the mine either because of natural process or by human intervention	3
	Permanent	Where mitigation either by natural process or by human intervention will not occur in such a way or in such a time span that the impact can be considered transient.	4
LIKELIHOOD	**Probability of potential occurrence of the Impact:**		
	Improbable	The possibility of the impact materializing is very low either because of design or historic experience.	1
	Probable	There is a distinct possibility that the impact will occur.	2
	Highly probably	It is most likely that the impact will occur.	3
	Definite	The impact will occur regardless of any prevention measures.	4
	Frequency of potential occurrence of the Impact:		
	Annually or less	Impact occurs at least once in a year or less frequently	1
	6 months	Impact occurs at least once in 6 months	2
	Monthly	Impact occurs at least once a month.	3
	Weekly	Impact occurs at least once a week.	4
	Daily	Impact occurs daily.	5

LIKELIHOOD \ CONSEQUENCE	3	4	5	6	7	8	9	10	11	12	13	14
2	5	6	7	8	9	10	11	12	13	14	15	16
3	6	7	8	9	10	11	12	13	14	15	16	17
4	7	8	9	10	11	12	13	14	15	16	17	18
5	8	9	10	11	12	13	14	15	16	17	18	19
6	9	10	11	12	13	14	15	16	17	18	19	20
7	10	11	12	13	14	15	16	17	18	19	20	21
8	11	12	13	14	15	16	17	18	19	20	21	22
9	12	13	14	15	16	17	18	19	20	21	22	23

Low	Where it will not have a significant influence on the environment. Management measures *can* be proposed to ensure that significance does not increase.	5-11
Medium	Where it could have a significant influence on the environment unless it is mitigated or managed.	12-17
High	Where it would have a significant influence on the environment regardless of any possible mitigation and hence must be either avoided or managed.	18-23

TABLE 10: SIGNIFICANCE RATING TABLE FOR IDENTIFIED IMPACTS

Impact before Mitigation	Nature/Intensity/Severity	Spatial Extent	Duration	Probability	Frequency	Rating
Bulldozing	3	1	2	3	5	14
Grading	3	1	2	3	5	14
Drilling	3	1	2	3	5	14
Blasting Ore	3	2	1	3	4	13
Conveyor transfer points	3	1	2	3	5	14
Tipping Ore	3	1	2	3	5	14
Loading and offloading haul trucks	3	1	2	3	5	14
Loading and offloading train	3	1	2	3	5	14
Storage piles, discard dumps and tailings	3	2	4	3	5	17
Open Pits	3	2	2	3	5	15
Beneficiation Plant	3	2	2	3	5	15
Impact after Mitigation	**Nature/Intensity/Severity**	**Spatial Extent**	**Duration**	**Probability**	**Frequency**	**Rating**
Bulldozing	3	1	2	3	5	14
Grading	3	1	2	3	5	14
Drilling	3	1	2	3	5	14
Blasting Ore	3	2	1	3	4	13
Conveyor transfer points	2	1	2	3	4	12
Tipping Ore	2	1	2	3	4	12
Loading and offloading haul trucks	2	1	2	3	4	12
Loading and offloading train	2	1	2	3	4	12
Storage piles, discard dumps and tailings	3	2	4	3	5	17
Open Pits	3	2	2	3	5	15
Beneficiation Plant	3	2	2	3	4	14

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Sebilo Perth

Visual Impact Assessment Report

April 2012

Client Name: Irene Lea Environmental & Hydrogeology cc

Project Number: 012-036

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Proposed Sebilo Perth Project
Visual Impact Assessment Report

April 2012

IRENE LEA ENVIRONMENTAL & HYDROGEOLOGY

Irene Lea Environmental & Hydrogeology cc

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EXECUTIVE SUMMARY

EnviroCam (Pty) Ltd was appointed by Irene Lea Environmental & Hydrogeology cc to complete the Visual Impact Assessment (VIA) that forms part of the proposed Sebilo Perth Environmental Impact Assessment (EIA). It addresses the visual impact of the proposed Sebilo Perth Project on the receiving environment.

The activities expected to cause visual impacts during construction and operational phases were identified. The criteria used to determine the intensity of these visual impacts includes the area from which the project can be seen (the viewshed), the viewing distance, the capacity of the landscape to visually absorb structures and forms placed upon it (the visual absorption capacity), and the appearance of the project from important or critical viewpoints (sensitivity). When the intensity of the impact is qualified, the significance thereof can be predicted taking into account the extent and duration of the proposed activity.

It was determined that the intensity of the visual impact of the proposed Sebilo Perth Project would be Low to Moderate and with successful mitigation measures the proposed activity is likely to have a Low Negative Significant visual impact for all sensitive receptors.

EXPERTISE AND DECLARATION OF INDEPENDENCE

Expertise

This report was prepared by Riaan van der Merwe of EnviroCam (Pty) Ltd, who is registered with the South African Council for Professional and Technical Surveyors (PLATO) and The Geo-Information Society of South Africa (GISSA). He holds a BMil Hons (Military Geography) from the University of Stellenbosch and completed his MSc (Environmental Science) from the University of Witwatersrand.

Riaan van der Merwe has undertaken visual impact assessments for the last 5 years both for the public and private sectors. Assessments range from the development of mining sites/infrastructure, commercial developments, linear infrastructure such as power lines and smaller developments.

Declaration of independence

This specialist report was compiled for Irene Lea Environmental & Hydrogeology cc on behalf of Sebilo Resources (Pty) Ltd.

I hereby declare that I am financially and otherwise independent of the applicant and Irene Lea Environmental & Hydrogeological.

R. F. VAN DER MERWE (PGPT 0023)

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LIST OF ACRONYMS

Acronym	Explanation
DEM	Digital Elevation Model
DMR	The Department of Mineral Resources
EIA	Environmental Impact Assessment
Mamsl	Metres above mean sea level
NEMA	National Environmental Management Act (Act No. 107 of 1998)
VAC	Visual Absorption Capability
VIA	Visual Impact Assessment

1 INTRODUCTION

EnviroCam (Pty) Ltd was appointed by Irene Lea Environmental & Hydrogeology cc to complete the Visual Impact Assessment (VIA) that forms part of the proposed Sebilo Perth Environmental Impact Assessment (EIA). The VIA addresses the visual impact of the proposed Sebilo Perth Project on the receiving environment.

1.1 Background and Brief

The project area is situated within the John Taolo Gaetsewe District Municipality and the Joe Morolong Local Municipality, with Kuruman as the main urban node. Other towns in the area include Kathu, Hotazel and Black Rock (please refer to Figure 8, Appendix B).

A Prospecting Right (MPT 240/2009) issued on the remaining extent of the farm Perth 276 in the Kuruman District was transferred according to section 11 of the Minerals and Petroleum Resources Development Act (Act 28 of 2002) from Assmang Limited to Sebilo Resources (Pty) Ltd during 2009. Sebilo completed the prospecting programme on the farm during 2010/2011 and developed a pre-feasibility study to develop a mine on the project. Sebilo is currently in the process of applying for a Mining Right on the farm. The Department of Mineral Resources (DMR) accepted Sebilo's application for a Mining Right on 11 November 2011 (Reference no NC 30/5/1/2/2/10004MR).

If the mining right is granted, Sebilo plans to extract manganese ore using both opencast and underground mining methods. At the start of the operations, only opencast mining will be conducted. Underground mining is expected to commence in 2023. Mining is expected to cease during 2026.

The ore mined will be transported with trucks from the mining area to the primary crusher. The crushed material will be transported with trucks to the processing plant. Here wet screening of the ore will take place and ore of different size fractions will be stockpiled. Processed ore will be transported via rail to Port Elizabeth and Durban for export.

Sebilo will undertake concurrent rehabilitation during opencast mining. This will entail the backfilling, shaping, top soiling and re-vegetation of mined out areas as mining progresses.

This VIA assesses the visual impacts of the proposed Sebilo Perth Project, approximately 170 hectares at an approximate structure height of between 1.5m (e.g. ore stockpile) - 40m (e.g. waste dump). It includes the extent of the view catchment area, known as the 'zone of visual influence' (approximate 4 km buffer area around the proposed activity) of the project.

The purpose of this VIA is to determine the impact of the proposed project on the visual and aesthetic character of the study area. The rationale for this VIA is that the proposed activity may fundamentally alter the landscape character and sense of place of the local environment. The primary objective of this VIA is to describe the potential impact of this activity on the visual character and sense of place of the area. This assessment has the following secondary objectives:

- Describe the existing visual characteristics of the proposed site in relation to the surrounding areas and the context of the site.
- Identify and assess the significance of the likely visual impacts resulting from the proposed project as viewed from transport corridors and other surrounding land-uses.
- Provide detailed diagrams/superimposed images portraying the expected visual impacts of the proposed project, especially the visual impact of the site from sensitive views.
- Identify practicable mitigation measures to reduce negative visual impacts.

1.2 Legislation and Guidelines

There are no specific legal requirements in the National Environmental Management Act (Act No. 107 of 1998) (NEMA) that specifically regulate activities that may infringe on the visual attributes of a region.

The National Heritage Resources Act (Act No. 25 of 1999) provides legislative protection for listed or proclaimed sites, such as urban conservation areas, nature reserves and proclaimed scenic routes. It requires that these areas be protected against physical and aesthetic change. Visual pollution is controlled, to a limited extent, by the Advertising on Roads and Ribbons Act (Act No. 21 of 1940), which deals mainly with signage on public roads.

The *'Guideline for involving visual & aesthetic specialists in EIA processes,'* by Oberholzer (2005) was developed to provide guidelines and general good practices for specialist visual input into the EIA process in South Africa. These guidelines are used extensively and will be used as a guide for this assessment (please refer to Appendix A).

2 STUDY APPROACH

2.1 Method

To evaluate the impacts of the proposed activity, the inherent scenic value of the landscape first needs to be determined. Data collected during a site visit allowed for a comprehensive description and valuation of the receiving environment. The following method was used for the project:

- Site visit - one field survey was undertaken and the study area scrutinized to the extent that the receiving environment could be documented and adequately described;
- Project components - the physical characteristics of the project components were described and illustrated;
- The setting, visual character and land use of the area surrounding the project, and the sense of place were determined;
- The extent of the affected visual environment, the viewing distance and the critical views/visual receptors that may be affected by the proposed project were defined;
- The Visual Absorption Potential (ability of the landscape to accommodate the proposed project from a visual perspective) was determined;
- The significance of the visual and landscape impacts was assessed;
- The impact of the proposed activity on the visual environment was rated; and
- Based on the assessment, measures are suggested that could mitigate the negative impacts of the proposed Sebilo Perth Project.

2.2 Assumptions and Limitations

The following assumptions and limitations are applicable to this study:

- No lighting plans, architectural design/style or colour schemes were available at the onset of the VIA specialist study;

- The conceptual layout plans of the proposed Sebilo Perth Project as received on March 2012 were used for the purposes of this assessment. Any subsequent changes to these site layout plans are not addressed within this report;
- This level of assessment excludes surveys to establish viewer preference and thereby their sensitivity. For example; localised visual perceptions of the economically depressed communities of the population may be influenced rather by the short term economic and job opportunities that will exist, than by the direct visual perception of the project; and
- Findings will be restricted to available information, as well as the quality of spatial data.

3 DESCRIPTION OF THE PROPOSED ACTIVITY

3.1 Overview of the Activity

The proposed mining infrastructure and mining components that will form part of the mining project are listed in Table 1 (adapted from Mineral Corporation, 2011).

Table 1: Proposed Activities

ACTIVITY	DIMENSION	DESCRIPTION
Main access road	3km	All weather access road to provide safe access. Roads will not be tarred, but will be sealed with Dustaside
Site access roads	5km, 12m wide	For use by secondary support fleet and earthmoving haul trucks
Electricity	132 kV line	From the main ESKOM supply to the main substation
Potable Water	200 m3 steel storage tank, mounted 10m above ground	Potable water use will reduce to 48 m3/d for change house and office use once water from pit is used in mine water balance
Process Water	Mine site PCD: 150 x 150 x 16m	Dam will be lined. Pumped from pit as well as stormwater runoff into settling ponds for use as process water
Process Water	Infrastructure PCD: 30 x 30 x 13m	Dam will be lined. Pumped from pit as well as stormwater runoff into settling ponds for use as process water
Stormwater	Trenches: 1.5m wide, 1m deep Berms: 1.5m high, 1.5m wide	Cutoff trenches and berms around mining area to intercept stormwater runoff
Rail Facility	2km	Rail link spurred off the main Kalahari Rail Facility
Rail Facility	1 150m siding	At termination point of the spur line, train length 1 100m
Opencast mining	Maximum depth 70m Current extent: 9.6ha	Planned from 2013 – 2023.

ACTIVITY	DIMENSION	DESCRIPTION
Decline cluster	3 units of 5 x 6 x 100m	Trucking, man and material and ventilation decline cluster, developed on dip from the open pit high wall
Underground mining	Current extent: 12.2ha	Room and pillar operation planned from 2023 - 2026
Exploration drilling	Final number of boreholes not currently available	On-going through the life of mine to identify extensions to the Ore body, which may allow further mining beyond 2026.
Topsoil stockpiles	100 x 100 x 1.5m	For future use during rehabilitation at the opencast operations
Explosives	Explosives magazine for 10000kg of emulsion	Stored in two separate fenced-in areas close to the pit. A powder magazine will house high velocity explosives.
Primary crusher	70 x 70m	Crushed material is stockpiled and delivered to processing plant. This area will not be paved.
Ore processing facility	100 x 100m	Includes stockpiles, secondary crusher, screens and lift conveyor to silo. Fines will be slurried to the tailings facility. Concrete foundations, 1.1m deep. Prefab buildings
Ore Stockpile	1.5m high 200m x 200m (4ha)	Situated adjacent to the ore processing facility.
Tailings facility	20m high 150 x 150m footprint (2.25ha)	Thickener and cyclone underflow pumped to tailings facility. Return water will be pumped back to the plant
Waste dump	40m high 300 x 300m footprint (9ha) (Current footprint: 8.3ha)	Waste rock will be backfilled into the pit during final rehabilitation before mine closure

3.1.1 Project Phasing

Based on the assumption that the mining right application will be approved before the end of 2012, the start of construction is planned for February 2013. A pre-production period of approximately 24 months will be required to bring the pit to full production. During the first phase the following activities will be conducted (Mineral Corporation, 2011):

- Access road and dam construction;
- Construction of rail siding and rail connection to main line;
- Construction of processing and stockpiling facilities;
- Construction of pollution control system;
- Construction of waste stockpile facility;
- Construction of workshops and associated stores; and
- Construction of office and parking facilities.

This phase will be followed by the commencement of pre-stripping operations starting in early 2013. The pre-stripped waste will be stockpiled until rehabilitation operations commence during the period 2016-2017. During this period pre-stripping operations will commence to open up initial ore reserves for drill sampling and enable the construction of the initial pit ramps.

The construction of the key mine facilities and pit access roads will be on the eastern side of the open pit and thus will be "permanent" and not impacted upon by the mining operations. This will remain the case until final mine closure and rehabilitation operations are completed.

4 DESCRIPTION OF THE AFFECTED ENVIRONMENT

The following sections discuss the environmental parameters that have a direct impact on the aesthetic value of the area.

4.1 Topography

The Sebilo Perth Project area is located on relatively flat terrain with average elevations of around 1050 meters above mean sea level (mamsl). The topography has however been disturbed by historical mining activates. The old ore floor was raised above the ground level. The waste rock dump and mining void has also altered the topography significantly. The topography within the project area falls towards the Witleegte dry water course, situated to the west River (please refer to Figure 9, Appendix B).

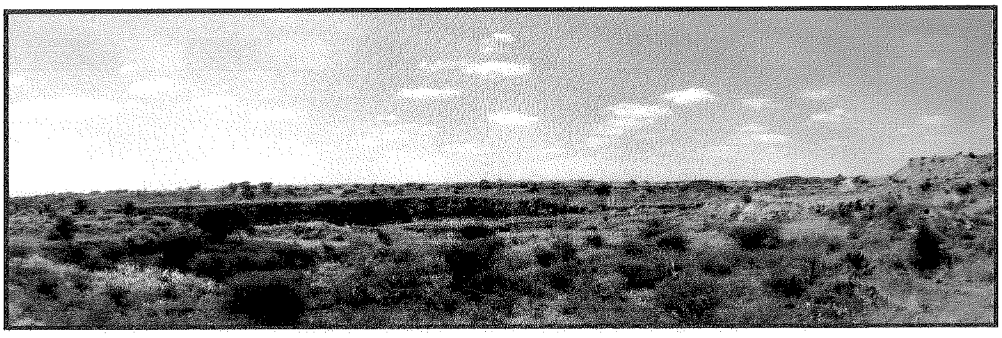

Figure 1: Old workings on site. Note the altered topography.

4.2 Hydrology

The non-perennial Ga-Mogara River runs approximately 2.5 km northwest of the proposed Sebilo Perth Project. The Witleegte dry water course which drains from the higher ground in the southeast runs next to the proposed Sebilo Perth Project towards the Ga-mogara River (please refer to Figure 9, Appendix B).

4.3 Vegetation

The vegetation in the project area is typical of the Shrubby Kalahari Dune Bushveld and the Kalahari Plains Thorn Bushveld, which is an open savannah to dense bush usually with a well developed tree layer (Acocks, 1977).

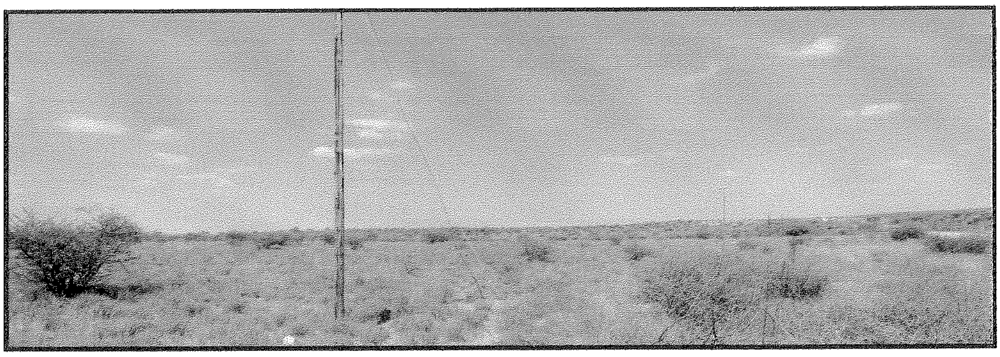

Figure 2: Typical vegetation cover within the study area.

4.4 Transportation Networks

Main and secondary roads within the area include (please refer to Figure 8, Appendix B):

- The R31 is the main route in the area and enters the project area from the southeast and stretches in a north western direction towards the Kgalagadi Transfrontier Park (Kalahari Gemsbok National Park).
- The R380 enters the project area from N14 national road in the south and stretches in a northern direction. It links up with the R31 in the north.
- The Transnet Freight Rail railway line runs parallel to the R380 and starts at Black Rock and runs south past the project area. The railway line is used to transport manganese ore to Port Elizabeth and Ngqura.

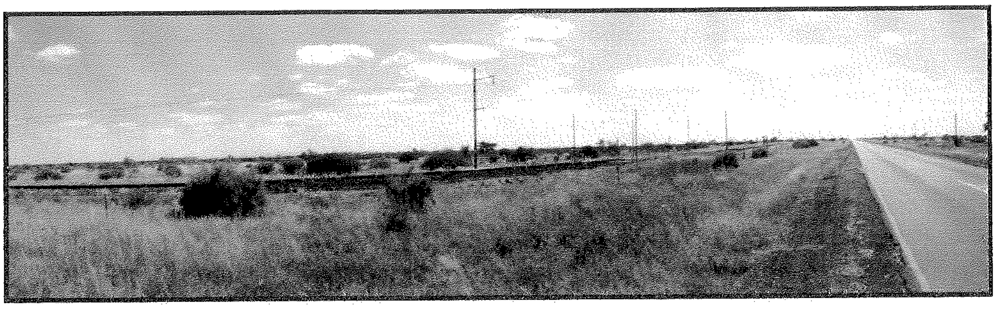

Figure 3: View along R380 main road and Transnet Freight Rail railway line in a northern direction.

4.5 Land Use

The surrounding land uses in the area consists of existing and historical mining as well as livestock and game farming (please refer to Figure 4).

Figure 4: Historical (foreground) and existing (far background) mining activities.

4.6 Sense of Place

Central to the concept of sense of place is that the landscape requires uniqueness and distinctiveness. The primary informant of these qualities is the spatial form and character of the natural landscape taken together with the cultural transformations and traditions associated with the historic use and habitation of the area.

The area to the north of the proposed Sebilo Perth Project has a definite mining character with a strong relationship to the mining activities at Hotazel and Black Rock. The power line corridors and railway line transecting this surrounding area strengthens the mining character of the region. The mining activities degrade the visual appeal along the R31 and R380 main roads (please refer to Figure 3 and 4).

Figure 5: Historic mining activities on site.

Areas to the west and east is characterised by a rural sense of place with agriculture (livestock) and game farming dominating the sense of place. The immediate area around the site is characterised by historic mining activities and degrades the rural visual character of the surrounding area (please refer to Figure 5).

Figure 6: Existing power line corridors (background) within the study area.

The study area has a relatively low sense of place due to the close proximity of the various clashing land use types (mining, game and livestock farming and vacant land). It is anticipated that the sense of place will be negatively affected. The impact on sense of place can be reduced by adhering to the mitigating measures suggested in Section 7 of this document.

4.7 Visual Quality and Character

4.7.1 Scenic Value and Tourism Value

Related to the scenic value of a specific area is the tourism value attached to that area. The properties in the immediate vicinity of the Sebilo Perth Project are not regarded as areas with a high scenic and/or eco-tourism potential due to the exiting mining activities at Hotazel, Black Rock and to the south at Mamathwane. The R31 main road are utilised by tourists to access well know tourist hot spots in the Kalahari (e.g. The Kalahari Gemsbok National Park).

5 IDENTIFICATION OF LANDSCAPE IMPACTS

Various risk sources for the visual impact have been identified for the construction and operation phases and can be classified as negative.

5.1 Construction Phase

The activities that are expected to cause visual impacts during construction would be:

- Excessive clearing and stripping of topsoil for site preparation and temporary access roads;
- Temporary work camps, large equipment and structures, may not be visually appealing;
- The extent and intensity of the security and construction lighting at night;
- Construction activities; and
- Dust from construction activities and access roads.

5.2 Operational Phase

The activities that are expected to cause visual impacts during operational phase would be:

- The Sebilo Perth Project could be aesthetically incompatible with surrounding landscape. The scale, style, orientation, height and position of the proposed activity on the site may impact on the visual aesthetics of the local surroundings (i.e. impact on surrounding community, as viewed from local roads or properties). This may result in a permanent change to the existing visual quality of visually sensitive areas;

- Uncontrolled development of the proposed site without compliance to environmental controls related to aesthetic criteria;
- The proposed activity may fundamentally alter the landscape character and sense of place of the local environment; and
- The extent and intensity of the security and operational lighting at night.

6 IMPACT DESCRIPTION AND ASSESSMENT

6.1 The Visual Analysis

This section describes the aspects that have been considered in order to determine the intensity of the visual impact on the area. The criteria includes the area from which the project can be seen (the viewshed), the viewing distance, the capacity of the landscape to visually absorb structures and forms placed upon it (the visual absorption capacity), and the appearance of the project from important or critical viewpoints (sensitivity).

6.1.1 The Viewshed

A viewshed analysis is carried out to define areas that contain all possible observation sites from which the proposed infrastructure would be visible. Topographic data was captured for the site and the surrounding environment (20 m contour intervals) to create the Digital Elevation Model (DEM). The DEM was draped over the topographic data (rivers, roads, cadastral, etc) to complete the model used to generate the viewshed analysis. This viewshed analysis assists this assessment, by identifying possible affected viewers and the extent of the affected environment.

Figure 10, Appendix B spatially depicts the viewshed area and the areas which have direct visibility of the proposed Sebilo Perth Project. A single analysis viewshed for the proposed Sebilo Perth Project was used, meaning that the figures show all the points from which the proposed Sebilo Perth Project can be seen incorporating an offset height of 40m for the waste dump, 20m for the tailings facility, 1.5m for the ore stockpile, etc. and an offset height of 1.6 m for observation points (please refer to Table 1).

The viewshed indicates that the proposed Sebilo Perth Project viewshed is extensive in all directions with some minor screening by topography towards the northwest and west. This is mainly due to the flat terrain, physical dimensions of the proposed Sebilo Perth Project and the limited vegetation screening in some areas.

Views towards the R380 and R31 main roads are also extensive with views onto the project area. The viewshed also indicates that the proposed Sebilo Perth Project will be visible to the majority of homesteads in the region.

Light sources at night, particularly poorly directed security flood lighting, can influence the visual impact of the project. Unobstructed light sources can cause a general glow in the area and will be visible from significantly longer distances than any structural features during daylight hours.

Using the criteria in Table 2, visibility of the proposed Sebilo Perth Project from the surrounding areas during the construction and operational phases will be high even if mitigation measures are correctly adhered to.

Table 2: Viewshed evaluation for proposed Sebilo Perth Project

High	Moderate	Low
If the project and its infrastructure is visible from over half the zone of potential influence, and/or views are mostly unobstructed.	If the project and its infrastructure are visible from less than half the zone of potential influence, and/or views are partially obstructed.	If the project and its infrastructure is visible from less than a quarter of the zone of potential influence, and/or views are mostly obstructed.

6.1.2 The Viewing Distance

The visual impact of an object in the landscape diminishes at an exponential rate as the distance between the observer and the object increases (Hull and Bishop, 1988) (please refer to Figure 7). Thus, the visual impact at 1000 m would be approximately a quarter of the impact as viewed from 500 m. Consequently, at 2000 m, it would be one sixteenth of the impact at 500 m.

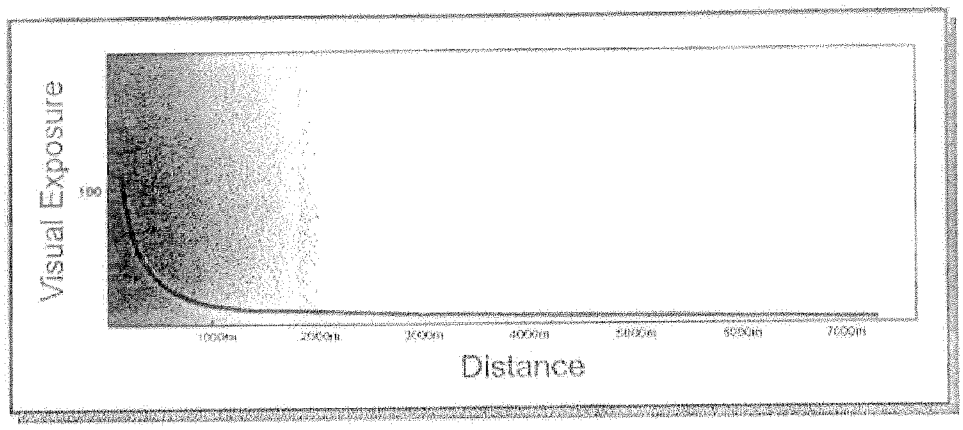

Figure 7: Visual Exposure Curve (Hull and Bishop, 1988).

The 'zone of potential influence' (the area defined as the radius about the centre point of the project beyond which the visual impact of the most visible features will be insignificant) was established at 4 km. Over 4 km the impact of the proposed infrastructure would have diminished considerably due to the diminishing effect of distance, intermediate objects in the foreground and atmospheric conditions (haze) on visibility. Conversely, the visual impact of the project components within a distance of 500m or less would be at its maximum. View distance is rated using four increments of severity, each with their respective qualification and contribution to visual impact (please refer to Table 3).

From the viewshed analyses (please refer to Figure 8 - 11, Appendix B), it is clear that the some sensitive viewer locations (homesteads and motorists limited to secondary roads) are located between the 0 - 500m metres radius from the proposed Sebilo Perth Project. Therefore, the proposed Sebilo Perth Project would be in the foreground of these sensitive views. This results in a high visual exposure of the proposed Sebilo Perth Project from these viewing points.

Table 3: View distance evaluation for proposed Sebilo Perth Project

	High Exposure (significant contribution to visual impact)	Moderate Exposure (moderate contribution to visual impact)	Low Exposure (minimal influence on visual impact)	Insignificant Exposure (negligible influence on visual impact)
Residents	*0 - 500m*	*500m - 2.0 km*	*2.0 - 4.0 km*	*Over 4.0 km*
Tourist	***0 - 500m***	*500m - 2.0 km*	*2.0 - 4.0 km*	*Over 4.0 km*
Motorist	*0 - 500m*	*500m - 2.0 km*	*2.0 - 4.0 km*	*Over 4.0 km*

From the viewshed analyses (Figure 8 - 11, Appendix B), it is also clear that the majority of sensitive viewer locations (please refer to section 6.1.4) are located within the 500m - 2km and 2km - 4km radius from the proposed Sebilo Perth Project. Therefore, the proposed activity would be in the middle ground and background of these sensitive views depending on the specific range. This results in a moderate visual exposure for the proposed Sebilo Perth Project from these viewing points depending on the range.

6.1.3 The Visual Absorption Capacity

Visual Absorption Capacity (VAC) signifies the ability of the landscape to accept additional human intervention without serious loss of character and visual quality or value. VAC is founded on the characteristics of the physical environment such as:

Degree of Visual Screening

A degree of visual screening is provided by landforms, vegetation cover and/or structures such as buildings. For example, a high degree of visual screening is present in an area that is mountainous and is covered with a forest compared to an undulating landscape covered in grass.

Terrain variability

Terrain variability reflects the intensity of topographic elevation and diversity in slope variation. A highly variable terrain will be recognised as one with great elevation differences and a diversity of slope variation creating talus slopes, cliffs and valleys. An undulating landscape with a monotonous and repetitive landform will be an example of low terrain variability.

Land Cover

Land cover refers to the perceivable surface of the landscape and the diversity of patterns, colours and textures that are presented by the particular land cover (i.e. urbanised, cultivated, forested, etc).

Areas that have a high visual absorption capacity are able to accept objects easily so that their visual impact is less noticeable. Conversely areas with low visual absorption capacity will suffer a higher visual impact from structures imposed on them.

Viewpoints representative of views experienced by residents, tourists, and motorists through the study area were used for the photographic simulations (please refer to Figure 12, Appendix D). The before and after simulations illustrated in Appendix D, show the proposed activity superimposed onto the existing landscape scene. The simulations illustrate the visual absorption potential of the affected landscape when viewed from various sensitive receptor positions within the study area (note that these simulations may vary from the actual impact).

It is apparent from the simulations that the landscape surrounding the proposed operations ability to 'visually absorb' the proposed project is moderate (moderate impact) due to the following:

- The proposed Sebilo Perth Project is situated between relative homogeneous landform types;
- The degree of visual screening is moderate to low due to the relative flat terrain and relative short vegetation cover; and
- The presence of similar mining activities to the south and north of the proposed Sebilo Perth Project will be increase the visual absorption capacity of the surrounding area.

The landscape therefore has a moderate visual absorption capacity and will suffer a moderate visual impact from the proposed activity imposed on it.

Table 4: Visual absorption capacity evaluation for the proposed Sebilo Perth Project

Criteria	High (Low Impact)	Medium (Medium Impact)	Low (High Impact)
Visual Absorption Capacity (VAC)	The ability of the landscape to easily accept visually a particular development because of its diverse landform, vegetation and texture.	The ability of the landscape to less easily accept visually a particular development because of a less diverse landform, texture and vegetation.	The ability of the landscape not to visually accept a proposed development because of a uniform texture, flat slope and limited vegetation cover.

It is also important to consider the effects of lighting when discussing visual intrusion. Operation and security lighting in and around the sites will be visible at night and might contribute to the cumulative effect of lights from the industrial and residential areas.

6.1.4 Critical Viewpoints

Areas with relative moderate volumes of traffic such as the R31 main road, R380 main road, and various homesteads were regarded as critical view zones against which the visual impact would be evaluated (please refer to Figure 8, Appendix B). Critical views were determined during the field trip and from the 1:50 000 topographical maps.

Viewer groups are a collection of viewers that are involved with similar activities and experience similar views of the proposed activity. Within the receiving environment, specific visual receptors experience different views of the proposed activity. They will be affected due to the alteration of their views and are therefore identified as part of the receiving and affected environment. The visual receptors are grouped according to the similarities in views. The visual receptors included in this study are:

- Residents;
- Tourists; and
- Motorists.

The visual receptors would be affected because of alterations to their views due to the proposed project. In order to determine the sensitivity of these visual receptors a commonly used rating system is utilised (please refer to Appendix C). This is a generic classification of visual receptors and enables the visual impact specialist to establish a logical and consistent visual receptor sensitivity rating for viewers who are involved in different activities without engaging in extensive public surveys.

Residents

In the case of static views, such as views from buildings, the visual relationship between an activity and the landscape will not change. The cone of vision is relatively wide and the viewer tends to scan back and forth across the landscape. Residents of the affected environment are therefore classified as visual receptors of high sensitivity owing to their sustained visual exposure to the proposed activity as well as their attentive interest towards their living environment.

It is anticipated that the homesteads in the vicinity will be affected negatively. The physical distance between the proposed Sebilo Perth Project and visual receptors (residents) varies from less than 500m to more than 4km. The visual exposure for these different visual receptors would therefore also vary due to distance. The orientation of the homestead and localised vegetation/structure screening around the homestead may reduce the visual impact of the proposed activity. For example the vegetation covers adjacent to the Kongoni Manganese Project Offices are denser and taller that the average vegetation cover found within the study area. This could screen potential views to the proposed activity to an extent (Please refer to Figure 8).

Figure 8: The Kongoni Manganese Project offices (behind trees in the middle ground).

Tourists

Tourists are regarded as visual receptors of exceptionally high sensitivity. Their attention is focused towards the landscape which they essentially utilise for enjoyment purposes and appreciation of the quality of the landscape.

The R31 main road is used by tourist visiting tourist attraction areas within the Kalahari region (e.g. the Kalahari Gemsbok National Park) and are likely to harbour expectations of an aesthetically pleasing environment, although the existing mining activities in the area (Hotazel, Black Rock, etc.) has already degraded the visual integrity of the surrounding area, especially the area to the north and south of the proposed Sebilo Perth Project.

<u>Motorists</u>

Motorists are generally classified as visual receptors of low sensitivity due to their momentary views and experience of the proposed activity. Under normal conditions, views from a moving vehicle are dynamic as the visual relationship between the activity is constantly changing as well as the visual relationship between the activity and the landscape in which they are seen. The view cone for motorists, particularly drivers, is generally narrower than for static views. Motorists will therefore show low levels of sensitivity as their attention is focused on the road and their exposure to roadside objects is brief.

6.2 The Visual Impact

Visual impact is defined as the significance and intensity of changes to visual quality of the area resulting from an activity or change in land use that may occur in the landscape.

Significance and intensity are measures of the response of viewers to the changes that occur. It represents the interaction between humans and the landscape changes that they observe. The response to visible changes in the landscape may vary significantly between individuals.

Perception results from the combination of the extent to which the activity is visible (level of visibility) and the response of individuals to what they see. A major influence on the perception of people in relation to the activity will be the visual character and quality of the landscape in which they would be located. Natural areas are renowned for their high visual quality. The proposed Sebilo Perth Project and associated landscape features may be seen as a negative impact on these areas of high visual quality.

The potential visual impact of the proposed activity will primarily result from changes to the visual character of the area within the viewshed. The nature of these changes will depend on measurable factors such as viewing distance, the visual absorption capacity of the surrounding landscape and the scale of the surrounding environment and landform. Other factors are subjective, such as the visual perception of people viewing the activity.

6.2.1 Intensity of Visual Impact

The intensity of visual impact is determined using the viewshed, viewing distance, visual absorption capability and the viewer sensitivity criteria. Additionally, the visual impact index (please refer to Figure 11) predicts the visual impact taking in consideration the identified observers (please refer to figure 8) or sensitive receptors and the viewshed (please refer to Figure 10).

Table 5 below summarises the results of the criteria used to determine the intensity of the visual impact. These results are based on worst-case scenarios when the impacts of all aspects are taken together.

Table 5: Intensity evaluation for proposed Sebilo Perth Project

	Quality of Visual Resource	**Viewshed**	**Visual Distance**	**VAC**	**Sensitivity**	**Visual Impact (Intensity)**
Prior to construction	*Low*					
Operational Phase Assuming mitigation is successful)		*High*	*High to Low (High to Low Impact)*	*Moderate (Moderate Impact)*	*High to Low*	*Low - Moderate*

The results as shown above, indicates that the intensity of visual impact associated with the proposed Sebilo Perth Project, will be Low - Moderate assuming that mitigation measures are successful.

6.2.2 Significance of Visual Impact

The significance of the visual impact was determined using a ranking scale, based on terminology from Irene Lea Environmental & Hydrogeology cc.

When the intensity of impact is qualified, the significance of the impact can be predicted taking into account core criteria such as the extent and duration of the proposed activity (please refer to Appendix E).

Table 6: Significance Evaluation for the proposed Sebilo Perth Project

	View from Homesteads		View From R380 Main Road		View from R31 Main Road	
Criteria	**Without mitigation**	**With mitigation**	**Without mitigation**	**With mitigation**	**Without mitigation**	**With mitigation**
Extent	Local (2)	Local (2)	Local (2)	Local (2)	Local (2)	Local (2)
Duration	Long term (3)	Long term (3)	Long term (3)	Long term (3)	Long term (3)	Long term (3)
Intensity	Low - Medium (1)&(3)	Low (1)	Low - Medium (1) & (3)	Low (1)	Negligible (0)	Negligible (0)
Probability	Definite (4)	Highly Probable (3)	Probable (2)	Probable (2)	Improbable (1)	Improbable (1)
Rating	10 & 12	8	8 & 10	8	6	6
Significance	Low- Medium	Low	Low	Low	Low	Low
Status of Impact	Negative	Negative	Negative	Negative	Negative	Negative
Nature of Cumulative impact	It is anticipated that the proposed project would have an overall negative visual influence within the region and increase the current degraded visual appeal of the surrounding area/land use. Therefore the proposed project would result in a negative cumulative impact increasing the visual impact from the surrounding mining/degraded areas. Although concurrent rehabilitation will degrease the cumulative impact.					
Degree to which impact can be reversed	Partially Reversible					
Degree to which impact may cause irreplaceable loss of resources	Low					
Degree to which impact can be mitigated	Medium (See section 7)					

Visual receptors in various homesteads in the surround area of proposed Sebilo Perth Project are classified as highly sensitive owing to their sustained visual exposure to the proposed activity as well as their attentive interest towards their living environment. Their close proximity (<500 - >4km), the proposed physical dimensions of the proposed Sebilo Perth Project , the ability of the landscape to moderately visually accept the development (VAC) and the presence of visual degraded surrounding areas would result in a Low - Moderate Intensity visual impact. This, in conjunction with the fact that the proposed Sebilo Perth Project would be of local extent and long term duration (please refer to Table 10 - 11, Appendix E) would exert a Low - Medium Negative Significant (without mitigation) visual impact for the homestead visual receptors. The visual impact of the proposed Sebilo Perth Project would therefore alter the affected environment but natural, cultural and social functions and processes would continue, albeit in a modified way. Mitigation measures as suggested in section 7 of this report are therefore essential to reduce the Low - Medium Negative Significance to Low Negative Significance from these views.

The Intensity of the visual impact from views associated with the R31 and R380 main roads visual receptors were determined as Low due to the their low to high sensitivity (motorist and tourist), proximity (500m - 2km and 2 - 4km), proposed physical dimensions of the proposed Sebilo Perth Project, the ability of the landscape to moderately visually accept the development (VAC) and the presence of visual degraded surrounding areas (mining activities). It is anticipated that the visual impact would be negative from these views and would exert a Low Negative Significant (with and without mitigation) impact due to the fact that it is of local extent and long term duration (please refer to Table 10 - 11, Appendix E).

7 MITIGATION MEASURES

The aim of mitigation is to avoid, reduce and where possible remedy or offset, any significant negative (adverse) effects on the environment arising from the proposed activity (GLVIA; 2008).

In considering measures to effect mitigation, there are three rules to consider. Mitigation measures should be:

- Economically feasible;
- Effective (time allowed for implementation and provision for management/maintenance); and

- Visually acceptable (within the context of the existing landscape).

To address these measures the following principles should be considered:

- Mitigation should be planned to fit into the existing landscape character. They should respect and build upon landscape distinctiveness;
- Mitigation should primarily aim to blend the proposed activity into its surroundings and generally reduce its visibility; and
- It should be recognised that many mitigation measures, especially planting/rehabilitation, are not immediately effective.

7.1 General Recommendations

Due to the dimensions of the proposed Sebilo Perth Project and relative flat topography, the proposed activity cannot be screened totally. The mitigation measures for the proposed activity would need to focus on effective concurrent rehabilitation, layout and design.

7.1.1 Site Preparation

The minimum amount of existing indigenous vegetation and topsoil should be removed from construction areas. Ensure that, wherever possible, all existing natural vegetation is retained. Eradication of vegetation should be done in a 'natural manner', avoiding harsh straight lines. Dust suppression measures should be in place at all times.

Rehabilitate disturbed areas as soon as practically possible after construction. This should be done to restrict extended periods of exposed soil.

<u>Temporary Access Roads</u>

All areas affected by the activity would need to be rehabilitated and re-vegetated. This includes areas such as temporary access roads, etc.

During the construction phase, construction roads would require an effective dust suppression management programme, such as regular wetting and/or the use of non-polluting chemicals that would retain moisture in the road surface.

Buildings and Structures

Temporary buildings and structures used during the construction phase that are required to be built from steel or concrete can be painted a dark natural tone to fit in with the surrounding environment. Olive greens and tans can be used at the base of buildings, fading to lighter colours, with the top section of the buildings painted a light grey to merge with the skyline. Tall structure's roofs should be painted a 'dirty' grey or light blue. A principle to note is that lighter tones advance toward the viewer while darker tones recede from the viewer. Pure whites, blacks and bright colours should be avoided.

To reduce the potential of glare, external surfaces of buildings and structures should be articulated or textured to create interplay of light and shade. Avoid shiny or bare metal. It is advisable to direct the slope of roofs away from critical views i.e. R380 main road and homesteads in the immediate vicinity.

Were feasible new power lines should be planned to follow exiting power line corridors. This will reduce the visual impact from the new power lines as it is located in an exiting visual impact area.

7.1.2 Landscaping

Indigenous trees and shrubs can be used to screen structures and break stark contrasting lines if carefully planned and positioned. Where structures are silhouetted when viewed from the critical views, the harsh lines can be broken by planting a combination of fast growing indigenous trees and shrubs adjacent to the Sebilo Perth Project as a visual screen in order to partially screen potential views towards project infrastructure.

In particular, the proposed species should be drought resistant, fast growing and locally occurring. The overall time period for new plants to become establish, could be reduced with a high quality specifications, implementation and subsequent management. A good quality contractor and specifications will ensure improved plant establishment and growth for new planting across the site.

7.1.3 Light Pollution

Light pollution should be seriously and carefully considered, and be kept to a minimum wherever possible as light at night travels great distances. Security flood lighting and operational lighting should only be used where absolutely necessary and be carefully directed, preferably away from sensitive viewing areas. Wherever possible lights should be directed downwards to avoid illuminating the sky and minimizing light spills.

8 CONCLUSION

The potential visual impact of the proposed Sebilo Perth Project has been evaluated against internationally accepted criteria to determine the impact it will have on the landscape character and the viewers that have been identified in the project area.

Visual impacts would result from the construction, and operational phase of the proposed Sebilo Perth Project. Specifically, impacts would result from the physical dimensions of the proposed activities and associated infrastructure compounded by the relative flat topography of the areas (viewshed), visual distance and moderate visual absorption capacity (VAC) of the surrounding area.

These visual impacts would be mitigated through appropriate concurrent rehabilitation, re-vegetation, glare reduction, dust suppression, screening and the reduction of light pollution.

It was determined that the intensity of the visual impact of the proposed Sebilo Perth Project would be Low to Moderate Negative and with successful mitigation measures the proposed activity is likely to have a Low Negative Significant visual impact.

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APPENDIX A: GUIDELINE FOR INVOLVING VISUAL & AESTHETIC SPECIALISTS IN EIA PROCESSES

Table 7 depicts the general expected level of visual impacts for various types of developments and environments. According to the categorisation of visual impacts (Oberholzer: 2005) the activity is expected to have a moderate visual impact.

Table 7: Categorisation of visual impacts (Oberholzer, 2005)

Type of environment	Type of development (Low to high intensity)				
	Category 1 development	Category 2 development	Category 3 development	Category 4 development	Category 5 development
Protected/wild areas of international, national, or regional significance	Moderate visual impact expected	High visual impact expected	High visual impact expected	Very high visual impact expected	Very high visual impact expected
Areas or routes of high scenic, cultural or historical significance	Minimal visual impact expected	Moderate visual impact expected	High visual impact expected	High visual impact expected	Very high visual impact expected
Areas or routes of medium scenic, cultural or historical significance	Little or no visual impact expected	Minimal visual impact expected	Moderate visual impact expected	High visual impact expected	High visual impact expected
Areas or routes of low scenic, cultural or historical significance / disturbed	Little or no visual impact expected. Possible benefits	Little or no visual impact expected	Minimal visual impact expected	Moderate visual impact expected	*High visual impact expected*
Disturbed or degraded sites / run-down urban areas / wasteland	Little or no visual impact expected. Possible benefits	Little or no visual impact expected. Possible benefits	Little or no visual impact expected	Minimal visual impact expected	*Moderate visual impact expected*

Table 8: Key to categories of development (Oberholzer, 2005)

Category 1 development:
e.g. nature reserves, nature-related recreation, camping, picnicking, trails and minimal visitor facilities.
Category 2 development:
e.g. low-key recreation / resort / residential type development, small-scale agriculture / nurseries, narrow roads and small-scale infrastructure.

Category 3 development:
e.g. low density resort / residential type development, golf or polo estates, low to medium-scale infrastructure.
Category 4 development:
e.g. medium density residential development, sports facilities, small-scale commercial facilities / office parks, one-stop petrol stations, light industry, medium-scale infrastructure.
Category 5 development:
e.g. high density township / residential development, retail and office complexes, industrial facilities, refineries, treatment plants, power stations, wind energy farms, power lines, freeways, toll roads, large-scale infrastructure. Large-scale development of agricultural land and commercial tree plantations. Quarrying and mining activities with related processing plants.

This VIA will therefore conform to the requirements of a level three assessment as identified by Oberholzer (2005) which requires the realisation of the following:

- Identification of issues raised in scoping phase, and site visit;
- Description of the receiving environment and the proposed project;
- Establishment of view catchment area, view corridors, viewpoints and receptors;
- Indication of potential visual impacts using established criteria;
- Inclusion of potential lighting impacts at night;
- Description of alternatives, mitigation measures and monitoring programmes; and

APPENDIX B: MAPS AND FIGURES

APPENDIX C: VISUAL RECEPTOR SENSITIVITY

Table 9: Visual receptor sensitivity

VISUAL RECEPTOR SENSITIVITY	DEFINITION (Adopted from GLVIA 2008)
Exceptional	Views from major tourist or recreational attractions or viewpoints promoted for or related to appreciation of the landscape, or from important landscape features.
High	Users of all outdoor recreational facilities including public and local roads or tourist alternatives whose attention or interest may be focussed on the landscape; Communities where the development results in changes in the landscape setting or valued views enjoyed by the community; Residents with views affected by the development.
Moderate	People engaged in outdoor sport or recreation (other than appreciation of the landscape).
Low	People at their place of work or focussed on other work or activity; Views from urbanised areas, commercial buildings or industrial zones; People travelling through or passing the affected landscape on transport alternatives.

APPENDIX D: SIMULATIONS

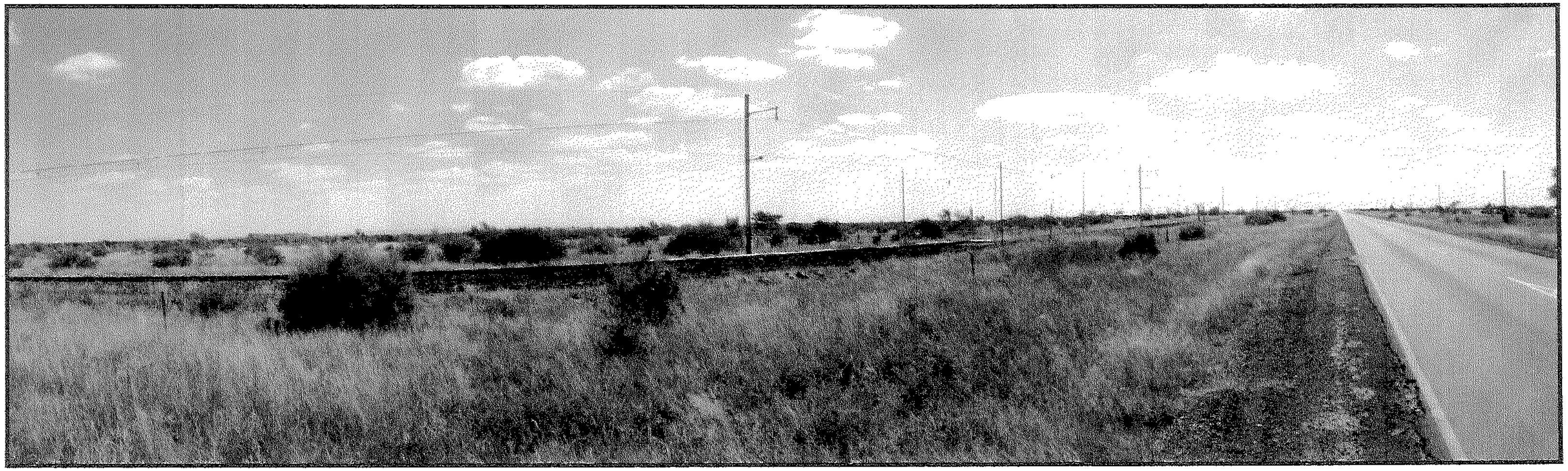

Figure 12: View towards the proposed Sebilo Perth Project from the R380 Main Road (Before).

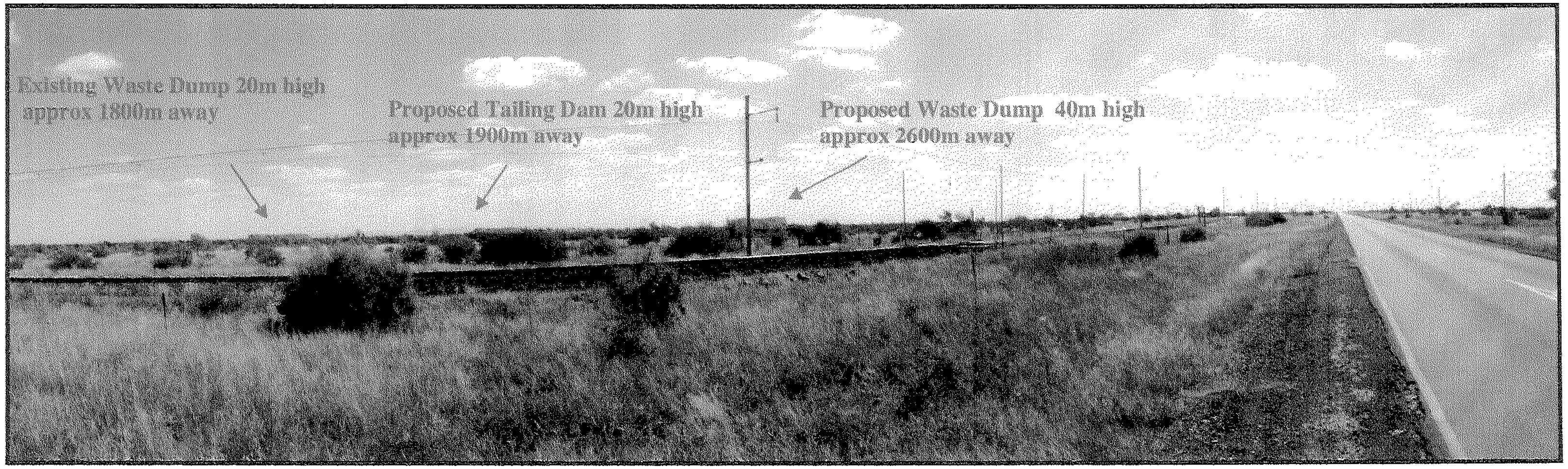

Figure 13: View towards the proposed Sebilo Perth Project from the R380 Main Road (After).

APPENDIX E: CRITERIA FOR SIGNIFICANCE OF IMPACT ASSESSMENT

Spatial Extent of Impact (Consequence Section)

"Extent" defines the physical extent or spatial scale of the impact (please refer table 10).

Table 10: Extent level chart and description

Category	Rating	Description
On-Site	1	Impact occurs on-site.
Local	2	Impact occurs within 5km radium of the site.
Regional	3	Impact occurs within a 100km radius of the site
National	4	Impact occurs within South Africa
International	5	Impact occurs internationally

Duration of Impact (Consequence Section)

"Duration" defines the time scale of the impact (please refer table 11).

Table 11: Duration level chart and description

Category	Rating	Description
Short-term	1	Through dilution and dispersion, the impact reduces to insignificant within 1 week.
Medium-term	2	Through dilution and dispersion, the impact reduces to insignificant within the life of the mine.
Long-term	3	The impact will cease after the operational life of the mine either because of natural process or by human intervention
Permanent	4	Where mitigation either by natural process or by human intervention will not occur in such a way or in such a time span that the impact can be considered transient.

Intensity (Consequence Section)

"Intensity" establishes whether the impact would be destructive or benign.

Table 12: Intensity chart and description

Category	Rating	Description
Low	1	Impacts affect the environmental in such a way that natural, cultural and/or social functions and processes are not affected.
Medium	3	Impacts affect the environment in such a way that natural, cultural and/or social functions and processes are altered
High	5	Impacts affect the environment in such a way that natural, cultural and/or social functions and processes will temporarily or permanently cease.

Probability of Occurrence of the Impact (Likelihood Section)

"Probability" describes the likelihood of the impact occurring.

Table 13: Probability of occurrence chart and description

Category	Rating	Description
Improbable	1	The possibility of the impact materializing is very low either because of design or historic experience.
Probable	2	There is a distinct possibility that the impact will occur.
Highly probably	3	It is most likely that the impact will occur.
Definite	4	The impact will occur regardless of any prevention measures.

<u>Significance</u>

The significance of impacts is determined based on the evaluation of an activity's impact in terms of consequence and likelihood.

Table 14: Significance rating and description

Category	Rating	Description
Low	5 -11	Where it will not have a significant influence on the environment. Management measures can be proposed to ensure that significance does not increase.
Medium	12 -17	Where it could have a significant influence on the environment unless it is mitigated or managed.
High	18 - 23	Where it would have a significant influence on the environment regardless of any possible mitigation and hence must be either avoided or managed.